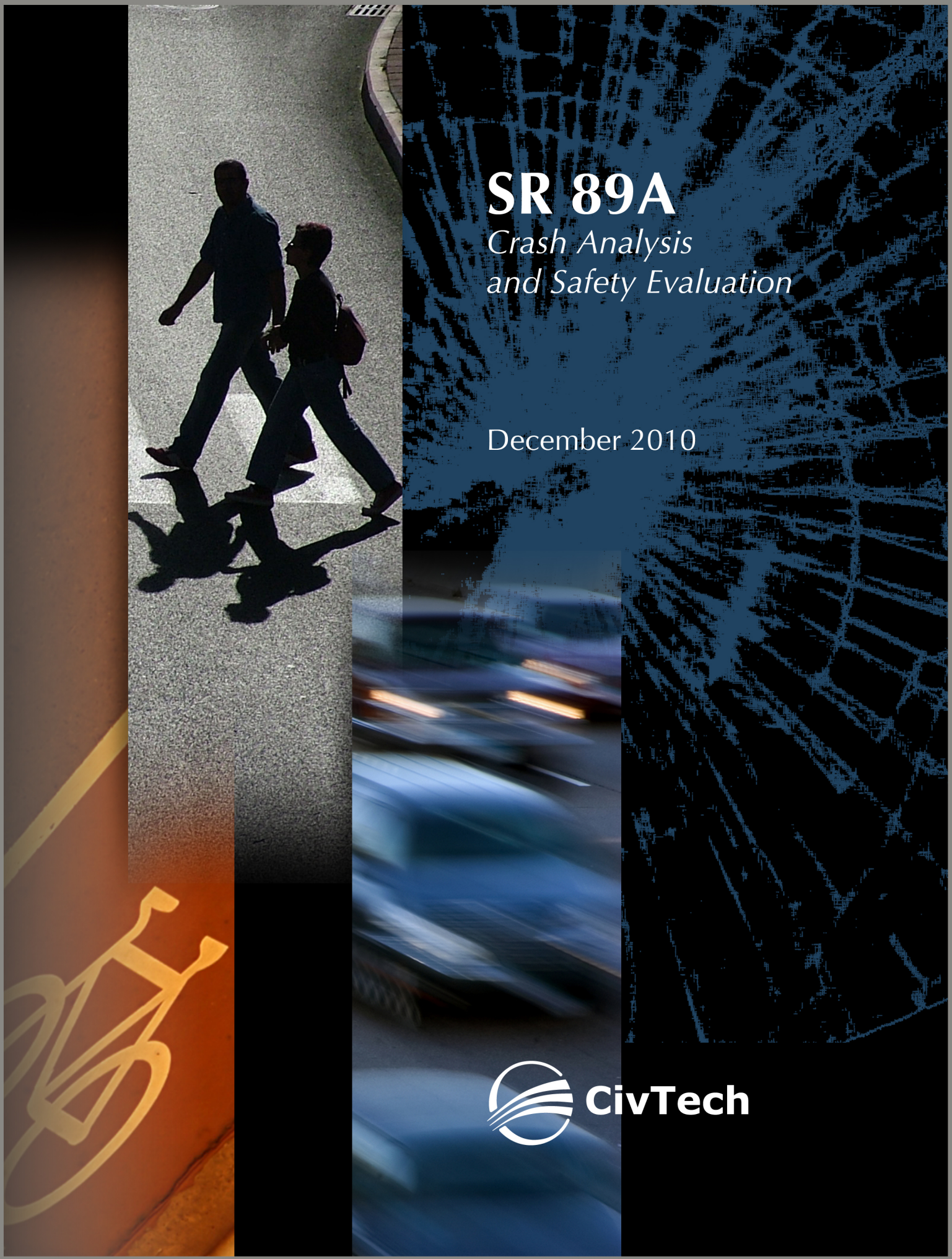


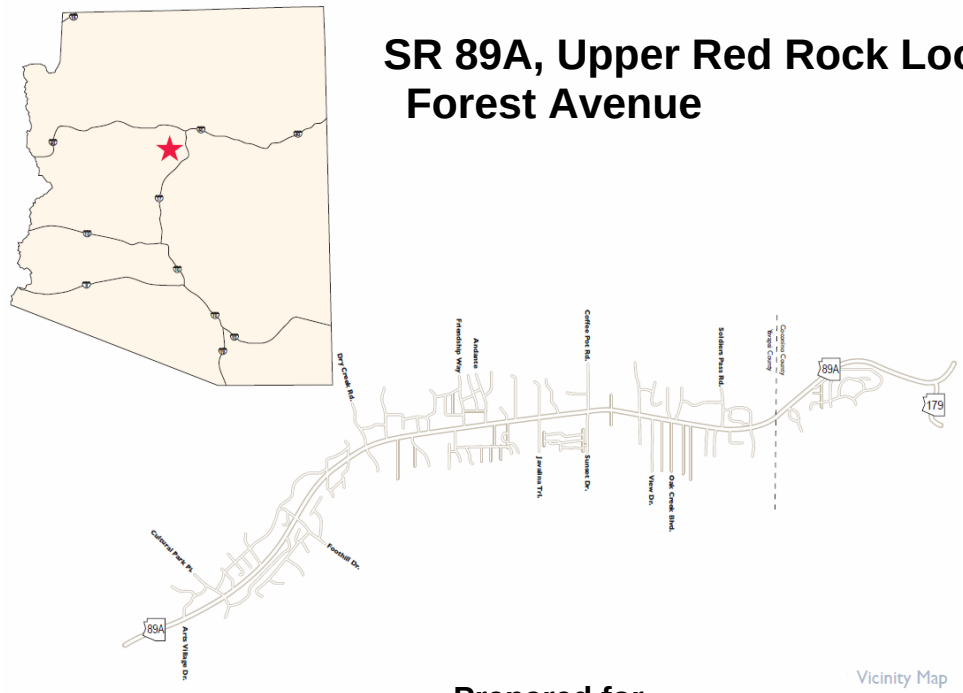
SR 89A

Crash Analysis and Safety Evaluation

December 2010

CivTech

SR-89A CRASH ANALYSIS & SAFETY EVALUATION



Vicinity Map

SR 89A, Upper Red Rock Loop Road to Forest Avenue

Prepared for:

City of Sedona
102 Roadrunner Drive
Sedona, Arizona 86336

Prepared By:

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Expires 12/31/2011

December 2010

CivTech Project # 10-400

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GLOSSARY OF TERMS

AASHTO

- American Association of State Highway & Transportation Officials is an organization consisting of each state's Department of Transportation.

Annual Average Daily Traffic (AADT)

- It is the total volume of vehicle traffic of a roadway for a year divided by 365 days. An alternative technique is called the short count data collection method also known as the coverage count data collection method. The AADT can be estimated with portable sensors that are attached to the road and record traffic data typically for 2 – 14 days.

Arizona Strategic Highway Safety Program (SHSP)

- The Arizona Strategic Highway Safety Plan has been developed through a data-driven collaborative approach between Arizona's many safety partners. The SHSP is a comprehensive statewide safety strategy document that will guide our existing safety planning and programming processes, that will facilitate the implementation of the recommended safety strategies and countermeasures through our existing plans and programs, and that can be used to modify our current planning processes over time to adopt and institutionalize the new SHSP safety culture.

Arizona Highway Safety Improvement Program Manual (HSIP)

- The specific purpose of the Highway Safety Improvement Program (HSIP) is to achieve a significant reduction in traffic fatalities and serious injuries on public roads. This is to be accomplished through the development and implementation of the Strategic Highway Safety Plan (SHSP) which is a statewide-coordinated safety plan that provides a comprehensive framework for reducing highway fatalities and serious injuries on all public roads. SHSP is intended to identify the State's key safety needs and guide HSIP investment decisions.

Arizona Statewide Bicycle and Pedestrian Plan

- ADOT Statewide Bicycle and Pedestrian Program, contains a wealth of information on bicycle and pedestrian programs. The major intent of the Statewide Bicycle and Pedestrian Plan is to provide a long-term plan for a system of shared roadways and bicycle and pedestrian facilities for the ADOT State Highway System. It provides information on the design of pedestrian and bicycle facilities, funding source availability to implement improvements and guiding statements.

Arizona Motor Vehicle Crash Facts 2008

- An annual compilation of crash tabulations related to statewide crashes. This is produced by the ADOT Traffic Records Section.

Benefit/ Cost Tabulation

- A calculation used to justify the use of safety funds for safety improvements. A benefit of an implemented countermeasure is calculated by multiplying the anticipated annual average reduction of crashes that have occurred against an amount set by the FHWA for each level of injury severity. An annualized cost of the project is compared to the benefit to determine if the benefit that will be derived is greater than the cost.

Continuous Roadway Lighting (CRL)

- ADOT recommended solution.

Crash Reduction Factor (CRF)

- A multiplicative factor used to determine the anticipated reduction in crashes for a specifically applied countermeasure at a specific site. The anticipated reduction in crashes is used in the calculation of the benefit/ cost ratio.

Collision Diagram

- A diagram that shows various elements that pertain to a crash. Crashes are located on a linear map. Direction of travel, date, time and first harmful event are easily discerned for each crash.

Countermeasures

- A safety improvement used to improve a specific crash type.

Federal Highway Administration (FHWA)

- Federal agency responsible for the oversight of highway construction and funding.

Gap Time/ Gap Study

- Used for pedestrian crossing studies. Calculates the amount of time needed by pedestrians to cross the street and gathers data to determine the number of available gaps that are usable to pedestrians.

High-intensity activated crosswalk (HAWK)

- A hybrid signal developed for use at mid-block crossings or un-signalized intersections to aid pedestrian and bicyclists crossing the multi-lane roadways with large volumes of traffic. The HAWK remains dark until activated. It alternates with yellow and red flashing lights to alert motorists of pedestrians crossing.

Highway Enhancements for Safety (HES)

- A section within ADOT Traffic Engineering Group whose focus is on improving safety on the states' roadways. One mission is to identify high crash locations and develop projects to mitigate crashes.

Light Emitting Diode (LED)

- A light source technology that uses considerably less energy as compared to incandescent technology**.**

NCHRP

- National Cooperative Highway Research Program administered by the Transportation Research Board (TRB) and sponsored by the member departments (i.e., individual state departments of transportation) of the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA), the National Cooperative Highway Research Program (NCHRP) was created in 1962 as a means to conduct research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide.

Pedestrian Safety Committee

- A public safety advisory committee (known as the Pedestrian Safety Committee) was formed in by the City Manager, after a September 11, 2007 presentation to the City Council. Membership consisted of individuals from ADOT, the City of Sedona, the International Dark Sky Association, the Naval Observatory, Industry Lighting consultants as well as private citizens. This committee met four times from November 2007 to February 2008. The committee brain-stormed and researched numerous alternative safety countermeasures to address any additional crash issues that existed. The results were presented to the City Council listing the 12 alternative countermeasures, the pros and cons, the responsible party to implement, and the cost and time frame to implement.

MUTCD

- Manual of Uniform Traffic Control Devices is a national publication administered by FHWA that provides guidance on traffic control devices.

PGP

- Policies, Guidelines and Procedures. Developed and maintained by ADOT Traffic Engineering Group to provide direction and guidance.

ADOT/Sedona Route Transfer Study, dated July 23, 2010

- This study is a cooperative effort between the Arizona Department of Transportation (ADOT) and the City of Sedona (City). The overall goal of the ADOT/City of Sedona Route Transfer Study is to develop, from existing documentation, a summary of system needs and an initial estimate of cost with implications for transferring State highway routes in the City from the State to the City of Sedona. The information provided in this report is intended to serve as the basis for future discussions between the City and the State regarding route transfers.

RDG

- Roadway Design Guide. Developed and maintained by the Roadway Group to provide direction and guidance for roadway design.

Retroreflectivity

- Retroreflection occurs when light rays are returned in the direction from which they came. Retroreflectivity is a measure of retroflection.

Reflective Pavement Markers (RPMs)

- Either raised or recessed RPMs are used as supplemental delineation of pavement markings.

ROAD SAFETY ASSESSMENT (RSA)

- A Road Safety Assessment (RSA) is the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. The RSA is a tool introduced by the FHWA. The FHWA works with State, local jurisdictions and Tribal Governments to integrate RSAs into the project development process for new roads and intersections. FHWA also encourages the use of RSAs on existing roads and intersections.

SAFETEA-LU

- An acronym for Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. (Public Law 109-59; **SAFETEA-LU**) is a funding and authorization bill that governs United States federal surface transportation spending. It was signed into law by President George W. Bush on August 10, 2005 and expired as of September 30, 2009. There have been interim reauthorizations. The $286.4 billion measure contains a host of provisions and earmarks intended to improve and maintain the surface transportation infrastructure in the United States, including the interstate highway system, transit systems around the country, bicycling and pedestrian facilities, and freight rail operations.

TWLTL

- An acronym for Two Way Left Turn Lane. This lane is used for vehicles turning left into a driveway or intersection or from a driveway or intersection into the TWLTL until merging into traffic can be accomplished.

USC

- United States Code, used when identifying Federal law.

EXECUTIVE SUMMARY

This study documents the development and evaluation of alternatives to continuous roadway lighting (CRL), as proposed by Arizona Department of Transportation (ADOT) on SR 89A between Dry Creek Road and Airport Road. This study identifies any safety, maintenance, repair or improvements needed to meet currently established minimum highway safety, urban arterial roadway, and MUTCD standards, for the section of SR 89A between Upper Red Rock Loop Road and Forest Avenue, as applicable, including estimated costs.

After a study was requested by the City to improve nighttime safety, following a citizen petition prompted by the occurrence of three pedestrian deaths along SR 89A between 2005 and 2006 , the Arizona Department of Transportation (ADOT) using safety funds approved by the Federal Highway Administration (FHWA) has proposed the installation of a continuous roadway lighting (CRL) system. This new system would be located along SR 89A from Dry Creek Road to Airport Road in the western portion of Sedona, Arizona. The expected benefit of the CRL is that improved lighting will assist drivers to better see the pedestrians, as well as to assist the pedestrians to safely cross the street.

The Sedona City Council has taken a position in opposition to the ADOT proposal. ADOT has taken the position that the City of Sedona may take back portions of SR 89A, if it does not want the CRL installed. The City decided that in order to best evaluate the implications of taking back portions of SR 89A (also called a turn back), the City would need to evaluate alternatives to CRL.

CivTech has been retained by the City of Sedona to analyze vehicle, pedestrian and bicycle crash trends for the after time period of 2007 to 2009 and to compare the after time period to the before time period of 1998 to 2006. Based on that analysis, alternatives to CRL were developed and evaluated.

In developing and analyzing potential countermeasures, numerous studies, standards and developed programs were researched. Previously completed studies, reports, safety committee meeting minutes and correspondence related to this study were reviewed and scrutinized. The conclusions listed below were identified through the analysis and research process.

CONCLUSIONS

- A serious pedestrian crash issue existed in 2006, however, pedestrian crashes have decreased since the 2005-2006 period to similar levels prior to 2005.
- Since 1998 there have been 1 or 2 pedestrian related daytime and nighttime crashes per year except for 2005 and 2006 when there were 3 and 6 crashes respectively, all nighttime related.
- Annual Average Daily Traffic (AADT) volumes obtained from data in the 2009 crosswalk warrant study have increased by 10% since 2006.

- Nighttime traffic 2009 AADT volumes were 9% to 9.5% of the total AADT. Nighttime volumes were summed from 7:30 pm to 5:30 am.
- The 2006 ADOT Crossing Study provided vital data regarding pedestrian and bicycle activities along SR 89A. This study illustrated in the collision diagrams that unsafe bicyclist operations contributed to an average of 2.55 bicycle/vehicle crashes per year from 1998 to 2006. Injury severity was typically less than pedestrian crashes, although there was a bicyclist fatality in 2007 at Lower Red Rock Loop Road.
- Bicycle crashes from 2007 to 2009 have increased to 4.67 crashes per year from 2.55 crashes per year for the 1998 to 2006 time frame.
- Nighttime crashes as a percentage of all crashes was 14.54% in the before period and decreased to 8.80% in the after period.
- The percent of single vehicle nighttime crashes was 41.55% in the before period and decreased to 27.87% in the after period.
- The majority of single vehicle crashes, 56%, were west of Dry Creek Road.
- Angle crashes between Navajo Drive/ Southwest Drive to Coffee Pot Drive/Sunset Drive were double the statewide average in the before period. There was an increase of 10% in the after period. Data collected during the 2009 crosswalk warrant study displayed an increase of 10% in the AADT as compared to the AADT from 2006.
- The Safety Advisory Committee (SAC) presented sixteen options. Twelve of these were recommended as part of a program that they believed would address the crash issues more completely than the recommended continuous lighting. The Pedestrian Road Safety Audits Guidelines and Prompt Lists published by the FHWA Office of Safety recommend similar countermeasures as those presented by the SAC to mitigate pedestrian and bicycle safety.

RECOMMENDATIONS

This scope included vehicular, pedestrian, and bicycle safety, in both the daytime and nighttime settings. CivTech has concluded, based upon its analysis, that an appropriate final recommended solution for the noted safety situation would include countermeasures to directly affect pedestrian and bicycle daytime and nighttime crashes by resolving the root cause of those crashes. The root cause was demonstrated in the 2006 crossing study by ADOT to be 50% of pedestrian and bicycle crossings occur randomly throughout the 2 mile corridor at driveways and un-signalized intersections. Redirecting these crossings to signalized intersections and proposed enhanced crossings would place these crossings at locations that meet driver expectations. This solution will address the scope of issues that the City requested CivTech to consider.

The CRL provides advance warning of pedestrians at night of pedestrian and bicycle activities, but does not resolve the crossing issue. The countermeasure of continuous raised medians will also have an impact in mitigating angle crashes, which were seen to be in excess of the statewide percentage.

The minimum recommended countermeasures directly address the issue of random pedestrian and bicycle crossings of SR 89A and provide reasonable distances between motorist recognized pedestrian crossing locations includes the following and are shown in graphically in **Figure 1A, Figure 1B and Figure 2**:

- Continuous raised medians, 6 inches in height, with anticipated median breaks at approximate ¼ mile breaks.
- A pedestrian barrier should be constructed throughout the length of the median to preclude random pedestrian crossings. Install guidance to direct pedestrians to protected crossings in conjunction with the barrier. Without the barrier the issue of random crossings will not be resolved and regardless of other countermeasure implemented, the CRL would be needed to identify random crossing pedestrians and bicycles at nighttime.
- Adding Enhanced Pedestrian Crossings that include:
  - Highly visible and durable crosswalk markings. Advance yield markings to provide sight distance of pedestrians that may be screened from vision by a stopped vehicle in another lane.
  - Pedestrian activated warning light system (i.e. rapid flashing beacons, the HAWK pedestrian beacons or in-pavement crosswalk lighting).
  - Median refuge area for pedestrians and bicyclists. The split median concept which requires pedestrians to turn and face oncoming traffic is recommended.
  - Pedestrian activated crossing with countdown LED pedestrian signals. Activation buttons and pedestrian signal heads should also be installed in the median refuge area to promote two separate crossing phases.
  - Overhead crosswalk lighting that meets dark sky compliant lighting requirements. Creating easily identifiable crossing locations to motorists, pedestrians and bicyclists for both daytime and nighttime is crucial.
  - A speed reduction effort with extra enforcement, automated enforcement or “Your Speed Is” signing to increase compliance with posted 35 mph speed limit.
  - Advance warning signs and advance stop bar.
- The minimum recommended length of ¾-mile to install the above recommended countermeasures for the 2 mile section is between Andante Drive and Rodeo Road which is 1500 feet long, and between Shadow Mountain Drive and Soldier Pass Road which is 2200 feet long. Based on traffic volumes the entire two mile section could benefit from the installation of medians; however this minimum recommendation is based on providing protection to the two of the three highest areas of pedestrian and bicycle crossing activity at other than existing signalized intersections. **Figure 1B** shows the plan view of the roadway where the TWLTL remains and bike lanes are added.
- Although the ADOT standard width of a median from the Roadway Design Guide (RDG) is 16 feet this would necessitate widening the roadway at significant cost. The recommended minimum cross section that could be constructed within the

existing roadway prism includes a 12 foot raised median with 10 foot left turn lanes, four 11foot through lanes and 4 foot striped bike lanes. Although the recommended width of bicycle lanes is 5 to 6 feet, 4 feet is allowed by the MUTCD where available width is restricted.

- Install the warranted signal at Andante Drive.
  - This will provide a protected pedestrian crossing in this area. The closest existing signal to the fatal pedestrian crashes crossing area is Rodeo Drive at approximately ¼-mile away. Andante Drive will provide a signalized crossing about 400 feet away from the area that the crashes occurred. ADOT has included installation of this signal within its initial improvement plans.
- Install marked bicycle lanes per the MUTCD.
  - ADOT has included bike lanes within the pavement rehabilitation project.
- Traffic modeling of proposed median system to determine effects on the corridor prior to planning and design.

Table EX1 shows a comparison of the minimum recommendations versus continuous roadway lighting for cost to implement and effectiveness to reducing crashes. Although the anticipated crash reduction factors appear to be nearly equal, the median countermeasure affects the reduction many more crashes than the CRL.

Table EX1: **Countermeasures Cost and Effectiveness**

Countermeasure	Medians with pedestrian barrier, additional enhanced crossings, bicycle lanes, speed enforcement	Continuous Roadway Lighting, Bicycle Lanes, Speed Enforcement
Anticipated Crash Reduction Factor For All Implemented Countermeasures	0.73	0.69
Type Of Crashes Mitigated	Both Daytime and Nighttime Pedestrian, Bicycle and Angle Crashes	Nighttime Pedestrian, Bicycle Crashes Daytime and Nightime
Cost	**$1.6M**	**$2.2M**

The crash reduction factor calculation for the minimum recommended countermeasures is 0.73. The CRFs used for the various countermeasures are listed below.

- Raised Medians 0.25
- Mid-block crossings 0.25
- HAWK signals 0.12
- Bicycle lanes 0.35
- Speed Enforcement 0.15

The crash reduction factor calculation for the CRL with speed reduction and bike lane countermeasures is 0.69. The CRFs used for the various countermeasures are listed below and were the most conservative factor found.

- Lighting 0.44
- Bicycle Lanes 0.35
- Speed Enforcement 0.15

Figure 1A**: Minimum Recommended Improvements - Median**

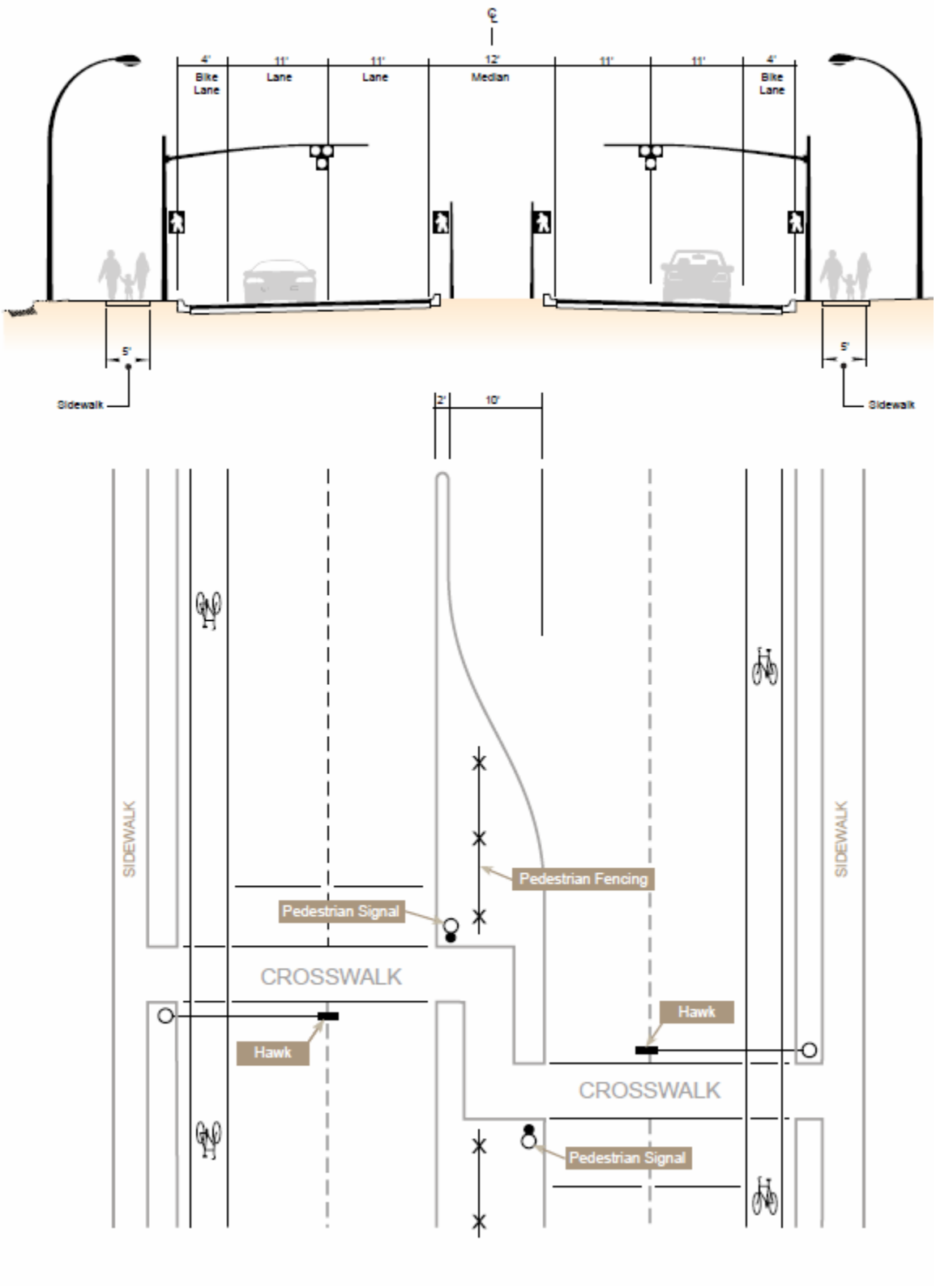


Figure 1B: Minimum Recommended Improvements - TWLTL

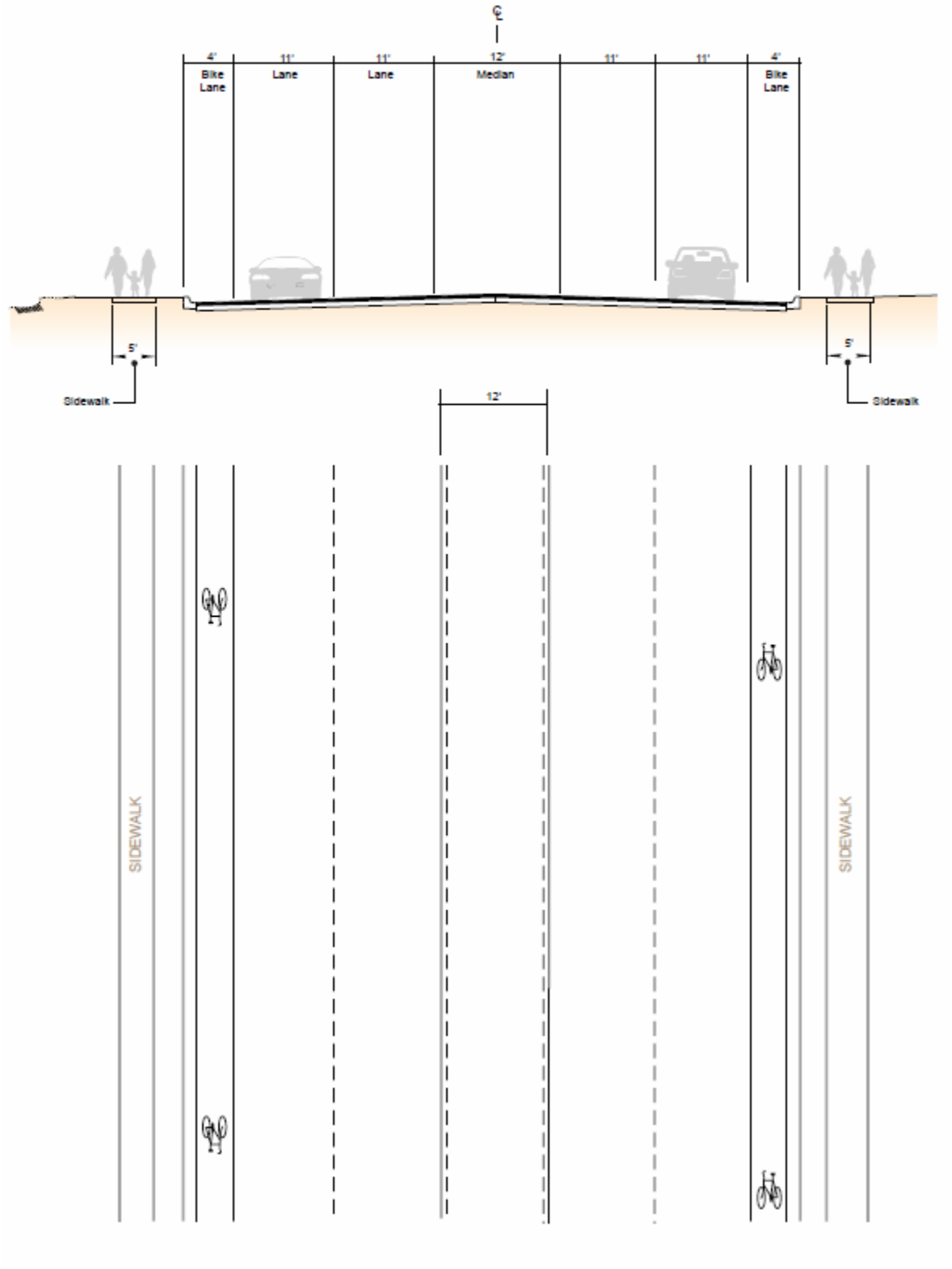
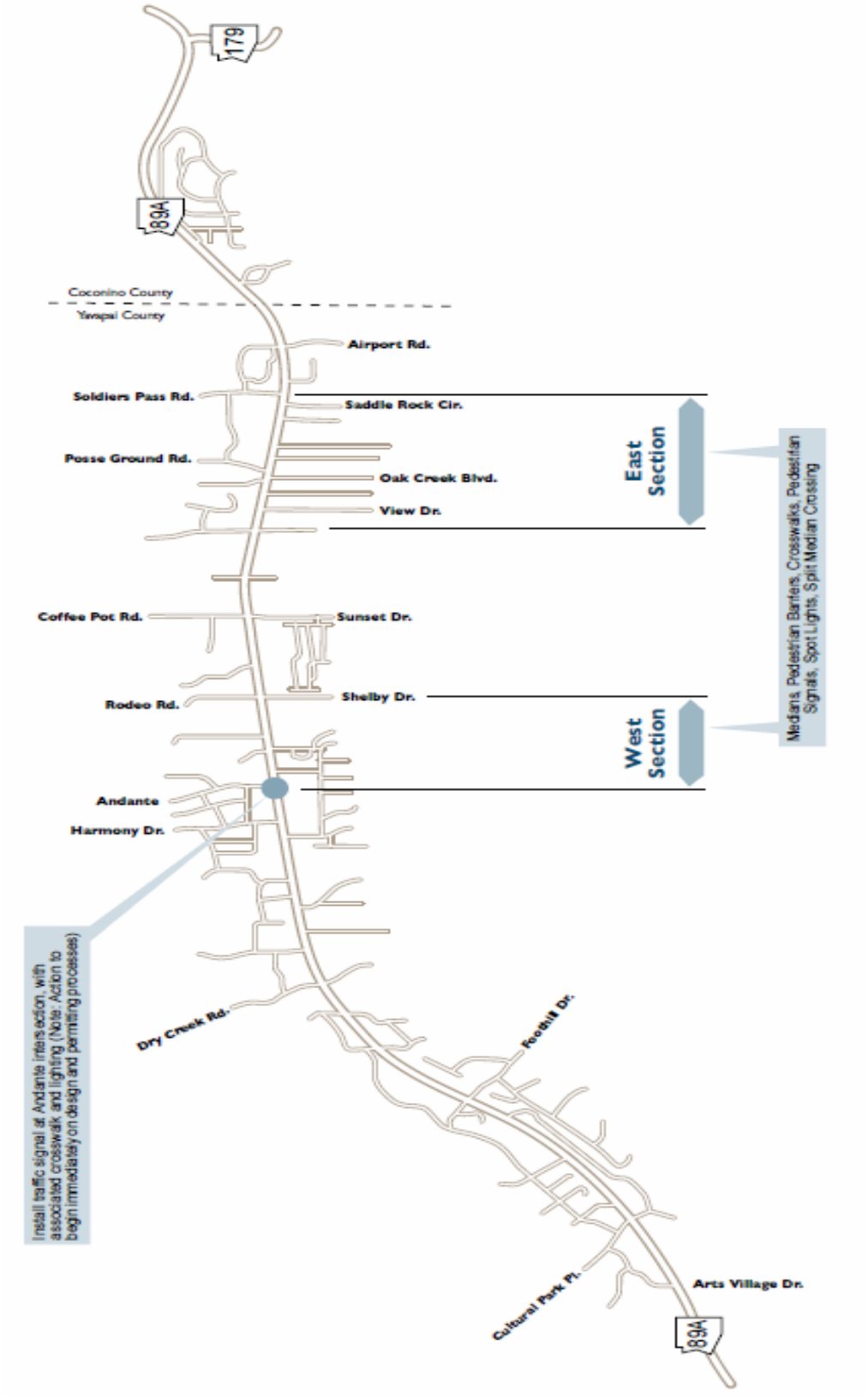


