

FINAL
LIGHTING DESIGN CRITERIA REPORT

SR 89A
Dry Creek Road to Airport Road
MP 371 - 373

ADOT Project No. 89A YV 371 H7130 01C
Federal Project No. HES-A89-B(202)

PREPARED FOR:



ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
TRAFFIC ENGINEERING GROUP
HIGHWAY ENHANCEMENTS FOR SAFETY (HES) TEAM

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1.0 INTRODUCTION

The following study has been prepared to support the development of the Final Lighting Design Concept for Arizona Department of Transportation (ADOT) Project 89A YV 371 H7130 01C, HES A89-B(202). State Route (SR) 89A, between milepost 371 and 373 has been the site of four nighttime fatal vehicle-pedestrian crashes between December 2000 and April 2006 (approximately a 5-year period). The purpose of the project is to improve pedestrian safety within the corridor through the installation of a continuous roadway lighting system.

A Project Assessment (PA) is prepared as part of the ADOT project development process. The purpose of the PA is to obtain consensus on potential scope, major design features, milestone development schedule, and development and construction budgets based upon available information. During the development of the Initial PA, ADOT and the City of Sedona received a high volume of public input from concerned citizens regarding the implementation of highway lighting along the corridor. As a result, the project scope was re-evaluated by ADOT and the City of Sedona. The City of Sedona formed a Pedestrian Safety Advisory Committee. Members from the ADOT project team also participated on the committee. The committee met several times and investigated several safety improvement alternatives. As a result of the City of Sedona Pedestrian Safety Advisory Committee meetings and subsequent actions by the Sedona City Council, it was determined that further investigation of safety enhancements and lighting alternatives beyond the original intent of the scoping document was required. The Final PA was based on a minimum average maintained illuminance level of 1.2 foot-candles and a uniformity ratio of 3:1, based on a roadway classification of major arterial with no access control and a general land use of "intermediate" between commercial and residential land uses.

The following report has been prepared to determine if a minimum average maintained illuminance level less than 1.2 foot-candles may be justified based on a more thorough investigation of existing conditions, background information, and analysis. The following report also provides background information in the appendix regarding the possible use of lighting curfews and dimming strategies to reduce the potential social and economic impacts of the roadway lighting system.

1.1 2006 Sedona Pedestrian Crossing Study

The ADOT Northern Traffic Engineering Regional Office prepared the Sedona Pedestrian Crossing Study in May of 2006 for SR 89A between MP 370.0 and MP 372.99. This study was prepared in partnership with the City of Sedona as the result of a nighttime pedestrian fatality that occurred in January of 2006 as well as two other nighttime pedestrian fatalities that occurred in June of 2005 and December of 2000.

1.1.1 2006 Study Crash History

Crash data were analyzed for a three year period, from September 1, 2002 to August 31, 2005. Of the 322 crashes occurring during this time frame, 6 involved pedestrians and 7 involved bicyclists. According to the 2006 study, the June 2005 fatality occurred approximately one hour before midnight when a pedestrian attempted to cross SR 89A between Rigby Road and Stutz Bearcat Drive. The victim was struck by a westbound vehicle in the leftmost westbound lane and the driver stated that the victim was not seen until immediately prior to impact. Four of the six pedestrian accidents and five of the seven bicycle crashes occurred during non-daylight conditions.

Two other pedestrian fatality crashes occurred within the study area, but outside of the study period. The first one occurred in December of 2000 at Andante Drive and the second occurred

in April of 2006 just west of Dry Creek Road. In both instances, the victims were struck by westbound vehicles in the leftmost westbound lane and the drivers stated that the victims were not seen until immediately prior to impact.

1.1.2 2006 Study Pedestrian & Bicyclist Crossings

The 2006 study included pedestrian and bicyclist crossing data that were collected and recorded in zones. For each zone, data were collected from 6:00 am to 6:00 pm. Signalized intersections were designated as separate zones and an additional 3 hours of data (6:00 pm to 9:00 pm) were collected at these locations. Summary information from the 2006 study includes the following:

- Daytime (6:00 am to 6:00 pm) crossings of SR 89A include approximately 880 pedestrians and 170 cyclists.
- 52% of the pedestrians crossed at signalized intersections.
- Nighttime (6:00 pm – 9:00 pm) crossings of 89A at the signalized intersections include approximately 80 pedestrians and 17 cyclists.

Nighttime crossing data were not collected away from the signalized intersections because it was too dark to see the pedestrians and cyclists crossing.

2.0 BACKGROUND INFORMATION ON ROADWAY LIGHTING DESIGN VALUES

ADOT typically uses the *American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide* as the basis for establishing the appropriate lighting level design values for roadway lighting on all state and federal highways within the State of Arizona. A significant portion of the background information presented herein is taken from the *AASHTO Guide*. The recommended minimum maintained lighting design values for illuminance and luminance are presented in Table 3-5 of the *AASHTO Guide*.

2.1 The AASHTO Roadway Lighting Design Guide Metrics

Industry development and general experience on lighting of roadways has resulted in a reasonably well-developed technique for the design of roadway lighting systems. Accepted methods exist for achieving a given light condition known as either level of illuminance or level of luminance. The design of a roadway lighting installation is a process of applying known or specified photometric characteristics of selected lamp-luminaire and support height and location combinations. A trial-and-adjustment process of assumed luminaire locations is used in making calculations of either the average amount of illuminance upon or the average luminance from the roadway. Illuminance in roadway lighting is a measure of the amount of light falling upon the horizontal pavement surface. Illuminance is measured in foot-candles (fc). Luminance in roadway lighting is a measure of the reflected light from the pavement surface that is visible to an assumed motorist's eye position. Luminance is measured in candela per square meter. **Illuminance is the metric typically used by ADOT for roadway lighting.** Calculations are performed using computer programs designed for lighting design purposes. The values for the average amount of light and the uniformity of the light (light to dark) are the primary measures for assessing the adequacy of the roadway lighting design.

The average level and uniformity of light along a roadway depends on the lumen output of the light source or lamp, the luminaire distribution, the arrangement and spacing of the luminaires, and the mounting height of the luminaire. The same average level can be obtained by different installation combinations, such as a few high-output light sources or a greater number of low-output sources. A concern in comparing such alternate systems is the uniformity of light over the roadway to be lighted. Higher luminaire mounting heights offer a number of advantages with respect to the number of luminaires required to light the roadway and the uniformity of light on the roadway.

The recommended minimum lighting design values presented in Table 3-5 of the *AASHTO Guide* include minimum average light levels and minimum uniformity levels measured as the ratio of the average light level to the minimum point. The average maintained illuminance values in Table 3-5 range from a low of 0.2 fc for residential alleys to a high of 2.0 fc for pedestrian ways and bicycle ways. The range in the uniformity ratio is from a less uniformed ratio of 6:1 for local streets and alleys to a more uniformed ratio of 3:1 for principal arterials, pedestrian ways and bicycle ways.

The selected minimum lighting design criteria or value is dependent on the functional classification of the roadway and the general land use along the roadway. The minimum lighting design values for illuminance also vary according to the pavement type or reflectance. Closely related to the general land use is the number and type of off-roadway light sources. Generally, higher light levels adjacent to the roadway warrant higher light levels on the roadway.

2.1.1 Functional Classification of the Roadway

Table 3-5 of the *AASHTO Guide* presents eight roadway and walkway classifications, as follows:

- Principal Arterials – Interstate and other freeways
- Principal Arterials – Partial or no control of access
- Minor Arterials
- Collectors
- Local
- Alleys
- Sidewalks
- Pedestrian Ways and Bicycle Ways

The *AASHTO Roadway Lighting Design Guide* refers to the *AASHTO Policy on Geometric Design of Highways and Streets* for definitions for each roadway and walkway classification. ADOT uses these definitions to assign a functional classification to all roadways within the state and federal system. These classifications are reviewed and approved by the Federal Highway Administration (FHWA). **The study section of SR 89A is classified as an Urban Principal Arterial.**

2.1.2 General Land Use

Table 3-5 of the *AASHTO Guide* presents three general land use classifications and definitions, as follows:

Commercial. That portion of a municipality in a business development where ordinarily there are large numbers of pedestrians and a heavy demand for parking space during periods of peak traffic or sustained high pedestrian volume and a continuously heavy demand for off-street parking space during business hours. This definition applies to densely developed business areas outside of, as well as those that are within, the central part of a municipality.

