CAMPUS ILLUMINATION

A ROADMAP TO SUSTAINABLE EXTERIOR LIGHTING AT THE UNIVERSITY OF WASHINGTON SEATTLE CAMPUS

PREPARED BY THE UW INTEGRATED DESIGN LAB

In Partnership with Seattle City Light's Lighting Design Lab and The Office Of The University Architect

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1. EXECUTIVE SUMMARY

PROJECT GOAL

The Campus Illumination roadmap establishes a guiding vision for exterior lighting on the University of Washington Seattle Campus (UW). The roadmap approach envisions a dramatic decrease in outdoor lighting energy consumption on campus while supporting a comprehensive understanding of sustainability that encompasses the human experience, ecological impact, maintainability and energy efficiency.

The document works in tandem with existing landscape planning collateral to ensure that lighting is implemented with an overarching vision as the campus transitions to more efficient lighting technology. Lighting recommendations align with the Campus Landscape Framework to identify strategies for specific campus space typologies. In response to extensive fieldwork and feedback from the campus community, the roadmap articulates recommendations for how these spaces can transition and relate to each other in order to enhance the legibility and navigability of the nighttime campus.

This document can be used as a reference to inform the retrofitting and replacement efforts of Campus Engineering, to coordinate the lighting design of new campus development, and as an educational tool for the wider campus community.

Figure 1. Light-emitting diode (LED) fixtures along UW's iconic Rainier Vista.

TIMELINE AND METHODS

The Campus Illumination project took place over four academic quarters, from Spring 2016 - Spring 2017. The primary accomplishments for each quarter include:

Spring 2016:

The Campus Illumination team developed an outdoor lighting survey to collect feedback from the campus community regarding their attitudes and opinions about existing lighting conditions at the UW. The survey featured an interactive campus map upon which survey participants placed qualitative markers and written comments about exterior lighting in specific areas on campus. The survey data provided an invaluable foundation for interpreting the existing conditions on campus from the public perspective.

Summer 2016:

The project team met with design practitioners and campus facilities staff to ensure that the roadmap addressed the needs of professionals that directly engage in the design, implementation, and maintenance of campus lighting.

Fall 2016:

During the fall quarter of 2016, students from the College of Built Environments participated in the

Campus Illumination project in a 400-level course taught in the Department of Architecture (ARCH 435: Principles and Practice of Environmental Lighting). Students explored lighting possibilities in various case-study areas across campus, engaging in fieldwork, developing technical skills and designing lighting proposals for their respective sites. This opportunity for applied learning offered students a valuable bridge between campus planning and classroom curriculum.

Winter and Spring 2017

Winter and spring quarters in 2017 were spent developing and refining the analysis and guidelines presented in the Campus Illumination roadmap. These recommendations reflect significant site observation and field measurements, academic research, and stakeholder collaboration.

PROJECT TEAM

The Campus Illumination team includes faculty and students from the College of Built Environments, the UW Integrated Design Lab (IDL), the Office of the University Architect, and Seattle City Light's Lighting Design Lab (LDL).

The project was funded primarily by the UW Campus Sustainability Fund, with additional support from the UW Office of Development and Planning and the Northwest Energy Efficiency Alliance.

The primary partners on the project team include:

Kelly Douglas, IDL Graduate Research Assistant, Graduate Student in Landscape Architecture

Christopher Meek, IDL director, Associate Professor of Architecture

Eric Strandberg, Senior Lighting Specialist, LDL

Kristine Kenney, University Landscape Architect, Director of Campus Design and Planning

Additional project contributors include Patrick Pirtle, Landscape Architecture Planner, Office of the University Architect and James Dahlstrom, GIS/GPS specialist, FS Campus Engineering. Lighting practitioners who collaborated with the project team include: CJ Brockway, principal at SparkLab Lighting Design, Jill Cody, principal at dark | light design, Denise Fong, principal at Stantec; and Dan Salinas, president of Salinas Lighting Consult.

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Figure 2. Traditional lighting fixtures in UW's historic Quad landscape.

PRIMARY CHALLENGES

As the UW transitions to more energy-efficient technology, new light-emitting diode (LED) sources produce a very different quality of light than the traditional high pressure sodium (HPS) fixtures on campus. The UW is faced with a challenge to resist an excess "brightening" of the campus landscape as LED sources become standard on campus. Currently, new lighting technologies are implemented in a project-by-project approach, resulting in a patchwork of lighting experiences across campus. It is critical that the UW identify experiential and environmental goals to guide this technological transition with a long-term vision.

An additional challenge for campus outdoor lighting is managing transitions between space types and along the edges of campus that interface with the urban context. As campus users move between various nighttime destinations, it is important that lighting strategies are designed to connect space types and support legible wayfinding.

Finally, it remains a challenge for the UW to support a sense of safety and security for pedestrians on campus without creating excess illumination or disrupting wildlife habitat.

GUIDING VISION

The roadmap envisions a future campus that supports a dramatic reduction in energy consumed by outdoor lighting as a result of more efficient technology and design strategies that minimize light levels without sacrificing perception of brightness. The UW nighttime campus strives to support comfortable passage and a sense of safety for pedestrians while minimizing light pollution and protecting wildlife habitat. Furthermore, the roadmap calls for a coherent UW lighting language at the campus scale while identifying spaces in the built environment for more unique lighting experiences.

GENERAL RECOMMENDATIONS

The following ten design principles encompass the overarching approach recommended by the project team:

1. Highlight connections and destinations
2. Respond to materials and surfaces
3. Eliminate excess light
4. Adhere to a long-term vision for LED replacement
5. Plan for future control capabilities
6. Reduce lumen ouptut
7. Avoid high contrast
8. Implement fixtures at the appropriate scale
9. Design for scene experience
10. Balance campus-level coherence with site-scale character

KEY TAKEAWAYS

An immediately actionable takeaway from the Campus Illumination project is to engage lighting decisions early in the planning process and to integrate required field observation into the lighting design scope of work. Campus lighting designs should communicate how new sites are tying into adjacent campus connections and potential opportunities for control systems Likewise, post-construction tuning is critical to balancing light levels at the campus scale.

The UW would benefit — in terms of maintenance and coherence — from a general simplification of its fixture palette, especially in regard to pole fixtures. Though new technology allows for more artful lighting expression, the UW should limit implementation of diverse fixtures to only those spaces that are identified for "character" lighting (i.e. residential courtyards or building terraces).

In terms of lighting priorities, the UW should focus on primary corridors, especially along the Burke-Gilman Trail. These major pathways support multimodal passage, and must be lighted cohesively and uniformly to support nighttime circulation through campus. Additionally, campus gateways around the Central Campus perimeter would benefit from more thoughtfully distributed light to better support nighttime wayfinding.

Finally, lighting should always be approached in relation to physical site conditions such as surface materials and vegetation, both in design choices and maintenance. These factors strongly influence the perception of brightness, in addition to light quality and distribution. The UW should adopt an understanding of lighting that operates at the scene level rather than relying on illumination standards for lighting goals.

NEXT STEPS

The Campus Illumination team recommends that the UW initiate a separate planning process for selecting a new controls system for exterior lighting. Contemporary controls offer significant reductions in energy consumption and ease maintenance concerns, which would dramatically improve UW's efforts to move toward a sustainable lighting model.

2. INTRODUCTION

PROJECT BACKGROUND

This document is the culmination of a yearlong effort to create a roadmap to guide the decision-making process as the University of Washington's Seattle Campus (UW) transitions to more energy-efficient lighting technology. The UW currently relies on a patchwork of legacy and contemporary light sources that have evolved with the built environment over time. As a result, much of the campus fabric is illuminated in a way that feels unintentional and ineffective. The UW faces a critical crossroads as it determines how new lighting technology can be implemented to support energy goals while also creating a more coherent nighttime landscape. In order to uphold its commitment to sustainability, the university must adopt updated light strategies that will dramatically reduce lighting energy consumption while simultaneously prioritizing human experience and maintainability as critical components of sustainability.

The UW Integrated Design Lab (IDL) partnered with the Office of the University Architect and Seattle City Light's Lighting Design Lab (LDL) to create the Campus Illumination roadmap, which encompasses an analysis of existing lighting conditions, an overarching vision for campus lighting, and design goals for specific campus space types. These lighting recommendations align with the mosaic of landscape typologies delineated in the Campus Landscape Framework, offering observations and strategies for an array of contexts. This document is intended to be used by planners, lighting designers, and other stakeholders in tandem with the Campus Landscape Framework and 2018 UW Campus Master Plan in order to ensure that the UW meets sustainability and experiential goals in the built environment with a 24-hour landscape perspective.

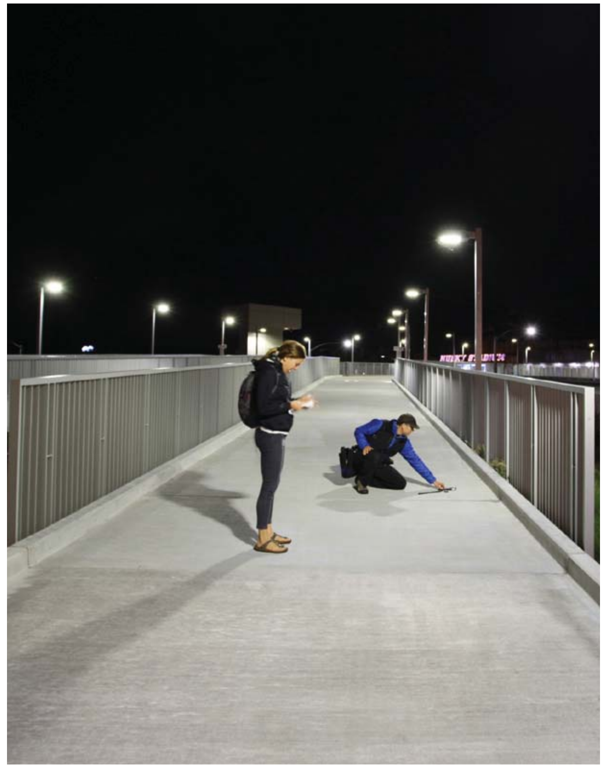

Figure 1. Field measurements and site observations were gathered throughout the span of the Campus Illumination project, both by members of the project team as well as small student groups.

The Campus Sustainability Fund (CSF) provided the primary funding for the Campus Illumination project, with additional support from the UW Office of Planning and Budgeting and the Northwest Energy Efficiency Alliance. The CSF supports student-led projects that demonstrate the UW's sustainability goals and measurably contribute to a more resilient campus. As a CSF-supported project, Campus Illumination provides a critical piece of university infrastructure that establishes a guiding vision for long-term sustainability and identifies lighting strategies that will significantly reduce the campus's electricity consumption.

THE NIGHTTIME CAMPUS

As a 24-hour residential campus, the UW landscape is active throughout the entire day, though most landscape planning efforts focus on the daytime qualities of outdoor spaces. Due to Seattle's northern latitude, the UW campus heavily relies on electrical exterior lighting, especially during winter months when the sun rises as late as 8:00 am and sets as early as 4:30 pm. As a result, it is imperative that the UW take a more targeted approach toward outdoor lighting to support a positive campus environment outside of daylight hours. Though the term “nighttime” is often used in this document to refer to times when the campus relies on electrical lighting, it is important to remember that for a significant portion of the academic year the campus is dark during peak commuting periods.

DEFINITION OF SUSTAINABILITY

The UW spends $15 million on electricity annually, with 35% of total electricity consumed by lighting.[1] Unfortunately, there is no reliable data that quantifies the relative share of consumption between interior and exterior sources on campus. Some studies posit that at least 8% of lighting energy in the United States is consumed by exterior sources, though this percentage may significantly underestimate the actual proportion of outdoor lighting. A campus setting particularly depends on outdoor lighting, with a dense concentration of electrically lit pedestrian pathways compared to other built environment typologies.

With 1,987 luminaires on campus—not including building-mounted light sources such as wall packs—the UW has an extraordinary opportunity to significantly reduce energy loads by installing more energy-efficient light sources. Currently, of the 1,987 luminaires on campus, 1,288 are high pressure sodium (HPS) sources and 128 are light-emitting diode (LED) sources. While LED installations have already begun on campus, the UW has no overarching vision

1 “The Source of Our Power,” UW Capital Planning and Development.

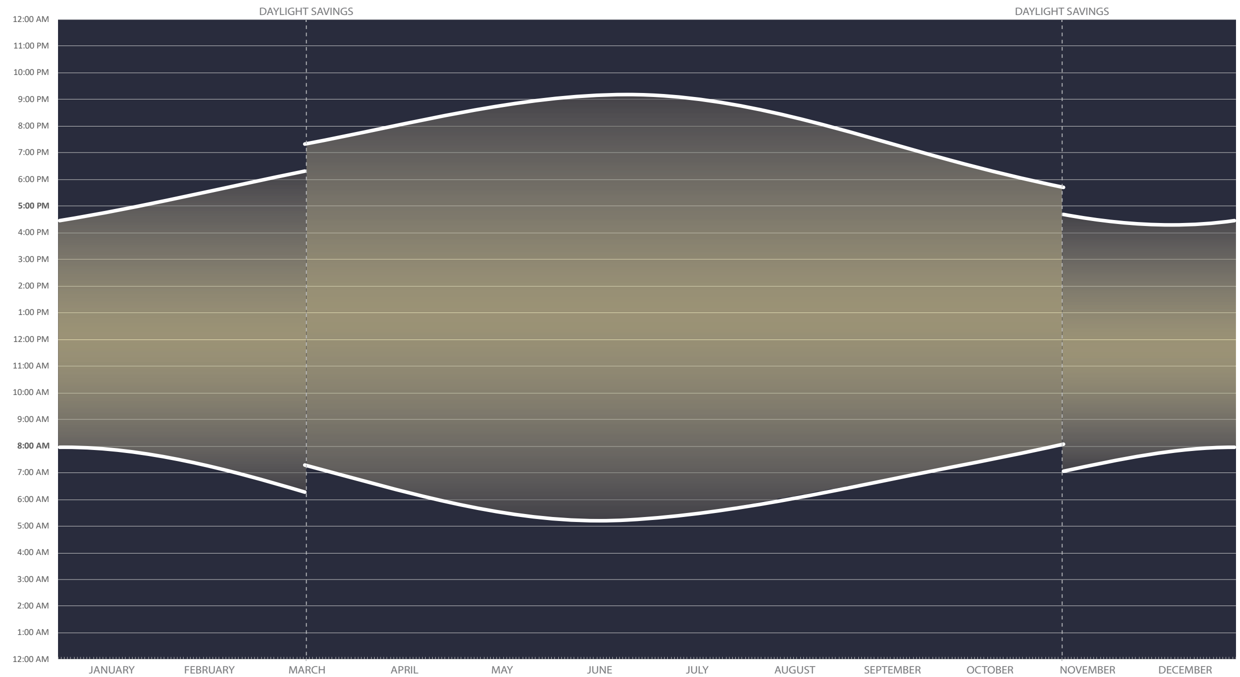

Figure 2. This chart illustrates the annual daylight patterns in Seattle, displaying the significant difference between winter and summer day lengths. Data from the Pacific Science Center.

to ensure that the transition to LED light sources are implemented with a more broadly defined sustainability strategy.

The Campus Illumination project looked beyond energy efficiency as the singular metric of sustainability. Instead, sustainable lighting supports human experience, respects wildlife habitat, minimizes light pollution, and is easily maintained. This more holistic interpretation of sustainability aspires to create resilient nighttime environments that advance a range of campus sustainability goals. New lighting technology can provide immediate reductions in energy consumption, but is only truly sustainable if it succeeds in the long term. LED sources have a much longer life span than traditional HPS sources, so it is critical that new LED installations are designed to maximize energy and experiential potential.

A thorough planning process is especially central to lighting a campus sustainably, as light cannot be understood simply as quantifiable points in an energy matrix. Instead, light is part of an integrated landscape experience and cannot be examined as an isolated variable; lighting must be understood in terms of qualitative perception. From an energy perspective, a

Figure 3. A sample of a lighting proposal for North Campus Housing by Evan Boyd and Jesse Chapman.

Figure 4. A sample of a lighting proposal for the Burke Gilman Trail by Erica Cartwright.

more comprehensive vocabulary of light can achieve even greater reductions in overall consumption than technology alone provides. For example, light levels can be tuned in response to specific site conditions— such as site materials and occupancy patterns — to minimize electrical loads.

OUTREACH + INVOLVEMENT

Throughout the Campus Illumination process, the project team strived to collaborate with the campus community and lighting practitioners in an effort to bridge the campus planning process with a more diverse group of stakeholders. The project began with a campus-wide survey about outdoor lighting conditions that collected invaluable feedback from a wide cross-section of the campus community. The survey was designed and administrated by Campus Engineering & Operations, and featured an interactive map that prompted faculty, students, and staff to place comments and qualitative markers on specific campus locations. These data reveled attitudes toward existing lighting conditions on campus, and helped to illustrate a portrait of the campus experience during dark hours.

In the fall quarter of 2016, the Campus Illumination project was applied in a 400-level Environmental Lighting course in the Department of Architecture. Student groups were assigned one of five case study areas on campus to perform qualitative and quantitative analysis of existing lighting conditions. Students also explored design opportunities in these campus nodes and proposed innovative lighting interventions that addressed project criteria. By integrating the project into course curriculum, students gained applied learning experience and insight into the campus planning process. Furthermore, the project benefitted from the creative freedom with which the students envisioned future campus lighting design.

Finally, the project team collaborated with local lighting professionals to target opportunities and challenges for future lighting guidelines from the designer perspective. The practitioners provided guidance throughout the project to ensure that the document could best facilitate a successful lighting design process. This feedback helped to establish an aspirational tone for the roadmap rather than prescriptive constraints.

ROADMAP ORGANIZATION

This document contains five major components: (1) a review of outdoor lighting research of particular relevance to the UW, (2) a summary of existing lighting conditions on campus, (3) findings from the Campus Illumination survey, (4) general recommendations for an overarching campus vision, and (5) lighting strategies for specific space types in line with the Campus Landscape Framework.

ADVANCES IN OUTDOOR LIGHTING

Outdoor lighting presents a wide array of complex considerations, ranging from pedestrian preferences to energy consumption. Often, these concerns compete with each other in the design process. For example, blue light's impact on human health is an increasing concern, while creating a sense of safety and security remains paramount in pedestrian areas. In the campus context, this complexity is amplified. The UW encompasses a wide variety of space types and site conditions, as well as a robust network of circulation routes that range from informal footpaths to multimodal corridors. Furthermore, the campus contains spaces with overlapping functions that resist standardized lighting approaches, such as service areas that also act as common pedestrian shortcuts or adjacencies between residential and academic areas with distinctly different occupancy patterns.

Current developments in the lighting industry present opportunities for tuning and controls that can address the diverse lighting needs of the university campus. The industry is evolving rapidly, with advancements swiftly becoming more affordable and feasible for large-scale implementation. As the UW transitions to more efficient, longer-lasting LED lighting sources, it is critical that the campus adheres to an overarching vision even as lighting solutions are innovated at an accelerated pace.

Recent trends in lighting research that are particularly relevant to the UW include (1) increased attention to pedestrian-specific outdoor lighting needs, (2) new approaches toward understanding and analyzing perceived brightness, and (3) networked and adaptive control capabilities in a campus context.

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Figure 5. Traditionally, high pressure sodium sources have been used to light pedestrian-oriented landscapes, with characteristic warm color temperatures and low color rendering properties.

PEDESTRIAN LIGHTING CONSIDERATIONS

Traditionally, outdoor lighting guidelines prioritize the visual needs of drivers over pedestrians and bicyclists. While the campus setting certainly supports a significant vehicular presence, the predominant campus user travels on foot. A growing body of research reflects an industry shift toward defining specific parameters for pedestrian-oriented lighting.

In collaboration with the US Department of Energy Solid-State Lighting Technology Demonstration GATEWAY Program, the Pacific Northwest National Laboratory (PNNL) published a 2013 report that offers an initial attempt to outline qualitative and quantitative variables that directly contribute to pedestrian friendly lighting.[1] The study focused on two pedestrian-oriented sites: the Stanford University campus and the hamlet of Chappaqua NY. The authors implemented a variety of luminaires over time in response to

1 NJ Miller, TK McGowan, RN Koltai, "Pedestrian Friendly Outdoor Lighting," prepared for US Dept. of Energy by Pacific Northwest National Laboratory, 2013.

community feedback in an iterative process to identify preferred lighting strategies. As a result of this research, the PNNL offers five primary variables that influence pedestrians' impressions of outdoor lighting:

1. **LUMINAIRE** – attractive and context-appropriate daytime luminaire appearance
2. **GLARE** – glare was the most "significant" determining factor in luminaire favorability
3. **DISTRIBUTION** – pedestrians preferred more uniform light distribution with soft edges
4. **COLOR TEMPERATURE** – pedestrians generally preferred light with warmer color temperatures (2700K-3000K)
5. **HORIZONTAL ILLUMINANCE** – illuminance measures at the low end of the IES spectrum were acceptable as long as glare was minimized

The PNNL results imply that pedestrians' lighting preferences cannot fully be addressed using conventional lighting standards. For instance, the researchers found that diffusion strategies, such as using frosted glass refractors, significantly mitigated perceived glare but would not be accounted for in the standard glare metrics.[2] Likewise, light distribution plays a significant role in perceived glare, with researchers noting that light spread more uniformly over large areas—as opposed to smaller, concentrated bright patches—can reduce overall glare perception.

This more nuanced understanding of glare can foster more comfortable pedestrian environments while simultaneously lowering overall illuminance levels without sacrificing perception of safety. Furthermore, factors such as angle of illuminance that can highlight uneven or slick surfaces can address tripping and slipping concerns without increasing illuminance levels.[3]

Additionally, the authors found pedestrians' glare zone occurs primarily between 0° and 75° as opposed to the glare zone for drivers, which is typically measured between 75° and 90°.[4] These observations can help guide lighting designers and campus facilities crews in creating environments that are visually comfortable for pedestrians while also creating safe driving environments.

There is growing consensus in the lighting industry that mesopic vision—vision that occurs in dim conditions—must be better understood in order to better support the functions of electrically lighted urban settings. As most of the nighttime landscape is experienced in the mesopic state—neither fully lighted (photopic) nor completely dark (scotopic)—it is critical to consider the full range of light sources that work together in the built environment to create the lighting landscape, rather than focusing solely on the photometrics of discrete fixtures. Kostic and Djokic (2014) found that illuminance uniformity, light color, and the "feeling of comfort" were the most influential factors in determining lighting preference in mesopic urban settings.[5]

Additional research examines the more granular mechanisms of pedestrian vision. Eye-tracking devices record pupil movement as pedestrians travel through the nighttime environment, providing valuable data for more targeted lighting decisions. Raynham and Davoodian, for example, conclude that pedestrians focus on the ground plane for 40-50% of their navigation time, and even less time in conditions in which the pedestrian feels unsafe.[6] These data support a move from focusing on illuminating the ground plane and instead consider the visual experience of an environment from the scene perspective.

L. Cellucci et al. elaborate on the idea that scene variables more strongly influence pedestrian sense of safety than average horizontal illuminance. The authors found, by conducting surveys based on computer simulations of nighttime environments, that situational elements such as adjacent buildings and light quality variables including color rendering index (CRI) strongly influence pedestrians' overall sense of safety.[7]

An additional consideration for pedestrian lighting at UW concerns how the optics of LED streetlights impact sidewalk lighting conditions. When LED roadway lighting replaces HPS sources, light is directed in a more controlled distribution along the street, reducing the amount of spillover light on adjacent sidewalks.[8] Without this light source, the campus may need to consider implementing more targeted lighting strategies that directly address the needs and preferences of pedestrians along sidewalks.

2 PNNL, "Pedestrian Friendly Outdoor Lighting," 2013.

3 PNNL, "Pedestrian Friendly Outdoor Lighting," 2013.

4 Ibid.

5 A Kostic and L Djokic, "Subjective impressions under LED and metal halide lighting," *Lighting Res. and Technology* 2014; Vol. 46: 293–307.

6 N Davoudian and P Raynham, "What do pedestrians look at at night?," *Lighting Research and Technology* 2012; 44: 438–448.

7 L Cellucci, F Bisegna, F Gugliermetti and M Navvab, "Lighting Distribution affects Pedestrians' Sense of Security," IEEE 2016.

8 M Navvab , F Bisegna , L Cellucci, "Defining Pedestrian's Visual Adaptation Field under Night Lighting in Venice," IEEE, 2016.

