Pedestrian Crossing Treatment Guidelines

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FOX TUTTLE

Next Phase Engineering

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EXECUTIVE SUMMARY

Providing safe and efficient pedestrian facilities is a goal of the Town of Timnath and to accomplish this the Town has established these "Pedestrian Crossing Treatment Guidelines (PCTG)" to provide a set of standard procedures to help inform the installation of pedestrian crossing treatments. Specifically, the PCTG provides guidance on when it is appropriate and needed to install a pedestrian crossing treatment and which types of pedestrian crossing treatments are most appropriate for specific circumstances.

National standards provide some guidance for the installation of marked crosswalks and treatments. The Manual on Uniform Traffic Control Devices 11th Edition (MUTCD) published by the Federal Highway Administration (FHWA) requires that crosswalks be marked at legally established crossings at non-intersection locations. The MUTCD suggests using engineering judgment to determine when crosswalks should be striped at intersections. The MUTCD also provides some guidance for when traffic control devices and other measures should be installed to support marked crosswalks. Key issues, such as more specific guidance about when a crosswalk should be installed, and the application of various crossing enhancements are still commonly debated topics.

Local communities, such as The City of Boulder, have experimented with different pedestrian crossing treatments, under a variety of crossing situations, to **improve safety for pedestrians by increasing the rate at which motorists yield to people crossing**. In fact, this document has used much of that work and has incorporated some components of Boulder's Pedestrian Crossing Treatment Installation Guidelines (2011).

Timnath's PCTG are intended to provide a consistent procedure for considering the installation of crossing treatments where needed on a case-by-case basis. Implementation of crossing treatments will require funds that could potentially have been spent on other transportation system improvements, and, therefore, must be considered carefully in the funding allocation process.

Timnath's PCTG contains general recommendations, and these recommendations should never take the place of good engineering judgment in determining whether to install a crossing treatment and what type of crossing treatment to install.

FHWA research suggests that on higher volume, multi-lane roadways, marked crosswalks alone (without any other treatments) are associated with higher vehicle-pedestrian accidents rates compared to unmarked locations.

PEER REVIEW AND NATIONAL RESEARCH

The development of Timnath's PCTG was informed by research into similar guidelines in several peer communities and a review of research performed by state and federal agencies, relative to the safety benefit of and installation practices for different types of pedestrian crossing treatments.

The guidelines for each of the following Colorado front-range and national communities and agencies were reviewed and considered as part of this research effort:

City of Boulder, Colorado

Town of Parker, Colorado

City of Grand Junction, Colorado

City of Fort Collins, Colorado

Clark County, Washington

St. Paul / Minneapolis, Minnesota

Maricopa County, Arizona

Town of Erie, Colorado

Town of Windsor, Colorado

City and County of Denver, Colorado

Colorado Department of Transportation

Scottsdale, Arizona

Burlington, Vermont

The following state and federal research and guidance were also reviewed and considered as part of this research effort:

- National Cooperative Highway Research Program (NCHRP) 562 – Improving Pedestrian Safety at Unsignalized Crossings
- National Cooperative Highway Research Program (NCHRP) 841 – Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments
- Illinois Center for Transportation – Establishing Procedures and Guidelines for Pedestrian Treatments at Uncontrolled Locations
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- National Association of City Transportation Officials (NACTO) Urban Street Design Guide
- PEDSAFE "Pedestrian Safety Guide and Countermeasure Selection System

There were several key takeaways from this research effort which influenced the recommendations in these guidelines, and they are summarized in the Appendix.

1.0 DEFINITIONS

This section includes the definitions of some of the common technical terms used in this document.

Average Daily Traffic (ADT)

The amount of vehicular traffic crossing an imaginary line across a roadway in a 24-hour period. ADT information typically includes all directions of vehicle travel.

Controlled Pedestrian Crossing

A pedestrian crossing where a traffic control device requires motorists to stop by either a stop sign or traffic signal (including a HAWK beacon).