Figure 2: Minimum Recommended Improvement Locations



Additional measures that warrant future consideration and evaluation are:

- Retrofitting existing signalized intersections with roundabouts to further improve pedestrian and vehicle safety. Traffic operations, especially U-turn movements, may be improved with roundabouts in conjunction with the continuous raised medians.
  - ✓ Cost of each is estimated to be $1.1M
- The 2006 crossing study showed that the section from Coffee Pot Road/ Sunset Drive to 600 feet west was the third area of concentrated random pedestrian crossing activity. This was despite the close proximity of the signalized intersection at Coffee Pot Road. Implementation of the minimum recommendations may need to be installed between Coffee Pot Road and Rodeo Road for a distance of ¼- mile.
  - ✓ Cost to implement this section is $0.8M
- Pedestrian level lighting along sidewalk will assist pedestrians, bicyclists and motorists during nighttime operations. Motorists will be able to find driveway entrances better and will see pedestrians crossing the driveways and at un-signalized intersections.
  - ✓ Cost to implement for the full corridor is anticipated to be greater than the cost to install the roadway lighting as the pole spacing will be reduced. ADOT presented 58 alternative lighting scenarios based on various fixtures, luminaries, wattages and pole heights. Alternative 26, Monterey lighting with 25 foot poles, was estimated to be nearly $2,500,000 for the 2 mile project.
  - ✓ If additional pedestrian lighting is considered just in the vicinity of the crossing area and in addition to the two luminaries at the crosswalk that creates a more identifiable crossing zone to pedestrians at night the estimated cost for an additional 4 poles and luminaries per crossing location is $10,000 per costs provided by the City of Sedona from the SR 179 project lighting.
- Add the additional pavement width to build section to ADOT standard. In order to build the median to standard, an additional 8 feet of pavement for the length of the corridor will be needed.
  - ✓ The cost to add 8 feet of additional paved width is estimated to be $5.8M

INTRODUCTION

The City requested that ADOT evaluate measures to improve nighttime safety following a citizen petition prompted by the occurrence of three pedestrian deaths along SR 89A between 2005 and 2006. In response to the City's request, the Arizona Department of Transportation (ADOT) using safety funds approved by the Federal Highway Administration (FHWA), proposed the installation of a continuous roadway lighting (CRL) system. This new system would be located along SR 89A from Dry Creek Road to Airport Road in the western portion of Sedona, Arizona. The expected benefit of the CRL is that improved lighting will assist drivers to better see the pedestrians, as well as to assist the pedestrians to safely cross the street.

The Sedona City Council has taken a position in opposition to the ADOT proposal. ADOT has taken the position that the City of Sedona may take back portions of SR 89A if it does not want the CRL installed. The City decided that in order to best evaluate the implications of taking back portions of SR 89A (also called a turn-back), the City would need to understand the possible alternatives to CRL.

CivTech was contacted by the City of Sedona in July 2010 to perform a study assisting the City of Sedona in developing and evaluating alternatives to CRL, as proposed by Arizona Department of Transportation (ADOT). The study was prepared to, "identify any safety, maintenance, repair or improvements needed to meet currently established minimum highway safety, urban arterial roadway, and MUTCD standards, as applicable."

There are three standards documents produced by ADOT with assistance from local municipalities and FHWA that were important in CivTech's analysis of SR 89A. The first is *the Arizona Strategic Highway Safety Program (SHSP*), the second is the *Arizona Statewide Bicycle and Pedestrian Plan*, and the third is the *Arizona Highway Safety Improvement Program Manual (HSIP)*; the following links provide access to these documents.

- http://www.azdot.gov/Highways/Traffic/TSS/SHSP/AZ_Strategic_Highway_Safety_Plan.pdf
- http://www.azbikeped.org/phase1documents.html
- http://www.azdot.gov/Highways/Traffic/TSS/HSIP/AzHSIP2010.pdf

The SHSP is a product of the Governor's Traffic Safety Advisory Council (GTSAC) that was established in 2004. The council serves as a role model in leadership for developing, promoting, and implementing cost effective traffic safety strategies within the state transportation system to counteract the impact of traffic crashes in Arizona. GTSAC sponsored the development of the SHSP in compliance with 23 USC 148 requirements. The guiding statement by GTSAC was that:

> "The SHSP is seen as a comprehensive statewide safety strategy document that will guide our existing safety planning and programming processes that will

facilitate the implementation of the recommended safety strategies and countermeasures…"

Through a data driven process there were six emphasis areas selected which are listed below.

- Restraint Usage
- Speeding
- Young Drivers
- Impaired Drivers
- Roadway/ Lane Departures/ Intersection Improvements
- Data Improvement

The second document is the ADOT Statewide Bicycle and Pedestrian Program. The major intent of the Statewide Bicycle and Pedestrian Plan is to provide a long-term plan for a system of shared roadways and bicycle and pedestrian facilities for the ADOT State Highway System. It provides information on the design of pedestrian and bicycle facilities, funding source availability to implement improvements and guiding statements. The plan identified the portion of SR 89A passing through Sedona as a bicycle corridor.

The third document is The Arizona Highway Safety Improvement Program Manual (HSIP). This document is the program manual that explains the process for qualifying a project for safety or HSIP funds.

There is an equally important document produced by the Federal Highway Administration, Office of Safety. It is the Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes, dated May 2008. This document contains proven solutions to addressing pedestrian crash issues. Measures of effectiveness are included for determining benefit/ cost ratios and will be used to evaluate the effectiveness of countermeasures to each other.

HISTORY

The City of Sedona requested that ADOT look into pedestrian safety after a recent fatal pedestrian crash in January 2006. This was the third fatal pedestrian crash since 2000. The ADOT northern regional traffic engineering office in Flagstaff conducted the Sedona Pedestrian Crossing Study dated May 2006. This study investigated pedestrian and bicycle crashes along SR 89A from MP 371.00 to MP 372.99, which corresponds to the section between Dry Creek Road and Soldier Pass Road. Data was obtained from the ADOT crash database and evaluated from 2002 to 2005, in keeping with their established practice of using the most recent 3 year period available in the ADOT crash database. Data was also gathered with assistance from the City of Sedona and local volunteers for pedestrian and bicycle activity along SR 89A. During the time of this study there was another fatal pedestrian crash in April 2006. This study gathered an extensive amount of data for analysis and the subsequent recommendation from this study was to install pedestrian warning signs and illuminate the study area since all of the fatal pedestrian crashes occurred during darkness. ADOT added pedestrian

warning signs at 3 locations in each direction with normal operating funds and also acted to reduce the speed limit from 40 MPH to 35 MPH after conducting the study in response to citizen concerns.

This 2006 Crossing Study was forwarded to the ADOT Traffic Engineering Highway Enhancements for Safety (HES) section to request funds to implement the study's CRL recommendations. The HES section concurred and performed a benefit/cost ratio calculation to demonstrate a positive benefit that outweighed the associated cost of improvements. This benefit cost ratio calculation is required by the FHWA in the approval process for safety funds to be used by ADOT or any other municipality and must equal or exceed a one to one ratio of benefit to cost. The HES evaluation concluded that the appropriate mitigation to resolve the nighttime pedestrian fatalities was continuous lighting for approximately 2 miles on SR 89A.

In response to the community sentiment both for and against the continuous lighting solution, a public safety advisory committee (known as the Pedestrian Safety Committee) was formed in by the City Manager, after a September 11, 2007 presentation to the City Council. Membership consisted of individuals from ADOT, the City of Sedona, the International Dark Sky Association, the Naval Observatory, Industry Lighting consultants as well as private citizens.

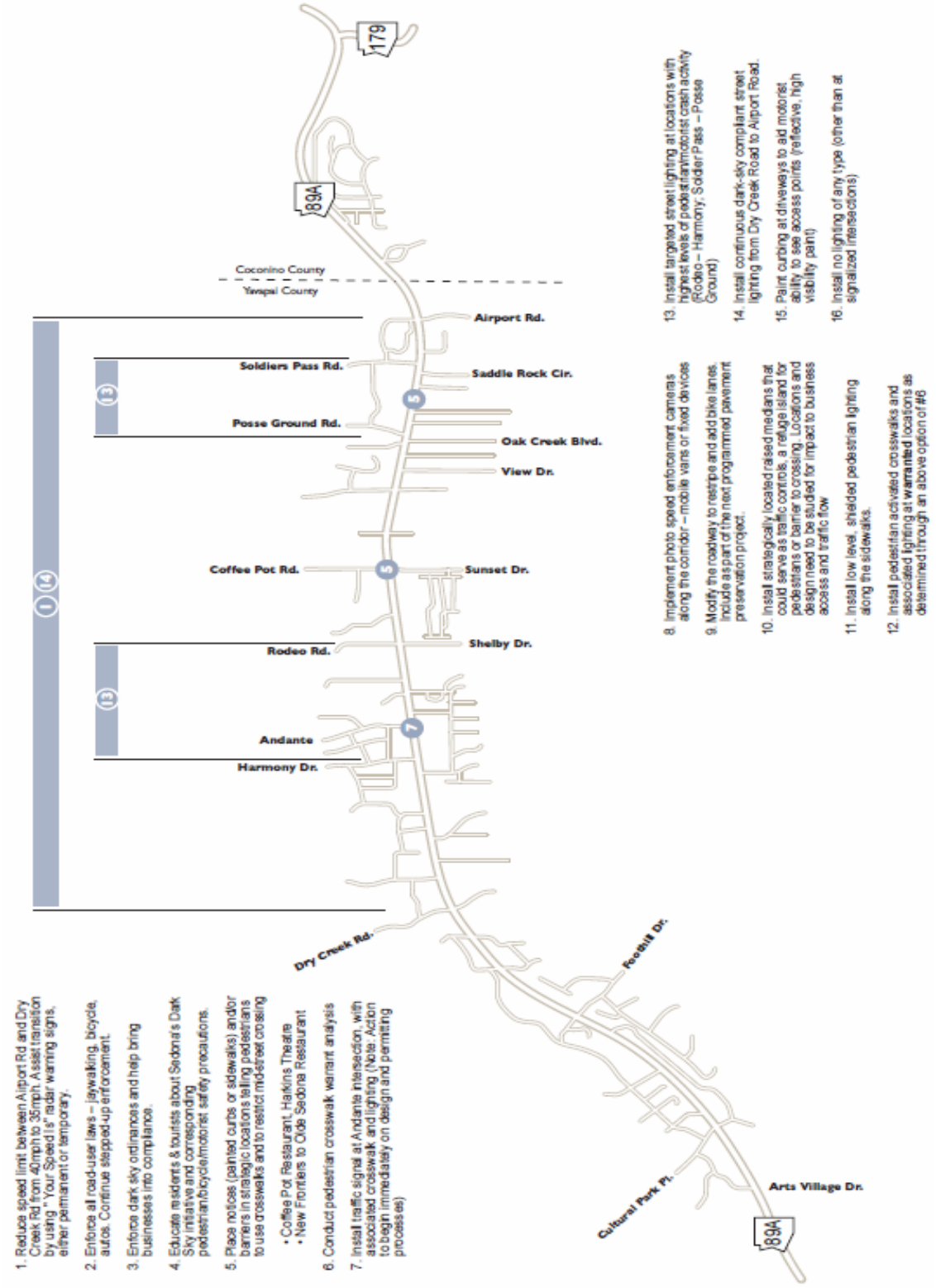
This committee met four times from November 2007 to February 2008. The committee brain-stormed and researched numerous alternative safety countermeasures to address any additional crash issues that existed. The results were presented at the June 10, 2008 City Council meeting. These results included the 16 options, with pros and cons, the responsible party to implement, and the cost and time frame to implement. Twelve of these options were presented as part of a program to address safety concerns in lieu of using CRL. **Figure 3** below shows the options that were presented by the Pedestrian Safety Committee. The full version of the matrix from the Pedestrian Safety Committee Possible Options can be found in Appendix A.

A memo that the City of Sedona believes provides an insight to ADOT's view of the recommended alternative measures is included in Appendix E. This is a copy of a memo from the City Manager to the City Council that contains annotated remarks.

After many months of discussions between the City and ADOT it was decided that the continuous lighting project that was nearly bid ready would be delayed until January 2011 at which time it would be advertised for construction. The caveat to precluding this advertisement is a City of Sedona commitment to accepting a turn back of SR 89A with the limits outlined in the *ADOT/Sedona Route Transfer Study, dated July 23, 2010.*

CivTech was contacted by the City of Sedona in July 2010 to perform a study assisting the City of Sedona in developing and evaluating alternatives to CRL to improve the safety of the SR 89A corridor between Dry Creek Road and Airport Road. The purpose of the evaluation is to, "identify any safety, maintenance, repair or improvements needed to meet currently established minimum highway safety, urban arterial roadway, and MUTCD standards, as applicable."

Figure 3: Pedestrian Safety Committee Graphical Recommendations



DATA OBTAINED AND EVALUATED

In order to gain an improved understanding of the traffic context of the study area the Verde Valley Multimodal Transportation Study (VVMTS) was reviewed, along with crash data over a 12 year period. Crash data was obtained from the ADOT statewide crash database.

Verde Valley Multimodal Transportation Study

The *Verde Valley Multimodal Transportation Study*, *dated May 2009*, defines the Verde Valley as encompassing 673 square miles in the northeastern Yavapai County with a study population of about 72,000 in 2007. The central Verde Valley is about 100 miles north of central Phoenix and 40 miles south of central Flagstaff.

The purpose of the Verde Valley Multimodal Transportation Study (VVMTS) is to develop a long-range regional transportation plan to guide the implementation of transportation improvements on the roads of regional significance in the Verde Valley, including I-17, State Routes (SR), and roads on the County Regional Road System. The May 2009 VVMTS is an update of the 1999 Verde Valley Transportation Study Update.

The study area includes the incorporated municipalities of Camp Verde, Clarkdale, Cottonwood, Jerome, and Sedona, as well as the Yavapai-Apache Nation and unincorporated parts of northeast Yavapai County. Although the eastern part of Sedona lies in Coconino County, all of Sedona is included in the study area to better reflect traffic conditions in the region. The Yavapai County portion of the study area contains about 31 percent of the County's population, or about 69,000 persons in 2007.

The Annual Average Daily Traffic (AADT) maps from the VVMTS, provided in appendix B, show the Sedona traffic levels for 2007 and anticipated for 2030. The numbers shown are the average annual daily traffic (number of vehicles) for various segments of SR 89A and SR 179. The high number of vehicles in the central portion of west Sedona are indicative of the many local trips by residents due to the focus of destination businesses in this portion of the SR 89A corridor.

Table 2: AADT, ADOT Planning Website

Count LOCID	Route	Beg MP	Beg Road	TOC Station	End MP	End Road	Length	2006 AADT	2007 AADT	2008 AADT
101687	SR 89A	371.01	Dry Creek Rd	371.61	372.21	Coffee Pot Rd	1.18	23,500	24,500	24,500
101693	SR 89A	372.21	Coffee Pot Rd	373.17	374.16	SR 179 South - Sedona	1.94	26,000	25,000	23,500

Source: ADOT Planning Website

The traffic volume data shown in **Table 2** shows that the AADT in 2006 was 23,500 between Dry Creek Road and Coffee Pot Road. The AADT was 26,000 between Coffee Pot Road and SR 179 for the same year.

Table 3: April 2009 Crosswalk Warrants Volume Data (Traffic Research & Analysis, Inc)

	EB	WB	AADT
Tortilla 48 hour count	24,953	27,317	26,135
Willow Way 48 hour count	28,090	28,385	28,238

Source: Volume data from Crosswalk Warrant Study

The data in **Table 3** illustrates the measured AADT in 2009 for the same sections in **Table 2**. The percent increase in AADT from 2006 to 2009 in the Dry Creek Road to Coffee Pot Road is 11.2% and from Coffee Pot Road to SR 179 is 8.61% for an average of 10%.

CRASH ANALYSIS 2007 TO 2009

Since there has now been more than 3 years since the completion of the study by ADOT, there is now adequate data to examine and compare the crash trends. Since the improvements that were recommended have not yet been implemented, except for decreasing the speed limit to 35 mph and installing pedestrian warning signs, this is not a true before and after study. However, for purposes of simplicity, the crash data for the periods from 1998 to 2006 will be referred to as the before data and the crash data from 2007 to 2009 will be referred to as the after data. These have been compared to determine what changes, if any, in the types or frequency of crashes may have occurred.

Data from the Stanley Consultants, Inc., *Pedestrian Crosswalk Warrant Study* was tabulated to show the Average Annual Daily Traffic (AADT) and the percentage of nighttime traffic. Information from the website Time and Date was used to determine the sunrise and sunset times during the study period. Nighttime volumes were summed for the 7:30 pm to 5:30 am period. Dusk volumes were summed from 7:00 pm to 7:30 pm and dawn volumes were summed from 5:30 am to 6:00 am periods.

The AADT of 26,135 at Tortilla Drive is an increase from the AADT of 23,500 in 2006, shown on the ADOT Planning website. This is an increase of 10% over three years. The AADT of 28,238 at Willow Way in 2009 is an increase from the 2006 ADOT AADT of 26,000, or an 8% increase. The 2009 AADT volumes and percentage distribution by lighting condition are summarized in **Table 4**.

Table 4: 2009 Traffic Volumes

	48 Hour Total	Dusk	Nighttime	Dawn	Daytime
Tortilla Drive	52,270	1,149	4,976	238	45,907
% Distribution	26,135	2.20%	9.52%	0.46%	87.83%
Willow Way	56,475	1,584	5,071	196	49,624
% Distribution	28,238	2.80%	8.98%	0.35%	87.87%

Source: Volume Data from Crosswalk Warrant Study

The nighttime percentage of traffic along SR89A is shown to be 9% to 9.5%; this can be used as a comparative analysis to the percent of nighttime crashes for the after study period.

Table 5: Single Vehicle Crash Data Summary

Single Vehicle Crashes										
	All	Avg/ year	Day	Avg/ year	Night	Avg/ year	Dusk/ Dawn	Avg/ year	Not Reported	% Night Crashes
1998-2006	217	24.33	108	12.11	90	10.11	18	2.00	1	41.55
2007-2009	61	20.33	37	12.33	17	5.67	4	1.33	3	27.87
Decrease		16.44		-1.83		43.96		33.33		32.93

All Crashes										
	All	Avg/ year	Day	Avg/ year	Night	Avg/ year	Dusk/ Dawn	Avg/ year	Not Reported	% Night Crashes
1998-2006	1225	136.78	992	110.67	177	19.89	55	6.22	1	14.54
2007-2009	443	147.67	363	127.00	37	13.00	23	7.67	20	8.80
Decrease		-7.96		-14.76		34.64		-23.21		39.46

Table 5 shows a comparison between all crashes and single vehicle crashes for the two data periods. Single vehicle crashes are comprised of the pedestrian and pedacyclist, but also include single vehicles departing the roadway, hitting fixed objects and overturning crashes. Two variables are compared, first, the time frame from 1998 to 2006 and from 2007 until the present. Second, the crashes for daytime, nighttime, dusk/ dawn and not reported are tabulated to see if changes occurred in the after period from 2007 to 2009.

Conclusions that can be drawn from this tabulation are:

- Single vehicle crashes, as compared to all crashes from 1998 to 2006 and 2007 to 2009, are over represented for nighttime crashes. There were 41.55% single vehicle nighttime crashes from 1998 to 2006 as compared to 14.54% for all nighttime crashes. There were 27.87% nighttime single vehicle crashes from 2007 to 2009 as compared to 8.8% nighttime crashes for all crash types. While the single vehicle nighttime crashes have decreased from 41.55% to 27.87% the nighttime single vehicle crashes occur at three times the rate of total vehicle nighttime crashes.

- There were two significant decreases. First, average annual single vehicle crashes decreased by 16.44% from the before study period to the after study period. Second, average annual nighttime single vehicle crashes decreased by 43.96% from the before period to the after period for single vehicle crashes.

- In analyzing the after data for all crashes there were increases from the before period to the after period for daytime and dusk/ dawn average annual crashes. However, the average annual nighttime crashes had a significant decrease of nearly 35%.

- The percent of all nighttime crashes closely mirrors the percent of nighttime traffic, while the percent of single vehicle nighttime crashes, though dramatically reduced, it is still double the existing nighttime traffic percent as compared to all other types of crashes along the SR 89A within the City of Sedona.

Table 6 shows the number and percentage of single vehicle crashes and the percentage of single vehicle crashes that occurred during darkness for the before, after and total data periods by milepost section. While the lighting is currently planned to occur between Dry Creek Road and Soldier Pass Road on SR 89A, CivTech was tasked with investigating a much longer section. During the before period 1998 to 2006 single vehicle crashes west of Foothills Drive were a much larger percentage of the total crashes than the statewide average of 20%.

For this same period, single vehicle nighttime crashes were a large percentage of the total single vehicle crashes for MP sections 368, 369 and 370. Looking forward to the after period of 2007 to 2009 we can see significant reductions in nighttime single vehicle crashes as compared to the before period. There is nearly a 60% reduction for the entire corridor. The percent of single vehicle crashes where alcohol was involved or a driver was sleepy/ fatigued was about 20% for the before period and about 10% for the after period.

Table 6: Single Vehicle Crash Data by Milepost

	1998-2009						
MP	368	369	370	371	372	373	374
From	Lower Red Rock	Upper Red Rock	Foothills	Navajo/Southwest	Coffee Pot/Sunset	Airport Rd	Y Roundabout
To	Upper Red Rock	Foothills	Navajo/Southwest	Coffee Pot/Sunset	Airport Rd	Y Rounabout	Forest
All Crashes	95	78	83	427	540	156	285
All Single Vehicle Crashes	73	36	16	48	41	32	29
% Single vs All Crashes	76.84%	39.24%	19.51%	11.24%	7.61%	20.65%	10.18%
Single Night Crashes	30	21	12	17	13	10	4
% Night Single vs All Single	38.36%	61.29%	68.75%	33.33%	31.71%	31.25%	13.79%
	1998-2006						
All Crashes	72	66	52	324	396	115	200
All Single Vehicle Crashes	52	31	9	44	31	24	24
% Single vs All Crashes	73.24%	53.57%	25.00%	16.00%	9.54%	33.33%	19.35%
Single Night Crashes	25	17	7	15	11	9	4
% Night Single vs All Single	48.08%	60.00%	77.78%	34.09%	35.48%	37.50%	16.67%
	2007-2009						
All Crashes	24	23	46	152	214	83	161
All Single Vehicle Crashes	21	1	7	4	10	8	5
% Single vs All Crashes	87.50%	4.35%	15.22%	2.63%	4.67%	9.64%	3.11%
Single Night Crashes	3	1	4	1	2	1	0
% Night Single vs All Single	14.29%	100.00%	57.14%	25.00%	20.00%	12.50%	0.00%
Average Nighttime 1998 - 2006	2.78	2.00	0.78	1.67	1.22	1.00	0.44
Average Nighttime 2007 - 2009	1.00	0.33	1.33	0.33	0.67	0.33	0.00
Reduction in Average Nighttime Crashes for Single Vehicles	64.00%	83.33%	-71.43%	80.00%	45.45%	66.67%	100.00%

Bicycle Crashes

Bicycle crashes, though they have experienced a lesser severity of injury compared to pedestrian crashes, have increased by over 80% in the after data period as compared to the before data period. Data analysis with small numbers, in particular percent changes between small numbers, can be misleading. The average number of bicycle crashes in the before period was 2.55 crashes per year and the average number in the after period was 4.67 crashes per year.

This is shown in **Table 7**. The statewide rate of bicycle crashes is 1.27% of all crashes (2008 Arizona Motor Vehicle Crash Facts); the rate of bicycle crashes in Sedona is 2.27%. A collision diagram from an ADOT report dated March 2006, shows that within the study area most of these crashes were the result of bicyclists traveling against traffic rather than with traffic as is the recommended safe practice. Bicyclists riding against traffic and on the sidewalks were observed numerous times during the site visit on September 20, 2010. There was one fatal bicycle crash in 2007, but it occurred outside the study limits in the vicinity of Lower Red Rock Road.

From the collision diagram in the 2006 ADOT crossing study report, the prevalent type of bicycle crash is due to vehicles entering driveways colliding with wrong way bicyclists. There were a couple of related to vehicles exiting driveway and a couple of

intersection related crashes. The crash data from the after period indicates that 37.5% of the crashes were related to driveways.

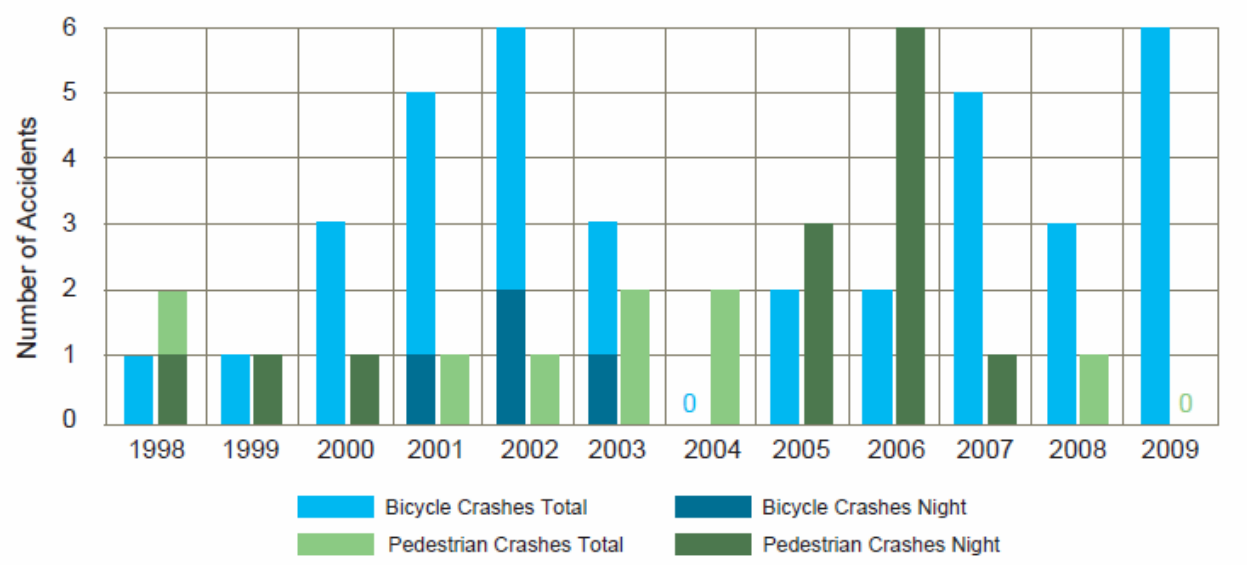
A roundtrip bike ride along SR 89A will require bicyclists to cross the highway twice if they ride with traffic both ways. When the destination is on the opposite side of SR89A from the origin, the bicyclist has no other option than to cross the highway twice. However when the origin and destination are on the same side of the highway, it will be difficult to convince the novice bicyclist that crossing the highway and riding with traffic both directions is a safer option. It may also be difficult to convince these bicyclists to abandon the sidewalk for the striped bicycle lane on the roadway.

