

Tribal Light Management Plan

Approved Light Plan

2014

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I. Preamble - Kaibab Indian Reservation Light Plan

The purpose of this Plan is to provide regulations for outdoor lighting which will:

1. Permit the use of outdoor lighting that does not exceed the minimum levels recommended for night-time safety, utility, security, productivity, enjoyment, and commerce.
2. Minimize adverse impacts of lighting such as light trespass, and obtrusive light.
3. Curtail light pollution, reduce skyglow and improve the nighttime environment for astronomy.
4. Help protect the natural environment from the adverse effects of night lighting from gas or electric sources.
5. Conserve energy and resources to the greatest extent possible.
6. Help protect and preserve the dark nights for continued cultural and traditional uses, to include storytelling, navigation, and food harvesting.

II. Lighting Zones

The Lighting Zone (LZ) shall determine the limitations for lighting as specified in this plan. The Lighting Zones shall be as follows:

LZ-0: No ambient lighting

Is defined as areas where the natural environment will be seriously and adversely affected by lighting. Impacts could include disturbing the biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of the natural environment. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the darkness, and they expect to see little or no lighting.

When not needed, lighting should be extinguished.

LZ-1: Low ambient lighting

Is defined as areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline.

LZ-2: Moderate ambient lighting

Is defined as areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may typically be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

LZ-3: Moderately high ambient lighting

Is defined as areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. After curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

Maps of Lighting Zones within Kaibab Paiute Reservation

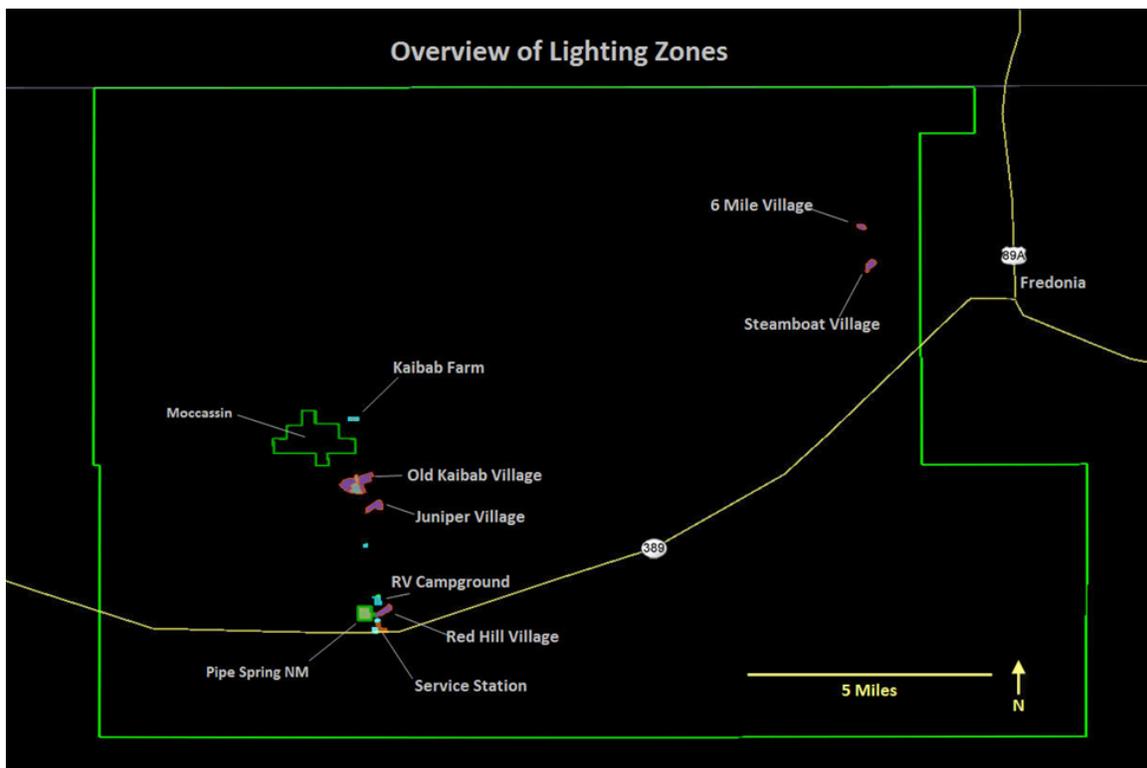


Figure 1. Lighting Zone overview.

