Flagstaff Area National Monuments Lighting Management Plan

1.1 Introduction

In conformance with NPS Management Policy 4.10— Natural Lightscapes, the installation and use of artificial outdoor lighting should be used only when and where dictated by safety, and should not be driven by convenience. Mitigation should be employed to the maximum practical extent. These guidelines direct park management to design park lighting to mitigate light pollution and to preserve natural darkness as much as possible.

The Flagstaff Area National Monuments (FLAG) includes Walnut Canyon, Sunset Crater Volcano, and Wupatki National Monuments. Visitors experience a meandering limestone canyon with wooded rims and cliff dwellings, stark black volcanic landscapes, and the prominent pueblos atop red sandstone. These experiences are solidified further by access to night-time views which allow for quiet contemplation of not just the vastness of the Southern Colorado Plateau landscape, but the vastness of our Universe. This night sky is a diminishing resource that the National Park Service seeks to preserve. The goal of this Lighting Management Plan (LMP) is to provide for the safety, security and route finding of Park visitors and staff without any significant impact on the night skies of FLAG.

Good lighting design and application requires the synthesis of several human and environmental factors— what visual tasks are to be performed, psychology of security, ocular adaptation level, fixture efficacy, lamp efficacy, fixture placement, ambient illumination level, light spectrum, and lighting controls (i.e. switches, timers, and dimmers) to name a few. Additionally there are environmental consequences of artificial outdoor lighting related to direct glare, angular distribution, atmospheric scattering, color, duration, and intensity. FLAG is surrounded by Coconino County, which has appreciably strict lighting codes. This lighting plan is no less restrictive than Coconino County's Section 27.6: General Requirements, all Zones.

The National Park Service Night Sky Team has created two documents to assist individual parks in creating an LMP. These are listed below under "Sources" along with other guiding documents that have contributed both ideas and language for this LMP. Fortunately, the primitive nature of most of FLAG, along with the small scope of facilities in the park, both extant and planned, means that the LMP for FLAG is generally simple and in line with what park staff and visitors have come to expect.

Light Pollution

A natural lightscape is one that is free of light pollution. Spilled light or wasted light are phrases that describe the misuse of outdoor lighting, especially in a natural or protected environment such as a national park. The term light pollution has commonly been used to emphasize the concept that anthropogenic light in the naturally dark environment is indeed a pollutant with undesirable ecological consequences, not just a nuisance. There are many good reasons to eliminate light pollution in national parks, including:

1. The preservation of natural lightscapes (the intensity and distribution of light on the landscape at night) will maintain the nocturnal scotopic (vision under low light conditions) environment within the range of natural variability.

2. The scenery of national park areas does not just include the daytime hours. A natural starry sky

absent of anthropogenic light is a key scenic resource.

3. The history and culture of many civilizations are steeped in interpretations of night sky observations, whether for scientific, religious, or time-keeping purposes. As such, the natural night sky is an important cultural resource, especially in areas where evidence of aboriginal cultures is present.

4. The recreational value of dark night skies is important to park visitors, allowing the experience of enjoying the night sky.

5. Night sky quality is an important wilderness value, contributing to the ability to experience a feeling of solitude in a landscape free from signs of human occupation and technology.

1.2 Guiding Principles

Providing light for visitor and staff safety in commonly used developed areas will be achieved while protecting the natural environment from light pollution.

Outdoor lighting zones will be delineated in the Flagstaff Area National Monuments management plans (specifically this document), with each zone having varying degrees of visitor expectations for natural darkness/outdoor lighting, varying degrees of nighttime use and activity, and/or varying degrees of cultural/natural sensitivity.

Energy efficiency is a goal for all outdoor lighting, as it lessens the park's carbon footprint. An important distinction here, however, is that an energy efficient light is not necessarily a night-friendly light. Long term sustainability in the operation and maintenance of outdoor lighting solutions should be maximized. The total lifecycle cost should be weighed in a sustainability assessment.

Outdoor lighting will be sensitive to the impact upon wildlife. The addition of artificial light into a park setting alters nocturnal habitat, and the impact may reach beyond the bounds of the developed area. Parameters of direct light intensity, scattered light intensity, light color, light timing and duration are all important considerations for wildlife.

Cultural and Historic Resources will be supported, not degraded, by outdoor lighting. The use of period light fixtures represents a special challenge, as these are generally more decorative and less efficient than their modern equivalents. Successfully preserving the cultural and historical integrity may require additional expense and creative solutions.