Crosswalk Lighting

Street lighting applied at a pedestrian crossing to help approaching motorists see a crossing pedestrian. Crosswalk lighting is at a "vehicular scale" like normal street lighting rather than a "pedestrian scale" that is often used along a sidewalk.

Curb Extensions

A roadway edge treatment where a curbline is bulged out toward the middle of the roadway to narrow the width of the street. Curb extensions are sometimes call "neckdowns" and are often used at the location of a pedestrian crosswalk to minimize the crossing distance and time that a pedestrian must be in the roadway.

Differential Vehicle Queuing

See also Vehicle Queue. A condition on a roadway with two or more travel lanes in a single direction where the line of stopped traffic in one travel lane is significantly longer than the line of stopped traffic in the adjacent travel lane. Differential vehicle queuing across a pedestrian crosswalk can cause a significant safety concern as it increased the potential for "multiple threat" pedestrian accidents where a pedestrian can step out from behind a stopped vehicle in one lane into the path of a moving vehicle traveling in the same direction in the adjacent lane.

Gap in Traffic

A gap in traffic is the space between vehicles approaching the pedestrian crossing. Gaps are typically measured in seconds, not distance, as it is the length of the gap in time that a pedestrian needs to cross the roadway without vehicular conflict. A directional gap is the

gap between vehicles approaching in a single direction. A directional gap can be measured between vehicles in a single lane, or between vehicles approaching in the same direction but in different lanes on a multi-lane approach. If there is no median refuge at the crossing, a pedestrian will need to find an acceptable gap in traffic approaching from two directions at once. This can be more challenging than finding a gap in each approach separately.

HAWK Beacon

A high intensity activated crosswalk (HAWK) beacon (also known as Pedestrian Hybrid Beacon) is used to both warn and control traffic at a pedestrian crossing. It is actuated by a pedestrian push button and uses a combination of circular yellow and red traffic signal displays to first warn motorists of a pedestrian that is about to cross the street, then require the motorist to stop for the pedestrian crossing, and then release the motorist to proceed once the pedestrian has cleared the crossing. The Beacon is a hybrid between a pedestrian traffic signal and a stop sign.

Lane

A portion of the roadway surface designated for motor vehicle travel, typically in a single direction, that is delineated by pavement marking stripes. Types of lanes include: “through lanes” for travel along the length of the roadway, often through intersections; “turn lanes” which are typically on intersection approaches and provide space for left or right turning motorists; and “bike lanes” which are designated for bicycle travel in the same direction as the automobile travel, are typically narrower than vehicle lanes, and are usually located along the outside edges of the roadway.

Marked Crosswalk

A pedestrian crossing that is delineated by white crosswalk pavement markings. Marked crosswalks typically have a variety of traffic signs or other traffic control. Marked crosswalks have curb ramps if there are curb and gutter and sidewalks in the area of the crossing.

Median Refuge Island

An area in the middle of a roadway where a crossing pedestrian can take shelter from approaching traffic in either direction. In the context of these guidelines, the median refuge island must include a raised median of some width (see Section 2.2.1 for more information about median refuge islands). A median refuge island allows a pedestrian to cross each direction of approaching traffic in a separate step. By using the refuge, the pedestrian can find an acceptable gap in traffic for one approach direction separately.

Minimum Pedestrian Volume Threshold

The minimum number of people crossing (typically in a one-hour period) that must be observed to "warrant" the installation of a pedestrian crossing treatment.

Motorist Compliance

The frequency with which a driver will yield to a person crossing in a crosswalk. Specifically, observations made and recorded at a pedestrian crossing where it is determined if the approaching driver complied with their legal requirement to yield to a person crossing in or who is about to enter the crosswalk.

Multi-Lane Threat Crashes

A type of pedestrian crash that can occur on a roadway with two or more lanes in the same direction. A motorist that stops for a crossing pedestrian can obscure the view of the pedestrian from another motorist approaching in the adjacent travel lane. If the second motorist does not slow down, it creates the potential for a crossing pedestrian to step out in front of a fast-moving vehicle with potentially severe consequences.