Overview of the various lighting zones with 5 residential zones (purple): Red Hill Village, Juniper Village, Old Kaibab village, 6 Mile Village, and Eagle Village (formally known as Steamboat Village) (Figure 1). There is one commercial zone near the main entrance that consists of a service station and shopette (orange). The remaining zones are Tribal buildings including the RV campground(blue), and Pipe Spring National Monument (green). By default any area outside of these defined zones are considered

LZ-0, which are undeveloped, natural areas. The following figures (2-8) show a series of detailed views of the Lighting Zones.



Figure 2. Main Entrance into Kaibab Paiute Reservation. This illustration displays the only commercial zone along with various Tribal Buildings.

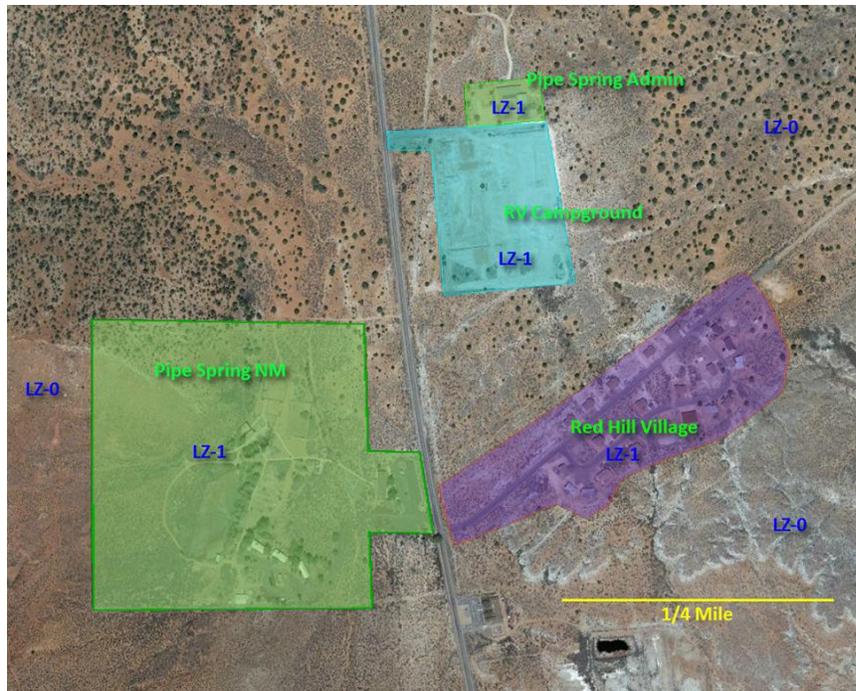


Figure 3. This map illustrates the 40 acre park unit, Pipe Spring National Monument and the Red Hill Village residential zone. The RV campground and Pipe Spring National Monument administrative buildings are in close vicinity.

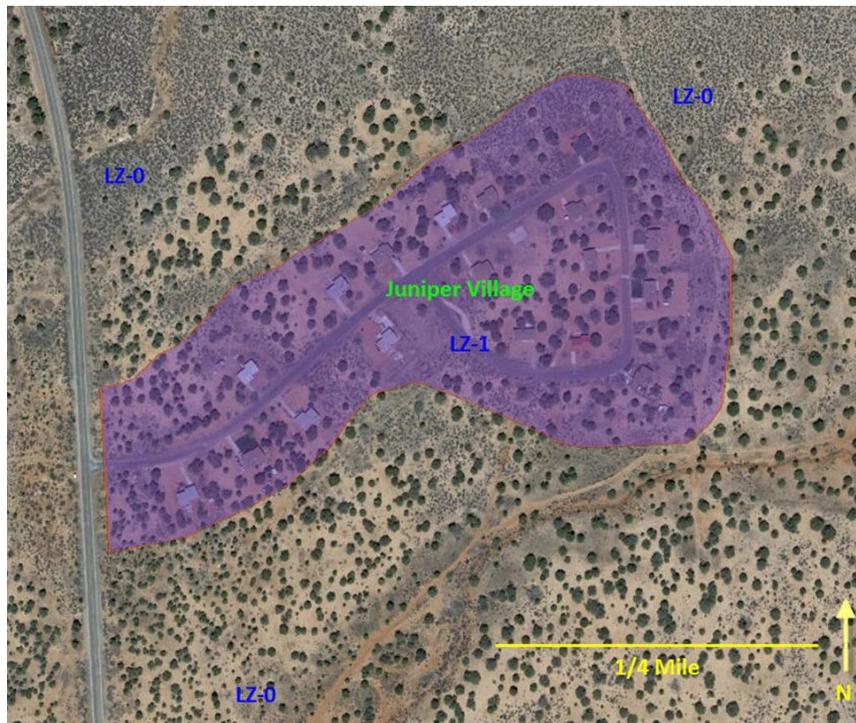


Figure 4. One of the residential zones located along the main conduit is Juniper Village with 19 houses and 7 street lights.