Protecting the naturally dark surroundings of many park environments is an essential factor in outdoor lighting design. Because of the human eye's reliance on contrast for vision, a dark ambient environment often enables the use of lower illumination levels to achieve the same visual effect.

External threats to the natural lightscape within the parks will be addressed, primarily by setting a leadership example for and working with surrounding communities. NPS management policies put a positive responsibility upon superintendents to partner, to the extent possible, with these communities to protect the natural environment of parks. Part of this effort is to provide examples of outdoor lighting Best Practices for the public. This requires that outdoor lighting in parks be held to a high standard, that the existing lights incorporate these principles, and that park facility lighting is interpreted to visitors and the surrounding community.

1.3 Lighting Guidelines

All exterior lighting in the Flagstaff Area National Monuments shall be designed to eliminate light trespass, minimize glare, and use an intensity, color, and duration that will preserve the natural darkness as much as possible.

NPS Management Policies direct parks to use artificial light on an "only as needed" basis and to minimize impact whenever possible. Merely shielding a light does not necessarily constitute lightscape, wildlife, or night-sky friendliness; especially if that light is unnecessary in the first place. Even when a light is necessary, the incorporation of a timer, motion sensor, or switch can greatly reduce its impact. The mitigation of outdoor lighting impacts upon the environment is best accomplished by addressing six parameters of lighting.

1) Warranting- Light only WHERE you need it

a. Lighting installations should be placed only where uses dictate.

2) Controls- Light only WHEN you need it

a. Rather than defaulting to a dusk-till-dawn operational cycle, lighting controls should be designed to minimize the amount of time the light is on while still fulfilling the need met by installing the light at that spot in the first place.

3) Shielding- Direct light DOWNWARD

a. No fixture should emit light above the horizontal. In most cases, beams of light should be restricted even further.

4) Spectrum- Select LAMPS that minimize negative impacts

a. Humans and many other animals are most sensitive to blue/white light. Most evening lighting goals can be achieved using warmer temperature lighting, which decreases the disruption to wildlife (including insects), maintains the human ability to adapt to low light conditions, and decreases sky glow.

b. The color tint of white light is measured in Kelvins (K), a scale in which warm-toned white light has smaller values (1800-3000K) and cold-toned light has larger values (5000K and higher). Between 3000 and 5000K, light is said to be "neutral" in tone. The common incandescent lamp is 2700K.

c. Traditional incandescent lighting is about 2700K, a warm toned light considered normal for residential and hospitality lighting in North America. For reasons of consistency and appearance, light sources should be 2700-3000K with a minimum Color Rendering Index of 70. Amber or yellow light sources are preferable, both to limit attraction by insects and to reduce sky glow. Light sources should be chosen for energy efficiency, long life and low maintenance. Because some locations in the park experience extremes of temperature, elevation and exposure, light sources must be suitable for all expected operating conditions. The following light sources are acceptable for outside use:

i. LED 2700K "warm" white lamps, yellow, or amber colored, 1, 3, or 7 watt. LED's superior life, energy efficiency, instant starting and low temperature performance are superior but some capabilities of the source are limited. Use with caution in hot climates. Use amber LEDs in most environmentally sensitive areas.

ii. Compact fluorescent, 9 watt, twin tube and 13 watt double twin tube or Edison base spiral 3, 7, 10, 13 or 26 watt (2700K only or yellow "bug lamps"). Because of low starting temperature and low cost components, this light source can be used for many basic outdoor lighting applications.

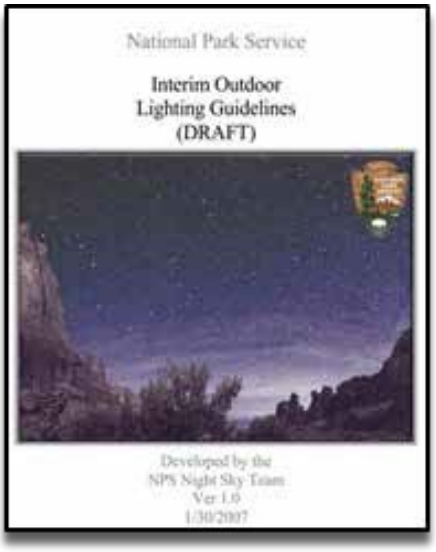
5) Intensity- Use the minimum AMOUNT of light necessary

6) Efficiency- Select the most energy EFFICACIOUS lamp and fixture

Existing Standards and Codes

A Royal Astronomical Society of Canada (RASC) Dark Sky Park is defined as an area whose night sky has little or no sky glow and minimal lighting within the DSP. As such, FLAG has created and adapted a lighting guideline outline that minimizes the lighting within the park.