Intermediate. That portion of a municipality which is outside of a down town area but generally within the zone of influence of a business or industrial development, often characterized by moderately heavy nighttime pedestrian traffic and somewhat lower parking turnover than is found in a commercial area. This definition includes densely developed apartment areas, hospitals, public libraries, and neighborhood recreational centers.

Residential. A residential development or mixture of residential and commercial establishments, characterized by few pedestrians and a lower parking demand or turnover at night. This definition includes areas with single family homes, townhouses, and/or small apartments. Regional parks, cemeteries, and vacant lands are also included.

The City of Sedona controls land use adjacent to this section of SR 89A through the zoning of the properties that abut the roadway. The existing City zoning maps indicate that a majority of the property adjacent to the study section of SR 89A is zoned commercial, C1 or C2. There are approximately six parcels abutting the roadway that are zoned for lodging, L. All the property adjacent to the study section of roadway is zoned for commercial or lodging land uses. Pedestrian activity is closely related to land use. Commercial properties mixed with lodging properties can generate nighttime pedestrian activity and crossings of SR 89A.

2.1.3 Pavement Type

The recommended roadway lighting design values differ for different pavement types due to the reflectance characteristics of different pavements. White Portland cement concrete pavement reflects more light than black asphalt. Table 3-5 of the *AASHTO Guide* presents illuminance design values for four types of pavement surface, as follows:

- R1 – Portland cement concrete road surface
- R2 – Asphalt road surface with aggregate 60% gravel
- R3 – Asphalt road surface with dark aggregate
- R4 – Asphalt road surface with very smooth texture.

The study section of SR 89A has an asphalt road surface that falls into either the R2 or R3 classification. The illuminance design values presented in Table 3-5 of the *AASHTO Guide* are the same for R2 and R3 roadway surfaces.

2.2 American National Standard Practice for Roadway Lighting (RP-8-00)

The American National Standard Practice for Roadway Lighting published by the Illuminating Engineering Society of North American (IESNA) is commonly used by many public agencies in the United States as the basis for establishing the appropriate lighting level design values for roadway lighting. This publication has been approved by the American National Standards Institute (ANSI) and is commonly referred to as ANSI/IESNA RP-8-00 or simply RP-8. The RP-8 lighting design criteria parallels the lighting criteria found in the *AASHTO Guide*, with the exception of the general land use parameter. The RP-8 criteria are based on an assessment of the roadway classification and pedestrian conflict area classification, rather than the general land use classification found in the *AASHTO Guide*. However, RP-8 does note that the magnitude of pedestrian flow is nearly always related to the abutting land use. The RP-8 identifies three classifications of pedestrian night activity levels and the type of land use with which they are typically associated. These three levels are presented below.

2.2.1 RP-8 Pedestrian Conflict Area Classifications

- *High* – Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit centers.
- *Medium* – Areas where lesser numbers of pedestrians utilize the streets at night. Typically are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, older city areas, and streets with transit lines.
- *Low* – Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets, very low density residential developments, and rural or semi-rural areas.

The recommended minimum lighting design values for illuminance are presented in the *RP-8*. A review of the recommended minimum lighting design values indicate that the high, medium and low pedestrian conflict classifications generally correlate with the commercial, intermediate, and residential land use classifications found in the *AASHTO Guide*, with the recommended minimum illuminance values are generally slightly higher (0.1 fc) in *RP-8* as compared to the values in the *AASHTO Guide*.

2.3 Additional Research Related to Lighting for Pedestrians

The FHWA recently published an *Informational Report on Lighting Design for Midblock Crosswalks* (FHWA-HRT-08-053). This report provides information on lighting parameters and design criteria that should be considered when installing fixed roadway lighting for midblock crosswalks. The report defines pedestrian visibility distance as the distance at which a driver can see a pedestrian well enough to be able to respond appropriately to the pedestrian's presence. The report notes that the greater the visibility distance the more time a driver will have to react to the pedestrian before a conflict occurs. At night, luminance contrast is the primary means by which an object is detected. The report also notes that overhead road lighting generally provides greater visibility distance than headlamps alone to illuminate a scene. Therefore, the basis for roadway lighting design is providing adequate luminance contrast.

The report identifies several factors that affect the luminance contrast between pedestrians and their visual backgrounds: fixed roadway lighting, headlamp lighting, pedestrian clothing, and the characteristics of the visual background. The background for most roadway pedestrian crossings consists of the roadway pavement surface and the environment surrounding the roadway. Bright roadway surfaces or bright off-roadway installations such as gas stations, banks, or shopping areas increase background luminance and reduce contrast, making pedestrian detection more difficult. The report states that a design level should be selected to provide adequate performance even with a bright background. Typically, the brighter the background, the higher the vertical illuminance required for a driver to clearly see a pedestrian.

The recommendations in the report are based on experiments of driver performance with regard to the detection of pedestrians in midblock crosswalks. The study uses the concept of vertical illuminance as the primary metric for the evaluation of the efficacy of the lighting system. This is in contrast to the horizontal illuminance upon the pavement surface that is described in the *AASHTO Guide*. Vertical illuminance is defined as the illuminance on a vertical surface or pedestrian. A height of 5 feet above the road surface was selected as the point at which the vertical illuminance was measured.

The research found that a vertical illuminance level of 20 lux or approximately 2 fc in the crosswalk, measured at a height of 5 feet from the roadway surface, provided adequate detection distances under rural conditions. The research notes that higher levels may be required for crosswalks when there is glare from opposing vehicles, the crosswalk is located in an area with high ambient light levels, or the crosswalk is located at a lighted intersection. The informational report points out that typical intersection lighting design positions the luminaires to provide a high level of pavement illuminance near the middle of the intersection to light the potential conflict areas for the vehicles. But this design does not light the side of the pedestrian facing the approaching vehicle. To address this shortcoming, the research suggests luminaires should be installed approximately ten feet in advance of the crosswalk. The research also notes that the luminaire selected will influence the best mounting location and height of the luminaire with respect to the crosswalk.

3.0 DATA COLLECTION AND ANALYSIS OF EXISTING LIGHT LEVELS

The study team made a site visit to the study corridor during nighttime hours to measure the existing roadway light levels. Light level data was collected along SR 89A on Thursday, February 5, 2009, beginning at approximately 8:00 PM and ending at approximately 11:30 PM. Horizontal and vertical illuminance readings were recorded at the five signalized intersections within the study area. These five locations are currently lighted by luminaires mounted on the traffic signal poles. The study team also performed a nighttime survey to identify light generated by the surrounding land uses along the study corridor. These observations were made to assess the potential impacts of this type of lighting on the drivers' nighttime visibility of pedestrians in the roadway.

3.1 Existing Field Measured Illuminance Levels

Horizontal and vertical illuminance readings were recorded at the five signalized intersections within the study area. Each signalized intersection is a four-legged intersection, with crosswalks on both the east and west legs of the intersection. For the purposes of this discussion, SR 89A is treated as an east-west roadway, following compass directions. A total of ten crosswalk crossings of SR 89A were evaluated. Multiple data points were recorded for each crosswalk. Data points were recorded at the curb and in the center of each lane. This resulted in a total of seven data points for those intersection legs with five lanes and eight data points for the legs with an additional right turn lane. The individual data points were used to calculate the average measured illuminance and uniformity ratio for each intersection. The results are presented in Table 1.

The average horizontal illuminance values are in the range of 1.6 to 4.7 fc. **Six of the ten crosswalks have an average horizontal illuminance between 2.2 and 2.9 fc.** Only one crosswalk has an average below 2.2 fc. All the crosswalks have a horizontal illuminance uniformity ratio better than 3:1.

The average vertical illuminance values are in the range of 0.4 to 1.8 fc. Consequently, the existing average vertical illuminance levels in all the crosswalks fall below the levels suggested in the FHWA informational report. This is primarily due to the traditional signalized intersection combination traffic signal/luminaire pole. This arrangement often results in the pole being directly over the crosswalk. These levels could be improved with the placement of a luminaire in the range of ten to fifty feet upstream from the intersection crosswalks, as recommended in the FHWA informational report. This distance will vary depending on the selected luminaire and mounting height. The vertical illuminance uniformity ratios are in the range of 9.4:1 to 1.3:1. The uniformity would also improve with the installation of an additional luminaire a short distance upstream of the intersection.