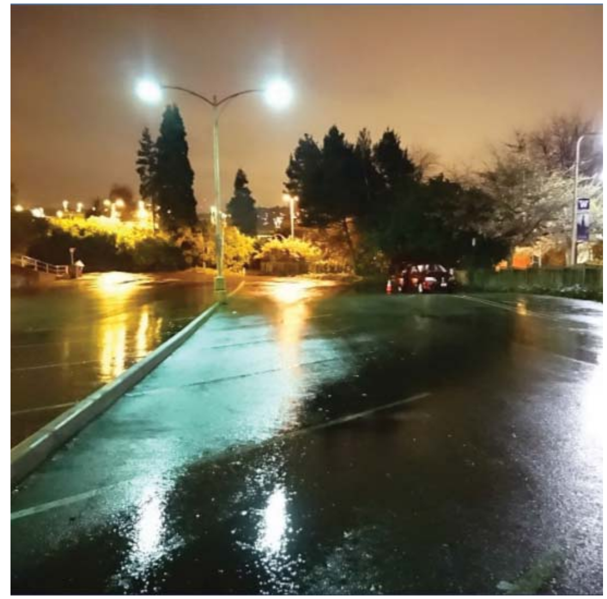


Figure 6. These images are from the Lighting Research Center and Seattle Lighting Design Lab study on the perception of brightness in UW parking lots. From left to right, these photographs show: high pressure sodium, LED, and metal halide lighting conditions.

At UW, pedestrian-oriented lighting offers a framework to more sensitively design for the nighttime experience for campus users. However, certain tradeoffs must be made when weighing pedestrian preferences against other lighting goals. For instance, strategies that reduce pedestrian perception of glare such as frosted refractors can create significant losses to lamp efficacy. Likewise—at the time of the study — LED luminaires with warmer color temperatures were less efficacious than cooler LED sources.[9]

Some of these tradeoffs will become irrelevant as lighting technology advances. In fact, the DOE predicts that the efficacy of warm-white LED will exceed 200 lumens per watt by 2020. The Northwest Energy Efficiency Alliance (NEEA) identifies strong opportunities for future lighting products to focus on innovative technological solutions that deliver efficiency and experiential goals including "brightness perception, color rendering, discomfort glare, circadian rhythm, and other possible health issues."[10] As technology develops in these areas, lighting designers can elegantly integrate pedestrian preferences with energy objectives.

9 PNNL, "Pedestrian Friendly Outdoor Lighting," 2013.

10 Northwest Energy Efficiency Alliance, "Seattle LED Adaptive Lighting Study," prepared by Clanton & Associates, 2014.

PERCEPTION OF BRIGHTNESS

The discourse on pedestrian lighting directly interfaces with research surrounding the perception of brightness. With the growing presence of LED lighting in the outdoor realm, researchers are identifying the impact of light quality—rather than photometry—on the way that humans perceive electrically lighted spaces.

The Lighting Research Center (LRC) at the Rensselaer Polytechnic Institute in New York has spearheaded foundational research efforts that investigate perception of brightness. Rea et al. (2015) argue that the lighting design community should design for the "perceived brightness of a scene" as opposed to illuminance standards.[11] The authors make the case that humans perceive brightness based on the color-rendering properties of light rather than light levels. Designing for perceived scene brightness has the potential to radically lower the power density needed to light a typical site as well as the overall wasted light leaving the site by reflecting off of the ground plane.

Of particular relevance to UW is the 2015 study conducted by the LRC in collaboration with Seattle's Lighting Design Lab (LDL) that analyzed three parking lots on the UW campus. A small group of participants was asked to complete questionnaires about perceived safety and brightness in parking lots with three different light sources: metal halide (MH), high pressure sodium (HPS), and LED, respectively. Researchers found that study participants perceived the HPS- and LED-illuminated parking lots as acceptably bright with the MH lot considered too dark. LED lots rated more positively overall in subjective responses to statements concerning sense of safety, i.e. "I would feel safe walking here." The researchers conclude that since LED operates at roughly half of the power density of HPS, designing for scene brightness can lead to dramatic energy savings.[12]

It is important, however, to keep in mind the difference in function between a parking lot and other pedestrian settings so that the specific qualities of light tested in this study not be applied to all landscape types. The LED sources in this study had a Correlated Color Temperature (CCT) of 4101K, which is much bluer than the preferred CCTs noted in the Stanford campus pedestrian lighting study. These are not conflicting results: pedestrians may value facial recognition and uniformity in a parking lot and prioritize aesthetics and scale in a residential courtyard. As such, it is critical that the university establish lighting criteria sensitive to site contexts and functions rather than adopting universal lighting standards.

CONTROLS

In recent years, the lighting industry has seen major advances in control system capabilities. While light source replacement (i.e. HPS to LED) will inevitably result in significant energy savings, there is increasing opportunity to dramatically expand these savings by coupling new light sources with advanced controls systems.

Currently, the UW operates on a "Cascade" system, which creates inefficiencies and complicates maintenance tasks. Business and academic campuses are adopting more flexible and streamlined controls systems that allow for greater sensing and dimming opportunities. Generally, these controls operate on a wireless network that bridges in-fixture controls through a "gateway" device to a central management

11 MS Rea, JD Bullough and JA Brons, "Spectral considerations for outdoor lighting: Designing for perceived scene brightness," *Lighting Res. Technol*. 2015; Vol. 47: 909–919.

12 MS Rea, JD Bullough and JA Brons, "Parking lot lighting based upon predictions of scene brightness and personal safety," Lighting Res. Technol. 2015; 0: 1–12.

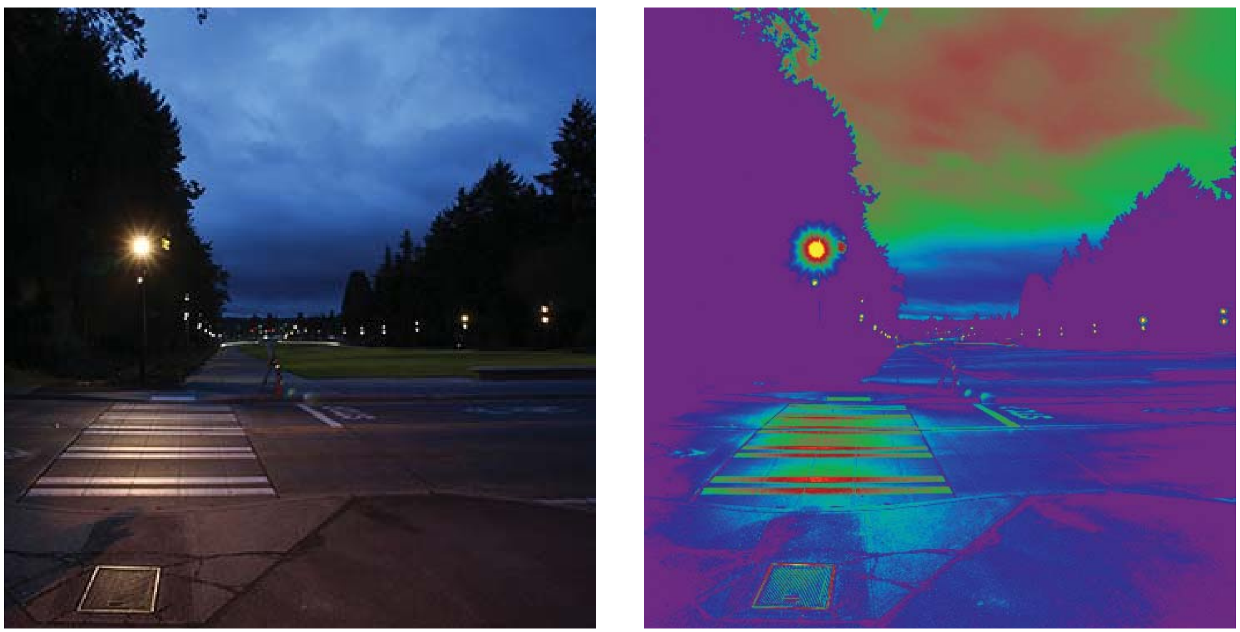


Figure 7. Illuminance measures the light that is emitted from a source, while luminance reveals light conditions as the eye perceives them This HDR analysis of a Rainier Vista crosswalk illustrates the luminance of this space.

system. Lighting administrators can control luminaires individually or in zones through the user interface of the central management system.

Networked lighting controls are a developing technology, so currently the field is largely composed of non-standardized proprietary systems. As such, it is premature to recommend a specific system for the UW. Contemporary examples of networked control systems, however, can provide a helpful foundation as the UW begins to consider transitioning from the Cascade system to a more adaptive network.

The California Lighting Technology Center (CLTC)[13] provides numerous case studies of adaptive controls implemented in public university settings. For example, University of California (UC) Davis established the Smart Lighting Initiative (SLI) to meet California's goal of reducing lighting energy consumption by 60-80% by the year 2020. The project team implemented more than 1,500 outdoor LED fixtures controlled by a wirelessly networked system. The project far exceeded predetermined goals, reducing energy consumption by 86% on average and producing sustained savings in maintenance and monitoring services.

UC Santa Barbara offers another example of networked controls in a campus context. This campus-wide project retrofitted existing streetlight and post-top luminaires on campus with LED light sources controlled by an adaptive mesh network system. The controls were fully dimmable and fully programmable, and featured in-fixture occupancy sensors that facilitated adaptive bi-level lighting in response to site activity. System administrators were afforded "unprecedented control" over the lighting system, and saw additional benefits such as granular energy monitoring, flexible dimming schedules, and fixture-specific maintenance alerts. All of these elements led to a striking 78% decrease in streetlight energy consumption and 88% energy savings in post-top fixtures. Tuning, in particular, generated dramatic savings by allowing standard fixtures to adjust output to site-appropriate levels.

Energy-saving strategies that are widely adopted in interior lighting environments, such as occupancy sensors, become significantly more complex when considered within an outdoor environment. Exterior spaces—especially those on active university campuses—support a variety of users, human and wildlife, and functions at any given time. Thus, elements such as occupancy sensors are currently most efficient in controlled, more single-use spaces such as parking lots and garages.

However, adaptive lighting systems with sensing technologies that can respond to more complex exterior conditions are not far off, though further research is necessary to understand how these systems may impact energy consumption. A California occupancy survey, as a part of the State Partnership for Energy Efficient Demonstrations (SPEED), found that the university campuses studied had nighttime occupancy rates of 15-40%, which indicates a significant opportunity to reduce nighttime light levels and subsequently reduce light pollution and maintenance costs.

Ultimately, controls are a critical piece of lighting sustainably at the campus scale. While an additional planning process to select a specific controls system is needed, there are clear lessons from the current literature of campus-wide lighting overhauls. The ability to easily tune or dim lighting fixtures and zones will result in significant energy savings for the UW. Furthermore, flexible controls allow the university to program lighting schedules to observed occupancy trends and adjust light levels to support special campus events and activities.

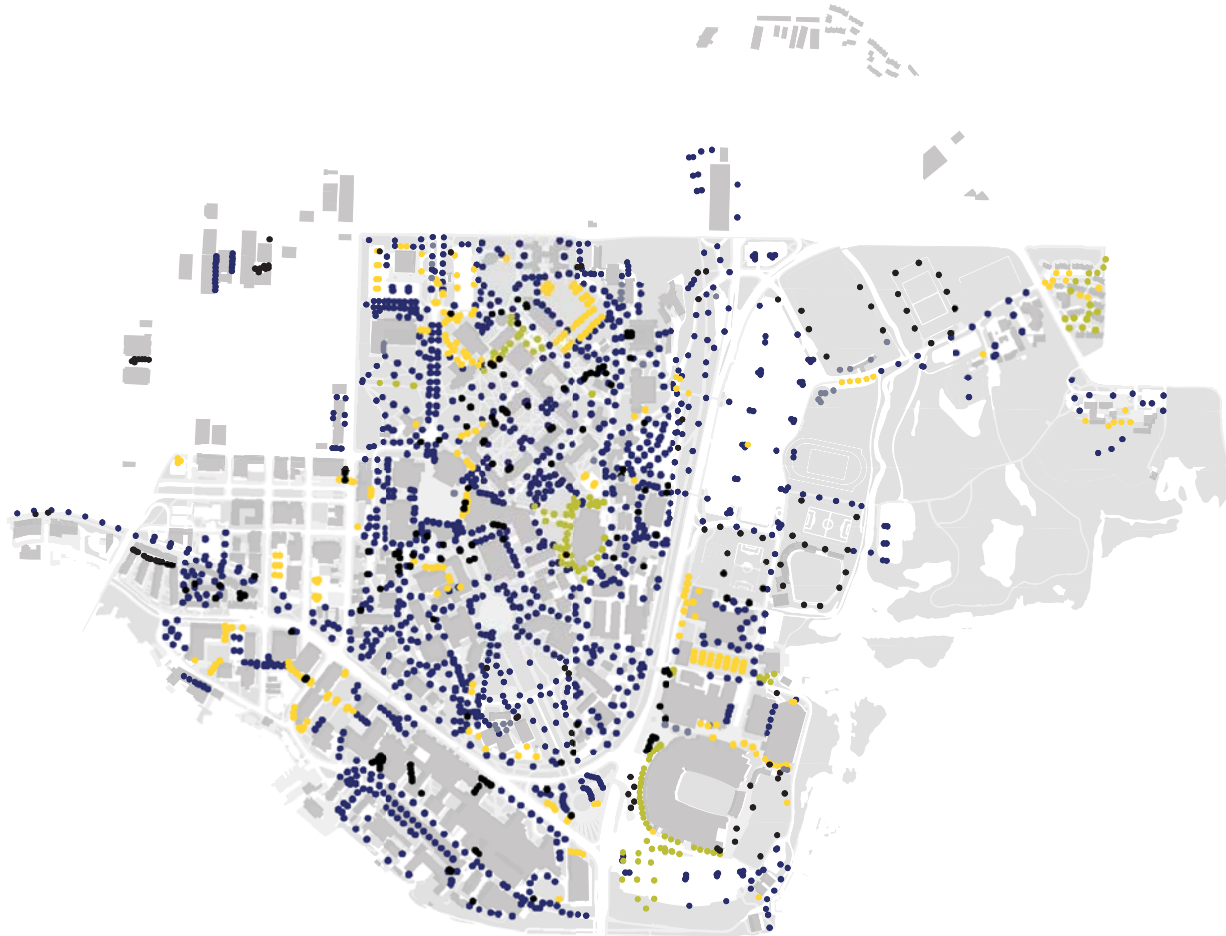
13 Information about these CLTC controls studies, along with additional projects, can be found at the CLTC website: http://cltc.ucdavis.edu/.

EXISTING CONDITIONS

Though there is an increasing number of LED fixtures on campus, the UW still predominantly relies on HPS light sources. Additionally, a small number of metal halide and other sources remain in use in certain spaces. As is typical of HPS light sources, much of the nighttime campus is lighted with very warm color temperatures with a low color rendering index (CRI).

Of the spaces with LED fixtures, there are three major conditions evident on campus: (1) new construction with LED-integrated fixtures, (2) LED retrofits of legacy cobrahead luminaires, and (3) new LED street lighting implemented under the purview of Seattle City Light. Generally speaking, the spaces with LED lighting are perceived as much brighter, due to the bluer color temperature and better color rendering capabilities of the LED sources on campus. Of the three LED conditions, Seattle City Light's luminaires are specified to the bluest color temperatures (CCT), measuring between 4200-4500K using a spectrometer in the field.

Luminaires in new construction on campus are typically specified for color temperatures around 3000K with 85 CRI. Compared to the standard 2200K with 25 CRI quality of HPS light, the new LED-illuminated spaces feel very distinct from the legacy campus spaces. In many cases, the transitions between legacy lighting and new light sources are harsh and create a discomfort glare when travelling into LED-lit spaces from other outdoor environments or can exaggerate the perception of darkness when exiting into HPS-lighted spaces.



EXISTING LUMINAIRES

- LED (128)
- High Pressure Sodium (1288)
- Metal Halide (281)
- Other (290)

Figure 8. LED fixtures by the HUB are an example of newly designed LED implementation.

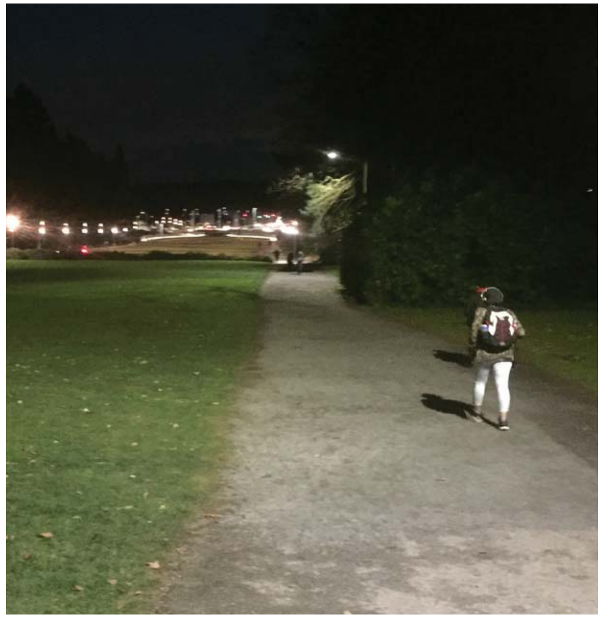


Figure 9. Upper Rainier Vista displays legacy cobrahead poles retrofitted with LED lamps.

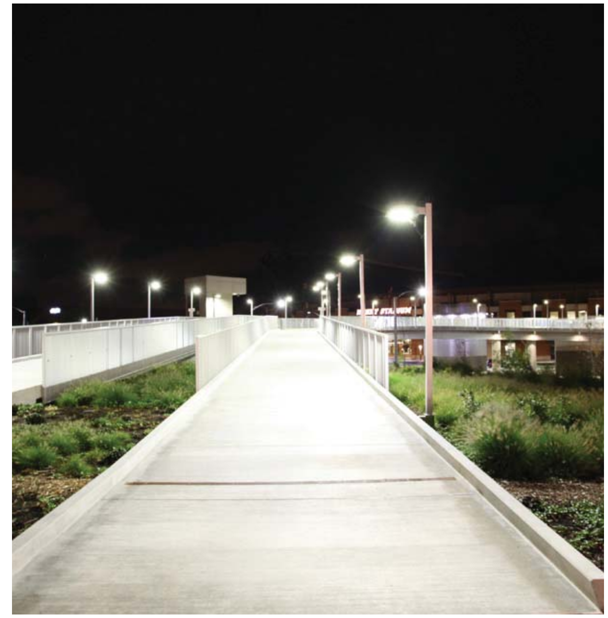


Figure 10. The pedestrian bridge to the University Light Rail station is illuminated to Sound Transit specifications.

Most pedestrian areas on campus are lighted with pole fixtures, though a varied array of wall packs and other ad-hoc lighting applications are present on many campus buildings. There are two campus standard fixtures specified by the UW Field Services Design Guide (FSDG): the traditional gothic poles throughout Central Campus and the Archetype series AR/SAR by KIM lighting. In addition to these standard fixtures, there are a number of unique pole fixtures, especially in South Campus and West Campus. A result of this inconsistency is a fragmented nighttime experience, which is exaggerated along the campus edges.

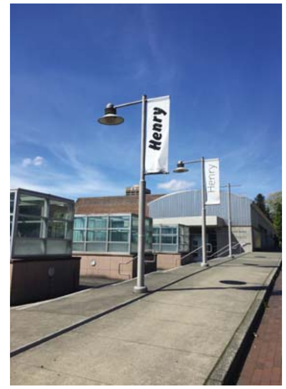
In addition to older campus landscapes, recently designed areas on campus also display pole fixtures that deviate from campus standards. The current FSDG stipulates that any new fixtures not in compliance with campus standards "shall be reviewed and approved by the UW Landscape Committee." While many recent installations are in line with the KIM standard fixture, high profile sites such as the HUB and Rainier Vista light major campus pathways with unique pole fixtures. When reviewing new site design proposals, the UW should carefully consider the potential consequences of allowing the a diverse palette of fixtures in the campus fabric sites in order to sustain long-term maintainability and support a coherent campus lighting identity.

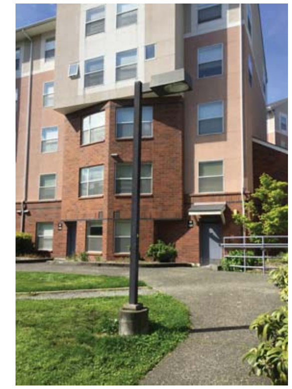
POLE FIXTURES

A survey of pole luminaires on campus reveals a palette of fixture types that range from historic gothic fixtures to LED-integrated poles. These fixtures range from the pedestrian scale at a pole height of 12'-15' to a cobraheads typically aligned with streetlight applications.

The daytime aesthetics of luminaires are an important aspect of exterior lighting, and contribute to the overall campus landscape. Currently, pole finishes range from a light, brushed steel to a dark bronze appearance. Poles can provide an important sense of progression and symmetry to the landscape during both daylight and electrically lighted conditions.

Poles present a challenge as the campus transitions to LED, as legacy fixtures were designed for omnidirectional light sources as opposed to directional LED lamps. As such, a one-for-one replacement approach often leads toward uncomfortably high light intensity at certain points and can darken adjacent pedestrian areas that relied on spillover light from omnidirectional sources.

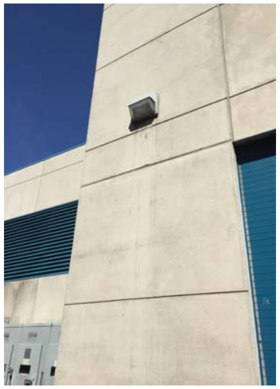



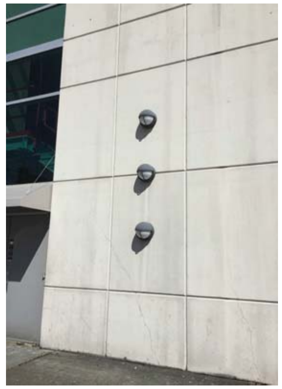



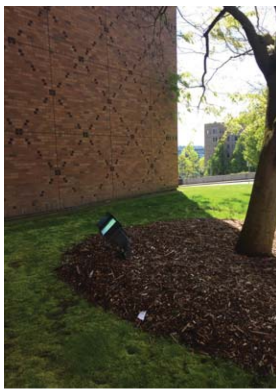


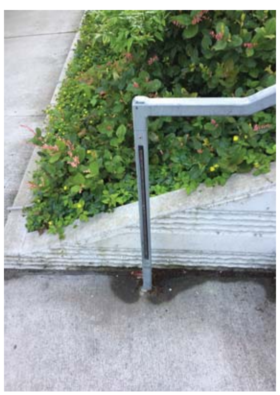
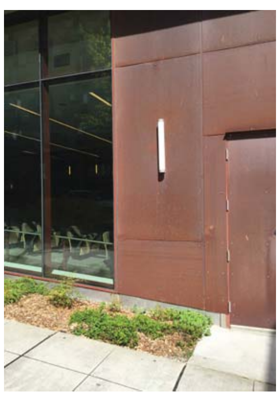


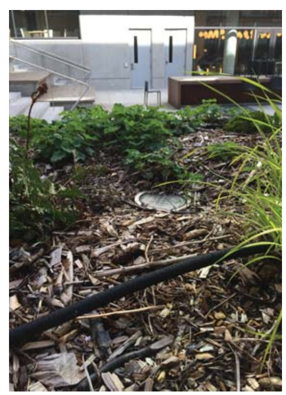








WALL PACKS, BOLLARDS + ACCENT LIGHTING

The variety of non-pole applications across campus presents a number of exterior lighting concerns. Wall packs, for instance, often create conditions of discomfort glare and can produce "bright spots" with high contrast ratios. Wall packs can be found installed on buildings across campus in a wide range of fixture housings.

Bollard lighting is not as common on campus, though is increasingly present in more recent construction projects. New bollard installations are generally incorporated into planting beds. Bollards can provide a helpful path lighting solution, but are at high risk for damage in an active campus setting and require careful maintenance of adjacent plant growth.

Accent lighting can create unique lighting experiences that enhance pedestrian-oriented spaces in the campus setting. In recently designed areas of campus, it is evident that lighting designers have taken a more playful, creative approach to lighting with the use of embedded LED strips, uplights, and catenary applications. While these interventions can be very successful in creating a positive human experience, the maintenance considerations increase significantly within these more artfully lighted places. The UW must establish an ethic that negotiates between design creativity, campus coherence, and maintainability in order to create a sustainable lighting strategy.

OVERARCHING CHALLENGES

Generally, the UW is well positioned to dramatically reduce the amount of energy consumed by campus exterior lighting. With such a ripe opportunity, however, come significant challenges that the UW must consider.

