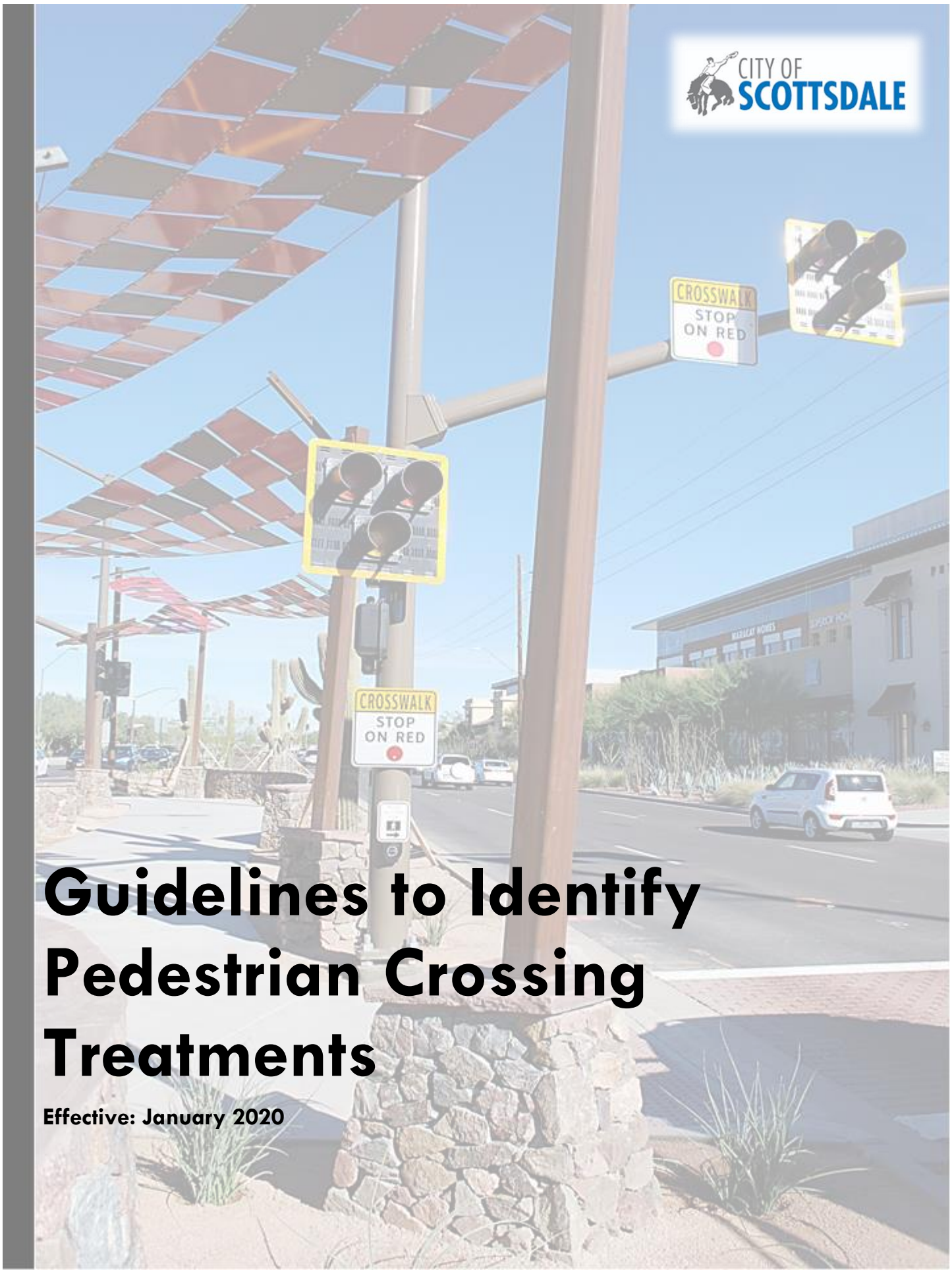


CITY OF SCOTTSDALE

Guidelines to Identify Pedestrian Crossing Treatments

Effective: January 2020

1.0 INTRODUCTION

The primary purpose of this document is to standardize the decision-making process to identify and prioritize the implementation of various pedestrian crossing treatments in the City of Scottsdale. Special attention is focused on consideration of standards set forth by Federal Highway Administration (FHWA), Institute of Transportation Engineers (ITE), Manual on Uniform Traffic Control Devices (MUTCD), National Association of City Transportation Officials (NACTO), and Transportation Research Board (TRB).

