NORTHERN ARIZONA UNIVERSITY

EXTERIOR LIGHTING MASTER PLAN

PREPARED BY

GLHN ARCHITECTS & ENGINEERS, INC

STAGE 3 FINAL

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Introduction

The Lighting Master Plan will discuss the existing campus lighting, identify deficiencies and address locations for improvements along with recommendations for future Campus Lighting Design.

It is anticipated that future updates, will be required to guide detailed planning revisions and to accommodate new technologies and changes to codes.

Goals

The goal for the Lighting Master Plan is to provide improved:

- Nighttime visibility and function
- Compliance with City of Flagstaff Outdoor Lighting Code
- Safety and Security
- Quality and Consistency of Light
- Maintenance, sustainability, and energy efficiency

Intent

The intent of this plan is to provide a welcoming dusk and nighttime atmosphere where campus entrances, destination buildings and entry courts are highlighted, campus courtyards are inviting, and traveled pathways are safely lighted. The Plan assists the University in being a good neighbor to the community by proposing design integration with the City and by limiting light trespass and light pollution.

The Lighting Master Plan is an integral part of the overall campus master plan. The material is intended to be a “Living Document” and as timeless as possible. In the future advancements in technology will provide new options. Proposed designs using materials not covered in the Plan will need to be reviewed on a case-by-case basis to ensure compliance with the intent of the document.

Project Scope and Boundaries

The focus of the Lighting Master Plan is on the Northern Arizona University Flagstaff campus. The intent is to preserve the historic aesthetics on the North portion of the campus and coordinating with the overall 2010 Campus wide Master Plan prepared by Ayers Saint Gross and the 2010 Utility Master Plan prepared by GLHN Architects and Engineers.

Appendix A Map 01: Lighting Master Plan Project Areas

Code Compliance

City of Flagstaff Lighting Code is respected by the NAU campus. Being a good neighbor to the stringent code creates good will and continuity with the surrounding community.

State of Arizona also recognizes the City of Flagstaff code. All references, details, and associated criteria are located in **Appendix C**: Codes.

Existing Lighting Conditions

Exterior lighting as defined in this report is the lighting provided for illumination of parking lots, pedestrian ways (pedway), and roadways. This report focuses on pedestrian and bicycle safety. Roadways are given lower priority except at crosswalks and intersections. Parking lot lighting evaluation matrices are included in Appendix B of this report as a quick reference. The matrices evaluate each parking area for environmental safety, code compliance, night activity level, as well as maintenance and appearance concerns for the existing pole, luminaire, and wiring systems.

The evaluation is based on subjective visual assessments, interviews, and document reviews conducted with NAU personnel and GLHN team members. Visual assessments were conducted during daylight and evening hours. Special attention was given to night active levels and safety issues.

The Northern Arizona University Campus has a long and varied lighting history. Some original lighting remains on the oldest part of campus, but much of this equipment has been modified and retrofitted with other lamp sources.

A larger percentage of the newer lighting was installed in response to a study of crime on campus performed in the early 80's. From the standpoint of technology, this equipment and lamping was state-of-the-art for that era and made substantial improvements in overall campus light levels and lighting maintenance procedures. This equipment worked best in vehicular environments because of the sharp cut-off light distribution, larger scale, and high lamp wattages however this fixture type was not ideally suited for the pedestrian.

Appendix A Map 02: Existing Lighting Sources by Area

Existing Lighting by Location-Deficiencies and Recommendations

Existing Entries

Campus entries are flanked by monument signage. The majority of the signage is not lighted other then surrounding roadway lighting.

Appendix A Map 03: Existing Campus Entry Sign Locations

Deficiencies:
No lighting other then roadway lighting at the monument signage leaves the entries and campus edges without clear definition.

Recommendations:
Add lighting at monument signs to match style expressed for Roadway Intersections in addition to adding low wall grazing of the monument signage for wayfinding and campus identification introducing the “campus style” at the entrances.

Existing Roadway and Intersections

Illumination levels and uniformities generally appear to be acceptable with a few exceptions.

Sources for the roadways vary, the most common is either low or high-pressure sodium sources with a few remaining areas utilizing mercury vapor sources. Existing luminaires vary between full cutoff and non-cutoff shielding. Intersections require a higher illumination for safety of pedestrian traffic.

Appendix A Map 04: Existing Campus Roadways

Deficiencies:
Non-cutoff mercury vapor lighting fixtures are prohibited under the current Flagstaff lighting Code.

- Knoles Dr. south of Dupont Av. to Blome building has very low light levels.
- Dupont Av. west of Beaver St. to Humphreys St. has very low light levels.
- Beaver St. of Dupont Av. south to Franklin Av. has very low light levels.
- Roadways with overhead lighting circuitry are considered as a maintenance and appearance deficiency due to age, damage hazards, and aesthetics.

Recommendations:
Replace non cutoff mercury vapor fixtures with compliant luminaires and all overhead wiring with underground installation. In addition replace HPS sources with new energy efficient sources for continuity and wayfinding.

Existing Pedways

Illumination levels and uniformities generally appear to be acceptable in most areas of the existing pedways a few exceptions are listed below as deficiencies. Pedway spines are illuminated with a mixture of low or high-pressure sodium sources. Fixtures also vary between full cutoff and non-cutoff shielding.

Appendix A Map 05: Existing Campus Pedways

Deficiencies:
Non-cutoff luminaires do not meet the Flagstaff Lighting Code.
High Pressure Sodium sources are considered deficiencies due to change in lamping, source and fixture style.

- The north pedway spine west of Physical Sciences has low uniformity.
- The north pedway spine west of McDonald Hall has low uniformity.
- The north pedway spine east of Plateau Center has low uniformity.
- The south pedway spine west of Reilly Hall has low uniformity. The apartment complex that will soon replace Campus Heights may remedy this deficiency.

Recommendations:
Establish a standard pedway luminaire to maintain continuity, campus identification and wayfinding. Choose a luminaire that is hardy with a long life expectancy and will not be outdated shortly (both Lamp and fixture).
Replace non-cutoff/non-LPS Luminaires with compliant fixtures.

Replace full cutoff / non-LPS luminaires with compliant fixtures.

Existing Parking

The Parking matrices located in Appendix B evaluate each parking area for environmental safety, lighting code compliance, night activity level, as well as maintenance and appearance concerns.

Appendix A Map 06: Existing Parking

Deficiencies:

- Parking areas are inconsistent in style and source.
- Several areas are identified as insufficient for activity level at night.

Appendix B Environmental Safety Matrices

Recommendations:
Establish a Parking standard luminaire to maintain continuity, campus identification and wayfinding.

To move toward a more consistent campus wide aesthetic it is recommended that all new poles be straight round type to provide the ability to easily attach banner arms. This would encompass all poles with the exception of the Cline Library and historic area of the north campus.

When luminaires are retrofit to existing poles, engineering attention should be given to the wind loading capability for existing poles and bases in combination with new and larger luminaires.

Replace non conforming luminaires with 90-135W LPS luminaires on 25-30 foot poles. Consideration should be given to snow removal equipment when determining concrete base height.

Existing Bus Stop and Transit Spine

Bus stops are typically illuminated with a mixture of low or high-pressure sodium sources generally from the adjacent roadway or parking lighting poles.

Appendix A Map 07: Existing Bus Stops and Transit Spine Route Locations

Deficiencies:

The bus stops themselves do not have dedicated lighting. Due to location of adjacent roadway poles, some areas are very minimally lit. In addition, studies have demonstrated that there is better visibility under white light vs. LPS and that the better visibility enhances student safety.

Recommendations:
When building the new bus transit spine and stops it is recommended that consideration be made to providing a light source with a combination of white and Amber LED, in a full cut-off luminaire in conjunction with higher wattage Low Pressure Sodium full cut-off luminaire at all bus stops, crosswalks, and intersections to improve pedestrian safety.

Existing Event Centers

The existing Event Center Lighting at the Walkup Sky Dome is a dual level source with LPS full cut off high on the pole and a Metal Halide source lower on the pole for pedestrian safety as well as general transit lighting. Poles have the ability for signage via the banner arms to provide wayfinding and advertising.

Appendix A Map 08: Event Centers and Major Pedestrian Crossing Points

Deficiencies:
Some "event" areas do not have the consistent use of the dual fixture with banner arms and lower level white light.

Recommendations:
Provide consistency at event centers by using the dual level luminaires to provide pedestrian safety, wayfinding and campus identification.

Existing Historic District

The existing luminaires in the Historic North Campus area are currently acrylic globes on classic historic poles in addition to pier mounted luminaires.

Appendix A Map 09: Historic District

Deficiencies:

- Existing globes do not comply with the full cut off requirements of the Flagstaff lighting Code.
- Existing HPS source does not comply with current Lighting Code.
- Globes are not correctly seated and provide a maintenance and safety hazard.

Recommendations:
Replace the existing heads with new amber LED full cutoff fixtures that maintain the historic intent while complying with current Dark Skies Code. In addition they will provide lower maintenance and higher energy efficiency. Replacement may require some new infrastructure such as wiring and potentially relocation of poles

Existing Infrastructure

Existing Lighting Circuits

Typically, lighting systems are connected to power via underground conduit and wire. NAU has some areas with existing overhead wiring for lighting circuits. Due to age, damage hazards, and aesthetics the overhead wiring method is identified as a maintenance and appearance deficiency.

The current circuiting is provided from multiple systems and thus inconsistent voltages are utilized for the existing exterior lighting systems adding some inefficiency to the maintenance for the system.

Deficiencies:

- Overhead wiring is identified as a deficiency due to aesthetics and maintenance concerns. In addition it is volatile to weather and snow removal equipment.

Recommendations: Provide new underground wiring at all locations. Revise poles to meet current recommended style and lamping for roadway lighting.

Provide all new or replacement wiring at 277V single phase for economic use of copper, more fixtures per circuit and consistency of equipment for long term maintenance.

Existing Emergency Lighting Circuits

Emergency lighting is that which is required to be provided by NFPA 101, Life Safety Code for illumination of the means of egress. This includes exterior path of egress to a ‘Public Way’ - typically a parking lot or street. Emergency power from a non-utility source is used to supply emergency lighting.

Deficiencies:
Most of the buildings on the NAU campus are assumed to have no exterior emergency lighting as a physical survey of the building lighting was not performed. A few of the recently constructed building may have included exterior egress lighting in their design. This report does not include any costs to provide exterior emergency lighting. Should a campus wide emergency power distribution system be added in the future, the cost to connect the lighting to that system should be minimal.

Recommendations:
Provide an emergency source of power. This can be accomplished by various means, a generator, lighting inverter, or emergency battery packs.

Existing Light Sources

Currently the campus has several different light sources installed throughout. The lamps listed below were the most commonly observed lamps:

- 90 Watt low pressure sodium
- 135 Watt low pressure sodium
- 250 Watt high pressure sodium
- 70 Watt high pressure sodium
- 180 Watt low pressure sodium
- 55 Watt low pressure sodium
- 18 Watt low pressure sodium
- 23 Watt compact fluorescent (retrofit)

Deficiencies:
Having multiple wattages of lamps add to costs of maintenance, in addition to differing appearance throughout the system.

Recommendations:
Establish consistency with Sources and Sizes of Lamping for specific Areas
90-135 Watt Low Pressure Sodium – Roadway on 25-30 foot poles
90 Watt Low Pressure Sodium
Amber LED for new Pedway, Pedestrian and Transit spines
50W Ceramic MH or white LED (3500k) – Bus stops and Event Centers combined with LPS up high will require control of white light per Code.
Amber LED for Emergency Lights at Building Exits on dusk to dawn operation.

Existing Lighting Control

Current exterior lighting control is not campus wide but independent by building surround in many locations around the campus.

Appendix A Map 10: Lighting Control Zones

There are four (4) locations where control cabinets have been installed to control associated roadway and parking lot lighting. These cabinets incorporate a panelboard along with contactors for photo cell on/off and photocell-time clock off. A Veris Industries meter is located in these cabinets to provide power monitoring. All components are located in a stainless steel outdoor cabinet. The existing cabinets have the capability to be networked in the future to provide a campus wide lighting control network.

Deficiencies:
A majority of the campus is individually controlled and not networked via a system.

Recommendations:
Establish consistency in lighting control for entire exterior lighting on campus working toward a full campus wide networked system in the future. Lighting control systems add to sustainability, energy efficiency, provide maintenance assistance, and load monitoring.

Campus Lighting Design Concepts

Implementation

Northern Arizona University places the highest priority on pedestrian-oriented activities and safety. However, implementation is always affected by funding and revenue issues. The ideal priorities are as follows:

- The Lighting Master Plan implementation goes hand in hand with the Comprehensive Campus Master Plan and Utility Master Plan.
- Priorities should focus first on elements that support and encourage pedestrian safety. Developing better lighting for pedway, bus stop and transit spine and parking will encourage foot traffic.
- Improving the quality of lighting in parking areas is a key factor in establishing entry points to pedway and encourages safe foot travel at night.
- Lighting improvements to roadways specifically for vehicle traffic is the final priority.

The north east entry corner is a campus entry lighting opportunity. Lighting of the monument sign with warm amber LED fixtures matching the new pedway fixtures would provide identification of campus boundary, continuity with the rest of the campus and would improve the University's evening time image.

Lighting Design Objectives

Having the campus lighted more effectively with an integrated appearance will improve safety, security, campus image, and nighttime wayfinding. Providing new energy efficient luminaires not only improve aesthetics but provide lower maintenance and compliance with Dark Skies Code.

Entries:

Identify the campus and its entry points. By highlighting the entry points the campus boundary is identified and an expression of arrival can be achieved. The goal is to light the entries in a warm and welcoming fashion.