A major risk that the UW faces is an overall "brightening" effect as the campus transitions to LED sources. In order to take full advantage of new lighting technology, the UW must consider light qualities and site-specific landscape conditions so as to maintain the lowest light levels possible without sacrificing pedestrian comfort and sense of safety. As new capital projects introduce LED lighting designs into the campus fabric, it is critical that the UW take a campus-scale perspective to ensure that lights are tuned to levels that best support energy and experiential goals at the campus scale.

Secondly, directionality becomes a major challenge for the campus in terms of retrofitting or replacing legacy fixtures. New LED lights have much different distribution and light quality than HPS or metal halide (MH) light sources, which is often not accounted for in a one-for-one replacement approach. In order to best exploit the capabilities of LED, considerations such as spacing and mounting height can radically influence experiential and efficiency goals.

An additional challenge presents itself as new technology allows for flexible fixtures that can create captivating nighttime landscapes, such as LED strips embedded below handrails and benches. These interventions are often successful from a design and user perspective, but may not be sustainable in terms of maintenance and upkeep in the long term. An increased palette of fixtures that require special tools or proprietary lamps will not be feasible at the campus scale. Therefore, the UW must establish a framework for identifying spaces that are best suited for more artful designs without creating overly complex maintenance programs.

Finally, as a campus in an urban environment, the UW must respond to lighting conditions outside of the campus ownership, such as rights-of-way controlled by Seattle City Light and Light Rail connections controlled by Sound Transit. Transitions between campus and its surrounding context become key for pedestrians, bicyclists, and drivers who move both within and through campus during electrically lighted hours. As a porous environment with many active urban edges, it will remain a challenge for the UW to establish meaningful edges and gateways.

3. CAMPUS LIGHTING SURVEY

During the Spring Quarter of 2016, students, faculty, and staff were asked to contribute their opinions regarding campus outdoor lighting in a widely distributed online survey. The survey was intended to gather feedback from the UW campus community about current exterior lighting conditions on campus in order to ensure that future lighting guidelines respond to the concerns of campus users.

Survey participants provided comments related to their individual experiences with UW outdoor lighting and were asked to locate certain lighting characteristics on a campus map. These markers—nighttime destinations, areas avoided at night, great lighting, too bright, and too dark—provided data from which lighting priorities began to emerge.

For the most part, respondents' opinions about lighting were closely linked to their perceptions of personal safety on campus. Survey comments tended to reflect a desire for more lighting across campus, with very few respondents expressing concern about over-lighting. Though campus users generally associate increased light levels with enhanced security, it is critical that lighting is not used as a unilateral response to address the campus community's concerns regarding personal safety at night.

While the survey reveals some campus areas that are commonly viewed as either too dark or successfully lighted, there are numerous areas on campus that received a diverse spectrum of qualitative markers. The plurality of perceptions regarding campus lighting highlight the importance of resisting prescriptive lighting guidelines, and call for a more sensitive approach to lighting across campus that respond to site-specific conditions.

Figure 11. Image from the Campus Illumination Survey outreach effort, which utilized UW networks such as the UW Daily newspaper to reach a wide cross section of the campus community.

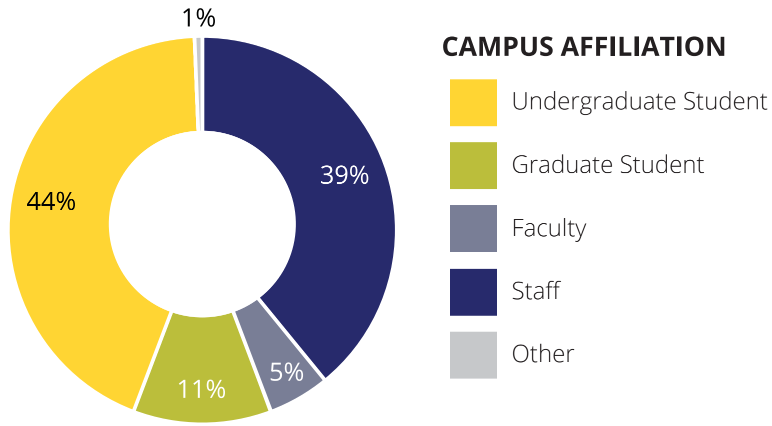
SURVEY PARTICIPANT PROFILE

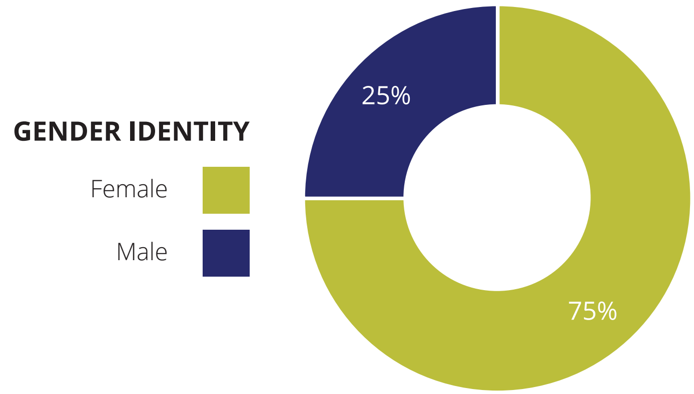
The survey received nearly 200 responses that reflected a nonrepresentative cross-section of the campus community. As the survey was intended as a platform for feedback rather than a tool for statistical analysis, there is limited interpretation regarding correlations between survey demographics and specific perceptions.

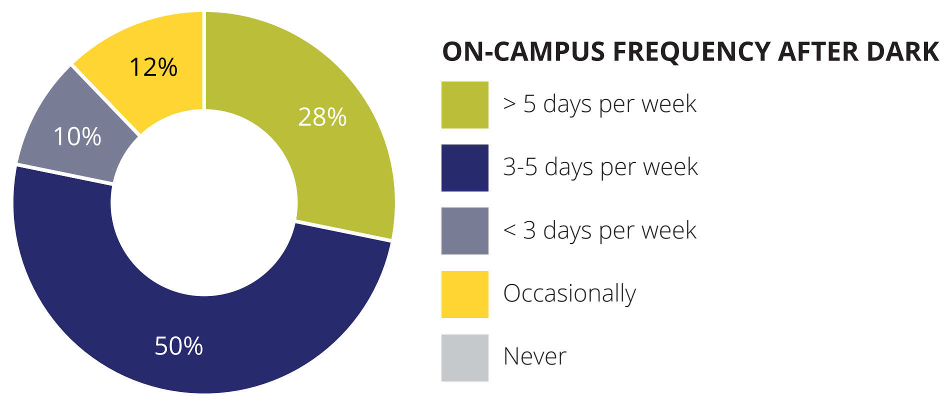
The survey respondents were evenly split between students and university employees, resulting in feedback that reflects observations about campus lighting across different time scales. As exterior lighting can be critical for new users navigating the campus, student attitudes provide invaluable insight into how campus lighting is perceived by a relatively recent campus population. Longtime faculty and staff, on the other hand, offer a sustained perspective of campus lighting conditions over time.

Three-quarters of survey participants identified as female, though no significant trends emerge that distinguish female and male impressions of campus lighting.

The survey was administered during the spring quarter, as days were getting longer — the sun set after 8:00 pm while the survey was active. This prolonged daylight may have skewed responses, leaving it difficult to gain an accurate sense of frequency with which campus community members are on campus after dark over the course of a year. While nearly 80% of respondents reported being on campus after dark at least three days per week, this number could potentially increase significantly during the winter when the sun sets as early as 4:20 pm. In any interpretation, there is a significant population of students and employees on campus throughout all hours of the night and early morning.







PRIMARY LIGHTING CONCERNS

Survey participants were asked to indicate their primary concerns related to outdoor campus lighting from a list of eight categories. Respondents could select as many lighting concerns from the provided list as desired.

Nearly all survey participants (95%) identified "personal safety" as a primary concern for campus lighting. Though the survey did not ask for respondents to rank their concerns, it is clear that a sense of personal safety dominates the campus community's understanding of the role of lighting at UW. This presents a challenge for lighting design and maintenance goals, as lighting's relationship to personal safety is extremely complex and nonlinear. It is important to respond to the campus community's concerns regarding personal safety during nighttime hours, but increased lighting does not necessarily correlate to increased safety. Personal safety concerns should not be interpreted as a need for increased light levels across campus, but rather as a need for more sensitively designed lighting that mitigates conditions such as glare and high contrast.

Roughly three quarters of participants cited visibility as a primary concern, while the remaining categories were selected by only one quarter or less of participants.

These results imply that the campus community overwhelmingly desires outdoor lighting to provide a legible, comfortable nighttime environment that feels safe and secure. These results offer a user perspective to be weighed alongside energy goals, maintenance, and additional considerations of campus lighting design and implementation.

Figure 12. Results from the Campus Illumination Survey question asking, "What are your primary concerns regarding lighting on campus? (Check all that apply)." Nearly all respondents selected Personal Safety as a primary concern and just under three-quarters of respondents identified Visibility as a primary concern.

NIGHTTIME CIRCULATION BEHAVIORS

Roughly half of survey participants indicated that they revised their routes through campus between day and night. These results reveal the need to consider nighttime campus circulation as distinct from daytime usage and ensure that lighting is tuned in a way that specifically enhances nighttime legibility and wayfinding.

***COMMENTS*:**

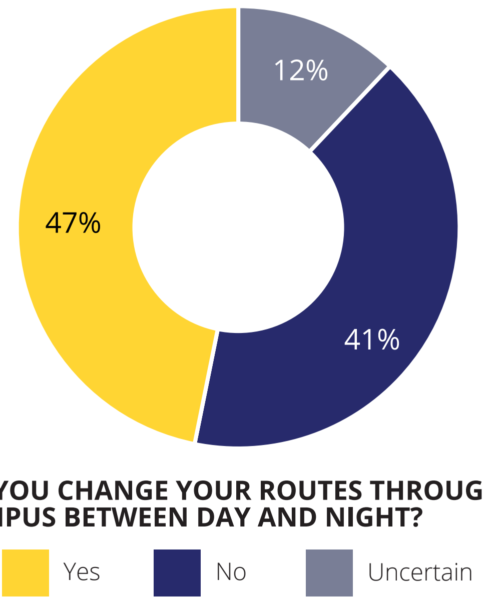
"I will walk a longer more well light route at night to avoid dark areas, even if doing so adds 10 minutes or more to my walk."

"I'll stick to better-lit sides of the street, or take paths I know are better lit, even if I have to go a little out of my way."

"When I am walking home late at night, I have three routes that I alternate between. I usually stick to one route but if I feel endangered, I'll switch to another that is more well lit and has more foot traffic."

"I avoid certain areas to be in more lighting, or sometimes follow a group a short ways if they're going a route I'm familiar with and heading in the same direction I want to go."

"I tend to drive more places on campus at night that I would walk to during the day."



DO YOU CHANGE YOUR ROUTES THROUGH CAMPUS BETWEEN DAY AND NIGHT?

THE QUAD

BURKE-GILMAN TRAIL

RED SQUARE

NIGHTTIME ROUTES

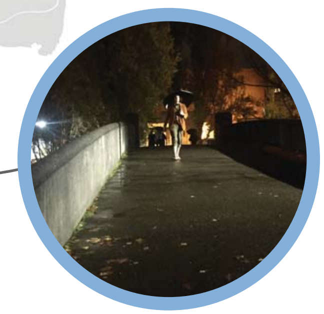
Generally, survey participants traced circulation routes during the night that align with the primary pathways identified in the 2018 Campus Master Plan. Connections between Central and West Campus appear to be major nighttime corridors. Red Square provides the central node for nighttime circulation.

PIERCE LANE

Traditional brick pathway that bisects the Quad, connecting Red Square and North Campus housing.

RED SQUARE

Primary circulation node in campus, providing central navigation point.



HEC ED BRIDGE

Pedestrian bridge over Montlake Ave that connects central campus to the IMA.

DRUMHELLER PLAZA

Secondary circulation node, marking transition from the campus core to Rainier Vista.

NE 40TH STREET

A primary connector for all transportation modes between West and Central campus, transitioning from an urban condition to the campus setting.

NIGHTTIME DESTINATIONS

Survey respondents indicated nighttime destinations on campus, which primarily comprised student housing and campus facilities such as the 24-hour undergraduate library, the Husky Union Building (HUB), and the Intramural Activities building (IMA). The map indicates that while outdoor spaces do not typically serve as landing places during nighttime hours, buildings throughout campus are used as nighttime destinations.

ODEGAARD LIBRARY

24-hour undergraduate research library located in the Red Square.

HUB

Student amenities and activity center, open 7AM-11PM most weekdays during the academic year.

IMA

Campus gym and recreational activity facility open from 6AM-10:30PM during the academic year.

LIGHT RAIL STATION

Trains leave UW station starting at 4:45AM and ending at 12:35AM daily.

ALDER HALL

Dormitory with ground-floor amenities open to the campus community with limited access to the general public, such as the District Market and the Alder Commons auditorium.

GREAT LIGHTING

Participants indicated areas on campus which they thought displayed "great lighting." These areas encompassed landscapes ranging from historic spaces with outdated technology to new construction with LED-integrated fixtures.

INTELLECTUAL HOUSE

"The new LED lights by the Intellectual House are AMAZING!"

HUB

"In front of the HUB entrance, [the lighting] is just about right."

RED SQUARE

"Red Square is always easy to find"

NE CAMPUS PARKWAY

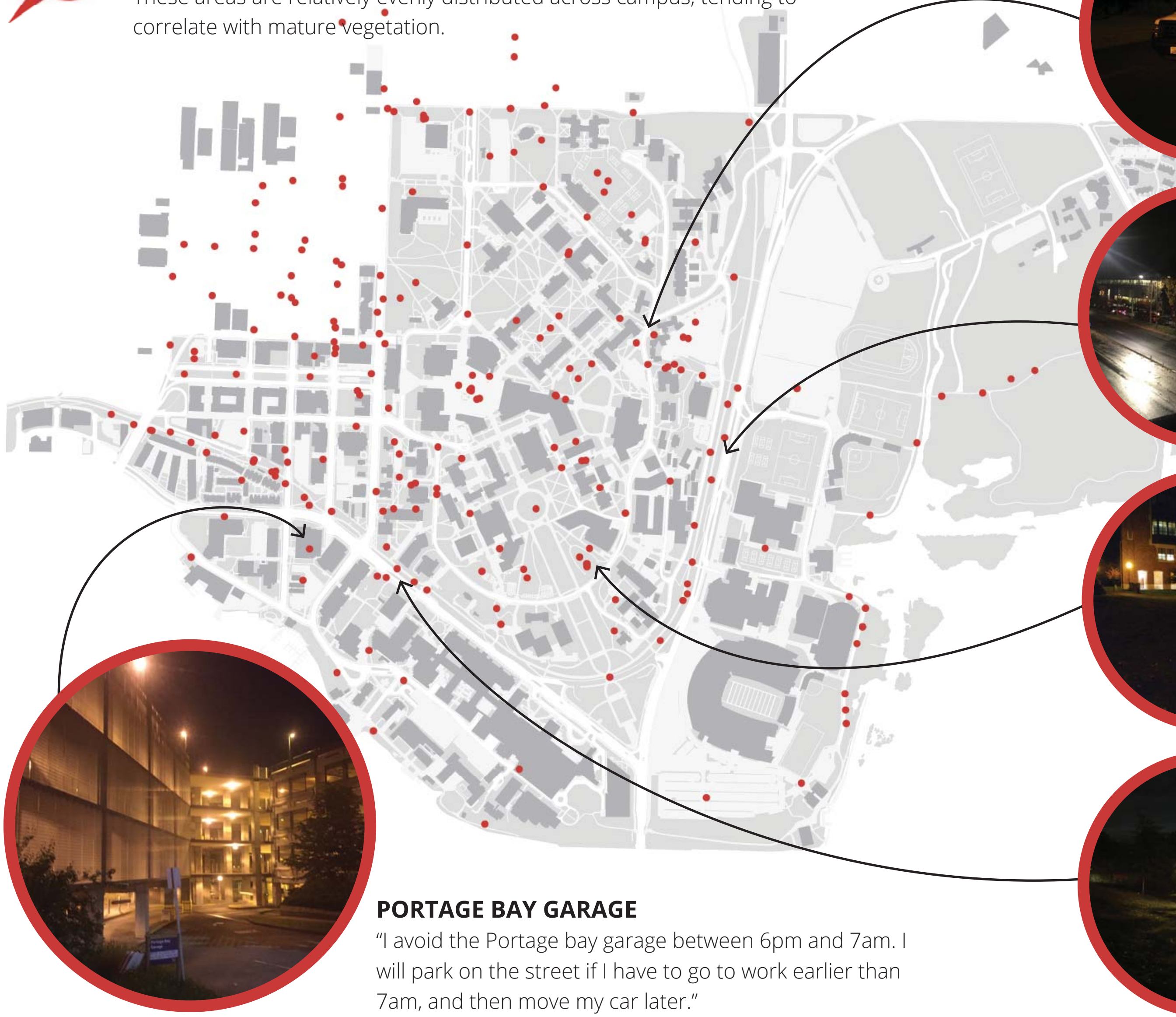
"I think this area is really bright and I feel safe when I'm waiting at the bus stop in front of Elm [Hall]."

RAINIER VISTA LAND BRIDGE

"Love the design on the lighting here for the new light rail -- the lights underneath the railing are subtle yet very effective."

AREAS AVOIDED AT NIGHT

Participants located areas on campus which they tend to avoid at night. These areas are relatively evenly distributed across campus, tending to correlate with mature vegetation.



E STEVENS INTERSECTION

"Too dark while waiting for the night shuttle."

EAST CAMPUS EDGES

"If I get out of work after 5pm, I walk up Montlake Avenue, but there are still some very dark sections there as well."

EAST RAINIER VISTA

"Always avoid this route. Seems sketchy, dimly lit and too far off the beaten path to walk alone."

BURKE GILMAN TRAIL

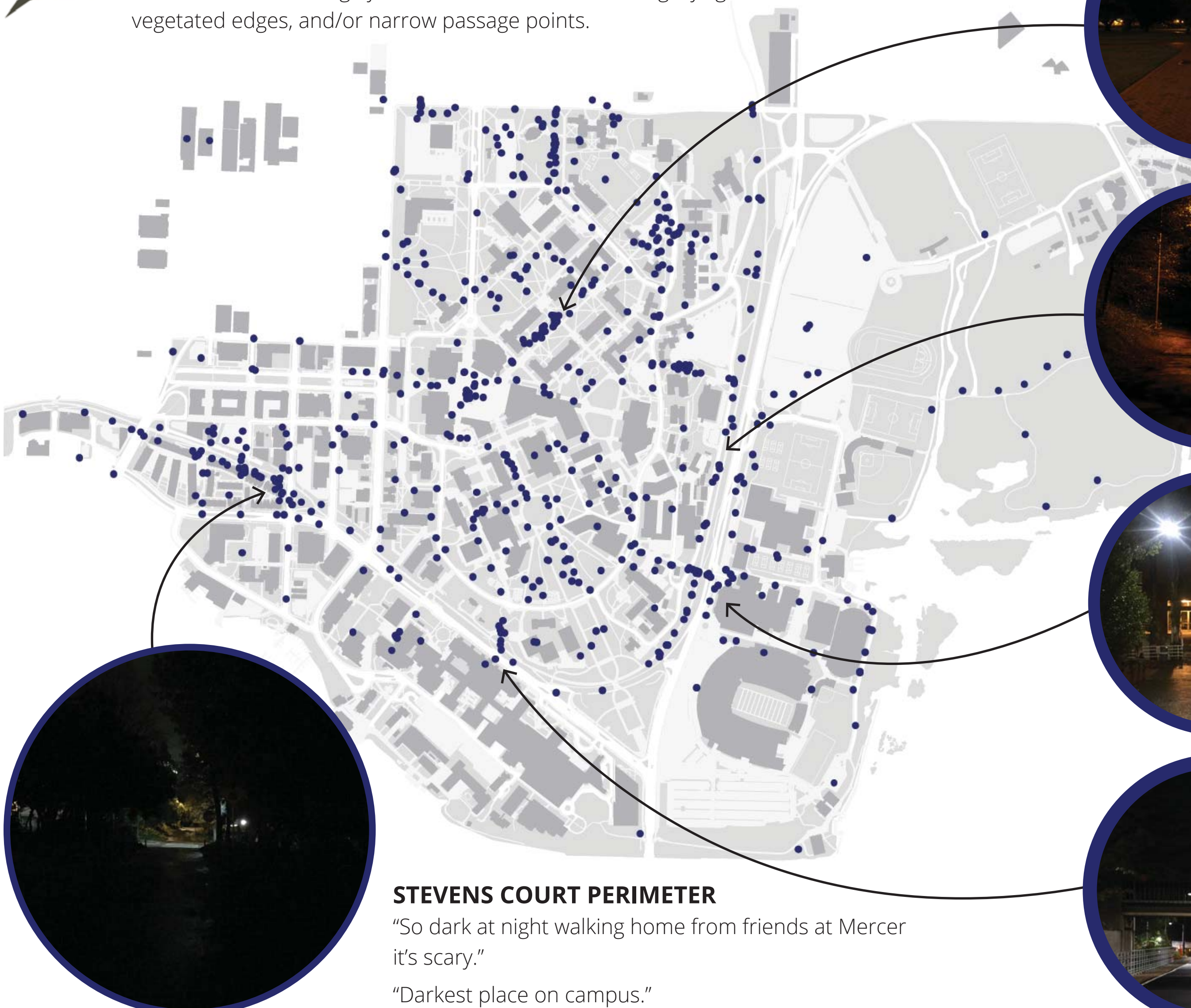
"For being so integral to campus navigation, the Burke Gilman is very unsettling, dark, and dangerous."

PORTAGE BAY GARAGE

"I avoid the Portage bay garage between 6pm and 7am. I will park on the street if I have to go to work earlier than 7am, and then move my car later."

TOO DARK

Participants indicated areas on campus which they considered "too dark". These markers are largely concentrated in areas with legacy light sources, vegetated edges, and/or narrow passage points.



THE QUAD

"The Quad is also very dark especially for an area walked by students very often."

BURKE GILMAN TRAIL WEST

"Entire stretch of Burke Gilman Trail could use more lighting to keep pedestrians safe and increase visibility of IMA patrons."

ARENA

"It almost pitch black down at the stadium sometimes. Additionally the [UWSB] women come in for early morning training--some times on their own--and it is very dark."

SOUTH CAMPUS BRIDGE

"Pathway from Stevens way to the 4th floor overpass is dark & pavement is extremely uneven"

STEVENS COURT PERIMETER

"So dark at night walking home from friends at Mercer it's scary."

"Darkest place on campus."

OVERARCHING CAMPUS COMMENTS

LIGHTING QUALITY

"I urge UW to gain an understanding of how nighttime illumination works to create a feeling of community, safety and belonging. Instead of just focusing on expediency, general illumination needs (horrible colors), look at how cities like Paris, San Francisco, Vancouver BC employ nighttime lighting with a mind towards illumination as a tool for civic improvement."

"If new lighting is installed, don't go overboard. It doesn't need to wash out an area with very bright, intense light; it just needs to be enough to see and be seen by."

SOURCES OF BRIGHTNESS

"Perhaps this isn't the proper venue for this, but I think that INDOOR lighting at night is an issue that needs to be addressed. I see dozens of unoccupied buildings across campus lit up like Christmas trees all the time, and it seems tremendously wasteful. I know UW embraces the idea of environmental awareness, and this seems like an aspect that would be very easy to address and change."

"I see enough lights around the campus however, somehow it still looks dim and gloomy. It may be because of the orange/yellow light that is being used for the street lights? I think it'll be a lot brighter if we can use LED lights."