Multi-Use Path

An off-street pathway (may be paved or soft surface) that is designated by the community as having increased significance for transportation and connectivity over that of a typical sidewalk or trail and are facilities where traveling as a pedestrian or bicyclist is encouraged.

Multi-Use Path Crossing

A location where a sidewalk or trail that has been designated as a multi-use path intersects a roadway at-grade, and the path extends on both sides of the roadway or terminates at a civic facility.

Neckdowns

See Curb Extensions

Pedestrian Traffic Signal

A conventional traffic signal with circular red, yellow, and green displays for motorists and Walk/Don't Walk signals for pedestrians that is applied at a pedestrian crossing. Typically, a pedestrian signal would be applied in a mid-block location since it would be considered a normal intersection related traffic signal if it were to be applied at an intersection.

Raised Median

An area in the middle of a roadway, commonly separating vehicles traveling in opposite directions, that is surrounded by curb and gutter and is physically raised above the surrounding pavement where vehicles travel. Raised medians often contain landscaped areas. *See also Median Refuge Island.*

Rectangular Rapid Flash Beacons (RRFBs)

RRFBs are small rectangular yellow flashing lights that are deployed with pedestrian crossing warning signs. They are typically actuated by a pedestrian push button and flash for a predetermined amount of time, to allow a pedestrian to cross the roadway, before going dark. RRFBs are warning devices and do not themselves create a legal requirement for a vehicle to stop when they are flashing.

School Crossing

A School Crossing is defined as a crossing location near a school where high numbers of student pedestrians cross during pickup or drop off times.

Uncontrolled Pedestrian Crossing

An established pedestrian crossing that does not include a traffic signal, a HAWK beacon, or a stop sign. At these crossings, a driver is required to identify a person crossing in a crosswalk and yield to them, rather than stop for a stop sign or red light. For example, Timnath's crosswalks with signs and/or pedestrian actuated flashing yellow lights are considered "uncontrolled".

Vehicle Queue

A line of stopped vehicles in a single travel lane, commonly caused by traffic control at an intersection or a driver yielding to a pedestrian in a crosswalk.

Vision Zero Principles

A strategy to eliminate all severe (fatal or serious injury) outcome crashes in a community, region or country, while increasing safe, healthy and equitable mobility for all. Vision Zero goals or goals similar to them have been adopted by many Front Range communities, the State of Colorado and the federal government.

2.0 CROSSING LOCATION EVALUATION

2.1 Evaluation Steps

Evaluation of an individual crossing location for potential crossing treatments in the Town of Timnath should include the following general steps:

Step 1. Identification and Description of Crossing Location

Step 2. Initial Evaluations

Step 3. Assess Need Based on Gaps in Traffic

Step 4. Assess Latent Demand / Existing Crossing Treatments

Step 5. Assess the Current Crossing Demand

Step 6. Determine Appropriate Crossing Treatment Type

Step 7. Prioritization

It is intended that marked crosswalks should ONLY be installed when PCTG guidance and/or engineering judgment recommend their installation. Most intersections will not warrant marked crosswalks. **Figure 1** is a flowchart which summarizes each of these steps and is included at the end of this section. It includes actions for both controlled and uncontrolled crossing locations.

Step 1 Identification and Description of Crossing Location

When a location for a potential pedestrian crossing treatment is identified, either by the public or by town staff, the first step is to document the following key pieces of information about the location:

1. The major street and the specific location of the crossing. It is important to note whether it is a mid-block location or an intersection, and if it is an intersection, which leg(s) are to be evaluated. Also note the Traffic control or other physical treatments present at the crossing location (signal, stop sign, yield sign, traffic calming, medians, curb ramps and presence / location of crosswalk lighting).
2. The posted speed limit along the major street at the crossing location.
3. Note the presence of potential latent demand through key land uses or connectivity elements (See Step 4 for additional information).