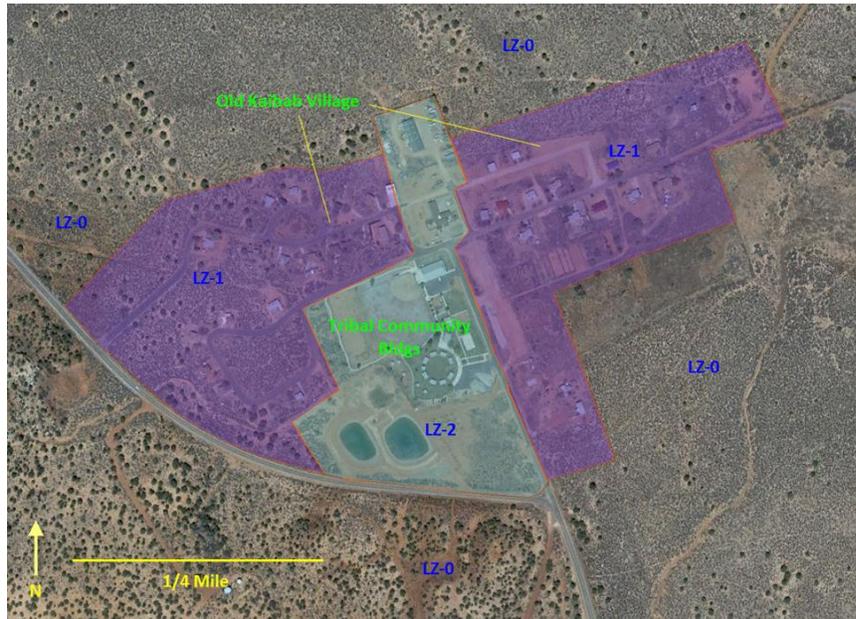


Figure 5. The largest residential zone is Old Kaibab Village with 53 houses, and 14 street lights. This residential zone is bisected by Tribal Community buildings, industrial work houses, and park facilities.

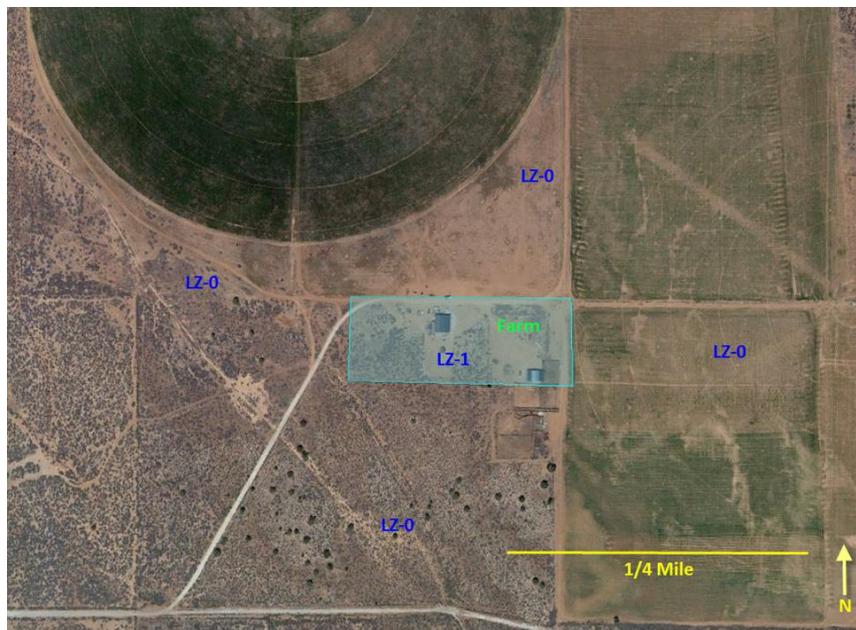


Figure 6. The tribal farm, a rural zone along the outskirts of the Kaibab Paiute Reservation.