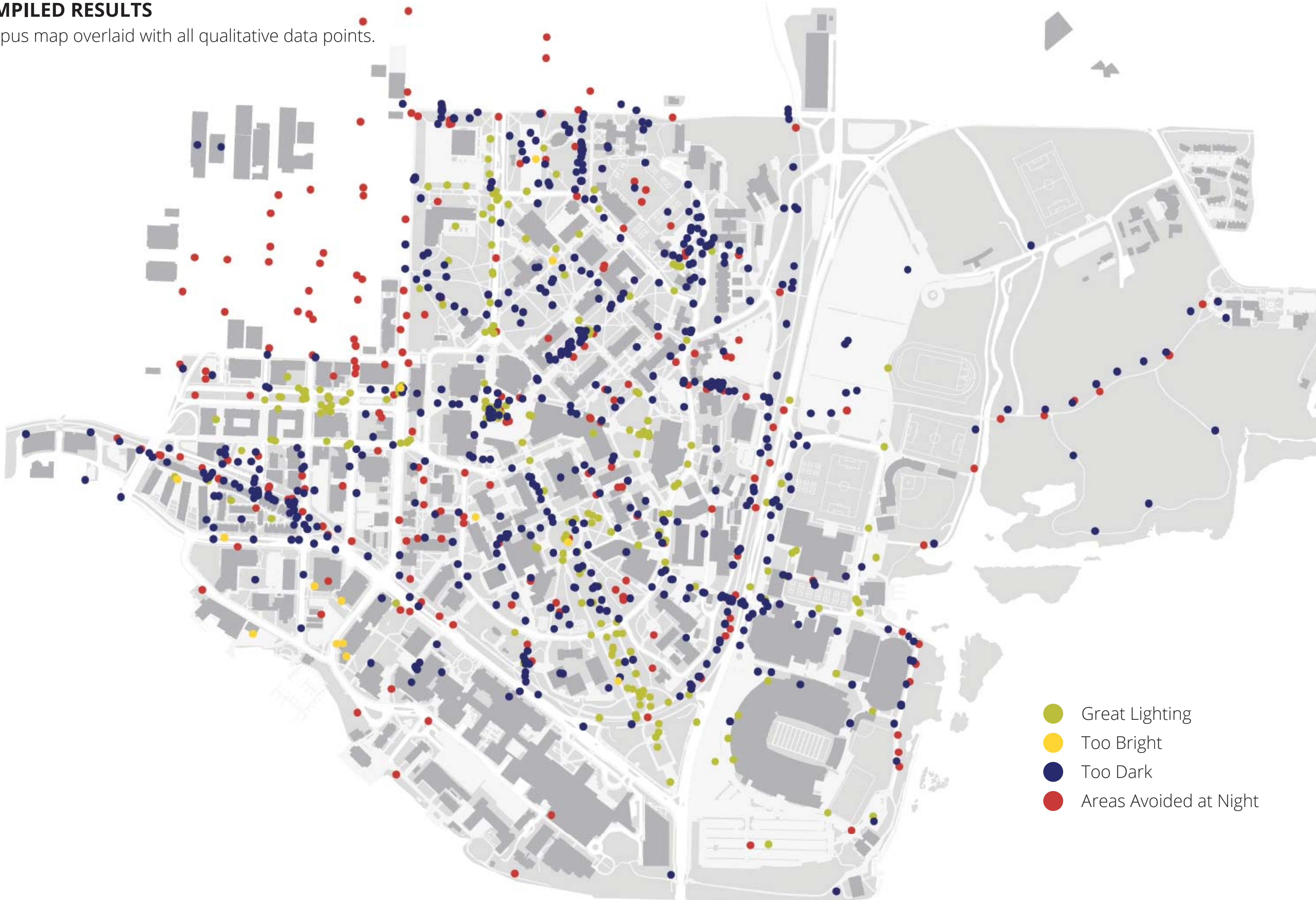
REDUCING CONTRAST

"I face campus across Portage Bay at home - way too many lights shining out on water versus down on ground – need full cutoff lights installed to keep dark skies but permit pedestrian safety. Work nights in my office (I'm an astronomer) so need safety when leaving at midnight or 5 am."

"Some areas need more illumination but if the light is too bright it makes it difficult to see after I pass through the bright area or look away from the light (affects night vision until I re-adjust). I work overnights and walk a loop around campus for breaks, 5 nights per week."

COMPILED RESULTS

Campus map overlaid with all qualitative data points.

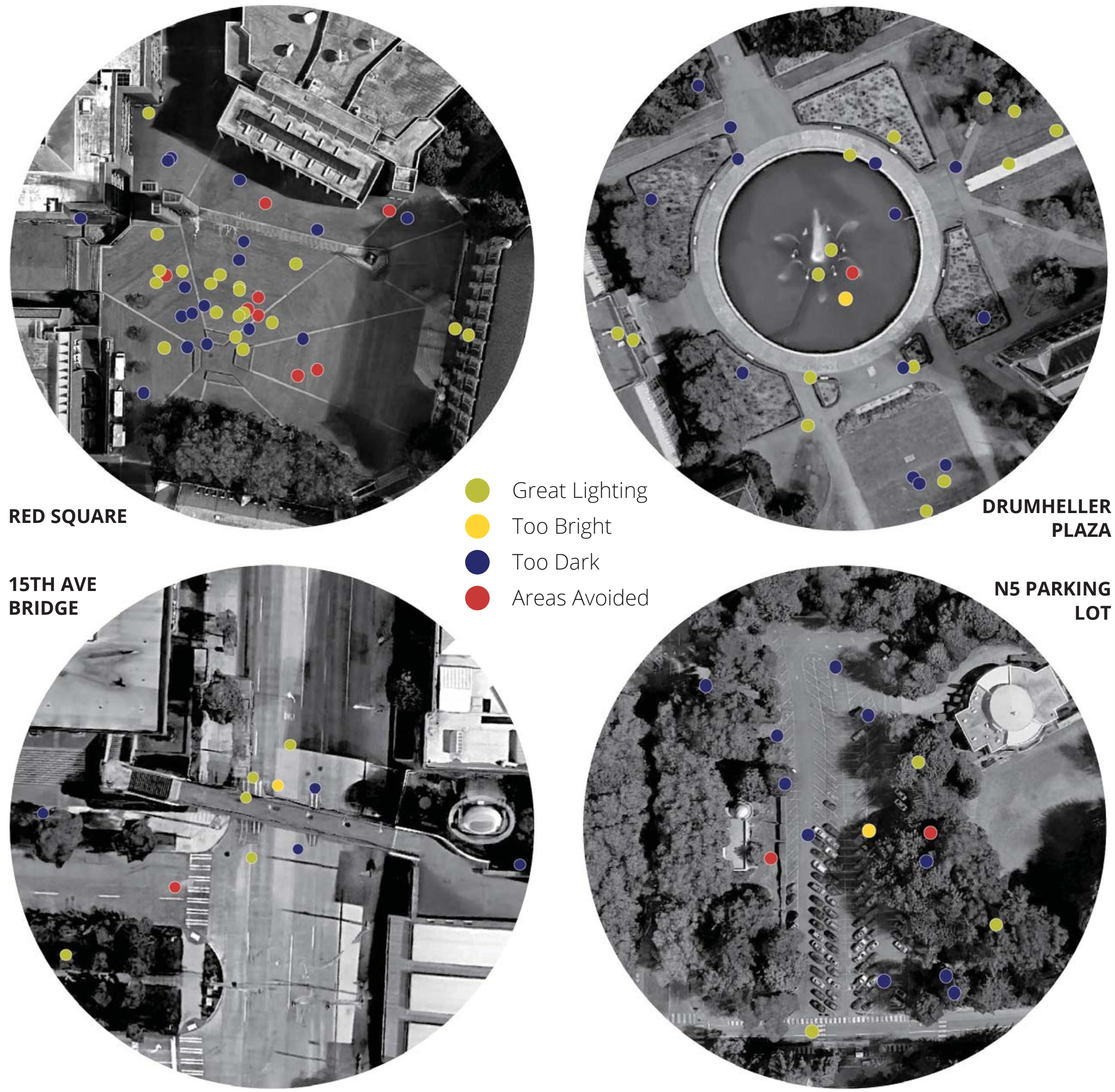


INTERPRETING CONTRADICTIONS

While some areas on campus reflected a general consensus as either having "great lighting" or seeming "too dark," there are a number of spaces that display conflicting results. For instance, Red Square — the key circulation and wayfinding node in Central Campus — was populated with an almost even distribution of "great lighting," "too dark," and "area avoided at night" markers.

Areas that received inconsistent interpretations illustrate that the perception of brightness is an inherently subjective experience. For instance, if a student travels from a brightly lit building interior directly into Red Square, the plaza may seem relatively dark. A student traveling through Red Square having already adjusted to an adjacent outdoor area, however, may perceive the space as adequately, or even beautifully, illuminated.

These results underscore the importance of considering light as a spatial experience rather than a measure of illumination. With this framework, transitions between landscape space types — as well as between interior and exterior spaces — become key to supporting comfortable passage across campus.



LOOKING BEYOND ILLUMINANCE

The survey feedback provides an illustration of a well known principle of lighting: that the experience of outdoor lighting is informed by specific scene conditions such as surface materials and edge conditions rather than objective illuminance measures.

Illuminance values were overlaid on survey responses in areas that were either generally agreed on as “too dark” (i.e. the Quad) or having “great lighting” (i.e. the HUB). On average, the Quad registers significantly lower illuminance values than the HUB. This apparent correlation between lighting preference and higher illuminance, however, is challenged by campus sites that have conflicting interpretations. For example, Red Square received both “great” and “too dark” responses on the survey map. The interior of Red Square plaza measured significantly lower illuminance than that of the Quad, raising questions of the relevance of using illuminance criteria as a guiding design consideration.

These results reveal that individual perspective and site-dependent conditions contribute more strongly toward the perception of brightness than do illuminance measures. For example, smooth transitions between campus space types and between building interiors and exteriors allow the eye to adapt to changing light conditions more gently at the speed of pedestrian travel.

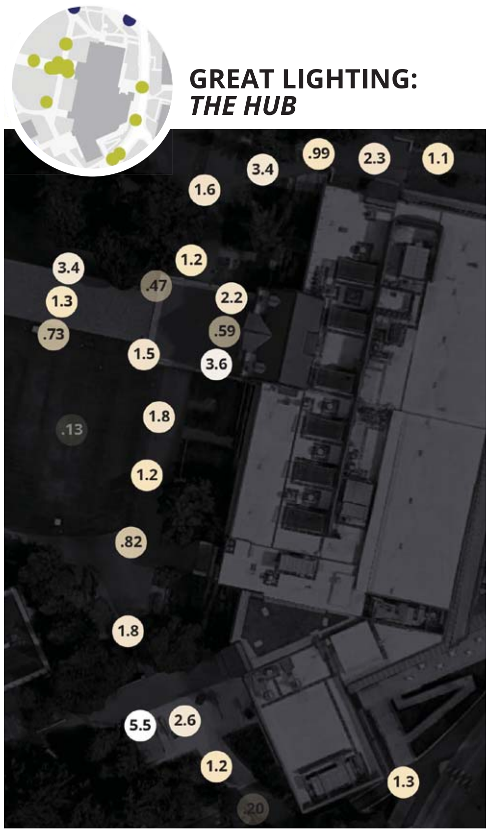
The Red Square illustrates how a unified strategy—lighting the perimeter rather than flooding the ground plane—can produce an outsized sense of visual comfort with significantly lower lumen output.

GREAT LIGHTING:
THE HUB

TOO DARK:
THE QUAD

SPLIT RESPONSE:
RED SQUARE

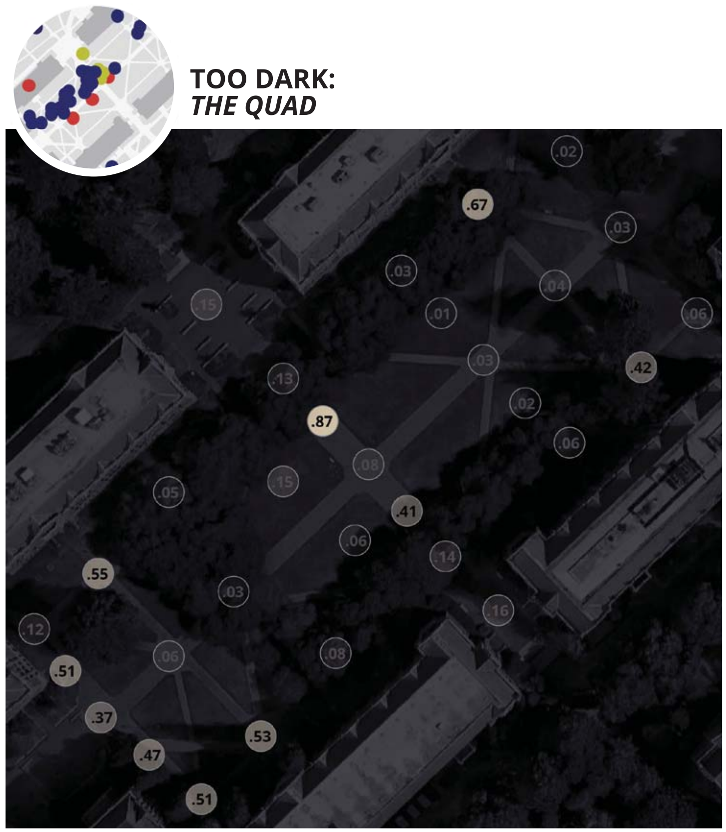
GREAT LIGHTING:
THE HUB



AVERAGE ILLUMINANCE

MAIN ENTRY: **1.72 fc**
PERIPHERAL PATHS: **1.55 fc**

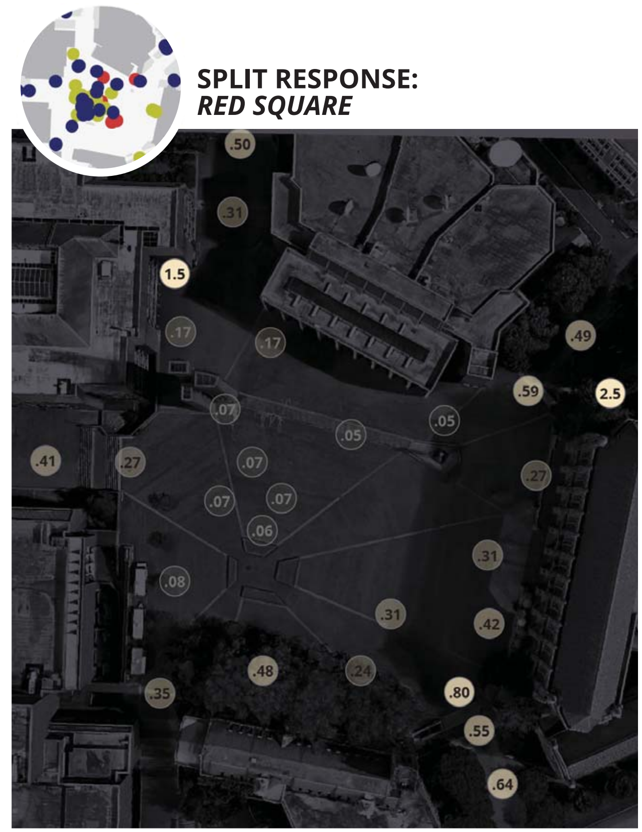
TOO DARK:
THE QUAD



AVERAGE ILLUMINANCE

MAIN AXES: **0.18 fc**
SECONDARY PATHS: **0.27 fc**

SPLIT RESPONSE:
RED SQUARE



AVERAGE ILLUMINANCE

PERIMETER: **0.32 fc**
INTERIOR: **0.10 fc**

KEY TAKEAWAYS

Four priority lighting needs emerged from the campus survey feedback: (1) creating consistency along the Burke-Gilman Trail, (2) articulating campus gateways, (3) tuning transitions between interior campus spaces, and (4) creating a lighting language for residential regions on campus. These lighting priorities respond to concerns of the campus community and represent the areas of campus that would benefit most from immediate lighting adjustments.

1. BURKE-GILMAN TRAIL
View of the Burke-Gilman trail along Montlake Blvd. NE.

2. CAMPUS GATEWAYS
Gateway into Central Campus from pedestrian bridge by the Henry Art Gallery.

3. INTERIOR TRANSITIONS
Transition between interstitial campus passage space and plaza at Mercer Hall.

3. RESIDENTIAL CONNECTIONS
Pathways within the North Campus housing community.

UNITING THE BURKE-GILMAN TRAIL

The Burke-Gilman trail consistently arose as an area of lighting concern across the entire campus community. The trail traverses an array of landscape typologies from a shared edge with NE Pacific St in the southern region of campus to an enclosed, wooded condition as the trail curves northward. Respondents cited concerns of pedestrian-bicycle collisions and generally described an environment that feels unsafe and insecure.

The Burke-Gilman is currently a patchwork of legacy fixtures and new construction with distinct pedestrian and cyclist ground surfaces and new LED fixtures. Areas that have not yet been renovated suffer from non-functioning fixtures and mature tree canopy contribute to a sense of enclosure and darkness. The Burke-Gilman is a critical connecter both within campus and to off-campus neighborhoods, and the UW should strongly prioritize this corridor for lighting implementation. The trail should serve as a coherent system, with uniform light levels across horizontal path surfaces, clearly legible intersections, and an emphasis on vertical illumination for clear facial recognition.

In the short term, it is critical that areas with non-functioning lamps or overhanging vegetation are addressed along the trail. In the long-term the campus should envision a trail with unified light levels and consistent lighting language.

Figure 13. The Burke-Gilman presents an array of lighting challenges, from mature vegetation to grade separation, yet is a critical nighttime circulation route that should take priority in lighting retrofit and redesign efforts.

DEFINING GATEWAYS

The existing conditions on campus lack a clear lighting strategy for articulating campus gateways. These gateways serve as the primary connections between Central Campus and its surrounding campus neighborhoods, as well as between UW and its urban context. As such, these connections should be illuminated in a way that signals these corridors as legible entries.

While major gateways such as Rainier Vista and Memorial Way successfully mark entry into UW campus through a combination of signage and lighting, a number of less prominent gateways are not clearly articulated. Tuning these entries to better transition between street lighting and campus lighting will help to provide clear wayfinding cues for navigating campus edges.

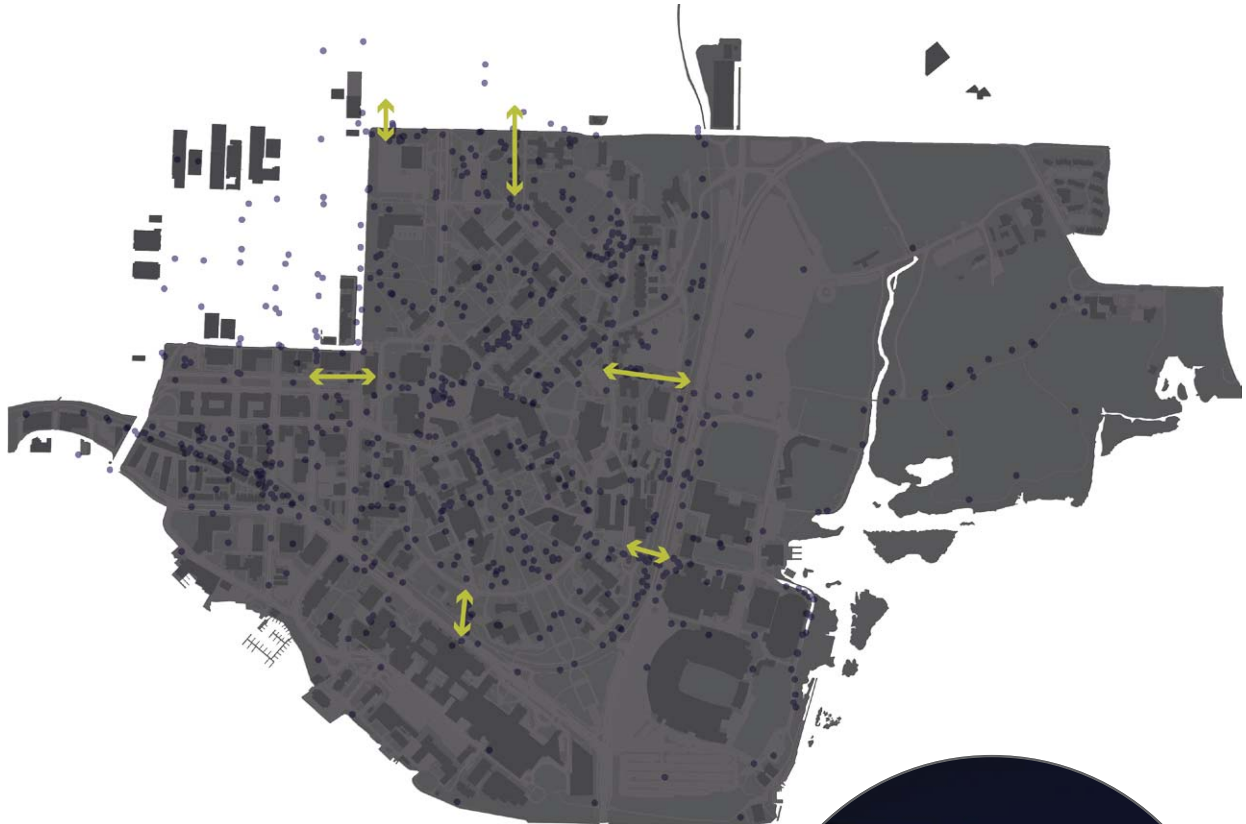


Figure 14. Campus gateways invite pedestrians into the campus environment, yet many of these connecting zones appear under-lit because of high contrast with adjacent streets or interfaces with vegetated areas. These entries are critical areas to focus on transitions between different lighting contexts and creating a hierarchy with light.

INTERIOR TRANSITIONS

Much like campus gateways, a number of pathways and interstitial spaces on campus provide passage between distinct lighting conditions. For example, the upper Rainier Vista connects the historic core of Central Campus with the newly redesigned lower Rainier Vista and Montlake Triangle. Similarly, Red Square is surrounded by radiating pathways that connect the node to a variety of landscape typologies. These transition zones are critical for supporting comfortable circulation at the campus scale.

By focusing on transitions between distinct campus landscape types, the UW can balance light levels without falling into the temptation to raise light levels across the campus as a whole. By focusing on transitions between campus space types—as opposed to a blanket increase in light levels across campus—the UW can reduce instances of high contrast that exacerbate perceptions of darkness at transition points through un-illuminated edge and woodland conditions.

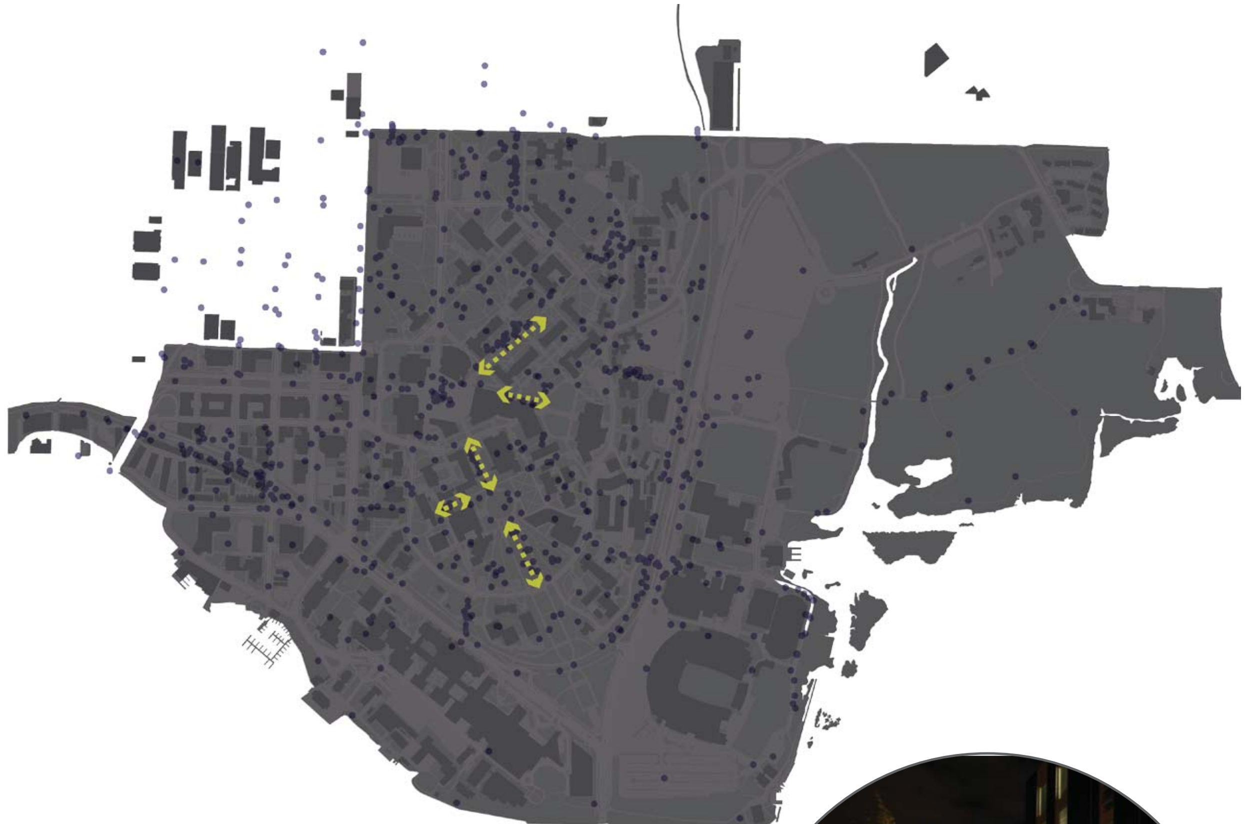


Figure 15. Transitions between campus space types are crucial to allowing the eye to adapt between different light levels and lighting conditions while moving through campus.