Lighting at campus entry points is used to improve evening time recognition of the entry and to help guide people into the campus for events. Campus entry points are also areas with major pedestrian and vehicle conflict zones, so lighting for safety is necessary. In addition, lighting at entry points is used to reinforce campus image, identity and character. Campus entry areas should have some of the highest light levels and most effective controlled brightness. Entry points are areas near the top of the campus lighting hierarchy.

Because of the large numbers of vehicles and pedestrians, entry points also need lighting designed for safety. Lighting at these areas must allow the greatest possible reaction time for motorists and bicyclists. Intersections of campus streets with City roadways require special consideration and need as much as 50% more illumination than the adjacent streets.

- Pedestrian lighting plays a key role at entry points by identifying and defining adjacent pedestrian egress, crossings and conflict zones. These luminaires improve safety, but also addresses security and image.
- Lighted entry signs should be consistent and prominent on campus.

Roadways and Campus Edges:

In areas where both vehicles and pedestrians are present, a combination or “dual lighting system” should be introduced. The dual lighting system has both pedestrian and roadway lighting equipment Primary paths are continuously lighted. The frequency of luminaires on primary paths is the greatest. Secondary paths should be lighted with less frequency. Pedestrian areas and tertiary or filter paths have some path lighting mixed with other lighting techniques to ensure continuity.

Dual level lighting provides way finding and visual clarity for identification banners and pedestrian safety.

Campus Edges:

McConnell Drive

This edge is a priority due to higher traffic speeds and inadequate lighting at the Pine and Knoll Drive campus entry and at pedestrian crossings. Identify and reinforce the campus entry by lighting the monument sign wall with amber LED's. The approach road should be provided with the campus standard roadway luminaire with banner arms and supplemental white light for the pedestrian crossing.

University Drive

University Drive is an access route for vehicles, bicycles, and pedestrians from the outlying areas to the main campus. In areas near the main campus, where pedestrian activity is high, the edge should be reinforced with white light at the pedestrian crossings.

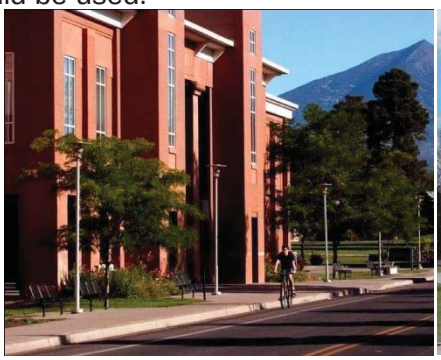
Rioridan Road

Rioridan Road is currently city-maintained like University Avenue. Rioridan is likely to remain a strong campus edge due to the lack of campus property on the city side of the street. Future plans to upgrade the parking lot with a Parking Garage warrants closer consideration to treating this similar to any major entry. With the high level of pedestrian and bicycle traffic, stronger pedestrian lighting on Rioridan Road is needed.

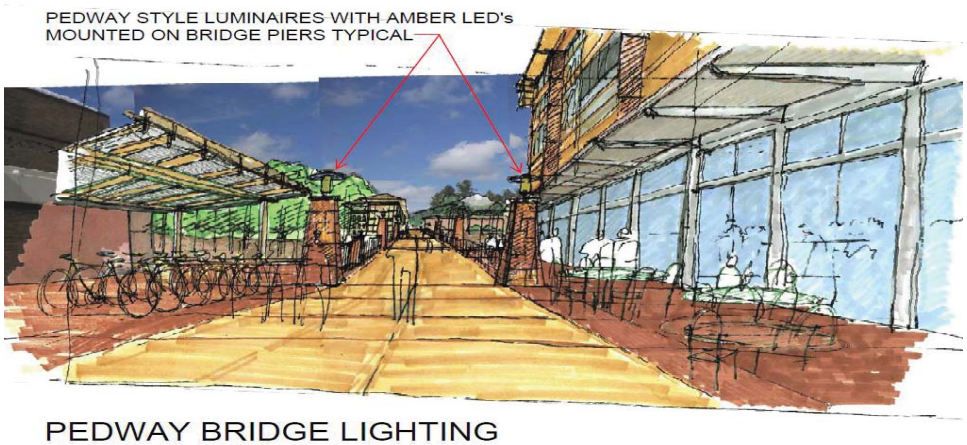
Pedways:

Lighting of pedestrian intersections

For safety and clarity provide a lighted path to the destination**.** Lighting the pedestrian paths with luminaires that are different in style from roadway and parking lot lighting provides direction and wayfinding. Smaller scale luminaires with low brightness light should be used.



The pedway would benefit from carefully placed smaller scale luminaires as shown in the picture on the left. The pole in the right photo is too large in appearance for the pedestrian and lacks the necessary character to reinforce the image of the campus.



PEDWAY BRIDGE LIGHTING

2010 Comprehensive Plan Proposed Pedestrian Bridge

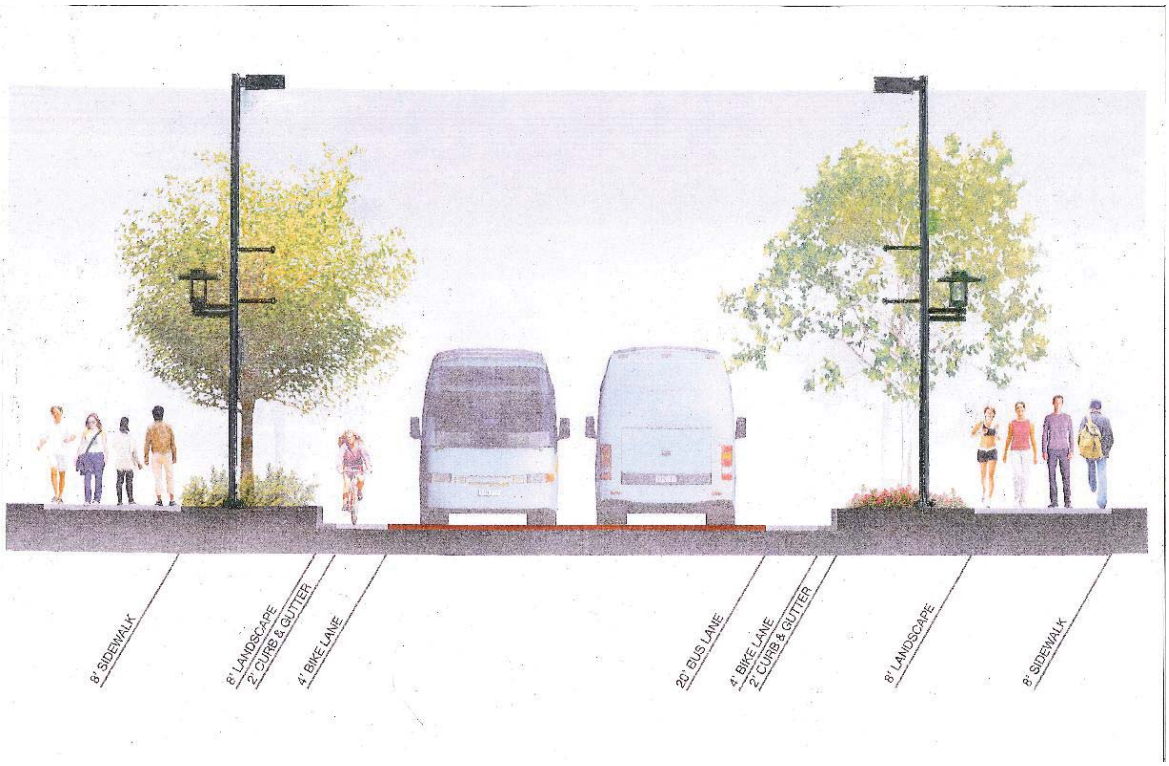
Parking

Use lighting to differentiate parking lots from pedestrian paths providing safe inviting parking spaces with defined pedestrian exit, entrances. Vehicular lighting should be seen from adjacent areas. The lighting should be used to help reinforce the separation between vehicles and pedestrians.

Bus Stops and Transit Spine

The lighting at the Bus Stops should be consistent at all locations to provide definition and wayfinding on the campus. Incorporation of white light into the environment will aid in color rendering and safety in the shelter areas. Surrounding luminaries should tie into the appropriate area of coverage from parking lot to pedway.

Use lighting to differentiate parking lots from pedestrian paths providing safe inviting parking spaces with defined pedestrian exit, entrances. Vehicular lighting should be seen from adjacent areas. The lighting should be used to help reinforce the separation between vehicles and pedestrians.



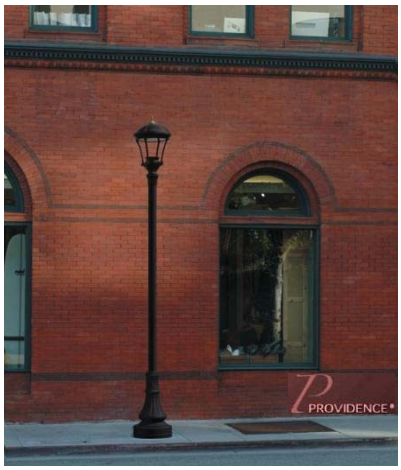
Low Pressure Sodium

Event Centers

Lighting around Event Centers should provide safety and security. The addition of white light will aid in color rendering and visual clarity. The supplemental white light will be required to be turned off at 9:00 p.m. per Lighting Code. Banner arms provide wayfinding and notification of events to campus occupants.

Historic District

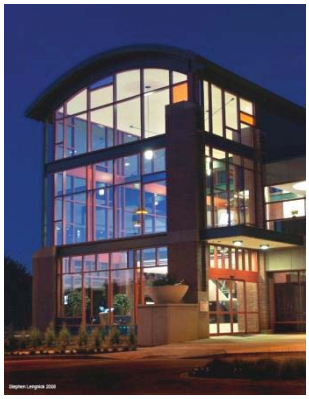
The Historic District of the Flagstaff campus presents a unique set of lighting opportunities. Historic facades are candidates for lighting and could make the open space feel much more secure and would improve the district image. Preservation and restoration of all original period lighting equipment is a priority.



Facade lighting of the building should contribute to the lighting of the common area. Lighting the edges reduces the need for open space lighting, by providing illumination at pedestrian origin and destination points.

Other Areas:

Building entry points should be highlighted and special destination buildings should be lighted. It is especially important to light destination buildings that are the focus of nighttime activity.



The North entry to HCCC can be clearly seen from roadway. Soft illumination from the interior reveals the shape and expanse of the building at night and clearly establishes this building as a night destination.

Residence halls and dormitories should have low-brightness porch lights and balcony lighting as well as special lighting at entry points. These luminaires should be free from glare and softly light the building and surrounding area.

Lighting Design Considerations

The following is a short narrative on the basic considerations of good campus site lighting proposed for the Flagstaff campus.

Safety involves providing light on hazards so that they are detected with sufficient reaction time. Hazards may include pedway, bikeway, and vehicle intersections, crosswalks, stairs and ramps. The lighting system, along with other site design elements, must provide visual information to assist campus users in avoiding such things as a collision or loss of bearings.

Security is often referred to as the perception of safety. Providing for security involves lighting potentially hazardous locations and situations. For example, an increase in reaction time can give potential crime victims a better chance to change direction, find refuge, or call for help. Lighting can also act as a deterrent by increasing the visibility in an area of concern.

Contrast between objects is required for the human eye to adequately see. There are two types of contrast that are relevant for good visibility; color contrast and value (brightness) contrast. Both are important however value contrast is especially important in low-light nighttime situations. If contrast between an object and the background is too little, the object becomes camouflaged. Providing lighting on the building surfaces can increase contrast, making silhouetted objects easier to see.

Glare is usually caused by uncontrolled light emitted from unshielded luminaires. Glare can be easily avoided with proper equipment selection, location, aiming and shielding.

Human night vision is very sensitive to short wavelength light (blue and green light), resulting in crisp and clear vision. Reaction time under low light levels is far superior with white light sources and color identification is also much easier with white light. This supports the addition of white light in high pedestrian areas.

Light pollution is uncontrolled light that travels into the atmosphere. This light is wasted energy and creates a “sky glow” over the Campus. Fortunately, the same techniques used to minimize glare and light trespass will also minimize light pollution. Campus lighting should minimize both light pollution and light trespass at all times. High wattage luminaires with poor visual cut-off are not permitted. Excessive light levels with high amounts of reflected light are not permitted. Every effort should be made to use low wattage, shielded luminaires that are properly located and aimed.

Light trespass is sometimes referred to as the “light shining in my window”. Usual culprits of light trespass are unshielded floodlights, high wattage pedestrian lights, wall packs and other unshielded luminaires that are improperly located and poorly aimed. Light trespass will not be tolerated on campus. Light trespass can be minimized with careful equipment selection, proper location, and proper aiming and shielding. Luminaires within “line of sight” of the observatory need to be completely shielded such that no light from a lamp, refractor, or reflector is visible from the observation decks.

Lighting Design Criteria

The key to quality exterior lighting is to place light only where it is needed, without causing glare along with improving visibility, reducing energy, and improving maintenance. Design criteria include basics such as lighting levels (illuminance), uniformity, and brightness balance (luminance), as well as recommendations for reducing glare, light trespass, and light pollution.

Surface brightness is critical for good nighttime visibility. Too often, lighting levels are used as the sole basis of a design. This approach may be adequate for detecting objects on the ground and sometimes potential hazards, but surface brightness on building facades and other vertical surfaces actually helps aid visibility more than light levels.

Lighting levels, or illuminance levels, are expressed in units of footcandles. Typical exterior lighting levels range from 0.5 to 2 footcandles.

Environmental Safety Concerns, The Parking Matrices in Appendix B focus on pedestrian and bicycle safety as well as security and liability issues. The primary goal is the ability to see and be seen under varying environmental conditions.

- Extreme – Little or no illumination.
- High – Low illumination levels, poor uniformity, and/or no redundancy.
- Medium – Poor uniformity.
- Low – Acceptable for current use.

