CITY OF SUN VALLEY

REPORT TO THE CITY COUNCIL

To:	Honorable Mayor and City Council
From:	MH Mark Hofman, Community Development Director
Meeting Date:	June 6, 2013
Agenda Item:	**2013 Sun Valley Elkhorn-Juniper Intersection Safety Study**

SUBJECT: Presentation, public comment, discussion and City Council action on the 2013 Sun Valley Elkhorn Juniper Intersection Safety Study prepared by the City's engineer, CH2M Hill, at the request of the City.

BACKGROUND: Over the past two decades, several brief reviews by City staff have occurred at the Elkhorn-Juniper Road intersection. No significant improvements have been made at the intersection during that time other than minor changes, including relocation of the Juniper stop sign, removal of the pathway stop sign from the pathway bollard, addition of increasing cautionary bands at the approach on both the pathway and Juniper Road approaches to the crosswalk, and the pruning and thinning of aspen trees on the southeast side of the intersection. On October 18, 2012, the City Council formally approved $15,050 from the FY 2013 General Fund Contingency for safety measures at the Juniper and Elkhorn bike path and street intersection. The Agenda Report to the City Council from Bill Whitesell, Street Superintendent, and associated approved/signed Regular Council Meeting Minutes for the October 18, 2012 meeting are attached to this Report as **Exhibit "CC-2"**. The work identified included reduction of the dirt road cut shoulder adjacent to the existing bike path and the installation of a standard street light. The dirt modification design received Sun Valley Elkhorn Association (SVEA) approval on September 27, 2012. The approved street light was installed and illuminated by the City and the dirt modification element of the project was left for the next building season due to the onset of winter conditions.

The City Council again discussed the modification project at their January 3, 2013 regular meeting in response to public comments on the project. The Agenda Report to the City Council and associated approved/signed Regular Council Meeting Minutes for the January 3, 2013 meeting are attached to this Report as **Exhibit "CC-3"**. After public comment and discussion, the Council directed staff to turn the street light off pending further investigation of potential safety, light and aesthetic impact issues and return to the next meeting of the Council with a range of options, measures or designs for consideration.

On February 7, 2013, the City Council reviewed a proposal from CH2M Hill which contained a series or range of potential subtasks for the Council to select from as may be deemed appropriate. The meeting materials, including the draft CH2M Hill Task Order and numerous public comment emails, are attached to this Report as **Exhibit "CC-4"** and include the associated

approved/signed Regular Council Meeting Minutes for the February 7, 2013 meeting. After public comment and discussion, the City Council passed a motion to select a revised Task 1 from the draft Task Order that evaluates solely the Juniper and Elkhorn Road intersection with additional evaluation of any existing crash data, a lighting evaluation, inclusion of other safety options, and consideration of off-site mitigation measures.

On March 7, 2013, the City Council reviewed, discussed and approved a revised scope of work and budget from CH2M Hill for the safety evaluation of the Elkhorn and Juniper Road intersection. The Agenda Report to the City Council and associated approved/signed Regular Council Meeting Minutes for the March 7, 2013 meeting are attached to this Report as **Exhibit "CC-5"**. Additionally, an official copy of the final, signed CH2M Hill Task Order for the City of Sun Valley for the 2013 Sun Valley Elkhorn-Juniper Intersection Safety Evaluation, approved by the City Council on March 7, 2013, is attached as **Exhibit "CC-6"** for review and background.

ANALYSIS: The goal for the City Council is to evaluate conditions at the Juniper and Elkhorn Road intersection to examine if a safety issue exists due to the interactions of various users of the roads and path. If a safety issue exists, the Council should decide which methods or options are most appropriate to mitigate danger and maximize public safety in a proactive manner that also minimizes lighting and aesthetic impacts on the neighborhood.

As directed, the Elkhorn-Juniper Intersection Safety Study prepared by CH2M Hill for the City of Sun Valley, and stamped received by the Community Development Department on May 19, 2013, is attached to this Report for consideration as **Exhibit "CC-7"**. One (1) additional public comment email has been received by staff since the March 7, 2013 meeting and is hereby added to the record and forwarded to the Mayor and City Council as attached **Exhibit "CC-1"**.

The agenda item before the City Council for this Thursday, June 6, 2013 meeting is to allow presentation, public comment and discussion on the 2013 Sun Valley Elkhorn Juniper Intersection Safety Study. The Community Development Director recommends the City Council take action on the recommendations and conclusions contained in the Evaluation and provide staff with direction accordingly to implement said measures deemed appropriate, as soon as practicable.

LIST OF ATTACHED EXHIBITS:

Exhibit "CC-1"	Public comment email received by staff since the March 6, 2013 City Council meeting on this matter, including a May 21, 2013 email from Linda Peterson.
Exhibit "CC-2"	Agenda Report to the City Council from Bill Whitesell, Street Superintendent, and associated approved/signed Regular Council Meeting Minutes for the October 18, 2012 meeting.
Exhibit "CC-3"	Agenda Report to the City Council and associated approved/signed Regular Council Meeting Minutes for the January 3, 2013 meeting.
Exhibit "CC-4"	Meeting materials for the February 7, 2013 regular meeting of the City Council, including the draft CH2M Hill Task Order, numerous public

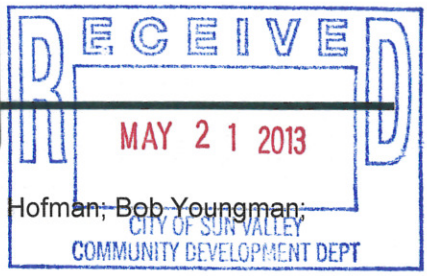
comment emails, and the associated approved/signed Regular Council Meeting Minutes.

Exhibit "CC-5" Agenda Report to the City Council and associated approved/signed Regular Council Meeting Minutes for the March 7, 2013 meeting.

Exhibit "CC-6" CH2M Hill Task Order for City of Sun Valley for the 2013 Sun Valley Elkhorn-Juniper Intersection Safety Evaluation, approved by the City Council on March 6, 2013 and consisting of four 8.5" by 11" pages.

Exhibit "CC-7" Elkhorn-Juniper Intersection Safety Study prepared by CH2M Hill for the City of Sun Valley and stamped received by the Community Development Department on May 19, 2013.

**The administrative record for this intersection safety evaluation is available for review in the Community Development Department at City Hall.



Mark Hofman

From: Linda Peterson [lindajpeterson@co
Sent: Tuesday, May 21, 2013 8:46 AM
To: Dewayne Briscoe; Franz Suhadolnik External; Ribi Nils; Mark Hofman; Bob Youngman; Michelle Griffith
Subject: Light standard ~ corner of Elkhorn/Juniper Roads

I am, along with many others in the Twin Creeks subdivision
extremely disappointed that the new light standard
at the corner of Elkhorn Road and Juniper (Twin Creeks)
is temporarily inoperable
because of the negative effect
it has on some resident's in the Sunrise subdivision.
Possibly a shield could be applied
so the light is not shining
in someone's home if that is the issue.
The light standard **has been installed**,
paid for ($6,500)
and is nonoperative.
Does that make sense?

I think it is a wonderful addition
to the corner.
For night time driving,
the intersection is obvious.
For safety purposes,
the light illuminates
those crossing the road.

I vote
to reactivate
the light now!

Intersection Review

Elkhorn – Juniper Intersection Safety Study

Prepared for

City of Sun Valley

Sun Valley, Idaho

May 2013

CH2MHILL
Boise Office

Project Background and Scope of Work

Background

Over the past two decades, several brief reviews have occurred at the Elkhorn-Juniper intersection. No significant improvements have been made at the intersection other than minor changes. Minor improvements include relocating the Juniper stop sign, removing the pathway stop sign from the pathway bollard, adding the increasing cautionary bands at the approach on both the pathway and Juniper Road approaches to the crosswalk, and pruning and thinning the aspens on the southeast side of the intersection. Most recently, an overhead light was installed and the Eggers plan for reducing the height of the ridge between Juniper Road and the north section of pathway was approved by Council in October of 2012. The light was installed and illuminated, but after a few complaints from local residents, was turned off. The approved earthmoving on the ridge was not completed. For information, the Eggers plan is provided in Appendix I and generally incorporated into the appropriate improvement option in the text below.

Scope of Work and Purpose

The City of Sun Valley, Idaho (the City), requested professional engineering services from CH2M HILL, Inc. (City Engineer) in development of a Technical Memorandum (TM) for the review of the Elkhorn-Juniper Road Intersection. This TM provides the City Engineer's evaluation of the Elkhorn-Juniper Road Intersection based on current, recognized engineering standard guidelines to facilitate the City Council's effort to maximize intersection safety proactively, based on the existing intersection configuration and interaction of various users. This TM provides alternatives for intersection improvements that the Council may consider implementing based on their conclusion regarding intersection safety. The evaluation is based on the following current standards and guidelines: American Association of State Highway and Transportation Officials (AASHTO) for both vehicle and bicycle facilities, the Manual on Uniform Traffic Control Devices (MUTCD), and the Illuminating Engineering Society (IES).

CH2M HILL has been the City's engineer for the past 20 years. During that time, we have worked on-site in City office space and lived in the community for entire construction seasons. We have worked directly with concerned citizens regarding issues ranging from construction to planning and budgeting. We understand the needs and concerns of this rural, world-class resort community and have attempted to weave that essence through our discussion and solutions. We have applied current standard guidelines where applicable and convey those results in the body of the TM. We have tried to provide solutions and improvements that reflect the values of the community, yet meet the recommended guidelines for intersection and bicycle facilities. We recognize that some of the potential solutions may not be appealing to all, but feel it is important to provide a range of possible improvements.

For purposes of this document, the existing landform between Juniper Road and the north section of path will be called a "ridge", though we understand it has been referred to as a berm as well. The ridge property is owned by the Sun Valley Elkhorn Association. We recognize that installation of mechanical or man-made items such as signs and lights have a certain aesthetic impact. Earth moving and modification of natural landforms also has an aesthetic impact, though may be considered a different impact by the viewer. For purposes of this report, we will refer to the installation of man-made items as having an "inorganic" impact and the modification of natural landforms as having an "organic" impact. Phrases such as "Dark Sky Ordinance" or "Dark Sky compliant" may occur in this document and refer back to the City's

Code, specifically Article B. Exterior Lighting Regulation, of Chapter 3 and Title 9. Engineering or technical conclusions have been provided at the end of each section. These conclusions are based on the engineering evaluation and incorporation of standard recommended guidelines.

Report Layout

This report generally presents existing conditions and background information first, followed by potential improvement options. The goal is to provide the reader with enough background information on original geometric design of the road and path, the current maintenance practices, and standard of the industry guides to be comfortable evaluating the optional solutions provided.

Appendices are included at the back of the document in order to provide supplemental information. The appendices have been compiled based on categories of information and may not necessarily be referenced in order through the document. The categories are:

Appendix I - October 2012 Council-Approved Eggers Plan

Appendix II - Roadway and Pathway Exhibits

Appendix III - Lighting Analysis - AGI32 Light Results

Appendix IV - Reference Material and Cut Sheets

Survey of Existing Property

Benchmark and Associates provided electronic 1-foot contour mapping with aerial photography background. An updated field survey was conducted and the combined map was provided on April 16, 2013.

Existing Conditions

Traffic Data

For the purposes of this evaluation, 2012 existing year traffic data for the Elkhorn Rd and Juniper Rd intersection was projected from counts completed in 1995 for the City of Sun Valley Transportation Plan. A combination of average daily traffic (ADT) and peak hour counts from the Transportation Plan were utilized to project a 2012 existing intersection ADT based on the assumption of 1% growth per year on Juniper Rd and 2% growth per year on Elkhorn Rd. An existing year 2012 ADT of 2,539 vehicles was calculated. This intersection ADT is comparable to traffic conditions of a low-volume, rural arterial intersection.

Intersection Crash Analysis

The City of Sun Valley provided a summary of crash incidents near the Elkhorn Rd and Juniper Rd intersection for the five-year period from January 2008 through December 2012. For the purpose of this analysis, a crash is considered an intersection crash if it is within 0.1 miles of the intersection. A crash maybe considered an intersection related crash beyond this distance if the main contributing circumstance is related to the intersection (geometric consideration, etc). Based on the GPS coordinates provided, one injury crash occurred at the intersection during this five-year period. The crash involved a driver running off the road and hitting a tree at

night. The vehicle was found on the bike path. The report indicated alcohol as a contributing circumstance.

Based on the existing traffic data, an intersection crash rate of 21.6 per 100 million annual vehicle miles traveled (AVMT) was calculated. For this location, the crash rate represents both the total crash rate and the injury crash rate since there is a single crash occurring at the intersection for the five-year period, and this crash incurred an injury. Based on the latest statewide Idaho Transportation Department (ITD) crash statistics (year 2011), the average local roads total crash rate is 169.0 per 100 Million AVMT. The injury crash rate is 60.1 per 100 Million AVMT. This indicates that the crash rate at the Elkhorn Rd and Juniper Rd intersection is below the state average for both total and injury crashes on local roads. ITD defines a local road as any road other than an Interstate, U.S., or State Highway.

Though the intersection is well below the statewide average, there is a perceived safety concern for drivers and pathway users due to the existing geometry and terrain at the intersection. The ridges on the northeast and southeast quadrants of the intersection pose speed and sight distance concerns between vehicle and pathway users. In addition, the curvature and downhill grade of Juniper Rd near the intersection, as well as the offset of the pathway from Elkhorn Rd contribute to sight limitations. The sight distance analysis is discussed in the following section.

Roadway and Pathway Design Conditions

The intersection of Elkhorn and Juniper Roads is a two-way stop controlled "T" intersection with the multi-use pathway running parallel to Elkhorn Road and crossing Juniper Road at an offset of approximately 45 feet from the Elkhorn Road centerline. Elkhorn Road has a posted speed limit of 35 mph at the intersection. Juniper Road has a posted speed of 25 mph. Posted speeds are typically signed at 5 mph below the actual designed speed for the given alignment. Vertical and horizontal alignments for bike paths are designed in a similar manner to roadway design. The design speed is a speed at which the vehicle or bicycle can safely traverse the road or path. The posted speed is typically lower to accommodate a margin of safety as well as the driver's comfort level. Most drivers will drive at their comfort level, which means that reducing posted speed limits on roads that are designed for higher speeds may not result in drivers actually reducing their speed.