RESIDENTIAL LANGUAGE

The UW campus hosts an array of building types with varied lighting needs that prove challenging for creating a consistent lighting vocabulary across the campus as a whole. Residential areas are occupied at all hours and must support circulation that feels secure throughout the night while eliminating light trespass into living space windows.

Currently, the interface between residential and academic areas on campus emerge as a considerable concern in the campus community in North Campus Housing as well as in older construction in West Campus. Both of these areas contain mature vegetation as well as active multimodal transportation corridors.

Residential areas on campus should employ pedestrian scaled lighting with warm color temperatures and a high color rendering index (CRI). Importantly, lighting between building interiors and exterior spaces should be tuned to provide smooth adaptive conditions. Wall packs and other sources of glare and light trespass should be eliminated if present and avoided as a solution to lighting problems unless absolutely necessary to meet code or emergency requirements.

Figure 16. Residential areas on campus support activity on a 24-hour basis and must offer a sense of safety for students traveling to dormitories at all hours of the night, as well as eliminate light trespass into adjacent residential windows.

4. GENERAL RECOMMENDATIONS

CAMPUS VISION

The nighttime environment at the University of Washington Seattle campus (UW) should support a comfortable experience for faculty, staff, students, community members, and visitors alike. When designed thoughtfully, lighting enhances navigation and wayfinding and facilitates safe interactions between pedestrians, bicyclists and vehicular traffic.

While the UW celebrates a variety of unique landscape typologies, these spaces change character dramatically outside of daylight hours. Lighting should strive to weave these diverse spaces together with a coherent campus language in order to aid movement between nighttime destinations. Furthermore, lighting can establish unique moments in the built environment with a more artful approach in pedestrian-oriented spaces tucked between buildings.

As the campus works to minimize its environmental impact, lighting must be implemented with a vision for long-term resilience. New lighting technologies do not simply present an opportunity for lowered energy loads, but also more sensitively tuned and directed light. These energy-saving strategies should work to enhance and inform the lighting experience on campus, rather than be considered independently from the qualitative perspective.

As the lighting industry evolves at a rapidly accelerating pace, maintaining an overall vision for the nighttime campus environment will be an ongoing challenge for lighting designers and campus operations alike. A keen focus on transitions between varied light conditions, a sensitivity to site-specific context, and an overarching approach to campus-level tuning will guide campus to a sustainable, comfortable LED-illuminated landscape.

GUIDING DESIGN PRINCIPLES

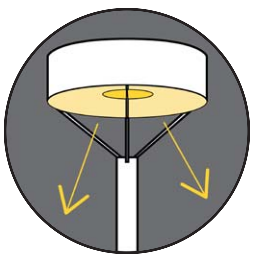
The following ten design principles reflect aspirational goals for outdoor lighting on campus that are meant to inspire designers and adapt to the rapidly evolving landscape of lighting technology while maintaining a vision for the campus as a whole.

1. HIGHLIGHT CONNECTIONS AND DESTINATIONS

Be intentional with light by highlighting paths and moments such as key gateways and building entries. Light hierarchies should prioritize connections and landing places, and avoid flooding large hardscaped areas, lawns, or wooded groves.

2. RESPOND TO SITE MATERIALS + SURFACES

Light reveals surfaces in the dark. As such, lighting should strive to work in tandem with site materials to best support a legible and comfortable nighttime experience. Light levels should respond to the reflectance of vertical and ground-plane surfaces rather than to prescribed standard illuminances.



3. MINIMIZE LIGHT TRESPASS

To the greatest extent possible, the UW campus should minimize light pollution by eliminating wasted light and reducing glare. Especially in sensitive habitat areas, such as along campus shorelines or woodland groves, fixtures should align with Dark Sky standards and be controlled to minimize or eliminate light when unnecessary or when spaces are not in use.

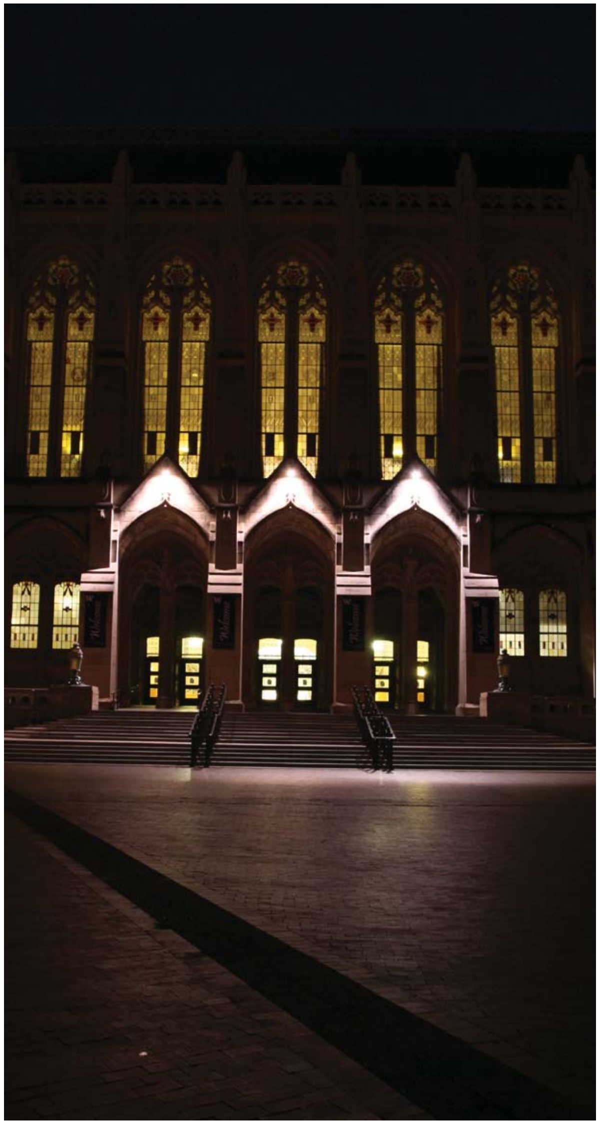


Figure 17. The facade of Suzzallo Library uses color temperature and vertical surfaces to articulate the building entry as a nighttime destination.

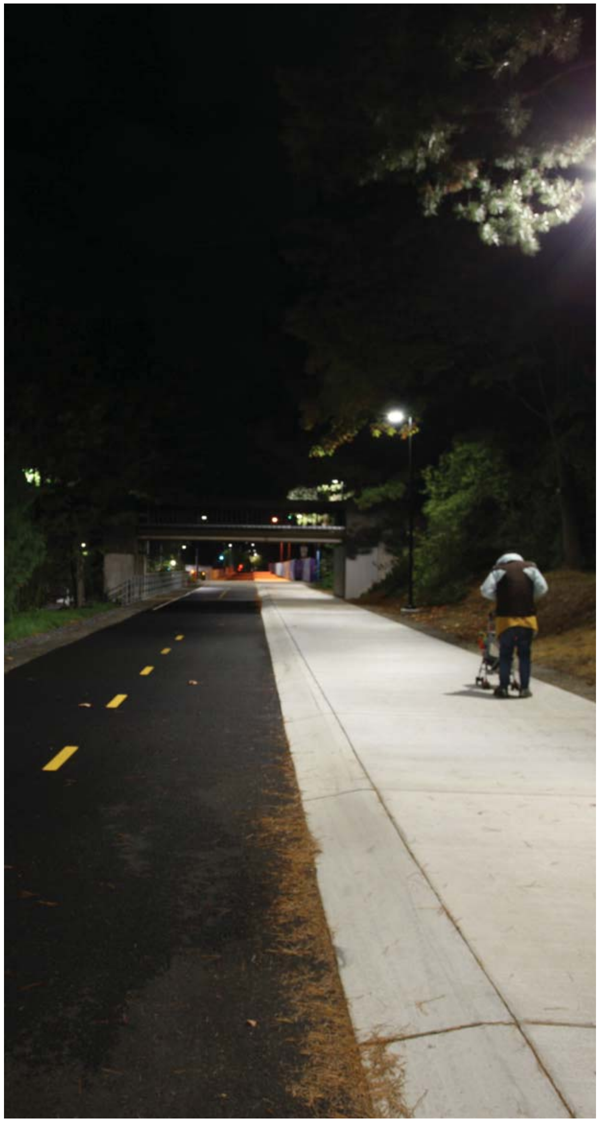


Figure 18. The Burke-Gilman Trail along NE Pacific St. uses landscape material surfaces with different reflectances to delineate nighttime circulation routes for different modes.

4. LONG-TERM PLAN FOR LED REPLACEMENT

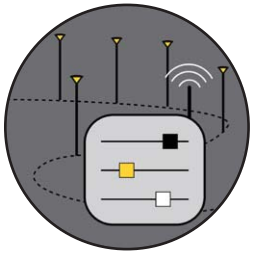
New technology allows for significant energy savings across nearly every measure, but the UW should aim to maximize the benefits of solid state lighting (SSL) by replacing legacy fixtures with a vision for the long term. Rather than approaching the transition as a one-for-one replacement methodology, UW should reconsider elements such as spacing and optics as LED sources are implemented across campus. Where point-to-point replacement is required for either cost or to retain historic fixtures and placement, consider adjusting the wattage and distribution of new lamps.

6. REDUCE LUMEN OUTPUT

In general, lamp intensity should be lowered across campus as LED lamps produce a better quality, more directed light source. As part of the commissioning scope, light levels should be tuned after implementation to ensure smooth transitions between campus spaces.

7. AVOID HIGH CONTRAST

Along pathways and circulation routes, light distribution should strive toward uniformity and gentle gradients between the brightest and darkest points to minimize glare for pedestrians, bicyclists, and drivers. Interventions that create high contrast conditions—such as wall packs—should be eliminated. Pedestrian glare can be mitigated with strategies such as shielding and diffusing lenses.



5. PLAN FOR FUTURE CONTROL CAPABILITIES

In anticipation of a future overhaul of the current "Cascade" control system, light fixtures should be selected with capabilities that leave opportunities open for new networked controls. As part of the design process, design teams should identify opportunities for dimming beyond daytime setbacks, especially in more easily controlled areas such as parking garages, and map new fixtures to control networks.

8. APPROPRIATE SCALE
Lighting should respond to the primary users of a space or path, both in scale and intensity. Pedestrian lighting should create a warmer, more human-scaled environment while multi-modal intersections will prioritize wayfinding and visibility. Proper pole spacing and mounting height can support efficiency goals and enhance the visual experience.

9. DESIGN FOR SCENE EXPERIENCE
Lighting designers should conduct an in-person nighttime site documentation and observation process prior to design development. Ultimate designs should target comfortable experience based on conditional site factors such as landscape surfaces, vegetation, and observed uses rather than prescribed targets.

10. CAMPUS-LEVEL COHERENCE WITH SITE-SCALE CHARACTER
Though an overarching language for campus lighting should be established in order to make the nighttime campus legible and consistency, small moments with unique lighting identities can be interspersed between and around buildings to enhance human-scaled spaces that add to the campus landscape character.

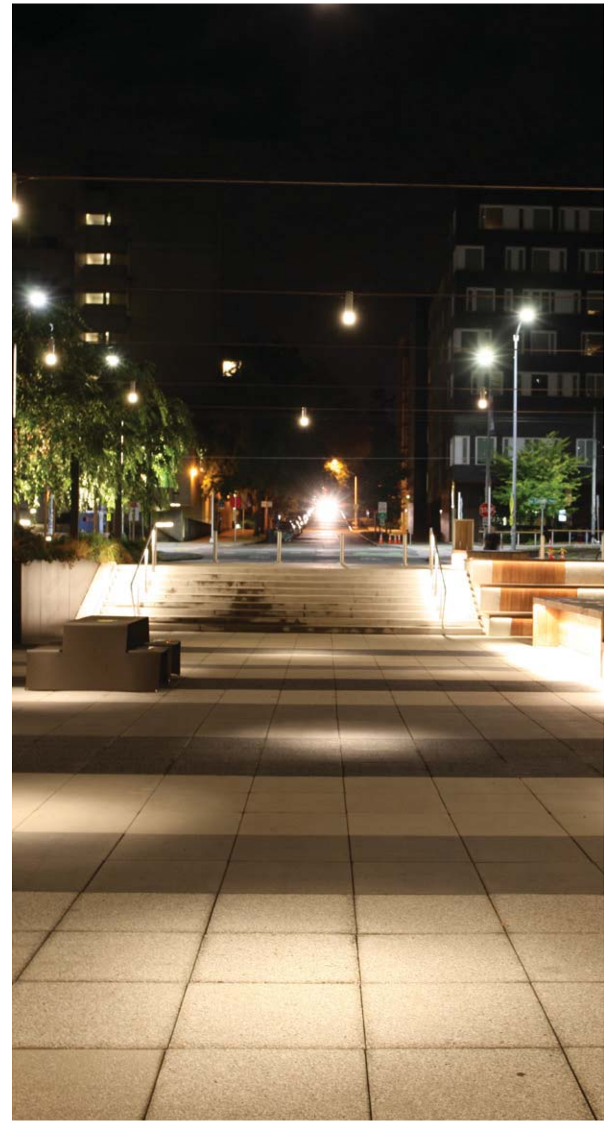


Figure 19. The plaza between Maple and Lander Halls in the West Campus Village uses human-scaled fixtures to create a unique "character" experience.

ADDITIONAL LIGHTING CONSIDERATIONS

SENSE OF COMFORT

A sense of safety and security in the nighttime campus is a clear priority for the UW community. Rather than increasing illuminance levels, a hierarchy of lighting can enhance a sense of comfort by increasing perceived brightness without increasing lumen output. Better quality light with a higher color rendering index in combination with a focus on vertical illumination can work to create environments that are legible and comfortable. In spaces where campus users may feel especially vulnerable, such as parking lots and limited access corridors, vertical illuminance can support facial recognition and eliminate high contrast areas.

DESIGN EFFICIENCIES

In order for new, more efficient technologies to perform at the highest possible levels, it is important to coordinate with designers and engineers to ensure lighting is integrated into the design of the built environment. These considerations include proper spacing—both pole spacing and mounting height—as well as interaction between light and site materials. Introducing lighting early in the design process can minimize the total number of fixtures and avoid ad hoc retroactive lighting solutions such as wall packs and flood lights.

EASE AND FREQUENCY OF MAINTENANCE

For lighting to be considered sustainable, measures must be adopted to minimize the frequency of fixture maintenance and to ensure that ease of maintenance is optimized. LED lighting has a much longer lifespan than other sources, and all fixtures should be selected that can be easily accessed and repaired.

CONTRAST AND GLARE

The UW campus presents a complex network of pedestrian and vehicular circulation, with many corridors supporting pedestrians, bicyclists, and drivers in a shared space. While the glare zone for drivers is between 75 and 90 degrees, pedestrians experience glare between 0 and 90 degrees of illumination. Site elements such as topography can increase glare risk for pedestrians and drivers. Lighting on campus should coordinate strategies such as shielding and diffusing lenses to minimize discomfort and disability glare, especially at key entries and intersections. Sources of glare, such as wall packs, should be removed or shielded.

COLOR TEMPERATURE

The UW strives to create a sense of community and identity in pedestrian-priority areas, and should adopt a warmer light color temperature— between 2700-3500K—in such spaces.

Though the UW aims to minimize vehicle-priority zones, in spaces such as parking garages and lots, a bluer color temperature can contribute to a sense of security and distinguish space types.

LIGHT DISTRIBUTION

The UW must minimize glare for bicyclists, drivers, and pedestrians by selecting fixtures and lenses that diffuse light and create more uniform light distribution along primary pathways. Lighting should generally aim for "soft edges," avoiding high contrast between the brightest and darkest points along pathways.

HIERARCHY

In the design process, a hierarchy of light should be delineated throughout the site. Major pathways, destinations, and key intersections should be prioritized.

LIGHT TRESPASS

The campus context encompasses an array of building uses, from classrooms to living spaces, that are occupied at all hours. It is crucial that fixtures are carefully shielded to avoid trespass into windows.

Additionally, Backlight, Uplight, Glare (BUG) ratings should be considered in order to eliminate trespass into sensitive ecological areas, between campus zones, and into neighboring communities.

LAMP EFFICACY

Lamps should be selected with the highest ratio of useful lumens per watt available, and reduce overall lumen output across campus.

COLOR RENDERING INDEX

High color rendering index values increase pedestrians' sense of safety and comfort, and enhance visual acuity. LED implementations should aim for 80 CRI or higher.

FIXTURE QUALITY

In order to extend the lifespan of lighting interventions, fixtures should be fully sealed and support high quality finishes to withstand environmental conditions.

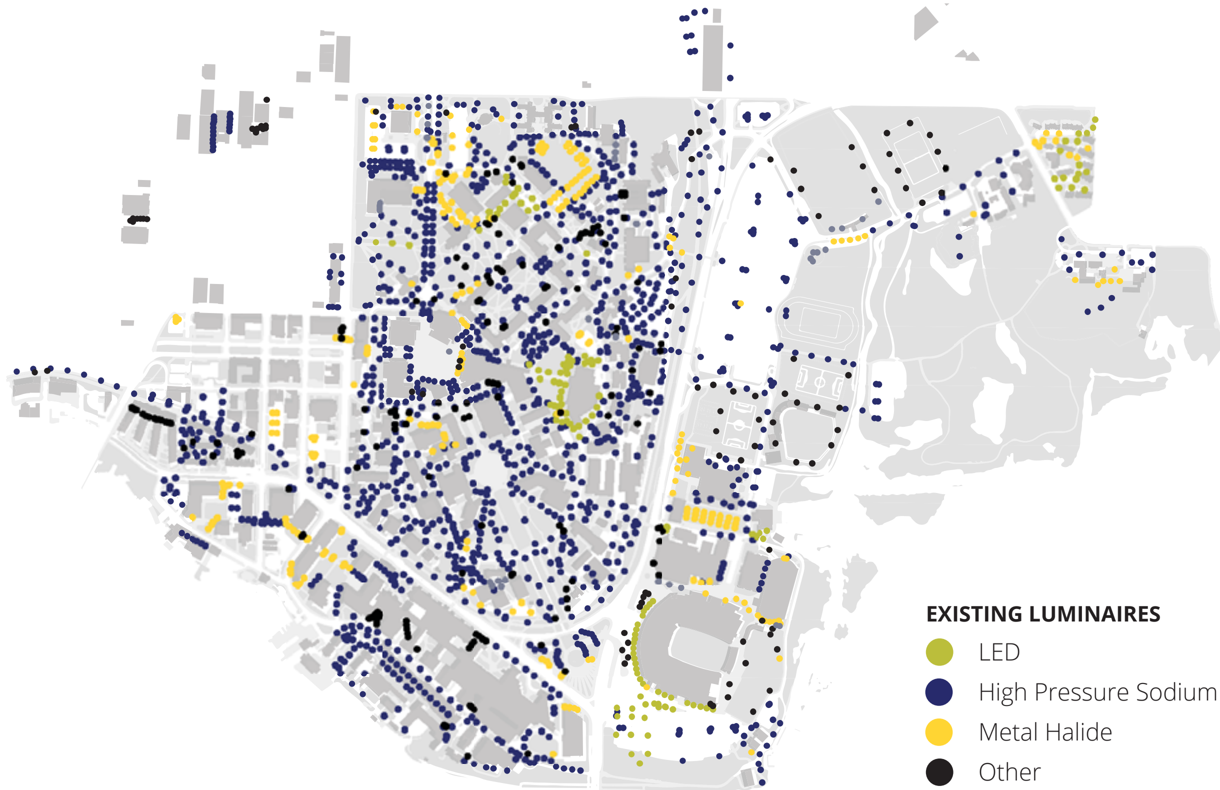
ENERGY GOALS

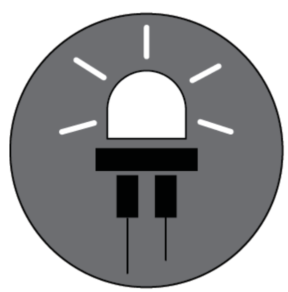
In order to reduce energy consumption by outdoor lighting UW should continually search for the most energy effective solutions for new and existing lighting on campus. Campus operations should look for opportunities to use controls (Occupancy, Scheduling, Bi-Level, Load Shedding, etc) on localized and campus-wide applications. Before the campus implements a new networked controls system, all lighting designs should include a controls intent narrative.

Beyond new technology, a more strategic lighting approach can achieve far greater energy savings than one-for-one replacements. Good LED design ensures that light is distributed only where appropriate and, with careful analysis, can result in improved visibility, less glare, and appropriate illuminance levels at significant reduction in running wattage and often beyond related equivalences.

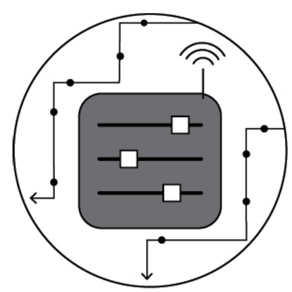
Additionally, high CRI lighting allows for lower light levels and hence lower energy consumption. When retrofitting fixtures or lamps, re-evaluate the need for light at the specific area being lit. More appropriate fixtures may require significantly less wattage and better distribution. Post-implementation tuning that adjusts dimmable fixtures to the most appropriate light output will ensure the most effective use of energy.

The UW continue to partner with Seattle City Light or the Lighting Design Lab for guidance on the latest technology and applications, and for potential utility conservation incentives for new fixtures and controls.

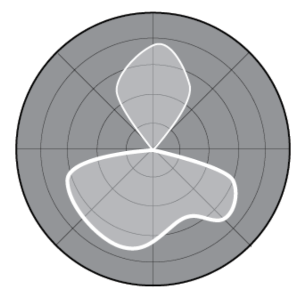




SOLID STATE LIGHTING



CONTROLS



PHOTOMETRICS

DARK SKY CONSIDERATIONS

The UW has adopted aggressive sustainability goals as part of the 2010 Climate Action plan. Exterior lighting plays a significant role in campus's overall environmental impact, not simply as a major consumer of energy, but also in terms of its impact on the night sky.

The International Dark-Sky Association (IDA) outlines strategies for exterior lighting that aim to diminish light pollution in the form of excess or misdirected illumination, protect sensitive wildlife habitats and cycles, and eliminate sources of disability glare. These measures enhance a sense of safety by eliminating areas of high contrast that provide hiding opportunities and support more comfortable nighttime environments.

The UW site lighting design guidelines focus on eliminating light above 90 degrees horizontal, which only accounts for sky glow. The UW must expand the glare zone to include anything above 60 degrees, and shielding or optics to prevent light trespass would be needed on a case-by-case basis depending on the luminaire location. The UW should further mitigate light pollution by factoring potential impact on sensitive habitats, such as shoreline and wetland areas and significant tracts of woodland ecosystems, into shielding and optics considerations.

The IDA recommends that outdoor lighting not exceed a color temperature of 3000K in order to prevent discomfort glare, protect healthy circadian rhythms in both humans and wildlife, and to move toward more naturally dark nightscapes. Lighting technology is rapidly evolving, and white light tuning is an increasingly available and feasible option for large-scale applications. The UW campus would benefit from using warmer light in pedestrian areas and in residential zones.