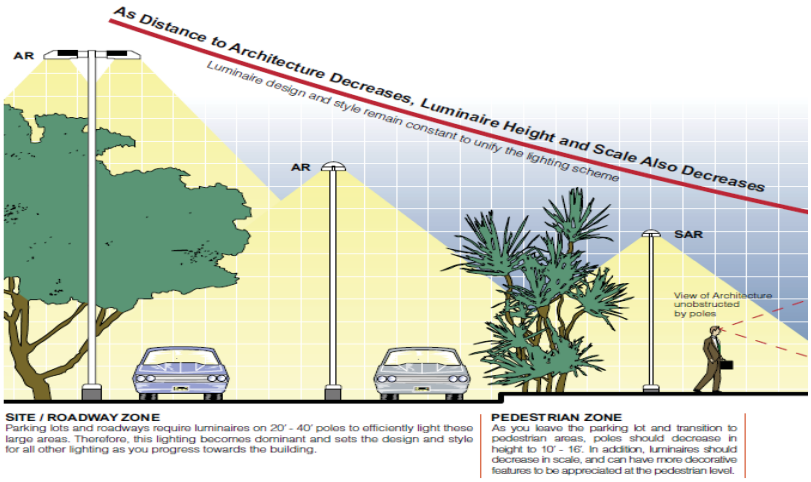
Lighting uniformity refers to the evenness of light. Visual adaptation changes when uniformities are greater than (10:1). Since our eyes adapt to the brightest object, any object lighted to 1/10th the level will appear dark and details harder to see. Lighting uniformities should not exceed (10:1) between maximum and minimum levels in areas of high lighting priority.

Brightness balance, or luminance ratio, refers to the brightness differences in reflected light. How bright objects appear compared to their immediate background is an example of this measure. This begins to address how easily objects and details are detected. In exterior lighting applications, luminance ratios should not exceed (10:1) between key backgrounds and objects.

Pole Heights

Lighting equipment appropriateness is crucial. Luminaire size and pole height will require aesthetic and performance suitability. Pedestrian areas require luminaires that feel appropriate in scale, architectural character and are low in brightness. Roadway and parking lots use fixtures which are neutral in character and have superior optics and glare control. Roadway equipment is also mounted on taller poles and at greater spacing than pedestrian lighting. In areas of mixed pedestrian and vehicle use, combinations of roadway and pedestrian lighting equipment are often required to meet the visual tasks of both vehicle and pedestrian. In all cases, the brightness of the luminaires must not impede task

Appropriate equipment selection is a key to successful lighting design.



This sketch depicts the appropriate height and character relationship between roadway and pedestrian luminaires. The roadway luminaire in the distance on the taller pole is neutral in character while the pedestrian luminaire in the foreground at the lower mounting height adds visual interest and provides optical guidance

Light Source Recommendations

The majority of light sources on the Flagstaff Campus will consist of Low Pressure Sodium or Amber LED to comply with the Flagstaff Sign and Lighting Code.

Augmentation using full cut off white sources for high pedestrian traffic areas around Event Centers and pedestrian Intersections is recommended for additional safety within the confines of the outdoor lighting code. Current shut off of all white light sources is required at 11:00 p.m. by code.

Light Source Color and Color Rendering Index

3000K Warm

In order to maintain a warm and soft atmosphere on campus, a 3000K (Kelvin temperature rating) is recommended for the specification of the augmented light sources. A high color rendering index is recommended to allow color differentiation.. A color rendering index of 70 or greater is the minimum recommended for light sources on campus. A color rendering index of 80 or greater is preferred.

Lamp Types

Incandescent (not allowed)

Since incandescent lamps require high maintenance and are energy inefficient, their use on campus is not allowed. Temporary uses may include lighting outdoor art exhibits, holiday lighting and other special events. Alternate sources to incandescent lamps such as full cut off compact fluorescents for building exiting and amber LEDS for landscape lighting are required.

High Pressure Sodium (not preferred)

High pressure sodium lamps produce an orange-colored light and the color rendering index of this source is not appropriate for use on campus. High pressure sodium is still present as a street lighting source on campus. There may be instances where high pressure sodium needs to be specified in order to maintain or improve visual continuities. However, in all such cases, every attempt should be made to first use a Low Pressure Sodium or amber LED source.

Low Pressure Sodium

Low pressure sodium is required per Flagstaff Lighting Code especially in areas immediately adjacent to the Observatory. Per the Lighting Code Campus lighting is required to be low pressure sodium and full cut off so that the stray reflected light will be minimal.

Mercury Vapor (not allowed)

Mercury vapor lamps can be identified by the blue-green light they emit. Due to high maintenance costs, poor energy efficiency, and insufficient color and color rendering properties, the mercury vapor light source is no longer allowed by code for use on campus. These luminaires should be replaced with low pressure sodium and or the combined LED amber/white sources.

Low Emitting Diodes (LED)

Future advancement in the LED technology is providing viable energy efficient options to the Low Pressure Sodium source required by the Observatories and Dark Skies Code Compliance. Manufacturers are improving current technologies (increased efficiency, lumen maintenance, better color and lamp life). These lamp sources and others, promise superior efficiencies, and long lamp life. LED's perform best in low ambient temperatures making them well suited to the Flagstaff environment. The true amber LED's closely mimic the LPS wavelength. Warm White LED's 3000K provides a good alternative to compact fluorescent or metal halide sources.

Sports and Floodlighting

Unshielded floodlights and wall packs as shown in the following figure are not acceptable for use on campus. Unshielded floodlights are notorious sources of glare, light trespass, and light pollution.

Floodlighting is appropriate only for sports lighting applications. In such applications, luminaires should have good optics and distribution and must be fully shielded and comply with the Flagstaff Lighting Code.

Infrastructure Design Considerations

Luminaire Performance

Lighting performance is directly related to the quality of the equipment. Well-controlled luminaires put light where it can be used and not wasted, resulting in fewer pieces of equipment. By properly selecting the correct photometrics, light usage is maximized with minimal light pollution and trespass.

Existing Electrical Distribution System

Electrical infrastructure improvements are needed in order to make lighting changes in many areas of the campus. The existing electrical infrastructure has many technical problems. The system has been added-to over time, and is now impacted by poor circuit loading and poor continuity. There are limited control points for the existing infrastructure.

Maintenance

Maintenance costs should be considered since the equipment operation costs will quickly exceed initial costs. Maintenance includes equipment replacement due to lamp/ballast failures, equipment breakage due to vandalism, water, wind or hail. Good quality equipment must be specified to minimize campus maintenance.

Lamp sources should be selected such that the list of lamp types which must be kept in inventory is minimized. Standardization of inventory will make the task of relamping simpler. Also, a maintenance manual could be developed from new standards set in the Master Plan.

Group Relamping

A good maintenance program is vital to preserving the intended illuminance levels and quality of the lighting design. Two maintenance methods are discussed here: spot and group relamping. The color temperatures and wattages of installed lamps are easier to control by group relamping. The practice of spot relamping is labor intensive and not cost effective, but is still commonly used to keep maintenance crews occupied while they are not performing other functions. Group relamping is less expensive on a per-fixture basis because it consolidates the use of resources such as trucks and lifts.

Group relamping should occur at 70% of the manufacturer's average rated lamp life. The manufacturer's definition of average rated life is the time when 50% of the lamps are burned out. Lighting equipment should be cleaned when relamping is done. Future controls for exterior lighting could help inform a group relamping schedule through circuit load monitoring. And, as campus lighting sources become more standardized, the task of group relamping will become less complicated.

Description	**Wattage**	**Color Temperature (Kelvin)**	**Color Rendering Index**	**Application**
Amber LED	varies	1800K	NA	Exterior Exits (Class 2)
Metal Halide	50	3000K	85	Bus Stop Lighting (Class 1 or 3)
Low Pressure Sodium	90-135	1800K	NA	Roadways (Class 2)

Bollard Luminaires

Bollard luminaires are not to be used on campus. The performance and maintenance characteristics of these fixtures and ability to be damaged by snow removal equipment make them inappropriate for campus use.

Vandalism

Vandalism needs to be considered in equipment selection, location and mounting details. Many times, “out of sight, out of mind,” holds true especially with easy to reach lighting equipment such as ground mounted landscape equipment. Care and consideration must be given to locate equipment out of easy pedestrian access.

Equipment selection should take advantage of normally offered vandal resistant options for hardware and fittings. Well designed luminaires that are sealed against the weather elements usually are more vandal resistant.

Sustainability

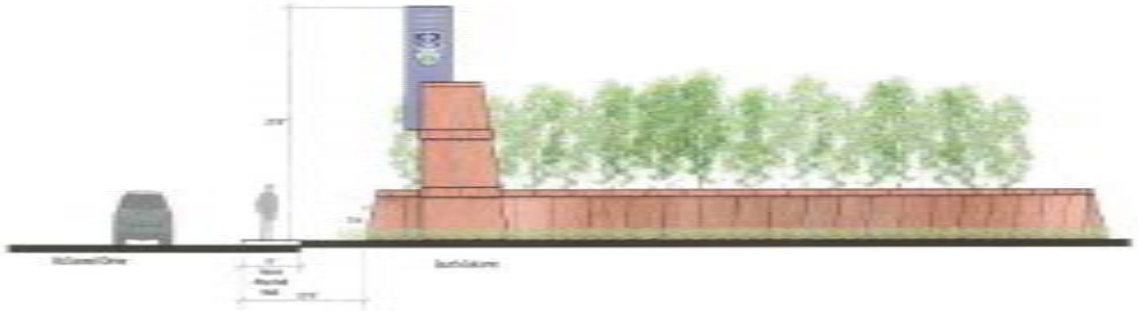
Consideration of energy efficiency and sustainability are high on the priority list for future designs. Focusing on use of low energy sources such as Amber LED’s combined with White LED (for color rendering and visual clarity) should be considered campus wide.

Continuing research and development into LED technology will make future applications economical. The low maintenance opportunities provided by the LED technology provides a long term maintenance reduction.

Disposal of fluorescent, mercury vapor, sodium and metal halide lamps must be properly handled per municipal codes and NAU risk management requirements. Low mercury content TCLP compliant lamps with extended life should be specified whenever available.

Lighting Design Recommendations and Cut Sheets:

Campus Entry Points



The campus standard entry luminaire should be specified to accommodate the following performance criteria:

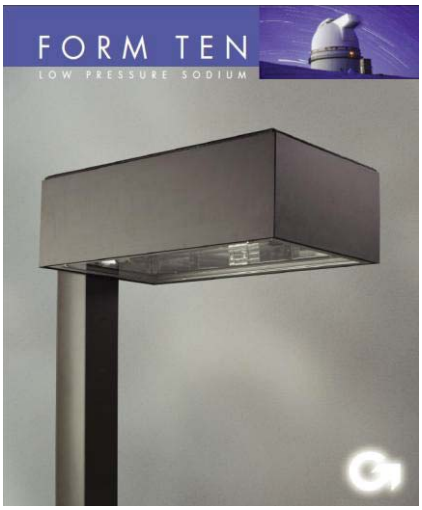
- Optics: Reflector, Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 90-135W low pressure sodium
- Mounting Height: 25-30 feet above grade with 36 inch concrete base.
- Mounting Configuration: single head, double head with banner options.
- Luminaire Form: Shoebox.
- Color: Consult NAU Design Standards.

Campus Roadway Lighting

Roadway and parking lot lighting should be neutral in character shoebox fixtures are recommended for their ease of layout. Existing cobra head luminaires should be phased out and replaced through the process of routine maintenance and new construction projects.

The following priorities can be used as guidelines to accomplish the goals for campus roadways and parking areas:

- Add dual level lighting at specific points of conflict such as intersections with pedestrian crossings.
- Organize lighting carefully in both alignment and spacing. It is important that the layout looks reasonable in plan view but more important that poles look organized in the environment for the driver and pedestrian.
- Add roadway equipment between potential points of conflict at appropriate spacing. Typical spacing to mounting height ratios for roadway equipment range between 4:1 and 6:1. Note that the placement of the fixture and its relation to its environment is more important than meeting spacing criteria. For example, placing a fixture at a crosswalk is more important than maintaining an ideal spacing interval.



90 or 135 Watt Low Pressure Sodium Luminaires on Round 25-30Ft Poles with 36In high concrete base

The campus standard roadway luminaire should be specified to accommodate the following performance criteria:

- Optics: Reflector, Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 90-135W low pressure sodium
- Mounting Height: 25-30 feet above grade with 3 foot concrete base for show removal protection.
- Mounting Configuration: single head, double head with banner options.
- Luminaire Form: Shoebox.
- Color: Consult NAU Design Standards.

Campus Pedway

The pedestrian standard luminaire should be used throughout the campus to reinforce campus image and to aid in wayfinding. There may be some differences or flexibility in the selected luminaire depending on specific use, but the basic architectural character should not change. For example the fixture optics and light distribution could be different in plaza and path applications. Banner arms may be added depending on specific needs. However, the form of the luminaire should remain the same.

Beacon, Slide

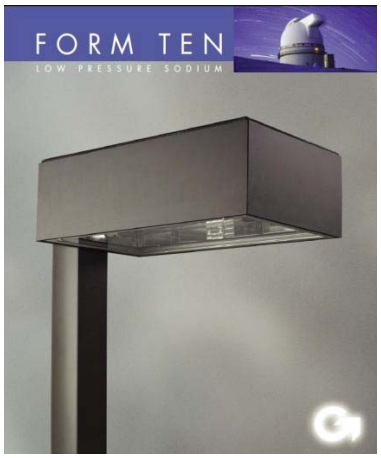
Full Cut off Luminaire with Amber LED

The campus standard pedestrian luminaire should be specified to accommodate the following performance criteria:

- Optics: Reflector, refractor, or combination optic system with IESNA Type III distribution. Cut-off and semi cut-off light fixture classification options.
- Amber LED source options.
- Mounting Height: 12-15 feet above grade.
- Mounting Configuration: single head, double head and wall bracket options.
- Luminaire Form: As shown above.
- Color: Consult NAU Design Standards.