The Elkhorn southbound approach occurs on a downhill grade of just over -2%. The northbound Elkhorn approach occurs on an uphill grade of just under 2%. The westbound Juniper Road approach occurs on a downhill grade of -4% at the intersection and includes a sharp curve there as well. The Juniper westbound approach sight distance is hindered by the ridge in the northeast quadrant and less severely by the ridge in the southeast quadrant of the intersection. The grade of the southbound Elkhorn Path approaching the intersection is approximately -3% and the grade of the northbound section of path is 2%.

The intersection includes increasing striping for the pathway approaches with the word "CAUTION". The Juniper westbound vehicle approach has similar gradient striping in advance of the stop bar as well as "X-ING PATH" painted on the pavement to indicate the approach of a pedestrian crossing. The Juniper approach also includes a pedestrian crossing warning sign and a standard painted crosswalk. Anecdotal information suggests that many drivers tend to roll through the stop bar behind the crosswalk as opposed to fully stopping. This is common in similar situations where the vehicle may need to stop a second time at the edge of the intersection as well as the crosswalk.

The City of Sun Valley uses the standard water-based reflective paint for marking the pathway and the streets. Current maintenance practices include sweeping and repainting of pathways and streets each spring. The City also uses standard regulatory street signs, such as the stop signs, though out the community. These signs meet the size, wording, and coloring required by the MUTCD.

Existing Roadway and Pathway Sight Distance Calculations

Juniper Road

The stopping sight distance calculated to the Juniper Road stop sign at the Elkhorn intersection is less than adequate according to AASHTO guidelines for a design speed on Juniper Road of 25 mph. By the time a vehicle on Juniper Road approaching the stop sign can actually see the stop sign, there is not adequate distance to ensure that the vehicle can stop behind the cross walk. It is understood that the majority of drivers in the area know from experience where the sign is located and prepare in advance to stop. This calculation is based on AASHTO guidelines, which provide adequate time for drivers to respond and come to a complete stop at the stop bar.

Conclusion: Juniper Road stopping sight distance – inadequate.

Elkhorn Pathway

Though we realize that most safety concerns regarding potential conflict with pathway users is considered to come from the north section of path (southbound), this TM evaluates the entire intersection including the stopping sight distance for pathway users on the south section of path (northbound) as well. In the past, the pathway bollard approaching the intersection from both directions had a stop sign for pathway users. The stop sign has been removed and replaced with a caution sign, giving the pathway users the right of way at all times. The path is currently striped using the City's shorter to longer cautionary bars (also repeated on the roadway for Juniper Road approaching the stop bar). This striping pattern replicates what the region has agreed to for standard intersection striping. Because pathway users do not actually have to stop at the crosswalk before entering and crossing Juniper Road while conflicting vehicle traffic does, calculating and providing adequate stopping sight distance for the pathway users is not technically required. However, when potential points of conflict between vehicles and bicycles are identified, it is prudent to provide the opportunity for defensive action by the cyclist where possible. In this case, it means ensuring stopping sight distance is available in the event a vehicle does not see them or stop behind the cross walk.

As with vehicles, the stopping sight distance for a bicycle is based on the speed the bicycle is traveling when it needs to stop. AASHTO recommends designing pathways using a range of design speeds from about 20 to 30 mph depending on the terrain, use, etc. See Appendix IV – Reference Material for section 5.2.4 Design Speed of the AASHTO Guide for the Development of Bicycle Facilities, 2012, Fourth Edition. Researching other local requirements, neither Blaine County Recreation District nor the County Sheriff have posted any speed limit signs on the county pathway system, though anecdotal information suggests it may have been posted at one time at 15 mph, which would be consistent with a 20 mph design speed. Pamphlets on pathway use as provided by the Recreation District and the County encourage safe speeds under which the rider can maintain control. Based on this information, we have calculated the bicycle stopping sight distance at 15, 20, 25, and 30 mph in both directions. Currently, on the north section of path (southbound), the stopping sight distance is not adequate at any of the identified speeds, because of the ridge between the path and Juniper Road on the north side of Juniper. As the path approaches Juniper Road from the south side, the stopping sight distance

is adequate for speeds of 15 mph, requires very little removal at 20 mph, but not adequate for speeds of 25 and 30 mph.

Conclusion: Elkhorn Pathway stopping sight distance from north - inadequate.

Elkhorn Pathway stopping sight distance from south - inadequate depending on selected speed.

Intersection Improvement Options

Roadway and Pathway Intersection Improvement Options

Juniper Road

To improve the inadequate advance warning of the upcoming stop sign on Juniper Road, a "Stop Ahead" sign could be installed at the appropriate distance back from the stop sign to allow the driver adequate time to react and begin braking in order to come to a full stop at the sign. The advance warning sign could be enhanced to include language such as "Bike cross traffic doesn't stop". This would satisfy the current situation; this improvement would be considered an "inorganic" impact.

The problem could also be solved "organically" by cutting back the ridge to provide adequate sight to the stop sign. See attached "Stopping Sight Distance" in Appendix II Exhibit 1 for both options.

Elkhorn Pathway

As with the Juniper Road improvement options, one of the options for Elkhorn Path is the "inorganic" type - including the addition of warning signage. Yellow warning signs could be installed at the appropriate stopping sight distance (from both north and south directions depending on the speed deemed appropriate) warning cyclists of vehicles ahead. See Exhibit 2, Option A.

The "organic" approach would be to remove a portion of the ridge between the pathway and Juniper Road on the north and south sides to provide adequate visual corridor to meet the requirements of the stopping sight distance. See Exhibits 2, Option B and Exhibit 3 for the various design speed sight distance impacts.

Combined Pathway and Roadway Improvement

Included in Appendix II Exhibit 4 is a hybrid design of a Rectangular Rapid Flashing Beacon. This design would detect bicycle or pedestrians on the path and could be activated via a motion detector for cyclists or a button for pedestrians. A flashing beacon would warn the driver that there is a pathway user within the vicinity of the crosswalk. Similarly, detection of an approaching vehicle could flash on the pathway to warn pathway users in advance of the intersection that there is an approaching vehicle. This would require a small cabinet (pole mounted on a signpost), electrical service connection, beacons, and signs. See Appendix IV for a flashing beacon cut sheet. We recognize that this "inorganic" improvement may not be a context sensitive solution for the City of Sun Valley, but want to provide the potential range of options for consideration.

Pathway Realignment

Another alternative to improve the visual ability of roadway and pathway users is to relocate the path adjacent to Elkhorn Road at the intersection. See Appendix II Exhibit 5 for illustration. The City of Sun Valley has a number of sections of path throughout the community that run parallel to the road and are separated from the road by a curb. The AASHTO Guide considers these types of pathways "sidepaths". With respect to sidepath intersections, AASHTO suggests "At lower speeds, greater separation does not reduce crashes; therefore the sidepath should be located in close proximity to the parallel roadway at intersections so that motorists turning off the roadway can better detect sidepath users." In this instance, "lower speeds" means anything below 50 mph. In the context of the Elkhorn path in this area, relocating the path closer to the roadway may impact the rural feel of this section of path as it winds along the mountainside above the road and then down in the creek area as it approaches the Lane Ranch area. Additional consideration should also be given to off-leash dogs. Many pathway users remove their pet's leash on this section of trail because of the space provided between the path and the roadway. The change to close proximity to the pathway could create potential risk of dog-vehicle conflicts. However, this "organic" option does provide better visibility all around and reduces the double stopping action that most vehicles on Juniper are required to make. Additionally, this solution moves the Juniper Road stop sign closer to the intersection, increasing the roadway stopping sight distance and eliminating the need for ridge cutting or addition of signs on either the path or Juniper Road.

Intersection Improvement Summary

Table 1 below provides a summary of the intersection improvements.

Table 1

Intersection Sight Distance Improvement Options (See Appendix II for Exhibits)

Intersection Improvement Option		Safety Improvement	Visual Impact	Cost	Comments
1– Vehicle Sight Improvements on Juniper One of these options is required to meet minimum standards of design if the pathway is not relocated. (See Intersection Improvement Option 4 that also satisfies requirement.)					
Exhibit 1 Option A	"Stop Ahead" Warning Sign	Provides adequate warning for drivers to stop at stop sign	Inorganic	Low	A warning sign on Juniper is a low cost option to meet the minimum stopping sight distance standards.
Pro – inexpensive, simple Con – increases visual pollution, signs can lose effectiveness over time for repeat users					
Exhibit 1 Option B	Ridge Cut	Provides visibility of the stop sign in time to stop without adding an additional sign	Organic	Medium	A ridge cut for Juniper Rd vehicles can be completed in place of the warning sign.
Pro – remains effective over time, can be made to look natural Con – costly, requires time to re-vegetate					
2 – Elkhorn Pathway Sight Improvements					
Exhibit 2 Option A	Warning Signs	Provides cyclists enough warning of potential vehicle conflict to stop if vehicle does not	Inorganic	Low	Pathway warning signs are a low cost option to warn pathway users of the upcoming intersection and provide enough time to slow or stop if a vehicle does not.
Pro – inexpensive, simple Con – increases visual pollution, signs can lose effectiveness over time for repeat users					
Exhibit 2 Option B Exhibit 3	Ridge Cut Design Speeds 15 mph 20 mph 25 mph 30 mph	Provides cyclists visibility and time to stop if vehicle does not without adding additional signs on the pathway	Organic	High	A ridge cut for pathway users will provide visibility for cyclists to assess potential conflicts and stop if necessary. The amount of ridge cut necessary will depend on the design speed assumed.
Pro – remains effective over time, can be made to look natural Con – costly, requires time to re-vegetate; more expensive					
3 – Vehicle and Pathway Warning Signs with Flashing Beacons					
Exhibit 4	See Appendix IV for product cut sheet	Provides flashing warning of an upcoming conflict when activated by motion sensor	Inorganic	Medium	Provides flashing warning to both pathway users and vehicles of downstream conflict.
Pro –remains effective over time; activates at time of potential conflict only Con – potentially intrusive light, may be considered visual pollution, moderately expensive					
4 – Relocation of Pathway					
Exhibit 5	Pathway located along roadway	Provides visibility for both vehicles and pathway users without adding signs or cutting ridge	Organic	High	This is a stand-alone option. It does not require any other Options to be implemented in conjunction
Pro – requires no other signage, improves both road and path simultaneously Con – cost; impact to path experience; increases potential dog-vehicle conflict					

Existing Intersection and Pathway Illumination

Existing Illumination Analysis

Dark sky is a function of how much light is cast upward into the night sky. Most light fixtures have a cut-off feature that reduces or removes all light above the light fixture. The City's standard light fixture that is installed at the Elkhorn-Juniper intersection has a full cut-off, resulting in no lumens being cast above the light fixture. Technically, the light installed at the Elkhorn-Juniper intersection meets the requirements of the City's Dark Sky ordinance.

The City of Sun Valley is rural, and lighting levels in general are low. Lighting at intersections is important to help provide illumination at potential points of conflict. Because of its rural nature, lighting can be important for making not just vehicles, cyclists, and pedestrians visible to each other, but also to help spot wildlife that might be in the path of vehicles or pathway users. The analysis below is provided so that the City Council can understand where the Juniper-Eklhorn Intersection fits within the range of lighting recommendations.

AGI32 lighting evaluation software was used to evaluate the current lighting condition at the Elkhorn and Juniper intersection. The current light that was provided by the City of Sun Valley is a Gardco 100W Metal Halide, Type III, Horizontal Lamp consisting of a shoebox style light fixture mounted at 20' high.

Pathway Illumination

The pathway area evaluated with the light model AGI32 encompasses the pathway crossing from one edge of Juniper Road to the other edge of the road. According to the illumination modeling of the existing lighting conditions, using the installed 20' light described above, the pathway lighting level is below recommended values on the south side of the Juniper Road. See Appendix III, Exhibit 6 for lighting outputs. Table 2 below shows where the lighting levels for the Elkhorn-Juniper intersection fall in comparison to recommended values. The table below is a piece of Table 7 out of the IES PR-8-00 guidelines for "low pedestrian conflict areas" (see Appendix IV for full table). The Elkhorn-Juniper intersection fits into the "low pedestrian conflict area" category based on ADT and the fact that the crossing is actually on Juniper Road, not Elkhorn Road.

Table 2

Pathway at intersections lighting levels

Rural/Semi-Rural Areas	IES RP-8-00 Recommended Values	Existing Condition from AGI model	Conclusion
E_H (fc)	0.2	0.5	Adequate – above recommended fc
E_{Vmin} (fc)	0.06	0.02	Inadequate – below recommended fc
EH_{avg}/EH_{min}	10.0	9.62	Adequate – ratio should be below recommended value

E_H =Average Horizontal Illuminance at ground surface

E_{Vmin} = Minimum Vertical Illuminicance at 4.9 ft above the ground surface

fc = foot-candle = the unit of illuminance on a surface one square foot in area on which there is a uniformly distributed flux of one Lumen.

E_{Havg}/E_{Hmin} = refers to the uniformity of lighting across a desired area

The table above refers to foot-candles as the measurement of light on a designated surface. Lumens were entered into the AGI32 evaluation as a function of the light. Lumens are determined from radiant power. The lumens of the light will decrease over time due to dirt and degradation of the light cover as well as aging of the light itself.

Conclusion: Lighting level at the pathway intersection - inadequate.

Neighborhood Glare

A glare rating evaluation was made of all homes within the area. See Exhibit 7 in Appendix III for evaluation points, and lighting outputs. The evaluation was made at three different elevations above the ground, at 5', 15' and 25'. This is to indicate eye heights at multiple floors within the house, or deck. All locations and elevations studied have Glare Ratings of 10, indicating that there is unnoticeable glare according to the IES. However, unnoticeable glare does not mean that the light cannot be seen. See Table 3 below for descriptions of typical glare ratings.