**Table 1:
SR 89A Signalized Intersections (MP 371 – 373)
Existing Crosswalk Illuminance**

Intersection Crosswalk	Horizontal		Vertical East (1)		Vertical West (2)	
	Average (fc)	Uniformity (avg:min)	Average (fc)	Uniformity (avg:min)	Average (fc)	Uniformity (avg:min)
Dry Creek Road						
West X-walk	4.7	1.4 : 1	1.5	1.3 : 1	0.9	2.5 : 1
East X-walk	2.2	2.7 : 1	0.7	6.2 : 1	0.9	1.2 : 1
Rodeo Road						
West X-walk	3.4	1.9 : 1	1.4	1.3 : 1	0.8	3.2 : 1
East X-walk	2.5	1.7 : 1	0.8	4.1 : 1	1.4	1.4 : 1
Coffee Pot Drive						
West X-walk	1.6	1.7 : 1	0.9	1.4 : 1	1.2	6.0 : 1
East X-walk	2.3	2.1 : 1	1.0	5.5 : 1	0.9	1.1 : 1
Mtn Shadows Drive						
West X-walk	2.6	1.8 : 1	1.4	1.3 : 1	0.4	2.5 : 1
East X-walk	2.9	1.5 : 1	0.7	2.5 : 1	1.4	1.4 : 1
Soldiers Pass Road						
West X-walk	2.5	1.4 : 1	1.8	1.7 : 1	0.6	3.4 : 1
East X-walk	3.7	1.8 : 1	1.0	4.0 : 1	1.3	9.4 : 1

(1) Vertical surface is facing east

(2) Vertical surface is facing west

3.2 Existing Surrounding Lighting

A nighttime ambient light survey was performed to identify light generated by the surrounding land uses along the study corridor. These observations were made to assess the affects of this lighting on the drivers' nighttime visibility of pedestrians in the roadway and to assist in the classification of the general land use for the study section of SR 89A. The survey was performed on Thursday, February 5, 2009 from approximately 11:30 PM to 12:30 AM on Friday, February 6, 2009. **The survey identified a total of 63 ambient light sources within the two mile long study corridor.** A large majority of this lighting is associated with business signing, business parking lot or area lighting, and business landscape lighting. The type of lighting ranges from low-pressure sodium full cut-off type fixtures that are very sensitive to the current City of Sedona dark sky ordinance to parabolic refractor (PAR) type sign lighting fixtures and drop lense area lighting fixtures that create significant glare and contribute to night sky glow. The documentation of the survey is presented in the Appendix of this report.

It is important to note that dark sky compliant lighting can still contribute to nighttime brightness. The dark sky ordinance is targeted at eliminating direct light being admitted into the atmosphere.

3.3 Headlight Glare

Along the section of SR 89A under study, opposing headlight glare is one of the major factors negatively impacting the drivers' ability to see pedestrians in the roadway. Due to vertical alignment changes in the roadway and opposing traffic utilizing the two-way left turn lane to execute left turns, vehicle headlights project at or near the line of sight of opposing drivers. This can lead to the driver's view being dominated by the opposing vehicle's headlights. Headlight glare can make it very difficult for a driver to see a pedestrian crossing the roadway, especially if the pedestrian is near the middle of the road.

Mitigating opposing vehicle headlight glare is one of the main reasons to consider providing continuous roadway lighting along this section of SR 89A. Continuous roadway lighting, when properly designed can help improve the driver's ability to see pedestrians when encountering headlight glare. Although glare will still remain a factor, its interference will not dominate the driver's ability to see pedestrians as it does without the presence of roadway lighting.

4.0 CITY OF SEDONA DARK SKY ORDINANCE ENFORCEMENT

The City of Sedona and the citizens' organization Keep Sedona Beautiful (KSB) have an ongoing program to identify and investigate potential dark sky ordinance violations. The first phase of this program inventoried the area between Dry Creek Road and Rodeo Road. The second phase will inventory the area east of Rodeo Road. Between Dry Creek Road and Rodeo Road, a total of 46 potential violations of the current ordinance have been reported and investigated since January 19, 2009. A total of 24 of the reports were found to be violations of the existing ordinance. The city is taking actions to bring these installations into compliance with the ordinance. An additional 15 lighting installations were found to predate the ordinance and therefore are allowed under "grandfather rights" defined in the ordinance. The city plans to refer these cases back to KSB who in turn will work with the property owners in an attempt to make changes that will bring the existing lighting into compliance with the ordinance. A total of seven of the reported violations were found to be in compliance with the existing ordinance.

5.0 LIGHTING LEVEL CRITERIA SUMMARY & RECOMMENDATIONS

State Route 89A within the study section is classified by ADOT and FHWA as an Urban Principal Arterial. The existing pavement is asphaltic concrete which falls into the categories of R2 or R3 pavement types. The general land use is the single remaining variable to be evaluated with regard to the recommended average maintained illuminance level for the proposed continuous roadway lighting system. The average maintained illuminance values from Table 3-5a of the *AASHTO Guide*, for principal arterials with no control of access, R2/R3 pavement types, and the various land use classifications are presented in Table 2. Closely related to general land use is the amount of ambient light adjacent to the roadway and the amount of pedestrian activity in the area. Commercial and lodging land uses tend to generate more ambient light and nighttime pedestrian activity.

Table 3 shows the recommended roadway lighting illuminance levels presented in the IESNA Roadway Lighting RP-8-00. The high, medium and low pedestrian conflict classifications correlate with the commercial, intermediate, and residential land use classifications found in the *AASHTO Guide* and are generally 0.1 fc higher than the corresponding AASHTO values.

Table 2:
AASHTO Roadway Lighting Design Guide Table 3-5a
Average Maintained Illuminance
Principal Arterial with No Control of Access with R2/R3 Pavement

Off-Roadway Light Sources	Pavement Illuminance	
	Average (fc)	Uniformity (avg:min)
General Land Use		
Commercial	1.6	3 : 1
Intermediate	1.2	3 : 1
Residential	0.8	3 : 1

Table 3:
IESNA Roadway Lighting RP-8-00 Table 2
Illuminance Method – Recommended Values
Major Road

Pedestrian Conflict Area	Pavement Illuminance	
	Average (fc)	Uniformity (avg:min)
High	1.7	3 : 1
Medium	1.3	3 : 1
Low	0.9	3 : 1

The Final PA was based on a minimum average illuminance of 1.2 foot-candles and a uniformity ratio of 3:1, based on a roadway classification of major arterial with no access control and a general land use of intermediate. The intermediate land use was determined to be appropriate due to the apparent mixed use nature of the land uses and apparent low level of ambient light along the corridor.