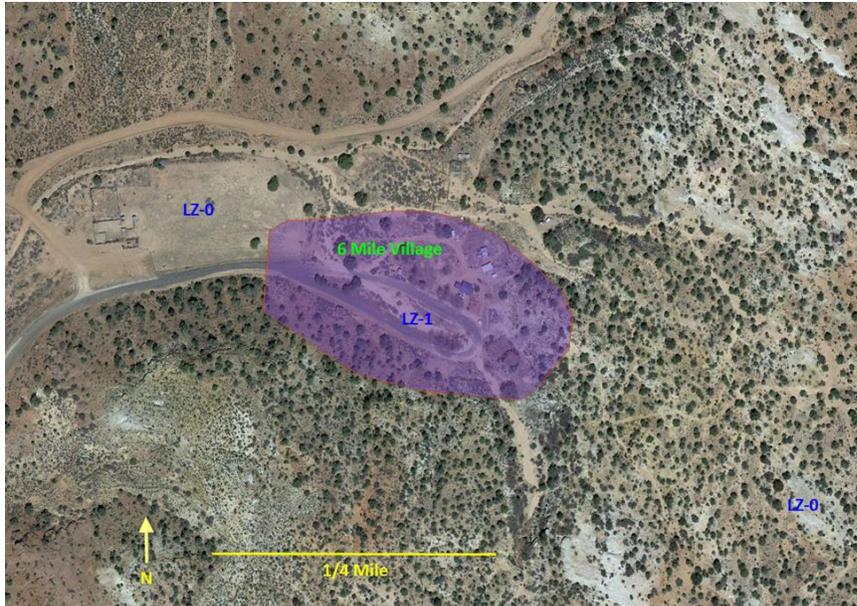


Figure 7. 6 Mile Village is the smallest of the residential zones with only 6 structures.

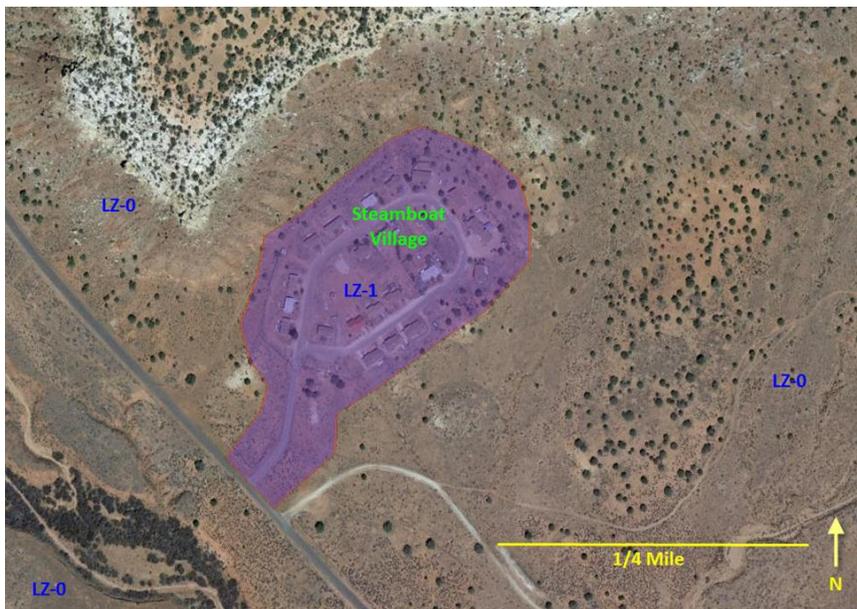


Figure 8. Eagle Village (formally known as Steamboat Village) has 23 houses and is the most eastern residential zone.

III. General Requirements for All Outdoor Lighting

Applicability

All outdoor lighting installed after the date of effect of this Plan shall comply with the stated requirements. This includes, but is not limited to, new lighting, replacement lighting, or any other lighting whether attached to structures, poles, the earth, or any other location, including lighting installed by any third party. A reference table is provided to compare watts and lumens (Table 1).

Table 1. Reference comparison of watts and lumens for incandescent bulbs

WATTS	LUMENS
40	450
60	800
75	1,100
100	1,600
150	2,600

Lighting Control Requirements

1. Automatic Switching Requirements

Controls shall be provided that automatically extinguish all outdoor lighting when sufficient daylight is available using a control device or system such as a photoelectric switch, astronomic time switch or equivalent functions from a programmable lighting controller, building automation system or lighting energy management system, all with battery or similar backup power or device.