Table 3
Table form AGI32 Lighting Software

	Glare Rating (GR)
Unbearable	90
	80
Disturbing	70
	60
Just Admissible	50
	40
Noticeable	30
	20
Unnoticeable	10

Conclusion: Glare rating at intersection - unnoticeable.

Intersection Lighting Options

Pathway Illumination

There are three typical ways to improve the area lighting levels:

- increase the tilt of light,
- install additional light on south section of path,
- increase mounting height and increase lumens

With respect to neighborhood complaints in the area regarding light intrusion at nearby homes, adding another light, tilting or raising the light could result in more complaints due to increased view directly into the light.

If desired, other options for improving lighting at the intersection could be explored. These options include modeling additional lighting scenarios, such as adding more and lower lights around the intersection. This will enhance the inadequate lighting on the south side of the intersection, and may reduce visual impact to neighbors if light fixtures are installed at lower, pedestrian levels. Lower light fixtures may include bollard-style lighting. This may not be as effective in helping spot wildlife, but may provide an overall improvement that is acceptable.

Neighborhood Glare

There is no apparent light intrusion with the existing light fixture according to current standards; however, based on complaints from the local homeowners, it has been an impact. Addition of a light shield would help mitigate this impact. There is an "internal house side shield" that could be installed in the light. This would reduce the light casting perpendicular to the fixture. Installing an external shield is another option; this would require a special design product, and would be visible during the day extending down from the light. The shield length should be one-half the width of the light and should be installed at an 80° angle. This would prevent nearby homeowners from looking directly into the light. Light shields can be effective

in reducing perceived glare while still providing adequate illumination where needed. Vegetative or landform shielding might be a viable alternative as well. Construction of a berm or planting of evergreen trees could provide shielding of the light from homes.

Illumination Improvement Summary

There are additional lighting options that could be explored that would provide additional illumination at the intersection, and reduce the impact to local homeowners. These options should be analyzed using a lighting model, evaluated for efficiency, cost, improvement to the intersection, and impact to local residents. To summarize, some of the options that could be evaluated might include:

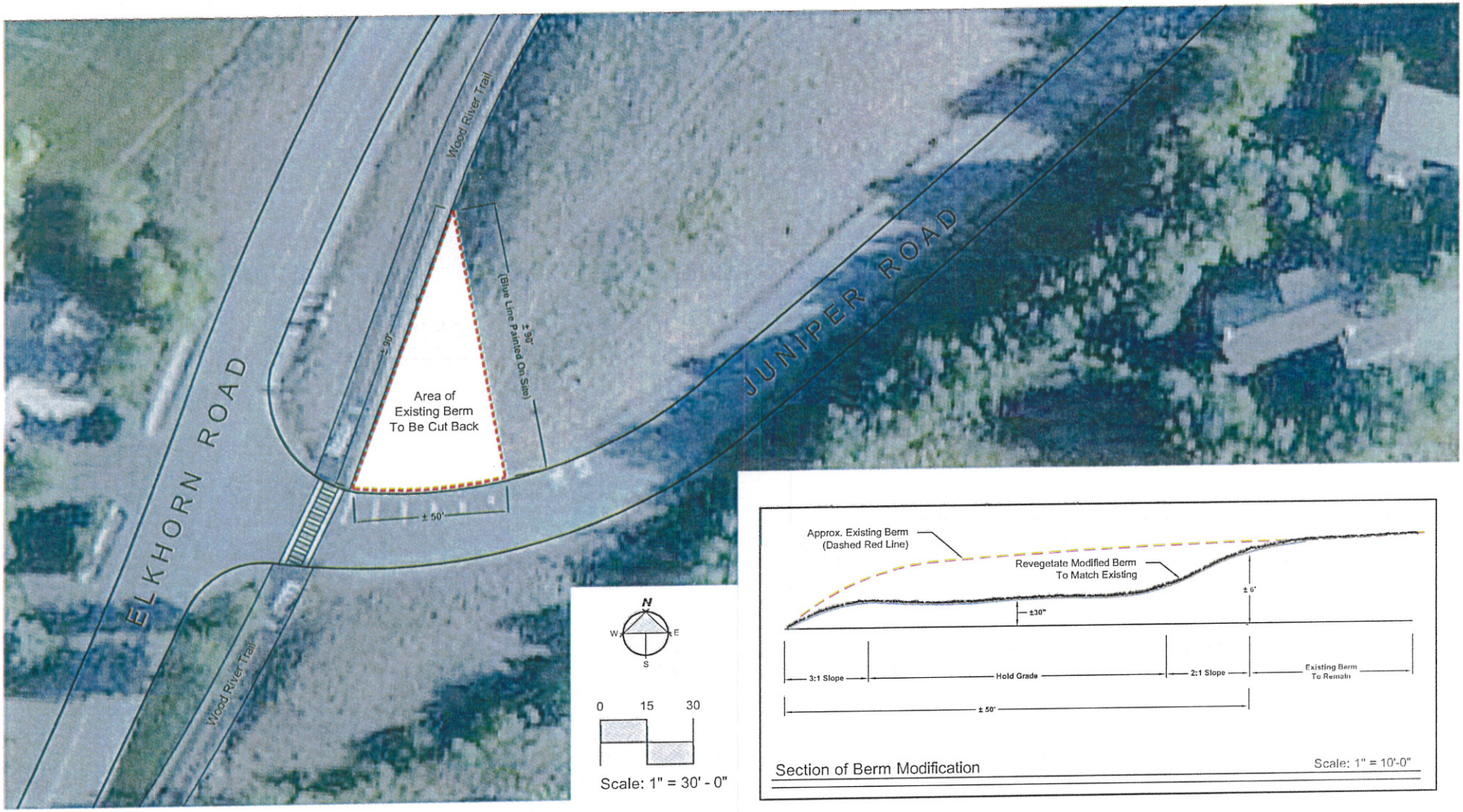
- lower height pedestrian lights, (bollard style),
- addition of a another light(s) to spread illumination coverage,
- relocation of the existing light to the south side of Juniper Road,
- additional evaluation of mounting heights and light lumens,
- additional physical landscape and vegetation screening

TM Summary

This TM provides an engineering analysis of the existing physical and functional features of the Elkhorn-Juniper intersection as well as the local illumination. Conclusions are provided regarding how well the intersection meets certain standard guidelines. A variety of improvement opportunities are provided. Though speed limit reductions and striping improvements are a consideration at the intersection, because neither directly addresses the sight distance or low lighting concerns between the Juniper Road approach and the pathway, they were not provided as potential solutions. If the City Council takes action on this issue and elects to conduct an improvement, we recommend a final design be developed to ensure the improvement meets the standards intended and can easily be conveyed to a contractor for construction, as needed.

Appendix I

October 2012 Council-Approved Eggers Plan



EGGERS ASSOCIATES, PA
landscape architecture

Juniper Road

Sun Valley, ID

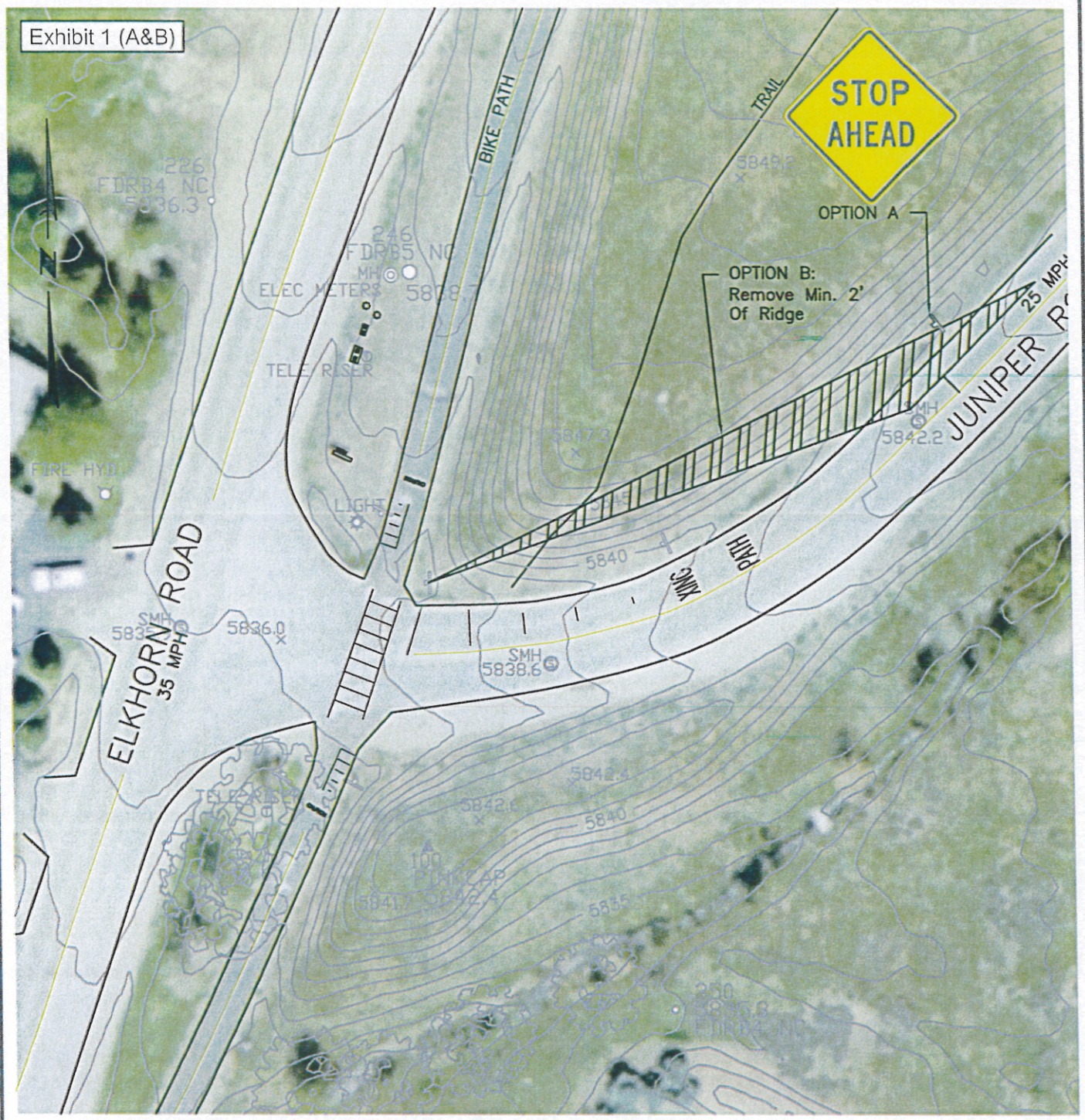
Sight Line Improvements

DATE: 10/25/12

Appendix II

Roadway and Pathway Exhibits

Exhibit 1 (A&B)



20' 10' 0' 20' 40'

SCALE:1" = 40'

Stopping Sight Distance

NOTES:

1. *Line Of Sight To Stop Sign With Stopping Distance From 30 mph To 25 mph.*

OPTION 1: Install Stop Sign Ahead Sign To Alert Drivers Of Stop.

OPTION 2: Peel Back Berm To Allow Line Of Sight To Stop Sign.

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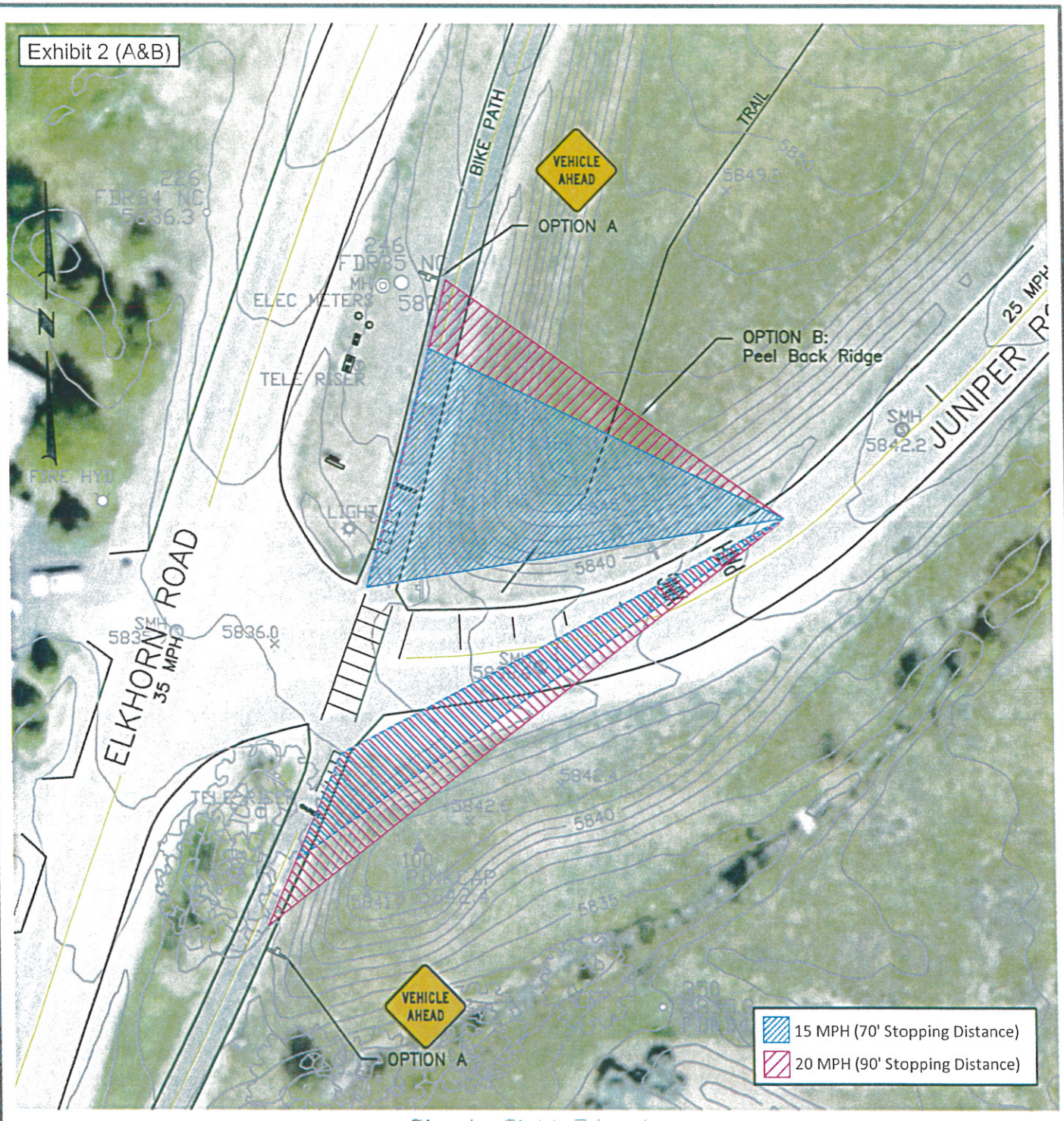
Exhibit 2 (A&B)