Parking Areas

There are a number of different equipment types, luminaire spacing, mounting heights, and light levels used for campus parking lots and roadways. This type of discontinuity leads to visual confusion, different levels and light uniformity problems. Consistency in lighting equipment and light levels should be established to distinguish streets and parking areas from pedestrian paths. The lighting priority is to first work on roadways and parking areas which are currently lighted using non cut-off cobra head using mercury vapor source and overhead wiring.



Option – PGA 90 0R 135Watt Low Pressure Sodium Luminaire for Large Areas mounted on round 25-30ft Poles on 36In high concrete base.

Campus parking luminaires should be specified to accommodate the following criteria:

- Optics: Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 90W low pressure sodium
- Mounting Height: 25 feet above grade with 3 foot concrete base for snow removal protection.
- Mounting Configuration: single head and double head.
- Luminaire Form: Shoe box
- Color: Consult the NAU Design Guide

Campus Bus Stops and Transit Spine

The lighting system throughout all stop locations should provide consistency and wayfinding in addition to safety and security. White light should be incorporated to aid in reading color coded bus maps. The lighting should provide transition into the pedway system further establishing the campus image and wayfinding for encouraging ease of use of the pedway spine. The supplemental white light will be required to be turned off at 9:00 p.m. per Lighting Code.

90 Watt LPS with 50 Watt CMH or White LED on Round 25-30 ft poles with 6 in High Concrete Base

Bus Stop luminaries should be specified to accommodate the following criteria:

- Optics: Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 90W low pressure sodium
- Mounting Height: 25 feet above grade with 36 inch concrete base.
- Mounting Configuration: single head and double head.
- Luminaire Form: Shoe box
- Color: Consult the NAU Design Guide

Event Centers

The lighting system at all event center locations should provide consistency and wayfinding in addition to safety and security. The lighting should provide transition into the pedway system further establishing the campus image and wayfinding for encouraging ease of use of the pedway spine. The supplemental white light will be required to be turned off at 9:00 p.m. per Lighting Code.

90 Watt LPS w/ 50 Watt CMH or White LED's on Round 25-30 Ft poles with 36 in Tall Base..

Event Center luminaries should be specified to accommodate the following criteria:

- Optics: Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 90W low pressure sodium + 50W Metal Halide or LEDs
- Mounting Height: 25 feet above grade with 36" concrete base for snow removal equipment protection.
- Mounting Configuration: single head and double head.
- Luminaire Form: Shoe box
- Color: Consult the NAU Design Guide

Historic District

The lighting recommendations for the District have been developed in conjunction with other in progress Master Plan documents and some of the recommendations relate to future design options. The goal is to maintain the character and scale of the existing light poles with luminaires that comply with the Lighting Code.

Roadways, Parking areas and pedways within the Historic area should maintain the style and character of the existing area. Stone pier lights at the north entry should be reused. New luminaires similar to pole mount type will provide code compliance in addition to energy efficiency and improved maintenance.

Options– NQA, NQB, & NQC with High Pressure Sodium
On Existing Poles and Piers whenever possible

Historic District luminaries should be specified to accommodate the following criteria:

- Optics: Reflector with IESNA Type II, III or V distribution as required for specific design. Full cut-off fixture classification.
- Lamping: 70 watt High Pressure Sodium.
- Mounting Height: On existing poles when possible or “match existing”.
- Mounting Configuration: single head and double head.
- Luminaire Form: Historic Head.
- Color: Consult the NAU Design Guide

Building-Mounted Luminaires

Building-mounted luminaires play an important role in nighttime way finding. Exterior downlights are used to mark entrances, and to light vertical surfaces along pedestrian paths adjacent to the building. Full cut off wall packs can be used for lighting service entrances and loading docks, as long as these fixtures are of the appropriate brightness. Controlling the brightness of building mounted luminaires is critical.

Decorative building-mounted luminaires should relate to the architecture of the building on which they are placed, and to the surrounding pedestrian and street lighting in location, layout, lamping and equipment style. It is important that the appropriate lamping is selected for building-mounted lighting. . Lamps should be of sufficiently low wattage and brightness to avoid glare and comply with the Light Code.

Full Cut-Off Wall Mounted Luminaire Options

- Amber LEDs for Dusk to Dawn/Egress
- White LED or Compact Fluorescent may be utilized for color rendering. All white light must be shut off at 11:00PM per the Lighting Code.

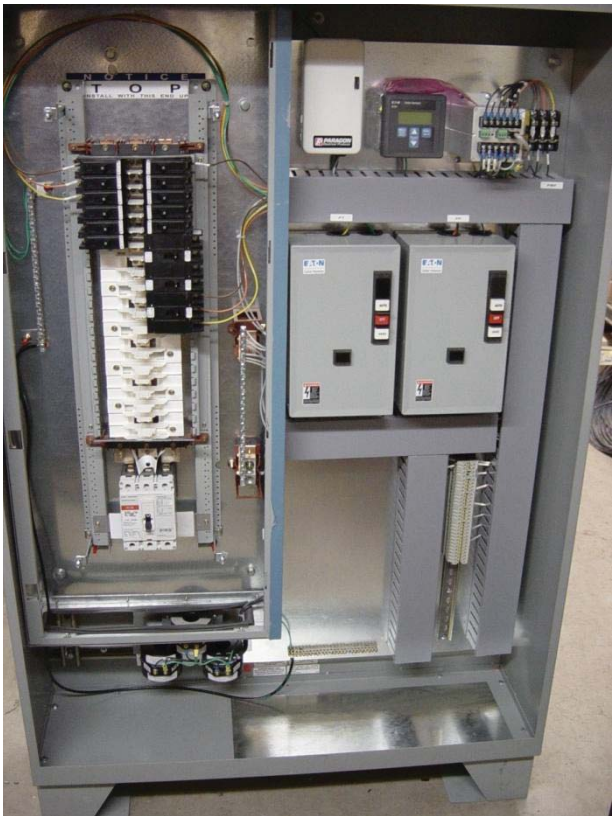
- Optics: Reflector, refractor, or combination optic system
- Mounting Height: approximately 8 to 12 feet above finished grade (mounting height depends on building scale).
- Luminaire Form: Existing fixtures vary, form of future fixtures to be determined. Style may relate to luminaire family or to building architecture.
- Color: Consult the NAU Design Standards. Other colors may be considered based on Architecture of building on which they are placed verify with the NAU project Manager for color approval.

Lighting Controls

Campus wide Lighting Control

Appendix A Map 10: Lighting Control Zones

An automated control system is recommended for the campus, starting with new projects with gradual expansion into other areas. An expansion and networking of the existing system cabinets is proposed. The goal is to create a zoned network of control cabinets throughout the campus to control all roadway, pedway, transit spine, and parking lot lighting.



Controls are to be located in NEMA 3R Stainless Enclosures

Lighting control should be specified to accommodate the following criteria:

- Cabinet: Stainless Steel NEMA 3R
- Interior: 277/480V Panel
- Mounting: Concrete Pad.
- Metering: Veris Industries Hawkeye 8163 Meter with CT's
- Contactors: Mechanically held, number of poles as required, HOA switch, Time Clock, and Light Sensor.
- Color: Stainless Steel

Proposed Phasing

Phasing is intended to be compatible with the NAU 2010 Comprehensive Master Plan prepared by Ayres Saint Gross.

Phase 1 (within 1-3 years)

Replace overhead wiring and all Mercury Vapor Luminaires with new underground wiring and new energy efficient, code conforming lamp sources. Areas of concern are the surrounding area at the Walkup Sky Dome and the area adjacent to the South Plant.

Relight parking and pedestrian areas that are a high level of concern. Install white-light luminaires at bus stops.

Relight all roadways illuminated with mercury vapor lamps and non-cutoff luminaires be replaced with code compliant low-pressure sodium full cutoff fixtures.

Relight the SW Parking lot currently shown having insufficient light levels and add a Campus Lighting controller for luminaires in this zone.

Relight the parking lot around the Babbit Administration building to replace the Mercury Vapor luminaires with code compliant energy efficient fixtures.

Add luminaries at entrances to define the Campus boundary.

Replace the non compliant globes in the Historic District with new full cut off energy efficient High Pressure Sodium sources. Add a Lighting Controller for Campus control of this area.

Phase 2 (3-10 years)

Replace of the Semi-cutoff non-LPS Luminaires that are not slated for Phase I moves demolitions or new construction per the 2010 Comprehensive Mater Plan.

Install new luminaires along the newly defined Pedway along with new Campus Lighting controller(s).

Install new luminaires along the newly defined Busway and at safety white light at the Bus stops. Provide new Campus Lighting controller

APPENDIX A – Maps

Map 01: Lighting Master Plan Project Areas

Map 02: Existing Lighting Sources by Area

Map 03: Existing Campus Entry Sign Locations

Map 04: Existing Campus Roadways

Map 05: Existing Campus Pedways

Map 06: Existing Parking

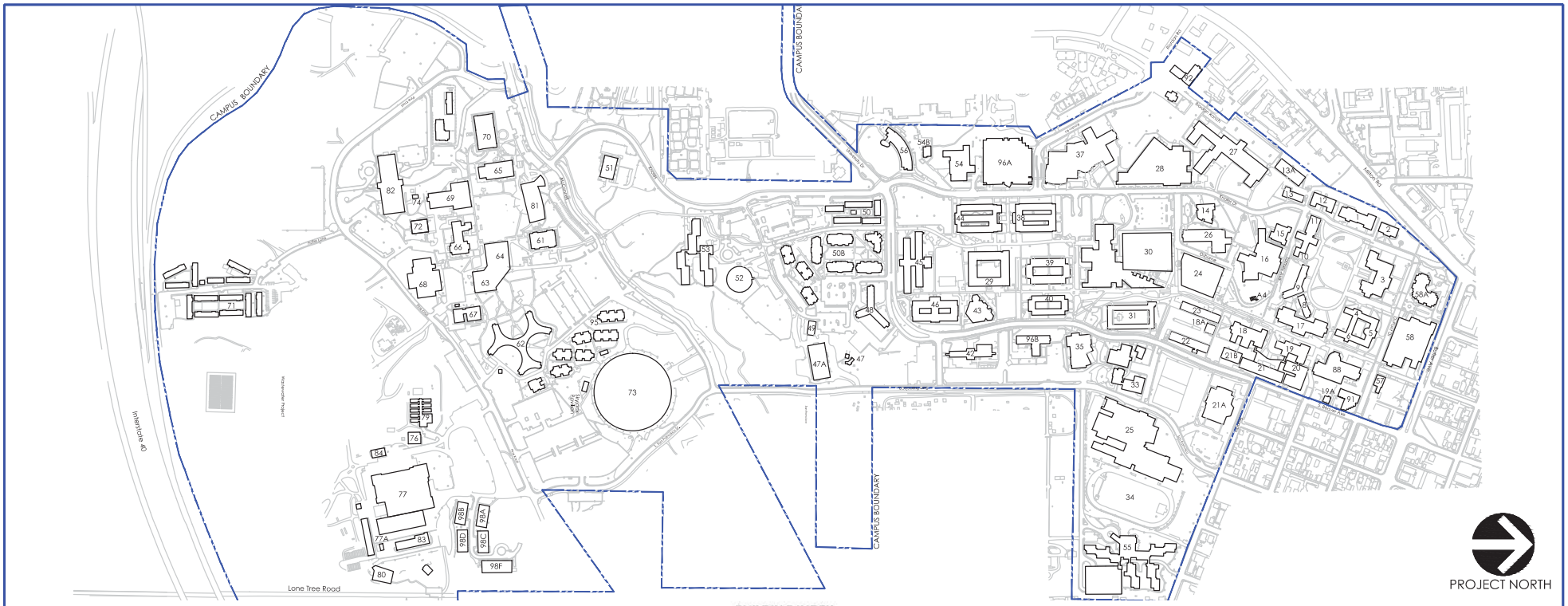
Map 07: Existing Bus Stops and Transit Spine Route Locations

Map 08: Event Centers and Major Pedestrian Crossing Points

Map 09: Historic District

Map 10: Lighting Control Zones

Map 11: Phasing Plan



BUILDING INDEX

BLDG#	NAME	BLDG#	NAME	BLDG#	NAME	BLDG#	NAME	BLDG#	NAME	BLDG#	NAME
1	Gammage	16A	Universities Network	29	Aspen Crossing Learning Community	48	Reilly Hall	63	South Dining	81	W. A. Franke College of Business
2	Blome	17	Science Lab Facility	30	Fieldhouse/University Union	49	Anthropology Laboratory	64	du Bois Center	82	Southwest Forest Science Complex
3	North Union/1899 Bar & Grill/ Prochnow Audit.	18	Liberal ArtsScience	31	Gillenwater Hall	50	Campus Heights Apartments	65	The Raul H. Castro Bldg. (SBS.)	83	KNAU/Shuttle ServicesSouthwest
		18A	Biology Greenhouse	33	HRM - Eugene M. Hughes Bldg.	50B	McKay Village	66	Health Professions	84	Sculpture Studio
4	Morton Hall	19	Physical Sciences	34	Lumberjack Stadium	51	Babbitt Administrative Center	67	South Heating & Cooling Plant	88	Wettaw
5	Residence Life Offices (North Hall)	19A	Human Resources Annex	35	Bookstore	52	Bilby Research Center	68	Rolle Activity Center	91	Centennial Bldg.
6	Campbell Hall	20	Chemistry	37	Performing & Fine Arts/Ardrey Audit.	53	Gabaldon Hall	69	Engineering & Natural Sciences	92	Ponderosa
8	Bury	21	Biological Sciences	38	Cowden Learning Community	54	Information Systems Bldg.	70	Social & Behavioral Sci. - West	95	Pine Ridge Village
9	Taylor Hall	21A	Wall Aquatic Center	39	Raymond Hall	54B	Information Systems Bldg. Annex	71	South Family Apartments	96A	Knoles Drive Parking Structure
10	Old Main	21B	Biological Sciences Annex	40	McDonald Hall	55	Mountain View Hall	72	Nursing	96B	San Francisco Parking Structure (Open 8/2012)
11	Ashurst	22	Peterson	42	Sechrist Hall (Campus Tours)	56	Applied Research & Development	73	Walkup Skydome		
12	Geology	23	Babbitt Academic Annex	43	Gateway Student Success Center	57	Printing Services	74	Renewable Energy Test Facility	97	Waste Water Training Facility
13	Geology Annex	24	North Heating & Cooling Plant	44	Tinsley Hall	58	High Country Conference Center	75	McConnell Drive Res. Hall (Open 8/2012)	98A	Campus Police Department
13A	Roseberry Apartments	25	Health & Learning Center	45	Wilson Hall	58A	Drury Inn	77	Capital Assets & ServicesCampus	98B	Program in Intensive English
14	Native American Cultural Center	26	Adel Mathematics	46	Allen Hall	59	Hilltop Residence Hall (Open 8/2012)	77A	Capital Assets & Services Annex	98C	Engineering Projects
15	Riles	27	Eastburn Ed./Institute for Human Dev.	47	Observatory/Lutz Telescope	61	Learning Resource Center	79	Greenhouse Complex	98D	Anthropology
16	Communications/Extended Campuses	28	Cline Library	47A	ROTC/Property Administration	62	McConnell HallW.	80	Ceramics Complex	98F	Residence Life Support Services Wh.