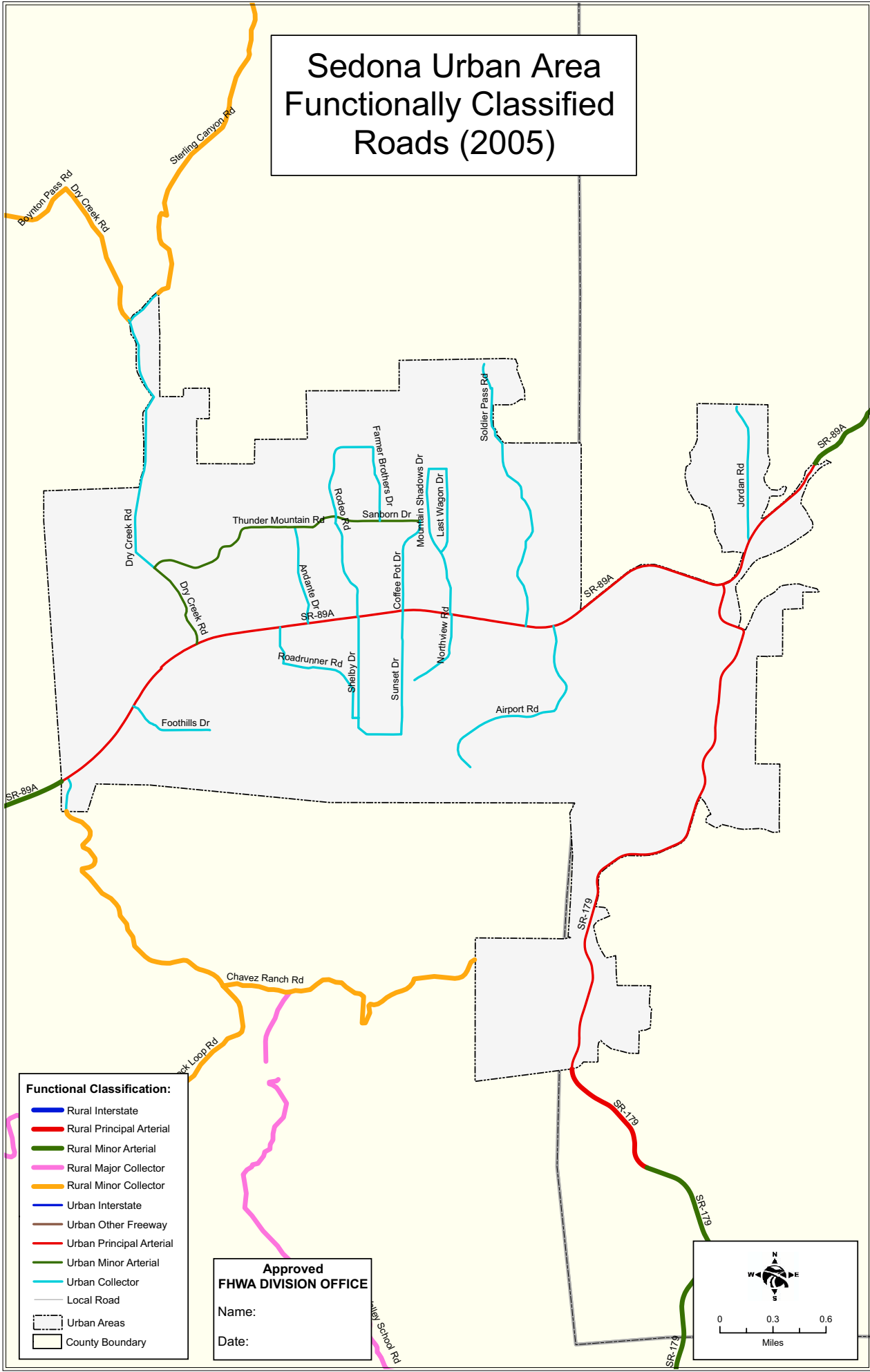
Subsequent investigation revealed that all the property that abuts the study section of SR 89A is zoned for commercial uses including lodging. The City of Sedona and KSB have done an admirable job identifying and working to eliminate outdoor commercial lighting installations that are not dark sky friendly. The February 2009 survey performed for this study identified over 60 ambient light sources in the study area. This includes both dark sky compliant and non-compliant lighting. This information is important, as even dark sky compliant commercial lighting adds to the ambient brightness that could negatively impact the drivers' ability to see pedestrians in the unlighted roadway.

Field measured illuminance values at the existing signalized intersections indicate that six of the ten crosswalks have an average horizontal illuminance between 2.2 and 2.9 fc while none of the crosswalks meet the 2.0 fc average vertical illuminance value recommended in the *FHWA Informational Report*. The research performed to develop the recommendations in the *FHWA Informational Report* appears to suggest that the roadway lighting illuminance levels required to provide adequate nighttime visibility of pedestrians may be generally higher than the values presented in the *AASHTO Guide*. However, it should be noted that FHWA research did not attempt to correlate horizontal and vertical illuminance values.

For these reasons, a minimum average maintained illuminance level less than 1.2 fc cannot be justified. The final lighting design for this project should be based on an average maintained illuminance of 1.2 fc, with a uniformity of 3:1 or better. Additionally, the continuous roadway lighting system should be designed with special consideration given to marked crosswalks within the corridor. Consideration should be given to spacing the poles such that a luminaire is located approximately 10 to 50 feet upstream of all crosswalks. The exact distance should be determined during the development of the final lighting design concept, based on the selected luminaire and mounting height to provide maximum vertical illuminance at the crosswalk.

**APPENDIX A:
SEDONA URBAN AREA
FUNCTIONALLY CLASSIFIED ROADS
(2005)**

Sedona Urban Area Functionally Classified Roads (2005)



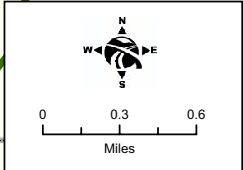
Functional Classification:

—	Rural Interstate
—	Rural Principal Arterial
—	Rural Minor Arterial
—	Rural Major Collector
—	Rural Minor Collector
—	Urban Interstate
—	Urban Other Freeway
—	Urban Principal Arterial
—	Urban Minor Arterial
—	Urban Collector
—	Local Road
	Urban Areas
	County Boundary