From the NPS Interim Outdoor Lighting Guidelines



Best management practices for outdoor lighting will:

- Curtail and reverse the degradation of the nighttime visual environment and the night sky, including casual observation, astronomy, and air quality related values.
- Minimize glare, light trespass, obtrusive light, and artificial sky glow by limiting outdoor lighting that is misdirected, excessive, or unnecessary.
- Ensure good neighbor lighting by minimizing light trespass.
- Help minimize suspected health risks to humans from adverse exposure to light at night.
- Help protect natural ecosystems from the damaging effects of night lighting.
- Permit reasonable and rational use of outdoor lighting for nighttime safety, utility, security, and productivity.
- Help to conserve energy and resources.
- Minimize maintenance and operating costs
- Provide some flexibility for architectural and artistic lighting within the above constraints

2.1 Lighting Zones

While the Flagstaff Area National Monuments cover a large area, their amenities are limited. Each monument contains a small visitor center, residential area, and maintenance/administrative areas. Beyond these limited visitor and employee areas, the park is unlit by artificial lighting. Trailheads and parking areas remain dark, and fulfill the visitor expectation for a dark sky experience.
The park can be divided into two zones:

- **Zone One**, where minimum artificial lighting is deemed necessary for safety—such as at residential and visitor services areas. Zone one exists as a **Standard Lighting Zone** (SLZ), and contains structures that support the operation needs of the park. Lighting here exists on a level dictated by necessity only, and should be restricted temporally and spatially.

- **Zone Two** is the majority of the park, and contains no artificial lighting. This zone includes trailheads, and roads, as well as the general areas of the park. Zone two is a **Natural Darkness Zone** (NDZ), where no permanent light fixtures exist. Any lighting needs in this zone will be on an individual case, and will be addressed by temporary lighting devices such as flashlights. This zone comprises the natural and solitude values of the park, and minimizing and eliminating light trespass into this zone is paramount.

Lighting Standards

Standard Lighting Zone (SLZ)

Exterior Lighting exists solely for security and convenience. Lights shall remain on only in minimum capacity, and with the aim of safety. FLAG has altered and retrofitted much of the outdoor lighting in all the monuments. Permanent fixtures are allowed in this zone, provided they are limited to immediate task area. Artificial lighting is used only when necessary for safety, as in lights around fee stations, residential porches, and visitor centers. Any future buildings or projects will conform to these standards. In order to alleviate light trespass, the following basic principles are observed:

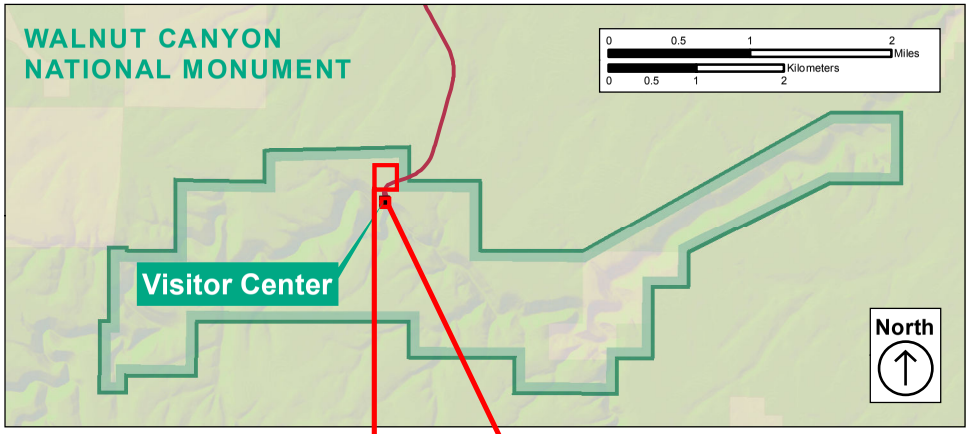
- Light fixtures should exist only where needed for specific tasks.
- Light should only exist when necessary. Lights should operate on manual switches or motion sensors/timers.
- Light should only exist in the minimum amount necessary. Individual fixtures should be limited to 600 lumens, with exceptions for specific safety and special uses based on need.
- Lights should be selected with warm colors, such as amber (≤2500K color temperature).
- Energy efficiency should be considered when choosing lighting. Standard bulbs should be compact fluorescent (CFL), which are low-wattage, or light-emitting diodes (LED).
- Lights should be directed downward and shielded.