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NORTHERN ARIZONA UNIVERSITY

NORTHERN ARIZONA UNIVERSITY LIGHTING MASTER PLAN

LIGHTING MASTER PLAN PROJECT AREAS

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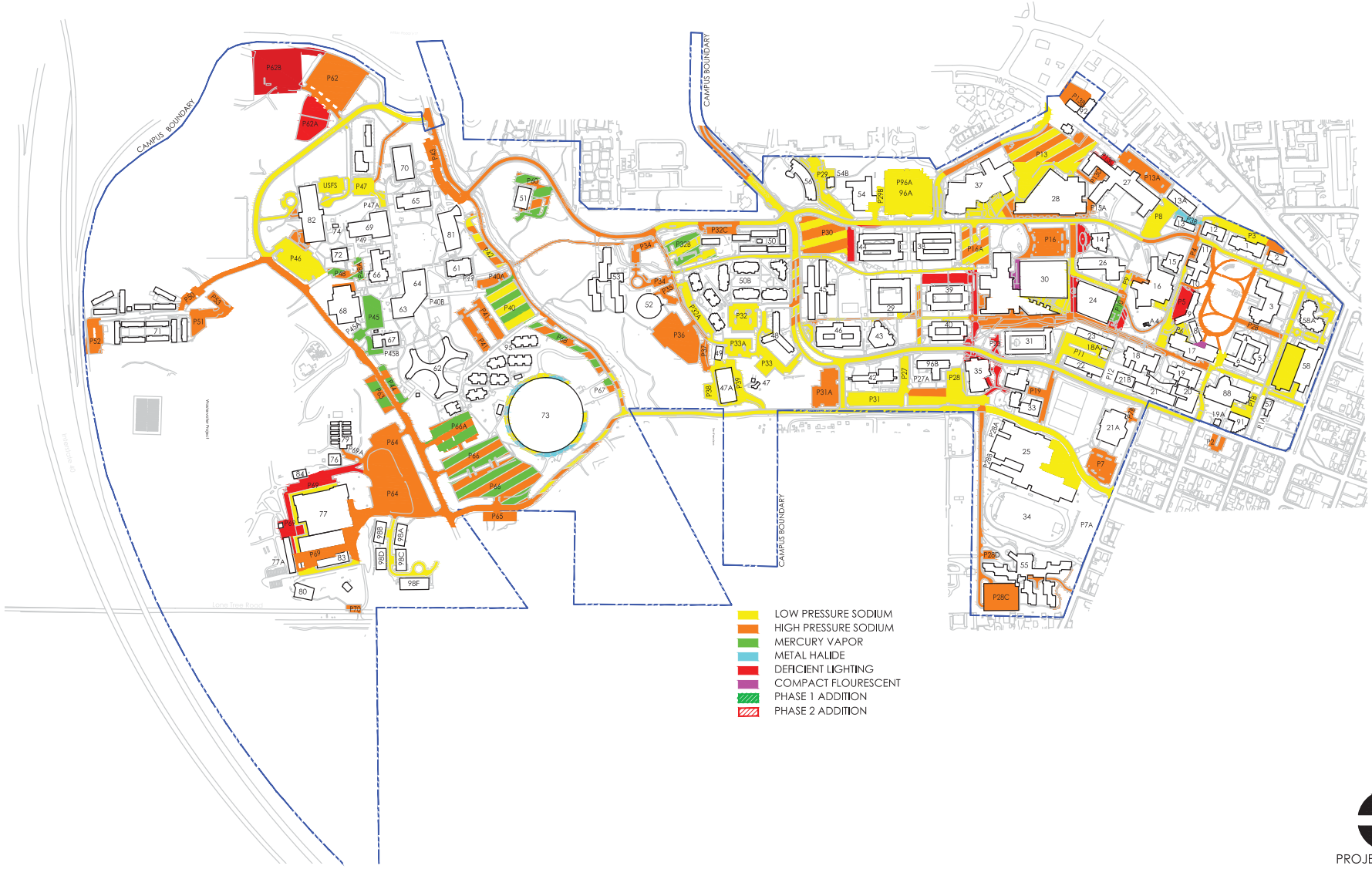
MAP 01



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EXISTING LIGHTING SOURCES BY AREA

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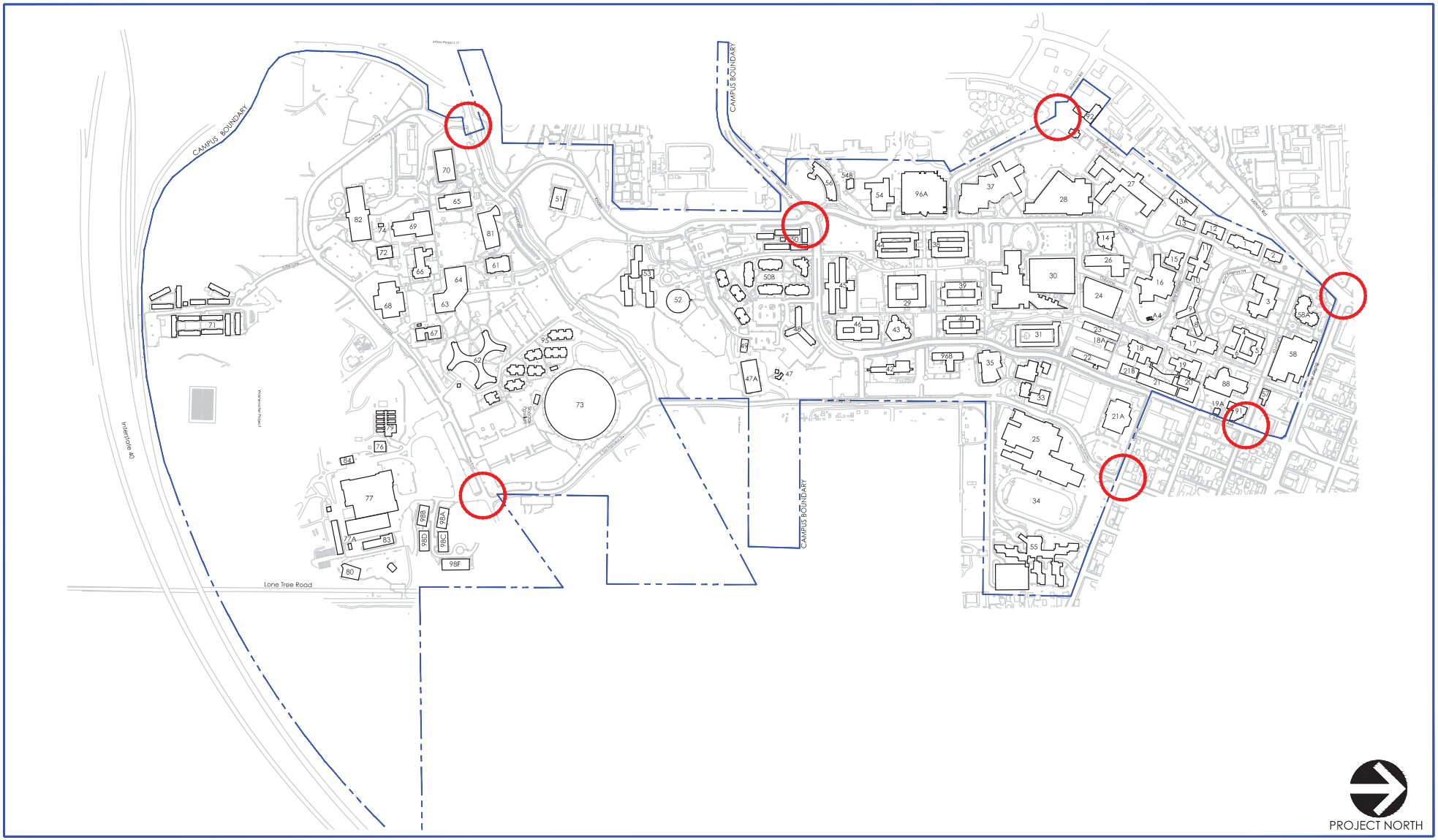
MAP 02



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EXISTING CAMPUS ENTRY SIGN LOCATIONS

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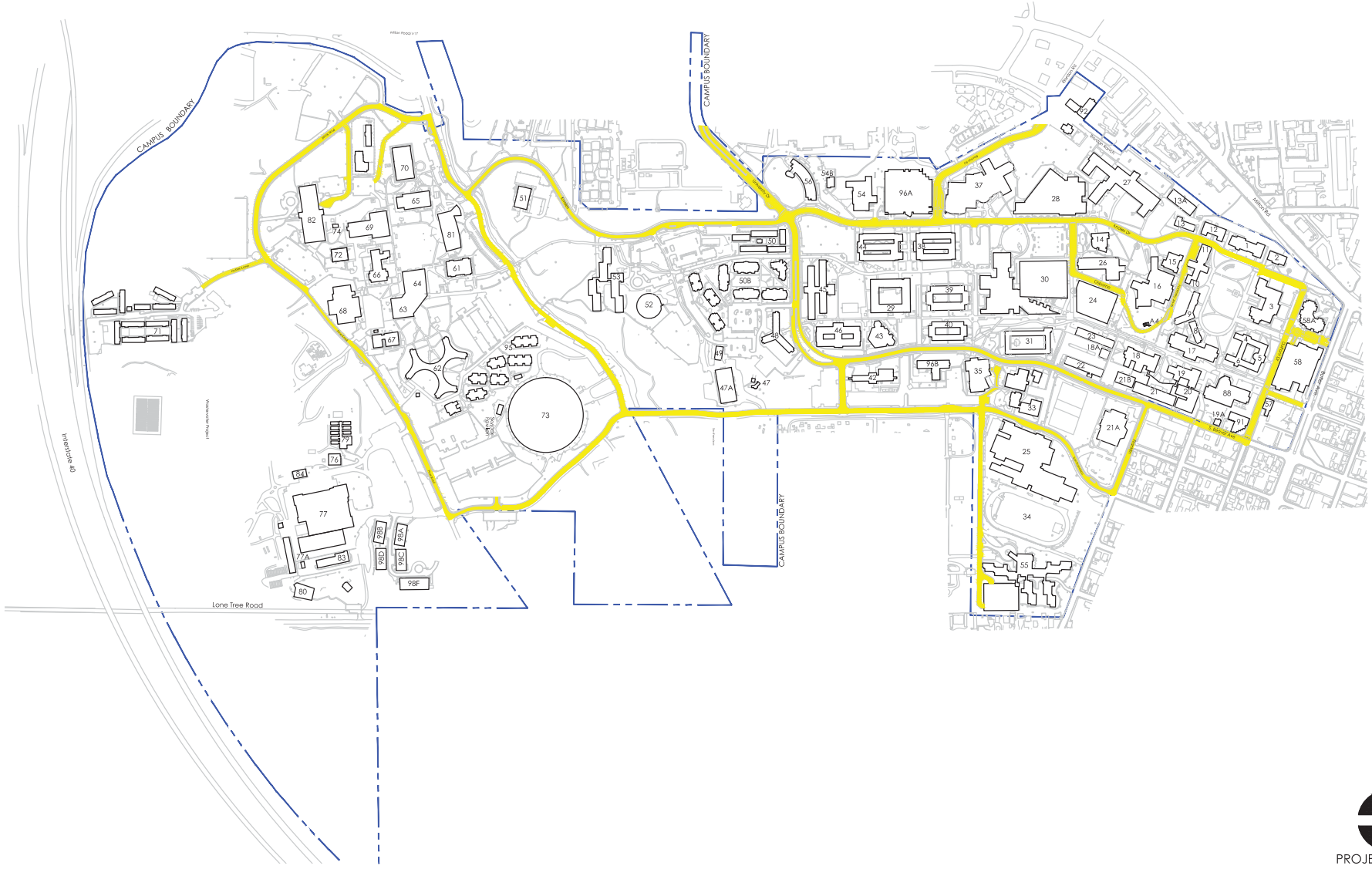
MAP 03