2. Light Curfew for Non-Residential Zones and Tribal Buildings

The tribe shall establish curfew time(s) for non-residential structures after which total outdoor lighting lumens shall be reduced by at least 50% or extinguished. Light curfews will go into effect one hour after

the close of business for tribal facilities, restaurants, and major entertainment facilities such as community parks. The tribe may elect to have no curfew for facilities with 24 hour operations, or to extend the curfew time to meet specific needs.

The intent is to reduce or eliminate lighting after a given time. Benefits include reduced environmental impact, longer hours of improved astronomy, energy savings, and improved sleeping conditions for residents.

Areas without street lights or with very low ambient light levels should consider turning off all non-emergency lighting.

3. Exceptions to Non-residential Light Curfew

Upon completion of lighting reductions retrofits, the following are permissible:

- a. When the outdoor lighting consists of only one light fixture.
- b. Code required lighting for steps, stairs, walkways, and building entrances.
- c. When in the opinion of the Tribe, lighting levels must be maintained.
- d. Motion activated lighting.
- e. Lighting governed by special use permit in which times of operation are specifically identified.
- f. Businesses that operate on a 24 hour basis.

Restrictions on Total Amount of Unshielded Lighting within all Zones

The unshielded lighting of all outdoor lighting shall not exceed the total site lumen limit (Table 2). The total site lumen limit shall be determined using either the Parking Space Method or the Hardscape Area Method (Table 3) for non-residential areas or by total lumens for residential areas (Table 8). Only one method shall be used per permit application, and for sites with existing lighting, existing lighting shall be included in the calculation of total installed lumens.

The total installed lumens are calculated as the sum of the lumens for all light fixtures.

All lighting fixtures over 3000 lumens initial lamp output (or equivalent wattages) will require to be fully-shielded or have a full-cutoff standard allowing only indirect lighting.

Table 2 - Allowed Total unshielded Lumens per Zone for Outdoor Lighting, Note: (lms = lumens)

LZ-0	LZ-1	LZ-2	LZ-3
0.1 lms per SF of Hardscape	0.25 lms per SF of Hardscape	1.5 lms per SF of Hardscape	2.0 lms per SF of Hardscape

IV. Street Lighting Plan

Street and roadway lighting is one of the world's largest causes of artificial skyglow.

The purpose of this Plan is to control the light pollution of street lighting, including all collectors, local streets, alleys, sidewalks and bike- ways, as defined by ANSI/IES RP-8 Standard Practice for Roadway and Street Lighting (IES is the Illuminating Engineering Society of North America) and in a manner consistent with this Lighting Plan.

1. Definitions

Roadway or Highway lighting is defined as lighting provided for freeways, expressways, limited access roadways. The primary purpose of roadway or highway lighting is to help the motorist remain on the roadway and help with the detection of obstacles within and beyond the range of the vehicle's headlights.

Street lighting is defined as lighting provided for major, collector, and local roads where pedestrians and cyclists are generally present. The primary purpose of street lighting is to help the motorist identify obstacles, provide adequate visibility of pedestrians and cyclists, and assist in visual search tasks, both on and adjacent to the roadway.

2. Scope

Applies to all street lighting not governed by regulations of federal, state, or other superseding jurisdiction.

Exception: lighting systems mounted less than 10.5 feet above street level and having less than 1000 initial lumens each.

3. Light Shielding and Distribution

All street lighting shall have shielded light fixtures to ensure no light is emitted above 90 degrees of the horizon.

Exception: Ornamental street lighting for specific districts or projects shall be permitted by special permit only, and shall meet the requirements of Table 4 below without the need for external field-added modifications.

V. Requirements for Non-Residential Outdoor Lighting

This section addresses Tribal Buildings and non-residential lighting. The intent is to:

- Limit the amount of light that can be used
- Minimize glare by controlling the amount of light that tends to create glare
- Minimize sky glow by controlling the amount of uplight
- Minimize the amount of off-site impacts or light trespass

The lumen allowances defined in Table 3 (Parking Space Method or Hardscape Area Method) will provide basic lighting (parking lot and lighting at doors and/or sensitive security areas) that is consistent with the selected lighting zone. Additional lumen allowances for specific sites are addressed in Table 4.