**Approved
FHWA DIVISION OFFICE**

Name: _____

Date: _____



**APPENDIX B:
SEDONA ZONING**

Legend

City Boundary

FOREST

City Boundary

USFS Boundary

Oak Creek

C-1 *General Commercial*

C-2 *General Commercial*

C-3 *Heavy Commercial/Light Manufacturing*

CF *Community Facilities*

NF *National Forest*

OP *Office Professional*

OS *Open Space*

P *Parking*

PD *Planned Development*

PRD *Planned Residential Development*

RC *Resort Commercial*

L *Lodging (*22)*

T-1 thru T-15 *Transitional Zoning*

SU *Special Use District*

RM-1 *Med. Density Multi Family Res.*

RM-2 *High Density Multi Family Res.*

RM-3 *High Density Multi Family Res.*

RMH-6 *Single Family Res. & Mobile Home*

RMH-10 *Single Family Res. & Mobile Home*

RMH-12 *Single Family Res. & Mobile Home*

RS-10a *Single Family Residential*

RS-10b *Single Family Residential*

RS-12 *Single Family Residential*

RS-18a *Single Family Residential*

RS-18b *Single Family Residential*

RS-35 *Single Family Residential*

RS-36 *Single Family Residential*

RS-6 *Single Family Residential*

RS-70 *Single Family Residential*

RS-5A *Single Family Residential*

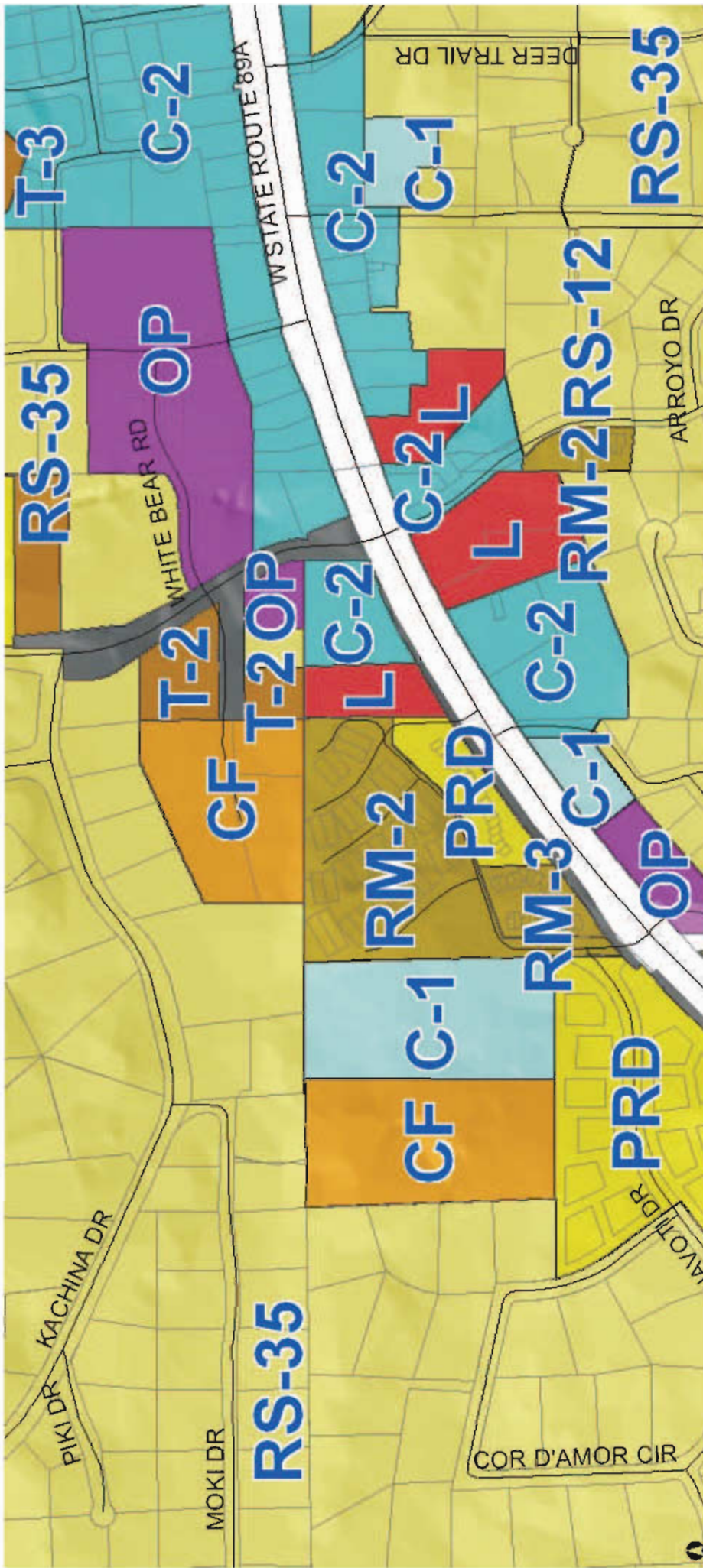
Hwy_Whiteout

Hillshade

Value

High : 254

Low : 0



T-3

C-2

RS-35

OP

T-2

CF

T-2OP

L

RM-2

CF

C-1

PRD

RM-3

PRD

OP

W STATE ROUTE 89A

WHITE BEAR RD

DEER TRAIL DR

ARROYO DR

COR D'AMOR CIR

AVOTI DR

C-2

C-1

C-2L

L

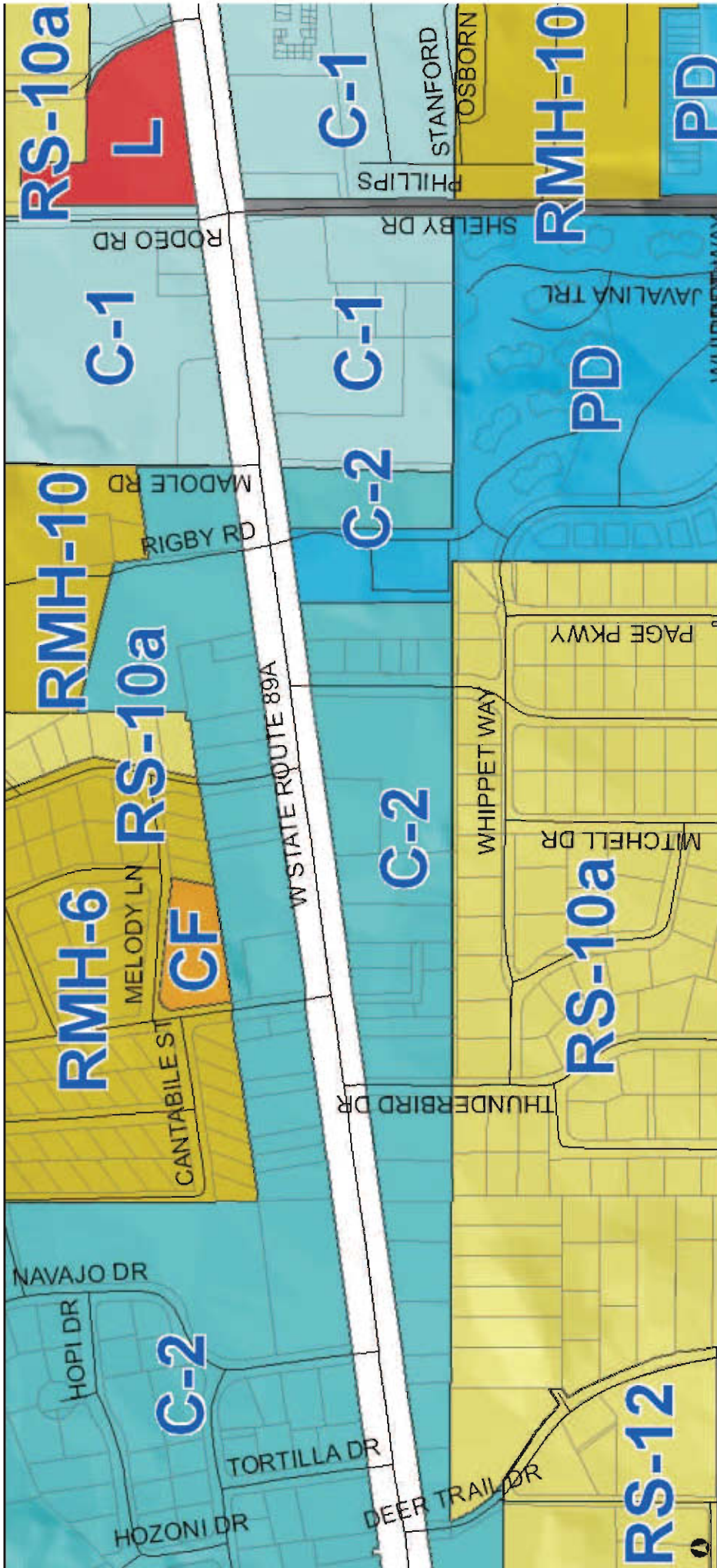
RM-2RS-12

C-2

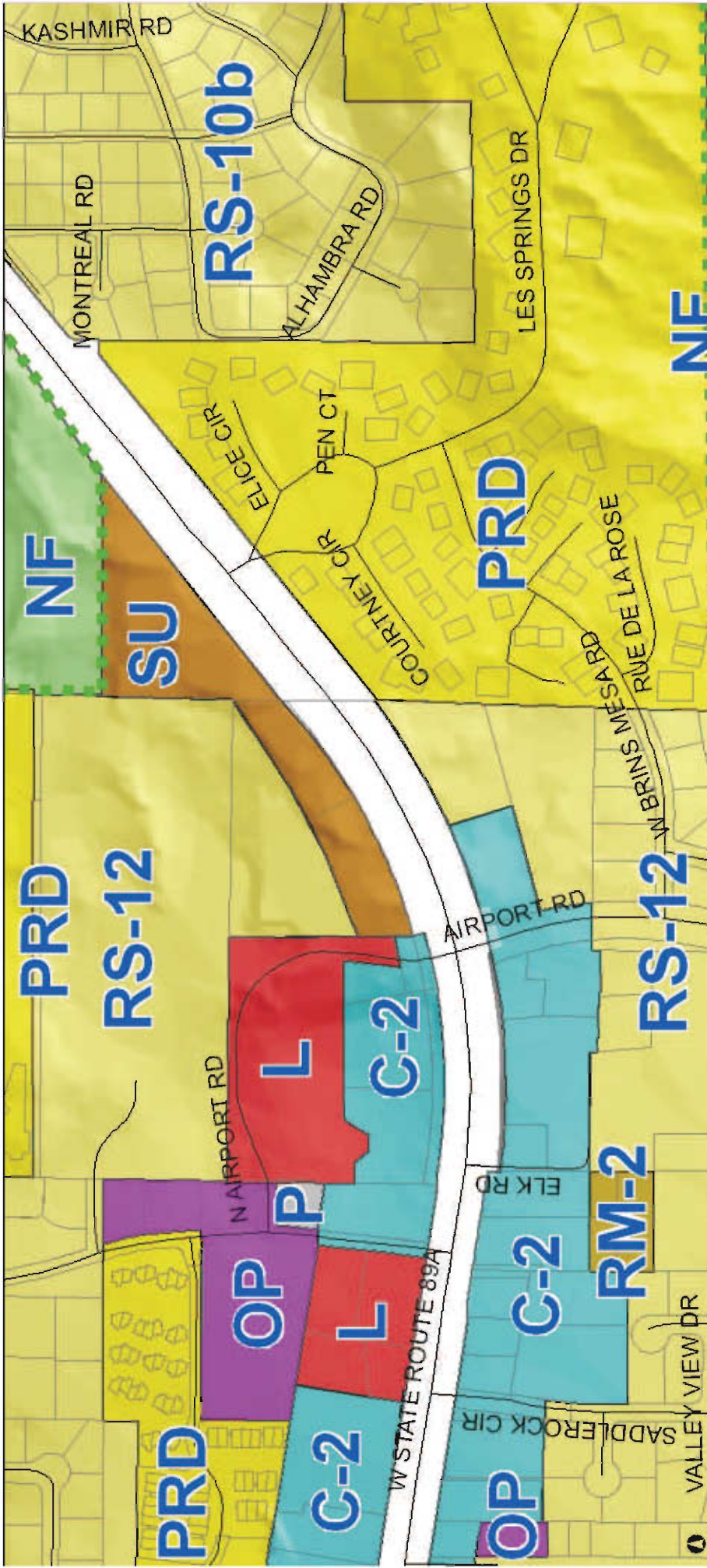
C-1

RS-35

RS-35







APPENDIX C: MEASURED ILLUMINANCE

**SR 89A & DRY CREEK ROAD
EXISTING ILLUMINANCE
February 5, 2009**

WEST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB LANE	EB CURB LANE	EB INSIDE LANE	EB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB					
Vertical East	1.60	1.43	1.53	1.80	1.72	1.29	1.19		1.51	1.19	1.80	1.27 : 1
Horizontal	4.88	4.31	4.20	5.16	5.53	5.38	3.39		4.69	3.39	5.53	1.38 : 1
Vertical West	0.41	0.34	0.49	1.30	1.23	1.33	0.89		0.86	0.34	1.33	2.52 : 1