20' 10' 0' 20' 40'

SCALE:1" = 40'

Bicycle Sight Triangle

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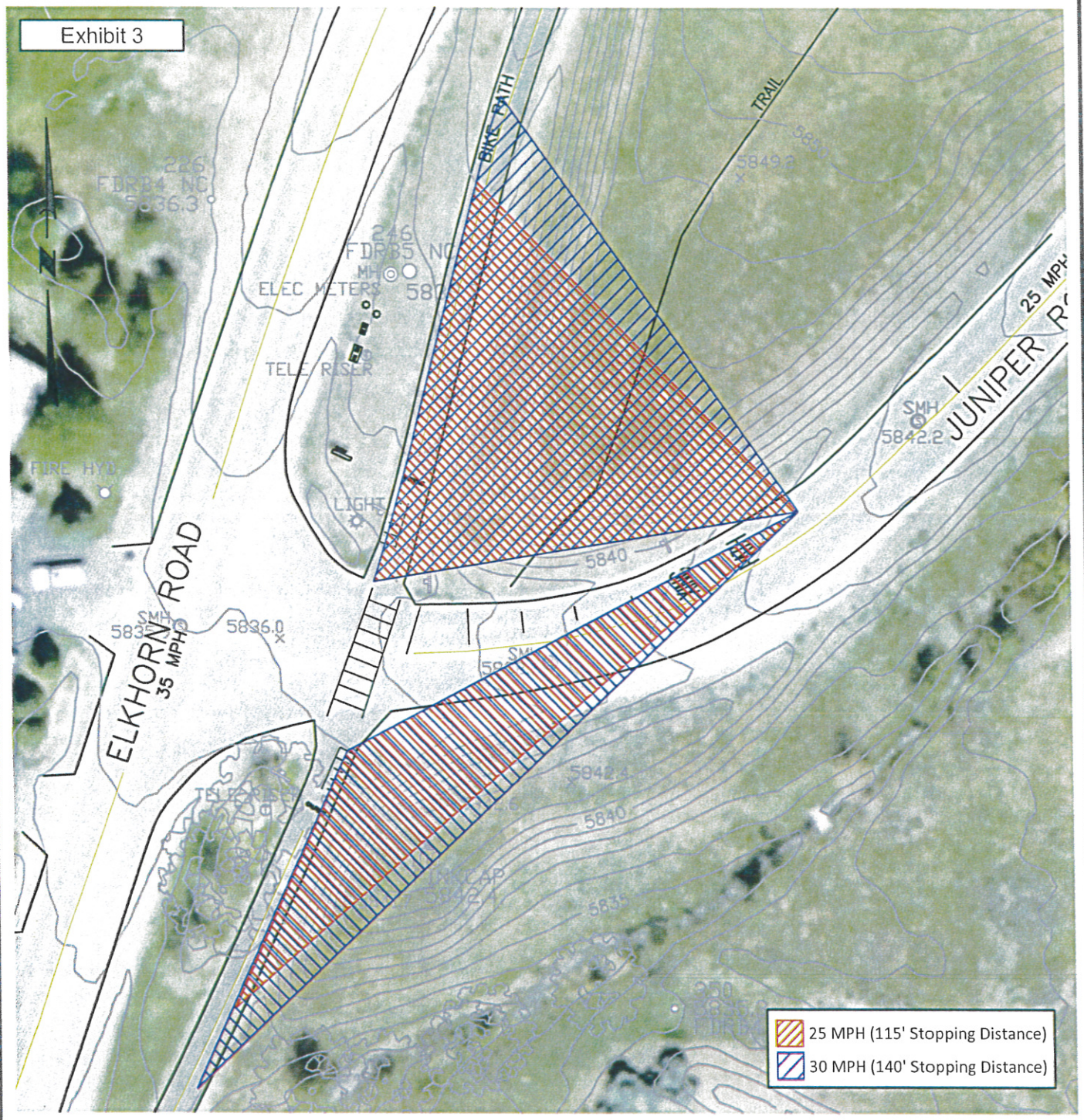
Exhibit 3



20' 10' 0' 20' 40'

SCALE:1" = 40'

Bicycle Sight Triangle

NOTES:

1. *For Bikes Traveling At 30 mph There Is Not Proper Line Of Sight To An Approaching Vehicle.*

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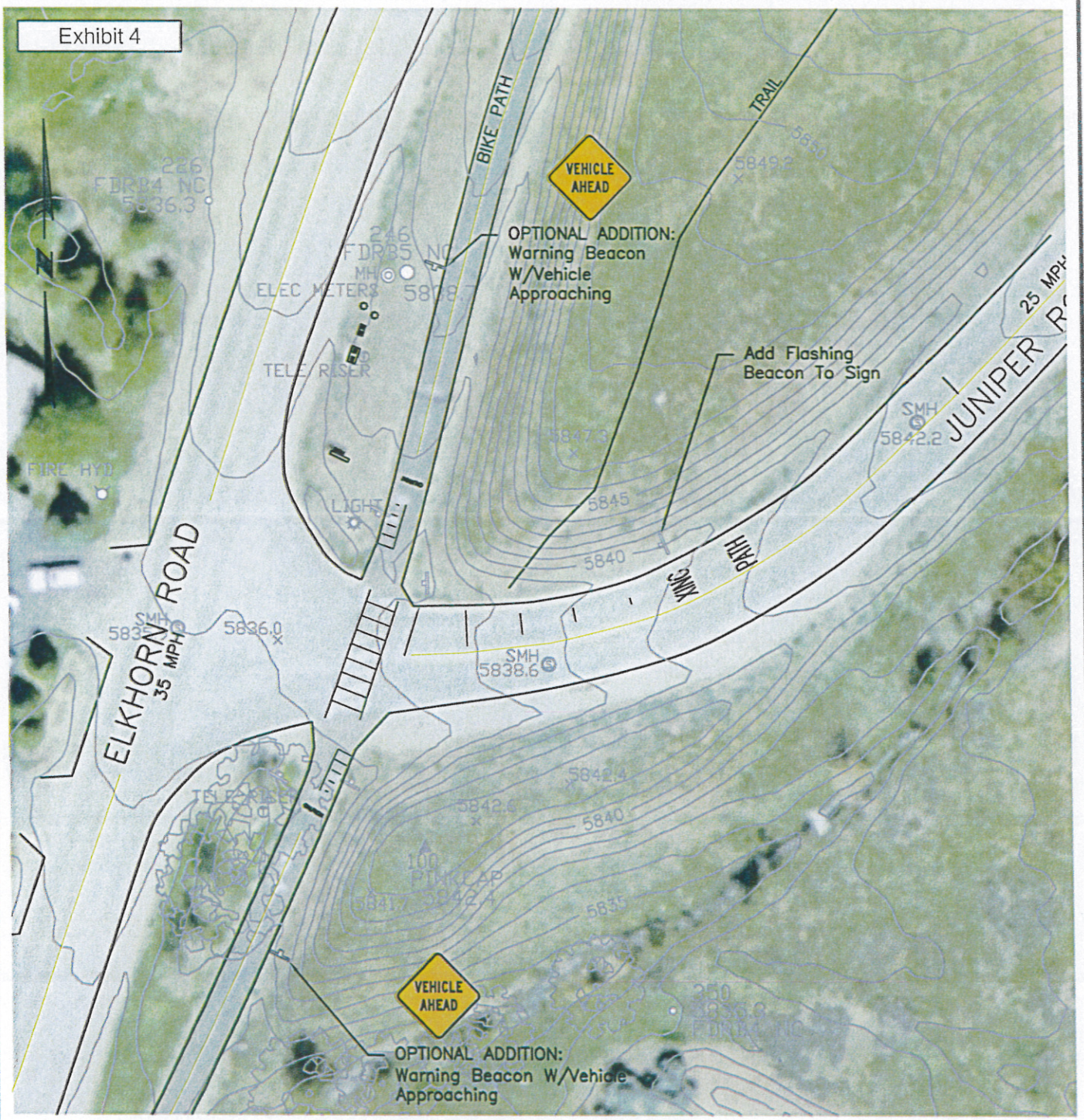
Exhibit 4



20' 10' 0' 20' 40'

SCALE:1" = 40'

Flashing Beacon Mitigation

NOTES:

1. *Beacon Will Activate At Pedestrian Or Bike Detection.*
2. *Detection Options Are Video, Wavetronix, Or Push Buttons For Path Users.*

OPTIONAL ADDITION:

1. *Add Vehicle Detection And Sign With Beacon On Pathway.*

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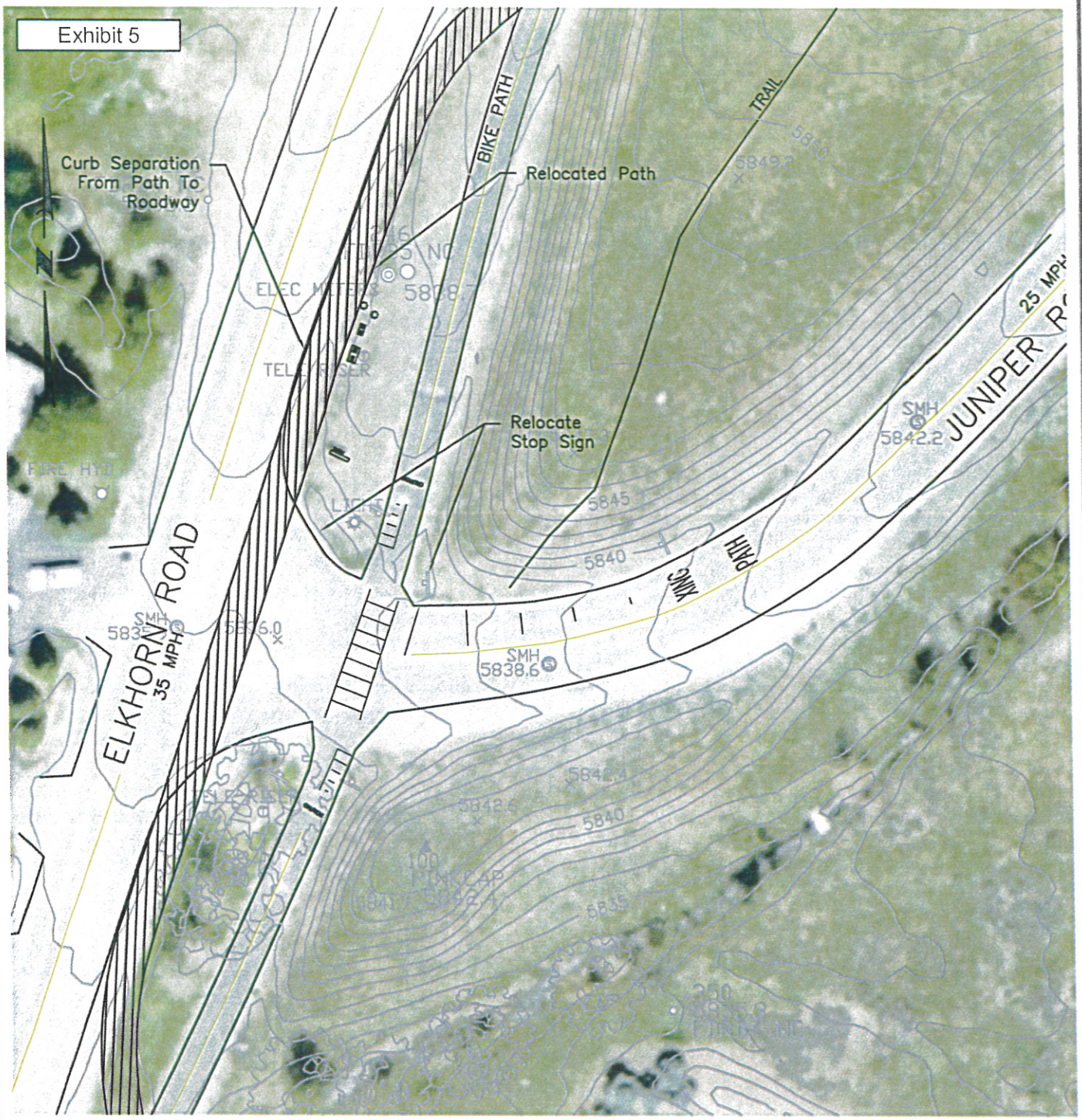
Exhibit 5



20' 10' 0' 20' 40'

SCALE: 1" = 40'

Path Relocation

NOTES:

1. *Add Curb On Elkhorn For Pathway Separation.*
2. *During Construction, Maintain And Protect All Utilities.*

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Appendix III

Lighting Analysis – AGI32 Light Results

Exhibit 6

E_H = Horizontal Grid At Ground Level

E_V = Horizontal Grid At 4.95' Above Ground

5' 2.5' 0' 5' 10'

SCALE:1" = 20'