The general guidance provided in this document should not serve as a replacement for engineering judgement. It is important that engineering flexibility is maintained, as each pedestrian crossing location presents unique obstacles which may be addressed in varying ways.

The 2009 MUTCD outlines such engineering judgement; in Section 1A.09 the following provision is presented:

> *The decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment. Thus, while this Manual provides Standards, Guidance, and Options for design and applications of traffic control devices, this Manual should not be considered a substitute for engineering judgment. Engineering judgment should be exercised in the selection and application of traffic control devices, as well as in the location and design of roads and streets that the devices complement.*

While these guidelines focus primarily on addressing the needs of pedestrians, they may also be used to address the needs of other non-motorized road users that may benefit from the installation of a pedestrian crossing improvement. Special consideration should be given in order to accommodate the needs of disabled persons.

2.0 EVALUATION PROCEDURE

Evaluation of an individual crossing location for potential crossing treatments in the City of Scottsdale should include the following steps:

Step 1: Identification and Description of Crossing Location

Step 2: Traffic Data Collection and Operational Analysis

Step 3: Crossing Evaluation

The Crossing Evaluation Worksheet is included in **Exhibit A** and may be utilized as a guide through these steps.

Step 1: Identification and Description of Crossing Location

Conduct an office level review of the location using geographic information and other city records to define the study limits. Consider the following characteristics:

- Character area and surrounding land use (school, park, etc.).
- Future development proposals.
- Potential path or trail connections.
- Posted speed along the major street at the crossing location.
- Nearest crossings in each direction and associated traffic controls.
- Crossing distance along with the number and type of lanes.
- Presence and type of median (raised, striped, center two-way left turn lane, etc.)

The primary goal of this step is to determine the precise crossing location and to note any important characteristics that should be observed during a field visit.

Step 2: Data Collection and Observational Analysis

- Conduct a field review and make note of pedestrian and vehicle activity and other factors that are not observable by reviewing a map or other electronic and paper records.
- Collect a minimum of two hours of pedestrian counts if there is a possibility that the number of crossings may exceed 20 in a peak hour within the crossing area. A reasonable effort should be made to collect counts during the hours when the most pedestrian crossing events are expected to occur.
- Gather or collect hourly and average daily traffic (ADT) volumes for automobile traffic along the roadway at the crossing location. This data is often obtainable through the city's past count records.
- Measure the stopping and crossing sight distance for each approach. Refer to **Exhibit C** for calculations.
- Due to the potential for vehicular traffic queues to impact safety at the crossings, the presence of queues extending from downstream signals or intersections back into the crossing location should be observed, as well as any "differential" queuing that may occur on a lane to lane basis.
- Collect and analyze pedestrian and bicyclist crash data for crashes occurring within or on either side of the crossing location for the most recent five years of available data.

Step 3: Crossing Evaluation

- Using all data and pertinent information collected in steps 1 and 2, complete the pedestrian crossing evaluation form and associated attachments in **Exhibits A - D**.

It is important to keep in mind that to be effective, a traffic control device should meet five basic requirements:

A. Fulfill a need;
B. Command attention;
C. Convey a clear, simple meaning;
D. Command respect from road users;
E. Provide adequate time for proper response.

3.0 EVALUATION CONSIDERATIONS

Recognizing the limited availability of resources to implement crossing treatments within the City, it is important to use careful discretion when deciding to install a crossing treatment. Potential crossing locations should exhibit substantial need for treatment. The primary considerations and factors involved in the decision-making process and evaluation score sheet (**Exhibit A**) are described in further detail in this section.

Origin and Destination

In a proactive effort to address safety concerns for active transportation users, the City of Scottsdale considers potential pedestrian and bicyclist origins and destinations within the vicinity of the crossing area as the most significant factor in warranting a pedestrian crossing treatment study. This factor also considers the latent demand for the crossing location. It is essential that the expected increase in volume of pedestrian crossings after the installation of a crossing treatment be considered as a part of this evaluation. This potential increase in usage is estimated by considering the existing surrounding land use, past trends in pedestrian activity, roadway characteristics and newly planned developments.