An application form for residents to use for identifying new potential crossing treatments is provided in the Appendix and it is recommended that this application form be placed on the Town of Timnath's Website for this project.

Step 2 Initial Evaluation

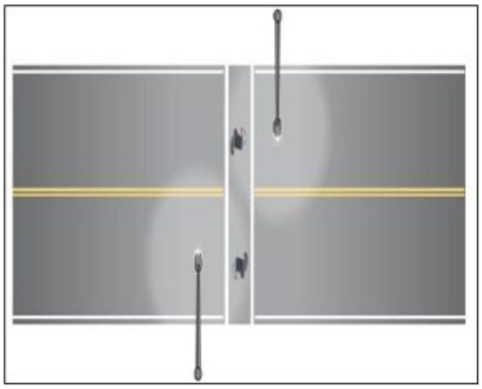
There are two key evaluations that are needed to determine whether it will be safe to provide certain types of crossing treatments and what treatments may be most appropriate for the conditions, along with any additional improvements needed to support these treatments.

1) Stopping Sight Distance (SSD) for a driver approaching a crosswalk is fundamental to allowing safe crossings. The driver must be able to see a person entering a crosswalk and have enough time to yield to them. Likewise, the person entering the crosswalk must be able to determine that the oncoming vehicle can stop for them.

   A key component to determine SSD is the speed of the vehicle, therefore it is desirable to collect speed data at this point in the evaluation. The most informative approach is to collect ADT and speed data for a full day. If this level of data collection isn't possible then peak hour speed data or using the speed limit of the roadway is a reasonable approach. A table showing the SSD for different speeds, provided by the FHWA can be found in the Appendix. The following link connects to an on-line calculator for SSD as well: Stopping Distance by Sight Calculator and Formulas (engineersedge.com)

   If adequate SSD is not present, engineering judgment should be used to determine whether improvements can be made to improve sight distance. These may be physical changes (such as obstruction removal or curb extensions), parking restrictions or the use of specific traffic control or treatments which enhance sight distance (such as RRFBs or advanced flashing displays).

2) Reasonable crosswalk lighting to illuminate people crossing the roadway in dark conditions is also fundamental to allowing safe crossings. Engineering judgment should be used to determine the need for street lighting at a potential crossing and the design of that street lighting. The image to the right illustrates the preferred lighting design for most crossing locations, with street lighting placed a short distance upstream from the crosswalk in each direction.



The inability to provide adequate SSD or the inability to provide adequate street lighting is a legitimate reason NOT to install a pedestrian crossing treatment at a location as it may be less safe to do so than to not provide the crossing treatment.

Step 3 Assess Need Based on Gaps in Traffic

One of the key purposes of a pedestrian crossing treatment is to encourage drivers to yield to people crossing in the crosswalk and create gaps in traffic which would otherwise not be there. Consequently, crossing treatments should generally be installed only where they are needed to create these gaps in traffic. **When the ADT on the roadway is less than 1,000 vehicles per day (or the peak hour count is less than 100 vehicles) then it is reasonable to assume that people crossing will find adequate gaps in traffic without the need for a Crossing Treatment.**

1. Gather or collect average daily traffic (ADT) or peak hour volumes for automobile traffic along the major roadway at the crossing location.

   A one-day sample should be adequate, with hourly volumes collected during the same hour as the pedestrian crossing data.

2. Crossing Treatments can also be used to highlight where a community wants pedestrians to cross such as school crossings or continuations of pathways. Engineering judgment should be used to determine if a crossing treatment is beneficial to the community even if it is not needed for adequate gaps.

Step 4 Assess Latent Demand / Existing Crossing Treatments

Existing infrastructure or area circumstances can make it difficult to determine the demand for a pedestrian crossing treatment. Engineering judgment may be needed to determine whether the surrounding land uses and/or connectivity elements are such that a pedestrian crossing treatment is desirable even if the demand is currently present. Land uses which serve as activity generators include the following:

- School sites – These include public and private schools and elementary, middle and high school facilities, where some of the students are anticipated to walk or bike to school. Kindergarten facilities do not typically meet these characteristics.