Pathway Crosswalk
Lighting Levels

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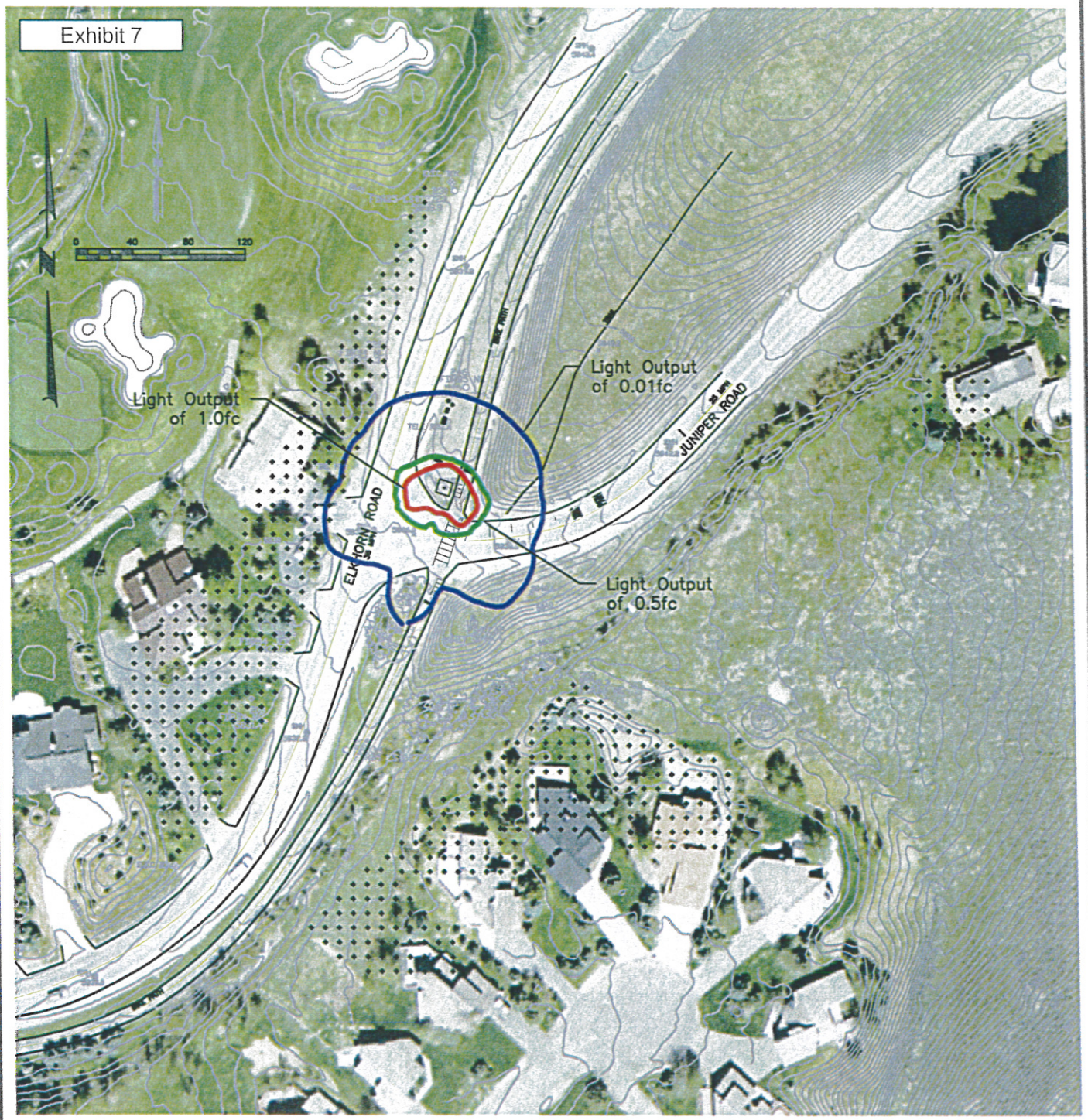
Exhibit 7



50' 25' 0' 50' 100'
SCALE:1" = 100'

Lighting Analysis
Of Existing Lighting
Conditions

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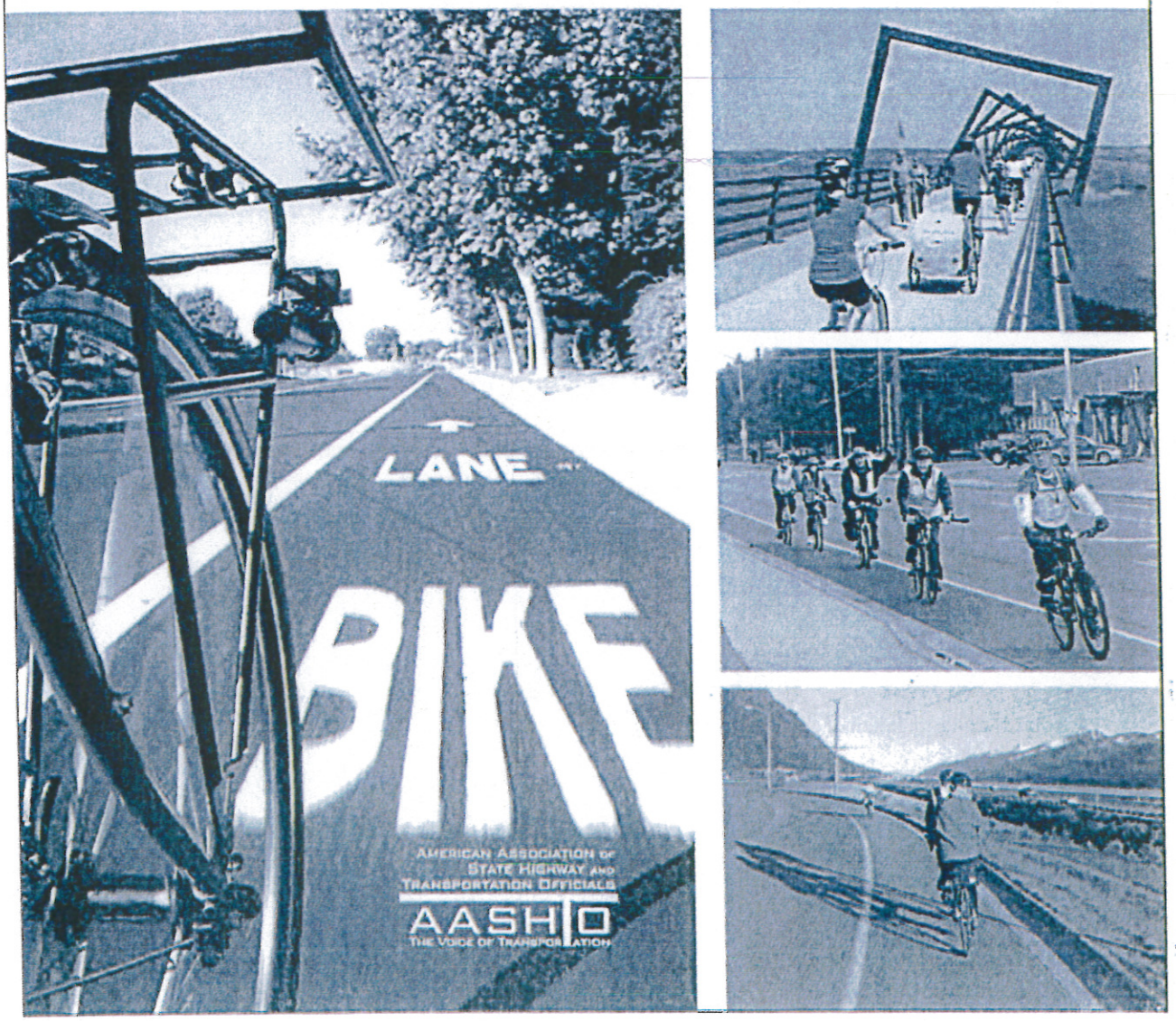
Appendix IV

Reference Material and Cut Sheets

Guide for the Development of Bicycle Facilities

2012 • Fourth Edition



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Front cover photographs courtesy of Alaska DOT, Carole Reichardt (Iowa DOT), and the Alliance for Biking and Walking. Back cover photograph courtesy of Patricia Little.

Publication Code: GBF-4 • ISBN: 978-1-56051-527-2

Bicycling and equestrian use have successfully been integrated on many pathways in the United States. However, care should be taken in designing these facilities to reduce potential conflicts between users. Bicyclists are often unaware of the need for slower speeds and additional clearance around horses. Horses can be startled easily and may act unpredictably if they perceive approaching bicyclists as a danger. Measures to mitigate bicyclist–equestrian conflicts include provision of separate bridle paths, maintenance of adequate sight lines so that bicyclists and equestrians are able to see each other well in advance, and signing that clarifies appropriate passing techniques and yielding responsibilities. Along paths with high- to moderate-use, the separate paved and unpaved treads should be divided by at least a 6-ft (1.8-m) wide vegetation buffer or barrier. Consideration can also be given to providing an elevation change between the treads (*15*). Where used, a separate, unpaved bridle path can often serve a dual purpose, as many joggers also prefer unpaved surfaces (see Figure 5-5).

Figure 5-5. Shared Use Path with Separate Unpaved Equestrian/Jogger Path

5.2.4 Design Speed

Design speed is a selected speed used to determine various geometric features of the shared use path. Once the design speed is selected, all pertinent path features should be related to it to obtain a balanced design. In most situations, shared use paths should be designed for a speed that is at least as high as the preferred speed of the fastest common user. The speed a path user travels is dependent on several factors, including the physical condition of the user; the type and condition of the user's equipment; the purpose and length of the trip; the condition, location, and grade of the path; the prevailing wind speed and direction; and the number and types of other users on the path.

There is no single design speed that is recommended for all paths. When selecting an appropriate design speed for a specific path, planners and designers should consider several factors including the context of the path, the types of users expected, the terrain the path runs through, prevailing winds, the path surface, and other path characteristics. The following examples help to illustrate these factors:

- **Types of Users and Context.** An urban path with a variety of users and frequent conflicts and constraints may be designed for lower speeds than a rural path with few conflicts that is primarily used by recreational bicyclists (potentially including recumbent bicyclists, whose 85th percentile speed is 18 mph [29 km/h]).
- **Terrain.** A path in fairly hilly terrain should be designed for a higher speed.
- **Path Surface.** Bicyclists tend to ride slower on unpaved paths, so a lower design speed may be used.

In street and highway design, design speeds are generally selected in 5 mph or 10 km/h increments; which are based on the approximate 85th percentile speed range on various types of roadways of 20 mph (30 km/h) to 75 mph (120 km/h) or higher. On paths, the range of speeds is much smaller, ranging as low as 12 mph (19 km/h) to 30 mph (50 km/h). Therefore, design speeds for paths can be selected in 2 mph (3 km/h) increments. Design criteria for geometric features in this document are provided in 2 mph (3 km/h) increments for the slower end of the scale (design speeds between 12 mph [19 km/h] and 20 mph [32 km/h]). For design speeds above 20 mph (32 km/h), 5 mph (8 km/h) increments are used.

The following guidance and the aforementioned consideration of various factors should guide the selection of an appropriate design speed:

- For most paths in relatively flat areas (grades less than 2 percent), a design speed of 18 mph (30 km/h) is generally sufficient, except on inclines where higher speeds can occur. The design speed should not be lower, except in rare circumstances where the context and user types support a lower speed.
- In areas with hilly terrain and sustained steeper grades (6 percent or greater), the appropriate design speed should be selected based on the anticipated travel speeds of bicyclists going downhill. In all but the most extreme cases, 30 mph (48 km/h) is the maximum design speed that should be used.

Lower speeds can reduce the likelihood for crashes at approaches to crossings or conflict points by allowing the path user to better perceive the crossing situation or potential conflict. It is important to give the bicyclist adequate warning (either through signs or by maintaining adequate sight lines) prior to areas of the pathway where lower design speeds are employed. See Section 5.4.2 for guidance on warning signs.

Geometric design and traffic control devices can be used to reduce path users' speed. Speeds can be reduced by geometric features such as horizontal curvature. Effectiveness of speed control through design is limited if bicyclists can veer off a path to "straighten out" curves, and speed limit signs on paths may not be effective, as most bicyclists do not use speedometers.

5.2.5 Horizontal Alignment

The typical adult bicyclist is the design user for horizontal alignment. The minimum radius of horizontal curvature for bicyclists can be calculated using two different methods. One method uses "lean angle," and the other method uses superelevation and coefficient of friction. As detailed below, in general, the lean angle method should be used in design, although there are situations where the superelevation method is helpful.

Calculating Minimum Radius Using Lean Angle

Unlike an automobile, a bicyclist must lean while cornering to prevent falling outward due to forces associated with turning movements. Most bicyclists usually do not lean drastically; 20 degrees is considered the typical maximum lean angle for most users (*10*). Assuming an operator who sits straight in the seat, Table 5-1 shows an equation that can determine the minimum radius of curvature for any given lean angle and design speed.