In order to provide a baseline for this analysis, the City of Scottsdale utilizes the active transportation gravity demand model developed by the Maricopa Association of Governments as a starting point. Refer to **Exhibit B** for further information regarding the demand model. Adjustments can be made to the gravity demand model score in order to account for unique and localized variations within the vicinity of the crossing area.

Pedestrian Volume

The number of existing pedestrian crossings at an uncontrolled location is often a good indicator of the overall demand for an improved crossing treatment. A general rule of thumb is that if 20 pedestrians are currently crossing within the study area during a typical peak hour then the location meets the minimum threshold for a higher-level crossing treatment (i.e. RRFB, PHB, Traffic Signal or Separated Grade Crossing). However, the lack of crossings does not always discount the need for a crossing treatment, since some locations may be difficult to cross, but still have a high demand. Latent demand captured within the origin and destination score is used to account for this.

Vehicular Volume

The conflicting vehicular volume is another significant factor when evaluating a crossing location since it is indicative of the delay that a pedestrian may experience while attempting to cross the road. The longer the pedestrian must wait, the less likely they will wait for an acceptable/safe crossing gap. Additionally, high traffic volumes increase the potential number of conflicts that a pedestrian may experience while crossing.

Distance to the Nearest Defined Crossing

Pedestrians are often unwilling to walk far out of their way to utilize an improved crossing. Many roads in the southwest portion of the United States, including the City of Scottsdale, have signalized intersections spaced at quarter mile or half mile increments and are often farther away than pedestrians are willing to walk. It can be expected that the number of midblock pedestrian crossing events will increase as the distance between the study location and the nearest improved crossing increases.

Posted Speed Limit

Similar to vehicular volume, the posted speed on the conflicting road within the study location can be used to better understand the potential outcomes of conflicts between pedestrians and motor vehicles. Higher vehicular speeds tend to correlate with higher injury rates in pedestrian-vehicle collisions. For many pedestrians, roads with high posted speeds are considered greater crossing obstacles and may discourage pedestrian trips in an area where pedestrian activity may otherwise be high.

Crossing Distance

The crossing distance or the combined width of each lane and potential median on the conflicting road is an indication of the amount of time it takes a pedestrian to cross at the study area. Additionally, a high vehicular volume in association with a long crossing distance generally indicates that the number of acceptable gaps for a pedestrian to cross are minimal.

Median Type

The presence and type of median may affect the degree of safety at a crossing location. In general, roads with raised medians are more accommodating for pedestrians than roads with no median because the median provides a refuge area to help the pedestrian complete a two-stage crossing, i.e., when a pedestrian crosses one direction of travel, waits in the refuge area and then crosses the second direction of travel.

Roadway Illumination

Many pedestrian collisions happen at nighttime when visibility is limited. Often in this case, the pedestrian may expect that the vehicles will notice them and slow down as they cross. However, the nighttime conditions make driver detection of a pedestrian less likely at necessary distances to allow for time to slow or take evasive action. The type and intensity of existing roadway lighting should be considered in the crossing evaluation. Double-sided street lighting is preferred for pedestrian crossing locations.

Collision History

Past trends in collision history are often good indicators to be used in determining the most appropriate treatment at a crossing location. However, it is important to recognize that there is often a high degree of randomness associated with pedestrian collisions. Some locations that experience a pedestrian crash may not be suitable for a new crossing treatment or may already have an effective treatment.

Sight Distance

Sight distance plays a pivotal role in the safety of pedestrians and drivers alike. A driver must be able to see that a pedestrian is in the roadway at sufficient distance to allow for time to react to avoid a collision. Similarly, a pedestrian looking to cross the roadway must be able to anticipate that they will have enough time to do so without risking exposure to a conflicting vehicle. Therefore, in selecting a crossing treatment both factors must be accounted for.

Stopping Sight Distance:
Vehicle stopping sight distance is the distance at which the driver of the vehicle must be able to identify a person or object, have time to react, and safely come to a stop.

Crossing Sight Distance:
Pedestrian crossing sight distance refers to the distance away that a pedestrian must be able to observe approaching vehicles in order to make the decision to cross the roadway and safely cross without potential conflict with a vehicle. Because vehicles are required to yield to pedestrians, crossing sight distance is not necessarily required. However, to reduce the potential conflicts providing the pedestrian adequate sight distance is highly desirable for any crossing.