EAST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB LANE	EB CURB LANE	EB INSIDE LANE	WB LT TURN LANE	WB INSIDE LANE	WB OUTSIDE LANE	WB RT TURN LANE	NORTH CURB				
Vertical East	0.76	1.24	1.14	0.96	0.40	0.16	0.11		0.68	0.11	1.24	6.19 : 1
Horizontal	2.20	3.21	3.61	2.98	1.44	0.81	0.95		2.17	0.81	3.61	2.68 : 1
Vertical West	0.78	1.05	1.13	0.93	0.82	0.85	1.02		0.94	0.78	1.13	1.21 : 1

**SR 89A & RODEO ROAD
EXISTING ILLUMINANCE
February 5, 2009**

WEST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	EB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB					
Vertical East	2.00	1.65	1.35	1.18	1.12	1.14	1.06	1.06	1.36	1.06	2.00	1.28 : 1
Horizontal	1.99	1.75	1.91	2.54	4.38	5.76	5.20	5.20	3.36	1.75	5.76	1.92 : 1
Vertical West	0.26	0.24	0.33	0.73	1.39	1.41	1.05	1.05	0.77	0.24	1.41	3.22 : 1

EAST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	WB LT TURN LANE	WB INSIDE LANE	WB OUTSIDE LANE	WB RT TURN LANE	NORTH CURB				
Vertical East	1.10	1.31	1.30	0.94	0.54	0.37	0.20	0.22	0.82	0.20	1.31	4.11 : 1
Horizontal	2.84	3.87	3.49	2.56	1.74	1.45	1.82	2.65	2.54	1.45	3.87	1.75 : 1
Vertical West	1.04	1.23	1.34	1.52	1.68	1.55	1.53	2.03	1.41	1.04	1.68	1.36 : 1

**SR 89A & COFFEE POT DRIVE
EXISTING ILLUMINANCE
February 5, 2009**

WEST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB	EB RT TURN LANE	EB OUTSIDE LANE	EB INSIDE LANE	EB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB				
Vertical East	1.60	1.14	0.80	0.85	0.81	0.74	0.66	0.55	0.94	0.66	1.60	1.43 : 1
Horizontal	1.86	1.25	0.92	1.15	1.67	2.05	2.04	1.48	1.56	0.92	2.05	1.70 : 1
Vertical West	0.21	0.28	0.67	1.64	1.93	1.93	2.11	1.61	1.25	0.21	2.11	5.97 : 1

EAST CROSSWALK												
FACING	READING (foot-candles)								AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7	8				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	WB LT TURN LANE	WB INSIDE LANE	WB OUTSIDE LANE	WB RT TURN LANE	NORTH CURB				
Vertical East	1.23	1.55	1.50	1.36	0.81	0.26	0.18	0.16	0.98	0.18	1.55	5.47 : 1
Horizontal	2.36	3.41	3.70	2.40	1.53	1.06	1.34	2.08	2.26	1.06	3.70	2.13 : 1
Vertical West	0.80	0.83	0.87	0.89	0.87	0.93	1.18	1.91	0.91	0.80	1.18	1.14 : 1

**SR 89A & MOUNTAIN SHADOWS DRIVE
EXISTING ILLUMINANCE
February 5, 2009**

WEST CROSSWALK											
FACING	READING (foot-candles)							AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	EB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB				
Vertical East	1.95	1.46	1.31	1.47	1.30	1.12	1.09	1.39	1.09	1.95	1.27 : 1
Horizontal	1.85	1.48	1.44	1.98	3.38	4.34	3.58	2.58	1.44	4.34	1.79 : 1
Vertical West	0.18	0.16	0.32	0.49	0.62	0.54	0.54	0.41	0.16	0.62	2.54 : 1

EAST CROSSWALK											
FACING	READING (foot-candles)							AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	WB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB				
Vertical East	0.77	0.93	0.86	0.84	0.74	0.41	0.28	0.69	0.28	0.93	2.46 : 1
Horizontal	3.05	4.06	3.35	2.29	1.91	2.36	3.06	2.87	1.91	4.06	1.50 : 1
Vertical West	0.99	1.19	1.43	1.01	1.20	1.48	2.39	1.38	0.99	2.39	1.40 : 1

**SR 89A & SOLDIERS PASS ROAD
EXISTING ILLUMINANCE
February 5, 2009**

WEST CROSSWALK											
FACING	READING (foot-candles)							AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	EB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB				
Vertical East	3.00	2.67	1.98	1.62	1.42	1.16	1.10	1.85	1.10	3.00	1.68 : 1
Horizontal	2.54	2.16	1.76	1.96	3.38	1.75	3.80	2.48	1.75	3.80	1.42 : 1
Vertical West	0.17	0.19	0.55	0.60	0.75	1.07	0.77	0.59	0.17	1.07	3.45 : 1

EAST CROSSWALK											
FACING	READING (foot-candles)							AVG. (fc)	MIN. (fc)	MAX. (fc)	UNIFORMITY (AVG./MIN.)
	1	2	3	4	5	6	7				
	SOUTH CURB	EB CURB LANE	EB INSIDE LANE	WB LT TURN LANE	WB INSIDE LANE	WB CURB LANE	NORTH CURB				
Vertical East	1.45	1.43	1.57	1.96	0.35	0.28	0.26	1.04	0.26	1.96	4.01 : 1
Horizontal	4.50	5.40	5.10	3.40	2.40	2.10	3.10	3.71	2.10	5.40	1.77 : 1
Vertical West	2.10	1.55	0.14	0.16	1.78	1.77	1.75	1.32	0.14	2.10	9.44 : 1

Approximately 100 feet east of Soldiers Pass Road on the southeast corner, the horizontal reading is 0.70 foot-candles and the vertical reading facing south is 2.10 foot-candles.

Approximately 100 feet west of Soldiers Pass Road on the southwest corner, the horizontal reading is 0.70 foot-candles, the vertical reading facing east is 0.31 foot-candles, and the vertical reading facing west is 0.05 foot-candles.

APPENDIX D: OUTDOOR LIGHTING SURVEY

Draft April 27, 2009

SR 89A West Sedona

Preliminary Outdoor Light Survey (Dry Creek to Airport Road)

Data Taken Thursday, February 5, 11:30 PM to Friday, February 6, 12:30 AM, 2009

Eastbound (South side of SR 89A)(From West end to East end)

No.	Description of Business or Institution	Outdoor Lighting	Other Comment
1	Sedona Real – Motel	Lighted Sign	
2	Kopelli – Motel	Lighted Sign some area lighting	
3	Lantern Light Inn – Bed & Breakfast	Unshielded quartz flood lights on sign	
4	Days Inn	Very Bright Signs & Numerous Street Lights for parking lot and area lighting	Potential Pedestrian Crossing Generator to Giant which is on the north side and an area of SR 89A which is very dark
5	Big O Tires	Utility pole mounted cobra head Dawn to Dusk Parking Lot Lighting	
6	NAPA Auto Parts	Unshielded drop lense area light fixture on Store Face	This type of fixture is sometimes referred to as a “glare bomb” in International Dark Sky Association (IDA) literature
7	Sedona Sheet Metal	Street Light for area and parking lot lighting	
8	Desert Hills Bank	Bright building face with lighted sign	
9	Church of Christ	Parking lot light – lighted sign which is shielded	
10	Sedona Lube Services (SLS)	Very Bright over lighted sign	
11	Greer’s Mortuary of Sedona	Bright sign & drop lense area light fixture on front of building (entry)	IDA “glare bomb”
12	Canyon Outfitters	Bright Store front	
13	Pizza Heaven /Nationwide Pack + Ship / Bakery	Unshielded incandescent PAR flood or spot light sign lighting	
14	Vacant Business	Unshielded incandescent PAR floods around the building	Not on at night
15	Super 8 Motel	Sign lighting and parking lot lighting	Potential Pedestrian Crossing Generator to the Circle K which is on the north side in an area of SR 89A which is very dark.
16	Cory Physical Therapy	Drop lense area fixture	IDA “glare bomb”
17	Wyndham – Motel	Well done sign	
18	New Building Material Center being Constructed		