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EXISTING CAMPUS ROADWAYS

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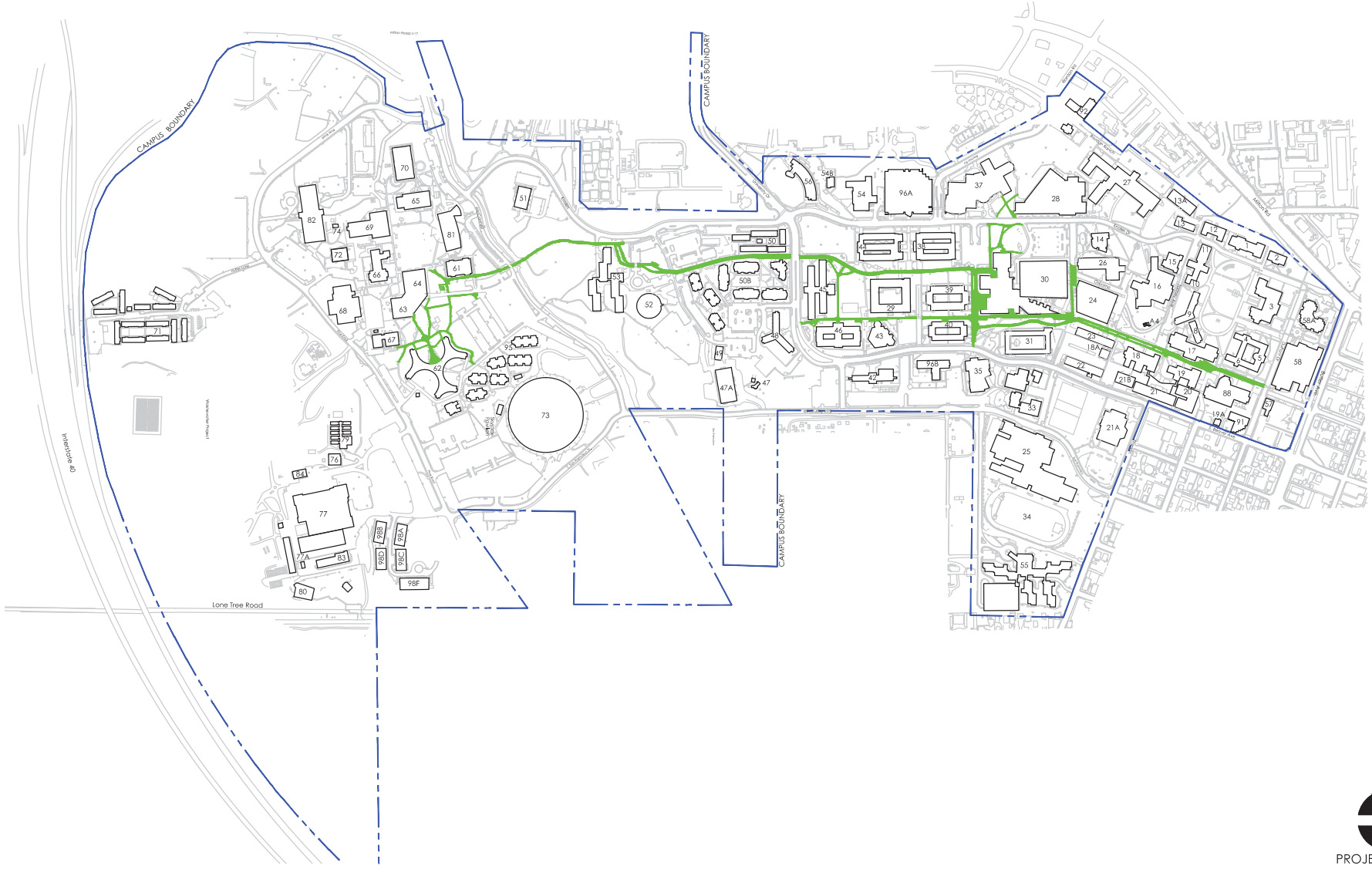
MAP 04



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EXISTING CAMPUS PEDWAYS

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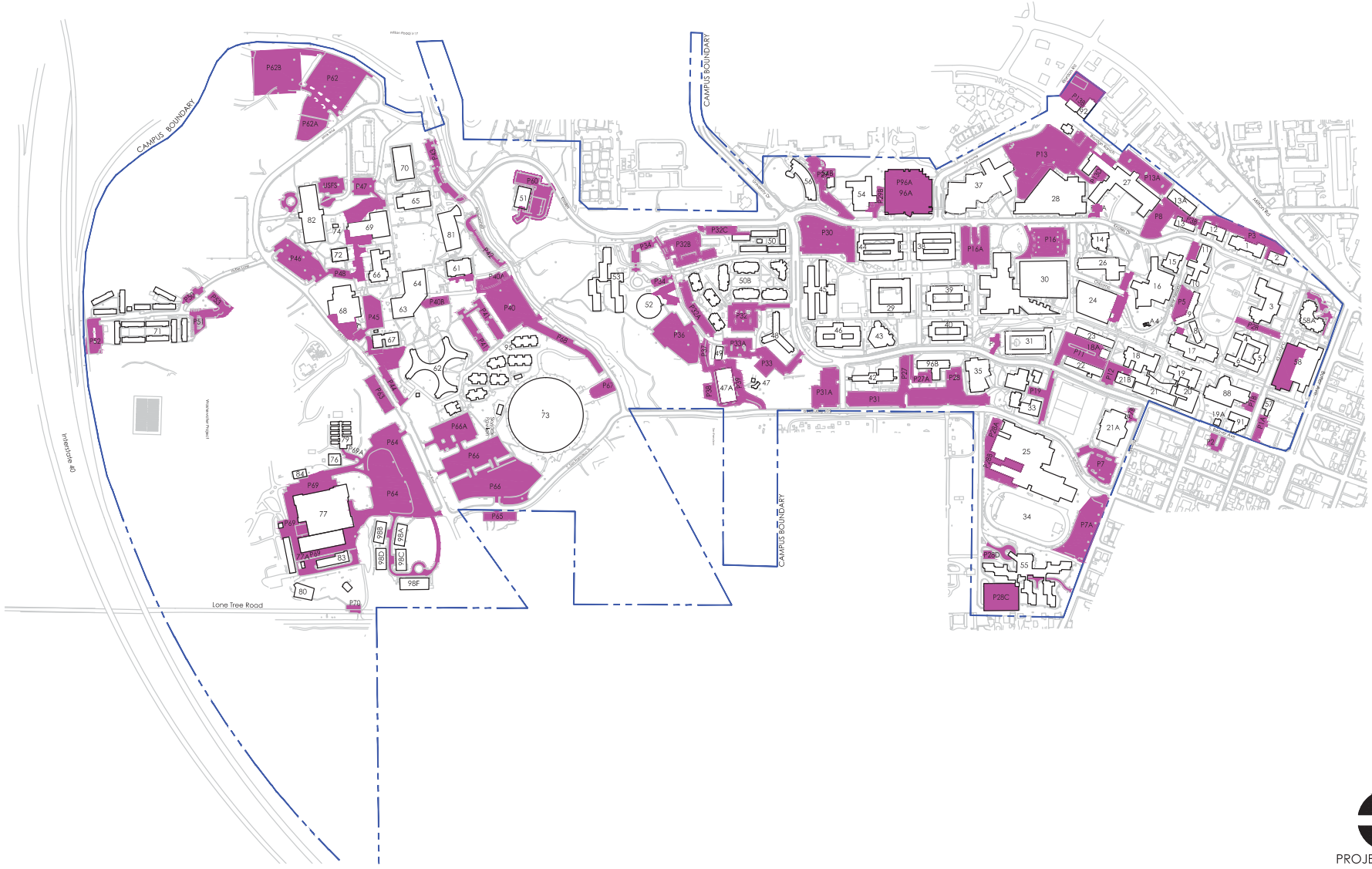
MAP 05



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EXISTING PARKING

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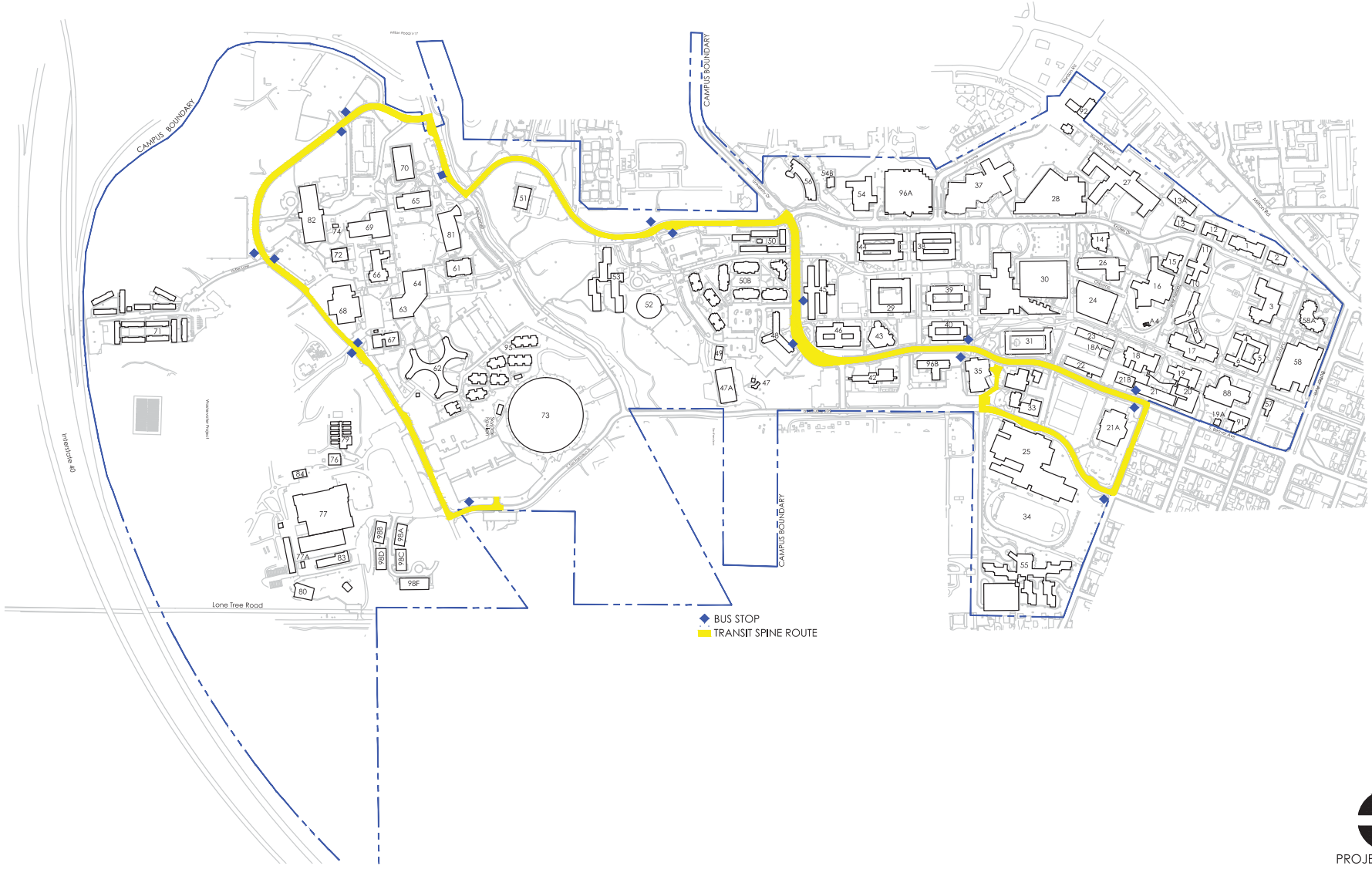
MAP 06



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BUS STOP AND TRANSIT SPINE ROUTE LOCATIONS

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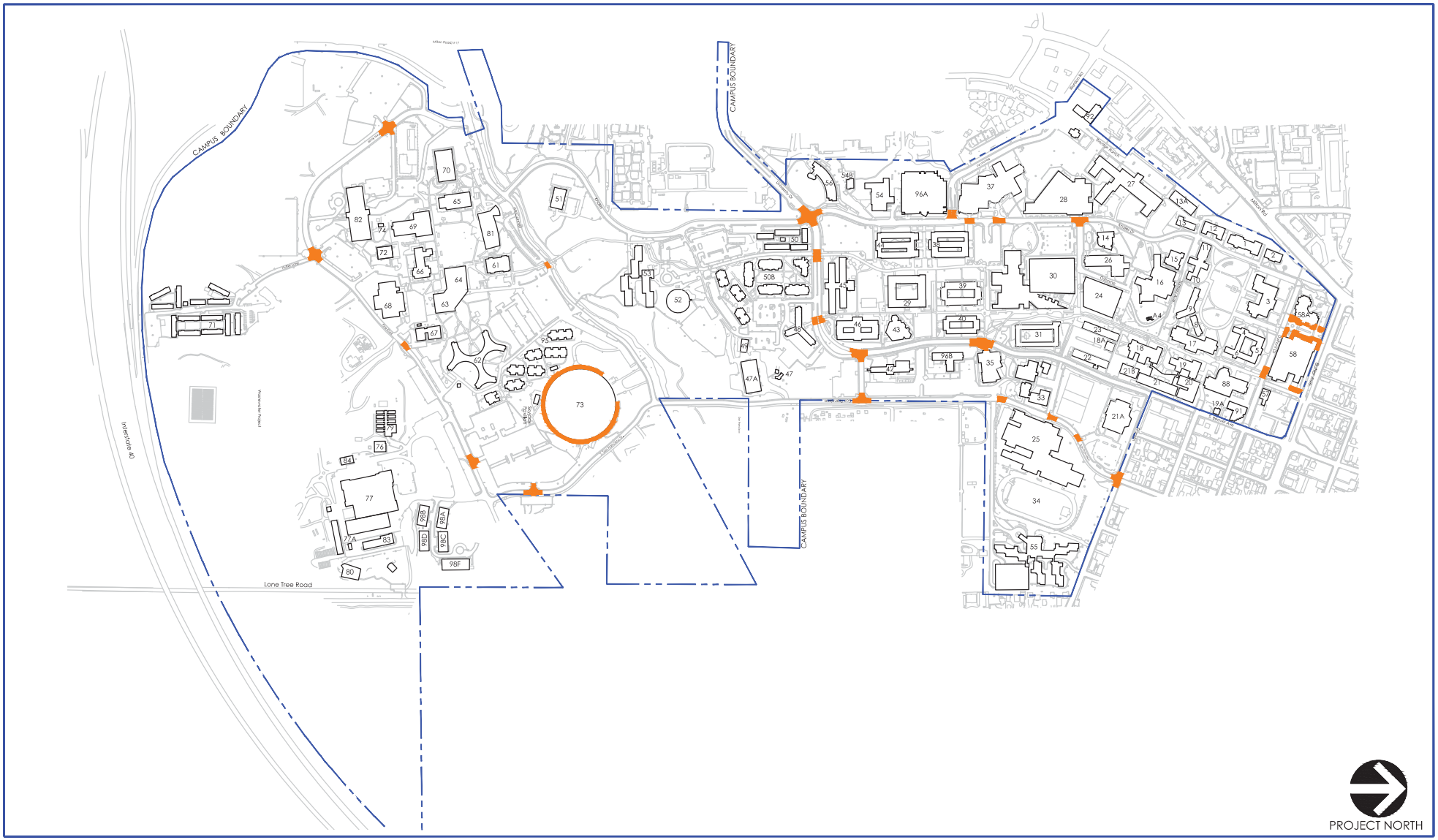
MAP 07