An inspection of the available sight distance should be performed, and the worksheet in **Exhibit C** should be used in all pedestrian crossing studies. If it is possible to provide the required pedestrian crossing sight distance, reasonable effort should be made. In locations that do not provide the pedestrian adequate crossing sight distance it becomes exceedingly important to incorporate added safety features if crossing treatment is pursued. Particularly, there should be added effort to raise driver awareness of the pedestrian in the crossing facility and reduce the required sight distance for crossing (i.e. reduce speeds, reduce crossing distance).

4.0 CONCLUSION

With the creation of these guidelines the City of Scottsdale intends to standardize the decision-making process for evaluating the installation of pedestrian crossing treatments at unsignalized and uncontrolled locations. When used in combination with engineering judgement and available resources for construction and operations, these guidelines will aid in reducing the number of daily instances where a pedestrian is faced with two undesirable options:

- Cross a busy street at an uncontrolled location; or,
- Walk an extended distance to utilize a safe crossing

Exhibit A: Pedestrian Crossing Evaluation

Location: _____ **Date:** _____

1. Origin/Destination (0–12 points) – Award points based on MAG Gravity Demand Model. Refer to Exhibit B:
Up to 5 points may be added or subtracted to the point value to account for special circumstances.
Provide Justification for any addition or subtraction in the comments section. _____

Less than 100	0 points
100 and 150	4 points
150 -185	8 points
185 – 223	12 points

2. Pedestrian Volume (0-10 points) – Award points based on the number of observed crossing events during a typical pedestrian peak hour: _____

Less than 10	0 points
Between 10 and 20	5 points
20 or more	10 points

3. Vehicular Volume (0-6 points) – Award Points: _____

Less than 3,000 ADT	0 points
3,000 – 9,000 ADT	2 points
9,000 – 15,000 ADT	4 points
15,000 ADT or greater	6 points

4. Distance to Nearest Controlled Crossing (0-8 points) – Award points: _____

Less than 300 feet	0 points
300 – 600 feet	2 points
600 – 900 feet	4 points
900 – 1,500 feet	6 points
Greater than 1,500 feet	8 points

5. Posted Speed (0-6 points) - Award points: _____

25 mph	0 points
30 mph	2 points
35 mph	4 points
40 mph or Greater	6 points

6. Crossing Distance (0-4 points) – Award points: _____

Less than 35 feet	0 points
35 - 50 feet	1 points
50 - 60 feet	2 points
60 – 70 feet	3 points
Greater than 70 feet	4 points

7. Median Type (0-5 points) – Award points: _____

10 feet or greater (raised)	0 points
Between 3 feet and 10 feet (raised)	2 points
Center two-way left turn lane	3 points
Striped median	4 points
No median	5 points

8. Roadway Illumination (0-3 points) – Award points based on presence and/or type of existing roadway illumination within proximity to the crossing area: _____

9. Collision History – Award 5 points for every correctable pedestrian, bicycle, skateboarder, or scooter related collision that has been reported within the study area in the most recent 5 years of collision data: _____

GRAND TOTAL _____

Note: A minimum total score of 30 points must be achieved for the location to be considered for a RRFB, PHB, Traffic Signal, or Separated Grade Crossing. Refer to **Exhibit D** for counter measure selection guidance. Scores may be used for prioritization of funds.

Origin/Destination Score Comments:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