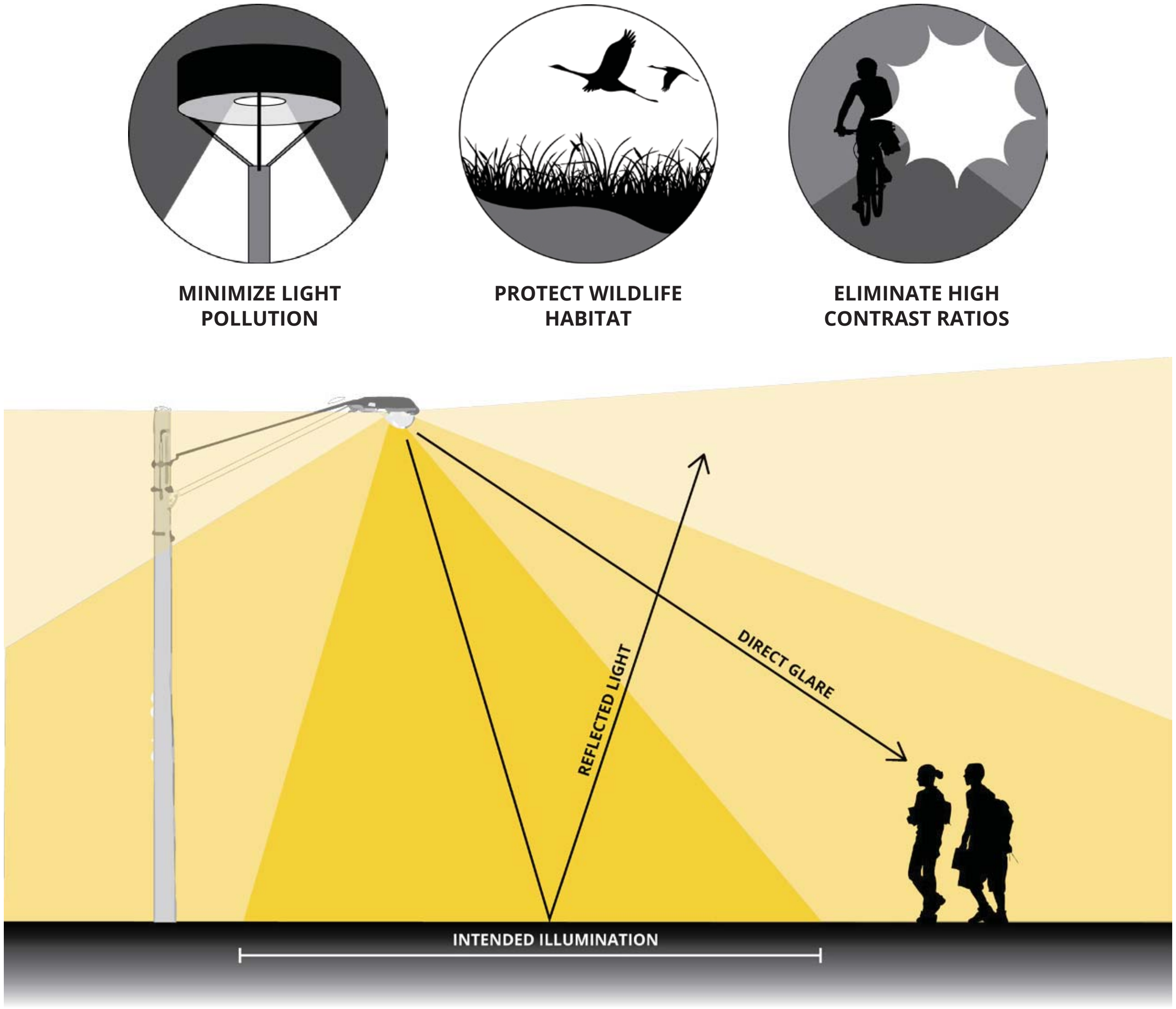


Figure 20. Dark Sky measures support healthy natural cycles and rhythms while creating a more comfortable experience for pedestrians and residents on campus.

CHARACTER VERSUS CAMPUS

Lighting at the UW Seattle campus is a tool both for creating a sense of legibility at the campus scale as well as delivering a more unique lighting experience at the site scale. The boundaries between campus standard lighting and building-specific “character” lighting may vary between projects, and should be determined as part of the design process.

Generally speaking, campus pathways and historic landscapes should move toward a more standardized fixture palette. In addition to fixture choice, qualities such as color temperature and perceived brightness should be considered at the campus scale. Open spaces that serve as campus gateways--such as the Montlake Triangle—can use lighting as a medium for transitioning between the city and campus contexts.

While campus standard areas focus on consistency, character spaces allow for more expressive lighting designs that enhance the architectural and landscape qualities of these sites. Character spaces have flexibility in terms of fixture type and color temperature, though ease and frequency of maintenance should remain a priority in design decisions.

While character spaces allow for more freedom in lighting expression, these zones should still align with overarching campus lighting goals including dark sky measures, an emphasis on destinations and connections, and achieving the lowest energy budget possible. Likewise, designers must illustrate how the character space will transition to the campus standard context. For example, pole fixtures may be consistent across all paths, while embedded fixtures around the building perimeter provide a more nuanced quality of light adjacent to the campus building.

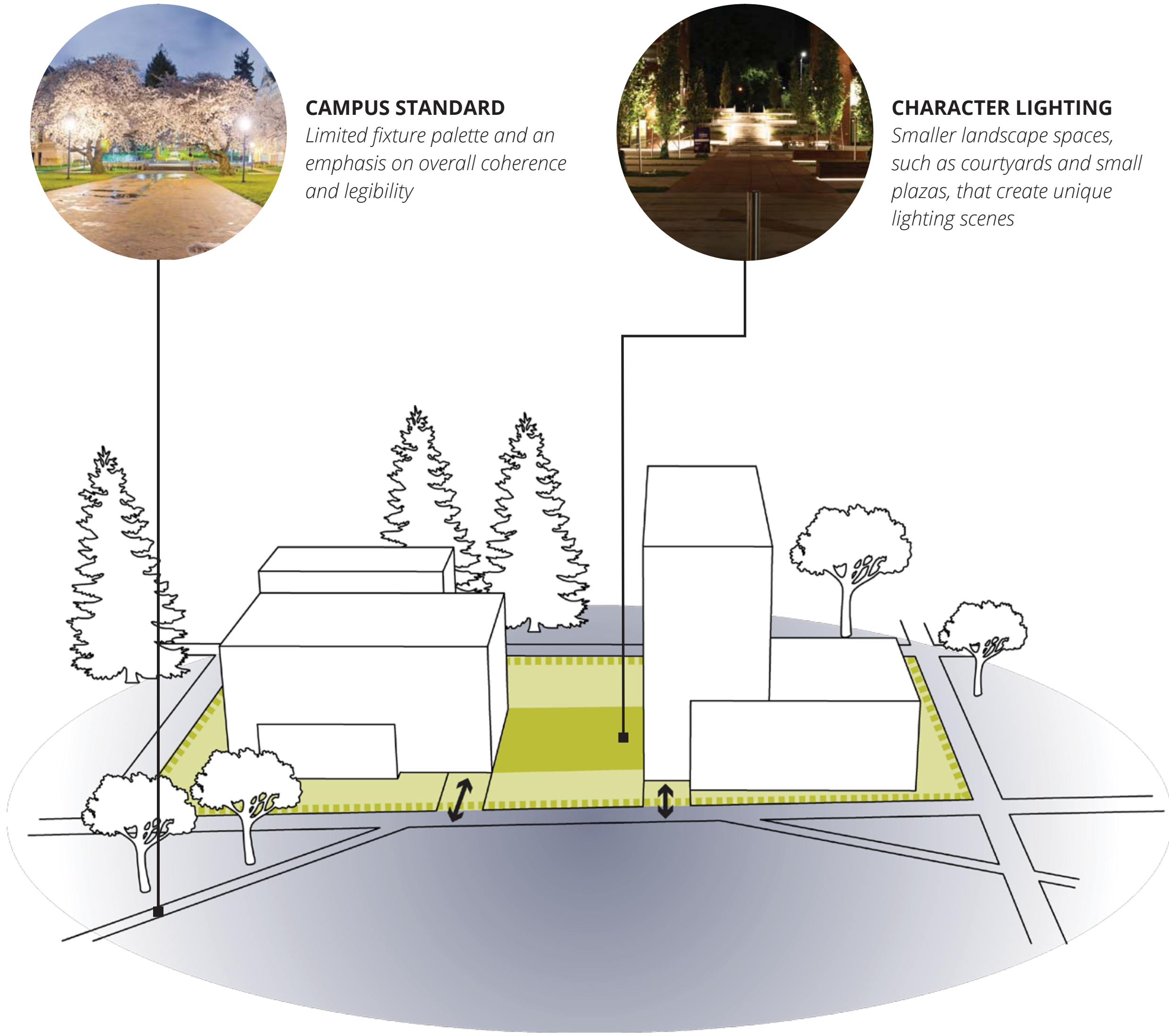


Figure 21. The majority of the campus circulation network falls within the campus standard approach, with a focus on creating a consistent nighttime environment across campus. Character spaces are those areas between and adjacent to campus buildings that provide opportunities for more expressive, unique lighting scenes.

CAMPUS CONTROLS

Lighting controls are part of a rapidly evolving industry and there are currently a variety of proprietary systems available on the market that feature promising capabilities that could greatly improve upon the current shortcomings of the Cascade system at UW. New adaptive controls have the potential to significantly reduce electrical loads that result from campus lighting and increase flexibility in tuning and dimming at the campus scale.

It is recommended that the UW conduct an additional study on lighting control systems prior to the adoption of a major overhaul. While it is outside the scope of this project to recommend a specific controls strategy for the UW Seattle campus, the following controls considerations should factor into future fixture and controls system selection processes:

ADAPTIVE COMPENSATION

UW should consider lowering the light level in the interior portals of buildings after sunset to aid in adaption from bright interiors to darker exteriors.

BI-LEVEL CONTROL

UW should consider having exterior lighting at a high level (110% of night target), at twilight when activity is highest and adaption is lowest, and then lowering the lighting to the target after an hour. Lighting can then be reduced further in some areas after an agreed upon time when activity is predicted to be lower (eg. After 2:00 AM). This sequence of operation could be initiated by an astronomical time switch or an astronomical time switch (ATS) and a photocell.

DAYLIGHT HOURS

Considered to be 30 min. before sunrise and 30 min. after sunset, but UW may choose to use a different interval.

LIGHTING CONTROL ZONE

At the UW as with many large and diverse campuses, logical groups of fixtures (Zones) may not have a common power circuit or power feed, this can make conventional control methods difficult. Wireless controls can help to mitigate this as they allow for control groupings to be done remotely and without the need for control wires.

MOTION SENSOR

Occupancy sensing used in exterior areas. For clarity, unless the lighting is tied directly to the building entrances, or interior spaces, the term Motion Sensor should be adopted for most outdoor applications.

NETWORKED LIGHTING CONTROL SYSTEM

UW should consider this to be a goal for a campus wide system. Perhaps all new construction and major renovations should conform to an agreed upon protocol, so that when a networked system is identified, the existing recent projects will be ready.

PHOTOSENSOR

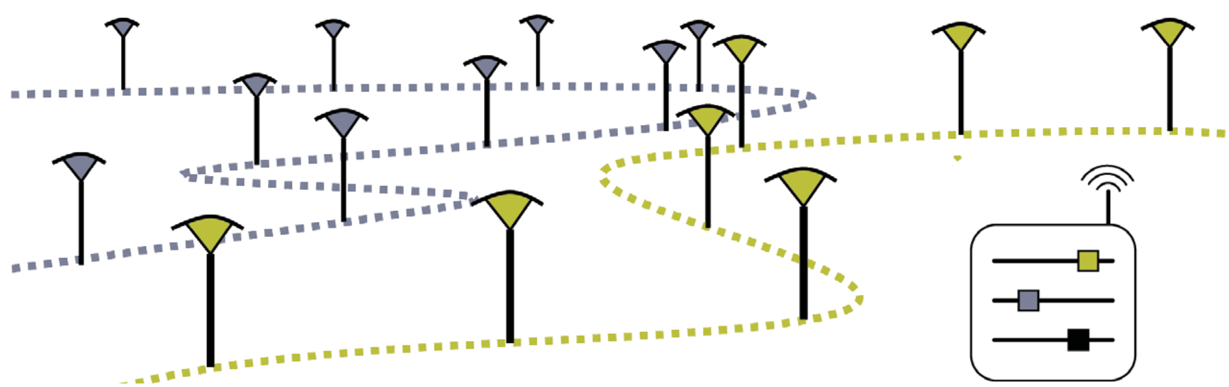
With the advent of LED luminaires, maintenance cycles are projected to be much longer. Most conventional exterior photosensors have a service life of about 5 years, making them a weak link in the longer time frame. New longer life sensors are available with ratings of 10 and even 15 years. UW should consider standardizing on these more durable products.

SEQUENCE OF OPERATION

Clarity and consistency are critical to a successful control system, and having a thoroughly planned out and agreed upon Sequence of Operation is fundamental to achieving those goals. The UW must be sure that all of the members of the design team and all of the contractors understand what the intent is and what Sequence of Operation is required to get there. In all exterior lighting projects there should be a written controls intent narrative. The contractor or installer should note any exceptions to the design intent prior to approval. The UW should consider creating a master controls intent narrative for the most prevalent outdoor lighting application types.

VACANCY SENSOR

Though Vacancy Sensing is popular and efficient in many interior spaces, Motion Sensing is appropriate for most exterior applications.



LIGHTING FOR EXPERIENCE

Campus lighting should be designed to meet experiential goals rather than prescribed illuminance standards. Lighting should strive to create an outdoor environment that feels comfortable during dark hours and that communicates clear connections and destinations to aid navigation for pedestrians, bicyclists, and vehicles alike.

Lighting designs should respond to specific site conditions — including the reflectance of landscape surfaces, the presence and type of vegetation, and adjacent building facades and intersections — to prioritize the factors that most strongly influence the pedestrian perception and experience. As such, it is strongly recommended that any new lighting design be preceded with a thorough nighttime site visit and documentation by the design team. The design team will take detailed notes about site uses and conditions in order to make informed decisions about light levels and qualities and how these elements fit into the adjacent campus context.

SEPTEMBER 2015 - HPS COBRAHEAD

JANUARY 2017 - LED REPLACEMENT

REPLACING OUTDATED TECHNOLOGY

A major lighting challenge that the UW faces in the short term is the transition between legacy lighting technologies and solid state lighting (SSL) strategies. As the campus moves forward in replacing outdated fixtures with LED, it is critical that the university sustain a long-term vision during this replacement phase.

Traditional campus fixtures are intended to support omnidirectional light sources. When legacy light sources are replaced with directional LED technology, it often results in a jarring sense that the new LED lighting is too bright or inappropriately intense for the scale of the campus area. Such conclusions are not necessarily the result of the new light source, but rather the one-for-one replacement approach that does not take into account the distinct qualities and capabilities of LED sources.

Moving forward, campus should adopt a replacement strategy for legacy HPS and MH fixtures that incorporates the directional and color rendering properties of LED into the replacement process. Since LED sources provide a much higher quality of light, these sources can be tuned to achieve a comfortable level of scene brightness at a much lower power density than the original HPS without sacrificing visual performance. Scene-level tuning should be incorporated as a part of the retrofit and replacement process in order to responsively balance light levels across campus spaces during and after the transition to LED sources.

Furthermore, UW should consider requiring a post-implementation tuning to help prevent an overall “brightening” effect on campus as new spaces tend to match the illuminance levels of the brightest areas. By managing light levels during even transitional lighting phases, the UW should strive to prevent the

Figure 22. LED campus standard fixture leading toward the UW Medical Center from Montlake Triangle.

Figure 23. LED campus standard fixture along path adjacent to the Intellectual House.

Figure 24. Temporary lighting on construction fence at site of the future Computer Science & Engineering building.

risk of over-lighting from using standards created for omnidirectional, low-color-rendering light sources for new LED capabilities.

The Montlake Triangle presents a successful implementation of new LED lighting in the connecting pathways between the central plaza and the UW Medical Center. The standard KIM fixture produces an even quality of light over the asphalt pathway surface without over-lighting adjacent landscape areas or competing with the surrounding context.

In areas within campus, such as in the North Campus housing community, LED implementation appears much bluer and brighter in relation to a context of legacy lighting. As these networks of SSL fixtures expand throughout campus, it is critical that light levels are tuned to balanced levels so that goals of experiential comfort and decreased lumen output are achieved simultaneously.

As the campus built environment constantly evolves, temporary lighting solutions during construction projects can significantly impact the nighttime campus. Construction lighting runs the risk of either creating significant glare or under-illuminating critical campus connections. The UW should consider standardizing temporary lighting practices or creating an opportunity for feedback from the campus community to ensure that these measures support positive nighttime circulation.

5. CAMPUS LIGHTING TYPOLOGIES

The Campus Landscape Framework is a 2015 document produced by the UW Office of the University Architect and Michael van Valkenburgh Associates that defines a mosaic of landscape typologies on campus. It provides observations and strategies for each space type in order to support an ongoing landscape identity as the campus evolves over time.

The campus mosaic is a helpful tool for facilitating design decisions in landscape interventions, but the landscapes are analyzed from solely from the daylight perspective. The following lighting strategies support the Campus Landscape Framework by offering design guidance for these spaces during dark hours.

While the daytime campus can support a fine grain of space types with a variety of uses, the nighttime landscape primarily supports passage between on- and off-campus destinations. As such, continuity and coherence become key outside of daylight hours. In response, the following lighting strategies have combined some of the mosaic categories that become more unified in use and appearance during dark hours.

Mosaic map from the Campus Landscape Framework document.

DAYTIME CAMPUS MOSAIC

- CAMPUS GREEN
- INFORMAL GREEN
- RECREATIONAL FIELD
- COURTYARD / TERRACE
- PLAZA
- WOODLAND GROVE
- INTERSTITIAL/BUFFER SPACE
- THRESHOLD
- PASSAGE
- URBAN FRONTAGE
- GARDEN
- SERVICE AND PARKING
- LAKE EDGE WETLAND
- MEADOW
- WATERFRONT

Figure 25. The campus mosaic envisioned as a nighttime landscape. This map is used to illustrate lighting hierarchy and campus coherence, and should in no way be interpreted as suggested light levels for these spaces.

SPACE TYPE APPROACH

Across all space types, it is critical to establish a lighting hierarchy within the site. Key intersections and entries deserve the most careful lighting attention, while vegetated areas and open lawns can remain relatively darkened. The space-type recommendations presented here are intended as aspirational goals that will be negotiated through site-specific design processes. It remains paramount that designers observe and experience the site and campus at night so that light responds symbiotically to the built environment.

Light is a three-dimensional element and it remains crucial to mitigate light trespass from all angles of a site. That being said, these space typologies — and coupled lighting strategies — should not be considered in isolation from each other. The space types should not be considered as discrete, bounded spaces, but should instead be understood as nodes fitting within the larger campus context. As a result, connections to adjacent sites become critical to ensure that users can fluidly move through campus without experiencing high-contrast transitions.

Figure 26. Lighting should draw people through and between space types rather than addressing them as discrete sites.

Figure 27. New construction should be designed in relation to its context and in anticipation of how the lighting language will scale in future campus development.

Figure 28. Continuity between lighting installations is key, especially along corridors such as the Burke Gilman.

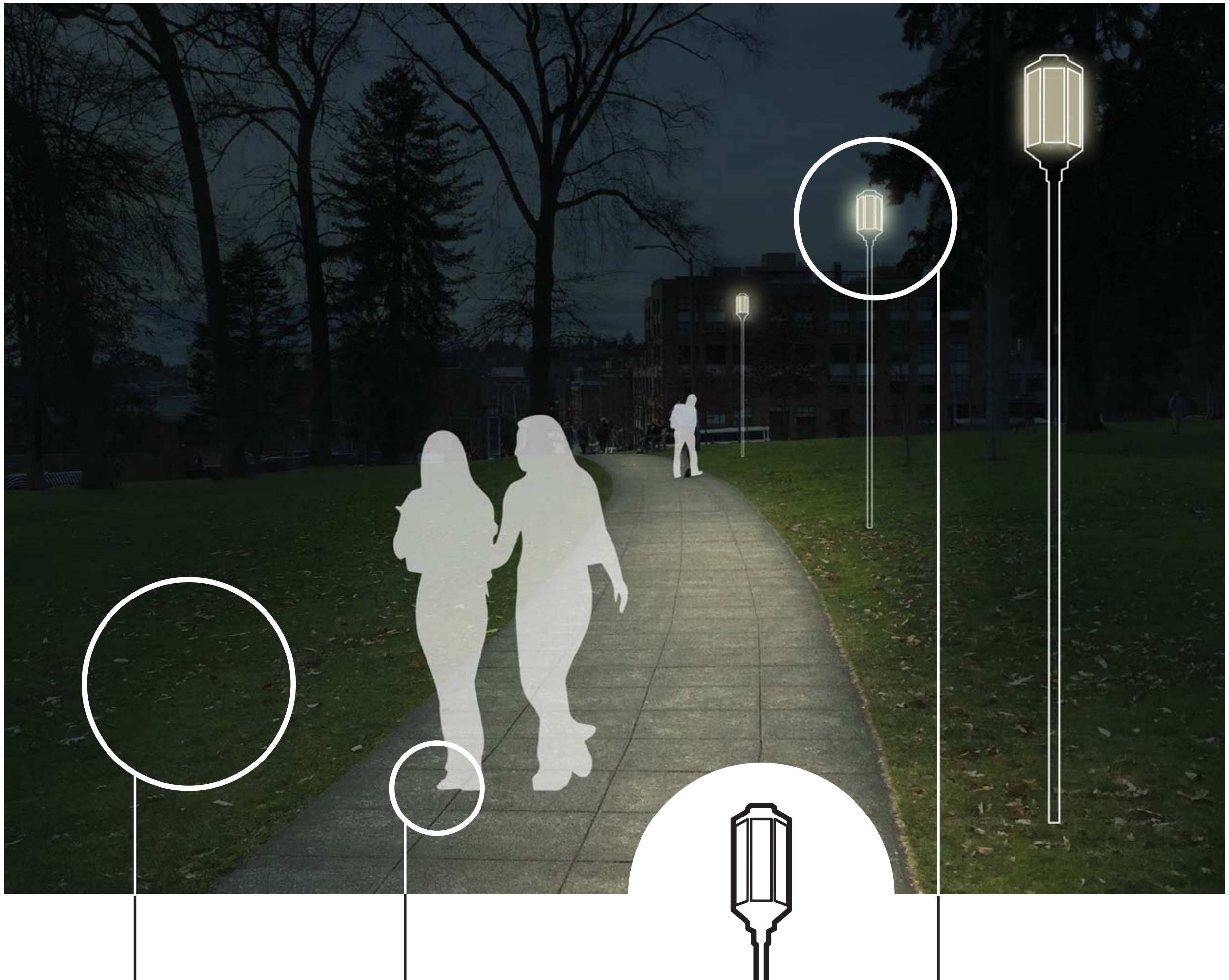
CAMPUS GREENS

NIGHTTIME CHARACTER

In the daytime, Campus Greens offer some of the most iconic landscape settings on campus including Rainier Vista and the Quad. By night, these spaces display a variety of lighting approaches, including traditional gothic fixtures with HPS lamps, legacy cobra head fixtures, and modern LED-integrated pole fixtures along the southern portion of Rainier Vista. Campus Greens are typically bounded by academic buildings, though Rainier Vista is bordered by groves of dark mature vegetation and a number of campus greens to the west share edges with 15th Avenue and NE Pacific St. The Campus Green ground plane comprises maintained turf, with path surfaces a mixed palette of asphalt, concrete, and brick.

NIGHTTIME FUNCTION

During the day, Campus Greens offer outdoor spaces for gathering, recreation, and studying. During the night, however, these spaces are primarily used for passage rather than as destinations. These recognizable spaces can potentially function as key navigation anchors in the nighttime campus.



Large expanses of lawn should not be flooded with light.

Light prioritizes primary pathways and key intersections and destinations.

Pedestrian-oriented lighting strategies including appropriate mounting height and warmer color temperatures.

CAMPUS GREENS

OBSERVATIONS

- The visual experience in Campus Greens is driven by edge conditions — vegetation and unoccupied buildings can make these open spaces feel isolated at night.
- Campus Greens that distribute light across lawns can feel overly bright and artificial.

LIGHTING STRATEGY

Lighting in Campus Greens should emphasize legibility and wayfinding to accentuate their function as key passage areas. Lighting should establish clear path hierarchy and lead pedestrians to nighttime destinations, including major building entries and connections to transportation corridors.

Light levels should be tuned in response to path surfaces, and distributed along path edges, resisting temptation to spread light over lawn areas. Campus Greens are iconic components of the campus character, and appropriately scaled pedestrian fixtures with a warmer color temperature should aim to facilitate a sense of comfort and confidence moving between campus spaces.