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EVENT CENTERS & MAJOR PEDESTRIAN CROSSING POINTS

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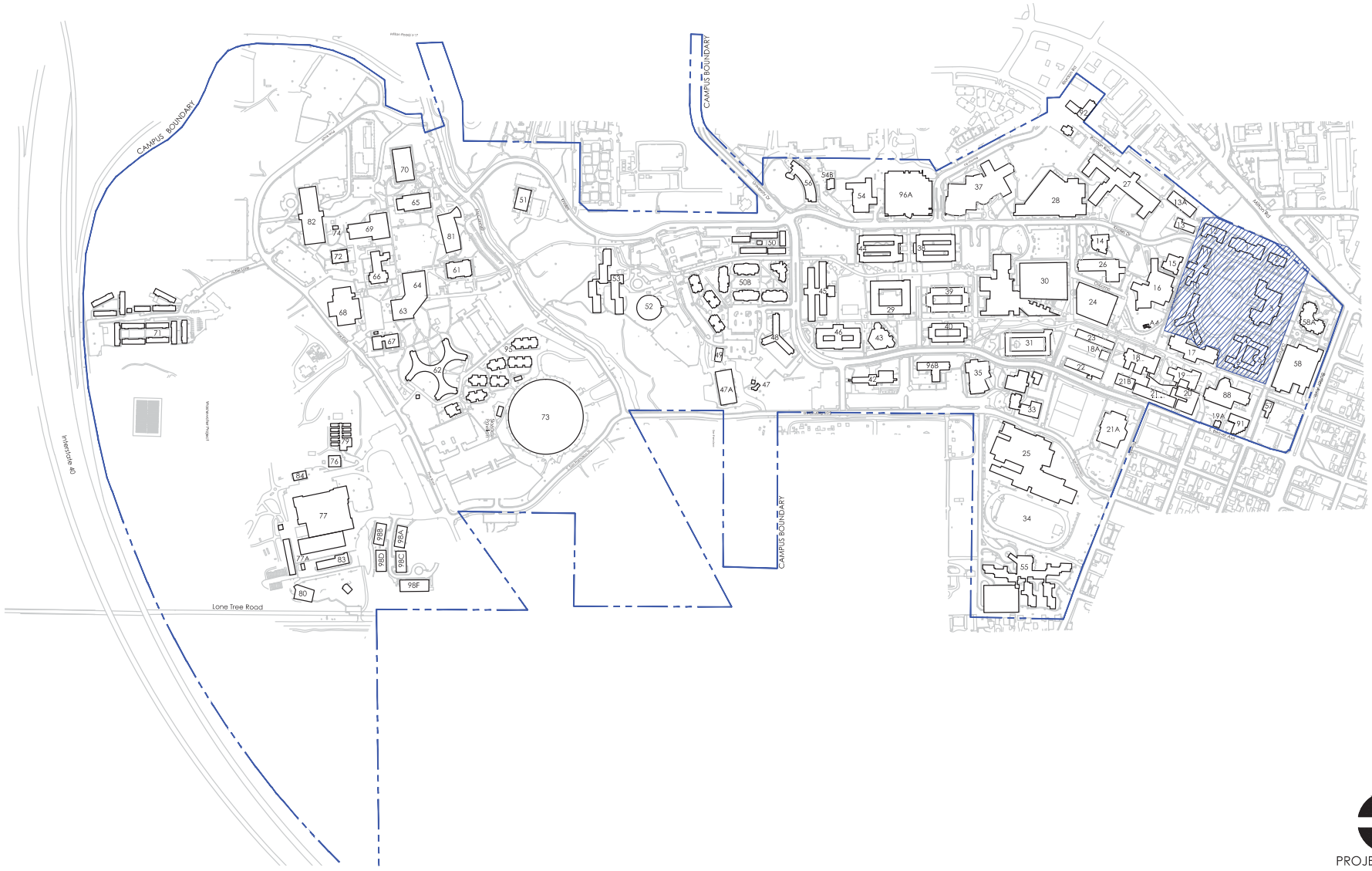
MAP 08



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HISTORIC DISTRICT

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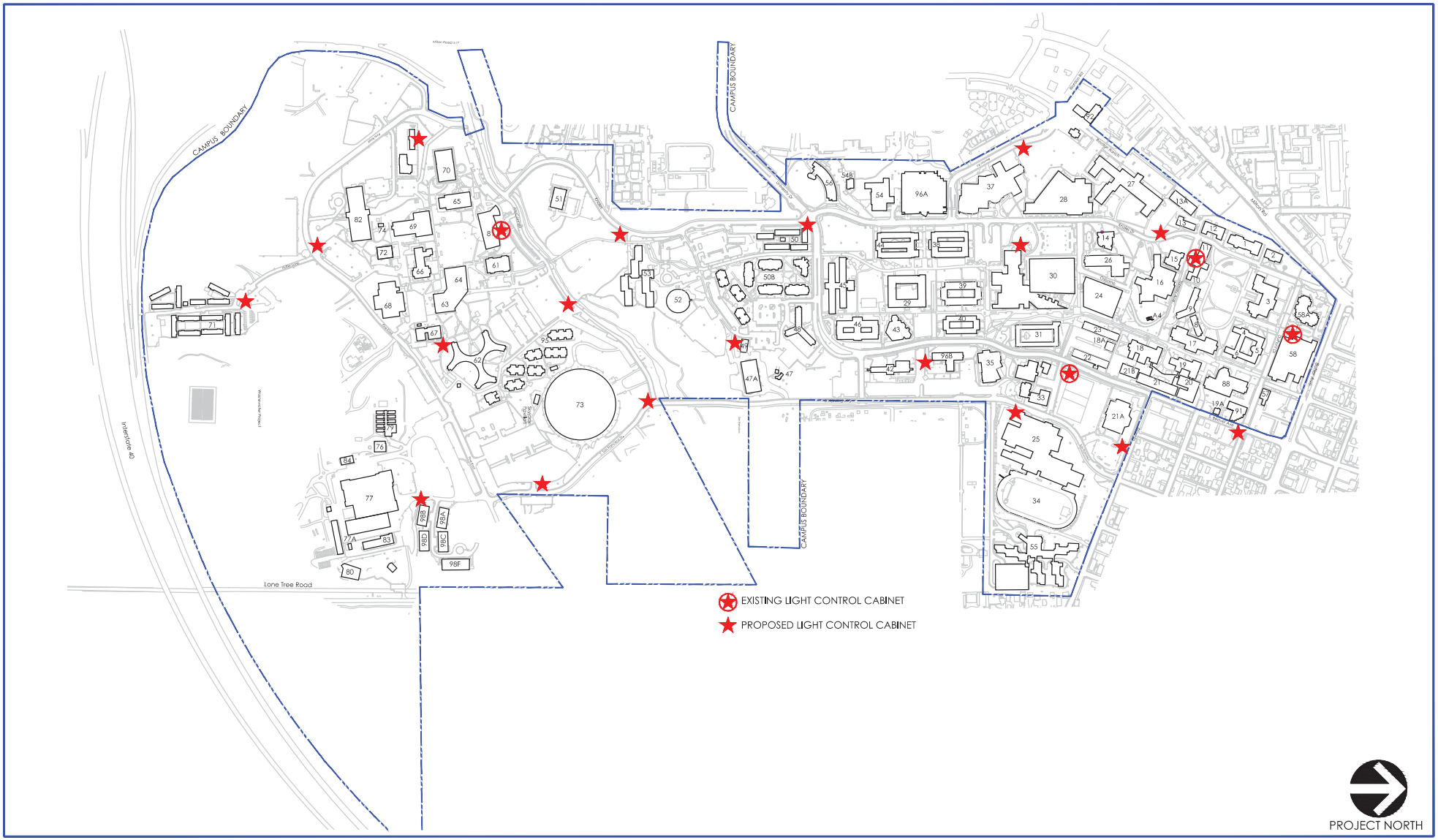
MAP 09



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LIGHTING CONTROL ZONES

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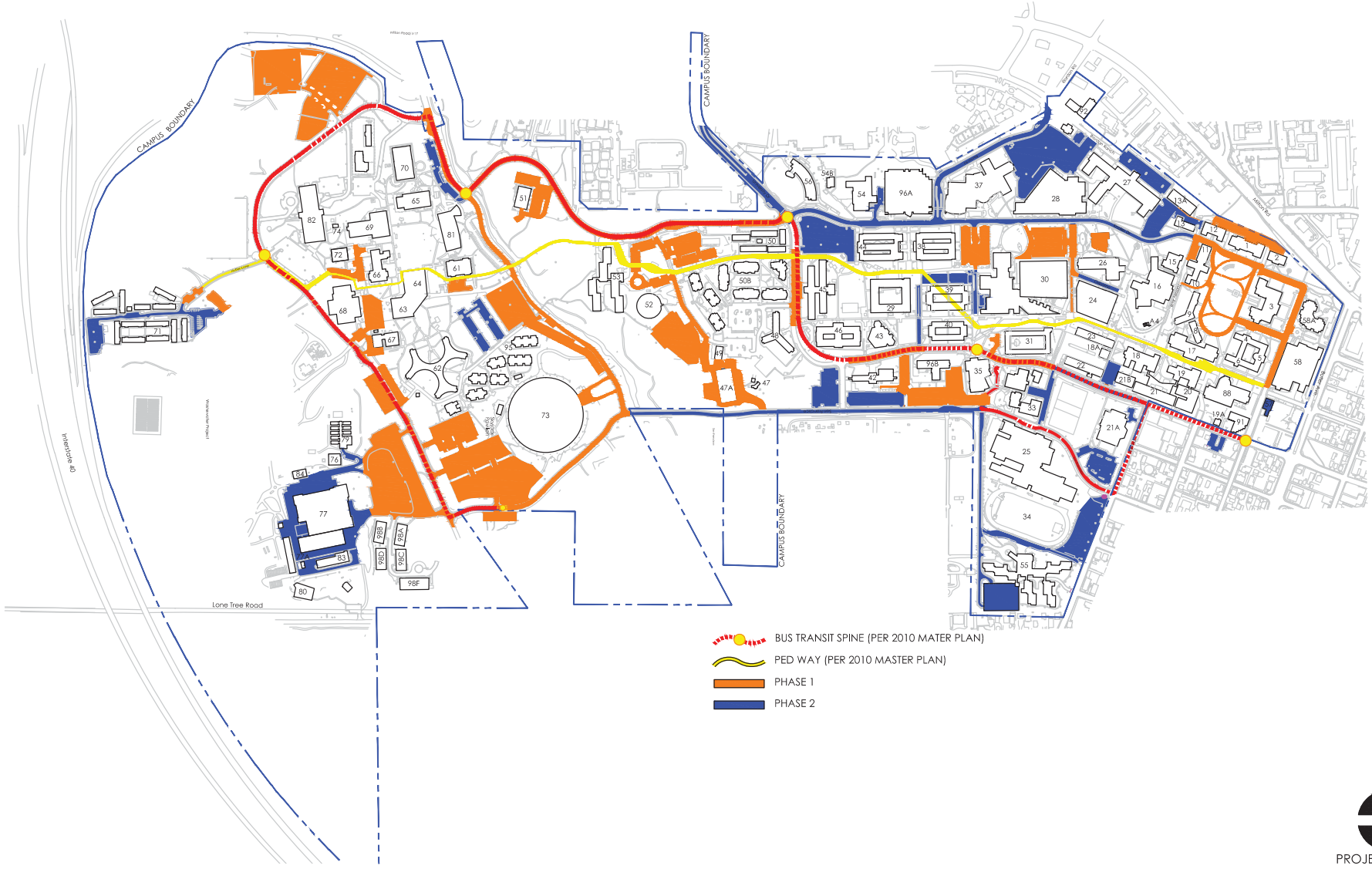
MAP 10