PLATT

LIGHTING QUOTATION

BID DATE:	09/19/12	QUOTE DATE:	09/19/12
COMPANY:	City of Sun Valley	PROJECT:	Dollar Rd Street Lights
ATTN:	Mark Hofman		
TERMS:	net	QUOTED BY:	Murle D. Miller
FREIGHT:	F.O.B.factory;std terms apply	PLATT BRANCH:	Br105 Hailey

TOTAL:

TYPE	QTY	MFG	DESCRIPTION	UNIT PRICE	U M	EXTENDED PRICE
			GARDCO GULLWING AREA LIGHTING			
			SMALL G13 UNIT			
Juniper	1	GARDCO	G13-(1)-4XL-100MH-QUAD BRPG/18680			
	1	GARDCO	SSS-20-4-11-D1-DARK BRONZE/Bolts			
			LOT SUB TOTAL G 13 UNIT W/ LAMP	$1,550.00		
			PPD & ADD INCOMING FREIGHT			
			SHIPS 30 DAYS A.R.O.			
			MARK, QUOTED AT 100 WATT METAL HALIDE.		ea	
					ea	
					ea	
					ea	
					ea	
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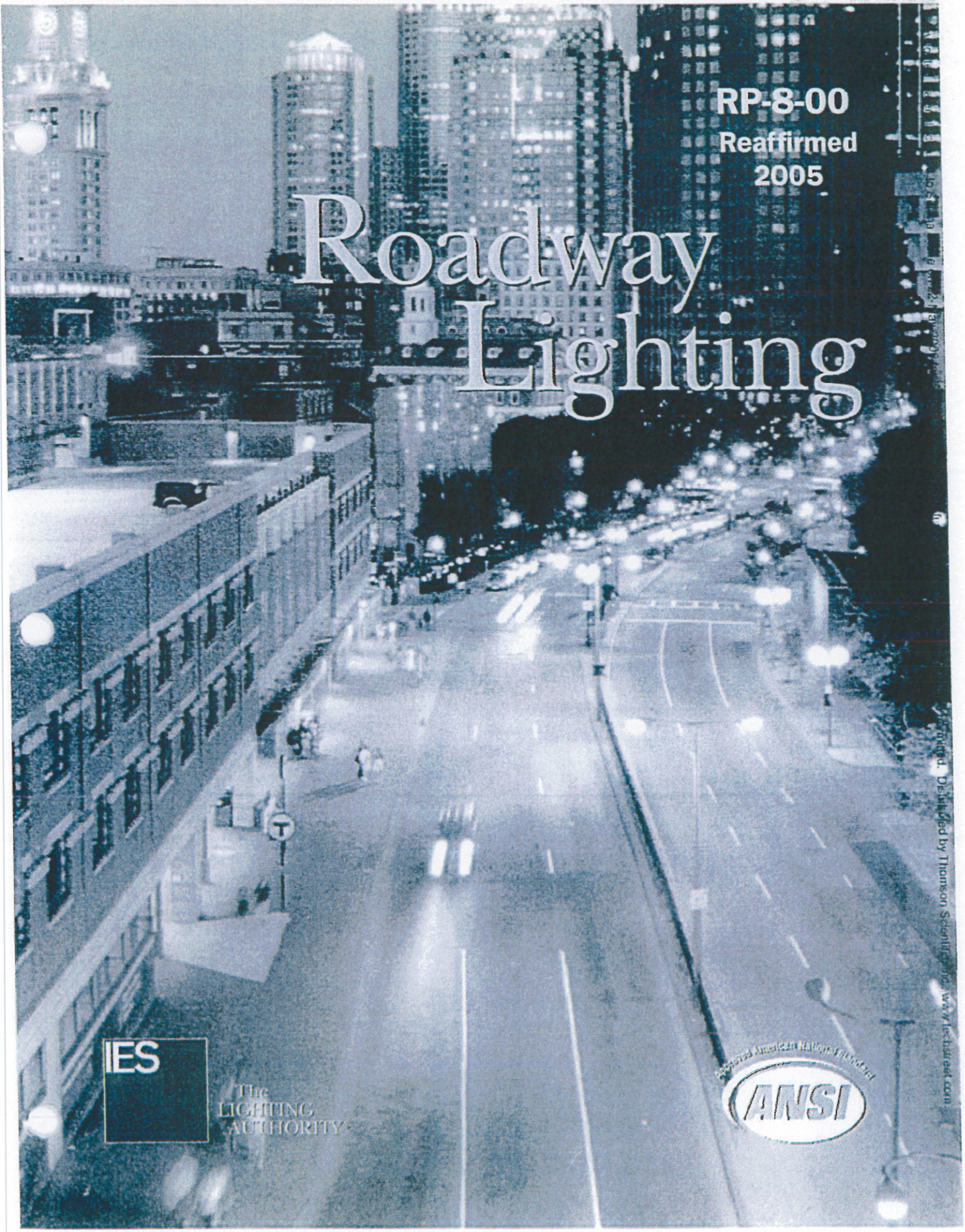
THIS QUOTATION IS BASED ON ALL TYPES AND QUANTITIES. ANY CHANGES WILL BE SUBJECT TO REQUOTE.



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120 Wall St. 17th Floor
New York, NY 10005

$45.00
Order # RP-8-00

ISBN # 978-0-87995-160-3
0-87995-160-5

ANSI / IESNA RP-8-00

ANSI Approval Date 6/27/00

American National Standard Practice for Roadway Lighting

Publication of this Committee Report has been approved by the IESNA. Suggestions for revisions should be directed to the IESNA.

Prepared by:

The Standard Practice Subcommittee of the IESNA Roadway Lighting Committee

Approved by the IESNA Board of Directors, August 8, 1999, as a Transaction of the Illuminating Engineering Society of North America.

Approved June 27, 2000 by the American National Standards Institute, Inc.

Published by the Illuminating Engineering Society of North America, 120 Wall Street, New York, New York 10005.

IESNA Standards and Guides are developed through committee consensus and produced by the IESNA Office in New York. Careful attention is given to style and accuracy. If any errors are noted in this document, please forward them to Rita Harrold, Director Educational and Technical Development, at the above address for verification and correction. The IESNA welcomes and urges feedback and comments.

ISBN # 0-87995-160-5

Printed in the United States of America.

Table 5: Recommended Values for High Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Mixed Vehicle and Pedestrian**	20.0/2.0	10.0/1.0	4.0
Pedestrian Only	10.0/1.0	5.0/0.5	4.0

* Horizontal only

Mixed vehicle and pedestrian refers to those areas where the pedestrians are immediately adjacent to vehicular traffic without barriers or separation. Does not apply to mid-block crossings. (See **Section 3.5.1.4.)

E_H = average horizontal illuminance at walkway/bikeway

E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

3.6 Intersections

3.6.1 Classification. Typically, about 50 percent of accidents in urban areas, excluding freeways, occur at intersections.[11] The basic classification system for urban surface streets as given in **Section 2.1** include:

Major (M)
Collector (C)
Local (L)

These streets intersect to form six types of intersections; M/M, M/C, M/L, C/C, C/L, and L/L. The Institute of Transportation Engineers (ITE) in Guidelines for Residential Subdivision Street Design[12], has identified the following volumes of average daily traffic (ADT) as typical for each type of street in residential areas:

Major ..... over 3,500 ADT
Collector ..... 1,500 to 3,500 ADT
Local ..... 100 to 1,500 ADT

Note: These street classifications do not apply to the road classifications of **Tables 2, 3, and 4**, but may be used in determining intersection lighting levels from **Table 9**.

3.6.2 Vehicular Traffic Volumes and Conflicts. Obviously, the volume of traffic at the intersection of one local street with another is quite low. Alternatively, volumes at intersections of local streets with major streets are primarily those on the major street. If the intersecting street is of collector or major type, the total volume is substantially increased due to the traffic on the cross street. Also, denser land uses, such as commercial or industrial, generate higher volumes for all types of streets. The likelihood of pedestrian conflict is also an important consideration.

Driveways onto other roadways are miniature intersections and should be classified accordingly. Those serving a single family home typically generate about ten trips per day; i.e., five vehicles in and five vehicles out and do not require any special lighting. At the other extreme, driveways serving high volume activities, such as regional shopping centers, will be used by thousands of vehicles per day and should be illuminated similar to a major/major intersection.

At the intersection of two streets, both carrying two-way traffic, with no restriction on turning movements and no signal control, a total of 16 vehicular conflict points exist as shown in **Figure 3**. An equal number of pedestrian conflict points exists; i.e., there are four

Table 6: Recommended Values for Medium Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Pedestrian Areas	5.0/0.5	2.0/0.2	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway

E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 7: Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min} *
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential	3.0/0.3	0.8/0.08	6.0
Medium Density Residential	4.0/0.4	1.0/0.1	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway
E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

crossing vehicular movements for each crosswalk (right turns and left turns from the cross street, and straight ahead from both directions on the street crossed by the walk).

Several studies have identified that the primary benefits produced by lighting of intersections along major streets is the reduction in night pedestrian, bicycle and fixed object accidents.[13, 14]

3.6.3 Pedestrian Visibility. Night visibility of pedestrians typically involves observance by one of two methods–silhouette or reversed silhouette. Reversed silhouette is produced by vehicle headlights in possible combination with any fixed street lighting. The value of direct visibility by headlighting or lights at the intersection, is significantly affected by the reflectivity of the clothing worn by the pedestrian. For a major street with properly designed continuous lighting, the silhouette vision of the pedestrian may actually be enhanced by dark clothing–the darker object is seen against the lighter background.

To maximize visibility of a pedestrian at an intersection, it is preferable to have street lighting configurations as shown in **Annex D, Figure D3**. If a major street is intersecting a lesser classification, such as collector or local, these positions will typically provide for reasonable visibility. In **Annex D, Figure D3-b, D3-c**, and **D3-d** the far right side light is appropriately located just beyond the crosswalk. The light distribution across the width of pavement will serve to provide high illuminance in the crosswalk area as well as high luminance on the intersection pavement. It will also illuminate the pavement beyond the pedestrian thereby forming a background to the pedestrians silhouette. This far right position is also appropriate for the location of a traffic signal, whether it is bracket mount to a street light pole, is of combination mast arm/street light type, or utilizes ring-around span wire poles.

3.6.4 Recommended Illuminance for Intersections. Table 9 shows the recommended illuminance values at intersections of continuously lighted streets, defined as the prolongation of the intersecting roadway edges. Other traffic conflict areas should be provided with illuminance values 50 percent higher than recommended for the street. It is based on the principle that the amount of light should be proportional to the classification of the intersecting routes and equal to the sum of the values used for each separate street. If an intersecting roadway is illuminated above

Table 8: Recommended Values for the Pedestrian Portion of Pedestrian Vehicular Underpasses and Exclusive Pedestrian Underpasses

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min} *
Day	100.0/10.0	50.0/5.0	3.0
Night	40.0/4.0	20.0/2.0	3.0

* Horizontal only

E_H = average horizontal illumination at walkway/bikeway
E_{Vmin} = minimum vertical illumination at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Annex D

Situations Requiring Special Consideration

(This Annex is not part of the *American National Standard Practice for Roadway Lighting*, RP-8-00, but is included for informational purposes only.)

Annex D – Situations Requiring Special Consideration

D1 Roadway Complexities

(1) The design data contained in this Standard Practice are for straight and level roadway areas and areas having minor curves and grades. Roadways, however, have many areas where the problems of vision and maneuvering of motor vehicles are much more complex, such as grade intersections, abrupt curves, underpasses, converging traffic lanes, diverging traffic lanes and various types of complicated traffic interchanges. The design of roadway lighting for these areas demands special consideration.

(2) When all of these areas are analyzed, it becomes apparent that there are the following three basic factors that are fundamentally different from those encountered on normal straight roadway areas:

(a) Motor vehicle operators are burdened with increased visual and mental tasks upon approaching and negotiating these areas.

(b) Silhouette seeing cannot be provided in many cases due to the vehicle locations, pedestrian locations, obstructions, and the general geometry of the roadways. Glare from oncoming headlights that sweep across the driver's line of sight is often a problem.

(c) Adequate vehicle headlighting often cannot be provided. This is due to the geometry of roadways, lack of stopping room within headlight distances at speeds above 55 kilometers per hour, and the fact that vehicle headlighting follows rather than leads the progress of a vehicle in negotiating turns.

(3) The lighting of such areas, at first glance, appears to be a very complicated problem. It becomes apparent upon analysis, however, that all such areas consist of several basic types of situations or a combination of these. The basic six situations are treated individually in the following sections.

D1.1 Grade Intersections (See Figures D1 and D3)

(1) These intersections may have unrestricted traffic flow on both roadways, restriction by means of stop signs on one or both of the roadways, control by traffic signals, control by police officers or other means. Some are complicated by pedestrian as well as vehicular traffic. The lighting problem on all of these, however, is fundamentally the same. The lighting level in these areas should be higher than the level of either intersecting road.

(2) Luminaires should be located so that lighting will be provided on vehicles and pedestrians in the intersection area, on the pedestrian walkways, and on the adjacent roadway areas. Of particular importance is the creation of contrast between the object to be seen and the pavement against which it is seen.

(3) Figure D1(b) shows a larger, more complex intersection. The lighting problems and techniques are similar to the small intersections. The size, however, may require the use of more or higher-output luminaires.

D1.2 Curves and Hills (See Figure D2)

(1) The visual problems in driving increase on curves and hills. In general, gradual, large radius curves and gently sloping grades are lighted satisfactorily if treated as straight level roadway surfaces. Sharper radius curves and steeper grades, especially at the crest of hills, warrant closer spacing of luminaires in order to provide higher pavement luminance and improved uniformities (see Figure D2 (e) and (f)).

(2) The geometry of abrupt curves, such as those found on traffic interchanges (see Figure D1) and many roadway areas, requires careful analysis. Headlighting is not effective in these situations and silhouette seeing cannot be provided in some instances. Luminaires should be located to provide ample light on vehicles, road curbings and berms, and guard rails. Poles should be located to provide adequate, safe clearance, behind guardrail or any natural barrier if such exists. There is some evidence that poles are more likely to be involved in accidents if placed on the outside of curves. Many vehicle operators may be unfamiliar with these areas and lighting the surroundings greatly helps their discernment of the roadway path (see Figure D2 (c) and (d)).

(3) Proper horizontal orientation of luminaire supports and poles on curves is important to assure balanced distribution of the light flux on the pavement (see Figure D2(a)).

(4) When luminaires are located on grades, it is desirable to orient the luminaire so that the light beams strike the pavement equidistant from the luminaire. This assures maximum uniformity of light distribution and keeps glare to a minimum (see Figure D2(b)).