- Local or Regional parks within walking distance of residential areas or other trip generating sites. Parks which are remote and can only be accessed by motor vehicle would not typically meet these characteristics.

- Medical offices, hospitals and pharmacies within walking distance of residential areas or other trip generating sites.

- Senior centers and Recreation or Community centers within walking distance of residential areas or other trip generating sites.

- Other potential pedestrian/bicycle trip generation centers such as libraries, grocery stores, pharmacies and neighborhood commercial centers, so long as these land uses are within walking distance of residential areas or other trip generating sites.

Latent demand is also possible where facilities designed for people to walk and bicycle (multi-use paths and trails) cross the roadway. Such facilities would include:

- Multi-use paths crossing the roadway and generally used by both people walking and people bicycling.

- Recreational trails crossing the roadway and generally used by both people walking and people bicycling.

- Bus stops which people need to cross the roadway to access, and which have a high frequency of boarding and alighting.

If one of these land uses or connectivity elements is within 300 feet of the location being evaluated, then a pedestrian crossing treatment may be desirable regardless of existing crossing activity. If a pedestrian crossing treatment is warranted based on these factors, Step 5 can be skipped.

However, it is important to note that the "number of pedestrians crossing" is required information in assessing the appropriateness of controlled pedestrian crossing treatments like traffic signals or HAWK beacons according to the requirements provided in the Manual on Uniform Traffic Control Devices (MUTCD) published by the FHWA.

In addition, the presence of existing pedestrian crossing treatments within the nearby vicinity can provide the needed crossing support for a location and it may be undesirable to have another pedestrian crossing treatment so close to the first. If an existing pedestrian crossing treatment is within 300 feet of the location being evaluated, then engineering judgment should be used to determine whether there may be operational issues because of their proximity and if the new crossing treatment can be operated safely and is truly needed.

Vehicle queues from downstream signals or intersections that back into the potential crossing location should be observed to determine if there may be impacts to safety as well as any "differential" queuing on multi-lane approaches.

Step 5 Assess the Current Crossing Demand

Research suggests there is a clear relationship between motorist compliance (yielding) and the number of people typically crossing at a location. Data collected in Boulder at crossings with RRFBs and State Law Yield signs show that motorist compliance typically increases with higher numbers of people crossing. It is theorized that the primary reason for this relationship is that drivers tend to ignore enhanced crossing treatments over time at locations where they infrequently see people crossing. The graphs in **Figure 2** illustrate this relationship.

This data illustrates that, below approximately 20 crossings per hour, driver compliance decreases significantly. Therefore, the base threshold in many communities that have adopted guidelines for consideration of an enhanced crossing treatment at an uncontrolled location is 20 pedestrians per hour. This threshold is consistent with recent national guidance and policies adopted by other states and cities, as determined through literature research.

Pedestrian Volume vs. Compliance (City of Boulder Study)