Pedestrian Crashes

CivTech analyzed data from the ADOT crash database. CivTech created report tabulations from the data received from ADOT. Pedestrian crashes, which prompted the original study, have become nearly non-existent since 2006.

There have been only two pedestrian crashes for the after period, 2007 to 2009. Looking at the pedestrian crash tabulations from **Table 7**, there is a two year period during 2005 to 2006 in which there were 9 nighttime pedestrian crashes with three fatalities. There were no daytime pedestrian crashes in 2005 to 2006. Other than these two years, there have been 12 pedestrian crashes for the remaining 10 years with 4 (25%) nighttime pedestrian crashes.

Table 7: Pedestrian and Bicyclist Crashes by Year



The four fatal pedestrian crashes all occurred in nearly the same location with similar circumstances. Three of the four pedestrians were struck in the inside westbound lane just east of Andante Drive by westbound vehicles during darkness. The fourth pedestrian was struck in the inner westbound lane west of Dry Creek Road, just outside the study area. There was an additional pedestrian crash that did not result in a fatality just east of Andante Drive in the same general area as the three fatalities. These fatal crashes occurred in 2000, 2005 and 2006.

There is another approximate ½-mile stretch of SR 89A that experienced several pedestrian crashes between 2003 and 2008. There were 8 pedestrian crashes that occurred between Coffee Pot/ Sunset Roads and Saddleback Circle. This accounts for 40% of the total pedestrian crashes in the 12 year evaluation period of crash data. Four of these crashes occurred between 2005 and 2006 and all were nighttime crashes. Two of those crashes involved alcohol. The only two pedestrian crashes that occurred in the after period, 2007 to 2009 were in this ½ mile stretch of SR 89A. One of these two crashes occurred in darkness and alcohol was involved.

The crosswalk warrant study was conducted at Tortilla Drive, and Willow Way/ Marketplace Drive. These two locations were selected based on the documented pedestrian and bicycle activity in the 2006 study. There were no warrants met that would justify the installation of crosswalks based on ADOT standards.

There are four warrants that are based on a point system evaluation, as follows:

- Gap Time, 10 points
- Pedestrian Volumes, 10 points
- Vehicle Approach Speed, 5 points
- General Conditions, 8 points

The maximum score is 33 points. The minimum warrant for the installation of a marked crosswalk at an unsignalized location is satisfied when 16 or more points are accrued. **Table 8** shows that the Tortilla Drive crossing location received 7 points and the Willow Way crossing received 11 points. Significant items to note that could change to allocation of criteria points are:

- Lowering the 85% speed to below 37 mph, from 42 mph which will add 4 additional criteria points.
- Crossing pedestrians were only counted in the immediate vicinity of the crossing location. If barriers were present and pedestrians were channeled to this location this number could increase. The 2009 study by Stanley Consultants used the 2006 crossing study to determine the highest 3 hours, and counted pedestrian crossing activity in 2009 for just those three hours, plus 3 additional hours from 6pm to 9 pm.
- No points for the General Conditions were assigned. These are subjective measures and there is no guidance given on how to assign points for this criterion. It is possible that an additional 6 points could be assigned given appropriate countermeasures to be implemented.

A national standard for warranting crosswalks at unsignalized intersections was not found. Some of the advantages and disadvantages of crosswalks are:

- Assists pedestrians with guidance across complex intersections.
- Designates the shortest path; many instances of non-perpendicular crossings for pedestrians and bicyclists were documented in the 2006 crossing study throughout the entire corridor at unsignalized intersections and driveways.
- Directs pedestrians to locations of best sight distance.
- Potentially could create a “false sense of security” for pedestrians.
- At uncontrolled locations on multi-lane streets with higher traffic volumes, may result in a greater number of pedestrian collisions if additional enhancements are not provided. (i.e., pedestrian median refuges, lighting and warning devices).
- Maintenance can be costly.

Table 8: Crosswalk Warrants

		Tortilla Drive	Willow Way
Gap Time	10		
0 - 0.99	10		
1 - 1.99	8		8
2 - 2.99	6	6	
3 - 3.99	4		
4 - 4.99	2		
5 or over	0		
Pedestrian Volumes	10		
over 100	10		
91 - 100	8		
61 - 90	6		
31 - 60	4		
11 - 30	2		2
0 - 10	0	0	
Vehicle Approach Speed	5		
under 20 mph	1		
20 to 28 mph	3		
29 to 37 mph	5		
38 to 45 mph	1	1	1
over 45 mph	0		
General Conditions	8		
Define pedestrian routes across complex intersections	2	0	0
Channelize pedestrians into a shorter path	2	0	0
Position pedestrians to be better seen by motorists	2	0	0
Position pedestrians to be exposed to fewer vehicles	2	0	0
Total		7	11

Vehicle Crash Types

Review of crash records disclosed a significant number of angle crashes in the section between MP 371 to MP 373 (Navajo/Southwest to Airport Road). Angle crashes are double the statewide average in milepost section 371 and not surprisingly increased in the after period at the same rate that traffic volumes increased, which was 10%. Contributing factors to the angle crashes at uncontrolled roadways and driveways are increased traffic with reduced gaps and reduced sight distances.

Rear end crashes are higher than the statewide norm derived from the 2008 Arizona Crash Facts for the same two mile section. Single vehicle crash data averages and percentages experienced in MP 371 and MP 372 sections are compared to the statewide data in **Tables 9 and 10** below. The angle and single vehicle crashes are bolded in **Table 9**. Angle crashes are higher than the norm but only by 8.5%. The single vehicle crashes which have been discussed as being over represented in other areas are much lower in these sections. The red bolded angle, rear end and single vehicle crashes in the 2007 to 2009 portion of the table is to demonstrate a deviation of more than 10% from the norm.

Table 9: Navajo Dr/ Southwest Dr to Coffee Pot Dr/Sunset Dr Crash Types

1998-2006 MP 371

	All	All %	State %	Night	Night %	Yearly Avg	Night Avg.
All	324	100.00%	100.00%	34	10.49%	36.00	3.78
Left Turn	26	8.02%	8.78%	2	7.69%	2.89	0.22
Angle	76	**23.46%**	14.92%	6	7.89%	8.44	0.67
Head On	1	0.31%	0.69%	0	0.00%	0.11	0.00
Sideswipe Same Direction	39	12.04%	12.04%	3	7.69%	4.33	0.33
Sideswipe Opposite Direction	2	0.62%	0.97%	0	0.00%	0.22	0.00
Rear End	125	38.58%	36.57%	7	5.60%	13.89	0.78
Single Vehicle	44	**13.58%**	20.20%	15	34.09%	4.89	1.67
Other	7	2.16%	3.46%	1	14.29%	0.78	0.11
Backing	4	1.23%	2.35%	0	0.00%	0.44	0.00

2007-2009 MP 371

	All	All %	State %	Night	Night %	Yearly Avg	Night Avg
All	103	100.00%	100.00%	6	5.83%	34.33	2.00
Left Turn	8	7.77%	8.78%	0	0.00%	2.67	0.00
Angle	28	**27.18%**	14.92%	2	7.14%	9.33	0.67
Head On	1	0.97%	0.69%	0	0.00%	0.33	0.00
Sideswipe Same Direction	13	12.62%	12.04%	0	0.00%	4.33	0.00
Sideswipe Opposite Direction	0	0.00%	0.97%	0	0.00%	0.00	0.00
Rear End	49	**47.57%**	36.57%	1	2.04%	16.33	0.33
Single Vehicle	4	**3.88%**	20.20%	1	25.00%	1.33	0.33
Other	0	0.00%	3.46%	0	0.00%	0.00	0.00
Backing	0	0.00%	2.35%	0	0.00%	0.00	0.00

Table 10: Coffee Pot Dr/Sunset Dr to Soldier Pass Road Crash Types

1998-2006 MP 372	All	All %	State %	Night	Night %	Yearly Avg	Night Avg.
All	396	100.00%	100.00%	48	12.12%	44.00	5.33
Left Turn	30	7.58%	8.78%	6	20.00%	3.33	0.67
Angle	59	14.90%	14.92%	6	10.17%	6.56	0.67
Head On	1	0.25%	0.69%	0	0.00%	0.11	0.00
Sideswipe Same Direction	39	9.85%	12.04%	8	20.51%	4.33	0.89
Sideswipe Opposite Direction	3	0.76%	0.97%	1	33.33%	0.33	0.11
Rear End	220	55.56%	36.57%	13	5.91%	24.44	1.44
Single Vehicle	31	7.83%	20.20%	11	35.48%	3.44	1.22
Other	8	2.02%	3.46%	1	12.50%	0.89	0.11
Backing	5	1.26%	2.35%	2	40.00%	0.56	0.22

2007-2009 MP 372	All	All %	State %	Night	Night %	Yearly Avg	Night Avg
All	143	100.00%	100.00%	9	6.29%	47.67	3.00
Left Turn	16	11.19%	8.78%	2	12.50%	5.33	0.67
Angle	21	14.69%	14.92%	1	4.76%	7.00	0.33
Head On	2	1.40%	0.69%	0	0.00%	0.67	0.00
Sideswipe Same Direction	19	13.29%	12.04%	1	5.26%	6.33	0.33
Sideswipe Opposite Direction	1	0.70%	0.97%	0	0.00%	0.33	0.00
Rear End	69	48.25%	36.57%	3	4.35%	23.00	1.00
Single Vehicle	10	6.99%	20.20%	2	20.00%	3.33	0.67
Other	4	2.80%	3.46%	0	0.00%	1.33	0.00
Backing	1	0.70%	2.35%	0	0.00%	0.33	0.00

COMPARISONS OF ALL SAFETY ALTERNATIVES

Highways Enhancements for Safety Report

ADOT's northern regional traffic engineering office in Flagstaff conducted the Sedona Pedestrian Crossing Study dated May 2006. The City of Sedona requested that ADOT evaluate pedestrian safety on SR 89A after a fatal pedestrian crash in January 2006. This was the third fatal pedestrian crash since 2000. This study investigated pedestrian and bicycle crashes along SR 89A from MP 371.00 to MP 372.99, which corresponds to the section between Dry Creek Road and Soldier Pass Road.

Data within this report was obtained from the ADOT crash database and evaluated from 2002 to 2005, in keeping with their established practice of using the most recent 3 year period available in the ADOT crash database. Data was also gathered and presented on pedestrian and bicycle activity along the corridor. During the time of this study there was another fatal pedestrian crash in April 2006. This study gathered an extensive amount of data for analysis and the recommendation from this study was to install pedestrian warning signs and illuminate the study area since all of the fatal pedestrian crashes occurred during darkness.

This study was forwarded to the ADOT Traffic Engineering HES section to request funds to implement the study recommendations. The HES section concurred and performed a benefit/ cost ratio calculation to demonstrate there was a positive benefit that outweighed the associated cost of improvements. This benefit cost ratio is required by the FHWA in the approval process for safety funds to be used by ADOT or any other municipality and must equal or exceed a one to one ratio of benefit to cost. This is shown in **Figure 4**. The HES evaluation concluded that the appropriate mitigation to

resolve the nighttime pedestrian fatalities was continuous lighting for approximately 2 miles on SR 89A.

Crash Reduction Factors

Crash Reduction Factors (CRFs) are used to determine the annual benefit of countermeasures. They have been calculated from numerous after-condition studies based on specific countermeasures that were employed nationally. The ADOT Traffic Safety page provides a link for the Crash Modification Clearing House, http://www.cmfclearinghouse.org/, indicating their general acceptance of both the countermeasures and the CRFs.

The range of CRFs found on this website are listed in **Table 12** for each of the listed countermeasures. If more than one countermeasure is installed the following formula is used to calculate a resultant CFR for multiple improvements.

$$CRFTi = 1- [(1- CRFi)*(l- CRF2i)*...*(1- CRFni)] \quad (1)$$

Where:

- CRFTi = the total crash reduction factor for the crash type i (angle, left turn, etc) in decimal format (25% = 0.25)
- CRF1i = the crash reduction factor for the first treatment for the given crash type in decimal format (25 % = 0.25)
- CRF2i = the crash reduction factor for the second treatment for the given crash type in decimal format.
- CRFni = the crash reduction for the nth treatment for the given crash type in decimal format.

ADOT used a CRF of 0.45 as the potential reduction of pedestrian crashes for the continuous lighting recommendation in their benefit/ cost ratio calculation. There was no explanation as to why this value was chosen from an extensive list of lighting CRFs.

Figure 4: Original Benefit/ Cost Ratio Calculation

Arizona Department of Transportation
HES-R-06-627
August 2006

APPENDIX B
SR 89A, MP 371 to MP 372.99
01/01/2003 to 12/31/2005

Benefit / Cost Ratio Tabulation

Annual Benefit Tabulation

Crash Severity	Annual Average	Estimated Reduction*	Total Reduction	Unit Cost**	Annual Benefit
Fatal	0.33	45%	0.15	$3,760,000	$558,360
Incapacitating	0.00	0.00	0.00	$188,000	$0
Non Incapacitating	0.33	45%	0.15	$48,200	$7,158
Possible	0.67	25%	0.17	$22,900	$3,836
Property Damage Only (PDO)	0.33	45%	0.15	$2,100	$312
Unreported	0.00	0.00	0.00	$2,100	$0
				Total Annual Benefits	$569,665

Costs

Total Construction Costs	$1,400,000
Project Life (years)	15
Interest Rate (%)	8%
Capital Recovery Factor	0.1168
Annual Construction Cost	$163,520
Annual Maintenance Cost	$150,000
Total Annual Costs	$313,520

Benefit / Cost

Annual Benefit	Annual cost	Benefit / Cost Ratio
$569,665	$313,520	1.82

* Development of Accident Reduction Factors, Research Report KTC-96-13, 1996
** Estimating the Costs of Unintentional Injuries, National Safety Council, 2004

Pedestrian Safety Committee

Table 11 illustrates a condensed version of the recommendations including the anticipated time frame and cost to implement as recommended by the Pedestrian Safety Committee. The full version of the matrix from the Pedestrian Safety Committee Evaluation can be found in Appendix A.

Table 11: Pedestrian Safety Committee Possible Options

POSSIBLE OPTION	RESPONSIBILITY	TIME/COST
1. Reduce speed limit between Airport Rd and Dry Creek Rd from 40mph to 35mph. Assist transition by using " Your Speed Is" radar warning signs, either permanent or temporary.	ADOT – sign changes Sedona police - Enforcement & Public Support	30-60 days Nominal Maintance Costs
2. Enforce all road-user laws – jaywalking, bicycle, autos. Continue stepped-up enforcement.	Sedona Police	Cost determined by level of enforcement resources applied Time to Implement TBD
3. Enforce dark sky ordinances and help bring businesses into compliance.	City of Sedona w/ support from Dark Sky Association and Keep Sedona Beautiful	Begin immediately Cost depends on level of enforcement & resource availability
4. Educate residents & tourists about Sedona's Dark Sky initiative and corresponding pedestrian/bicycle/motorist safety precautions.	Keep Sedona Beautiful Chamber of Commerce Local Chapter IDA Local Media	Begin immediately Expenses offset through private/public grants and donations
5. Place notices (painted curbs or sidewalks) and/or barriers in strategic locations telling pedestrians to use crosswalks and to restrict mid-street crossing • Coffee Pot Restaurant, Harkins Theatre • New Frontiers to Olde Sedona Restaurant	ADOT - permits City of Sedona – funding and installation	6-12 months Cost TBD
6. Conduct pedestrian crosswalk warrant analysis	ADOT w/ City of Sedona Support	3-6 months Cost TBD
7. Install traffic signal at Andante intersection, with associated crosswalk and lighting (Note: Action to begin immediately on design and permitting processes)	ADOT – Design & Construction	18-24 months $300,000 (2/3 ADOT, 1/3 City)
8. Implement photo speed enforcement cameras along the corridor – mobile vans or fixed devices	City of Sedona w/ ADOT support	9-18 months Costs depend upon type of system TBD
9. Modify the roadway to restripe and add bike lanes. Include as part of the next programmed pavement preservation project.	ADOT	2011 Cost included in planned project Implement with pavement preservation project
10. Install strategically located raised medians that could serve as traffic controls, a refuge island for pedestrians or barrier to crossing. Locations and design need to be studied for impact to business access and traffic flow	ADOT w/ support from City of Sedona	Time TBD Cost TBD
11. Install low level, shielded pedestrian lighting along the sidewalks.	City of Sedona – Enhancement Application	As part of 2011 89A improvements Cost TBD
12. Install pedestrian activated crosswalks and associated lighting at warranted locations as determined through an above option of #6	ADOT w/ support from City of Sedona	24-36 months Cost TBD
13. Install targeted street lighting at locations with highest levels of pedestrian/motorist crash activity (Rodeo – Harmony; Soldier Pass – Posse Ground)	ADOT w/ support from City of Sedona	24-36 months Cost TBD
14. Install continuous dark-sky compliant street lighting from Dry Creek Road to Airport Road.	ADOT w/ City maintenance	24-36 months Cost $2,000,000
15. Paint curbing at driveways to aid motorist ability to see access points (reflective, high visibility paint)	Local Businesses with support from Chamber of Commerce	Time TBD Nominal cost by business owners
16. Install no lighting of any type (other than at signalized intersections)		

Source: City of Sedona, Pedestrian Safety Committee

Road Safety Assessment

Road Safety Assessment (RSA) is the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvement in safety for all road users. The RSA is a tool introduced

by the FHWA. The FHWA works with State and local jurisdictions and Tribal Governments to integrate RSAs into the project development process for new roads and intersections, and also encourages RSAs on existing roads and intersections.

The aim of the RSA is to answer the following questions:

- What elements of the road may present a safety concern: to what extent, to which road users, and under what circumstances?
- What opportunities exist to eliminate or mitigate identified safety concerns?

Public agencies with a desire to improve the overall safety performance of roadways under their jurisdiction could utilize the RSA concept. The RSA can be used in any phase of project development from planning and preliminary engineering, design and construction. RSAs can also be used on any sized project from minor intersection and roadway retrofits to mega-projects.

CivTech personnel have participated on four RSAs during the past few years. For the Sedona assignment we did not engage a full multidisciplinary team but performed a site investigation during late afternoon and evening on July 19, 2010 and again on September 20, 2010 for one day and evening. The full section investigated was on SR 89A from Lower Red Rock Loop Road to Forest Avenue. Significant observations and commentary are presented below.

- Approaching Lower Red Rock Loop Road are warning signs for “slippery when wet” conditions.
  - Ultimately the friction coarse should be improved in lieu of warning drivers of this potential hazard.
- Enhanced delineation.
- Add left edge yellow Reflective Pavement Markers (RPMs) for additional guidance.
- Replace lane line white RPMs, past usable life.
- Striping retroreflectivity is poor; should be restriped.
- Flexible delineators along the right side of SR 89A will provide additional guidance in the four lane divided section west of Dry Creek to the limits of the turn-back.
  - Enhanced delineation is recommended in the Arizona Strategic Highway Safety Plan (SHSP) for sections of highways that experience higher than normal run-off road crashes. The SHSP addresses six emphasis areas that it strives to improve statewide. The development of the SHSP was mandated by SAFETEA-LU federal legislation.
  - One emphasis area in the SHSP addresses road departures and intersection improvements. Delineation is an important countermeasure for run-off the road crashes. Delineation consists of pavement markings, raised or recessed reflective pavement markers, off pavement flexible delineators, guardrail or barrier delineator tabs.

- No marked bicycle lanes. Bicyclists are using sidewalks, riding with and against traffic. This behavior has contributed to several bicycle/ vehicle crashes because drivers did not see the bicyclists on the sidewalk and the bicyclists were approaching from a direction that the motorists would not normally check when turning or pulling out into traffic. One such near incident was observed during this site visit and many wrong way bicyclists were observed. ADOT has included this with the proposed pavement rehabilitation project.
  - Sufficient road width does not exist to add bike lanes without reducing travel and two way left turn lanes. The available roadway sections must either be re-striped with reduced lane widths or must be widened to accommodate a 4 foot bike lane.
- Install share the road warning signs in areas where the curb lane is less than 16 feet wide.
  - Reminder to motorists of bicycle activity along SR 89A.
- Sidewalks are present for the length of SR 89A from Upper Red Rock Loop Road to Forest Avenue. Part of the route has sidewalks connected to the roadway and part has detached sidewalks.
  - Improved ADA compliant pedestrian ramps were to be constructed during the pavement preservation project.
- Closely spaced driveways create many conflict points;
  - between vehicles entering and exiting the highway and vehicles on the highway,
  - between pedestrians crossing the highway or bicyclists traversing the highway,
  - making it difficult to associate a particular driveway with a specific business, particularly at night. This creates indecision and can be a contributing factor in rear end and angle crashes.
- Channelization reduces the number of conflict locations by focusing turning and crossing activity once scattered along the entire section to a few selected locations. This can be accomplished with raised medians.
- Driveways close to intersection can interfere with intersections left turn queuing traffic. One of the emphasis areas in the Arizona SHSP is reducing the number and severity of intersection related crashes. Partial medians at signalized intersections would prevent the left in and left out movements and would reduce traffic operations and crashes.

- Vertical curve approaching Andante Drive westbound.
  - Advance pedestrian warning sign for westbound traffic is currently installed
- Very infrequent gaps observed along SR 89A. Vehicles exiting driveways use the two way left turn lane (TWLTL) for refuge and acceleration lane.
  - Part of the project scope for the pavement preservation would be to reduce the interior through lane widths to 11 feet. Five foot wide bike lanes would be provided immediately adjacent to the curb. This would allow the outside lanes to meet the ADOT standard width of 16 feet, including provision of a striped bike lane. The TWLTL width would be reduced from its current 14 foot width to 10 foot width. There is concern about reducing the width of the TWLTL. Traffic departing from intersection or driveway into the TWLTL to utilize the near side gap and wait for the far side gap before merging into the far side lanes usually must make a quick maneuver into this lane. They are not always properly aligned within the lane; reducing the width could lead to increased sideswipe, rear end or head on crashes. Reduction of the TWLTL lane depends on site conditions. ADOT has 10-foot TWLTL in use along the I-40 Business Route in Flagstaff, Arizona. However, there are two differences between that location and the SR 89A:
    - The spacing of driveways and intersecting streets spacing along B-40 is much greater than SR 89A.
    - There is only access from one side of B-40 because of the railroad on the south side of the roadway.
- Sign retroreflectivity may not meet new standards in 2009 MUTCD. (This version has not been formally adopted by ADOT at this time).
  - Signs should be updated and replaced.
- LED signal heads may need to be replaced.
  - ADOT attempts to replace LED signal heads on a 3 year cycle.
- Mid-section pedestrian crossings based on pedestrian activity may be warranted. Although the 2006 crossing study showed activity along the entire section of SR 89A from Dry Creek road to Soldier Pass Road, there were areas of concentrated activity not at signalized locations. ADOT had crosswalk studies performed at two locations.

COUNTERMEASURES

Based upon the safety issues observed along the corridor, a review of crash data, existing and anticipated traffic volumes, and development patterns along the corridor, CivTech began evaluating a number of countermeasures to address the safety issues identified.

Countermeasures are developed to address the safety issues such as hazard visibility, distraction visibility, distraction reduction, adequate and timely information, and conflict

resolution. Various measures may address one or more of these issues. Likewise, several measures may operate better together to address an issue.

Countermeasures are shown below in **Table 12** and discussed in depth for each. The table illustrates the types of crashes that each countermeasure mitigates, displays a range of CRFs from the Crash Modification Clearing House, indications to the effectiveness for daytime or nighttime crashes and an estimated construction cost.

Table 12: Countermeasures

Countermeasures	Types of Crashes Mitigated	CRFs	Day	Night	Cost
Continuous Lighting , Dry Creek Road to Soldier Pass Road	All Nighttime	18% 69%		X	$2.2M
Full Length Median, 6 inches high	Angle, Pedestrians	20% 75%	X	X	$3.5M
Full Length Median with Median Lighting (Reduction of Lighting Poles by Half)	All Angle, Nighttime, Pedestrian	25% 80%	X	X	$5.2M
Full Length Median with Pedestrian Barriers	Angle, Pedestrian	No Reduction Factors Found	X	X	$4.0M
Roundabouts	Angle, Intersection Related,	30% 90%	X	X	$1.1M Each
Mid Block Crossings, Curb Protection Only	Pedestrian, Bicyclists	39% 46%	X	X	$15K Each
Hawk Pedestrian Signals	Pedestrian, Bicyclists	80% 90%	X	X	$25K Each
Strobe Warning	Pedestrian, Bicyclists	80%	X	X	$11K Each
In-Road Crosswalk Lighting	Pedestrian, Bicyclists	60%	X	X	$30K Each
Automated Enforcement	Crash Severity Reduction	70%	X	X	No Estimate
Speed feedback Signs	Crash Severity Reduction	NA	X	X	No Estimate
Police Enforcement	Crash Severity Reduction,	70%	X	X	No Estimate
Reduce Jaywalking, Speeding	Pedestrian, Bicyclists	70%	X	X	No Estimate
Striped Bike Lanes	Bicyclists	70% 75%	X	X	$45K

(CFR) Crash Reduction Factors - Crash Modification Factors (CMF) Clearinghouse

Continuous Lighting

ADOT's original proposed countermeasure for the pedestrian crash issue was adding advance pedestrian warning signs and continuous roadway lighting (CRL). There were opposing viewpoints to this solution. The ADOT viewpoint was that lighting would enable drivers to see pedestrians sooner and have more reaction time to avoid crashes. The viewpoint of citizens opposed to continuous lighting was that the fatal pedestrian crashes all occurred in one location. Thus lighting could be focused at the crossing and not the entire corridor. There are both pro and con elements regarding the CRL recommendation.

- While lighting will greatly help motorists see pedestrians and bicyclists during darkness there will still be a randomness of crossing pedestrians and bicyclists at locations other than signalized intersections with marked crosswalks. Lighting combined with other countermeasures such as marked crosswalks, pedestrian median refuges and a warning light system will also address the random pedestrian crossings and bike issues and crashes. This issue was recognized in the original study but not addressed. This issue was also recognized by the safety advisory committee and similar recommendations were made in their final report.
- The continuous roadway lighting and pedestrian warning signs are improvements that indirectly address the pedestrian and bicyclist random crossing issues. They improve visibility but do not correct the contributing issue.
- There is much more value to lighting than just helping motorists see pedestrians during darkness. During the nighttime evaluation of SR 89A it was difficult to determine the correct driveway to use, to access an intended business as a visitor unfamiliar with the area. Approaching traffic created a glare that made it difficult to see down the roadway. Lighting provides a more uniform, consistent environment for visibility.
- There is more than one isolated area where pedestrian and bicyclist crossing crashes occurred; there were just no fatal crashes in those locations.
- When the lighting design principles are properly applied the increased visibility provided on the roadways can provide social and economic benefits to the public, including:
  - Reduction of nighttime crashes
  - Aid to police protection
  - Facilitation of traffic flow
  - Promotion of businesses
  - Safety for pedestrians
- There are no national warrants available to determine when continuous lighting should be installed. There are guidelines in the AASHTO Green Book for continuous lighting on non-freeway roadways. These guidelines are the same as stated in the ADOT Traffic Engineering Policies, Guidelines and Procedures (PGPs.)

Full Length Raised Medians

Access management is a critical component to traffic safety because it reduces conflicts. Medians are just one component that can be implemented to improve access control and safety. Other components include, but are not limited to, consolidation of driveways, adding or lengthening right and left turn bays, improving and/ or maintaining sight distance, and adding traffic control devices such as signals and roundabouts.

The Arizona SHSP identifies medians as an important countermeasure. Raised medians can be combined with any or all of the following countermeasures: pedestrian barriers combined with protected crossings, lighting, and roundabouts.

Safety studies conducted around the country have demonstrated that replacing a TWLTL by raised medians as traffic volumes approach an AADT of 28,000 will increase safety. A raised median is a likely scenario based on traffic projections in the Verde Valley Multimodal Transportation Study, 2009, and may be currently justified with the existing traffic volumes.

Raised medians by themselves are a similar countermeasure as the continuous lighting for mitigating pedestrian crashes in that they are both not complete solutions to reducing pedestrian crashes. The medians provide a refuge so that a pedestrian can use directional traffic gaps to cross more safely. However neither can correct the randomness of the pedestrian crossings in the areas between signalized intersections.

As outlined in the ADOT Roadway Design Guide (RDG) Section 304 – Medians,

> *"For non-controlled-access highways in urban areas, curbed medians should generally be **16 ft wide** from face of curb to face of curb. For controlled-access highways in urban areas, the median width should be based on the need to provide for potential future additional traffic lanes or for possible alternative modes of transportation."*

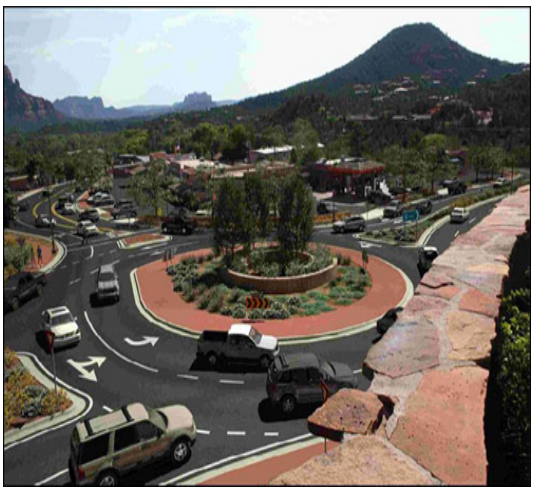
In order to accommodate a 16 foot wide median, an additional 8 feet of paved width is required to meet ADOT RDG standards.