Natural Darkness Zone (NDZ)

All areas outside of Zone One, the Standard Lighting Zone, fall under this zone. These areas include the entirety of Sunset Crater Volcano's legislative boundary, the 545 Road corridor through Wupatki and Sunset Crater Volcano, and the historic Ranger Cabin at Walnut Canyon. No permanent lighting exists or is allowed in this area. Light trespass from outside sources and Zone One is minimal and all attempts are made to eliminate any excess light pollution. This area makes up the large majority of the Flagstaff Area National Monuments.

Conclusion

FLAG is dedicated to maintaining a lighting system that is low-impact and exists only as necessary for safety. Future lights will comply with this low-impact lighting management system and with NPS Management policies, which state that it is important to specify the need in each case of outdoor lighting and choose the appropriate lighting design. Artificial lighting in the park does not exist in areas where there is an expectation for darkness by the visitor and employees.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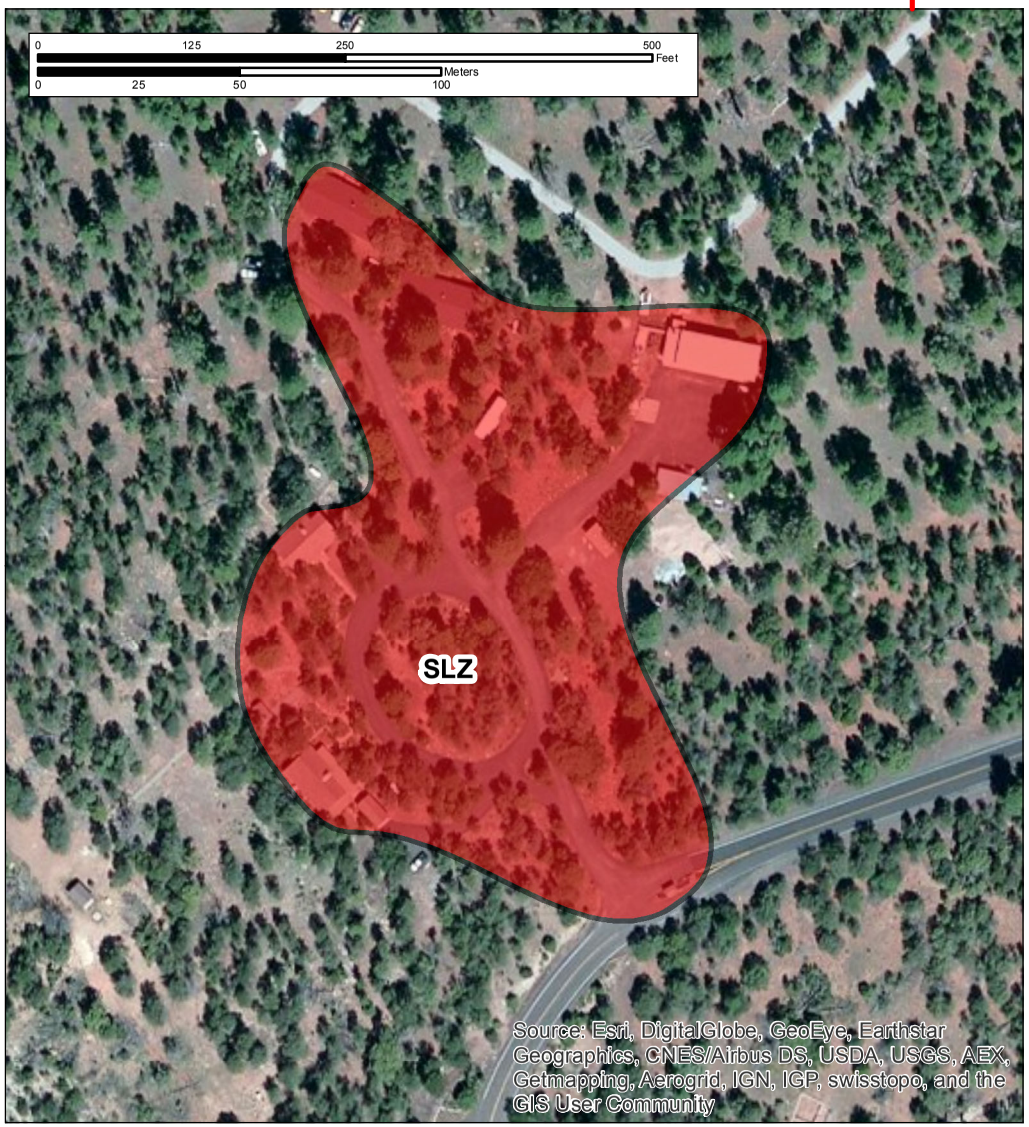
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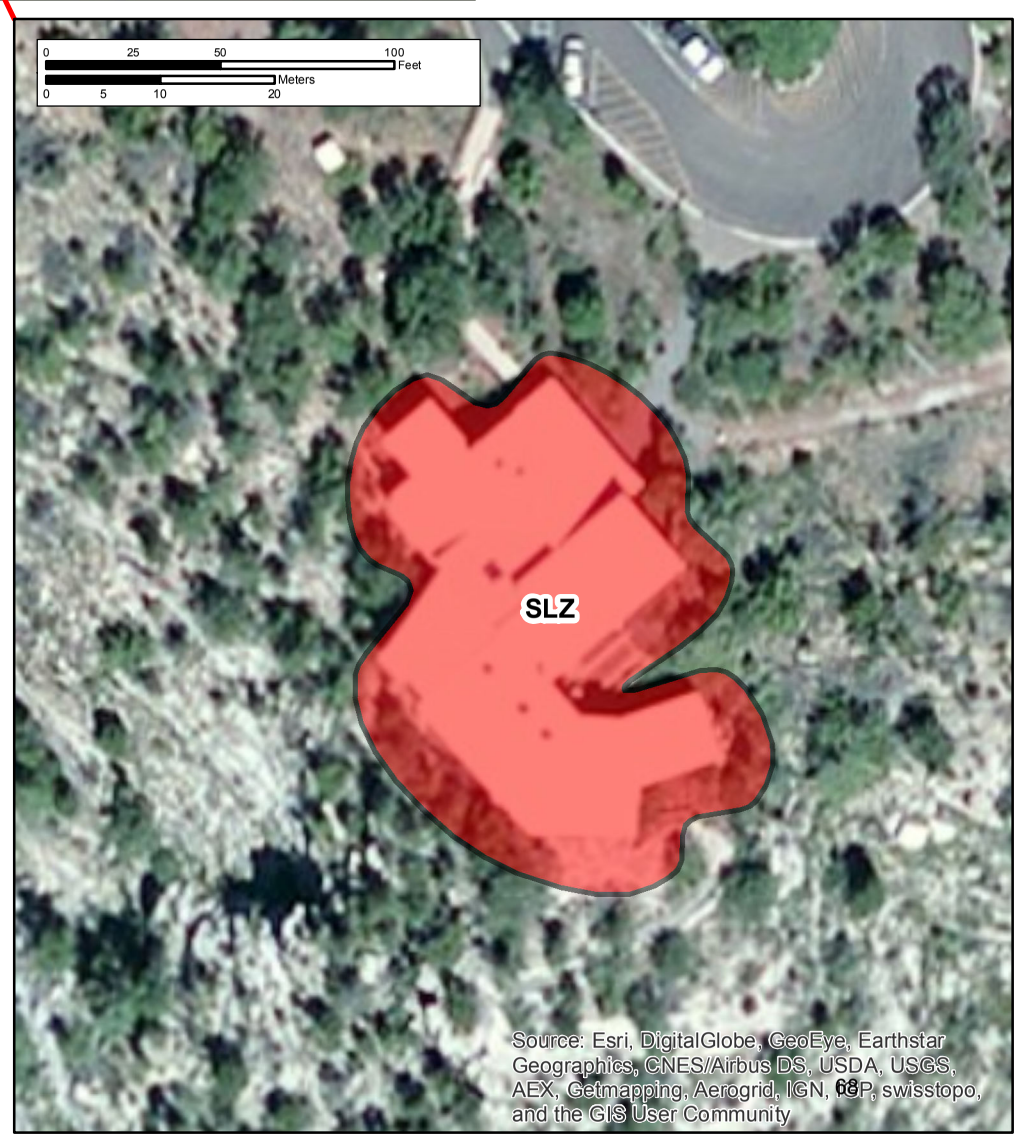
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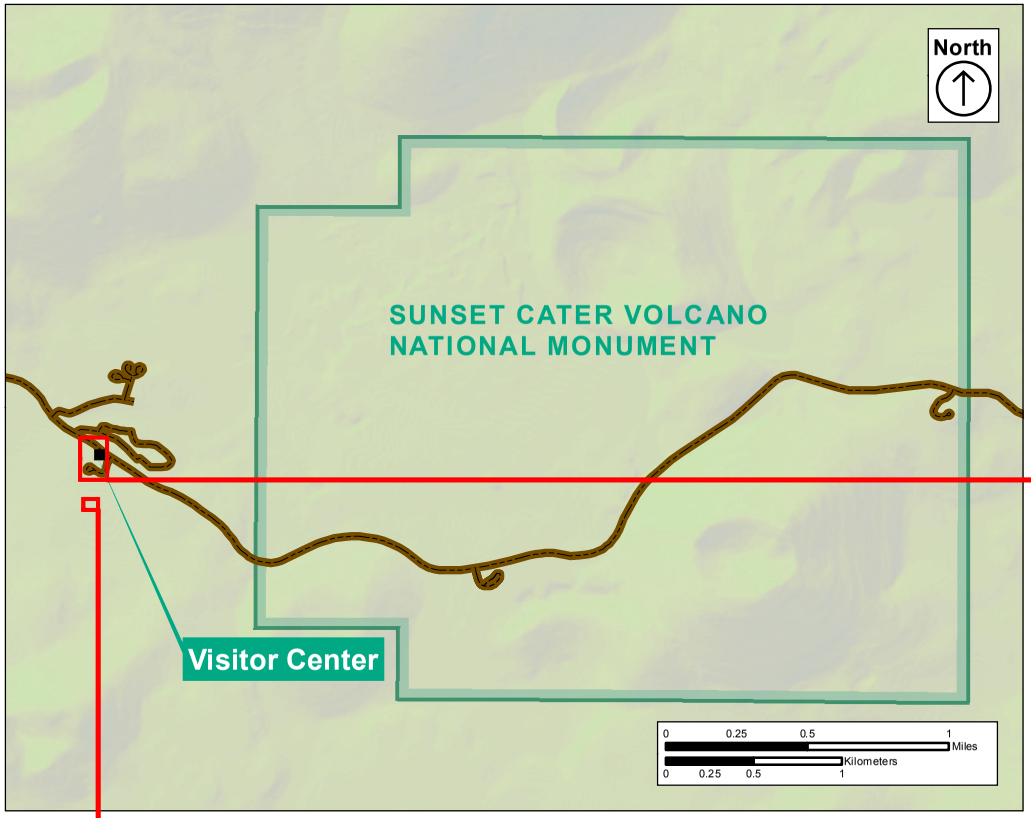
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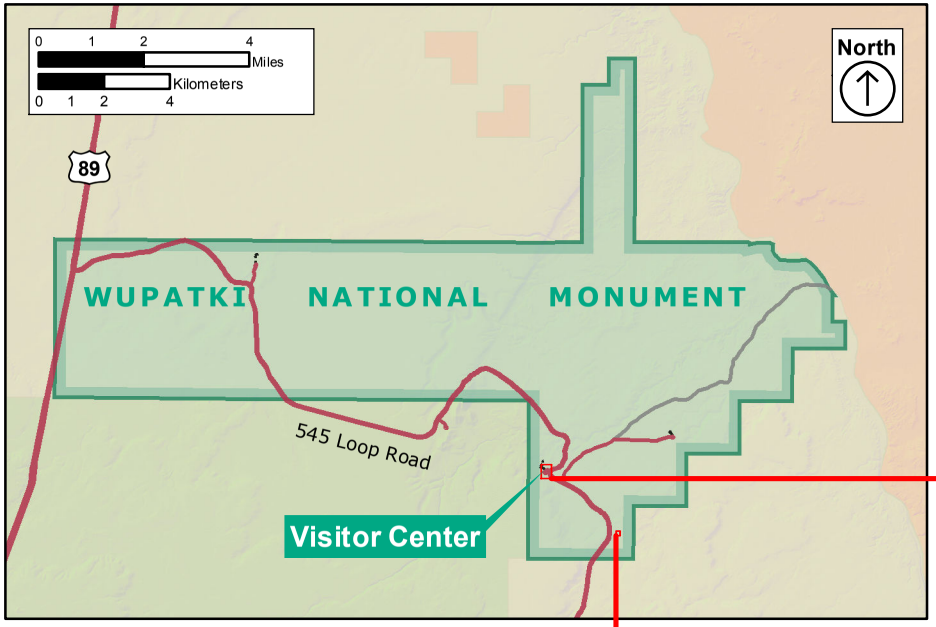
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545 Loop Road
Visitor Center