D1.3 Underpasses and Overpasses (see Figure D1)

(1) Short underpasses such as those encountered where a roadway goes beneath a two-or four-lane

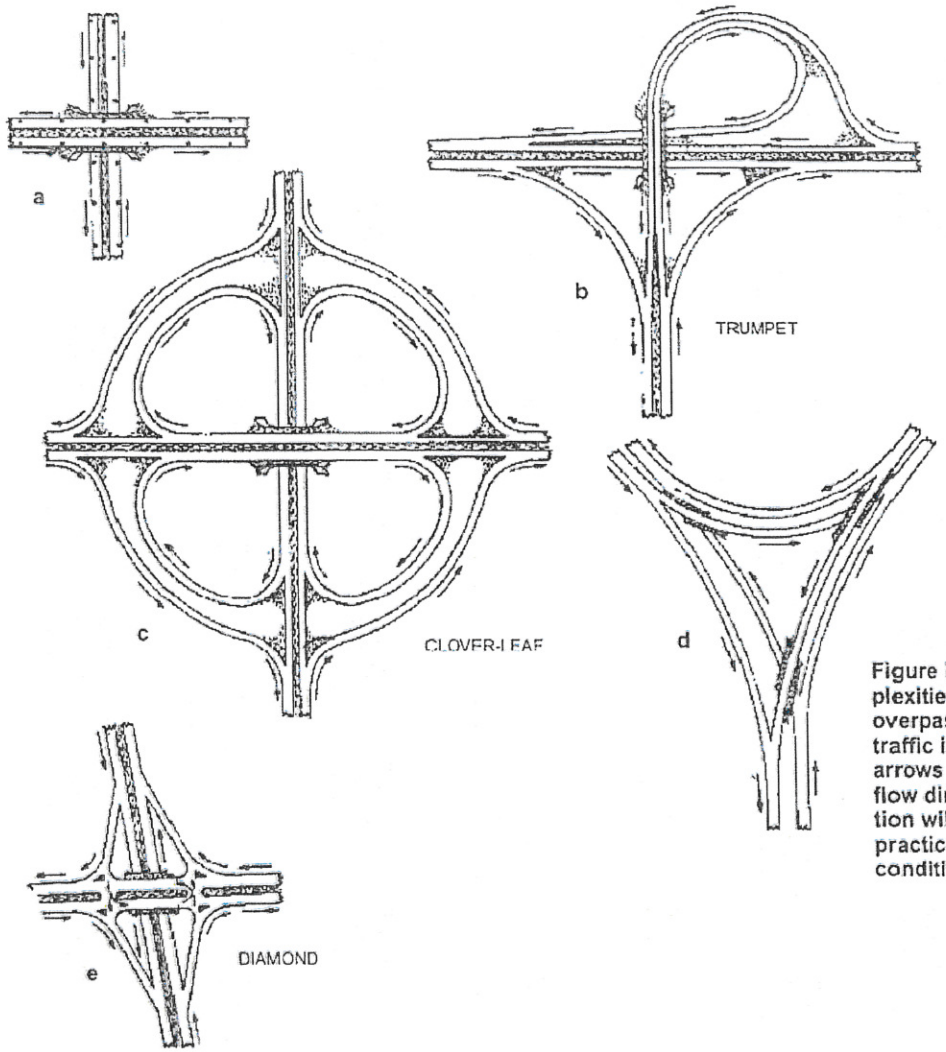


Figure D1. Roadway complexities: (a) underpass-overpass; and (b) to (e) traffic interchanges. *Note*: arrows indicate traffic flow directions. Pole location will depend on local practice and physical conditions of the area.

roadway can generally be lighted satisfactorily with standard luminaires if they are properly positioned. Luminaires on the lower roadway should be positioned so that there are not large discontinuities in the pavement lighting from that on either side of the overpass and so that the recommended levels are provided. Care should be taken so that the uniformity does not fall below the minimum values recommended in **Tables 2, 3, or 4**, depending upon selected method. These luminaires should also provide vertical illumination on the supporting structures.

(2) Long underpasses, where such overlapping of the lighting from the street luminaires cannot be accomplished, require special treatment. Long underpasses also greatly reduce the entrance of daylight, warranting lighting during the daytime. (See ANSI/IESNA RP-22-96, *Recommended Practice for Tunnel Lighting*.)

D1.4 Intersections of High-Speed, High-Traffic-Density Roadways (See Figures D1 and D3)

(1) At first glance, interchanges appear to be complex lighting problems. However, analysis shows that they are comprised of one or more of the basic problems that are dealt with in previous paragraphs and may be treated accordingly.

(2) The regular roadway lighting system will usually provide sufficient surrounding illuminance to reveal the features of the entire scene so that drivers will know where they are and where they are going at all times. An inadequately lighted interchange with too few luminaires may lead to confusion for the driver, by giving misleading clues due to the random placement of the luminaires. (This does not apply to high mast lighting).

(3) When continuous lighting of the entire interchange area cannot be provided, it may be desirable to light intersections, points of access and egress,

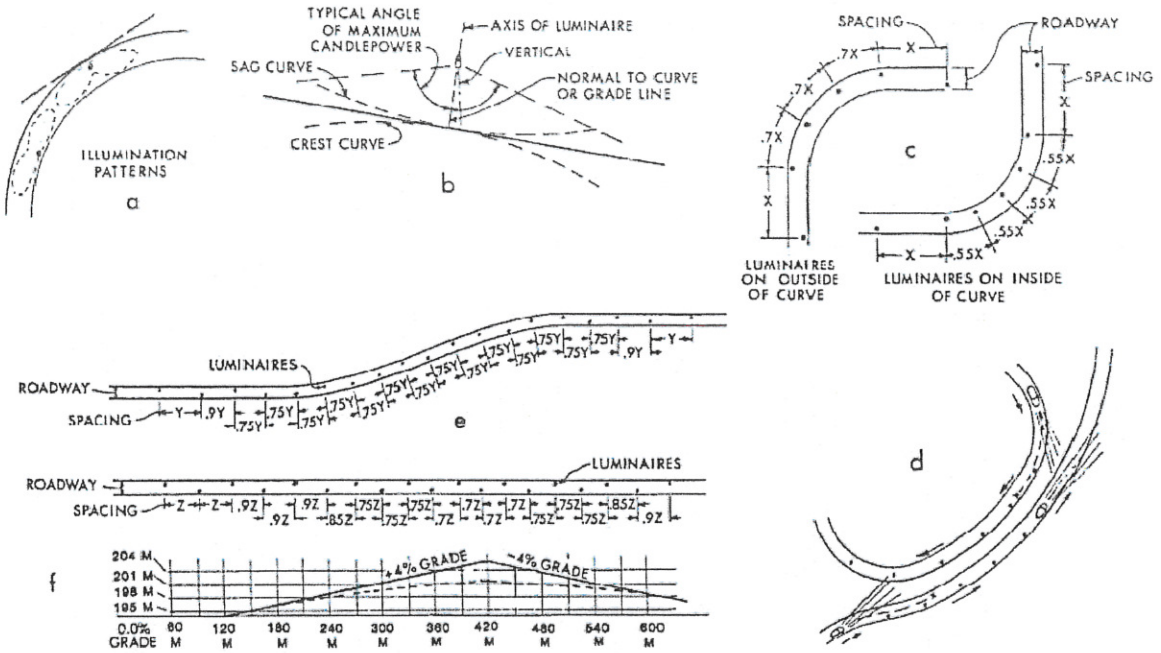


Figure D2. Typical lighting layouts for horizontal and vertical curves. (a) Luminaires oriented to place reference plane perpendicular to radius of curvature. (b) Luminaire mounting on hill (vertical curves and grade). (c) Short radius curves (horizontal). (d) Vehicle illumination limitations. (e) Horizontal curve, radius 305 meters, super elevation 6 percent. (f) 380-meter vertical curve with 4 percent grade and 230-meter sight distance.

curves, hills and similar areas of geometric and traffic complexity. In these cases, lighting should be extended beyond the critical areas. Two fundamental reasons for this are:

(a) The eyes of the driver, adapted to the level of the lighted area, need about one second to adjust to the changes in the illumination upon leaving the lighted area to maintain vision during the period of dark adaptation. Lighting transition, however, should be beyond the end of the maneuver area.

(b) Traffic merging into a major roadway from an access road is often slow in accelerating to the speed on the major roadway. The lighting along this area for a distance beyond the access point extends visibility and facilitates the acceleration and merging process.

(c) Diverging traffic lanes warrant extremely careful consideration because these are areas where motorists are most frequently confused. Luminaires should be placed to provide illumination on curbs, abutments, guard rails, and vehicles in the area of traffic divergence. Poles should be located to provide adequate safety clearance for vehicles that may cross the core area. Lighting should also be provided in the deceleration zone. Diverging roadways frequently have all the problems of abrupt curves and should be treated accordingly.

(4) The placement of luminaires should be carefully considered to minimize glare to the drivers and especially so as to not detract from sign legibility or to block the view of signs.

D1.5 Isolated Traffic Conflict Areas (Partial Intersection Lighting)

Partial intersection (non-continuous) lighting refers to lighting at an isolated intersection area, which has critical features such as curbed channelization and/or high vehicular volumes or pedestrian traffic.

The illumination of the intersection of a major street with a local street extending in only one direction (a T-type) is usually adequate if the major street luminaire is located opposite the intersecting street.

For the purposed of calculations in isolated traffic conflict areas, the conflict area is defined as the largest area within lines extended from (defined by):

- The face of the curb or the edge of the roadway
- The stop bars if present
- The crosswalks or the logical extension of the sidewalks, if used at night.

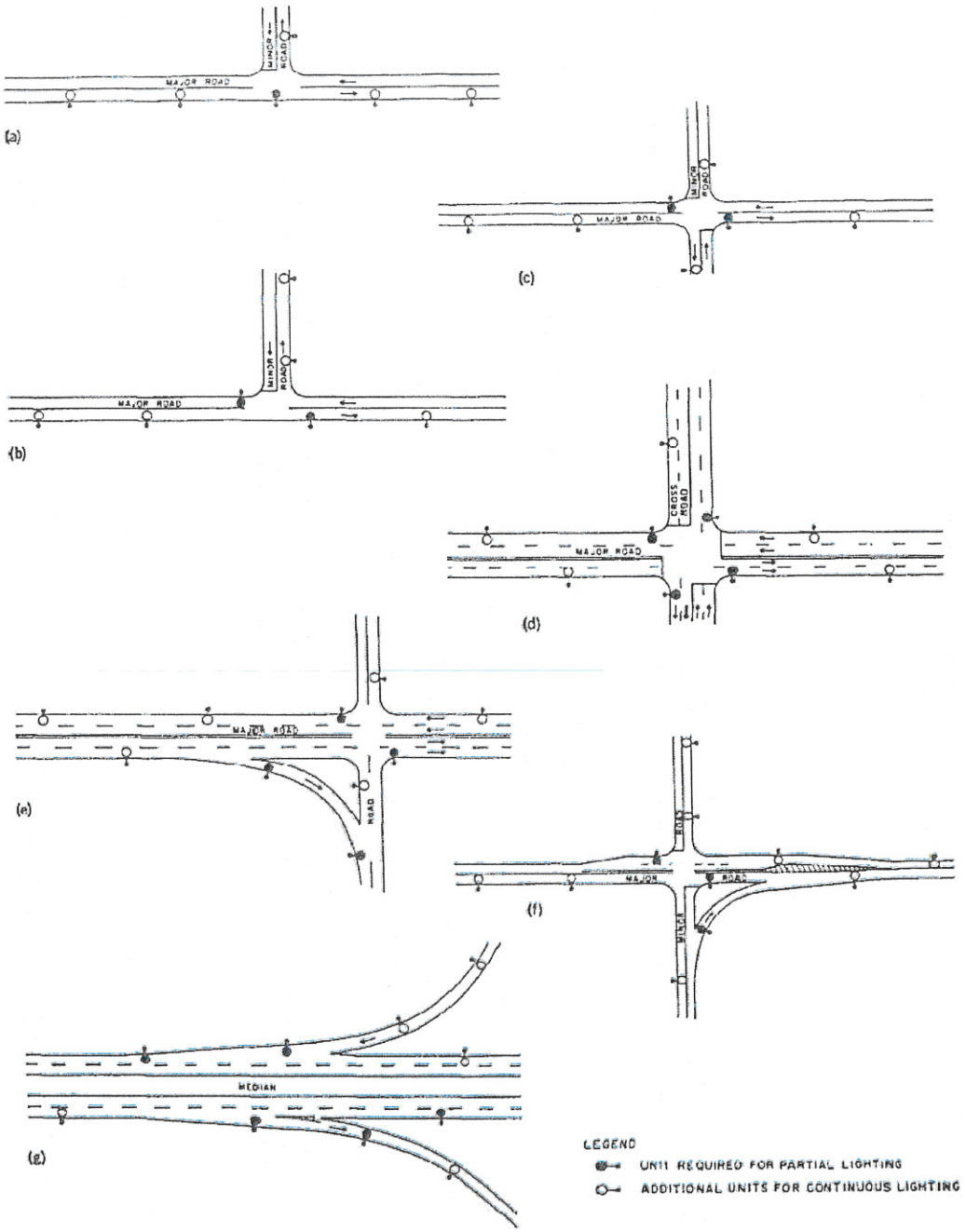


Figure D3. Examples of lighting configurations at intersections to provide illumination on vehicles and pedestrians in the intersection area, on the sidewalks, and on adjacent roadway areas for: (a) T-intersection; (b) T-intersection (alternate); (c) four-way intersection, two-lane road with two-lane sideroad; (d) signalized intersection, four-lane road with four-lane crossroad; (e) four-lane road with channelizing island; (f) intersection with channelizing island; and (g) typical acceleration and deceleration lanes at on and off ramps. *Note:* drawings are not to scale and the light locations shown are not to be considered complete in number or better than approximate in position.

For illuminance, the entire (more or less) rectangular area of the conflict area should be evaluated.

For roadway luminance and veiling luminance, each driving direction must be evaluated (separately).