U-Turns

With the 12 foot median and 26 foot half roadway section, most passenger vehicles will be able to make the u-turn maneuver. Larger vehicles with turning radii in excess of 40 feet will not be able to make this maneuver with the current roadway section and will have to turn left at signals or at the anticipated median breaks into businesses to turnaround. Additional pavement widening at the median breaks will facilitate the u-turn movements.

Roundabouts

Roundabouts are a natural compliment to continuous median barriers as they facilitate left turn and U-turn movements with ease. They calm traffic as entering traffic must slow down to negotiate the roundabout. They reduce injury severity of angle type



crashes. Several roundabouts have been installed in the City as part of the SR 179 ADOT project. Two roundabouts were installed on SR 89A within the focus area of this report. The area needed for installing similar roundabouts would exceed the existing roadway width and the 132 feet of right-of-way available. Typical roundabouts for similar roadways have ranged from 150 to 160 feet in diameter based on information provided by the City of Sedona.

If roundabouts replace the current signalized intersections and those that are planned to be signalized with the implementation of raised medians, there would be the availability about every quarter of a mile for a natural u-turn to aid with accessing businesses on both sides of the roadway. If this is a serious consideration for the near future, then Andante Drive should be evaluated for a roundabout instead of a signalized intersection to avoid throwaway costs.

Right-of-way will be an important consideration for the retrofit or new construction of roundabouts. Estimating the costs of these improvements is difficult due to the unknown right-of-way needs.

Mid-Block Pedestrian Crossings

The original pedestrian crossing study in 2006 determined that 50% of pedestrian and bicycle crossing activity occurs at unsignalized intersections and driveways between Dry Creek Road and Soldier Pass Road on SR 89A. There are currently 5 signals between Dry Creek Road and Soldier Pass Road with the spacing between signals as shown in **Table 13** below.

Table 13: Existing Signalized Intersection Spacing*

Dry Creek Road/ Arroyo Pinon Drive	
	4800 Feet
Rodeo Road/ Shelby Drive	
	1500 Feet
Coffee Pot Drive/ Sunset Drive	
	1400 Feet
Mountain Shadows Drive/ Northview Road	
	2300 Feet
Soldier Pass Road	

**Approximate measures from Google Earth*

Table 14 shows the spacing with the five existing signals, the warranted and recommended signal at Andante Drive and the two studied crossings at Tortilla Drive and Willow Way that were analyzed for crosswalk warrants.

Table 14: Spacing With Proposed Signal and Crossings

Dry Creek Road/ Arroyo Pinon Drive	1500 Feet
Tortilla Drive (Crosswalk Study)	1800 Feet
Andante Drive (Warranted)	1500 Feet
Rodeo Road/ Shelby Drive	1500 Feet
Coffee Pot Drive/ Sunset Drive	1400 Feet
Mountain Shadows Drive/ Northview Road	1400 Feet
Willow Way/ Market Place (Crosswalk Study)	900 Feet
Soldier Pass Road	

*Approximate

measures from Google Earth

In the February 2009 study by Stanley Consultants, neither Tortilla Drive nor Willow Way met the warrants from ADOT PGP 910 that would allow installation of a marked crosswalk. In the conclusion the following statement was made:

> *"The 2006 Sedona Pedestrian Crossing Study indicates there are several hundred pedestrians and bicyclists crossing SR 89A in West Sedona on days with peak pedestrian activity. The study also indicates many of these crossings are occurring away from the signalized intersections, at unsignalized intersections and mid-block locations. Nevertheless, these two unsignalized intersections,* ***taken in isolation,*** *do not generate sufficient pedestrian crossings to warrant a marked crosswalk. (emphasis added)*
>
> *The current roadway, with open access, allows pedestrians to cross anywhere along this corridor. This dispersion of pedestrian activity works against the concept of a few organized crossings, with respect to the warranting criteria and effective implementation of this concept. The design and installation of effective pedestrian crossings with enhanced traffic controls such as the HAWK would also require the installation of some combination of medians, pedestrian barriers, and landscape. . This need for access control applies to pedestrian crossings at intersections and mid-block crossings.*
>
> *These treatments would need to be carried throughout the corridor to channelize the pedestrians to the existing signalized crossings and to the new organized crossings. The design and locations of the median and pedestrian barrier system would be problematic in the West Sedona corridor, as many of the businesses have direct driveway access to SR 89A. The design of such a system would need to include a thorough analysis of business access as well as vehicular and pedestrian traffic flows throughout the corridor."*

These marked crossings could meet ADOT warrants if:

- They were installed with median refuge and split crossovers, a warning light system (HAWK, rapid flashers or in-road crosswalk lighting), medians with pedestrian barriers to direct pedestrians to approved crossings, and overhead spot lighting.
- The 85th percentile speed were reduced. Even though the speed limit was changed to 35 mph, the 85th percentile speeds were measured to be greater than 42 mph. Maximum points are assigned for 85th percentile speeds in the range of 29 mph to 37 mph.

An additional ten points in criteria evaluation can be obtained by meeting the Approach Speed and General Conditions. Furthermore, channeling pedestrians to one mid-section crossing would likely result in higher pedestrian and bicyclist counts at these crossings. This is explained in more detail under the Pedestrian Crashes portion of the "Crash Analysis 2007 to 2009" section of this report.

There are median and lighted crossing concepts that should be considered for mid-block crossings. They are presented in detail below.

Split Median Concept

This pedestrian refuge median barrier concept is based on the premise of separating the paths for each side of the roadway, thus turning the pedestrian toward traffic so that they have a clear view.

- Enables pedestrians to focus on crossing each direction of traffic separately and provide a safe place in the middle of the street to wait.
- By requiring pedestrians to walk toward traffic, the refuge provides them a better view of oncoming traffic; allows drivers to clearly see pedestrians.
- If these median crossings are not installed with continuous raised medians then a safe waiting location is provided, where there is a surrounding TWLTL.

Pedestrian Warning Light Systems

There are several types of devices on the market today that provide an extra measure of visibility at pedestrian crosswalks. These devices include the pedestrian hybrid beacon known by the acronym HAWK (High-intensity activated crosswalk), rapid flashing light beacons mounted to signs, and in-pavement lights along crosswalks.

They can all be utilized separately, or the in-pavement crosswalk lights can be used in conjunction with ground mounted or overhead warning light systems. Warning light

systems have been shown to increase motorist awareness with measured compliance of 80%. Crash reduction factors from the Crash Modification Clearing House were determined to be a 60% reduction in pedestrian crashes for the in pavement lights, 80% reduction for the rapid flashing beacon and 80% to 90% reduction for the HAWK signals.

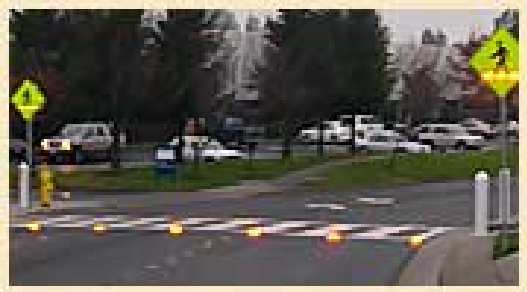
All systems are capable of both pedestrian manual activation or pedestrian detection sensors. The above ground rapid flash beacon and the HAWK can be seen at distances of greater than 1000 feet during the day and greater than a mile at night. The in pavement crosswalk lighting can be seen at distances of 400 feet during the day and at a half-mile at night. All systems remain in the dark or unlit stage until activated.

The rapid flashing beacons can be operated from a solar power unit attached to the pole. This enables rapid deployment as it is a self contained system that requires no AC power and thus, no trenching is required.

The HAWK pedestrian beacon requires AC power. The in pavement crosswalk lighting system operates on both AC and solar power. The HAWK can be pole or mast arm mounted. For the SR 89A application it is recommended that they be mounted on a mast arm over the traffic lanes.

The possibility exists that these systems can be accessed for monitoring information or to make changes from a central location via the internet. The use of the HAWK, once an experimental device, is included in the 2009 MUTCD. There are no minimum warrants to be met for their use.

Recent information provided from a vendor stated that a study of all in pavement crosswalk lighting systems has shown that greater maintenance costs are being experienced than originally anticipated. Research and analysis of this issue is highly recommended before purchasing any of these systems.



BICYCLE LANES

One of the Pedestrian Safety Committee recommendations was the striping of bicycle lanes. One of the prevalent crash issues has been bicycle crashes, specifically bicyclists riding against traffic and being struck by motorists who did not see them. Adding bike lanes will not necessarily alleviate this crash issue, unless bicyclists will use

the bike lanes, ride with traffic and thus, become a little more visible to motorists. The pavement arrows will give guidance as to the proper direction of travel, but education, enforcement and a behavioral change are the key components to reducing bicycle crashes.

Studies in Eugene, Oregon and Cambridge, Massachusetts showed that adding bike lanes accomplished the following:

- determined support and encourage bicycling as a means of transportation;
- helped define road space;
- promoted a more orderly flow of traffic;
- encouraged bicyclists to ride in the correct direction, with the flow of traffic;
- provided bicyclists a clear place to be so they are not tempted to ride on the sidewalk;
- reminded motorists to look for cyclists when turning or opening car doors;
- signaled motorists that cyclists have a right to the road;
- reduced the chance that motorists will stray into cyclists' path of travel;
- made it less likely that passing motorists swerve toward opposing traffic;
- decreased the stress level of bicyclists riding in traffic.

SPEED LIMITS AND ENFORCEMENT

Reducing the 85th percentile speeds, as discussed in the crosswalk warrant analysis within the Pedestrian Crash section of this report, prompted questions at the November 23, 2010 City of Sedona Council Meeting about lowering the speed limits to 25 mph on SR 89A as a means to reducing crashes and or the severity of crashes.

The most recently available 85th percentile speed data was measured in 2009 during the crosswalk warrant analysis. The 85th percentile speed was found to be approximately 42 mph. This data was obtained after the speed limits were changed

from 40 mph to 35 mph. Certainly, if traffic would travel at a posted speed of 25 mph, crashes or their severity would be reduced. However, experience has shown that if the motoring public believes the speed limits are not realistic for conditions, then the majority will not comply.

This creates a speed differential and studies have shown that a correlation exists between speed differential increases and crash incidence increases.

Currently SR 89A is classified as a principal arterial. Reducing the speed limit to 25 mph would have the effect of reducing the classification of the roadway to a minor arterial. The capacity of the roadway would be diminished by 25% to 33% for equivalent levels of service. The current capacity of the roadway is estimated at 35,000 vpd with the current 85th percentile speed of 42 mph. If the speed limit was reduced to 25 mph, and the motoring public reduced their speed accordingly, the capacity of the four lane roadway would decrease to about 25,000 vpd. This could create the need for additional lanes on SR89A if traffic volumes were to remain at their existing levels. This option is not recommended since the existing traffic volumes would exceed the capacity of SR89A.

ARS 28-703 requires an engineering study be conducted to set or change speed limits. The MUTCD provides standards and guidance for the requirements of an engineering study should further investigations be desirable.

ANALYSIS OF TURN BACK DOCUMENT

Civtech reviewed the ADOT/Sedona Route Transfer Study for completeness. This review was intended to assist the City in determining that an adequate range of issues had been considered relative to the route transfer (also called a “turn-back”). During the preparation of this report the draft ADOT/Sedona Route Transfer Study, dated July 23, 2010, was available for review.

While this draft was under review, negotiations with ADOT continued. Therefore this evaluation consists of the draft report review. The Transfer Study addresses two (2) routes located within the City of Sedona, SR-89A (From MP 369.40 to MP 374.20) and SR-179 (From MP 313.27 to MP 313.42).

The route transfer report was developed to summarize system needs and provide an initial estimate of cost with implications for transferring State Highway routes within the City limits from the State to the City of Sedona. The report addresses a scope of issues that exceeds the alternative pedestrian and vehicular safety issues, which are the focus of this study.

As determined in the Transfer Study, a few of the current roadway conditions do not meet ADOT roadway design criteria. The following is a summary of the Transfer Study findings for SR-89A (from MP-369.40 to MP-374.20):

- *Right-of-Way (ROW)* – current ROW meets ADOT RDG standards.

- *Posted Speed* – current posted speed varies between 25 mph to 40 mph. Since the ADOT RDG specifies desirable speeds ranging between 30 mph to 50 mph, the current posted speeds meet ADOT standards except for the 25 mph posted speed limit located at Forest Avenue (MP-374.24 to MP-374.76).
- *Lane Configuration* – current lane configuration conditions meet ADOT RDG standards.
- *Pavement Width* – the current typical pavement width is 64-feet and ADOT RDG standard is 68-feet for pavement width; therefore, current pavement width is not met.
- *Bike Lanes* – there are currently no bike lines along the SR-89A study segment. Per ADOT RDG standards a 16-foot outside lane should be constructed to accommodate bikes; therefore, bike lane requirements are not met.
- *Edge Treatment* – current edge treatment conditions meet ADOT RDG standards.
- *Sidewalk* – current sidewalk conditions meet ADOT RDG standards. However, the ramps do not meet current ADA standards. Sidewalk ramps are also in-place at all intersections that have sidewalks. ADOT standard C-05.30 was not evaluated as ramps will be replaced under the pavement preservation project.

One of the countermeasures to be considered is continuous raised medians. However this was not a consideration in the turn-back document. The requirement from the ADOT Roadway Design Guide (RDG) is for a 16-foot wide, raised median. A raised median is a likely scenario based on traffic projections in the Verde Valley Multimodal Transportation Study, 2009.

The current roadway section for SR 89A from Dry Creek Road to Forest Avenue is currently 64 feet wide. The recommended section from the RDG that should be in place to accommodate both bike lanes (ADOT's preference is to have an outside lane width of 16 feet to accommodate bicycles), 4 travel lanes and a raised median in a curb and gutter section is 72 feet. As the current conditions are 64 feet of roadway, an additional 8 feet of roadway will be required to meet the RDG standards.

The cost of this improvement for the widening of 8 feet to one side of the roadway (rebuilding curb, gutter and sidewalk) is $5.8M. Additional issues to be considered if proceeding with turn-back negotiations are:

- Pavement preservation is a cyclical item that can be anticipated on a 10 to 15 year cycle. The pavement preservation cost in the turnback agreement for the currently proposed 3.3 mile section of SR 89A is $4,400,000. This includes some non-recurring costs for ADA ramps and city street paving. The value of this non-recurring work is approximately $666,700. Subtracting this cost from the total shown in the turnback agreement provides a cost for the pavement preservation work of $3,733,300 for the 3.3 mile segment.

  The total turn back length is 4.95 miles; thus, an equivalent cost to replace the total length is $5,600,000. Based on an expected 2% per year increase in costs over a

15 year period, the future expected cost to replace the 4.95 miles of pavement would be $7,557,254. If a 2.5% per year increase is used, the total cost of the future project would be $8,144,701.

The City is receiving $3,400,000 from ADOT for future pavement rehabilitation work. If this amount is invested and receives a 2.5% rate of return, a yield of $4,945,041 will be available for future pavement rehabilitation.

- The maintenance costs for the newest signal at Airport Road and the proposed signal at Andante Drive were not included in previously calculated maintenance costs. Additionally, the northern regional traffic office in Flagstaff indicated that although no studies had been performed that warranted installation of a traffic signal at Foothills Drive, it was anticipated that it would indeed be warranted in the future. Additional funding for these additional signals will be needed and has been included in turn back negotiations.

CONCLUSIONS

- A serious pedestrian crash issue existed in 2006.
- Pedestrian crashes have decreased since the 2005-2006 period to similar levels prior to 2005.
- Since 1998 there have been 1 or 2 pedestrian crashes per year except for 2005 and 2006 where there were 3 and 6 crashes respectively, all nighttime related.
- Traffic AADT volumes from the 2009 crosswalk warrant study have increased by 10% since 2006.
- Nighttime traffic AADT volumes were 9% to 9.5% of the total AADT.
- The 2006 Crossing Study provided vital data regarding pedestrian and bicycle activities along SR 89A. This study illustrated in the collision diagrams that unsafe bicyclist operations contributed to an average of 2.55 bicycle/vehicle crashes per year from 1998 to 2006. Injury severity was typically less than pedestrian crashes, although there was a bicyclist fatality in 2007 at Lower Red Rock Loop Road.
- Bicycle crashes from 2007 to 2009 have increased to 4.67 crashes per year.
- Nighttime crashes as a percentage of all crashes was 14.54% in the before period and decreased to 8.80% in the after period.
- The percent of single vehicle nighttime crashes was 41.55% in the before period and decreased to 27.87% in the after period. Nighttime traffic volumes were 9% - 9.5% of the AADT.
- The majority of single vehicle crashes, 56%, were west of Dry Creek Road.
- The nighttime single vehicle crashes decreased by an average of 60% along the corridor in the after period.
- Angle crashes between Navajo Drive/ Southwest Drive to Coffee Pot Drive/Sunset Drive were double the statewide average in the before period. There was an increase of 10% in the after period which is consistent with the increase of 10% AADT in the after period.
- The Safety Advisory Committee presented 12 recommendations that they believed would address the crash issues more completely than the recommended continuous lighting. Some of the recommendations included:
  - Install strategically located raised medians that would also serve as pedestrian refuge islands.
  - Install pedestrian activated crosswalks and associated lighting at warranted locations.
  - Install semi-continuous roadway lighting.
  - Use pedestrian barriers to channelize pedestrians to crosswalk locations
  - Reduce speed limits.
  - Stripe bike lanes.

- The Pedestrian Road Safety Audits Guidelines and Prompt Lists published by the FHWA Office of Safety recommend the following countermeasures to mitigate pedestrian and bicycle safety.
  - Install strategically located raised medians that would also serve as pedestrian refuge islands.
  - Install pedestrian activated crosswalks and associated lighting at warranted locations.
  - Install crosswalks along pedestrian desire lines
  - Reduce speed limits
- Many of the recommendations by the Safety Advisory Committee, are the same countermeasures contained in the FHWA document "Pedestrian Road Safety Audit Guidelines and Prompt Lists" as recommended mitigations. This was published by the FHWA Office of Safety in July 2007.
- Due to the demonstrated results of improved pedestrian safety, FHWA removed from experimental status the HAWK pedestrian hybrid beacon in the 2009 MUTCD.
- The Transportation Research Board, NCHRP Report 500 lists all the above as appropriate countermeasures.
- These countermeasures are the exact countermeasures identified in numerous FHWA documents and are considered to be the best recommended practices for improving and mitigating pedestrian and bicycle accidents.
- These recommended countermeasures are consistent with the objectives in the State SHSP, The Bike and Pedestrian Plan and the HSIP Plan.
- There are additional considerations not discussed in the original turn back document.

RECOMMENDATIONS

This scope included vehicular, pedestrian, and bicycle safety, in both the daytime and nighttime settings. CivTech has concluded, based upon its analysis, that an appropriate final recommended solution for the noted safety situation would include countermeasures to directly affect pedestrian and bicycle daytime and nighttime crashes by resolving the root cause of those crashes. The root cause was demonstrated in the 2006 crossing study by ADOT to be 50% of pedestrian and bicycle crossings occur randomly throughout the 2 mile corridor at driveways and un-signalized intersections. Redirecting these crossings to signalized intersections and proposed enhanced crossings would place these crossings at locations that meet driver expectations. This solution would address the scope of issues that the City requested CivTech consider.

The CRL provides advance warning of pedestrians at night of pedestrian and bicycle activities, but does not resolve the crossing issue. The countermeasure of continuous

raised medians will also have an impact in mitigating angle crashes, which were seen to be in excess of the statewide percentage.

The minimum recommended countermeasures to directly address the issue of random pedestrian and bicycle crossings of SR 89A and provide reasonable distances between motorist recognized pedestrian crossing locations includes the following and are shown in **Figure 1A, Figure 1B and Figure 2**:

- Continuous raised medians, 6 inches in height, with anticipated median breaks at approximate ¼ mile breaks.
- A pedestrian barrier should be constructed throughout the length of the median to preclude random pedestrian crossings. Install guidance to direct pedestrians to protected crossings in conjunction with the barrier. Without the barrier the issue of random crossings will not be resolved and regardless of other countermeasure implemented the CRL would be needed to identify random crossing pedestrians and bicycles at nighttime.
- Adding Enhanced Pedestrian Crossings that include:
  - Highly visible and durable crosswalk markings. Advance yield markings to provide sight distance of pedestrians that may be screened from vision by a stopped vehicle in another lane.
  - Pedestrian activated warning light system, such as rapid flashing beacons, the HAWK pedestrian beacons or in pavement crosswalk lighting.
  - Median refuge area for pedestrians and bicyclists. The split median concept which requires pedestrians to turn and face oncoming traffic is recommended.
  - Pedestrian activated crossing with countdown LED pedestrian signals. Activation buttons and pedestrian signal heads should also be installed in the median refuge area to promote two separate crossing phases.
  - Overhead crosswalk lighting that meets dark sky compliant lighting requirements. Creating easily identifiable crossing locations to motorists, pedestrians and bicyclists for both daytime and nighttime is crucial.
  - A speed reduction effort with extra enforcement, automated enforcement or “Your Speed Is” signing to increase compliance to the currently signed 35 mph speed limit.
  - Advance warning signs and advance stop bar.
- The minimum recommended length of ¾-mile to install the above recommended countermeasures for the two mile section is between Andante Drive and Rodeo Road which is 1500 feet long, and between Shadow Mountain Drive and Soldier Pass Road which is 2200 feet long. Based on traffic volumes, the entire two mile section could benefit from the installation of medians; however this minimum recommendation is based on providing protection to two of the three highest areas of pedestrian and bicycle crossing activity at other than existing signalized intersections. **Figure 1B** shows the plan view of the roadway where the TWLTL remains and bike lanes are added.

- Although the ADOT standard width of a median from the Roadway Design Guide (RDG) is 16 feet this would necessitate widening the roadway at significant cost. The recommended minimum cross section that could be constructed within the existing roadway prism includes a 12 foot raised median with 10 foot left turn lanes, four 11 foot through lanes and 4 foot striped bike lanes. Although the recommended width of bicycle lanes is 5 to 6 feet, 4 feet is allowed by the MUTCD where available width is restricted.
- Install the warranted signal at Andante Drive.
  - This will provide a protected pedestrian crossing in this area. The closest existing signal to the fatal pedestrian crashes crossing area is Rodeo Drive at approximately ¼-mile away. Andante Drive will provide a signalized crossing about 400 feet away from the area where the crashes occurred. ADOT has included installation of this signal within its initial improvement plans.
- Install marked bicycle lanes per the MUTCD
  - ADOT has included bike lane striping in the pavement rehabilitation project.
- Traffic modeling of proposed median system to determine effects on the corridor prior to planning and design.

A comparison of the minimum recommendations versus continuous roadway lighting for cost to implement and effectiveness to reducing crashes is shown in **Table 15**. The equation below is used to calculate the CFR when more than one countermeasure is employed.

CRFTi = 1- [(1- CRFi)*(l- CRF2i)*...*(1- CRFni)] (1)

The Crash reduction factor calculation for the minimum recommended countermeasures is:

CRF= 1-{(1-0.25)(1-0.25)(1-0.12)(1-0.35)(1-0.15) = 0.73

- Raised Medians 0.25
- Mid block crossings 0.25
- HAWK signals 0.12
- Bicycle lanes 0.35
- Speed Enforcement 0.15

The Crash reduction factor calculation for the CRL and speed reduction countermeasures is:

CRF= 1-{(1-0.44)(1-0.15)(1-.35) = 0.69

- Lighting 0.44
- Bicycle lanes 0.35
- Speed Enforcement 0.15

The Crash Reduction Factors used were the lowest CFRs found, so as to calculate the most conservative combined CRF.

Table 15: **Countermeasures Cost and Effectiveness**

Countermeasure	Medians with pedestrian barrier, additional enhanced crossings, bicycle lanes, speed enforcement	Continuous Roadway Lighting, Bicycle Lanes, Speed Enforcement
Anticipated Crash Reduction Factor For All Implemented Countermeasures	0.73	0.69
Type Of Crashes Mitigated	Both Daytime and Nighttime Pedestrian, Bicycle and Angle Crashes	Nighttime Pedestrian, Bicycle Crashes Daytime and Nightime
Cost	**$1.6M**	**$2.2M**

Additional measures that warrant future consideration and evaluation are:

- Retrofitting existing signalized intersections with roundabouts to further improve pedestrian and vehicle safety. Traffic operations, especially U-turn movements, may be improved with roundabouts in conjunction with the continuous raised medians.
  - Cost of each is estimated to be $1.1M
- The 2006 crossing study showed that the section from Coffee Pot Road/ Sunset Drive to 600 feet west was the third area of concentrated random pedestrian crossing activity. This was despite the close proximity of the signalized intersection at Coffee Pot Road. Implementation of the minimum recommendations may need to be installed between Coffee Pot Road and Rodeo Road for a distance of ¼- mile.
  - Cost to implement this section is $0.8M
- Pedestrian level lighting along sidewalks. This will assist pedestrians, bicyclists and motorists during nighttime operations. Motorists will be able to find driveway entrances better and will see pedestrians crossing the driveways and un-signalized intersections.
  - Cost to implement for the full corridor is anticipated to be greater than the cost to install the roadway lighting as the pole spacing would be reduced. ADOT alternative 26, Monterey lighting with 25 foot poles was estimated to be nearly $2,500,000 for the 2-mile section.
  - If additional pedestrian lighting is considered just in the vicinity of the crossing area and in addition to the two luminaries at the crosswalk that creates a more identifiable crossing zone to pedestrians at night the estimated cost for an additional 4 poles and luminaries per crossing location is $10,000 per costs provided by the City of Sedona from the SR 179 project lighting.
- Add the additional pavement width to build section to ADOT standards at a cost of $5.8M.

During the identification, analysis and development process for ADOT safety projects an engineering decision is made to implement interim countermeasures when the implementation of final recommended countermeasures cannot be executed for many

years or when experience deems that interim measures may improve the crashes with a minimal investment. Whether an interim, transitional or final countermeasure is implemented, surveillance is conducted in the after period to determine if additional measures will be required.

Interim or transitional improvements have proven to be a successful strategy for other ADOT HES projects that involved serious crash trends such as the head-on crash issue for the Gonzales Pass area of US 60, between SR 79 and the Town of Superior and for the angle crash issue at the end of the SR 143 freeway at I-10 eastbound off-ramp.

Signing, centerline rumble strips and increased enforcement efforts were implemented and successful until the ultimate improvement of a planned 4-lane divided highway could be constructed on US 60. Transverse rumble strips, signal modifications and an overhead dynamic message board that alerted southbound SR 143 motorists that the signal at the I-10 eastbound off-ramp had changed to red. This minimal investment improved the worst location in the state for angle crashes. The annual benefit supported the construction of a grade separated interchange.