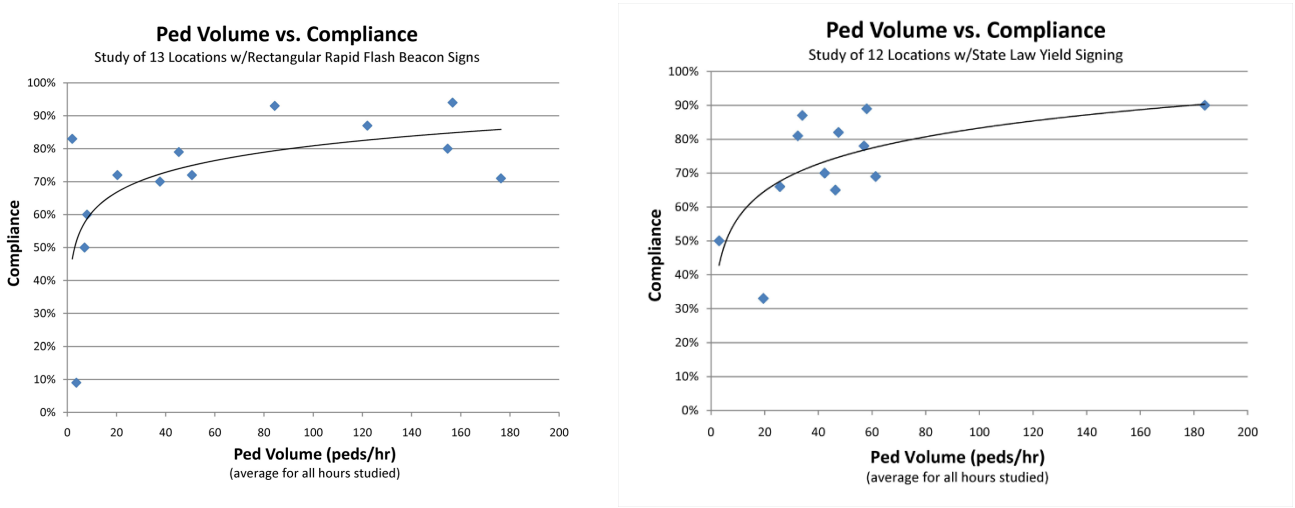


Figure 2 – Comparison of Crossing Demand and Yielding Compliance

Given this data and considering the context of the Town of Timnath which may have less locations generating high pedestrian volumes, slightly lower volume thresholds have been set.

Town of Timnath's Minimum Pedestrian Volume Thresholds are as follows:

- **18 peds per hour* in any one hour, or**
- **16 peds per hour* in any two hours, or**
- **12 peds per hour* in any three hours**

**** Young, elderly and disabled pedestrians count 2x towards volume thresholds***

Engineering judgment should be used to determine the time period(s) of highest crossing activity. This is when crossing data should be obtained. Typically, this will be the morning and afternoon peak periods and possibly the noon time period if midday pedestrian travel is expected. In the vicinity of schools, the period encompassing student pickup and drop off would be advisable. Weekend data may also be desirable if the crossing is near a land use with high weekend use (such as parks or ballfields).

Step 6 Determine Appropriate Crossing Treatment Type

Once it has been determined that a location should have a pedestrian crossing treatment, then it is important to determine the most appropriate treatment for that location. There are many different types of pedestrian crossing treatments and factors which are important to determining the most appropriate treatment. These factors and the associated recommendations are summarized in **Table 1**. Each of these factors influence how many adequate gaps are present for a person trying to cross and inform the selection of types of crossing treatments.

1. Speed of Motor Vehicles – Most pedestrian crossing treatments rely on a driver to see the crossing treatment, notice that there is a person crossing and slow their vehicle so that they can yield to that person. The higher the speed they are traveling, the more difficult it is for a driver to do that, and the more difficult it is for a person crossing to determine whether a gap in traffic is adequate. **Speed data collected at the location should be used to provide the "speed" information needed on Table 1 where possible.** If such data cannot be obtained, then it is reasonable to use the posted speed limit of the roadway.

2. Traffic Volume on the Roadway – The amount of motor vehicle traffic at a location will influence how many adequate gaps in traffic are present and the importance of having a crossing treatment which forces gaps in traffic. A higher motor vehicle volume is a reason to select crossing treatments which generally have higher driver compliance with yielding. **ADT data collected at the location should be used to provide the "volume" information needed on Table 1 where possible. If such data cannot be obtained, then it is reasonable to collect the peak hour of data and multiply that by a factor of 10 to estimate the ADT.**

3. Number of Lanes to Cross – It is intuitive that the longer a crossing distance, the longer that a person crossing is in potential conflict with motor vehicle traffic and the potential for a crash is increased. This is exacerbated by the potential of multi-lane threat crashes where there are two or more lanes in the same direction. Consequently, the geometry of the roadway is a significant factor in determining an appropriate crossing treatment. The number of lanes described in **Table 1** is for both directions (i.e 2-lane roadway is typically one lane in each direction). One-way roadways will require additional engineering judgment in determining the appropriate crossing treatment. When a roadway is described as having an odd number of lanes, it is assumed that one of the lanes is a turn lane. **There are many different possible types of lane configurations and engineering judgment should be used when one does not align directly with the categories offered in Table 1**.