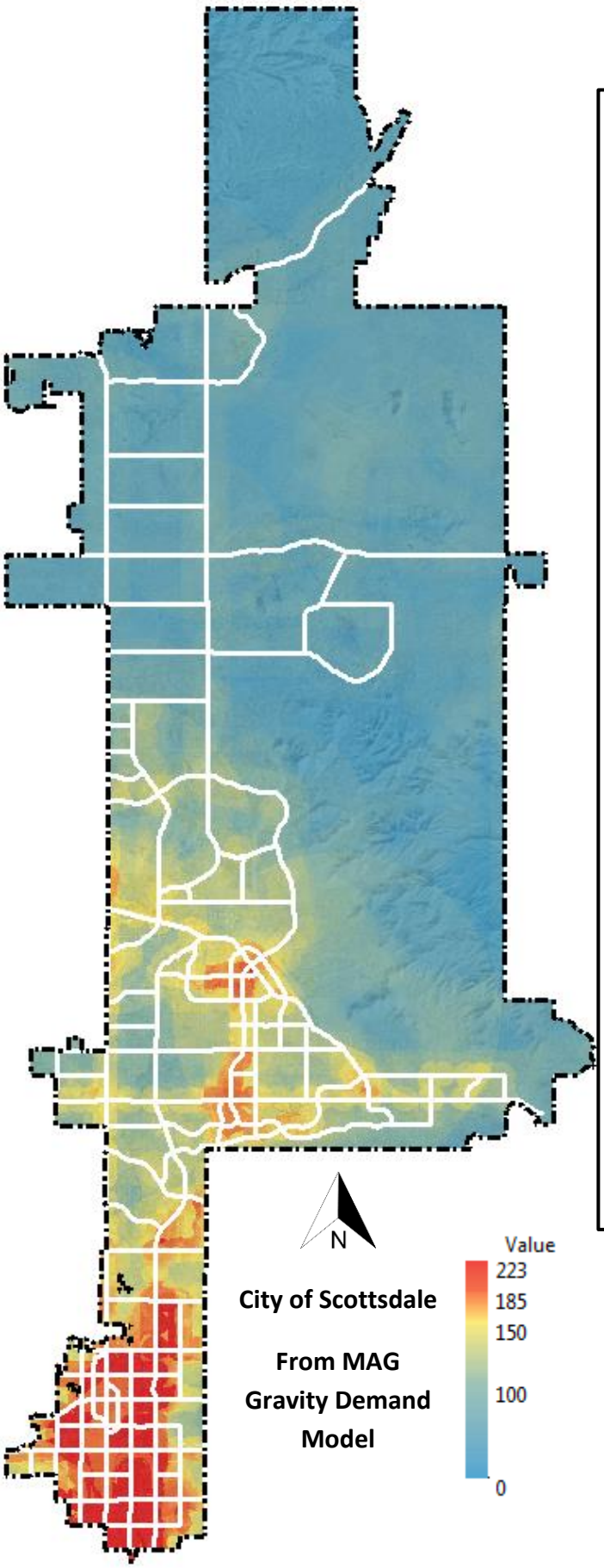
Roadway Illumination Score Comments:

_____
_____
_____
_____

Other Comments:

_____
_____
_____
_____

Exhibit B: MAG Gravity Demand Model



City of Scottsdale

From MAG Gravity Demand Model

Gravity Analysis Factors and Variables

Factor	Variable	Distance	Weight
Pedestrian and Bicycle Crash History *	Weighted crash kernel density	0.25 mile	10
Employment Density (number of jobs)*	Proximity to employment and number of jobs	2 miles	20
School	Proximity to schools	0.5 mile	10
University	Proximity to Universities	1 mile	15
Existing Transit	Proximity to bus stops	0.25 mile	10
	Proximity to light rail stops	0.50 mile	10
	Proximity to transit stops with high ridership	bus 0.25 miles rail .050 mile	10
Parks	Proximity to parks	.025 mile	10
Demographics*	High population density	NA	20
	High bike mode share	NA	10
	High walk mode share	NA	10
	High transit mode share	NA	10
	High percentage of low-income households	NA	10
	High percentage of older adult population (65+)	NA	10
	High percentage of zero vehicle households	NA	10
	High percentage of school-aged children (<19)	NA	10
Strava Data*	Annual Bicyclist Activity	0.5 mile	20
	Annual Pedestrian Activity	0.5 mile	20

* These factors use a tiered weighting method in which the variables are broken into quintiles and scored using a quintile scale. For example, a variable with a weight of 10 will apply a score of 10 to the highest quintile and the proceeding quintiles receive a score of 8, 6, 4, and the lowest quintile receiving a score of 0.

Contact City of Scottsdale Traffic Engineering staff for locational demand model scores.

Refer to the MAG Active Transportation Plan for more Information regarding demand model scoring and analysis.