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TECHNICAL APPENDIX

APPENDIX A: PEDESTRIAN SAFETY COMMITTEE ALTERNATIVES MATRIX

APPENDIX B: 2007 AND 2030 VERDE VALLEY STUDY MODELS FOR SEDONA

APPENDIX C: 2002 FHWA RECOMMENDATIONS/IMPROVEMENTS AT UNCONTROLLED LOCATIONS

APPENDIX D: FINAL REPORT SR-89A ROUTE TRANSFER: CITY MANAGER RESPONSE TO ADOT

APPENDIX E: CITY MANAGER MEMO TO MAYOR AND COUNCIL, WITH SETH'S COMMENTS

APPENDIX F: ADOT'S POSITION LETTER, FEBRUARY 23, 2010

APPENDIX G: COST ESTIMATES

APPENDIX H SEDONA ROADWAY LIGHTING ALTERNATIVES

APPENDIX A

PEDESTRIAN SAFETY COMMITTEE ALTERNATIVES MATRIX

Highway 89A Possible Options

POSSIBLE OPTION	PROS (If Implemented)	CONS (If Implemented)	RESPONSIBILITY	TIME/COST
1. Reduce speed limit between Airport Rd and Dry Creek Rd from 40mph to 35mph Assist transition by using "Your Speed Is" radar warning signs/trailers to remind motorists to watch speed	• Impacts on vehicular and pedestrian accidents less severe. • More time for reaction at lower speeds. • Inexpensive option • Will improve safety and slow people down • It might slow some motorists down. • "Your speed is" signs can be effective, but eventually need to be backed up with enforcement • Could result in increased safety and less accidents. • 32 to 51% improvement in Pedestrian to Vehicle Crashes (PVC) per references "c", "e", & "f" shown on References below • Slows traffic • Prevents accidents • Reduce severity of accidents • Could lead to a reduction in accidents • If compliance can be attained there would be some reduction in crash severity. • May help reduce the speed of vehicles and thereby vehicle-vehicle or pedestrian-vehicle crash severities if properly enforced.	• Reducing speeds may not prevent accidents. • The 35 MPH will seem too slow to many drivers during much of the day. • There are likely to be more speeders and a greater span of speeds on the road. • Due to reduced roadway capacity because of lower speeds there will be longer period of "rush hour" congestion • People drive at the speed they feel comfortable. Artificially lowering the speed limit may not get the desired effect. • Could be an enforcement problem. Most drivers will likely go above 35 MPH because the design speed of 89A is much greater. This will be especially true at night when traffic is less. • During the day, speeds on the SR89A are often lower than the currently posted 40 mph. Reducing the speed limit may not achieve goal of improving safety. • Drivers involved in the pedestrian fatalities were traveling below the posted speed limit, so reducing the speed may not prevent fatalities. • Labor intensive to enforce • Night enforcement may be difficult because of other call for service	ADOT – sign changes Sedona Police – enforcement Sedona Police w/ public support	30-60 days Nominal Maint. Cost Nominal with use of grant funding – KSB has approved $1500

		• demands on police • Behavior will remain unchanged which breeds disrespect for vehicular law. • None.		
2. Enforce all road-user laws – jaywalking, bicycle, autos. Continue stepped-up enforcement.	• Reduced jaywalking due to Sedona reputation • Improved vehicular flow • Will improve safety • Nice, if you could do it, but probably too idealistic to continue for an extended period of time. • Could result in increased safety and less accidents. • 50% improvement in PVC per references "b" & "c" shown on References below • Creates revenue • Reduce severity of accidents • Could lead to a reduction in accidents • May result in some crash reduction. • Will reduce the probability of pedestrian-vehicle crashes during the period it is enforced…most likely during daytime only.	• May have some negative feedback from the community. • Adverse impact on tourist impact. • Community relations with City likely to become more contentious due to perception of wrong use of police. • More police needed • Possible negative perception in community • Tremendous, continuous, manpower effort needed to enforce. • Increasing enforcement to a greater extent may create a negative impression for locals and give Sedona a negative image in the eyes of tourists. • High cost to staff additional targeted enforcement • Labor intensive • Increased cost to local law enforcement. • None.	Sedona Police	Cost determined by level of enforcement resources applied
3. Enforce dark sky ordinances and help bring businesses into compliance.	• Higher awareness of ordinances • Improved dark sky experience • Will improve distractions from the road	• Problem may not be as large as suspected and may not have the intended desired outcome. • Greater contrast light for headlights. This may affect ability of eyes to adjust.	City of Sedona w/ support from Dark Sky Association and Keep Sedona Beautiful	Begin immediately Cost depends on level of enforcement & resource

	• Will help meet the intent of the ordinance • Could save energy and result in less impact on Sedona's dark night skies • For the public safety and through eminent domain if necessary, businesses will help Sedona • Who's in conflict? • Would reduce glare from non-compliant lighting which could improve visibility • May improve light pollution for Sedona. • May partially help address night-time visibility issues.	• Could make some business harder to see at longer distances. Vehicles may slow if looking for businesses. • Possible negative perception/impacts on business community • Resistance by businesses to comply. • May upset business owners and may require additional staff resources depending on the level of enforcement desired. • Resistance by businesses • No measurable reduction to crash frequency is likely. • Not aware of any.		availability
4. Educate residents & tourists about Sedona's Dark Sky initiative and corresponding pedestrian/bicycle/motorist safety precautions.	• Higher awareness of dangers in the community • Good opportunity to better promote Sedona for dark skies: tourism • Inexpensive option • Education is a plus • Good luck • Education is good PR and a user-friendly approach to a problem • Increased awareness to Dark Sky issues and Safety. • May have very little effect on pedestrian safety and that too during daytime only.	• More paper, which if the campaign is not carefully constructed, could just become trash. • Aesthetics. • Cost. • Restricted sight distance issues coming out of a driveway. • This could be very time consuming. The ongoing effectiveness of such an education campaign is uncertain given the tourist and transient nature of Sedona's population. • Labor intensive • Impact is short-lived	Keep Sedona Beautiful Chamber of Commerce Local Chapter IDA Local Media	Begin immediately Expenses offset through private/public grants and donations

		• May be seen as a reason of not implementing necessary safety improvements such as lighting. This could lead to liability issues for both the City of Sedona and ADOT. • None.		
5. Place notices (painted curbs or sidewalks) and/or barriers in strategic locations telling pedestrians to use crosswalks and to restrict mid-street crossing • Coffee Pot Restaurant, Harkins Theatre • New Frontiers to Olde Sedona Restaurant	• Permanent and timely reminders, if maintained • May cause locals to change their habits • Inexpensive option • If the barrier system were implemented, it would direct pedestrians to a safer crossing location. I don't believe signage or painted curbs would have much effect. • Could result in increased safety and less accidents. • Sight pollution • Helps direct traffic away from problem areas • May direct pedestrians and bicyclists to safer controlled crossings at traffic signals rather than uncontrolled mid-block crossings. • May help reduce pedestrian-vehicle crashes mostly during daytime.	• No apparent consequences for failure to heed. • May be hard to see at night. • Cars may obscure during traffic volume times. • Barriers may create negative perception in community, may impact businesses • People may ignore the notices. • If not done correctly, barriers could be unattractive. • Barriers may restrict vehicular access to businesses. • Without jaywalking enforcement, will be hard to enforce. • May be expensive • Resistance by business community • Street or sidewalk barriers may not be acceptable to the community. There are maintenance and enforcement costs related to barriers. • Signings are not proven to be effective in pedestrian crossings. Also, these may not be aesthetically pleasing/acceptable.	ADOT - permits City of Sedona – funding and installation	6-12 months

6. Conduct pedestrian crosswalk warrant analysis: • Near Marketplace west of Soldier Pass Rd • Posse Grounds • Near Tortilla Dr.- hotels/restaurants/Giant If warranted, see #12 Request new businesses conduct pedestrian analysis	• Provides data • Keeps preventative plans up-to-date by insisting new businesses analyze their impact on pedestrian movement.. • A study might satisfy those who think there are pedestrians crossing in enough volume to warrant some sort of treatment such as a crosswalk or lighting. However, they will probably be disappointed with the results. • Will help determine the best locations for crosswalks. • It is obvious that they should be warranted as they consistently show up highest in PVC reductions in references marked "a" & "d" shown on References below • Save our money • Focuses safety in areas most likely to have a problem • May indicate the need for a more controlled crossing location. • May help reduce pedestrian-vehicle crashes mostly during daytime.	• Unlikely to meet warrants for volume of pedestrians needed to consider a crosswalk. • Money and time. • Land uses that generate the need for the crosswalks may change over time, making the study's information invalid. • Will delay implement of mid/long term #6 item, if warranted • Labor intensive • Changing conditions and businesses may change need and locations for warrants • More liability for the roadway agency if installed without sufficient lighting.	ADOT w/ City of Sedona support	3-6 months
7. Install traffic signal at Andante intersection, with associated crosswalk and lighting (Note: Action to begin immediately on design and permitting processes)	• Will slow movement of traffic in the 89A corridor. • It will provide gaps in the traffic. • If the signal is visible for long distance, pedestrians may use this an indicator of safe crossing. • Will improve safety in area identified, based on need • A traffic signal is a safe location for pedestrians to cross. This would also make Andante a safe	• Traffic along the corridor will be slowed. • The Andante/Stuz Bearcat intersection may not operate properly. It may be difficult to exit from going left. • Small impact on dark skies in the immediate vicinity. • Higher potential for rear end	ADOT – Design & Construction	18-24 months $300,000 (2/3 ADOT, 1/3 City)

	location for side road traffic to access SR89A. • Will address a major safety problem at this intersection. Will allow the entire Harmony area, which has a high population density, access to SR 89A at a signalized intersection. • 50% improvement in Pedestrian Vehicle Crashes (PVC) per reference "a" shown on references below • Provides crosswalk • Controls traffic • Will improve intersection safety if traffic signal is warranted. • Relatively quick solution for an identified problem area • Provides a controlled crossing location (greatest safety) for pedestrians and bicyclists. • Improves the service for the minor side street, Andante.	accidents. Ongoing maintenance and power costs. • May add to traffic congestion on SR 89A. • None • Other areas of corridor need some form of safety improvement based on data • This location barely warrants a traffic signal. It will produce greater delay for SR 89A traffic. • There will be an increase in rear end type crashes of 40%. • Cannot install if not warranted. Will not have much impact on pedestrian-vehicle crashes for the 2-mile segment.		
8. Implement photo speed enforcement cameras along the corridor – mobile vans or fixed devices	• May bring additional revenue to the City. • Will ensure the speed limits are enforced uniformly. • Automated enforcement will mean uniform enforcement • Increased revenue from tickets • Use of mobile vans may cause those regularly using the route to avoid trying to beat the photo system by driving faster or slower in certain sections. • No impact on dark skies.	• Tourists and others may feel that the City is overly aggressive regarding ticketing. • Possible negative perception in community • None • Possible perception that this will be a loss of small town character. • Maintenance and installation costs. • Resistance to technology could lead to legislative prohibition in future	City of Sedona w/ ADOT support	9-18 months Costs depend upon type of system - TBD

	• Will slow people down • Revenue for city • Will make motorists aware of their speed, cause them to slow down and will likely increase safety. The existing fixed unit on Dry Creek Road has been very effective. • Slows drivers • Creates revenue • Relatively quick and easy to implement • Technology frees officers • Greatest impact to driver behavior in reducing speed. • A reduction in speed may have some reduction to crash frequency and severity. • May help reduce the speed of vehicles and thereby vehicle-vehicle or pedestrian-vehicle crashes anytime of the day.	• Resistance to technology could lead to legislative prohibition in future • West Sedona may become viewed as a "speed trap" and unfriendly to tourists. • May not be pleasing for the citizens.		
9. Modify the roadway to restripe and add bike lanes. Include as part of the next programmed pavement preservation project.	• This may provide a narrowing of the high speed lanes that must be crossed. • Needed • Will improve bicycle safety • Would make this corridor more multi-modal. • Will increase safety for bicyclists and motorists. • Makes roadway safer • Improves bicyclist safety • Provides a facility designed just for bikes.	• Pedestrians may wait in the bike lane to cross. This is unsafe because the pedestrian/vehicle separation will be lost. • Very high cost if this was implemented prior to the next pavement preservation project. • Could add to traffic congestion. • None. • Doesn't resolve visibility problem • Limited to bicycle safety	ADOT	2011 Cost included in planned project

	• Gets bikes off the sidewalks. • Net improved safety for bikes and less sidewalk conflicts with pedestrians. • Mulitmodal approach.	• Practically no impact on pedestrian-vehicle crashes.		
10. Install strategically located raised medians that could serve as traffic controls, a refuge island for pedestrians or barrier to crossing. Locations and design need to be studied for impact to business access and traffic flow	• Shortens the crossing path. • No impact on dark skies. • Will provide refuge while crossing. • Any median refuge would be of benefit to pedestrians. • Will increase safety. Could be attractive if done correctly and break up the expanse of pavement. • 50% improvement in PVC per reference "a" shown on references below • Substantial safety improvement • May provide better vehicular access control. Reduces conflict points, which should reduce crash frequency. • Provides a median refuge. • May partially reduce pedestrian-vehicle crashes.	• Limits vehicular turning movements. • Without lights, pedestrians may be invisible in the middle of a dark street. • Maintenance may be an issue • Costs associated with maintenance • May be an unexpected barrier to motorists using the two way continuous left turn lane. • Businesses will have a concern regarding impact on business access. • This will be staff intensive to work with business owners. • Can't have bike lanes without major work • Expense and resistance by business • Usually not accepted by the business community. • Does not provide as much safety to pedestrians as a controlled crosswalk. • Does not improve nighttime	ADOT w/ support from City of Sedona	TBD

		visibility to bikes or pedestrians. • Approval may take time. Nighttime issues are still there. • May have visibitlity issues for motorists. • May need to extend intersection lighting to make visible where barriers end.		
11. Install low level, shielded pedestrian lighting along the sidewalks.	• Increases/provides back lighting of pedestrians. • Lower lighting level can help dark skies. • Will encourage folks to walk more at night – due to improved safety, may enhance businesses • Very pedestrian friendly solution to those using the sidewalks • These lights will be much more dark sky friendly than 30 foot tall poles. • Lights will make it easier to see pedestrians on the sidewalk and as they step from the curb. • Makes for a good walk at night • Allows pedestrians to move more easily along sidewalks because they can now see. • Provides motorists with a view of pedestrians along the roadway and at the edge of the roadway before they may enter the traffic path for crossing. • Will make walking secure on sidewalks.	• Will not light the roadway and assist with lighting the roadway for drivers. • A driver may not notice someone leaving the sidewalk lighted area or may think they went into an adjacent business rather than crossing the dark street. • Produces a light strip through the community and may affect dark skies. • Initial cost and funding source. • Ongoing maintenance and power costs. Doesn't address pedestrians crossing the highway at night. • These lights will not illuminate SR 89A and will not help motorists see pedestrians that are in the roadway. Doesn't address daytime pedestrian safety issues. • None • Minimal help for motorists • Does not light the roadway.	City of Sedona – Enhancement Application	As part of 2011 89A improvements

		• May have no or negative impact on pedestrian-vehicle crashes.		
12. Install pedestrian activated crosswalks and associated lighting at **warranted** locations as determined through an above option of #6	• Provides drivers notice that pedestrians may be crossing. • Limits lighting to an as needed basis, therefore helps dark skies. • Will improve overall safety (both day and night) • Potentially safer crossing location if designed and maintained properly. Unlikely there are enough pedestrians in any one location to warrant this type of crosswalk. • Will increase safety. • 40 to 90% improvement in PVC when using sensor activated on-off method per references marked "a" & "d" shown on References below • Provides for pedestrian crossing • Focuses solution on areas of concern • Allows pedestrians to move more easily along sidewalks because they can now see. • Provides motorists with a view of pedestrians along the roadway and at the edge of the roadway before they may enter the traffic path for crossing. • Will have impacts on night-time pedestrian-vehicle crashes if pedestrians use these crosswalks.	• People can play with the crosswalk lights not intending to cross. • Drivers may not anticipate people not crossing in the crosswalk. • May create unexpected stopping points on the highway for motorists. • May increase rear end accidents. • May embolden pedestrians with a false sense of security. • Will increase traffic congestion. Land uses that generate the need for the crosswalks may change over time, which could make the crosswalk locations obsolete. • 32 to 43% improvement in PVC without sensor activation per references marked "a" & "d" shown on References below • May slow traffic • Only effective if pedestrian chooses to use them • Only lights a specific area and therefore does not benefit all users at all locations. • Not aware of any.	ADOT w/ support from City of Sedona	24-36 months Costs TBD
13. Install targeted street lighting at locations with highest levels of pedestrian/motorist crash	• Focuses on past experience. • Limits lighting and therefore can help dark skies.	• The business occupancy of the corridor may change over time, making the proposed lighting obsolete.	ADOT w/ support from City of Sedona	Cost TBD 24-36 months

activity (Rodeo – Harmony; Soldier Pass – Posse Ground)	• Will improve nighttime safety • Any street lighting will have a positive effect on motorist/pedestrian interactions and will make it safer for both. Most City street intersections with SR89A would benefit from this treatment. • Will increase safety and improve visibility in these targeted areas. • Makes it easier to see pedestrians • Should improve safety for all users of lighted area • Is helpful for specific areas. • May have very little impact on night-time pedestrian-vehicle crashes. • Is supported by ADOT if done in conjunction with raised median barriers along entire studied corridor.	• Uneven lighting pattern may affect ability of people's eyes to adjust. • Ongoing maintenance and power costs. • Could create lighting contrast issues and make the situation less safe outside of the targeted areas. Will have somewhat of a negative impact on dark night skies. Land uses that generate the need for the targeted lighting may change over time, which could make the targeted lighting locations obsolete. Doesn't address daytime pedestrian safety issues. • As we were told at the first meeting in 11/07 by ADOT that we will have only data driven solutions, the requirement for a nighttime study is obvious before we can discuss 7 • None if proper lighting is used • Resistance from "no light," factions • Only provides benefit to specific areas and cannot benefit all users at all locations. • May create non-uniform lighting situation along the 2-mile segment negatively impacting the night-time pedestrian-vehicle crashes.		
14. Install continuous dark-sky compliant street lighting from Dry Creek Road to Airport Road.	• Minimizes impact on dark sky. • Improves pedestrian/driver safety. • Will improve nighttime safety	• There will be more lighting in the community. • Ongoing maintenance and power costs.	ADOT w/ City maintenance	Approx. $2 million 24-36 mo.

	• Meets the objective of reducing nighttime pedestrian accidents. • Provides for a more comfortable nighttime driving experience. • Potentially helpful to local businesses – motorists can find their way to that business. • Studies show a 16:1 cost benefit ratio for this type of lighting system. Poles and lights can be designed to be aesthetically pleasing. • Will provide lighting along the entire corridor, considerably increasing safety at night. • May provide an opportunity to underground power lines at the same time this project is done. • Improves safety and visibility along entire corridor • Has the greatest positive safety impact for all nighttime roadway users. • The best possible option to reduce nighttime pedestrian-vehicle crashes.	• Community support. • Doesn't address daytime pedestrian safety issues. Will be unattractive and will have a negative impact on dark night skies. Could be perceived as being inconsistent with the Community Plan's vision for Sedona. • 5.6% 24 hour "Sedona" improvement in PVC and 35% national nighttime only improvement leaves continuous lighting as lowest possible solution per reference marked "h" shown on References below. • High resistance from "no light," factions • Will contribute new lighting to the roadway corridor. • When applying the 40% national nighttime data to Sedona's unique situation and historic 84% daytime and 16% nighttime crash rate, Sedona may not necessarily see a significant improvement in nighttime injuries or crashes due to continuous roadway lights on SR 89A.		
15. Paint curbing at driveways to aid motorist ability to see access points (reflective, high visibility paint)	• Improves visibility of business and street access points. (Reflectors have already been installed at some intersections in the City.) • Might help motorists find a driveway. • May help traffic flow. • Sight pollution	• Questions regarding maintenance of the painting. • All driveways don't need this since they may not operate at night. • Ongoing maintenance. Aesthetics. • Very little, if any, benefit to pedestrian/motorist interaction.	Local Businesses with support from Chamber of Commerce	Nominal cost by business owners

	• Quick, low cost • May provide some additional driveway guidance. • May have very little effect on mainline pedestrian-vehicle crashes.	• Will likely not be very effective and will present an ongoing maintenance issue. • Sight pollution • Lack of consistency in markings possible. Unknown if paid for publicly or privately • High maintenance poor aesthetics. • Does nothing to improve pedestrian or bike safety. • None.		
16. Install no lighting of any type (other than at signalized intersections)	• Will maintain dark night sky and will not create additional visual impact during the day. • Public expenditures will be reduced. • Dark Sky situation will remain unchanged • The skyline of Sedona will remain unchanged. • City maintenance costs will remain unchanged relative to City lighting. • Preserves dark sky • No added roadway lights to the corridor. • None.	• Will not address nighttime safety issues. • Depending on the reason for no lights, the value of human life preservation vs. dark sky preservation will continue to be debated within the community. • The probability of more near misses and accidents remains unchanged. • The contrast of ambient light and headlights will remain high. This affects visibility. • Doesn't resolve problem • Does not solve the nighttime safety issues for all roadway users. • Based on recently completed studies on this corridor, lack of action shows negligence on the part of ADOT and the City of Sedona in		

		addressing the problem. • Will continue with more pedestrian-vehicle crashes and fatalities due to existing visibility problem.		

References:

a. American Journal of Public Health; author: Insurance Institute for Highway Safety

b. Ryerson Polytechnic University, Insurance Institute for Highway Safety, University of Maine

c. National Highway Traffic Safety Administration/Department of Transportation, Washington, DC

d. Federal Highway Administration/Department of Transportation, Washington, DC

e. NHMRD Road Accident Research Unit, University of Adelaide, Australia

f. Insurance Institute for Highway Safety, Highway Loss Data Institute

g. National Highway Traffic Safety Administration, National Center for Statistics & Analysis, Washington, DC

h. Roadway Lighting: An Investigation and Evaluation of Three Different Light Sources; Final Report Prepared by Ian Lewin of Lighting Sciences & Paul Box of Paul Box Associates both from Scottsdale, AZ for the Arizona Department of Transportation in cooperation with the US DOT and FHA, May 2003 (please see note #4 below for the summary for this Final Report)

THE DATA: PVC 24 hour NIGHT/DAY IMPROVEMENTS (PVC N/D I)	PVC N/D I %	References
1) Sensor activated on demand in-pavement lighted crosswalks	40 to 90%	a, d
2) Roundabout at Andante deaths decrease (vehicle to vehicle crashes)	90%	b
3) Roundabout at Andante crash decrease (vehicle to vehicle crashes)	76%	b
4) Speed and Jaywalking enforcement	50%+	b, c
5) Lowering speed limit on 89A	32 to 51%	c, e, f
6) Traffic Light at Andante	50%	a
7) Refuge islands at marked crossings	50%	a
8) In pavement lighted crosswalks without sensor activation	32 to 43%	a, d
9) Refuge Islands at unmarked crossings	40%	a

10a) Highway & Rural Continuous roadway lighting (35% night only)	19.6%	h
(40% on Freeways night only, 18% night/day)		
10b) corrected for Sedona's 16% 84% night-day crash data:	5.6%	

Notes:

1) PVC = pedestrian vehicle crash improvements

2) % of PVC deaths that are daytime: 40 to 42%, please see references f, g

3) Sedona nighttime crashes 16%, daytime crashes 84% per Sedona Pedestrian Crossing Study, May 2006

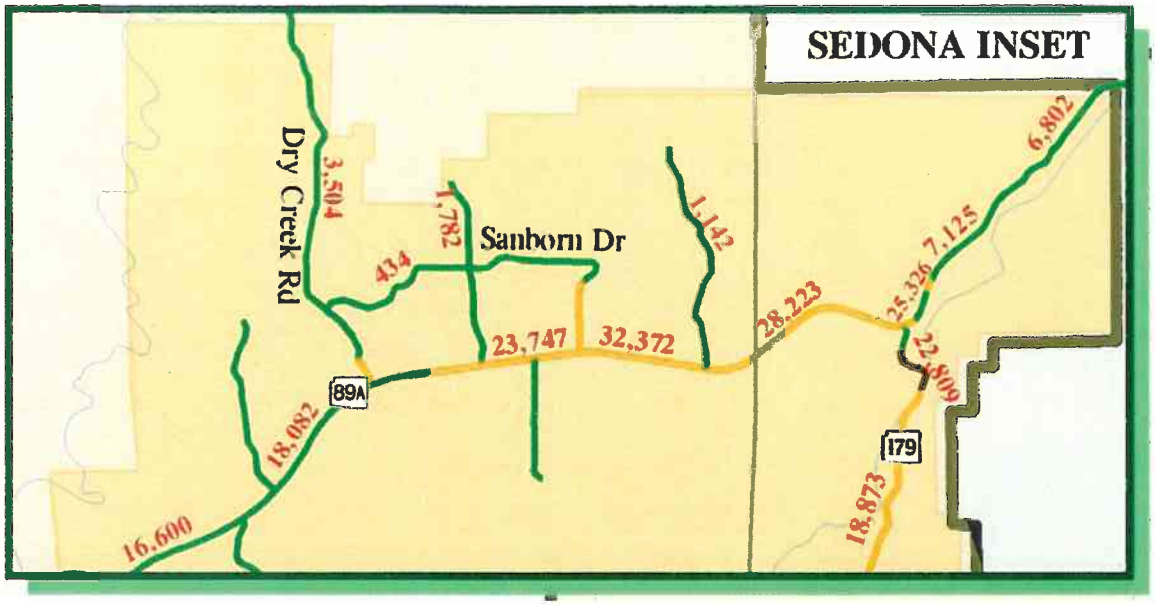
4) The Summary for the Ian Lewin, Paul Box, ADOT Final Report (reference "h") reads as follows:

> **"While it is seldom possible to warrant continuous rural highway lighting on a benefit-cost basis, a moderate expenditure for intersection lighting may be warranted, based on these studies."**

APPENDIX B

2007 AND 2030 VERDE VALLEY STUDY MODELS FOR SEDONA

2007 AADT for Sedona



2030 AADT for Sedona

APPENDIX C

2002 FHWA RECOMMENDATIONS/IMPROVEMENTS AT UNCONTROLLED LOCATIONS

Table 1. 2002 FHWA recommendations for considering marked crosswalks and other needed pedestrian improvements at uncontrolled locations[a].

	≤ 9,000 ADT			> 9,000 to ≤ 12,000 to			> 12,000 to ≤ 15,000 ADT			> 15,000 ADT		
	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph[b]
2 lanes												
3 lanes												
++4 lanes, raised median[c]												
++4 lanes, no median												

Key

Candidate sites for marked crosswalks. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

Probable candidate sites for marked crosswalks. Potential increase in pedestrian crash risk may occur if marked crosswalks are added without other pedestrian facility enhancements. These locations should be closely monitored and may be considered for enhancements as feasible.

Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.

a. These guidelines include interestion and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

b. Where the posted speed limit or 85th percentile speed exceeds 40 mph, marked crosswalks alone should not be used at uncontrolled locations.

c. The raised median or refuge island must be at least 4 ft. (1.2 m) wide and 6 ft. (1.8 m) long to adequately serve as a refuge area for pedestrians.

APPENDIX D

FINAL REPORT SR-89A ROUTE TRANSFER:

CITY MANAGER RESPONSE TO ADOT

Public Works Dept.

Memo

To: John Harper, ADOT Flagstaff District Manager

From: Charles Mosley, PE MPA Public Works Director/City Engineer

CC: Tim Ernster, City Manager
John O'Brien, Communtiy Development Director

Date: August 16, 2010

Re: Comments on Final Report SR 89A Route Transfer Dated

Below are my comments on the July 23, 2010 Report.

1. The City's acceptance of the report does not limit its options to raise issues during the negotiation. The phrase, "The information provided in this report is intended to serve as the basis for future discussions between the City and the State regarding route transfers." In the Introduction should not be held to infer the City's acceptance of such a conclusion on the City's part.
2. Please note that the City may not wish to take back the area on SR 179 or the area north of Airport Road/SR 89A intersection. The City may wish to designate the south end of the turnback area as Dry Creek Road intersection.
3. Why isn't Foothills Drive shown as a future signalized intersection. The City would like to see this designation in light of the existing medical facility at the intersection.
4. Were some discrepancies between plans and 2008 photo log resolved by field trips or just Google view? What would a digitized topographic survey of the roadway cost (curbs, sidewalks, utility covers, poles, signs) cost?
5. It appears that the drainage facilities capacities were not compared to ADOT standards. This information should be included in the study, along with the 100-year flood plain investigation. Mention should be made of the areas where the City Storm Drain Master Plan indicates a lack of capacity based upon ADOT or City standards.
6. Note that although classified, as an arterial SR 89A does not function as an arterial. State the number of intersections and driveways in the various segments of the study area. This information was on page 2 of the Andante Traffic Signal Needs Study (January 5, 2009).
7. In Table 1 notes it should be stated whether the bike lane to be developed will meet minimum standards. Also could the road be modified within the existing Right-of-way to comply with the ADOT standards? This applies to bike lane and other ADOT standards that are not currently met.
8. In Table 1 notes it should be stated that some drainage facilities are known not to comply with the identified standard.

9. What about utilities paying for their relocations? In some situations would the City have to reimburse the utilities where if the work were performed under ADOT the utilities would have to bear the costs?
10. Note that the pavement work also includes replacement of handicapped ramps for ADA compliance. Some sidewalk area and driveway areas do not comply with ADA requirements. Future reconstruction of these non-compliant areas could require significant rework of existing areas, such as construction of walkways behind driveway accesses and even some reconstruction of driveway slopes.
11. Can Table 2 be expanded to identify known crossings and what standards they meet or don't meet? Also under drainage add a subheading for Soldier Wash similar to Southwest Drive.
12. The Coffee Pot, Dry Creek Road, Madole, and Posse Ground intersections are also intersections of concern for drainage per the City Master Plan and City experience. Please add them to tables 2 and 9. (See Drainage Table below)
13. In the traffic section can projections be made of the need for additional traffic signals relative to increased ADT.
14. It needs to be noted that the Airport Road project is under construction and the anticipated project cost is about one-half of what is shown.
15. For the maintenance paving please list the nearest intersections at the limits in addition to the mileposts.
16. Other projects to be included under "Identified Road Improvements" would include a traffic signal at Foothills Road, the completion of installation of video cameras at signalized intersections, construction of a low retaining wall at the north east corner of Soldier Pass Road going east due to dirt sloughing on the sidewalk (about 300 feet of 2 foot high wall), and also placement of filters in storm drain catchbasin to reduce stormwater pollution. As traffic increases there may be ingress and egress problems at the SR 89A/Rolling Hills Road. The City also thinks that an on-demand emergency traffic light is appropriate at the SR 89A/Southwest Drive intersection. The Sedona Fire District has a fire station on Southwest Drive. A cost range for the road improvements should be projected as part of the report. Also see comment 12 above regarding drainage comments.
17. When looking at the project cost for ADOT work add an estimate of utility relocation cost and identify if the City would be able to require the utility to pay the cost in the case of a turn back.
18. ADOT should have an evaluation of the drainage structures on SR 179 in light of the completed project. Table 4 needs to be revised.
19. Note with regard to the SR 179 segment the City of Sedona takes the position that ADOT should consider the retention of that segment and the SR 89A segment at least to a point east and west of the roundabouts at Brewer and the "Y".
20. As regards the Roadway Maintenance costs what would the ADOT cost be if it had included issues such as roadway crack sealing, periodic application of rejuvenating agents, and also storm drain catchbasin cleaning?
21. There is some question regarding the completeness of Table 7. For instance it does not identify the Posse Ground intersection, which has had at least 30 accidents per City of Sedona Police Department records. What actions, at what costs, would ADOT criteria recommend for high accident intersections. Is it correct to anticipate that as

APPENDIX E

CITY MANAGER MEMO TO MAYOR AND COUNCIL, WITH SETH'S COMMENTS

City Manager's Office
Memo

Date: April 21, 2008 with Seth's comments and/or suggestions

To: Mayor Colquitt and City Council

From: Eric J. Levitt
City Manager

RE: Highway 89 Safety Panel Options

In early 2006, the City of Sedona expressed a concern to the Arizona Department of Transportation (ADOT) regarding several fatal vehicle/pedestrian accidents along Highway 89A in West Sedona from approximately Airport Road to Dry Creek Road. In June 2006, ADOT presented the results of its Pedestrian Crossing Study to the City Council, recommending the installation of pedestrian warning signs and highway lighting in this area. A lighting project analysis was initiated in early 2007 and in August, ADOT presented a proposal to the Sedona City Council to install 76 streetlights along SR 89A. The project qualified for Federal Safety funds to be used to pay for the lighting improvements based on its potential nighttime crash reduction potential.