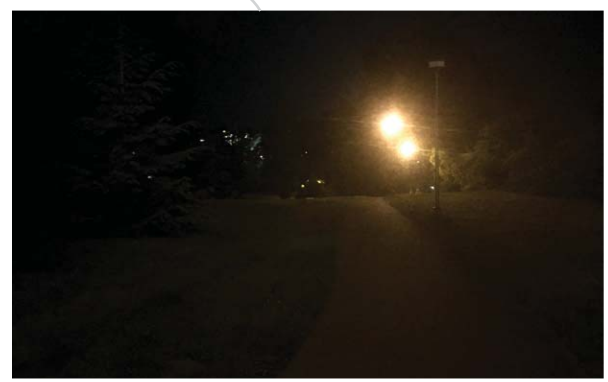
INFORMAL GREENS

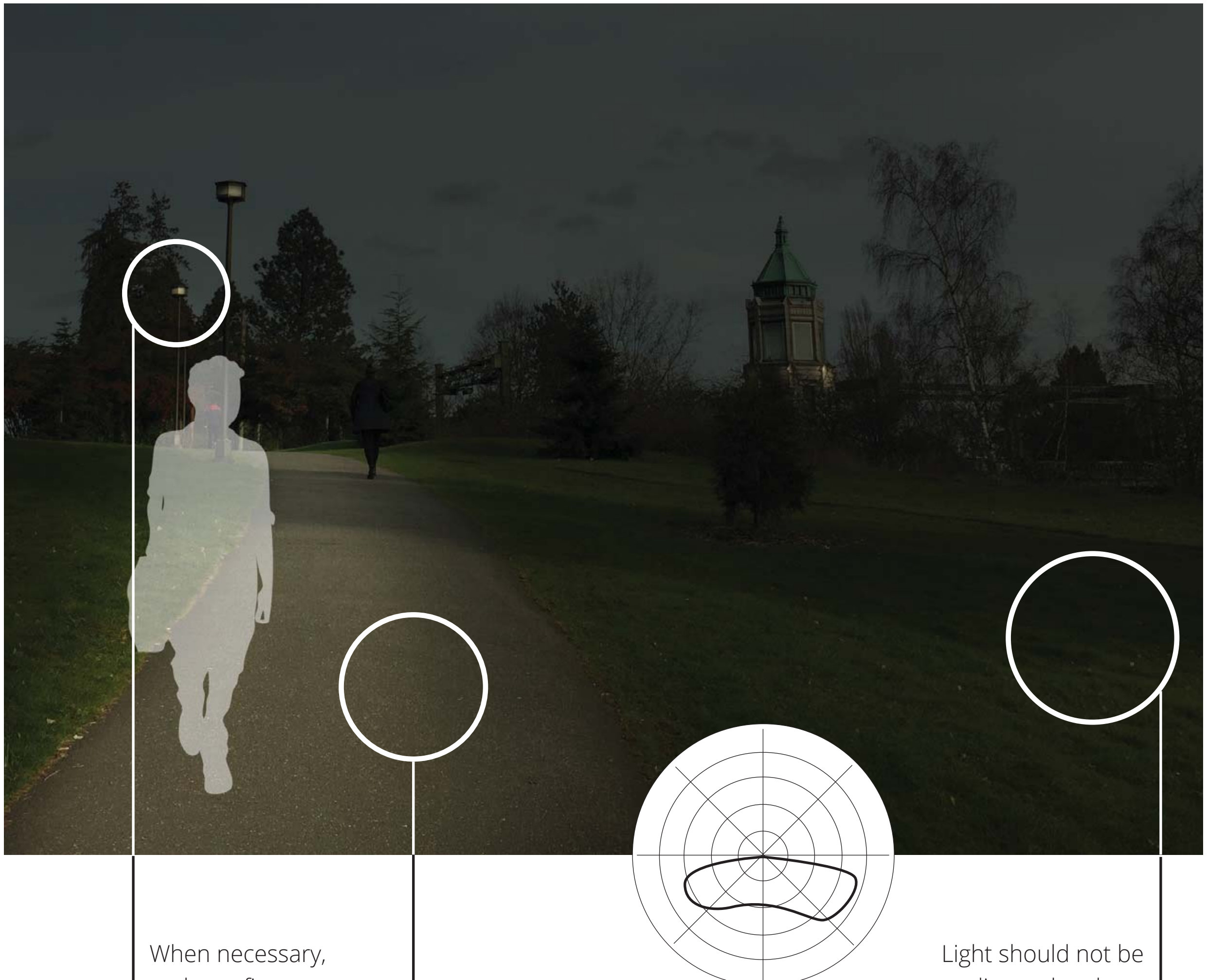
NIGHTTIME CHARACTER

Informal greens, like campus greens, largely comprise open lawn areas bounded by building facades or mature canopy cover. Unlike the more structured Campus Green designs, Informal Greens offer a range of surface conditions from defined concrete paths, unfigured dirt paths, or lawn without paths. Light fixtures in these areas range widely from traditional campus gothic in Central Campus, to varied pole fixtures in South Campus. Spaces without pathways are generally unlit, but are often illuminated by spillover from adjacent cobra head fixtures or interior and exterior building light sources.

NIGHTTIME FUNCTION

Informal Greens are neither primary destinations nor major corridors in the nighttime campus. In some instances, these landscapes buffer building entries, in which case they provide transition from major routes to campus buildings. The Informal Green area along the southern shoreline is not currently a primary nighttime pathway, but could become increasingly significant as a nighttime connector as increased development is anticipated in the South Campus neighborhood.





When necessary, pathway fixtures should align with campus standards.

Pathway material can be selected to enhance nighttime navigation and legibility.

Light should not be directed on lawn or vegetated areas, especially by waterfront

INFORMAL GREENS

OBSERVATIONS

- For the most part, lighting in these spaces feels somewhat unintentional, save for newly redesigned building sites.
- Most Informal Greens do not support significant traffic at night, and are not a lighting priority.

LIGHTING STRATEGY

Generally, Informal Greens without pathways can be comfortably lit by adjacent path and building sources. When the Informal Green supports pathways that extend beyond these sources, campus standard fixtures will typically be appropriate. Expanses of lawn and vegetation should remain unlit; building facades and wayfinding signage can provide the visual cues necessary to navigating the nighttime campus confidently and comfortably. As the campus waterfront receives more landscape attention, lighting should be installed at the pedestrian scale and be carefully shielded and appropriately tuned to avoid light trespass on sensitive aquatic habitat. Pathway and ground material contrast can help with navigation and nighttime legibility.

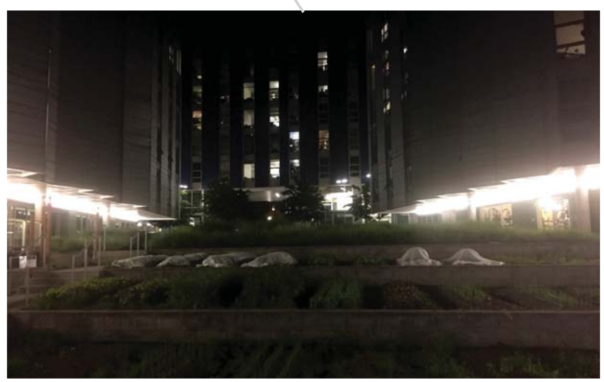
GARDENS

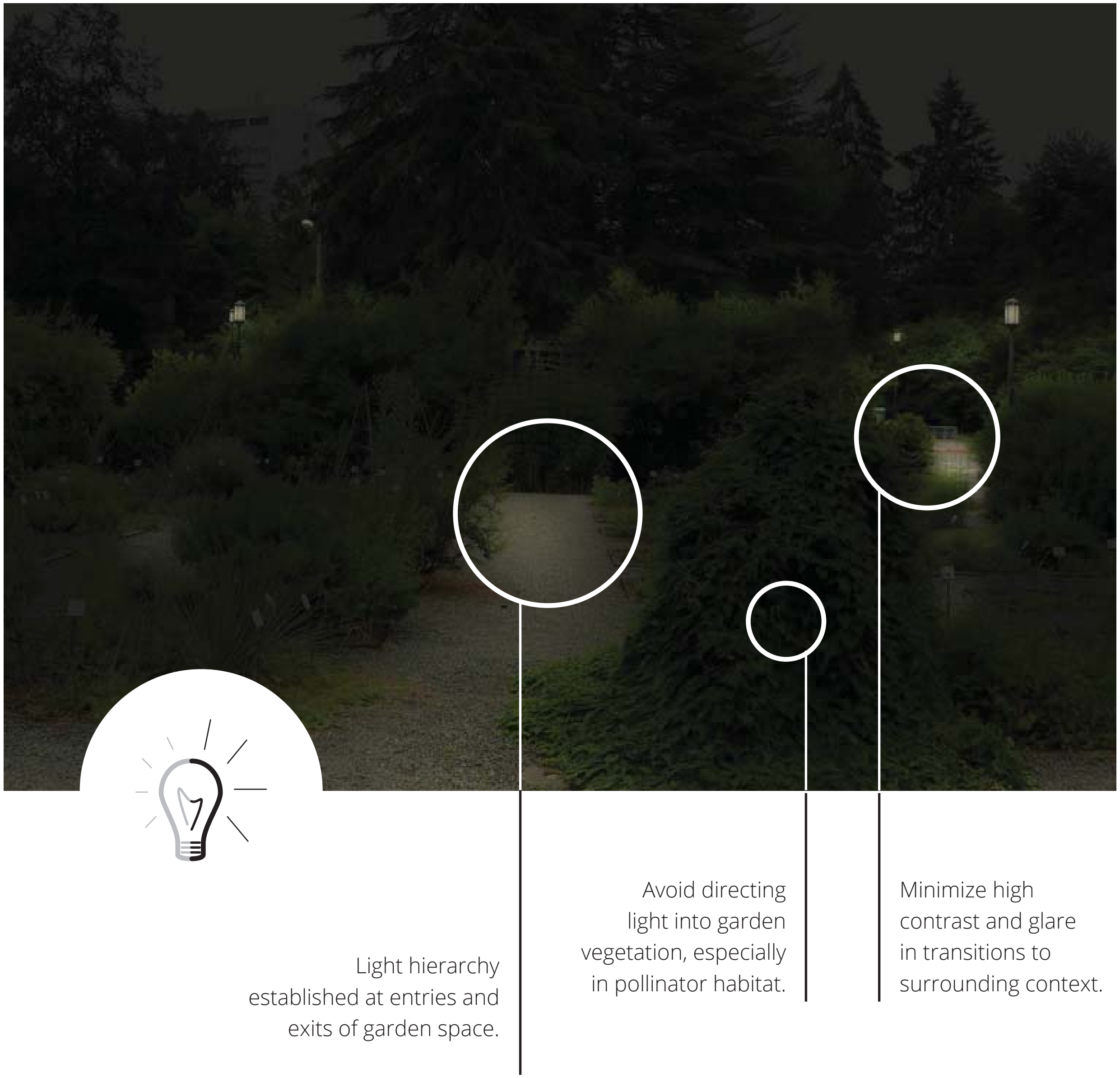
NIGHTTIME CHARACTER

Garden landscapes are of a smaller scale than Campus or Informal Greens, and largely unoccupied and rarely travelled through during non-daylight hours. During the day, these spaces provide respite from more active areas of campus, but at night they can often feel closed off and uncomfortable. Garden spaces in Central Campus are enclosed with tall deciduous and evergreen canopy, as well as dense shrubs. The Mercer Court gardens act more as courtyard spaces, lit primarily by wall packs mounted on adjacent facades.

NIGHTTIME FUNCTION

Due to landscape conditions, garden spaces on Central Campus will never accommodate significant campus activity during dark hours. As enclosed spaces, they are less desirable as nighttime passages, though must be sensibly lit to ensure a sense of safety for pedestrians who do choose to occupy these spaces after sunset.





GARDENS

OBSERVATIONS

- Often these spaces can feel enclosed and perceived as especially dark during the night, especially if there is high contrast at the entry
- Gardens do not support significant nighttime passage or activity

LIGHTING STRATEGY

Garden landscapes should fold seamlessly into the nighttime campus, avoiding glare or contrast that could contribute to a sense of insecurity in these spaces. Entries and connections between Gardens and adjoining pathways should transition smoothly, while taking care not to over light these small spaces. Recent and future garden designs in more urban or courtyard settings have a potential to be expressed with more unique character lighting that reflects the special quality of the garden typology. For gardens attempting to attract pollinators or other beneficial wildlife, care should be taken to avoid directing light or excessive blue frequencies into garden vegetation that could disrupt intended habitat formation and plant growth cycles.

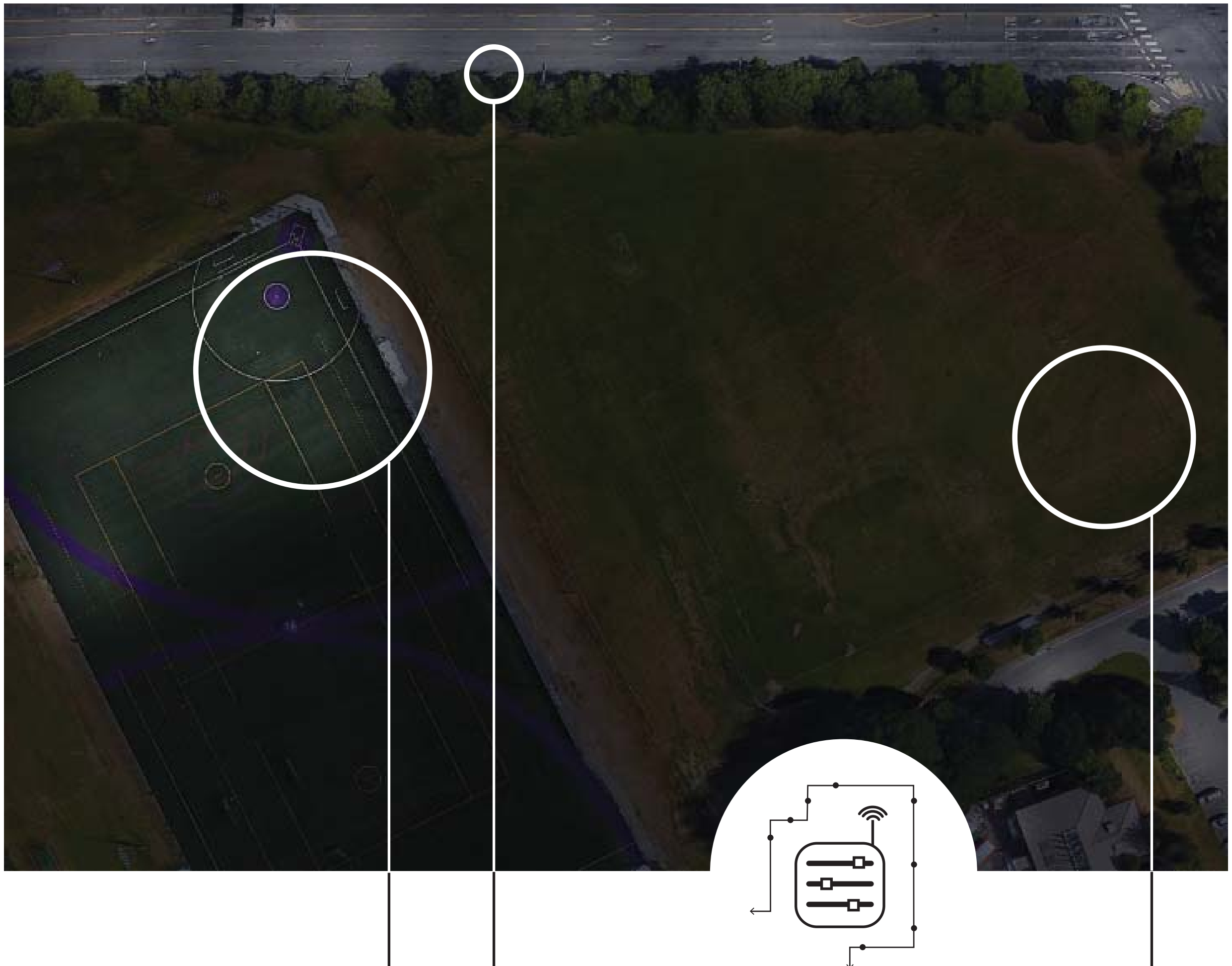
RECREATIONAL FIELDS

NIGHTTIME CHARACTER

Recreational fields are activated at night on a variable basis. Especially during the winter season, these spaces are regularly used by varsity, club, and intramural sports teams for practice and competition after sunset. When not in use as a recreational space, these fields are largely unoccupied and rarely traversed as passage. Grass fields currently do not host any light sources, while synthetic fields generally have metal halide or LED fixtures on timers that are turned on when in use. Recently the UW installed more efficient controls so that certain portions of the fields can be illuminated in isolation.

NIGHTTIME FUNCTION

Recreational fields have a limited, single-use function with little ecological habitat value. As a whole, they provide space for organized recreation and are lighted to support the visual tasks of athletic activities. Grass fields are rarely activated during dark, while electrically lighted synthetic fields are more frequently used during evening and early morning hours.



Only occupied portions of the field should be lighted at any given time.

Fixtures should be carefully shielded to avoid light trespass into neighboring areas.

Grass fields should remain unlighted.

RECREATIONAL FIELDS

OBSERVATIONS

- These single-function spaces are often used during the evening for organized recreation
- The open nature of these areas create conditions that allow for minimal light levels along paths when fields are not in use

LIGHTING STRATEGY

Recreational fields present an opportunity for the UW to further explore tighter controls and more efficient fixtures to further reduce electrical loads in these spaces. While recreational field lighting should prioritize visibility and uniformity for athletic programming, any pedestrian paths transecting these areas should retain the standard campus fixture language. Only occupied portions of the field should be illuminated at any given time. Adaptive controls can provide additional specificity in light levels depending on the nature of the recreational activity. Where these fields are adjacent to greenbelts, care should be taken to minimize the light spill into this habitat.

WOODLAND GROVE

NIGHTTIME CHARACTER

The Woodland Grove is a central component of UW's Pacific Northwest identity, with dappled sunlight and verdant growth providing an essential perimeter to the campus as well as critical habitat for birds, bats, and other terrestrial species. At night, however, these spaces can often feel overly dark and unsettling. The dense vegetation, which is crucial to a healthy forest ecosystem, does not offer many lighting opportunities without negatively impacting forest habitat. Many key corridors transect Woodland Groves, such as the Burke Gilman and paths traversing the North Campus Housing area and these pathways present a challenge for supporting comfortable passage without creating conditions of high contrast. Currently, an eclectic mix of pole fixtures is present throughout Woodland Grove landscapes.

NIGHTTIME FUNCTION

The primary—and often competing—functions of Woodland Groves at night are supporting pedestrian passage and providing ecological habitat. Pathways through these areas range from large, multi-modal corridors to small connector paths between campus buildings. Many major campus gateways interface between Woodland Groves and perimeter rights-of-way.

Facial recognition is key to creating sense of safety in vegetated areas.

Low-output, soft lens pedestrian-scale fixtures to minimize glare.

Light distributed along path, minimizing trespass in adjacent areas.

WOODLAND GROVE

OBSERVATIONS

- These spaces are perceived as the darkest on campus, with non-functioning fixtures and un-maintained vegetation exacerbating these conditions
- High contrast transitions into Woodland Groves amplify the feeling of enclosure in these spaces

LIGHTING STRATEGY

The Woodland Grove is an essential feature of the UW campus landscape identity, but presents a unique challenge in lighting to ensure a sense of security, facilitate safe multi-modal transportation, and protect sensitive wildlife habitat. Light can be tool to move users through these spaces, and it is of utmost importance that these areas minimize contrast and glare to ensure gentle transitions between more open campus landscape spaces and wooded areas. Path surfaces with higher reflectances such as concrete can illuminate a legible ground plane without raising light levels. Pole fixtures can provide a processional language that leads users through wooded corridors and key intersections should be clearly articulated to minimize risk of collision. Facial recognition is key component of enhancing a sense of safety in these enclosed conditions.Vegetation should be carefully pruned so as not to obscure any light sources. An increased frequency of soft-lensed pedestrian fixtures below the canopy level—with front and back shielding to distribute light along the path—would maximize facial recognition while minimizing glare.

COURTYARDS | TERRACES

NIGHTTIME CHARACTER

Courtyards are relatively small spaces, with varying ratio of hard to vegetated ground surfaces. These areas are often designed in tandem with adjacent buildings, and have more unique landscape identities than larger campus spaces. Lighting within these courtyards takes on the individual character of the courtyard, often with a more artistic design intent.

NIGHTTIME FUNCTION

Courtyard spaces are one of the more actively occupied landscape spaces after dark, providing gatherings space in addition to passage. Adjacent residential buildings can contribute to a sense of security, and these spaces serve as important nodes in residential areas of campus. In many cases, they contain key building entries. Courtyards and terraces are also viewed from windows of adjacent buildings.

Lower light levels with warmer color temperatures prioritize pedestrian uses.

Opportunities for character lighting with artful touches.

Highlight building entries and use vertical surfaces to create an “envelope” of light.

COURTYARDS | TERRACES

OBSERVATIONS

- There is a varied palette of fixtures across these distinct landscapes
- Courtyards that have vertical illumination along the perimeter feel the most comfortable

LIGHTING STRATEGY

Courtyards offer an opportunity for lighting designers to express creative designs that enhance the architecture of the surrounding environment. In relation to the overall campus context, light levels in courtyards should be relatively subdued. Light trespass considerations become key in these spaces, as buildings windows are directly adjacent to these sites. Courtyards can take advantage of vertical surfaces to create envelopes of experience tucked away between campus buildings. Light can be a tool for nighttime whimsy, but care should be taken to limit the number of fixture types to ensure that these spaces can be easily maintained in the long run.

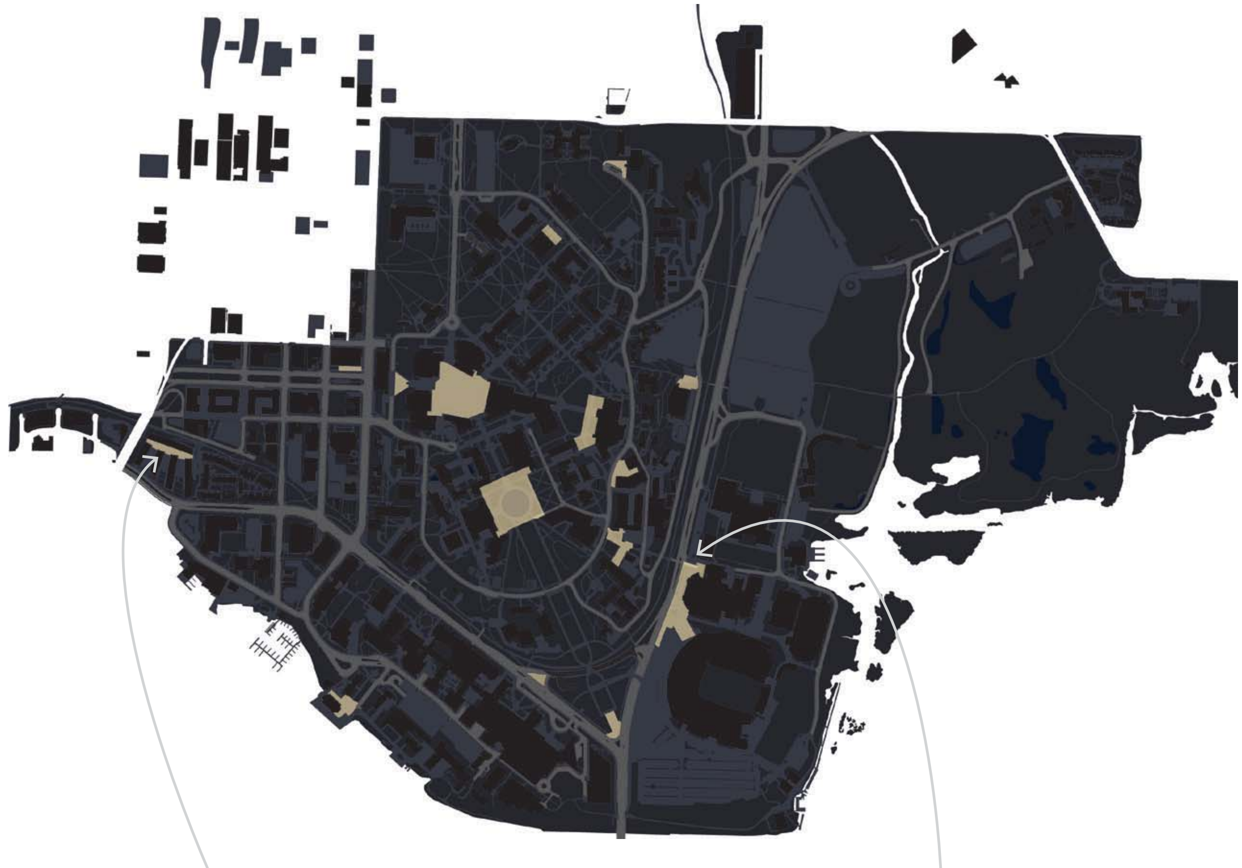
PLAZAS

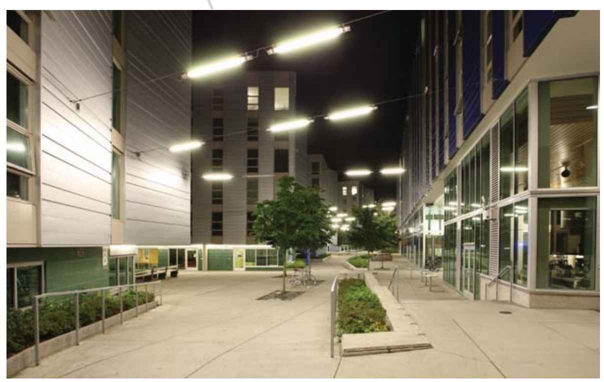
NIGHTTIME CHARACTER

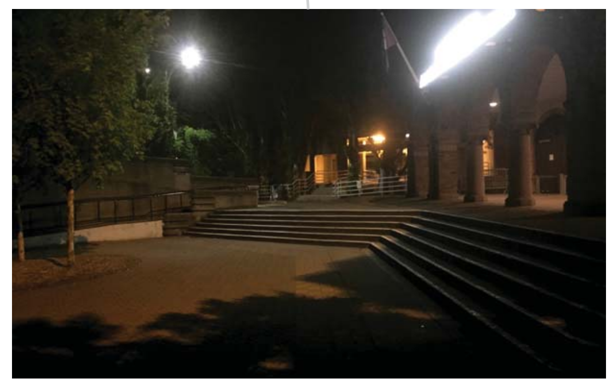
Plazas generally feature hardscape ground planes, and are bounded by building facades and, occasionally, street edges. Lacking defined pathways, light fixtures tend to be relegated to the perimeter of these spaces and much of the visual experience is gained from illuminated vertical surfaces that define the edges of Plazas. The Drumheller fountain is somewhat of an outlier, with distinct paths and traditional gothic fixtures.