Table 3. Allowed Total Lumens per Site for Non-residential Outdoor Lighting. Per Parking Space Method may only be applied to properties with up to 10 parking spaces (including handicapped accessible spaces). Note: (lms = lumens, SF = Square feet)

Method	LZ-0	LZ-1	LZ-2	LZ-3
Parking Space	350 lms/parking space	490 lms/parking space	630 lms/parking space	840 lms/parking space
Hardscape Area	0.5 lumens/SF of Hardscape	1.25 lumens/SF of Hardscape	2.5 lumens/SF of Hardscape	5.0 lumens/SF of Hardscape

Table 4 - Additional Lumen Allowances for Site Specific Uses (Lumens per Square Foot unless otherwise noted)

Lighting Application	LZ-0	LZ-1	LZ-2	LZ-3
<p>Commercial Buildings. This allowance is lumens per square foot for the total area within the property line. In order to qualify for this allowance, light fixtures must be located under the canopy.</p>	0	3	6	12
<p>Tribal Community Property. This allowance is lumens per square foot of Tribal non-residential structures.</p>	0	6	12	24
<p>Outdoor Dining. This allowance is lumens per square foot for the total illuminated hardscape of outdoor dining. In order to use this allowance, light fixtures must be within 2 mounting heights of the hardscape area of outdoor dining</p>	0	1	5	10
<p>Drive Up Windows. This allowance is lumens per drive-up window. In order to use this allowance, luminaires must be within 20 feet of the center of the window.</p>	0	2,000	4,000	8,000
<p>Vehicle Service Station Hardscape. This allowance is lumens per square foot for the total illuminated hardscape area less area of buildings, area under canopies, area off property, or areas obstructed by signs or structures. In order to use this allowance, light fixtures must be illuminating the hardscape area and must not be within a building below a canopy, beyond property lines, or obstructed by a sign or other</p>	0	4	8	16

In the following example (Table 5), three types of light fixtures are used to light a parking area and building entry in a light commercial area. Two of these three light fixtures use metal lamps: 70 watt wall mounted area lights and 150 watt pole mounted area lights. The total lumens for the site is equal to 247,840. The allowable lumens are based on the lighting zone and the total hardscape area. Referencing Table 3, the allowed lumens are 2.5/SF for LZ-2. Multiplying this by the total hardscape square footage gives a value of 250,000 lumens allowed. Because this value is greater than the value calculated for the site, the project complies.

Table 5: Example of a Tribal Building Meeting Light Compliance:

SITE ALLOWED TOTAL Example LUMENS	
<i>Site Description</i>	<i>Office 101</i>
<i>Lighting Zone</i>	LZ-2
<i>Hardscape Area (SF)</i>	100,000
<i>Allowed Lumens per SF of Hardscape (Table C)</i>	2.5
<i>Site Allowed Total Lumens (lumens per SF) x (hardscape area)</i>	250,000

EXAMPLE - COMPLIANCE CHART			
<i>Lamp Descriptions</i>	<i>QTY</i>	<i>Lumens</i>	<i>Total</i>
70 W Metal Halide	8	3,920	31,360
150 W Metal Halide	20	9,600	192,000
18 W LED	24	1,020	24,480
TOTAL INITIAL LUMINAIRE LUMENS			247,840
SITE ALLOWED TOTAL INITIAL LUMENS*			250,000
PROJECT IS COMPLIANT?			YES

VI. Requirements for Residential Outdoor Lighting

General Requirements

For all properties, including multiple residential properties, all outdoor light fixtures shall not exceed the allowed lumen output in Table 6. Refer to Map section on identified residential zones.

Over-lighting

All residential outdoor lighting shall adhere to Table 6 lumen limits and have shielded light fixtures to ensure no light is emitted above 90 degrees of the horizon.

Table 6 - Residential Lighting

Lighting Application	LZ-0	LZ-1	LZ-2	LZ-3
Maximum Allowed Lumens for Unshielded light fixtures at one entry only	Not allowed	420	630	630
Maximum Allowed Lumens for each Fully Shielded light fixtures	630	1,260	1,260	1,260
Maximum Allowed Lumens for each Unshielded light fixture excluding main entry	Not allowed	315	315	315
Maximum Allowed Lumens for each Landscape Lighting	Not allowed	Not allowed	1050	2100
Maximum Allowed Lumens for each Shielded Directional Flood Lighting	Not allowed	Not allowed	1,260	1,260
Maximum Allowed Lumens for each Low Voltage Landscape Lighting	Not allowed	Not allowed	525	525

VII. Lighting by Special Permit Only

This section addresses types of lighting that are intrusive or complex in their impacts and need a higher level of scrutiny and/or site sensitivity.