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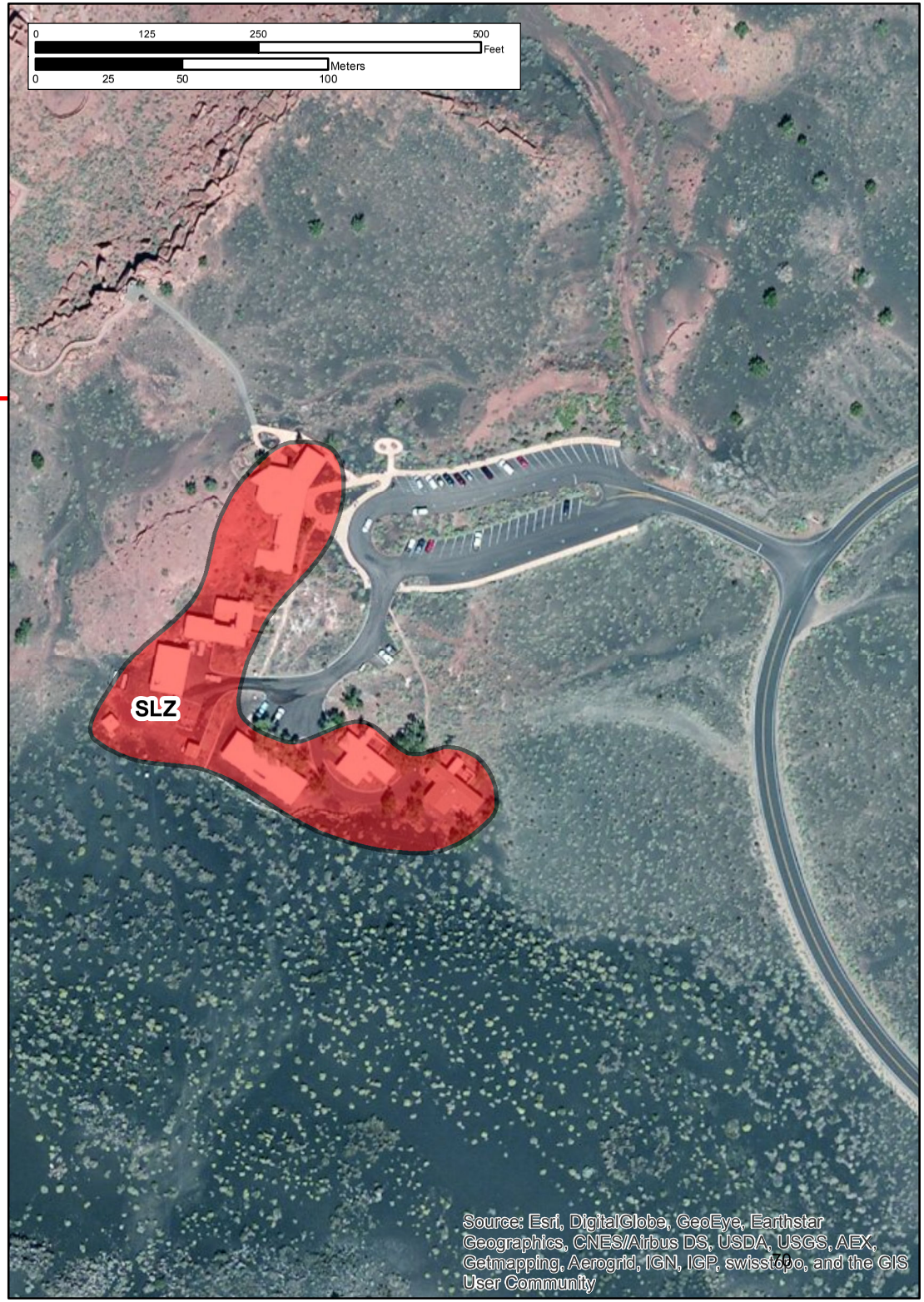
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