Exhibit C: Sight Distance Calculations

$$SSD = (1.47 * PS * 2.5secs) + 1.075 * (\frac{PS^2}{11.2ft/s^2})$$

Posted Speed - PS (mph)	Stopping Sight Distance - SSD (ft)	Posted Speeds - PS (mph)	Stopping Sight Distance - SSD (ft)
15	80	40	305
20	115	45	360
25	155	50	425
30	200	55	495
35	250		

$$CSD = 1.47 * PS * (2.5sec + \frac{CD}{3.5\ ft/s})$$

Posted Speed -PS (mph)	Crossing Distance - CD (ft)	Crossing Sight Distance - CSD (ft)	Posted Speed -PS (mph)	Crossing Distance - CD (ft)	Crossing Sight Distance - CSD (ft)
25	24	344	45	24	619
25	36	470	45	36	846
25	48	596	45	48	1073
30	24	413	50	24	688
30	36	564	50	36	940
30	48	715	50	48	1192
35	24	481	55	24	757
35	36	658	55	36	1034
35	48	834	55	48	1311
40	24	550			
40	36	752			
40	48	953			

Evaluation:

Posted Speed: _____

Crossing Distance: _____

*Crossing distance may be measured to the median if a 10 foot or wider raised median is present

Required Stopping Sight Distance: _____

Required Crossing Sight Distance: _____

Satisfies Both Required Sight Distance Criteria?

Yes / No

Existing Sight Distance:

Stopping: Direction (___) = _____ ft. Direction (___) = _____ ft.

Crossing: Direction (___) = _____ ft. Direction (___) = _____ ft.

Exhibit D: Pedestrian Crossing Treatment Options

Treatment Option	Appropriate Conditions
Improved Street Lighting	- Posted Speed: Any - Traffic Volume: Any - Used to improve visibility of the crossing area during nighttime hours - Average Cost: $2,000 per street light pole and light fixture*
High Visibility Striped Crosswalk with Warning Signs (Uncontrolled)	- Posted Speed: 25 – 30 mph - Traffic Volume: 3,000 – 5,000 ADT - Crossing distance: less than 50 feet - Often used where yield compliance is a concern - Average Cost: $1,500*
In Pavement Signage	- Posted Speed: 25 – 30 mph - Traffic Volume: 5,000 – 10,000 ADT - Often used where both yield compliance and speed compliance are concerns - Include High Visibility Crosswalk - Average Cost: $1,000*+$1,500 accounts for ongoing maintenance
Raised Crosswalk	- Posted Speed: 25 mph - Traffic Volume: 1,500 – 5,000 ADT - Often used where both yield compliance and speed compliance are concerns - Include High Visibility Crosswalk + In Pavement Signage (If feasible) - Average Cost: $8,000*
Bulb out/Curb Extension	- Posted Speed: 25 – 30 mph - Traffic Volume: 3,000 – 9,000 ADT - Used to shorten crossing distance and improve sight distance - Used in areas with on-street parking, must not restrict bike lanes and drainage - Include High Visibility Crosswalk + In Pavement Signage + Raised Crosswalk (If feasible) - Average Cost: $15,000 per extension*
Pedestrian Refuge (Unmarked)	- Posted Speed: 30 – 45 mph - Traffic Volume: 5,000 – 15,000 ADT - Used where crossing distance, vehicular volumes, and speeds are concerns - Often used as a first step in areas with low existing or latent pedestrian demand - Average Cost: $30,000*
Rectangular Rapid Flashing Beacon (RRFB)	- Posted Speed: 30 – 35 mph - Traffic Volume: 9,000 – 15,000 ADT - Often used to improve yield compliance and visibility - Often used as a first step in areas with moderate pedestrian demand (< 20 pedestrian crossing in a peak hour) - Add Pedestrian Refuge (If feasible) - Average Cost: $20,000 beacon/signing and striping only*
Pedestrian Hybrid Beacon (PHB)	- Posted Speed: 35 – 50 mph - Traffic Volume: 12,000 ADT or greater - Typically used on arterial roads with high speeds and volumes - May be warranted by MUTCD guidance - Used to assign right of way to pedestrians - Average Cost: $150,000*
Traffic Signal	- Posted Speed: 25 – 55 mph - Traffic Volume: 10,000 ADT or greater - Used where vehicular activity at an intersection may also warrant the installation of a traffic signal - A complete traffic signal warrant analysis must be completed in accordance with MUTCD Chapter 4C - Average Cost: $275,000*
Separated Grade Crossing	- Posted Speed: 30 – 55 mph - Traffic Volume: 15,000 ADT or greater - Used at multi-use path crossings or other high-profile crossing locations - Average Cost: Highly variable between $600,000 and $6,000,000*

*Average costs are rough estimates based on 2019 market value; the actual project cost may vary considerably by location. Two or more treatment options may be used in conjunction with one another