Upon special permit issued by the tribe, lighting not complying with the technical requirements of this plan but consistent with its intent may be installed for complex sites or uses or special uses including, but not limited to, the following applications:

1. Sports facilities, including but not limited to unconditioned rinks, open courts, fields, and stadiums.
2. Construction lighting.
3. Lighting for industrial sites having special requirements, such as manufacturing or storage, shipping piers, etc.
4. Parking structures.
5. Parks
6. Ornamental and architectural lighting of bridges, public monuments, statuary and public buildings.

To obtain such a permit, applicants shall demonstrate the proposed lighting installation:

The applicant has sustained every reasonable effort to mitigate the effects of light on the environment and surrounding properties, supported by a signed statement describing the mitigation measures. Applicant employs lighting controls to reduce lighting at a Project and/or has a specific Curfew time to be established in the Permit.

The Tribe shall review each such application. A permit may be granted if, upon review, the Tribe believes that the proposed lighting will not create unwarranted glare, sky glow, or light trespass.

VIII. Existing Lighting

Phasing in the Light Plan (Amortization) allows existing lighting to gradually and gracefully come into compliance. Substantial changes or additions to existing properties are considered the same as new construction, and must comply. Lighting installed prior to the effective date of this plan shall comply with the following.

1. Amortization

On or before December 31, 2018, all outdoor lighting shall comply with this Code.

2. New Uses or Structures, or Change of Use

Whenever there is a new use of a property (zoning or variance change) or the use on the property is changed, all outdoor lighting on the property shall be brought into compliance with this Plan before the new or changed use commences.

3. Additions or Alterations

If an addition occurs on a property, lighting for the entire property shall comply with the requirements of this Code. Any new lighting shall meet the requirements of this Plan.

4. Resumption of Use after Abandonment

If a property with non-conforming lighting is abandoned for a period of six months or more, then all outdoor lighting shall be brought into compliance with this Plan before any further use of the property occurs.

XI. Enforcement and Penalties

Lighting conformance will be maintained by the assigned Tribal Environmental Director to include verification of Light Plan compliance within all Tribal light zones.

Tribal council will be promptly notified of any lighting infractions and will rectify the non-compliance to include alternate lighting, permits, or other method ensuring compliance to this Light Plan.

Education of dark skies will be utilized as a key tool in promoting compliance.

All contracts and with builders or developers will contain a clause, acknowledging in writing, that he or she is familiar with the lighting requirements and will submit a lighting plan to the tribal council for approval.

X. Future actions and Master Lighting Plan

Master Lighting Plan

The tribe shall develop a Master Lighting Plan which will cover:

1. Goals of street lighting in the jurisdiction by Lighting Zone
2. Assessment of the safety and security issues in the jurisdiction by Lighting Zone
3. Environmentally judicious use of resources by Lighting Zone
4. Energy use and efficiency by Lighting Zone
5. Curfews to reduce or extinguish lighting when no longer needed by Lighting Zone
6. Policy indicating where, when, and under what circumstances new public outdoor lighting (street lighting and lighting on other public property and rights-of-way) is warranted and will be permitted
7. Adaptive controls and curfews to be employed in all future installations of public outdoor lighting.

Warranting

The tribe shall establish a warranting process to determine whether lighting is required. Such warranting process shall not assume the need for any lighting nor for continuous lighting unless conditions warrant the need. Lighting shall only be installed where warranted.

XI. Definitions

Definitions are typically generally added to any code when new code sections are added. The definitions are legally required and play a significant role in the interpretation of the plan and code.

Emergency conditions	Generally, lighting that is only energized during an emergency; lighting fed from a backup power source; or lighting for illuminating the path of egress solely during a fire or other emergency situation; or, lighting for security purposes used solely during an alarm.
Footcandle	The unit of measure expressing the quantity of light received on a surface. One footcandle is the luminance produced by a candle on a surface one foot square from a distance of one foot.
Forward Light	For an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the direction of the intended orientation of the luminaire.
Fully Shielded Luminaire	A luminaire constructed and installed in such a manner that all light emitted by the luminaire, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any part of the luminaire, is projected below the horizontal plane through the luminaire's lowest light-emitting part.
Glare	Lighting entering the eye directly from luminaires or indirectly from reflective surfaces that causes visual discomfort or reduced visibility.
Hardscape	Permanent hardscape improvements to the site including parking lots, drives, entrances, curbs, ramps, stairs, steps, medians, walkways and non-vegetated landscaping that is 10 feet or less in width. Materials may include concrete, asphalt, stone, gravel, etc.