For roadway luminance, the test points are along the quarter lane lines for all lanes in the chosen direction. Longitudinal spacing shall be:

- One tenth the longitudinal spacing but not more than 5 meters

TAPCO
TRAFFIC & PARKING CONTROL COMPANY

Blinker LED Products

Rectangular Rapid Flash Beacon: RRFB-XL

Extra-large beacons provide greater visibility, ideal for high-speed and multi-lane pedestrian & school crossings

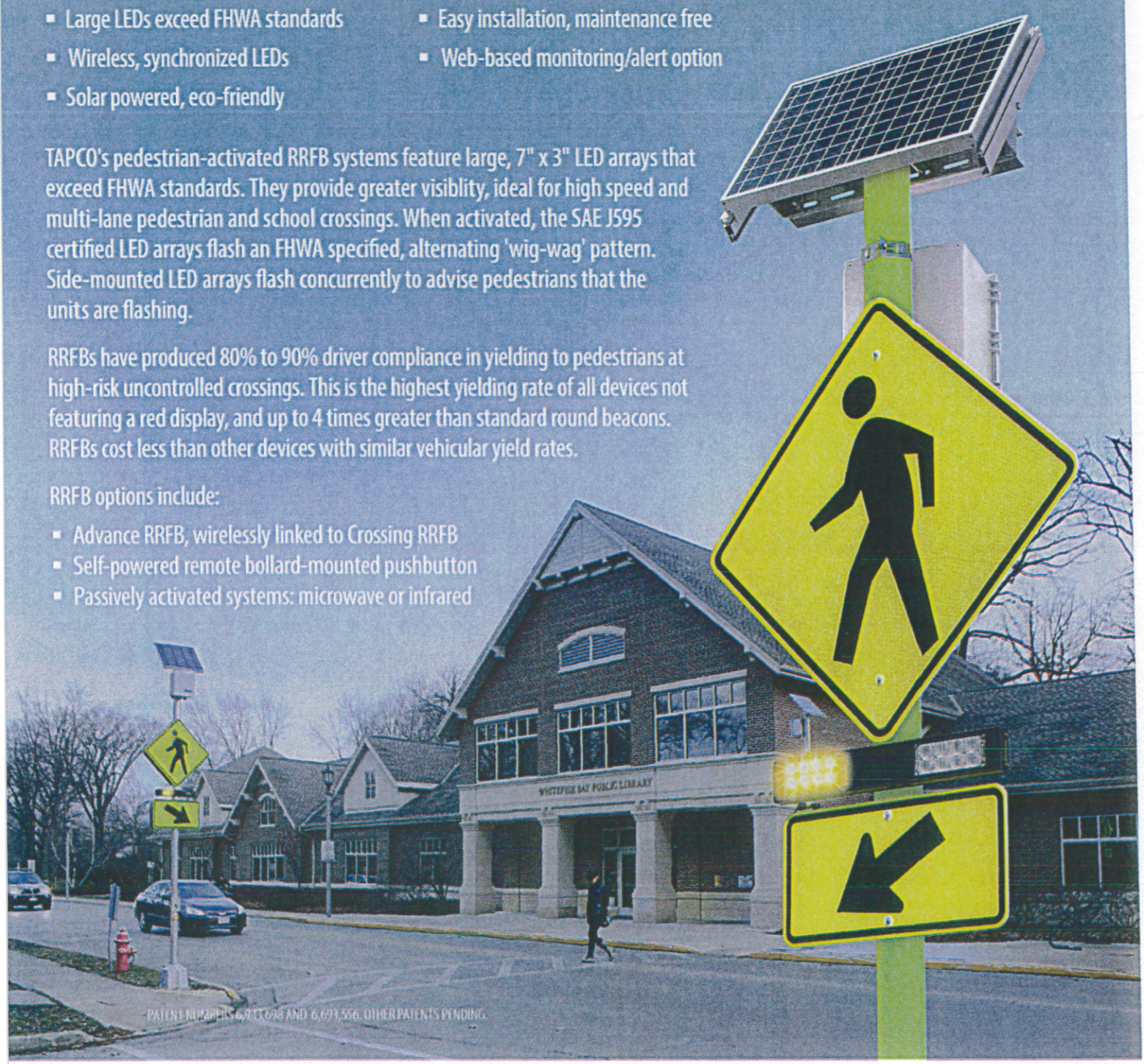
- Driver yielding rates of 80-90%
- Large LEDs exceed FHWA standards
- Wireless, synchronized LEDs
- Solar powered, eco-friendly
- Up to 30 days autonomy
- Easy installation, maintenance free
- Web-based monitoring/alert option

TAPCO's pedestrian-activated RRFB systems feature large, 7" x 3" LED arrays that exceed FHWA standards. They provide greater visiblity, ideal for high speed and multi-lane pedestrian and school crossings. When activated, the SAE J595 certified LED arrays flash an FHWA specified, alternating 'wig-wag' pattern. Side-mounted LED arrays flash concurrently to advise pedestrians that the units are flashing.

RRFBs have produced 80% to 90% driver compliance in yielding to pedestrians at high-risk uncontrolled crossings. This is the highest yielding rate of all devices not featuring a red display, and up to 4 times greater than standard round beacons. RRFBs cost less than other devices with similar vehicular yield rates.

RRFB options include:

- Advance RRFB, wirelessly linked to Crossing RRFB
- Self-powered remote bollard-mounted pushbutton
- Passively activated systems: microwave or infrared



PATENT NUMBERS 6,917,698 AND 6,693,556. OTHER PATENTS PENDING.

Applications

- High-speed and multi-lane crossings
- School crossings
- Pedestrian crossings
- Roundabout crossings

Benefits

- Larger 7"x 3" LED arrays provide increased visibility
- Significantly higher driver awareness and compliance
- High-intensity leds command attention, day and night

Features

- Multiple units are wirelessly synchronized, flash in unison
- Installation onto new or existing sign poles: single bar or back-to-back available
- Stand-alone, self-powered remote pushbutton bollard available
- 3-Year warranty

YouTube Visit **Traffic and Parking on YouTube for videos on these products and more.**

Standard specifications (subject to change without notice)

Extra Large Rectangular Rapid Flash Beacon RRFB-XL

MUTCD Approval	Interim FHWA Approval Memorandum (1A-11)
Housing	Powder coated aluminum
LED modules: 7¼" x 3"	2 arrays of 8 amber LEDs, SAE J595 certified
Pedestrian LED module : 1½" x 3⅝"	Side-mounted, flash concurrent with Vehicle LEDs
Flash pattern	MUTCD specified 'wig-wag' flash pattern
Mounting hardware	Stainless steel u-bolts for 4" to 4½" O.D. pole

Solar-assisted Battery-powered System

Housing	NEMA 4X rated fiberglass or aluminum cabinet with lockable clasps
Solar panel: 55 watt	25¼"H x 25¾"W x 1½"D. Adjustable 40° to 60°. Articulating mount rotates and pivots. Conforms to IP-67
Mounting	Aluminum mounting bracket (fits 4"– 4½" O.D. pole)
Battery (one per assembly)	12V, 40AH sealed gel battery requires no periodic watering. Sealed construction eliminates corrosive acid fumes and spills.
Battery lifespan	Up to 5 years
Autonomy	Up to 30 days without sun
Control Circuit	IP-67 NEMA rated enclosure: dust proof and waterproof (up to 30 minutes in 3 feet of water)

BlinkerBeam™ Wireless Communication System

Frequency	900 MHz FHSS
Range	3 miles with optional external antennas. For system separation over 900', a site survey is recommended
Radio	Operates on 900 MHz frequency hopping spread spectrum network. Operating range from 3.6vdc to 15vdc
Connectivity	Crosswalk and optional Advance LEDs flash concurrently
BlinkSync™ Wireless Synchronized Activation	Individual units in one system flash in synchronized patterns (avoids light noise of system operation). Ideal for multiple assemblies flashing in the same direction.
Push-button activation*	ADA pushbutton, typical (<120 millisecond)

*Optional remote, stand-alone pushbutton available (includes self-contained, replaceable battery with typical two-year life)

Programming

Windows TAPCO configuration software

Optional web -based cellular communication for monitoring and control available

Optional time clock system available for school zone signs

Warranty

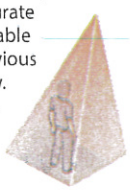
3 year standard warranty

Optional Push Button Activation

Activated with less than 2 lbs. of force. Provides two-tone audible confirmation as well as visual confirmation. Meets ADA, MUTCD and TAC requirements, and housing meets NEMA specifications. Remote mounting available. Audible navigation units are available.

Optional Pedestrian Motion Detector

Active infrared and microwave technologies work together to provide precise presence and accurate motion detection. Mountable between8' and 16'. Impervious to light, sun rain and snow. Housing is rated NEMA-4.



Optional Wireless Bollard Activation

Pedestrians and bicyclists can passively trigger flashing BlinkerSign™ LED signs, RRFB, BlinkerBeacon™ LED Beacons, in-pavement LEDs and other ITS devices. Actuators are housed in anodized aluminum cabinets that can be secured to concrete or asphalt. Battery operated: no grid wiring required.

TAPCO 1-800-236-0112 • www.tapconet.com • blinkersales@tapconet.com

Traffic & Parking Control Co, Inc. 5100 West Brown Deer Road, Brown Deer WI 53223 U.S.A. Phone 800-236-0112 FAX 800-444-0331
www.tapconet.com

Made in the USA

GSA Contract Holder GS-07F-5924R GS-07F-0234U

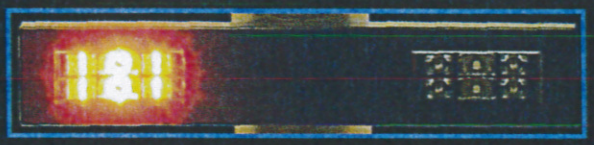
1005-00001 (03/13)

TAPCO
TRAFFIC & PARKING CONTROL CO., INC.

Solar, Wireless LED Solutions

LED Rectangular Rapid-Flash Beacon (RRFB)

Increased Conspicuity for Pedestrian Crossings and School Zone Crossings



- Increases driver yielding rates
- More effective than round beacons
- Solar = Zero operating costs
- No maintenance required
- Clean, uncomplicated installation
- LED Indicators for pedestrians
- Retrofittable from round beacons
- BlinkSync™ wireless synchronization
- Pedestrian activated
- Day-Viz™ Automatic LED Brightness

RRFB studies show a dramatic increase of driver compliance in yielding to pedestrians at high-risk uncontrolled crossings. Research shows that RRFBs produce the highest yielding rate of all devices that do not feature a red display, higher rates than a regular round beacon, and at a lower cost than other devices that produce similar vehicular yield rates.

RRFB feature multiple arrays of brilliant LEDs that, when activated, flash a warning in a specified, alternating 'wig-wag' pattern, thereby commanding the attention of drivers by ***Day And Night***. Additional side-mounted LED arrays flash concurrently to let pedestrians know that the unit is flashing. Optional self-powered remote pushbutton activation available.

TAPCO's RRFB feature aimable LEDs in a sturdy, lockable housing with a closed top and bottom, and no exposed wiring. See reverse for specifications.

RECTANGULAR RAPID-FLASH BEACON (RRFB)

RECTANGULAR RAPID - FLASH BEACON (RRFB)

Applications

- School Crossings
- Pedestrian Crossings
- Roundabouts

Benefits

- Significantly higher driver awareness and compliance
- Hi-intensity LEDs command attention, both day and night
- Increased visibility

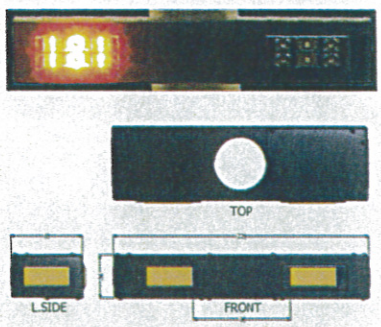
Features

- Multiple units are wirelessly synchronized, flash in unison
- Day-Viz™ circuitry monitors ambient light levels and adjusts the LED output automatically for maximum visibility & battery efficiency
- Installation onto new or existing sign poles
- Stand-alone, self-powered remote pushbutton bollard available (see below, inset)

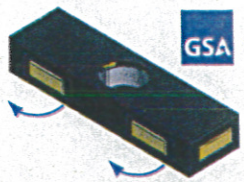
Multiple Solar-Powered beacons flash in unison, wirelessly synchronized by BlinkSync™ technology

Standard Specifications For RRFB System†

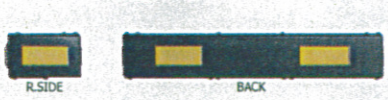
Rectangular Rapid-Flash Beacon	
MUTCD Approval, Optional Use of RRFB	Interim FHWA Approval Memorandum (1A-11)
Housing	Powder coated aluminum
LED Modules (2 per direction)	6 amber LED array , ~ 5" x 2", SAE J595 certified
Flash Pattern	MUTCD recommended 'wig-wag' flash pattern
Mounting Hardware (enclosed)	Stainless steel u-bolts for 4" to 4½" O.D. pole
Solar System	
Housing	NEMA 4 rated fiberglass cabinet with lockable clasps
Solar Panel (25.75" x 25.25" x 1.4375")	55 watt solar panel set at 40° or 60°. Conforms to IP-67. Includes aluminum mounting bracket for 4" to 4½" O.D. pole.
Batteries (one per assembly)	12V, 40AH Sealed Gel battery requires no periodic watering. Sealed construction eliminates corrosive acid fumes and spills.
Battery Lifespan	Up to 3 years
Autonomy	Up to 30 days without sun
Control Circuit	IP-67 NEMA rated enclosure, dustproof and waterproof in water up to 3' for 30 minutes
BlinkerBeam™ Wireless Communication System	
Frequency	900 MHz FHSS
Range	Up to 3 miles with optional external antennas. For system separation over 900', a site survey is recommended for optimal performance.
Radio	Operates on 900 MHz frequency hopping spread spectrum network. Operating range from 3.6vdc to 15vdc
Programmability	Up to 50 systems in one network
Push-button Activation*	ADA pushbutton, typical (<120 millisecond)
*Optional remote, stand-alone pushbutton including self-contained, replaceable battery with typical two-year life	
Programming	
RS232 Communications Port	
Programming via Windows basic software: Optional wireless cellular or internet programming	
W11-2 Pedestrian Xing and S1-1 School Crossing Signs & Plaques (W16-7P or W16-9P)	
Sign Substrate (30" or 36" signs)	.080" Highway grade aluminum
Reflective Sheeting	3M™ DG³ FYG 4083 with anti-graffiti overlay
Hardware	Zinc-plated steel anti-vandal fasteners for signs and RRFB units
MUTCD Compliance	MUTCD Section 2A Compliant
BlinkSync™ Wireless, Synchronized Device Activation Systems	
Multiple units in one system will flash in synchronized patterns to avoid light noise of system operation. Ideal for multiple units flashing in the same direction, without the need for wiring.	



Aimable LED arrays



GSA Contract Holder



† Specifications are subject to change without notice. For additional specifications and details, please contact us!

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