At the August 2007 Council meeting, and at a subsequent meeting in September, several Sedona citizens expressed their concerns and displeasure with the lighting proposal. They were worried the additional lighting would impinge upon the dark sky nature of the community, and the poles would detract from the aesthetics of the area. They were also skeptical that lighting (really most citizens claimed that the lighting would not make any difference or it was way overkill for what they thought was reasonable. The point was also made that the lighting would only achieve benefit at night and would have no impact for the day issue) would have any real improvement effect. Due to the significant negative response to the proposal, the Council requested the formation of an Advisory Panel to consider the proposed solution of lighting only (in reality the actual problem was not studied, the problem is evident (e.g. the problem is unrestricted pedestrian crossings can result in crashes), what was studied was the best approach to this problem within the context of the City of Sedona) further study the problem and determine if there are other alternatives that could improve pedestrian and bicycle safety along 89A.

Deleted: alone

Through this panel, seventeen various short and long-term options were discussed, as well as the pros and cons associated with each possible option. In the order of a completion timeframe, the following options are considered more feasible in the short-term and are recommended by the panel:

1. Reduce the speed limit between Airport Road and Dry Creek Rd from 40 mph to 35 mph (with the assistance of "your speed is" radar warning signs).
2. Enforce all road user laws, including jaywalking, bicycle, and vehicles. Continue stepped-up enforcement.

3. Enforce dark sky ordinances and help bring businesses into compliance. Add why this is being done, this is an offset to help reduce the City wide net impact of adding more road lighting on 89A.
4. Educate residents and tourists about Sedona's Dark Sky initiative and corresponding pedestrian/bicycle/motorist safety precautions. Need to more specific that the idea is for folks to wear light colored clothing with retroreflective tabs and/or carry flashlights (which are on) so they are more visible to drivers under headlight seeing conditions. That Sedona resists encouraging any outdoor lighting to help preserve the night sky for all to enjoy. However, this comes with the additional burden for individual to be aware of this and take proper precautions so they do not get hurt or killed when they cross roadway where they should not at night because drivers may not be able to see them because there is little or no supplemental road lighting..
5. Place notices (painted curbs or sidewalks) and/or barriers in strategic locations telling pedestrians to use crosswalks and to restrict mid-street crossing (with potential areas including locations near Coffee Pot Restaurant and Harkins Theater and New Frontiers and Olde Sedona Restaurant)
6. Conduct pedestrian crosswalk warrant analysis in the vicinities of Near Marketplace west of Soldier Pass Road, Posse Grounds, Near Tortilla Dr.- hotels/restaurants/Giant gas station. (If warranted, see #12). Request new businesses conduct pedestrian analysis

The advisory panel also recommends the following longer-term options:

1. Install a traffic signal at Andante intersection, with associated crosswalks and a length of continous lighting on either side of it.
2. Implement photo speed enforcement cameras along the corridor with either mobile vans or fixed devices.
3. Modify the roadway to restripe and add a shoulder and include as part of the next programmed pavement preservation project.
4. Install a pretty much continious raised median (basically between each of the existing traffic signals for the entire 2 mile corridor) that would serve as a traffic control (reduce left in left out vehicle conflicts) and a refuge island for pedestrians and barrier to unrestricted pedestrian crossings. The median and fence will be designed to channel pedestrians to organized crossings either at existing signalized intersections or new pedestrian signals that are to be placed at logical areas along the corridor. It is important to note that the new median will impact left in and left out access to many existing businesses. The advantage of the median with the pedestrian barrier fence is that it will work both day and night and it also should help reduce right angle vehicle crashes that are result of the unrestricted left in and left out access per the two way double left turn lane.
5. Install at least one pedestrian activated crosswalk (I think it will be more like 3 or 4 hawks, one will not be enough) and associated lighting at **warranted** locations (to be determined).
6. Install targeted street lighting at locations with highest levels of pedestrian/motorist crash activity (Rodeo – Harmony; Soldier Pass – Posse Ground) in combination with a comprehensive raised median with a pedestrian crossing barrier fence system to be installed along the corridor that would be developed in conjunction with the character of the community. (Note: Cliff Ochser did not agree with the panel recommendation.) An e-mail from ADOT will be attached clarifying ADOT's agreement with this solution.

Deleted: bike lanes

Deleted: strategically located

Deleted: raised medians

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Deleted: Locations and design need to be studied for impact to business access and traffic flow.

Deleted: median/barrier

I would also like to thank the following individuals who participated in the Advisory Panel and provided many hours of service.

City of Sedona

Eric Levitt	City Manager
John O'Brien	Community Development Director
Charles Mosley	Director of Public Works
Joe Vernier	Police Chief

Sedona Fire District

Matt Shobert	Fire Chief

Arizona Department of Transportation

John Harper	District Engineer, Flagstaff
Chuck Gillick	Traffic Engineer, Flagstaff
Kohinoor Kar	Manager, Safety Section
Richard Weeks	Traffic Engineer, Safety Section
Seth Chalmers	consultant

Sedona Public Representatives

Jennifer Wesselhoff	President/CEO Sedona Chamber of Commerce
Doug Blackwell	Douglas Blackwell Photography
Cliff Ochser	Evening Sky Tours
K.B. Bren	Citizens for Safety

Technical Assistance

David Crawford, Scott Davis, & Pete Strasser	International Dark Sky Association
Chris Luginbuhl	Naval Observatory, Flagstaff
Terry Smiley	Stanley Consultants (Consultant to ADOT)
Russ Hanson	TransTech Consulting (Meeting facilitator, Panel coordination)

APPENDIX F

ADOT'S POSITION LETTER, FEBRUARY 23, 2010

Arizona Department of Transportation

Office of the Director

206 South Seventeenth Avenue Phoenix, Arizona 85007-3213

Janice K. Brewer
Governor

John S. Halikowski
Director

John A. Bogert
Chief of Operations

John McGee
Executive Director
for Planning & Policy

February 23, 2010

The Honorable Rob Adams
City of Sedona
102 Roadrunner Drive
Sedona, AZ 86336

Dear Mayor Adams:

Thank you for your letter dated February 12, 2010. As I noted in my previous letter of January 28, 2010, the Arizona Department of Transportation (ADOT) has been openly working with the City of Sedona and the community since 2006 to address safety concerns on State Route 89A (SR 89A) in West Sedona. ADOT remains committed to public safety and to specifically addressing the safety issues on SR 89A.

The following are responses to the questions in your letter.

The Department has reviewed past documentation on the median and pedestrian barrier concept. Based on documentation found in the June 2009 Final Project Assessment (PA), the topic of medians and pedestrian barriers was discussed by the City of Sedona Pedestrian Safety Advisory Panel at their meeting on April 9, 2008. Medians were also discussed at the June 10, 2008, Council meeting, the July 8, 2008, Council meeting, and the August 12, 2008, Council meeting. Mr. Harper's letter to you dated August 12, 2008, outlined the Department's expectation that the City of Sedona would be responsible for the necessary studies required for the locations and designs of the proposed medians, traffic controls, and pedestrian barriers. The Department's position has not changed on this point. It appears that installation of medians and pedestrian barriers has been discussed and that the Council did not believe it to be a viable alternative to address the immediate needs within the corridor.

ADOT has performed warrant analyses for two potential pedestrian crossings of the type you describe in your letter. The study was performed as a result of the August 13, 2008, request from the Council. It is my understanding the preliminary results of these analyses were presented at the October 28, 2009, Council meeting. Both intersections failed to meet the minimum warrant criteria. The study has recently been finalized and is available for review on the project website.

With regard to your funding question, the authorization received from the Federal Highway Administration (FHWA) for Highway Enhancement for Safety (HES) funding is limited to the scope of the project submitted, which is continuous roadway lighting and a traffic signal at the SR 89A / Andante intersection. The submittal to FHWA includes a planning level cost estimate of the proposed improvement and a benefit/cost calculation based on the anticipated reduction in crashes using established crash reduction factors accepted by

FHWA. Any safety project submitted to the FHWA for consideration must have a benefit/cost analysis and may not qualify for HES funding. If it does not meet HES funding criteria, the project must then compete with other statewide projects that have already received or are awaiting funding authorization.

After examining the alternatives, we agree with the Council's belief that they are not viable, and ADOT believes that continuous highway lighting is the preferred option. ADOT does not have a "do nothing" option as long as the State is responsible for SR 89A. Consequently, unless the City assumes ownership of this state highway, ADOT is not fulfilling its duty to the taxpayers of this State who must all share the burden for any lawsuits prevailing against the State due to inadequate safety measures on SR 89A. In addition, the State's resources to mitigate the safety and liability issues are limited and time is of the essence to construct these improvements. ADOT has designated federal funds and has received approval from the State Transportation Board on February 19, 2010, to proceed with this project.

A recent appellate decision stated in brief that ADOT cannot create a policy that is contrary to its duty as set fourth in ARS 28-322 (a) (b) (2), which in part states that "ADOT shall exercise exclusive control and jurisdiction over state highways." The court opined that through ADOT's action and statements regarding its need to cooperate with local jurisdiction and receiving a consensus before moving forward with a safety improvement, essentially was offering the cities veto power over ADOT's design decisions, which appears contrary to the statute.

If the citizens of Sedona want to keep this issue confined to their City, then ADOT can arrange a route transfer in six months or possibly less. Otherwise, in the interest of improving public safety and reducing liability to Arizona taxpayers, ADOT intends to install a new lighting system on SR 89A between Dry Creek Road and Airport Road.

Sincerely,

John S. Halikowski

cc: Tim Ernster, City Manager
Alison Zelms, Assistant City Manager
Charles Mosley, Public Works Director
John O'Brien, Community Development Director
Cliff Hamilton, Vice Mayor
Jerry Frey, Councilor
Pud Colquitt, Councilor
Nancy Scagnelli, Councilor
Mark DiNunzio, Councilor
Dan Surber, Councilor

APPENDIX G

COST ESTIMATES

15% Construction Cost Estimate

SR 89A Safety Alternative - Median From Airport to Dry Creek

October, 2010

Project No.:
Location: SR 89A
Project Limits: Airport to Dry Creek

Bid Item No.	Description	Unit	Quantity	Unit Price	Total
2020036	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ. YD	17,256	$3.00	$51,767
2030301	ROADWAY EXCAVATION	CU. YD.	7,669	$9.00	$69,022
3030022	AGGREGATE BASE, CLASS 2 (12" THICK)	CU. YD.	2,742	$22.00	$60,324
4090006	ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL) (SPECIAL MIX)	TON	1,594	$130.00	$207,192
6070041	SIGN POST (P-1)(PERFORATED)(SINGLE)	L.FT.	552	$15.00	$8,280
6070046	FOUNDATION FOR SIGN POST (P-1)(PERFORATED)	EACH	46	$240.00	$11,040
6080003	REGULATORY,WARN, OR MARKER SIGN PANEL W/TYPE III/IV SHEET	SQ.FT.	912	$30.00	$27,360
7015052	OBLITERATE PAVEMENT MARKING (STRIPE)	L.FT.	2,550	$1.00	$2,550
7090001	DUAL COMPONENT PAVEMENT MARKING (WHITE EPOXY)	L.FT.	2,550	$1.00	$2,550
7090010	DUAL COMPONENT PAVEMENT LEGEND ("ONLY")	EACH	34	$200.00	$6,800
7090012	DUAL COMPONENT PAVEMENT SYMBOL (LEFT TURN ARROW)	EACH	68	$200.00	$13,600
9080084	CONCRETE CURB AND GUTTER (C-05.10) (TYPE D)	L.FT.	24,678	$30.00	$740,340
				Subtotal 1	**$1,200,825**
9240050	MISCELLANEOUS WORK (10%)	L.SUM	1	$120,083	$120,083
				Subtotal 2	**$1,320,908**
2060002	FURNISH WATER SUPPLY (2%)	L.SUM	1	$26,418	$26,418
9999910	LUMP SUM (LANDSCAPING)(15%)	L.SUM	1	$198,136	$198,136
7010003	MAINTENANCE AND PROTECTION OF TRAFFIC (20%)	L.SUM	1	$264,182	$264,182
9240170	CONTRACTOR QUALITY CONTROL (2%)	L.SUM	1	$26,418	$26,418
9250001	CONSTRUCTION SURVEYING AND LAYOUT (2%)	L.SUM	1	$24,017	$24,017
				Subtotal 3	**$1,860,078**
9010001	MOBILIZATION (10%)	L.SUM	1	$186,008	$186,008
				Subtotal 4	**$2,046,086**
	ENGINEERING CONTINGENCIES (10%)	L.SUM	1	$204,609	$204,609
	CONSTRUCTION CONTINGENCIES (15%)	L.SUM	1	$306,913	$306,913
	INDIRECT COST ALLOCATION (5.19%)	L.SUM	1	$265,053	$265,053
	PUBLIC RELATIONS (2%)	L.SUM	1	$40,922	$40,922
	CONSTRUCTION ADMINISTRATION (10%)	L.SUM	1	$204,609	$204,609
				Subtotal 5	**$3,068,191**
	FINAL DESIGN COSTS (15%)	L.SUM	1	$460,229	$460,229
				TOTAL PROJECT COST	**$3,528,419**

CivTech

Total Length of Project - Airport to Dry Creek

11300 minus major intersection (5 at 80' wide)

2.140152 miles

	Curb & Gutter - Type D		
Sheet	Begin Sta	End Sta	Length
	11300	11300	22600
	17	17	1598
	12		480
Total			**24678**

Total length of project

Assume 1/8 mile left-ins, 90' taper (45' extra curb), 2' nose

Asume 12 end points to median, 12' width return (24' radius = 40' extra curb each)

	Striping Obliteration		
	17	17	2550
Total			**2550**

Assume each turn lane is 75' in length

	Signs		
	17	17	68
	17	17	68
	29	17	46
	29	17	46
Total			**228**

Assume standard ADOT signage, 2 left turn lane signs @ each turn pocket, median nose signs, object markers
24x36 (left turn signs)
24x12 (seft turn lane signs)
24x36
24x24
ONLY FOR MEDIAN

Pavement Area	
	15300
	140000
Total	**155300**

turn lane pockets = striping obliteration length * (2' median + 2' sawcut on either side)

total length minus turn pockets = 11300-2550 * (12+2+2)

15% Construction Cost Estimate

SR 89A Safety Alternative - 8' added Pavement, driveways & c/g From Airport to Dry Creek

October, 2010

Project No.:
Location: SR 89A
Project Limits: Airport to Dry Creek

Bid Item No.	Description	Unit	Quantity	Unit Price	Total
2020036	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ. YD	25,111	$3.00	$75,333
2020053	REMOVE (CATCH BASIN)	EACH	40	$750.00	$30,000
2030301	ROADWAY EXCAVATION	CU. YD.	5,580	$9.00	$50,222
3030022	AGGREGATE BASE, CLASS 2 (12" THICK)	CU. YD.	6,278	$22.00	$138,111
4090006	ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL) (SPECIAL MIX)	TON	3,649	$130.00	$474,365
5012530	STORM DRAIN PIPE, 30"	L.FT.	480	$85.00	$40,800
5030092	CONCRETE CATCH BASIN (C-15.40) ONE 3.5' WING, H=8' OR LESS	EACH	40	$4,000.00	$160,000
6070041	SIGN POST (P-1)(PERFORATED)(SINGLE)	L.FT.	2,712	$15.00	$40,680
6070046	FOUNDATION FOR SIGN POST (P-1)(PERFORATED)	EACH	226	$240.00	$54,240
6080003	REGULATORY,WARN, OR MARKER SIGN PANEL W/TYPE III/IV SHEET	SQ.FT.	2,712	$30.00	$81,360
7015052	OBLITERATE PAVEMENT MARKING (STRIPE)	L.FT.	33,900	$1.00	$33,900
7090001	DUAL COMPONENT PAVEMENT MARKING (WHITE EPOXY)	L.FT.	33,900	$1.00	$33,900
7090010	DUAL COMPONENT PAVEMENT LEGEND ("ONLY")	EACH	34	$200.00	$6,800
7090012	DUAL COMPONENT PAVEMENT SYMBOL (LEFT TURN ARROW)	EACH	68	$200.00	$13,600
9080084	CONCRETE CURB AND GUTTER (C-05.10) (TYPE D)	L.FT.	11,300	$30.00	$339,000
9080201	CONCRETE SIDEWALK (C-05.20)	SQ.FT.	66,000	$4.00	$264,000
9080296	CONCRETE SIDEWALK RAMP (TYPE B)	EACH	20	$1,750.00	$35,000
9080301	CONCRETE DRIVEWAY (C-05.20)	SQ.FT.	21,600	$6.00	$129,600
				Subtotal 1	**$2,000,911**
9240050	MISCELLANEOUS WORK (10%)	L.SUM	1	$200,091	$200,091
				Subtotal 2	**$2,201,002**
2060002	FURNISH WATER SUPPLY (2%)	L.SUM	1	$44,020	$44,020
9999910	LUMP SUM (LANDSCAPING)(15%)	L.SUM	1	$330,150	$330,150
7010003	MAINTENANCE AND PROTECTION OF TRAFFIC (20%)	L.SUM	1	$440,200	$440,200
9240170	CONTRACTOR QUALITY CONTROL (2%)	L.SUM	1	$44,020	$44,020
9250001	CONSTRUCTION SURVEYING AND LAYOUT (2%)	L.SUM	1	$40,018	$40,018
				Subtotal 3	**$3,099,412**
9010001	MOBILIZATION (10%)	L.SUM	1	$309,941	$309,941
				Subtotal 4	**$3,409,353**
	ENGINEERING CONTINGENCIES (10%)	L.SUM	1	$340,935	$340,935
	CONSTRUCTION CONTINGENCIES (15%)	L.SUM	1	$511,403	$511,403
	INDIRECT COST ALLOCATION (5.19%)	L.SUM	1	$441,652	$441,652
	PUBLIC RELATIONS (2%)	L.SUM	1	$68,187	$68,187
	CONSTRUCTION ADMINISTRATION (10%)	L.SUM	1	$340,935	$340,935
				Subtotal 5	**$5,112,465**
	FINAL DESIGN COSTS (15%)	L.SUM	1	$766,870	$766,870
				TOTAL PROJECT COST	**$5,879,335**

CivTech

Total Length of Project - Airport to Dry Creek

11300 minus major intersection (5 at 80' wide)

2.140152 miles

	Curb & Gutter - Type D		
Sheet	Begin Sta	End Sta	Length
	11300		11300
	0		0
	0		0
Total			**11300**

Total length of project

Assume 1/8 mile left-ins, 90' taper (45' extra curb), 2' nose

Asume 12 end points to median, 12' width return (24' radius = 40' extra curb each)

	Striping Obliteration		
	0	0	0
Total			**0**

Assume each turn lane is 75' in length

	Signs		
	113	0	226
	113	0	226
	113	0	113
	113	0	113
Total			**678**

Assume standard ADOT signage, 2 left turn lane signs @ each turn pocket, median nose signs, object markers
24x36 (left turn signs)
24x12 (seft turn lane signs)
24x36
24x24
ONLY FOR MEDIAN

Pavement Area	
	0
	113000
Total	**113000**

turn lane pockets = striping obliteration length * (2' median + 2' sawcut on either side)

total length minus turn pockets = 11300-2550 * (8+2)

Minimum Recommended Estimate

		East End	West End
Length		2,200	1,500
Length Factor		0.208	0.142
Median for 2 miles	$3,528,419	735,087	501,196
Ped Barrier for 2 miles	$500,000	104,167	71,023
HAWK Signal per site	$35,000	35,000	35,000
Signal, 2 A poles and 4 ped signals	$15,000	15,000	15,000
Lighting	$30,000	30,000	30,000
Bike Lanes	$45,000	22,500	22,500
		941,754	674,719
		1,616,473	

APPENDIX H

SEDONA ROADWAY LIGHTING ALTERNATIVES

SEDONA ROADWAY LIGHTING
Project No. 21278
Explanation of Alternatives Spreadsheet

A total of 68 roadway lighting alternatives were analyzed for State Route 89A from Dry Creek Road (Milepost 371.01) to Airport Road (Milepost 373.2). Along the top of the alternatives spreadsheet, the various columns consist of three main sections:

1. **Lighting Characteristics – Orange**
   The lighting characteristics section includes the input characteristics of each specific alternative, such as the pole heights, the mast arm lengths, the fixture types, the photometric file, the lamp type, and the lamp wattage.

2. **System Measures of Effectiveness – Blue**
   The system measures of effectiveness section includes the output values for each specific alternative, such as the maximum spacing between light poles on one side, the approximate number of poles required to light this section of roadway, the average illuminance, the uniformity, and the total watts and lumens used.

3. **Lighting Cost Estimate - Green**
   The lighting cost estimate section includes the total construction cost for the installation of the system, the annual system operations and maintenance costs, and the City of Sedona's estimated responsibility.

Within the spreadsheet, the highlighted cells represent the following:

- Orange – The lighting characteristic that varied in the group.
- Blue – The maximum spacing of the group. The dark blue is the alternative that was selected for cost estimate evaluation.
- Red/Pink – The approximate number of streetlight poles needed for the blue highlighted alternatives.
- Green – The total system construction cost, the annual system operations and maintenance cost, and the City of Sedona cost.

The following are descriptions of the alternatives:

- **Alternative PA** - The alternative in the final project assessment. This alternative was developed using a pole offset of 8' from back of curb. Subsequent alternatives were evaluated using a pole offset of 4' from back of curb.

- **Alternatives 1-24 looks at the ADOT and City of Mesa High Pressure Sodium (HPS) Type II and Type III cobrahead street lights**

- **Alternatives 1 to 12** – Compares the standard ADOT and City of Mesa High Pressure Sodium (HPS) Type II and Type III cobrahead street lights.
  - **Alternatives 1 to 4** – Using a G pole (35') with a 20' mast arm in a staggered configuration with a 250W lamp, the following were compared:
    - ADOT Type II GE7620
    - **City of Mesa Type II GE9215**
    - ADOT Type III GE7323
    - **City of Mesa Type III GE8892**

    Best Alternative: The City of Mesa Type II (GE9215) and Type III (GE8892).
  - **Alternatives 5 to 8**– Taking the best of Alternatives 1-4 (GE9215 and GE8892), the pole type was varied:
    - **GE9215 H pole (45')**
    - GE9215 I pole (50')
    - GE8892 H pole (45')
    - GE8892 I pole (50')

    Best Alternative: GE9215 with an H pole.
  - **Alternatives 9 to 12**– Taking the best of Alternatives 5-8 (GE9215), the lamps were varied:
    - GE9215 H pole (45') 310W
    - **GE9215 H pole (45') 400W**
    - GE9215 I pole (50') 310W
    - GE9215 I pole (50') 400W

    Best Alternative: GE9215 with an H pole using a 400W lamp.

- **Alternatives 13 to 14** – Compares Low Pressure Sodium (LPS) street lights.
  - **Alternatives 13 to 14** – Using a G pole (35') with a 20' mast arm in a staggered configuration, the following were compared:
    - 135W LPS
    - **180W LPS**

    Best Alternative: 180W LPS.

- **Alternatives 15 to 24** – Compares the best of Alternatives 1-4 in a one sided configuration.
  - **Alternatives 15 to 20** – Using the GE9215 and GE8892, with a 20' mast arm with a 250W lamp, the pole type was varied:
    - GE9215 G pole
    - GE9215 H pole
    - GE9215 I pole
    - **GE8892 G pole**
    - GE8892 H pole
    - GE8892 I pole

    Best Alternative: The GE8892 with a G pole.

- **Alternatives 21 to 24**– Taking the best of the Alternatives 15-20 (GE8892), the pole type and lamps were varied:
  - GE8892 H pole 310W
  - **GE8892 H pole 400W**
  - GE8892 I pole 310W
  - GE8892 I pole 400W

  Best Alternative: GE8892 with an H pole using a 400W lamp.

- **<u>Alternatives 25-40 looks at the architectural Monterey fixture and light pole</u>**

  - **Alternatives 25 to 29** – Compares the Monterey fixture and light pole in an opposite configuration:
    - **Alternatives 25 to 27** – Using an opposite configuration with a 2.5' shepard hook arm with a 175W metal halide pulse start (MHPS) lamp, the pole heights were varied:
      - 175W MH PS 30' pole
      - **175W MH PS 25' pole**
      - 175W MH PS 20' pole

      Best Alternative: The 175W MH PS with a 25' pole.
    - **Alternatives 28 to 29** – Using an opposite configuration with a 2.5' shepard hook arm with a 20' pole and 250W lamp, varied fixture:
      - **250 MH PS**
      - 250W HPS

      Best Alternative: The 250W MH PS.

  - **Alternatives 29A to 29J** – Compares the Monterey fixture and light pole in a staggered configuration, varying the pole height:
    - **Alternatives 29A to 29D** – Using a 2.5' shepard hook arm and 250W HPS lamp, the pole heights were varied:
      - 2.5' shepard hook arm 250W HPS 30' pole
      - 2.5' shepard hook arm 250W HPS 35' pole
      - 2.5' shepard hook arm 250W HPS 40' pole
      - **2.5' shepard hook arm 250W HPS 45' pole**

      Best Alternative: The 2.5' shepard hook arm 250W HPS with a 45' pole.
    - **Alternatives 29E to 29H** – Using a 8' mast arm and 250W HPS lamp, the pole heights were varied:
      - 8' mast arm 250W HPS 30' pole
      - 8' mast arm 250W HPS 35' pole
      - 8' mast arm 250W HPS 40' pole
      - **8' mast arm 250W HPS 45' pole**

      Best Alternative: The 8' mast arm 250W HPS with a 45' pole.

- **Alternatives 29I to 29J** – Using a 8' mast arm and 150W HPS lamp, the pole heights were varied
  - **8' mast arm** **150W HPS** **30' pole**
  - 8' mast arm 150W HPS 35' pole

  Best Alternative: The 8' mast arm 150W HPS with a 30' pole

  Best Alternative of Alternatives 29A to 29J: The 2.5' shepard hook arm 250W HPS with a 45' pol

- **Alternatives 30 to 37** – Compares the Monterey fixture and light pole in a staggered configuration.
  - **Alternatives 30 to 32** – Using a 2.5' shepard hook arm with a 30' pole, the fixture type and lamp wattage were varied:
    - 175W MH PS
    - **250W MH PS**
    - 250W HPS

    Best Alternative: The 2.5' shepard hook arm with a 30' pole and 250W MH PS.
  - **Alternatives 33 to 34**– Taking the best of the Alternatives 30-32, the mast arm lengths were varied:
    - 250W MH PS 6' mast arm
    - **250W MH PS** **8' mast arm**

    Best Alternative: The 30' pole 250W MH PS with an 8' mast arm.
  - **Alternatives 35 to 37**– Using an 8' mast arm, the pole height, fixture type and lamp wattage were varied:
    - **8' mast arm** **35' pole** **250W MH PS**
    - 8' mast arm 35' pole 400W HPS
    - 8' mast arm 40' pole 400W HPS

    Best Alternative: The 35' pole 250W MH PS with an 8' mast arm.

    Best Alternative of Alternatives 30 to 37: The 8'mast arm 250W MH PS with a 30' pole

- **Alternatives 38 to 40** – Compares the Monterey fixture and light pole in a staggered configuration with an LED fixture.
  - **Alternatives 38 to 40** – Using a 30' pole (as shown in Alternatives30 to 37 as the optimum pole height) in a staggered configuration with a 148W LED lamp, the mast arm lengths were varied:
    - 30' pole 148W LED 2.5' shepard hook
    - 30' pole 148W LED 6' mast arm
    - **30' pole** **148W LED** **8' mast arm**

    Best Alternative: The 30' pole with the 148W LED lamp with an 8' mast arm.

- **Alternatives 41-43 looks at the LED roadway fixture using standard ADOT poles**

  - **Alternatives 41 to 43** – Compares the LED roadway fixture in a staggered configuration with a 20' mast arm, varying the poles:
    - **157W LED (Roadway) G Pole**
    - 157W LED (Roadway) H Pole
    - 157W LED (Roadway) I Pole

    Best Alternative: The 157W LED (Roadway) with a G pole (35' pole).

- **Alternatives 44-50 looks at the architectural Revitalization pole with a Pechina fixture**

  - **Alternatives 44 to 50** – Compares the Pechina fixture with the 30' Revitalization pole and a 6' mast arm in a staggered configuration, varying the fixture type, distribution and lamp wattage:
    - 100W HPS Type II
    - 100W MH Type II
    - 100W HPS Type III
    - 175W MH Type II
    - 175W MH Type III
    - **250W HPS Type II**
    - 250W MH Type III

    Best Alternative: The 250W HPS Type II with a 30' Revitalization pole and a 6' mast arm.

- **Alternatives 51-58 looks at the Shoebox fixture**

  - **Alternatives 51 to 58** – Compares the Shoebox fixture with an 8' mast arm with a 250W HPS lamp in a staggered configuration, varying the pole height and distribution:
    - 250W HPS Type II 30' pole
    - **250W HPS Type II 35' pole**
    - 250W HPS Type II 40' pole
    - 250W HPS Type II 45' pole
    - 250W HPS Type III 30' pole
    - 250W HPS Type III 35' pole
    - 250W HPS Type III 40' pole
    - 250W HPS Type III 45' pole

    Best Alternative: The 250W HPS Type II with a 35' pole and an 8' mast arm.