NIGHTTIME FUNCTION

Plazas are important nodes for nighttime circulation, acting as major intersections between primary and secondary campus routes. Plazas provide a mixing space of pedestrians that can potentially help orient campus users within the larger campus. These spaces are critical in the nighttime campus, hosting entries to major nighttime destinations including the HUB, Odegaard Library, and the East Campus plaza that leads toward the IMA and the University Light Rail station.







Low-contrast transitions allow for fluid movement through plaza into adjacent sites.

Light distributed around perimeters of plaza with lower light levels in hardscape interiors.

Key building entries and circulation nodes are prioritized in lighting hierarchy.

PLAZAS

OBSERVATIONS

- Plazas encompass some of the most diverse lighting strategies on campus, with the most successful plazas having relatively low light levels in the interior and softly illuminated facades around the perimeter
- Generally, there is a lack of articulation of entries to adjacent circulation routes, which can leave plazas to be disorienting at night

LIGHTING STRATEGY

As critical components of the nighttime landscape, Plazas can take advantage of plentiful paving on the ground plane and available vertical surfaces to provide the bulk of illumination. The primary function of lighting in these spaces is to articulate the plaza perimeter and identify key entries, both to major buildings and to primary pathways that adjoin the plaza space. These spaces should feel vibrant and active at night, taking advantage of additional sense of security perceived from the presence of adjacent buildings. Light fixtures must avoid over illuminating the ground plane and allow vertical surfaces to cue the visual experience. The color temperature should support a sense of comfort and gathering, tending toward the warmer pedestrian aesthetic.

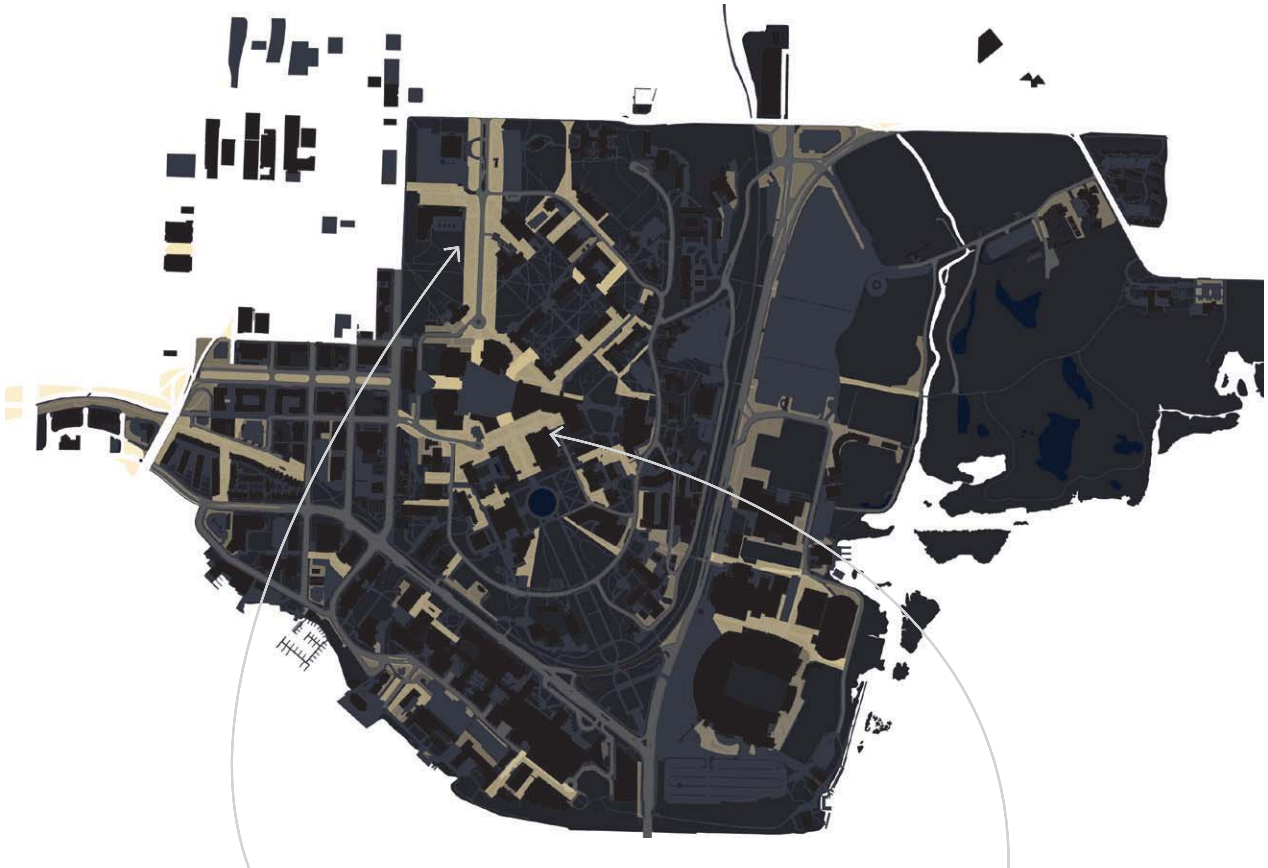
BUFFER | THRESHOLD | PASSAGE

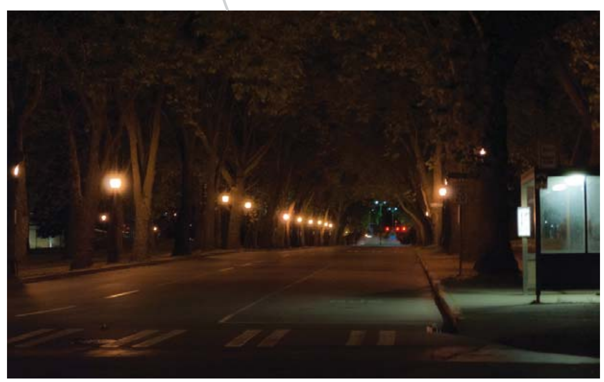
NIGHTTIME CHARACTER

During the day, these spaces are defined as three distinct campus typologies; at night they largely support similar uses. These in-between and through spaces present a mix of edge conditions, including low vegetation, high canopy, and building facades. There are a patchwork of lighting conditions, which can lead to a fragmented experience moving between these spaces at night. Often ad-hoc wall packs and flood lights can be found in these areas that can create conditions of high contrast and glare that detract from an overall campus legibility. The more formal pathways generally have gothic or cobrahead pole fixtures.

NIGHTTIME FUNCTION

The primary and uniting function of these diverse spaces is passage, ranging from major circulation corridors like Memorial Way to less-frequented interstitial spaces between academic buildings. These spaces should aim to facilitate connections between nighttime destinations and more open spaces.





Soft-edged light distribution along edges of pathways.

Establish light hierarchy and eliminate wall packs and floodlights.

Balanced light levels between space types.

BUFFER | THRESHOLD | PASSAGE

OBSERVATIONS

- There are a mix of intentional and unintentional lighting conditions, which creates a fragmented nighttime experience when moving through campus, even as people move fluidly between them.

LIGHTING STRATEGY

These campus spaces are critical to creating a cohesive campus experience, and should use a standard language to balance light levels at the campus scale. Consistency in color temperature, light qualities, and mounting heights can offer a cohesion in the nighttime experience that will greatly contribute toward successful wayfinding and navigation during dark hours. Reliance on measures such as wall packs and floodlights should be eliminated, and ease of maintenance prioritized. It may be helpful to coordinate lighting at the scale of the campus neighborhood.

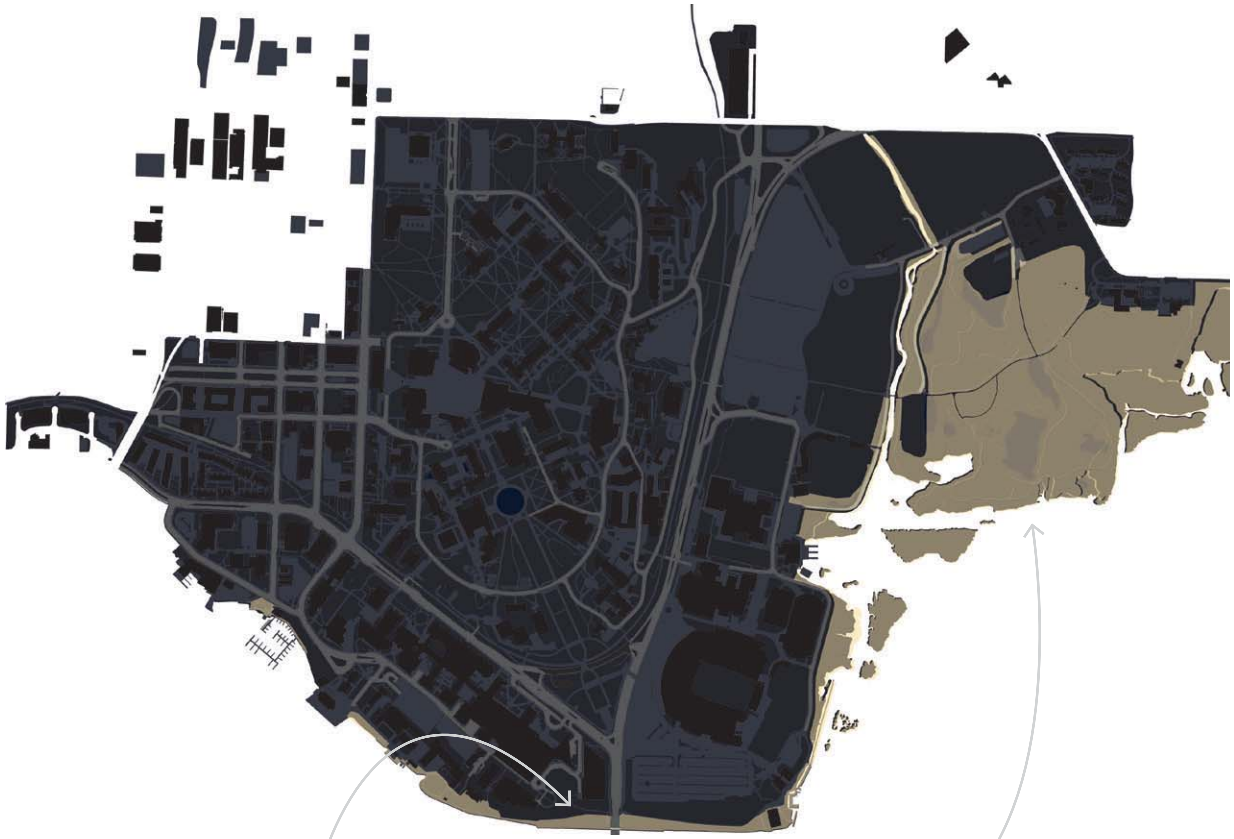
SHORELINE HABITAT

NIGHTTIME CHARACTER

The shoreline is a quiet space at night, without much human presence. The constructed waterfront interfaces with South Campus buildings and service areas, while the Union Bay Natural Area (UBNA) encompasses a larger region without campus buildings. These spaces are largely free of light fixtures, though the constructed waterfront receives a significant amount of light trespass from adjacent buildings and path lighting.

NIGHTTIME FUNCTION

There is potential for light pedestrian circulation along the campus waterfront, but the primary use of these areas is as ecological habitat for avian, aquatic, and amphibious species. UBNA is both the most expansive and the darkest area of campus, and supports a large diversity of diurnal and nocturnal species that rely on darkness for health and survival.



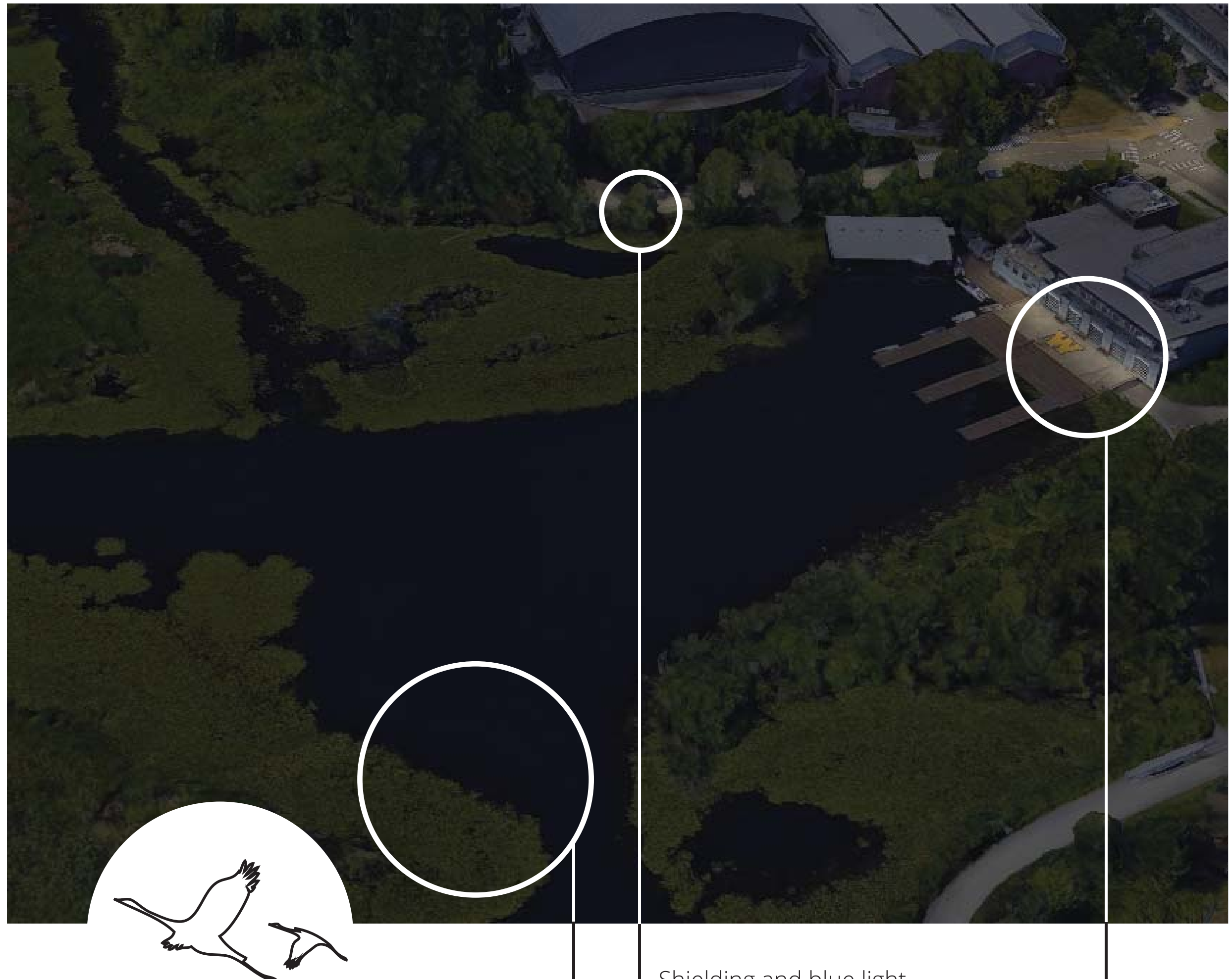
SHORELINE HABITAT

OBSERVATIONS

- UBNA utilizes very little electrical light, which should remain a campus priority to protect sensitive ecosystems and wildlife cycles.
- There is considerable light trespass onto the water along the southern shore of campus which needs to be mitigated through retrofits and eliminated in new design through the use of shielding or specially selected optics

LIGHTING STRATEGY

To the greatest degree possible, the UBNA should remain dark. If it becomes necessary to light key pathways, fixtures should reduce blue light levels and be fully shielded to avoid light trespass into critical aquatic or terrestrial habitats. Along the southern shore's pedestrian pathway, a conscientious standard campus language with warmer color temperature is appropriate, with fixtures carefully shielded so that light is only directed on path surfaces. Additionally, there are LED fixtures that pull out the blue spectrum as the night progresses, so that light is high CRI during periods of pedestrian activity, but transitions to green and yellow wavelengths after peak occupancy hours to have less impact on wildlife.



Shielding and blue light controls can mitigate impact on habitat.

Allow sensitive terrestrial and aquatic habitat areas to be dark at night.

Prevent light trespass on water in areas where buildings face the shoreline.

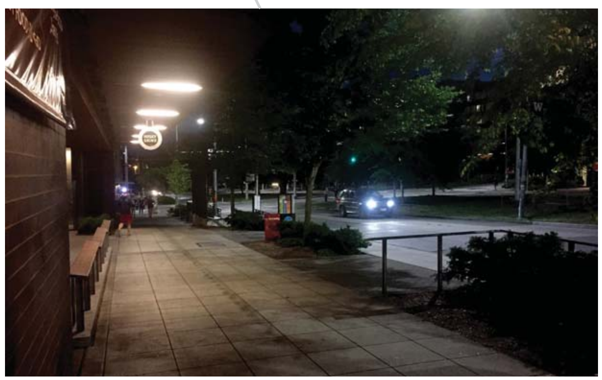
URBAN FRONTAGE

NIGHTTIME CHARACTER

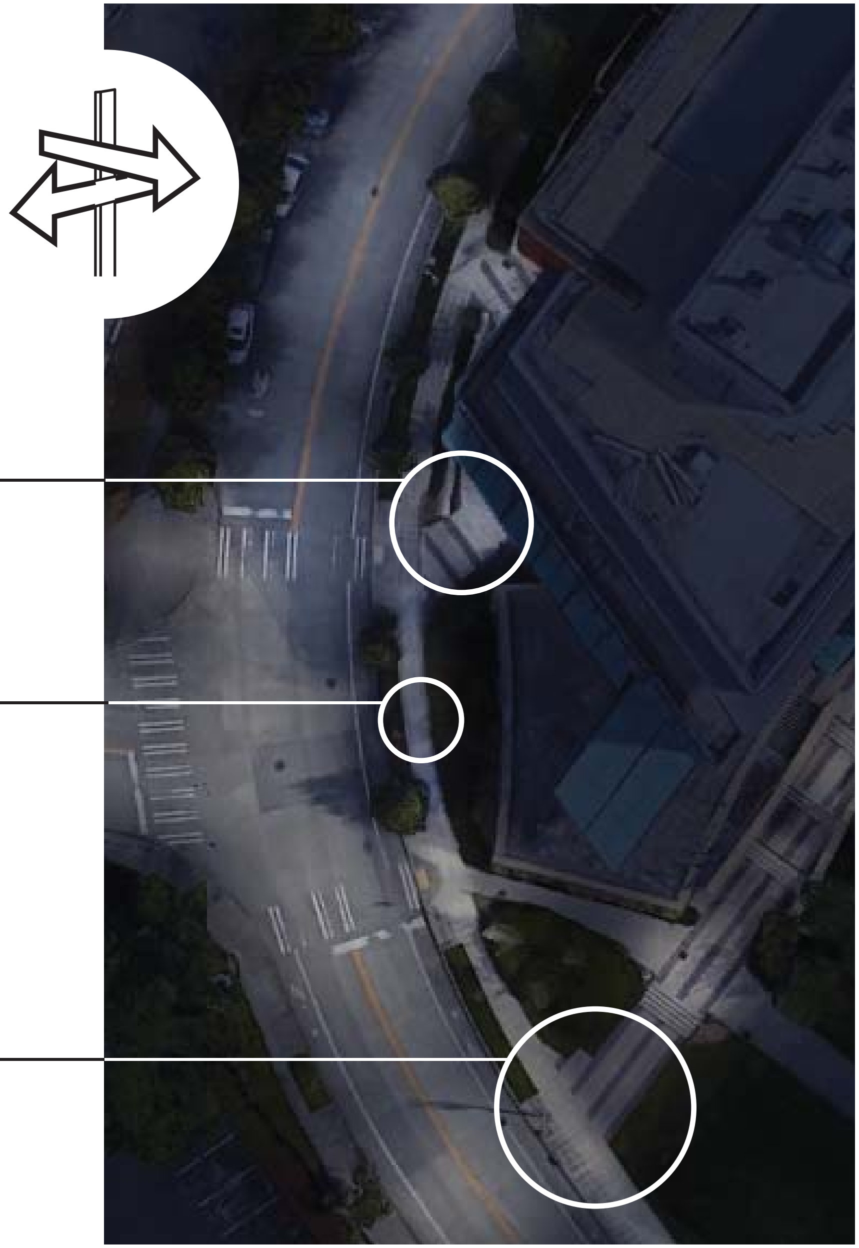
Urban frontages interface directly with the city-owned right-of-way and support an active urban energy. In West Campus, these frontages correspond with active ground floors in residential buildings that feature amenities such as cafes, markets, and gyms. Along South Campus, the urban frontage largely encompasses academic buildings and set-back medical facilities. Lighting is generally provided from backlight of cobra head streetlights and spillover from adjacent building interiors. The ground plane is entirely concrete sidewalks.

NIGHTTIME FUNCTION

These spaces provide passage, invite entry into campus buildings and accommodate pedestrians waiting at transit stops.



URBAN FRONTAGE



Lighting engages active ground floor entries.

Sidewalks prioritize uniformity and visibility.

Connections to interior campus landscapes transition legibly from the urban lighting language to the campus standard.

OBSERVATIONS

- West Campus Urban Frontage supports significant student activity and integrates well into adjacent courtyards and transit stops.
- South Campus Urban Frontage areas are less active at night and its buildings set back from the street edge, which creates a need for more pedestrian-oriented lighting along the sidewalk

LIGHTING STRATEGY

As LED sources replace omnidirectional cobra heads, sidewalks will receive less spillover illumination from street light fixtures. In West Campus conditions where the sidewalk interfaces directly with active buildings and plaza spaces, most sidewalks will feel sufficiently bright due to illuminated building interiors. The use of bollard lights, such as at the bus stop by Elm Hall, work well to define important pedestrian landmarks on the sidewalk but present potential maintenance concerns. In conditions such as South Campus where academic buildings and vegetation abut the sidewalk, pedestrian scale light interventions can help articulate the sidewalk and identify key transit stops along this street. Lighting should provide visibility and comfort for pedestrians, as well as safe interaction with vehicular traffic.

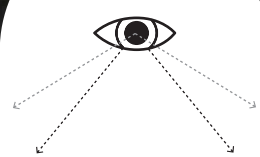
SERVICE + PARKING

NIGHTTIME CHARACTER

These spaces present a mixture of larger parking areas and smaller service entries, both of which are typically lighted to higher levels than other campus areas. Light is most frequently supplied by cobra head fixtures and wall packs.

NIGHTTIME FUNCTION

These spaces support pedestrians moving from campus buildings to their vehicles and a low level of vehicular traffic from individual cars and service trucks and vans. Service areas often accommodate a degree of pedestrian traffic making informal connections between circulation corridors and campus buildings.



SERVICE + PARKING

OBSERVATIONS

- Evidence of shielding and ad-hoc light strategies in parking lots and service area indicate increased concern over safety in these areas.
- Central light sources often lead to conditions of contrast along parking lot perimeters, which negatively impacts the visual experience.

LIGHTING STRATEGY

Lighting can articulate the distinct setting and function of parking areas from pedestrian spaces on campus, prioritizing facial recognition and visibility. Slightly bluer light and higher color rendering index in larger parking lots is appropriate in order to prioritize a sense of security, and the lack of ecological habitat allows for these bluer lighting conditions. In service areas, lighting should transition more subtly between pedestrian and utilitarian areas to reduce jarring contrast. . Parking areas offer an opportunity to employ controls that respond to occupancy levels and can be appropriately dimmed during unoccupied hours.