Hardscape Area	The area measured in square feet of all hardscape. Refer to Hardscape definition.
IDA	International Dark-Sky Association
IESNA	Illuminating Engineering Society of North America
Impervious Material	Sealed to severely restrict water entry and movement
Industry Standard Lighting Software	Lighting software that calculates point-by- point luminance that includes reflected light using either ray-tracing or radiosity methods.
Lamp	A generic term for a source of optical radiation (i.e. “light”), often called a “bulb” or “tube”. Examples include incandescent, fluorescent, high-intensity discharge (HID) lamps, and low pressure sodium (LPS) lamps, as well as light-emitting diode (LED) modules and arrays.
Landscape Lighting	Lighting of trees, shrubs, or other plant material as well as ponds and other landscape features.
LED	Light Emitting Diode
Light Pollution	Any adverse effect of artificial light including, but not limited to, glare, light trespass, sky- glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.
Light Trespass	Light that falls beyond the property it is intended to illuminate.
Lighting	“Electric” or “man-made” or “artificial” lighting. See “lighting equipment”.
Lighting Equipment	Equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.
Lighting Zone	An overlay zoning system establishing legal limits for lighting for particular parcels, areas, or districts in a community.
Low Voltage Landscape Lighting	Landscape lighting powered at less than 15 volts and limited to luminaires having a rated initial luminaire lumen output of 525 lumens or less.
Lumen	The unit of measure used to quantify the amount of light produced by a lamp or emitted from a luminaire (as distinct

	from “watt,” a measure of power consumption).
Luminaire	The complete lighting unit (fixture), consisting of a lamp, or lamps and ballast(s) (when applicable), together with the parts designed to distribute the light (reflector, lens, diffuser), to position and protect the lamps, and to connect the lamps to the power supply.
Outdoor Lighting	Lighting equipment installed within the property line and outside the building envelopes, whether attached to poles, building structures, the earth, or any other location; and any associated lighting control equipment.
Partly shielded luminaire	A luminaire with opaque top and translucent or perforated sides, designed to emit most light downward.
Pedestrian Hardscape	Stone, brick, concrete, asphalt or other similar finished surfaces intended primarily for walking, such as sidewalks and pathways.
Photoelectric Switch	A control device employing a photocell or photodiode to detect daylight and automatically switch lights off when sufficient daylight is available.
Property line	The edges of the legally-defined extent of privately owned property.
Relative photometry	Photometric measurements made of the lamp plus luminaire, and adjusted to allow for light loss due to reflection or absorption within the luminaire. Reference standard: IES LM-63.
Repair(s)	The reconstruction or renewal of any part of an existing luminaire for the purpose of its ongoing operation, other than relamping or replacement of components including capacitor, ballast or photocell. Note that retrofitting a luminaire with new lamp and/or ballast technology is not considered a repair and for the purposes of this plan the luminaire shall be treated as if new. “Repair” does not include normal relamping or replacement of components including capacitor, ballast or photocell.
Replacement Lighting	Lighting installed specifically to replace existing lighting that is sufficiently broken to be beyond repair.
Sales area	Uncovered area used for sales of retail goods and materials,

	including but not limited to automobiles, boats, tractors and other farm equipment, building supplies, and gardening and nursery products.
Seasonal lighting	Temporary lighting installed and operated in connection with holidays or traditions.
Shielded Directional Luminaire	A luminaire that includes an adjustable mounting device allowing aiming in any direction and contains a shield, louver, or baffle to reduce direct view of the lamp.
Sign	Advertising, directional or other outdoor promotional display of art, words and/or pictures.
Sky Glow	The brightening of the nighttime sky that results from scattering and reflection of artificial light by moisture and dust particles in the atmosphere. Skyglow is caused by light directed or reflected upwards or sideways and reduces one's ability to view the night sky
Temporary lighting	Lighting installed and operated for periods not to exceed 60 days, completely removed and not operated again for at least 30 days.
Third Party	A party contracted to provide lighting, such as a utility company.
Time Switch	An automatic lighting control device that switches lights according to time of day.
Translucent	Allowing light to pass through, diffusing it so that objects beyond cannot be seen clearly (not transparent or clear).
Unshielded Luminaire	A luminaire capable of emitting light in any direction including downwards.
Uplight	For an exterior luminaire, flux radiated in the hemisphere at or above the horizontal plane.
Vertical Luminance	Luminance measured or calculated in a plane perpendicular to the site boundary or property line.