SEDONA ROADWAY LIGHTING
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	ALTERNATIVE	STREET WIDTH (FEET)	POLE TYPE	CONFIGURATION	MOUNTING HEIGHT (FEET)	ARM LENGTH (FEET)	FIXTURE TYPE	PHOTOMETRIC FILE	FULL CUT-OFF	DISTRIBUTION	LAMP WATTAGE (WATT)	WATTS (WATT)	LUMENS (LUMENS)	MAXIMUM SPACING ON ONE SIDE (FEET)	APPROX. NO. OF POLES	AVERAGE ILLUMINANCE (FC)	UNIFORMITY (AVG/MIN)	WATTS USED (WATT)	AVERAGE ENERGY USED PER NIGHT (KWH)	LUMENS USED (LUMENS)	SYSTEM CONSTRUCTION COSTS (a)	ANNUAL SYSTEM ENERGY COSTS (b)	ANNUALIZED SYSTEM MAINTENANCE COSTS (c)	ANNUAL SYSTEM O&M (b+c)	APPROXIMATE CITY OF SEDONA COST
	LIGHTING CHARACTERISTICS													SYSTEM MEASURES OF EFFECTIVENESS							LIGHTING COST ESTIMATE				
	9A	64	G	2 SIDED STAGGERED	35	20	HPS	GE7323		II	250	316	30000	304	76	1.2	3.0	23,940	263	2,280,000	$ 1,867,047.99	$ 9,530.92	$ 4,940.00	$ 14,470.92	$ 90,000.00
	COMPARING STAGGERED ADOT AND MCLA M-40A2 LUMINAIRES																								
STAGGERED	1	64	G	2 SIDED STAGGERED	35	20	HPS	GE7630	Y	II	250	313	30000	135	130	1.2	2.4	46,950	316	4,500,000					
STAGGERED	2	64	G	2 SIDED STAGGERED	35	20	HPS	GE9215	Y	II	250	313	30000	265	66	1.2	3.0	20,345	224	1,950,000					
STAGGERED	3	64	G	2 SIDED STAGGERED	35	20	HPS	GE7325	Y	II	250	313	30000	318	73	1.2	3.0	22,849	251	2,190,000					
STAGGERED	4	64	G	2 SIDED STAGGERED	35	20	HPS	GE88F2	Y	II	250	313	30000	[illegible]	[redacted]	1.2	3.0	20,345	224	1,950,000	$ 1,746,196.04	$ 8,148.55	$ 4,225.00	$ 12,373.55	$ 162,500.00
	COMPARING STAGGERED H AND I POLES AT 250W																								
STAGGERED	5	64	H	2 SIDED STAGGERED	45	20	HPS	GE9215	Y	II	250	313	30000	329	71	1.2	2.4	22,223	244	2,130,000					
STAGGERED	6	64	I	2 SIDED STAGGERED	50	20	HPS	GE9215	Y	II	250	313	30000	310	75	1.2	2.0	23,475	258	2,250,000					
STAGGERED	7	64	H	2 SIDED STAGGERED	45	20	HPS	GE88F2	Y	II	250	313	30000	306	76	1.2	2.0	23,788	262	2,280,000					
STAGGERED	8	64	I	2 SIDED STAGGERED	50	20	HPS	GE88F2	Y	II	250	313	30000	286	81	1.2	2.2	25,353	279	2,430,000					
	COMPARING STAGGERED H AND I POLES AT 310W & 400W																								
STAGGERED	9	64	H	2 SIDED STAGGERED	45	20	HPS	GE9215	Y	II	310	380	37000	405	37	1.2	2.4	21,831	240	2,109,000					
STAGGERED	10	64	H	2 SIDED STAGGERED	45	20	HPS	GE9215	Y	II	400	475	50000	[illegible]	[redacted]	1.2	3.0	19,950	219	2,100,000	$ 1,429,499.89	$ 8,009.95	$ 2,730.00	$ 10,739.95	$ 147,000.00
STAGGERED	11	64	I	2 SIDED STAGGERED	50	20	HPS	GE9215	Y	II	310	380	37000	383	41	1.2	2.4	23,343	257	2,257,000					
STAGGERED	12	64	I	2 SIDED STAGGERED	50	20	HPS	GE9215	Y	II	400	475	50000	518	48	1.2	2.4	21,375	235	2,250,000					
	COMPARING STAGGERED G POLES AT 135W & 180W																								
UPS	13	64	G	2 SIDED STAGGERED	35	20	LPS	SE-24 135LPS-T21-3	Y	II	135	190	22500	300	114	1.2	3.3	21,660	238	2,565,000					
UPS	14	64	G	2 SIDED STAGGERED	35	20	LPS	SE-48 180LPS-T21-3	Y	II	180	190	33000	[illegible]	[redacted]	1.2	2.0	14,820	163	2,574,000	$ 1,867,733.31	$ 5,920.23	$ 8,590.00	$ 14,510.23	$ 197,090.33
	COMPARING ONE SIDED G, H AND I POLES AT 250W																								
ONE SIDED	15	64	G	1 SIDED	35	20	HPS	GE9218	Y	II	250	313	30000	UNIFORMITY CANNOT BE ACHIEVED											
ONE SIDED	16	64	H	1 SIDED	45	20	HPS	GE9218	Y	II	250	313	30000	164	71	1.2	3.0	22,223	244	2,130,000					
ONE SIDED	17	64	I	1 SIDED	50	20	HPS	GE9215	Y	II	250	313	30000	155	75	1.2	2.4	23,475	258	2,250,000					
ONE SIDED	18	64	G	1 SIDED	35	20	HPS	GE88F2	Y	II	250	313	30000	177	46	1.2	3.0	20,658	227	1,980,000	UNIFORMITY CANNOT BE ACHIEVED FOR 6 LANES				
ONE SIDED	19	64	H	1 SIDED	45	20	HPS	GE88F2	Y	II	250	313	30000	153	76	1.2	2.0	23,788	262	2,280,000					
ONE SIDED	20	64	I	1 SIDED	50	20	HPS	GE88F2	Y	II	250	313	30000	142	82	1.2	1.7	25,666	282	2,460,000					
	COMPARING ONE SIDED H AND I POLES AT 310W & 400W																								
ONE SIDED	21	64	H	1 SIDED	45	20	HPS	GE88F2	Y	II	310	380	37000	189	61	1.2	2.4	23,343	257	2,257,000					
ONE SIDED	22	64	H	1 SIDED	45	20	HPS	GE88F2	Y	II	400	475	50000	[illegible]	[redacted]	1.2	3.0	21,850	240	2,300,000	$ 1,406,188.61	$ 8,772.80	$ 2,990.00	$ 11,762.80	$ 167,000.00
ONE SIDED	23	64	I	1 SIDED	50	20	HPS	GE88F2	Y	II	310	380	37000	176	44	1.2	2.0	25,278	278	2,442,000					
ONE SIDED	24	64	I	1 SIDED	50	20	HPS	GE88F2	Y	II	400	475	50000	208	49	1.2	2.4	23,275	256	2,450,000					
	COMPARING OPPOSITE POLE HEIGHTS AT 175W																								
MONTEREY	25	64	DECOR.	2 SIDED OPPOSITE	30	3.5	MH PS	M231175PF	Y	II	175	208	17500	176	132	1.2	2.6	27,456	302	2,310,000					
MONTEREY	26	64	DECOR.	2 SIDED OPPOSITE	35	3.5	MH PS	M231175PF	Y	II	175	208	17500	[illegible]	[redacted]	1.2	3.0	28,288	311	2,380,000	$ 2,485,312.[illegible]	$ 11,357.63	$ 17,680.00	$ 29,037.63	$ [illegible]
MONTEREY	27	64	DECOR.	2 SIDED OPPOSITE	30	3.5	MH PS	M231175PF	Y	II	175	208	17500	137	183	1.2	2.8	38,064	419	3,207,500					
	COMPARING OPPOSITE 250W MH & HPS																								
MONTEREY	28	64	DECOR.	2 SIDED OPPOSITE	30	3.5	MH PS	M232250PF	Y	II	250	291	25000	128	186	2.6	2.9	54,126	595	4,650,000					
MONTEREY	29	64	DECOR.	2 SIDED OPPOSITE	30	3.5	HPS	M232250HP	Y	II	250	295	28000	92	253	5.1	3.3	74,635	821	7,210,000					
	COMPARING STAGGERED 250W HPS 3.5' ARM POLE HEIGHTS																								
MONTEREY	29A	64	DECOR.	2 SIDED STAGGERED	30	3.5	HPS	M232250HP	Y	II	250	295	28000	169	137	2.6	2.6	40,413	445	3,904,300					
MONTEREY	29B	64	DECOR.	2 SIDED STAGGERED	35	3.5	HPS	M232250HP	Y	II	250	295	28000	241	89	1.6	2.9	26,255	289	2,534,300					
MONTEREY	29C	64	DECOR.	2 SIDED STAGGERED	40	3.5	HPS	M232250HP	Y	II	250	295	28000	[illegible]	[redacted]	1.2	2.7	20,945	230	2,023,300	$ 2,506,264.99	$ 8,923.37	$ 4,615.00	$ 13,537.57	$ 421,240.00
MONTEREY	29D	64	DECOR.	2 SIDED STAGGERED	45	3.5	HPS	M232250HP	Y	II	250	295	28000	229	71	1.2	3.0	20,945	230	2,023,300					
	COMPARING STAGGERED 250W HPS 8' ARM POLE HEIGHTS																								
MONTEREY	29E	64	DECOR.	2 SIDED STAGGERED	30	8	HPS	M232250HP	Y	II	250	295	28000	164	142	2.9	2.4	41,890	461	4,047,000					
MONTEREY	29F	64	DECOR.	2 SIDED STAGGERED	35	8	HPS	M232250HP	Y	II	250	295	28000	164	142	2.7	2.2	41,890	461	4,047,000					
MONTEREY	29G	64	DECOR.	2 SIDED STAGGERED	40	8	HPS	M232250HP	Y	II	250	295	28000	164	142	2.5	2.5	41,890	461	4,047,000					
MONTEREY	29H	64	DECOR.	2 SIDED STAGGERED	45	8	HPS	M232250HP	Y	II	250	295	28000	295	78	1.3	2.6	23,300	256	2,251,000					
	COMPARING STAGGERED 150W HPS 8' ARM POLE HEIGHTS																								
MONTEREY	29I	64	DECOR.	2 SIDED STAGGERED	30	8	HPS	M131150HP	Y	II	150	188	16000	149	156	1.2	3.0	29,328	323	2,496,000					
MONTEREY	29J	64	DECOR.	2 SIDED STAGGERED	35	8	HPS	M131150HP	Y	II	150	188	16000	139	167	1.2	1.7	31,396	345	2,672,000					
	COMPARING STAGGERED 175W MH, 250W MH AND 250W HPS																								
MONTEREY	30	64	DECOR.	2 SIDED STAGGERED	30	3.5	MH PS	M231175PF	Y	II	175	208	17500	176	134	1.2	1.7	27,872	307	2,345,000					
MONTEREY	31	64	DECOR.	2 SIDED STAGGERED	30	3.5	MH PS	M232250PF	Y	II	250	291	25000	257	90	1.2	2.0	26,190	288	2,250,000					
MONTEREY	32	64	DECOR.	2 SIDED STAGGERED	30	3.5	HPS	M232250HP	Y	II	250	295	28000	169	137	2.6	2.9	40,415	445	3,904,300					
	COMPARING STAGGERED MAST ARM LENGTHS																								
MONTEREY	33	64	DECOR.	2 SIDED STAGGERED	30	6	MH PS	M232250PF	Y	II	250	291	25000	244	87	1.2	2.4	25,317	278	2,175,000					
MONTEREY	34	64	DECOR.	2 SIDED STAGGERED	30	8	MH PS	M232250PF	Y	II	250	291	25000	[illegible]	[redacted]	1.2	2.4	24,735	272	2,125,000	$ 3,222,209.24	$ 9,931.15	$ 11,050.00	$ 20,981.15	$ 387,166.25
	COMPARING STAGGERED POLE HEIGHTS & WATTS																								
MONTEREY	35	64	DECOR.	2 SIDED STAGGERED	35	8	MH PS	M232250PF	Y	II	250	291	25000	286	91	1.2	1.7	26,481	291	2,275,000					
MONTEREY	36	64	DECOR.	2 SIDED STAGGERED	35	8	HPS	M234400HP	Y	II	400	444	50000	164	162	4.7	2.2	65,888	725	7,100,000					
MONTEREY	37	64	DECOR.	2 SIDED STAGGERED	40	8	HPS	M234400HP	Y	II	400	444	50000	164	142	4.3	2.5	65,888	725	7,100,000					
	COMPARING STAGGERED LED MAST ARM LENGTHS																								
MONTEREY	38	64	DECOR.	2 SIDED STAGGERED	30	2.5	LED	MON-3-T3-125-LED	Y	II		148	8400	70	332	1.2	1.5	49,136	540	2,788,800					
MONTEREY	39	64	DECOR.	2 SIDED STAGGERED	30	6	LED	MON-3-T3-125-LED	Y	II		148	8400	73	310	1.2	1.7	45,880	505	2,604,000					
MONTEREY	40	64	DECOR.	2 SIDED STAGGERED	30	8	LED	MON-3-T3-125-LED	Y	II		148	8400	[illegible]	[redacted]	1.2	2.0	44,104	485	2,503,200	$ 4,926,317.61	$ 17,707.76	$ 8,940.00	$ 26,647.76	$ 3,261,274.53
	COMPARING STAGGERED G, H AND I POLES																								
LED ROAD WAY	41	64	G	2 SIDED STAGGERED	35	20	LED	BRMC-X-A3	Y	II		157	9600	[illegible]	[redacted]	1.2	3.0	24,178	266	1,478,400	$ 2,760,017.[illegible]	$ 9,717.54	$ 6,140.00	$ 15,857.54	$ 1,094,974.68
LED ROAD WAY	42	64	H	2 SIDED STAGGERED	45	20	LED	BRMC-X-A3	Y	II		157	9600	132	176	1.2	2.3	27,632	304	1,689,600					
LED ROAD WAY	43	64	I	2 SIDED STAGGERED	50	20	LED	BRMC-X-A3	Y	II		157	9600	123	189	1.2	1.7	29,673	326	1,814,400					
REVITALIZATION W/ PECHINA	44	64	DECOR	2 SIDED STAGGERED	30	6	HPS	P100HPSDNFX	Y	II	100		9500	90	258	1.2	1.7	0		2,451,000					
REVITALIZATION W/ PECHINA	45	64	DECOR	2 SIDED STAGGERED	30	6	MH	P100MHDNFX	Y	II	100		9000	86	270	1.2	1.8	0		2,430,000					
REVITALIZATION W/ PECHINA	46	64	DECOR	2 SIDED STAGGERED	30	6	HPS	P100HPSDNFX	Y	II	100		9500	97	240	1.2	2.4	0		2,280,000					
REVITALIZATION W/ PECHINA	47	64	DECOR	2 SIDED STAGGERED	30	6	MH	P175MHDNFX	Y	II	175		12800	99	235	1.2	2.0	0		3,008,000					
REVITALIZATION W/ PECHINA	48	64	DECOR	2 SIDED STAGGERED	30	6	MH	P175MHDNFX	Y	II	175		12800	109	230	1.2	2.8	0		2,944,000					
REVITALIZATION W/ PECHINA	49	64	DECOR	2 SIDED STAGGERED	30	6	HPS	P250HPSDNFX	Y	II	250	315	28000	179	195	2.9	2.9	61,425		5,460,000					
REVITALIZATION W/ PECHINA	50	64	DECOR	2 SIDED STAGGERED	30	6	MH	P250MHDNFX	Y	II	250	315	20000	94	247	2.9	2.9	77,805		4,940,000					
SHOEBOX	51	64	DECOR.	2 SIDED STAGGERED	30	8	HPS	GE88F2	Y	II	250	313	30000	228	100	1.2	2.8	31,730	351	3,060,000					
SHOEBOX	52	64	DECOR.	2 SIDED STAGGERED	35	8	HPS	GE88F2	Y	II	250	313	30000	[illegible]	[redacted]	1.2	3.0	23,142	255	2,220,000	$ 1,837,965.89	$ 9,299.38	$ 4,810.00	$ 14,109.38	$ 185,000.00
SHOEBOX	53	64	DECOR.	2 SIDED STAGGERED	40	8	HPS	GE88F2	Y	II	250	313	30000	298	78	1.2	2.4	24,414	269	2,340,000					
SHOEBOX	54	64	DECOR.	2 SIDED STAGGERED	45	8	HPS	GE88F2	Y	II	250	313	30000	281	82	1.2	2.0	25,666	282	2,460,000					
SHOEBOX	55	64	DECOR.	2 SIDED STAGGERED	30	8	HPS	GE7315	Y	II	250	313	30000	229	100	1.2	3.0	31,613	348	3,030,000					
SHOEBOX	56	64	DECOR.	2 SIDED STAGGERED	35	8	HPS	GE7315	Y	II	250	313	30000	286	81	1.2	3.0	25,353	279	2,430,000					
SHOEBOX	57	64	DECOR.	2 SIDED STAGGERED	40	8	HPS	GE7315	Y	II	250	313	30000	268	87	1.2	2.4	27,231	300	2,610,000					
SHOEBOX	58	64	DECOR.	2 SIDED STAGGERED	45	8	HPS	GE7315	Y	II	250	313	30000	257	92	1.2	1.7	28,794	317	2,760,000					

SEDONA ROADWAY LIGHTING
PROJECT NO. 21278

DRAFT 9/2/09

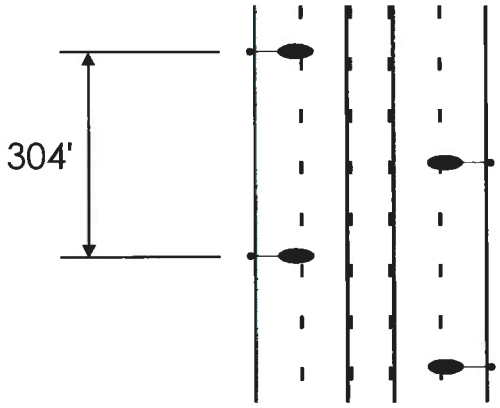
			LIGHTING CHARACTERISTICS				SYSTEM MEASURES OF EFFECTIVENESS		COSTS		
ALTERNATIVE	POLE TYPE	CONFIGURATION	MOUNTING HEIGHT (FEET)	ARM LENGTH (FEET)	FIXTURE TYPE	LAMP WATTAGE (WATT)	MAXIMUM SPACING ON ONE SIDE (FEET)	APPROX. NO. OF POLES	SYSTEM CONSTRUCTION COSTS (a)	ANNUAL SYSTEM ENERGY COSTS (b)	ANNUAL SYSTEM O & M (b + c)
PA	G	2 SIDED STAGGERED	35	20	HPS	250	304	76	$ 1,855,042.99	$ 9,550.92	$ 14,490.92
4	G	2 SIDED STAGGERED	35	20	HPS	250	355	65	$ 1,746,196.06	$ 8,168.55	$ 12,393.55
10	H	2 SIDED STAGGERED	45	20	HPS	400	549	42	$ 1,629,499.81	$ 8,009.95	$ 10,739.95
14	G	2 SIDED STAGGERED	35	20	LPS	180	298	78	$ 1,862,133.31	$ 5,950.23	$ 14,530.23
22	H	1 SIDED	45	20	HPS	400	255	46	$ 1,406,188.61	$ 8,772.80	$ 11,762.80
26	MONTEREY DECOR.	2 SIDED OPPOSITE	25	2.5	MH PS	175	171	136	$ 2,485,512.66	$ 11,357.63	$ 29,037.63
29C	MONTEREY DECOR.	2 SIDED STAGGERED	40	2.5	HPS	250	325	71	$ 2,086,284.99	$ 8,922.57	$ 13,537.57
34	MONTEREY DECOR.	2 SIDED STAGGERED	30	8	MH PS	250	273	85	$ 2,222,209.24	$ 9,931.15	$ 20,981.15
40	MONTEREY DECOR.	2 SIDED STAGGERED	30	8	LED		78	298	$ 4,926,317.51	$ 17,707.76	$ 26,647.76
41	G	2 SIDED STAGGERED	35	20	LED		151	154	$ 2,760,017.66	$ 9,707.54	$ 15,867.54
52	SHOEBOX DECOR.	2 SIDED STAGGERED	35	8	HPS	250	314	74	$ 1,837,965.49	$ 9,299.58	$ 14,109.58

DRAFT 8/24/09

Project Assessment

POLE:	*G POLE*
FIXTURE	*COBRA HEAD*
MOUNTING HEIGHT:	*35-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*250 WATTS*
TOTAL WATTS:	*23,900 WATTS*
TOTAL LUMENS:	*2.28 MILLION LUMENS*

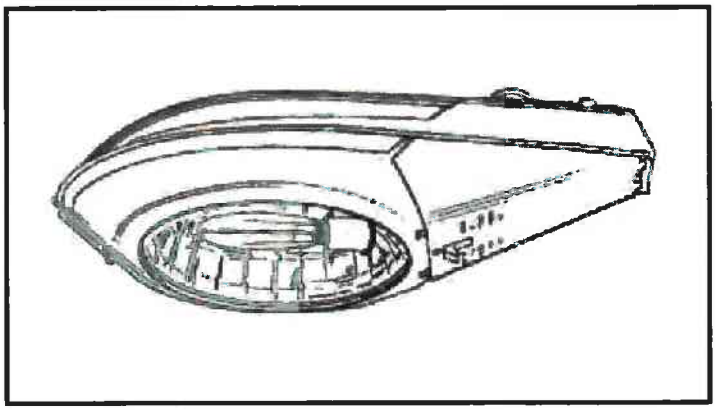
2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *304-FEET*

APROX. NO. OF POLES: *76*

SYSTEM CONSTRUCTION COST:		$1.86 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$190,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$14,500/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

*From Proj. No. 18377.04.00. Computed by Terry Smiley.

FINAL PROJECT ASSESSMENT - G POLE 250W STAGGERED GE7323 TYPE III HPS 20' MAST ARM (8-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310070	POLE (TYPE G) (STANDARD BASE)	EACH	76	$1,500.00	$114,000
7310260	POLE FOUNDATION (TYPE G) (STANDARD BASE)	EACH	76	$1,000.00	$76,000
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	76	$750.00	$57,000
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,967	$45.00	$358,495
7320410	PULL BOX (NO. 5)	EACH	84	$500.00	$42,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,064	$0.90	$42,358
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,532	$0.90	$21,179
7350820	PHOTO ELECTRIC CELL	EACH	3	$25.00	$75
7360030	LUMINAIRE (HORIZONTAL MOUNT) (HPS 250 WATT)	EACH	76	$500.00	$38,000
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	3	$7,000.00	$21,000
				LIGHTING ITEMS SUBTOTAL	$847,934
934XX01	MISCELLANEOUS WORK (15%)	COST	15%		$127,190
				SUBTOTAL	$975,124
207XX01	DUST PALLIATIVE (1%)	COST	1%		$9,751
209XX01	FURNISH WATER (1%)	COST	1%		$9,751
701XX01	MAINTENANCE AND PROTECTION OF TRAFFIC (10%)	COST	10%		$97,512
807XX01	LANDSCAPE REPLACEMENT (5%)	COST	5%		$48,756
810XX01	EROSION CONTROL AND POLLUTION PREVENTION (1%)	COST	1%		$9,751
925XX01	CONSTRUCTION SURVEYING AND LAYOUT (1%)	COST	1%		$9,751
				SUBTOTAL	$185,274
901XX01	MOBILIZATION (10%)	COST	10%		$116,040
				LIGHTING ITEMS TOTAL	$1,276,437

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	76	$2,500.00	$190,000
				PAINTING TOTAL	$190,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$146,644
951X002	CONTINGENCY	COST	5%		$73,322
				PROJECT WIDE	$219,966

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$168,640
				OTHER COST	$168,640

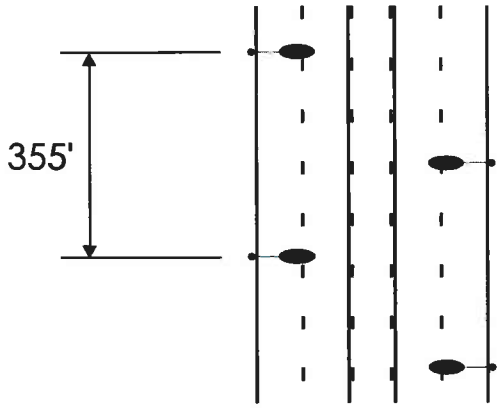
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,276,437
PAINTING TOTAL	$190,000
PROJECT WIDE	$219,966
OTHER COST	$168,640
TOTAL LIGHTING SYSTEM	$1,855,043

DRAFT 8/19/09

Alternative 4

POLE:	*G POLE*
FIXTURE	*COBRA HEAD*
MOUNTING HEIGHT:	*35-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*250 WATTS*
TOTAL WATTS:	*20,300 WATTS*
TOTAL LUMENS:	*1.95 MILLION LUMENS*

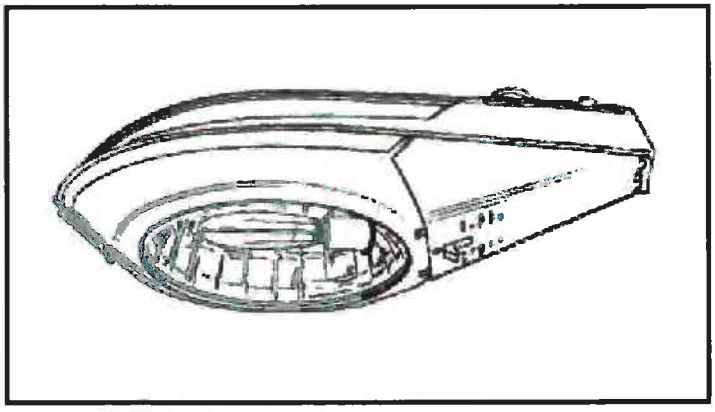
2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *355-FEET*

APROX. NO. OF POLES: 65

SYSTEM CONSTRUCTION COST:		$1.75 MILLION
ADOT/FEDERAL HIGHWAY:	$1.59 MILLION	
CITY OF SEDONA:	$160,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$12,400/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 4 - G POLE 250W STAGGERED GE8892 TYPE III HPS 20' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310070	POLE (TYPE G) (STANDARD BASE)	EACH	65	$1,500.00	$97,500
7310260	POLE FOUNDATION (TYPE G) (STANDARD BASE)	EACH	65	$1,000.00	$65,000
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	65	$750.00	$48,750
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,867	$45.00	$353,995
7320410	PULL BOX (NO. 5)	EACH	73	$500.00	$36,500
7320520	CONDUCTOR (NO. 8)	L.FT.	46,864	$0.90	$42,178
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,432	$0.90	$21,089
7350820	PHOTO ELECTRIC CELL	EACH	2	$25.00	$50
7360030	LUMINAIRE (HORIZONTAL MOUNT) (HPS 250 WATT)	EACH	65	$500.00	$32,500
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	2	$7,000.00	$14,000
				LIGHTING ITEMS SUBTOTAL	$789,389
934XX01	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,217,892

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	65	$2,500.00	$162,500
				PAINTING TOTAL	$162,500

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$138,039
951X002	CONTINGENCY	COST	5%		$69,020
				PROJECT WIDE	$207,059

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$158,745
				OTHER COST	$158,745

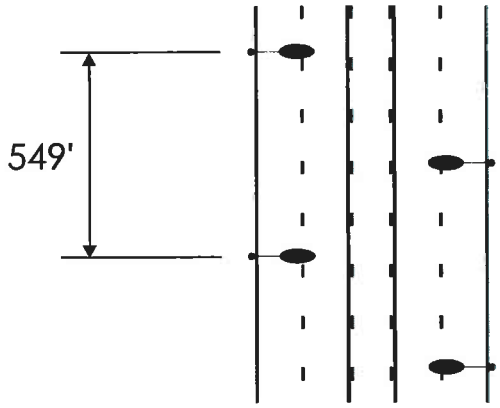
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,217,892
PAINTING TOTAL	$162,500
PROJECT WIDE	$207,059
OTHER COST	$158,745
TOTAL LIGHTING SYSTEM	$1,746,196

DRAFT 8/19/09

Alternative 10

POLE:	*H POLE*
FIXTURE	*COBRA HEAD*
MOUNTING HEIGHT:	*45-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*400 WATTS*
TOTAL WATTS:	*20,000 WATTS*
TOTAL LUMENS:	*2.10 MILLION LUMENS*

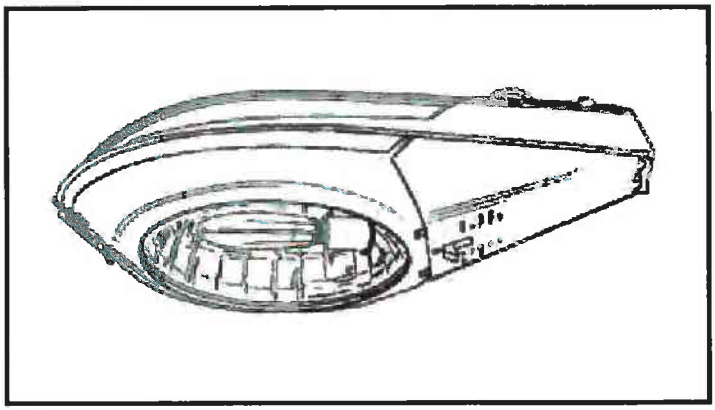
2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *549-FEET*

APROX. NO. OF POLES: *42*

SYSTEM CONSTRUCTION COST:	$1.63 MILLION
ADOT/FEDERAL HIGHWAY:	$1.48 MILLION
CITY OF SEDONA:	$150,000
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:	$10,700/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 10 - H POLE 400W STAGGERED GE9215 TYPE II HPS 20' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310090	POLE (TYPE H) (STANDARD BASE)	EACH	42	$1,750.00	$73,500
7310270	POLE FOUNDATION (TYPE H) (STANDARD BASE)	EACH	42	$1,100.00	$46,200
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	42	$750.00	$31,500
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,867	$45.00	$353,995
7320410	PULL BOX (NO. 5)	EACH	50	$500.00	$25,000
7320520	CONDUCTOR (NO. 8)	L.FT.	46,864	$0.90	$42,178
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,432	$0.90	$21,089
7350820	PHOTO ELECTRIC CELL	EACH	2	$25.00	$50
7360050	LUMINAIRE (HORIZONTAL MOUNT) (HPS 400 WATT)	EACH	42	$650.00	$27,300
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	2	$7,000.00	$14,000
				LIGHTING ITEMS SUBTOTAL	$712,639
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,141,142