Eastbound Continued (South side of SR 89A)(From West end to East end)

No.	Description of Business or Intuition	Outdoor Lighting	Other Comment
19	Dahl & Diluca Italian Restaurant	Dusk to Dawn Street Light on drive way	
20	Harkins Plaza -	Very bright parking lot lighting and store fronts	
21	Grasshopper Store and Gas Station	Bright sign and areas lighting	
22	KFC	Lighted Signs	
23	Walgreens	Driveway lighting	
24	Picazzo's	Lighted Sign	
25	Business Plaza	Parking lot lighting & lighted store fronts	
26	Bank of America	Lighted sign	
27	Arizona Auto Wash	Lighted sign & Parking Lot lighting	
28	Business Plaza	Lighted store fronts	
29	Olde Sedona Bar & Grill	Bright signs and drive way lights	
30	Stone Age Sedona	Lighted sign	
31	Biddle Outdoor Center – Landscape	Two 250 watt Dawn to Dusk Street Lights on utility pole and PAR lighted store front	Significant spill light on to SR 89A
32	Sedona Plaza – Remax / CTX	Bright Sign Lights	
33	ATV / Hair Cottage	Drop lense area lighting parking lot	IDA “glare bomb”
34	Trading Post – Visitor Information – Wyndham Vacation Resorts	Quartz sign lights directed up at sign and into the sky	
35	Sky Ranch Lodge One Mile Sign	Advertising Sign light at Airport Street. Fluorescent light is directed up at the sign and into the sky.	Light is powered by a battery which is solar charged

Westbound (North side of SR 89A) (From East End to West End)

No.	Description of Business or Intuition	Outdoor Lighting	Other Comment
1	Best Western - Motel	Bright Sign	
2	La Pasada Plaza	Bright Sign and store front	Sign is lighted overhead with compact fluorescent
3	Chase Bank	Bright Sign	
4	Old Market Place – N.Y. Bagels / Szechuan / Martini Bar	Bright Sign, some parking lot lighting and some store front lighting	
5	The Heartline Cafe	Bright building lighting	
6	Mayan Taco	Significant number of unshielded lighting fixtures	Appears may be out of business.
7	Mexidona Store	Bright sign	
8	Buena Vista & Quartz Buildings	Lighted sign and store front	
9	Top Shelf Liquors Plaza	Drop lense area lighting and lighted store front	IDA “glare bomb”
10	Hampton Inn	Lighted signs and parking lot lighting	
11	Sedona Village Shopping Center - Bashas / Bealls Outlet	Lighted Sign and Parking lot lighting	
12	Arco Store and Gas Station	High pressure sodium canopy lighting	
13	Sedona Center	Quartz flood light parking lot lighting	
14	Coffee Pot Restaurant	Bright sign and drop lense parking lot lights	IDA “glare bomb”
15	Sugar Loaf Lodge - Motel	Bright sign	
16	Sedona Rouge – Motel, Spa & Reds Restaurant	Parking lot lighting	
17	Safeway Plaza	Parking lot lighting and lighted signs and store fronts	Lights adjacent to SR 89a are shielded
18	Windsong Mobile Home Park	Entrance Dusk to Dawn Street Light	
19	Moon Dogs Pizza	Lighted sign	
20	Circle K Store and Shell Gas Station	Bright sign, flood lighting area lighting and canopy lights. Bright store front	
21	\$5 Dollar Car Wash	Bright sign	
22	Sedona Motors	Bright sign, flood lights spread across the site lighting cars.	Many of the flood lights are shining directly into the eyes of WB SR 89A traffic.
23	Southwest Car Corner Park n’ Sell	Parking Lot lighting	
24	Kelser’s West building	PAR flood light area and parking lot lighting	
25	Giant Store and Gas Station	Bright sign and gas canopy lights	
26	White House Inn – Motel & Plaza next door	Bright signs and unshielded area lighting	

Draft April 27, 2009

Westbound Continued (North side of SR 89A) (From East End to West End)

No.	Description of Business or Intuition	Outdoor Lighting	Other Comment
27	Southwestern Eye Center / Red Rock Knit Shop /Frame Maker	Lighted sign	
28	Dry Creek Plaza	Lighted sign	

**APPENDIX E:
SEDONA LIGHTING CODE
ENFORCEMENT DATABASE
2008-2009**

Code Enforcement Night Lighting Complaints

2008-2

Case Number	Date Received	Address of Complaint	Tax Parcel Number	Complaint Submitted by	Assigned to	First Inspection date (date)	Findings (Violation, No Violation)	Grandfathered	Verbal Warning Issued (date)	Notice of Violation Issued (date)	Citation Issued (date)	LP Applied for (date)	LP Issued (date)	LP Final (date)	Other (explain/date)	Closed (date)	Additional Comments	Location recommended for KSB follow up.
L09-01	01/19/09	3190 SR 89A Sic 300	408-11-082A	KSB	JW	02/02/09 violation	No Violation	Grandfathered		2/9/2009								
L09-02	01/19/09	35 Dry Creek Road	408-02-068	KSB	JW	02/02/09		Grandfathered										Yes.
L09-03	01/19/09	3150 SR 89A / Dry Creek Plaza	408-11-081C	KSB	JW	02/02/09 violation				2/9/2009								No.
L09-04	01/19/09	3130 SR 89A / Animal Clinic	408-02-119C	KSB	JW	02/05/09		Grandfathered										Yes.
L09-05	01/19/09	3100 W SR 89A / Knt Shop	408-02-119B	KSB	JW	02/05/09		Grandfathered										Yes.
L09-06	01/19/09	3080 W SR 89A / SW Eye	408-02-119A	KSB	JW	02/05/09		Grandfathered										Yes.
L09-07	01/19/09	3058 W SR 89A / Sedona Floral	408-02-118	KSB	JW	02/05/09		Grandfathered										Yes.
L09-08	01/19/09	102 Roadrunner Dr / City Hall	408-02-116	KSB	JW	02/05/09		Grandfathered										Yes.
L09-09	01/19/09	3004 W SR 89A	408-02-064	KSB	JW	02/05/09 violation				2/9/2009								Yes.
L09-10	01/19/09	3000 W SR 89A / Wayne B Light	408-24-324	KSB	JW	12/29/08 violation												Yes.
L09-11	01/19/09	2986 W SR 89A / White House	408-24-323	KSB	JW	02/19/09 violation												Yes.
L09-12	01/19/09	2986 W SR 89A / Thea Spaces	408-24-322	KSB	JW	02/19/09 violation												Yes.
L09-13	01/19/09	2960 W SR 89A / Giant	408-24-124F	KSB	JW	02/09/09 no violation												Yes.
L09-14	01/19/09	2920 W SR 89A / Kaisers	408-24-315	KSB	JW	02/19/09 violation												Yes.
L09-15	01/19/09	2900 W SR 89A Southwest Car Corner	408-24-310	KSB	JW	02/19/09 violation												Yes. If they want to go after the pole lights.