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PHASING PLAN

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MAP 11

Appendix B – Parking Lot Matrices

Map 12: Parking Matrices North Campus

Map 13: Parking Matrices South Campus

LOCATION	58	P1A	P1B	P2	P2B	P3	P3B	P4	P5	P6	P7	P7A	P7B	P8	P9	P10	P11	P12	P13	P13A
ENVIRONMENTAL SAFETY												N/A				N/A	N/A	N/A		
LIGHTING CODE COMPLIANCE												N/A				N/A	N/A	N/A		
NIGHT ACTIVITY												N/A				N/A	N/A	N/A		
MAINTENANCE / APPEARANCE									N/A			N/A				N/A	N/A	N/A		
PRIORITY / NOTES				5	5			1	1			4				4	1	2	2	

LOCATION	P13B	P13C	P13D	96A	P15A	P16	P16A	P19	P23	P27	P27A	P28	P28A	P28B	P28C	P28D	P29	P29B	P30	P31
ENVIRONMENTAL SAFETY																				
LIGHTING CODE COMPLIANCE																				
NIGHT ACTIVITY																				
MAINTENANCE/APPEARANCE																				
PRIORITY/NOTES		2				2	3	1	1,5	1	1	1	4	4			1		3	

LOCATION	96B
ENVIRONMENTAL SAFETY	
LIGHTING CODE COMPLIANCE	
NIGHT ACTIVITY	
MAINTENANCE/APPEARANCE	
PRIORITY/NOTES	4

LEGEND

ENVIRONMENTAL SAFETY CONCERNS
- EXTREME
- HIGH
- MEDIUM
- LOW

LIGHTING CODE COMPLIANCE
- PROHIBITED SOURCE
- NON-CUTOFF
- SEMI-CUTOFF/NON-LPS
- COMPLIANT

NIGHT ACTIVITY LEVEL
- HEAVY
- HIGH
- INTERMITTENT
- LOW

MAINTENANCE/ APPEARANCE ISSUES
- O/H WIRING
- ATYPICAL/UNUSUAL COMPONENTS/MISC.
- DEFECTIVE OR MISSING COMPONENT(S)
- NO APPARENT CONCERNS

PRIORITY LEVEL
- PHASE 1 (1st YEAR)
- PHASE 1
- PHASE 2
- NO WORK REQ'D.

NOTES:
1. AREA TO BE REBUILT DURING PHASE 1 BUILDING CONSTRUCTION PROJECT. PER 2010 MASTER PLAN.
2. AREA TO BE REBUILT DURING PHASE 2 BUILDING CONSTRUCTION PROJECT. PER 2010 MASTER PLAN.
3. AREA TO BE REBUILT DURING PHASE 3 BUILDING CONSTRUCTION PROJECT. PER 2010 MASTER PLAN.
4. CURRENTLY UNDER CONSTRUCTION.
5. AREA TO BE REBUILT WITH TRANSIT SPINE PER 2010 MASTER PLAN.
6. AREA TO BE REBUILT WITH PEDWAY RENOVATION PER 2010 MASTER PLAN.

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NORTHERN ARIZONA UNIVERSITY

NORTHERN ARIZONA UNIVERSITY LIGHTING MASTER PLAN

PARKING MATRICES NORTH CAMPUS

2011.08.19

MAP 12

LOCATION	P31A	P32	P32A	P32B	P32C	P33	P33A	P34	P35	P36	P37	P38	P39	P40	P40A	P40B	P41	P42	P43	P44
ENVIRONMENTAL SAFETY																				
LIGHTING CODE COMPLIANCE																				
NIGHT ACTIVITY																				
MAINTENANCE/APPEARANCE																				
PRIORITY/NOTES		1	1	2	2,3			6	6	1	1	1	1	1,6	1,6	1,6	1		2	5

LOCATION	P45	P45A	P45B	P46	P47	P47A	P48	P48A	P49	P50	P51	P52	P53	P54	P60	P62	P62A	P62B	P63	P64
ENVIRONMENTAL SAFETY																				
LIGHTING CODE COMPLIANCE																				
NIGHT ACTIVITY																				
MAINTENANCE/APPEARANCE																				
PRIORITY/NOTES					1	1	2,6	2,6		6						1	1&2	1&2	5	2

LOCATION	P65	P66	P66A	P68	P69	P69A	P70	USFS
ENVIRONMENTAL SAFETY								
LIGHTING CODE COMPLIANCE								
NIGHT ACTIVITY								
MAINTENANCE/APPEARANCE								
PRIORITY/NOTES		5			2	2		

LEGEND

ENVIRONMENTAL SAFETY CONCERNS
- EXTREME
- HIGH
- MEDIUM
- LOW

LIGHTING CODE COMPLIANCE
- PROHIBITED SOURCE
- NON-CUTOFF
- SEMI-CUTOFF/NON-LPS
- COMPLIANT

NIGHT ACTIVITY LEVEL
- HEAVY
- HIGH
- INTERMITTENT
- LOW

MAINTENANCE/ APPEARANCE ISSUES
- O/H WIRING
- ATYPICAL/UNUSUAL COMPONENTS/MISC.
- DEFECTIVE OR MISSING COMPONENT(S)
- NO APPARENT CONCERNS

PRIORITY LEVEL
- PHASE 1 (1st YEAR)
- PHASE 1
- PHASE 2
- NO WORK REQ'D.

NOTES:
1. AREA TO BE REBUILT DURING PHASE 1 BUILDING CONSTRUCTION PROJECT. PER 2010 MASTER PLAN.
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NORTHERN ARIZONA UNIVERSITY LIGHTING MASTER PLAN

PARKING MATRICES SOUTH CAMPUS

2011.08.19

MAP 13

Appendix C – Codes and Standards

City of Flagstaff Lighting Code

Internet location: **http://www.flagstaff.az.gov/DocumentView.aspx?DID=195**

CHAPTER 10-08. SIGNS AND LIGHTING

DIVISION 10-08-002. DEVELOPMENT LIGHTING REGULATIONS
10-08-002-0001. INTENT AND PURPOSE:
It is the intent of this Division to encourage lighting practices and systems which will: minimize light pollution, glare, light trespass; conserve energy and resources while maintaining night time safety, utility, security, and productivity; and curtail the degradation of the night time visual environment. It is recognized that since topographic and atmospheric conditions surrounding the City of Flagstaff are uniquely suited for astronomical observation and since observatories have been established in the City's vicinity, the City of Flagstaff, through the provisions herein contained, promotes the reduction of light pollution which interferes with the successful operation of such observatories. The effects of outdoor lighting on the light pollution over the observatories is strongly dependent on the distance of those lights from the observatories; therefore, three Astronomical Zones are hereby established, allowing increased flexibility in the uses of outdoor lighting farther from the observatories.

10-08-002-0002. APPLICABILITY

A. NEW USES, BUILDINGS AND ADDITIONS: All proposed new land uses, developments, buildings, structures, or building additions of twenty-five (25) percent or more in terms of additional dwelling units, gross floor area, seating capacity, or other units of measurement specified herein, either with a single addition or cumulative additions subsequent to the effective date of this provision, August 5, 1999, shall meet the requirements of this Division for the entire property. This includes additions which increase the total number of required parking spaces by twenty-five (25) percent or more. For all building additions of less than twenty-five (25) percent cumulative, the applicant shall only have to meet the requirements of this Division for any new outdoor lighting provided. (Ord. 1997, 6-15-99)

B. CHANGE OF USE/INTENSITY: Except as provided in subsection C below, whenever the use of any existing building, structure, or premises is changed to a new use, or the intensity of use is increased through the incorporation of additional dwelling units, gross floor area, seating capacity, or other units of measurement specified herein, and which change of use or intensification of use creates a need for an increase in the total number of parking spaces of twenty-five (25) percent or more, either with a single change or cumulative changes subsequent to the effective date of this provision, August 5, 1999: then all outdoor lighting facilities shall meet the requirements of this Division for the entire property, to the maximum extent possible as determined by the Planning Director. For changes of use or intensity which require an increase in parking of less than twenty-five (25) percent cumulative, the applicant shall only have to meet the requirements of this Division for any new outdoor lighting provided. (Ord. 1997, 6-15-99)

C. NONCONFORMING USES, STRUCTURES OR LOTS: Whenever a nonconforming use, structure or lot is abandoned for a period of one hundred eighty (180) consecutive days and then changed to a new use according to the requirements of Sections 10-10-005-0003 and 0004 of this Code, then any existing outdoor lighting shall be reviewed and brought into compliance as necessary for the entire building, structure or premises, to the maximum extent possible as determined by the Planning Director. (Ord. 1997, 6-15-99)

10-08-002-0003. APPROVED MATERIALS AND METHODS OF CONSTRUCTION OR INSTALLATION/OPERATION:

A. Preferred Source - Low-pressure Sodium (LPS) lamps are the preferred illumination source throughout the City; their use is to be encouraged, when not required, for outdoor illumination whenever its use would not be detrimental to the use of the property.

B. Uses that can turn off their outdoor lighting during night hours are to be encouraged in Astronomical Zone I (Section 10-08-002-0004); those which require all night illumination are to be discouraged.

C. The provisions of this Division are not intended to prevent the use of any design, material, or method of installation or operation not specifically prescribed herein, provided any such alternate has been approved by the Planning Director. The Planning Director may approve any such proposed alternate provided he/she finds that it:
   1. Provides at least approximate equivalence to the applicable specific requirements of this Division; and
   2. Is otherwise satisfactory and complies with the intent of this Division.

10-08-002-0004. ESTABLISHMENT OF ASTRONOMICAL ZONES:

A. Three Astronomical Zones are hereby established. Zone I is in two parts centered at the observatories located on Anderson Mesa (Lowell Observatory) and west of Flagstaff (Naval Observatory); the outer boundary of Zone I is set at approximately two and one-half (2.5) miles from these observatories. Zone II extends from the outer boundary of Zone I to approximately seven (7) miles from the observatories. Zone III is all remaining property within the City limits. These zones are shown in Illustration 10-08-002-0004, the Astronomical Zone Map, and by this reference made a part hereof.

B. A parcel located in more than one of the described zones shall be considered to be only in the more restrictive zone.

NAU is in Lighting Zone II

10-08-002-0007. SPECIAL REQUIREMENTS, ZONE II:

A. Total outdoor light output (excluding street lights used for illumination of public rights-of-way) of any development project in Zone II shall not exceed 50,000 lumens per net acre, averaged over the entire project. Furthermore, no more than 5,500 lumens per net acre may be accounted for by lamps in unshielded or

partially-shielded fixtures permitted in Table 10-08-002-0005, except that lamp(s) emitting no more than 4,720 lumens per single-family dwelling unit or duplex dwelling unit for residential outdoor lighting purposes are exempt from the shielding requirements of Table 10-08-002-0005, though they must conform to all other applicable restrictions. Single-Family attached units (e.g. townhouses), and multi-family residential units are limited to 2360 lumens of unshielded lights per unit. (Ord. 1997, 6-15-99)

B. Outdoor recreational facilities are not subject to the lumens per net acre limit set in Subsection 10-08-002-0007.A. However, no such facility in Zone II shall be illuminated after 11:00 pm, except to conclude a scheduled recreational or sporting event in progress prior to 11:00 pm.

C. Outdoor internally illuminated advertising signs shall be constructed with an opaque background and translucent letters and symbols or with a colored (not white, cream, off-white, or yellow) background and lighter letters and symbols). Reader panels may be constructed either with an opaque background and translucent letters and symbols, or with a colored (not white, cream, off-white or yellow) background and lighter letters and symbols. Lamps used for internal illumination of such signs shall not be included in the lumens per net acre limit set in this Subsection. Such signs shall be turned off at 11:00 pm or when the business closes, whichever is later. (Ord. 1741, 3-17-92)

D. Class 3 lighting must be extinguished at 11:00 pm or when the business closes, whichever is later,

10-08-002-0013. NONCONFORMING LIGHTING:
(See Section 10-08-002-0002, Applicability, for nonconforming uses) (Ord. 1997, 6-15-99)

A. Mercury vapor lamps in use for outdoor lighting in Zones I, II, and III on the effective date of this Division shall not be so used after 1 May 1996.

B. Any construction permit which invokes Certificate of Occupancy requirements shall specify and require that any nonconforming sign, as to lighting, located within the boundaries of the development site authorized by said permit shall be brought into conformance with the provisions of this Division.

C. No outdoor lighting fixture which was lawfully installed prior to the enactment of this Division shall be required to be removed or modified except as expressly provided herein; however, no modification or replacement shall be made to a nonconforming fixture unless the fixture thereafter conforms to the provisions of this Code.

D. In the event that any nonconforming sign, as to lighting, is abandoned or is damaged, and if the damage exceeds fifty (50) percent of the reproduction value, exclusive of foundations, to replace it, the sign shall be brought into conformance with the provisions of this Division.

Arizona State Lighting Code

State of Arizona capital projects are required to comply with the outdoor lighting Code per Senate Bill 1218. NAU voluntarily complies with the City of Flagstaff's lighting Code, which is among the most stringent in the world. It limits the amount of illumination per acre based on lamp type, wattage, location, and shielding. To meet the current lighting Code, non-cutoff luminaires will have to be replaced if an area is affected by a construction project; otherwise no changes are required.

Priority levels for code compliance:

- Prohibited Source – Mercury vapor or high-wattage incandescent bulbs including halogen.
- Non-cutoff – Luminaires, which do not shield the light above the horizontal plane.
- Semi-cutoff – Luminaires, which provide partial shielding of light above the horizontal plane.
- Non-LPS – Luminaires with permissible sources at above 50 watts other than Low Pressure Sodium (LPS) as allow by the current lighting Code.
- Compliant – Luminaires that meet the current lighting Code.

APPENDIX D – Lighting Design Criteria and Light Level References

The NAU Technical Standards as revised in 2010 provide the criteria and recommended illuminance levels for the Campus.

Reference Section: 26 56 00 Exterior Lighting, Design Requirements