PAINTING

9240120	MISCELLANEOUS WORK (PAINT 45' POLE & MAST ARM) (SEDONA RED)	EACH	42	$3,500.00	$147,000
				PAINTING TOTAL	$147,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$128,814
951X002	CONTINGENCY	COST	5%		$64,407
				PROJECT WIDE	$193,221

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$148,136
				OTHER COST	$148,136

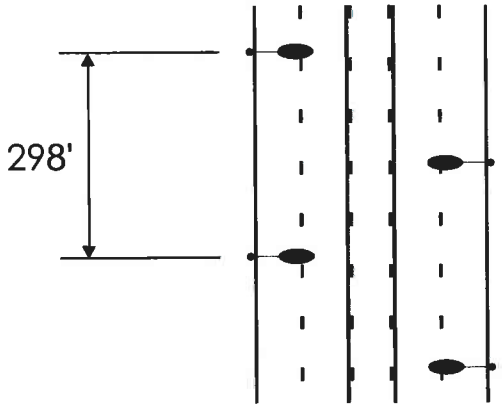
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,141,142
PAINTING TOTAL	$147,000
PROJECT WIDE	$193,221
OTHER COST	$148,136
TOTAL LIGHTING SYSTEM	$1,629,500

DRAFT 9/21/09

Alternative 14

POLE:	*G POLE*
FIXTURE	*ARCHITECTURAL SHOE BOX*
MOUNTING HEIGHT:	*35-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*LOW PRESSURE SODIUM*
WATT:	*180 WATTS*
TOTAL WATTS:	*14,800 WATTS*
TOTAL LUMENS:	*2.57 MILLION LUMENS*

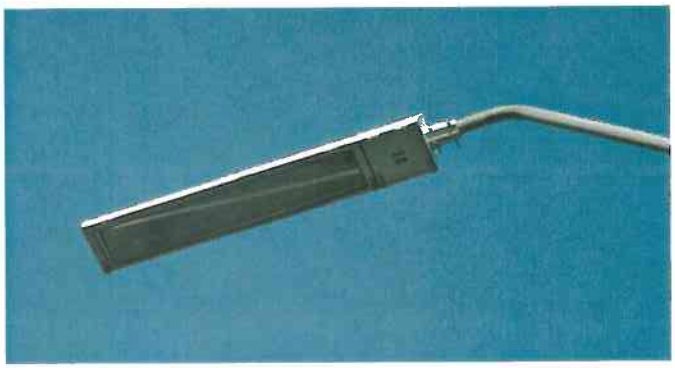
2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *298-FEET*

APROX. NO. OF POLES: *78*

SYSTEM CONSTRUCTION COST:		$1.86 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$190,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$14,500/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 14 - G POLE 180W STAGGERED SE-48-180LPS-T21-3 TYPE III LPS 20' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310070	POLE (TYPE G) (STANDARD BASE)	EACH	78	$1,500.00	$117,000
7310260	POLE FOUNDATION (TYPE G) (STANDARD BASE)	EACH	78	$1,000.00	$78,000
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	78	$750.00	$58,500
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,867	$45.00	$353,995
7320410	PULL BOX (NO. 5)	EACH	86	$500.00	$43,000
7320520	CONDUCTOR (NO. 8)	L.FT.	46,864	$0.90	$42,178
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,432	$0.90	$21,089
7350820	PHOTO ELECTRIC CELL	EACH	2	$25.00	$50
7360104	LUMINAIRE (HORIZONTAL MOUNT) (LPS 180 WATT)	EACH	78	$550.00	$42,900
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	2	$7,000.00	$14,000
				LIGHTING ITEMS SUBTOTAL	$848,539
934XX01	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,277,042

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	78	$2,500.00	$195,000
				PAINTING TOTAL	$195,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$147,204
951X002	CONTINGENCY	COST	5%		$73,602
				PROJECT WIDE	$220,806

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$169,285
				OTHER COST	$169,285

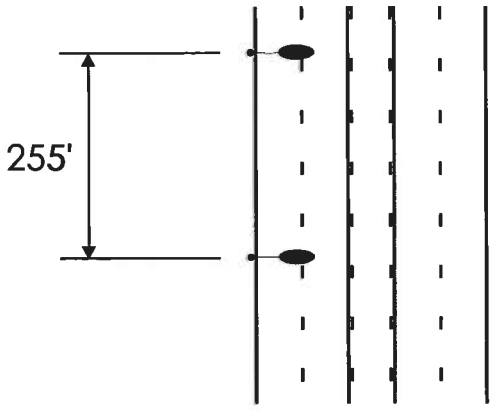
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,277,042
PAINTING TOTAL	$195,000
PROJECT WIDE	$220,806
OTHER COST	$169,285
TOTAL LIGHTING SYSTEM	$1,862,133

DRAFT 8/19/09

Alternative 22

POLE:	*H POLE*
FIXTURE	*COBRA HEAD*
MOUNTING HEIGHT:	*45-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*400 WATTS*
TOTAL WATTS:	*21,900 WATTS*
TOTAL LUMENS:	*2.30 MILLION LUMENS*

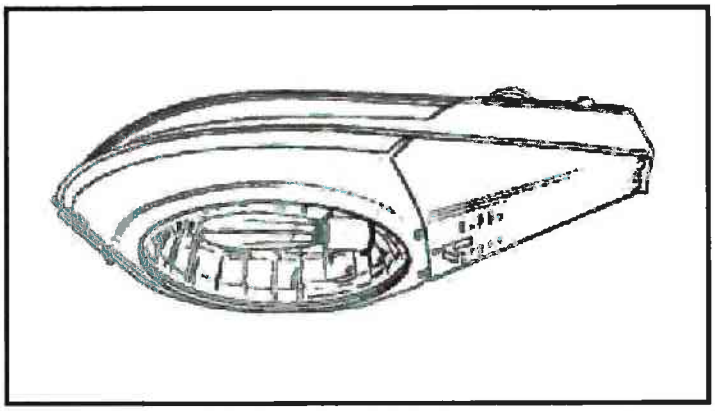
1 SIDED



MAX. SPACING ON ONE SIDE: *255-FEET*

APROX. NO. OF POLES: *46*

SYSTEM CONSTRUCTION COST:	$1.41 MILLION
ADOT/FEDERAL HIGHWAY:	$1.25 MILLION
CITY OF SEDONA:	$160,000
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:	$11,800/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 22 - H POLE 400W ONE SIDED GE8892 TYPE III HPS 20' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310090	POLE (TYPE H) (STANDARD BASE)	EACH	46	$1,750.00	$80,500
7310270	POLE FOUNDATION (TYPE H) (STANDARD BASE)	EACH	46	$1,100.00	$50,600
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	46	$750.00	$34,500
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	7,783	$5.00	$38,914
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	4,133	$45.00	$185,998
7320410	PULL BOX (NO. 5)	EACH	54	$500.00	$27,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,664	$0.90	$42,898
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	11,916	$0.90	$10,724
7350820	PHOTO ELECTRIC CELL	EACH	3	$25.00	$75
7360050	LUMINAIRE (HORIZONTAL MOUNT) (HPS 400 WATT)	EACH	46	$650.00	$29,900
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	3	$7,000.00	$21,000
				LIGHTING ITEMS SUBTOTAL	$522,108
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$950,612

PAINTING

9240120	MISCELLANEOUS WORK (PAINT 45' POLE & MAST ARM) (SEDONA RED)	EACH	46	$3,500.00	$161,000
				PAINTING TOTAL	$161,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$111,161
951X002	CONTINGENCY	COST	5%		$55,581
				PROJECT WIDE	$166,742

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$127,835
				OTHER COST	$127,835

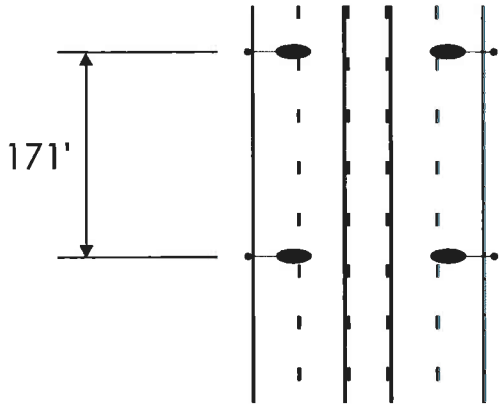
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$950,612
PAINTING TOTAL	$161,000
PROJECT WIDE	$166,742
OTHER COST	$127,835
TOTAL LIGHTING SYSTEM	$1,406,189

DRAFT 8/24/09

Alternative 26

POLE:	*MONTEREY*
FIXTURE	*MONTEREY*
MOUNTING HEIGHT:	*25-FOOT*
MAST ARM:	*2.5-FOOT*
LAMP:	*METAL HALIDE PULSE START*
WATT:	*175 WATTS*
TOTAL WATTS:	*28,300 WATTS*
TOTAL LUMENS:	*2.38 MILLION LUMENS*

2 SIDED OPPOSITE



MAX. SPACING ON ONE SIDE: *171-FEET*

APROX. NO. OF POLES: *136*

SYSTEM CONSTRUCTION COST:		$2.49 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$820,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$29,000/YEAR

ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 26 - 25' MONTEREY POLE 175W OPPOSITE M23175MF TYPE III MH 2.5' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310190	POLE (25-FOOT VISIONAIRE MONTEREY)	EACH	136	$3,000.00	$408,000
7310371	POLE FOUNDATION (VISIONAIRE MONTEREY)	EACH	136	$2,000.00	$272,000
7310650	MAST ARM (2.5 FT.) (VISIONAIRE MONTEREY)	EACH	136	$700.00	$95,200
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	8,067	$45.00	$362,995
7320410	PULL BOX (NO. 5)	EACH	144	$500.00	$72,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,264	$0.90	$42,538
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,632	$0.90	$21,269
7350820	PHOTO ELECTRIC CELL	EACH	4	$25.00	$100
7360110	LUMINAIRE (HORIZONTAL MOUNT) (MH 175 WATT)	EACH	136	$1,150.00	$156,400
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	4	$7,000.00	$28,000
				LIGHTING ITEMS SUBTOTAL	$1,536,329
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,964,832

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	0	$3,000.00	$
				PAINTING TOTAL	$

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$196,483
951X002	CONTINGENCY	COST	5%		$98,242
				PROJECT WIDE	$294,725

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$225,956
				OTHER COST	$225,956

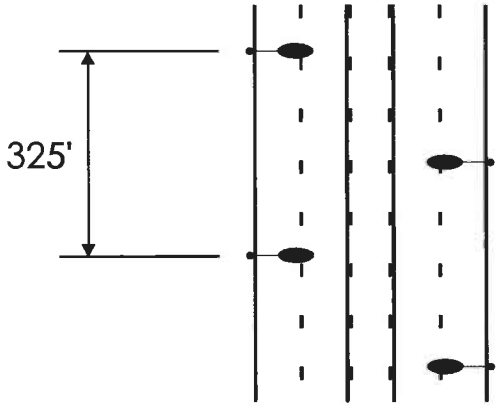
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,964,832
PAINTING TOTAL	$
PROJECT WIDE	$294,725
OTHER COST	$225,956
TOTAL LIGHTING SYSTEM	$2,485,513

DRAFT 9/2/09

Alternative 29C

POLE:	*MONTEREY*
FIXTURE	*MONTEREY*
MOUNTING HEIGHT:	*40-FOOT*
MAST ARM:	*2.5-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*250 WATTS*
TOTAL WATTS:	*20,900 WATTS*
TOTAL LUMENS:	*2.02 MILLION LUMENS*

2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *325-FEET*

APROX. NO. OF POLES: *71*

SYSTEM CONSTRUCTION COST:		$2.09 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$420,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$13,500/YEAR

ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 9/2/09

ALTERNATIVE 29C - 40' MONTEREY POLE 250W STAGGERED M23250HF TYPE III HPS 2.5' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310192	POLE (SPECIAL) (40-FOOT VISIONAIRE MONTEREY)	EACH	71	$4,800.00	$340,800
7310371	POLE FOUNDATION (VISIONAIRE MONTEREY)	EACH	71	$2,000.00	$142,000
7310651	MAST ARM (8 FT.) (VISIONAIRE MONTEREY)	EACH	71	$2,000.00	$142,000
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,967	$45.00	$358,495
7320410	PULL BOX (NO. 5)	EACH	79	$500.00	$39,500
7320520	CONDUCTOR (NO. 8)	L.FT.	47,064	$0.90	$42,358
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,532	$0.90	$21,179
7350820	PHOTO ELECTRIC CELL	EACH	3	$25.00	$75
7360030	LUMINAIRE (HORIZONTAL MOUNT) (HPS 250 WATT)	EACH	71	$500.00	$35,500
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	3	$7,000.00	$21,000
				LIGHTING ITEMS SUBTOTAL	$1,220,734
934XX01	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,649,237

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	0	$3,000.00	$
				PAINTING TOTAL	$

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$164,924
951X002	CONTINGENCY	COST	5%		$82,462
				PROJECT WIDE	$247,386

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$189,662
				OTHER COST	$189,662

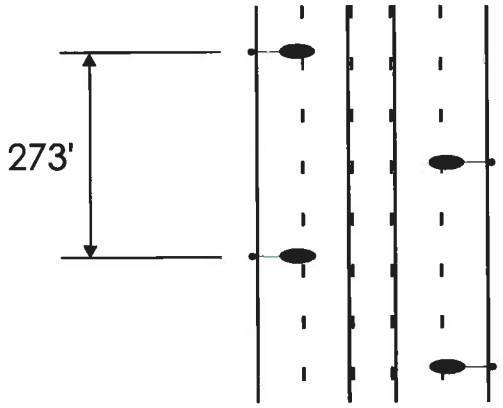
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,649,237
PAINTING TOTAL	$
PROJECT WIDE	$247,386
OTHER COST	$189,662
TOTAL LIGHTING SYSTEM	$2,086,285

DRAFT 9/2/09

Alternative #34

POLE:	*MONTEREY*
FIXTURE	*MONTEREY*
MOUNTING HEIGHT:	*30-FOOT*
MAST ARM:	*8-FOOT*
LAMP:	*METAL HALIDE PULSE START*
WATT:	*250 WATTS*
TOTAL WATTS:	*24,700 WATTS*
TOTAL LUMENS:	*2.13 MILLION LUMENS*

2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *273-FEET*

APROX. NO. OF POLES: *85*

SYSTEM CONSTRUCTION COST:		$2.22 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$550,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$21,000/YEAR

ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 34 - 30' MONTEREY POLE 250W STAGGERED M23250MF TYPE III MH 8' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310191	POLE (30-FOOT VISIONAIRE MONTEREY)	EACH	85	$3,600.00	$306,000
7310371	POLE FOUNDATION (VISIONAIRE MONTEREY)	EACH	85	$2,000.00	$170,000
7310651	MAST ARM (8 FT.) (VISIONAIRE MONTEREY)	EACH	85	$2,000.00	$170,000
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,967	$45.00	$358,495
7320410	PULL BOX (NO. 5)	EACH	93	$500.00	$46,500
7320520	CONDUCTOR (NO. 8)	L.FT.	47,064	$0.90	$42,358
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,532	$0.90	$21,179
7350820	PHOTO ELECTRIC CELL	EACH	3	$25.00	$75
7360111	LUMINAIRE (HORIZONTAL MOUNT) (MH 250 WATT)	EACH	85	$1,350.00	$114,750
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	3	$7,000.00	$21,000
				LIGHTING ITEMS SUBTOTAL	$1,328,184
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,756,687

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	0	$3,000.00	$
				PAINTING TOTAL	$

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$175,669
951X002	CONTINGENCY	COST	5%		$87,834
				PROJECT WIDE	$263,503

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$202,019
				OTHER COST	$202,019

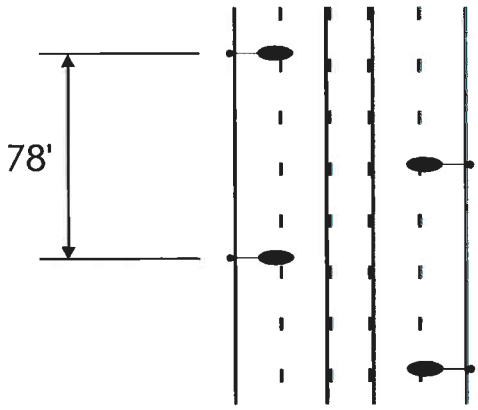
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,756,687
PAINTING TOTAL	$
PROJECT WIDE	$263,503
OTHER COST	$202,019
TOTAL LIGHTING SYSTEM	$2,222,209

DRAFT 9/2/09

Alternative #40

POLE:	*MONTEREY*
FIXTURE	*MONTEREY*
MOUNTING HEIGHT:	*30-FOOT*
MAST ARM:	*8-FOOT*
LAMP:	*LED*
WATT:	*148 WATTS*
TOTAL WATTS:	*44,100 WATTS*
TOTAL LUMENS:	*2.50 MILLION LUMENS*

2 SIDED STAGGERED

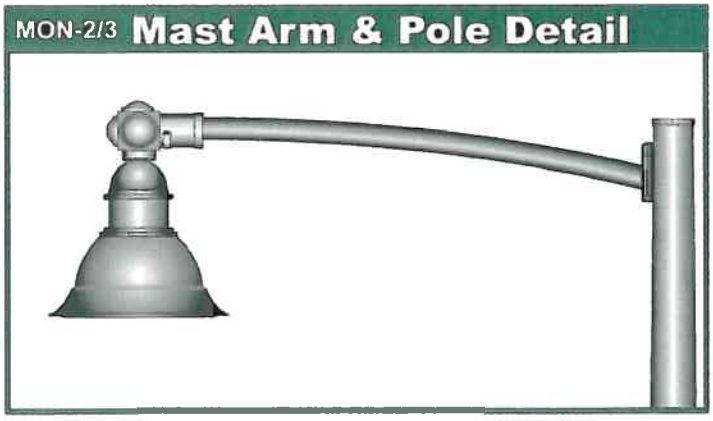


MAX. SPACING ON ONE SIDE: *78-FEET*

APROX. NO. OF POLES: *298*

SYSTEM CONSTRUCTION COST:		$4.93 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$3.26 MILLION	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$26,600/YEAR

LED SERIES



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 9/2/09

ALTERNATIVE 40 - 30' MONTEREY POLE 125W STAGERED MON-2-T3-125-LED TYPE III LED 8' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310191	POLE (30-FOOT VISIONAIRE MONTEREY)	EACH	298	$3,600.00	$1,072,800
7310371	POLE FOUNDATION (VISIONAIRE MONTEREY)	EACH	298	$2,000.00	$596,000
7310651	MAST ARM (8 FT.) (VISIONAIRE MONTEREY)	EACH	298	$2,000.00	$596,000
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	8,267	$45.00	$371,995
7320410	PULL BOX (NO. 5)	EACH	306	$500.00	$153,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,664	$0.90	$42,898
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,832	$0.90	$21,449
7350820	PHOTO ELECTRIC CELL	EACH	6	$25.00	$150
7360112	LUMINAIRE (HORIZONTAL MOUNT) (LED 125 WATT)	EACH	298	$1,650.00	$491,700
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	6	$7,000.00	$42,000
				LIGHTING ITEMS SUBTOTAL	$3,465,819
934XX01	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$3,894,322

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	0	$3,000.00	$
				PAINTING TOTAL	$

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$389,432
951X002	CONTINGENCY	COST	5%		$194,716
				PROJECT WIDE	$584,148

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$447,847
				OTHER COST	$447,847

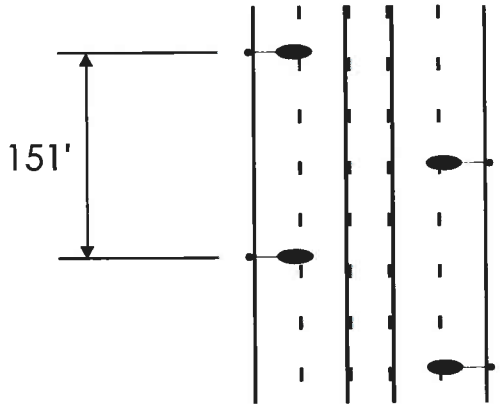
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$3,894,322
PAINTING TOTAL	$
PROJECT WIDE	$584,148
OTHER COST	$447,847
TOTAL LIGHTING SYSTEM	$4,926,318

DRAFT 8/19/09

Alternative #41

POLE:	*G-POLE*
FIXTURE	*LED ROADWAY*
MOUNTING HEIGHT:	*35-FOOT*
MAST ARM:	*20-FOOT*
LAMP:	*LED*
WATT:	*157 WATTS*
TOTAL WATTS:	*24,200 WATTS*
TOTAL LUMENS:	*1.48 MILLION LUMENS*

2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *151-FEET*

APROX. NO. OF POLES: *154*

SYSTEM CONSTRUCTION COST:		$2.76 MILLION
ADOT/FEDERAL HIGHWAY:	$1.67 MILLION	
CITY OF SEDONA:	$1.09 MILLION	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$15,900/YEAR

ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 8/11/09

ALTERNATIVE 41 - G POLE STAGGERED ERMC-X-A3 TYPE III LED 20- MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310070	POLE (TYPE G) (STANDARD BASE)	EACH	154	$1,500.00	$231,000
7310260	POLE FOUNDATION (TYPE G) (STANDARD BASE)	EACH	154	$1,000.00	$154,000
7310551	MAST ARM (20 FT.) (TAPERED)	EACH	154	$750.00	$115,500
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	8,067	$45.00	$362,995
7320410	PULL BOX (NO. 5)	EACH	162	$500.00	$81,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,264	$0.90	$42,538
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,632	$0.90	$21,269
7350820	PHOTO ELECTRIC CELL	EACH	4	$25.00	$100
7360113	LUMINAIRE (HORIZONTAL MOUNT) (LED)	EACH	154	$1,650.00	$254,100
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	4	$7,000.00	$28,000
				LIGHTING ITEMS SUBTOTAL	$1,368,329
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,796,832

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	154	$2,500.00	$385,000
				PAINTING TOTAL	$385,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$218,183
951X002	CONTINGENCY	COST	5%		$109,092
				PROJECT WIDE	$327,275

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$250,911
				OTHER COST	$250,911

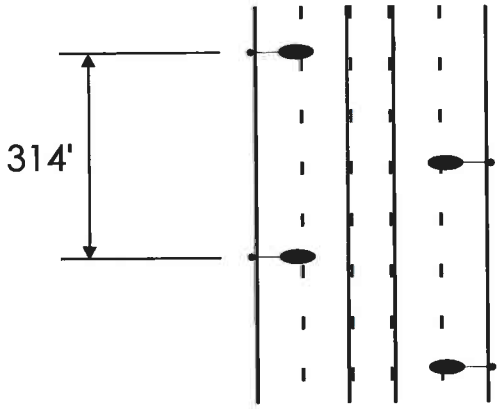
SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,796,832
PAINTING TOTAL	$385,000
PROJECT WIDE	$327,275
OTHER COST	$250,911
TOTAL LIGHTING SYSTEM	$2,760,018

DRAFT 9/2/09

Alternative 52

POLE:	*SHOEBOX*
FIXTURE	*SHOEBOX*
MOUNTING HEIGHT:	*35-FOOT*
MAST ARM:	*8-FOOT*
LAMP:	*HIGH PRESSURE SODIUM*
WATT:	*250 WATTS*
TOTAL WATTS:	*23,100 WATTS*
TOTAL LUMENS:	*2.22 MILLION LUMENS*

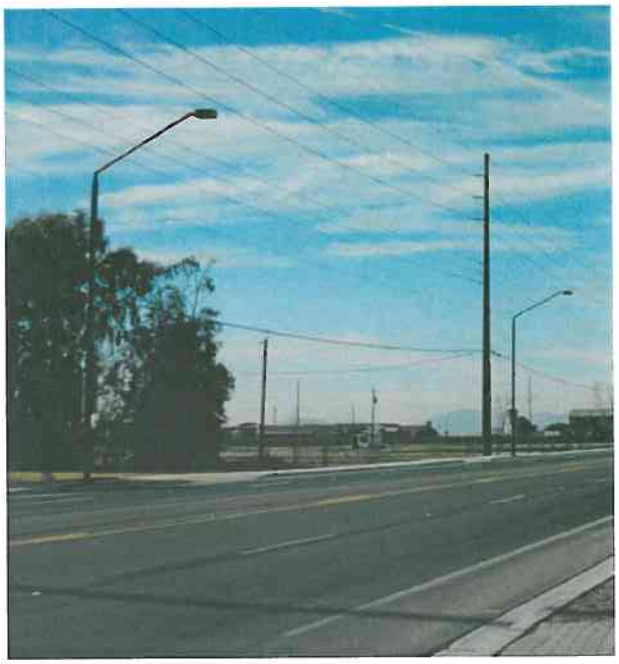
2 SIDED STAGGERED



MAX. SPACING ON ONE SIDE: *314-FEET*

APROX. NO. OF POLES: *74*

SYSTEM CONSTRUCTION COST:		$1.84 MILLION
ADOT/FEDERAL HIGHWAY:	$1.65 MILLION	
CITY OF SEDONA:	$190,000	
ANNUALIZED SYSTEM OPERATION & MAINTENANCE COST:		$14,100/YEAR



ESTIMATE OF QUANTITIES AND COSTS

STANLEY CONSULTANTS, INC.

PROJECT NO: STANLEY PROJECT 21278
LOCATION: SEDONA, ARIZONA

DATE : 9/2/09

ALTERNATIVE 52 - SHOEBOX 250W STAGGERED GE 8592 TYPE II HPS 8' MAST ARM (4-FOOT SETBACK)

LIGHTING ITEMS

Item No	Item Description	Unit	Quantity	Unit Price	Amount
7310193	POLE (SPECIAL) (35-FOOT SHOEBOX)	EACH	74	$1,500.00	$111,000
7310372	POLE FOUNDATION (SHOEBOX)	EACH	74	$1,000.00	$74,000
7310652	MAST ARM (8 FT.) (SHOEBOX)	EACH	74	$750.00	$55,500
7320260	ELECTRICAL CONDUIT (2 1/2")	L.FT.	15,565	$5.00	$77,827
7320291	ELECTRICAL CONDUIT (2 1/2") (PVC) (HORIZONTAL DIRECTIONAL DRILLING)	L.FT.	7,967	$45.00	$358,495
7320410	PULL BOX (NO. 5)	EACH	82	$500.00	$41,000
7320520	CONDUCTOR (NO. 8)	L.FT.	47,064	$0.90	$42,358
7320585	CONDUCTOR (INSULATED BOND) (NO. 8)	L.FT.	23,532	$0.90	$21,179
7350820	PHOTO ELECTRIC CELL	EACH	3	$25.00	$75
7360030	LUMINAIRE (HORIZONTAL MOUNT) (HPS 250 WATT)	EACH	74	$500.00	$37,000
7360220	LOAD CENTER CABINET (TYPE II) (120/240 VOLT)	EACH	3	$7,000.00	$21,000
				LIGHTING ITEMS SUBTOTAL	$839,434
934X001	MISCELLANEOUS WORK	COST			$127,190
XXXXXXX	MINOR ITEMS/MOBILIZATION	COST			$301,313
				LIGHTING ITEMS TOTAL	$1,267,937

PAINTING

9240119	MISCELLANEOUS WORK (PAINT 30' POLE & MAST ARM) (SEDONA RED)	EACH	74	$2,500.00	$185,000
				PAINTING TOTAL	$185,000

PROJECT WIDE

951X001	CONSTRUCTION ENGINEERING	COST	10%		$145,294
951X002	CONTINGENCY	COST	5%		$72,647
				PROJECT WIDE	$217,941

OTHER COST

	FINAL DESIGN COSTS	COST	10%		$167,088
				OTHER COST	$167,088

SUMMARY	
SECTION	TOTAL
LIGHTING ITEMS TOTAL	$1,267,937
PAINTING TOTAL	$185,000
PROJECT WIDE	$217,941
OTHER COST	$167,088
TOTAL LIGHTING SYSTEM	$1,837,965

SYSTEM CONSTRUCTION COSTS (a) DATE : 9/9/09

(a) Total anticipated construction cost which includes survey, design, traffic control, contingencies, etc.

ANNUAL SYSTEM ENERGY COSTS (b)
@ $0.10 KWH

PA:	250 WATT HPS	313 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1256.7 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 125.67	/YR/FIXTURE
	76 FIXTURES	95,509 KWH/YR	= $ 9,550.92	/YR
ALT 4:	250 WATT HPS	313 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1256.7 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 125.67	/YR/FIXTURE
	65 FIXTURES	81,686 KWH/YR	= $ 8,168.55	/YR
ALT 10:	400 WATT HPS	475 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1907.13 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 190.71	/YR/FIXTURE
	42 FIXTURES	80,099 KWH/YR	= $ 8,009.95	/YR
ALT 14:	180 WATT LPS	190 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	762.85 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 76.29	/YR/FIXTURE
	78 FIXTURES	59,502 KWH/YR	= $ 5,950.23	/YR
ALT 22:	400 WATT HPS	475 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1907.13 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 190.71	/YR/FIXTURE
	46 FIXTURES	87,728 KWH/YR	= $ 8,772.80	/YR
ALT 26:	175 WATT PS	208 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	835.12 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 83.51	/YR/FIXTURE
	136 FIXTURES	113,576 KWH/YR	= $ 11,357.63	/YR
ALT 29C:	250 WATT HPS	313 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1256.7 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 125.67	/YR/FIXTURE
	71 FIXTURES	89,226 KWH/YR	= $ 8,922.57	/YR
ALT 34:	250 WATT PS	291 WATT x 11 HRS/DAY x 365 DAYS/YEAR / 1000 W/KW	=	1168.37 KWH/YR/FIXTURE
		@ $0.10 KWH	= $ 116.84	/YR/FIXTURE
	85 FIXTURES	99,311 KWH/YR	= $ 9,931.15	/YR