Code Enforcement Night Lighting Complaints

2008-21

Case Number	Date Received	Address of Complaint	Tax Parcel Number	Complaint Submitted by	Assigned to	First Inspection date (date)	Findings (Violation, No Violation)	Grandfathered	Verbal Warning Issued (date)	Notice of Violation Issued (date)	Citation Issued (date)	Applied for (date)	LP Issued (date)	Final (date)	Other (explain/date)	Closed (date)	Additional Comments	Location recommended for KSB follow up.	
L09-16	01/19/09	2782 W St 89A / Plaza Del Oeste 2740 & 2720 W SR 89A / Sedona	408-24-106	KSB	JW	02/19/09	Grandfathered.								courtesy letter 02/19/09	01/00/00	Property developed prior to Sedona incorporation, however fixture replaced with CFL	Yes.	
L09-17	01/19/09	408-24-103 & 1 KSB			JW	02/23/09	violation								courtesy letter 02/23/09				
L09-18	01/19/09	2660 W SR 89A / Sedona Car Wash	408-24-487C	KSB	JW	02/20/09	violation								courtesy letter 02/23/09				
L09-19	01/19/09	2620 W SR 89A / Barking Frog	408-24-498C	KSB	JW	02/23/09	violation	Grandfathered							Sign light adjusted 3/19/09	03/19/09	Carriage lights are grandfathered.	Yes.	
L09-20	01/19/09	2570 W SR 89A / Circle K	408-24-098B	KSB	JW	02/23/09	violation								courtesy letter 02/23/09		This location is an example of good lighting. No actions taken.	No.	
L09-21	01/19/09	2550 W SR 89A / Smiths Corner	408-24-097	KSB	JW	02/23/09	no violation									02/23/09			No.
L09-22	01/19/09	2530 W SR 89A / Urgent Care	408-24-095	KSB	JW	02/23/09	violation	Grandfathered							courtesy letter 2/3/09		This building built per Building Permit B4852-A,B & C, and Development Review DE198-01. Finished 03/19/09 on 10/1/09.	Yes.	
L09-23	01/19/09	2490 W SR 89A / Moon Dogs	408-24-094	KSB	JW	02/23/09	violation								courtesy letter 02/23/09	03/19/09	Light Bulb at front door removed. P/O working on replacement fixture.	No.	
L09-24	01/19/09	2290 W SR 89A / Wachovia Bank	408-24-074C & 073D	KSB	JW	02/23/09	violation								courtesy letter 02/23/09		Nick has file.	No.	
L09-25	01/19/09	2250 W SR 89A / Sedona Rouge	408-24-070D	KSB	JW	02/23/09	No Violation								courtesy letter 02/23/09	03/20/09	This Hotel and Spa built per B7389 and DE101-6 and ZC01-3. Finished 8/3/06	Yes.	
L09-26	01/19/09	2300 W SR 89A / Safeway	408-24-073F	KSB	JW	02/23/09	no violation								courtesy letter 02/23/09		No violations just an example of good Shopping center lighting.	No.	
L09-27	01/19/09	2301 W SR 89A / Chimney Rock Plz	408-24-025K	KSB	JW	02/23/09	no violation								courtesy letter 02/24/09	02/23/09	No violations just an example of good Business center lighting.	No.	
L09-28	01/19/09	2321 W SR 89A / Dahl & Di Luca	408-24-025A	KSB	JW	02/24/09	violation								on 3/24/09 owner adjusted lights to comply.	03/24/09	lights adjusted to comply	No.	
L09-29	01/19/09	2445 W SR 89A / Wyndham	408-28-363	KSB	JW	02/24/09	violation								courtesy letter 02/24/09				
L09-30	01/19/09	2515 W SR 89A / Rolo Vista	408-24-020	KSB	JW	02/24/09	violation								courtesy letter 02/24/09		extension granted till 4/30/09		
L09-31	01/19/09	2545 W SR 89A / Super 8	408-24-018	KSB	JW	02/24/09	violation								courtesy letter 02/24/09				

Code Enforcement Night Lighting Complaints

2008-2

Case Number	Date Received	Address of Complaint	Tax Parcel Number	Complaint Submitted by	Assigned to	First Inspection date (date)	Findings (Violation, No Violation)	Grandfathered	Verbal Warning Issued (date)	Notice of Violation Issued (date)	Citation Issued (date)	LP Applied for (date)	LP Issued (date)	LP Final (date)	Closed (date)	Additional Comments	Location recommended for KSB follow up.
L09-32	01/19/09	2611 W SR 89A / Savannahs	408-24-016A	KSB	JW	02/24/09 violation										courtesy letter 02/24/09	
L09-33	01/19/09	2675 W SR 89A/sectiona sweet art	408-24-012B	KSB	JW	02/24/09 violation										courtesy letter 02/24/09	
L09-34	01/19/09	2675 W SR 89A	408-24-012C	KSB	JW	02/24/09 violation										courtesy letter 02/24/09	
L09-35	01/19/09	2881 W SR 89A/Canyon Outfitters	408-24-011	KSB	JW	02/24/09	Grandfathered									Sign Permit SP92-46 issued and finalized on 02/24/09	Yes.
L09-36	01/19/09	2725 W SR 89A	408-24-010	KSB	JW	02/24/09 violation										courtesy letter 02/24/09	
L09-37	01/19/09	2745 W SR 89A	408-24-009	KSB	JW	02/24/09 violation										courtesy letter 02/24/09	
L09-38	01/19/09	2757 W SR 89A / Church of Christ	408-24-008	KSB	JW	02/24/09 no violation										Example of good sign lighting	No.
L09-39	01/19/09	2785 W SR 89A / Desert Hills Bank	408-27-007	KSB	JW	02/24/09 no violation										Example of good development lighting. Built per B8748.	No.
L09-40	01/19/09	2885 W SR 89A / NAPA	408-24-003E	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	
L09-41	01/19/09	2985 W SR 89A / Big O	408-24-001	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	
L09-42	01/19/09	3009 W SR 89A / Facebees	408-11-078B	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	
L09-43	01/19/09	2991 W SR 89A / Days Inn	408-28-011A	KSB	JW	02/24/09 no violation										Example of good sign lighting. SP07-	
L09-44	01/19/09	3035 W SR 89A / Sedona Tire	408-11-078A	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	
L09-45	01/19/09	3075 W SR 89A / Quilt Store	408-11-076H	KSB	JW	02/25/09	Grandfathered									Light bulbs have been changed to better shield light.	No.
L09-46	01/19/09	3085 W SR 89A / Lantern Light	408-11-093Q	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	
L09-47	01/19/09	3118 W SR 89A / Kokopelli	408-11-083J	KSB	JW	02/25/09 violation										courtesy letter 02/25/09	

**APPENDIX F:
CURFEW LIGHTING AND
LIGHTING MANAGEMENT SYSTEMS**

CURFEW LIGHTING AND LIGHTING MANAGEMENT SYSTEMS

The *AASHTO Roadway Lighting Design Guide* contains extensive discussions on lighting curfews and Electrical and Lighting Management Systems (ELMS). A significant portion of the background information presented herein is taken directly from the *AASHTO Guide*. Curfews for lighting involve the use of modern controls to turn off or dim selected parts of lighting systems. Lighting curfews have the potential to save energy, save money, and reduce light-trespass. However, the *AASHTO Guide* points out, officials implementing such options should be aware of consequences and conduct meaningful studies of costs and benefits.

The *AASHTO Guide* indicates that studies have shown that crash rates increase where systems are turned off or where every other luminaire is turned off. Alternate luminaire operation results in poor uniformity ratios. The issue of driver needs and safety versus conservation efforts should be closely examined when considering curfews. Poorly conceived conservation efforts may contribute to increases in traffic crashes and operational problems. These problems may actually result in higher overall costs.

The *AASHTO Guide* states the following items should be considered before implementing a lighting curfew:

- Special events, maintenance or construction activities, weather, and other local considerations should be included in the decision to implement lighting curfew.
- Implementation of curfews should occur through traffic management centers or other central locations and should be monitored to gain experience as to the best operational procedures.
- FHWA report *Reduced Lighting During Periods of Low Traffic Density* should be read in full when considering lighting curfews.
- Modern crash data should be analyzed.

From a safety standpoint, turning off or dimming selected parts of a lighting system results in a definite reduction in (simulated) hazard detection performance, which theoretically implies some reduction in safety. However, this implied reduction in safety has not been shown to be statistically significant for the dimming tactic. Unfortunately, it is not possible at this time to quantify the exact decrease in safety in terms of frequency of nighttime accidents, the nighttime accident rate, or the night-to-day accident ratio. Only an evaluation of long term installations can address this issue.

The *AASHTO Guide* also states that “dimming should be considered if light levels are higher than those required by AASHTO. In some instances lighting is installed at levels higher than the minimum required because of safety or work zones. It may be reasonable to dim this to only the required level after heavy traffic subsides. The same logic can be applied to dimming as is applied to curfews.”

The proposed average maintained illuminance for design of SR 89A, Dry Creek Road to Airport Road is 1.2 fc and a uniformity of 3:1 or better. This is the minimum required by AASHTO for the assumed land use and roadway type. Therefore, dimming should not be considered, based on the information in the *AASHTO Guide*.