Table 1 provides recommendations for the following types of crossing treatments.

Type A – Marked Crosswalk – The most common type of crossing treatment is a marked crosswalk.

- ✧ Warning signs should be installed at the crosswalk. These are typically the standard MUTCD warning sign (W11-2). However, these signs can be augmented with supplemental signs or replaced with signs noting the requirement for drivers to yield to pedestrians. An example of a state law yield sign used in other communities is provided to the right.

- Advance pedestrian warning signs (W11-2) signs mounted upstream from the crossing should be considered.
- If the location is a school crossing, then the school crossing (S1-1) sign should be used in place of the W11-2 sign.
- If the location has a center median island, then the "State Law – Yield to Pedestrians – Within Crosswalk" signs (R1-6) may be mounted on the median to supplement the previous signing. The R1-6 sign is shown to the right. This sign may also be used on a bollard placed on the lane line of the roadway.

Type B – Marked Crosswalk with Median Refuge Island – This crossing treatment is the same as Type A except that it should also include a median refuge island. These islands can slow traffic and allow people to cross one direction at a time and have a place to refuge in between crossings.

- The literature research showed that median refuge islands improve safety at a crossing with a crash reduction factor of 0.68 (32% crash reduction).
- FHWA notes that median refuge islands are "highly desirable" when the ADT on the roadway is 10K or greater. This is because higher traffic volumes result in fewer adequate gaps in traffic for crossing.
- FHWA also notes that median refuge islands may be particularly effective on multi-lane roadways.

When a Type B treatment is recommended and conditions do not allow for a median refuge island, then it is recommended that a Type C treatment be used instead.

Type C – Marked Crosswalk with Rectangular Rapid Flash Beacons (RRFBs) – This crossing treatment is the same as Type A except that it should also include RRFBs on the warning sign assemblies. RRFBs are effective at letting drivers know that a person is trying to cross at a crosswalk even if they cannot see them due to obstructions.

- The literature research showed that RRFBs improve safety at a crossing location with a crash reduction factor of 0.53 (47% crash reduction).

- ✧ The literature research suggests that RRFBs are most appropriate when the ADT volume is between 9K and 15K and speeds are between 30mph and 35 mph.
- ✧ RRFBs may be a mitigation for a lack of SSD if the crossing can be designed so that one of the RRFB displays can be seen with adequate SSD.
- ✧ Note that when an RRFB is used on a multi-lane roadway, it is recommended that advanced yield lines and related advanced signing (R1-5) also be used.

- ✧ FHWA guidance allows for the use of RRFB displays which are placed in advance of the crosswalk to augment RRFB displays at the crosswalk. These are useful where sight distance is a challenge and/or on roadways with higher speeds.

The literature research suggests that RRFBs are best used in combination with a median refuge island. However, these guidelines acknowledge that this will not always be possible and allows for the consideration of RRFBs without medians in certain circumstances.

Type D – Marked Crosswalk with median refuge island and RRFBs – This crossing treatment is a combination of the features provided in Type B and Type C. **It is desirable that RRFBs be used in combination with median refuge islands. The conditions prompting the recommendation of a Type D treatment suggest that if the median refuge island cannot be included, then the crossing treatment should default up to Type E (controlled treatments).**

- ✧ FHWA notes that the RRFB is "ideally suited" for four-lane roadways when used with median refuge islands because it increases drivers yielding to people crossing.
- ✧ FHWA notes that the RRFB is more effective with medians which include beacons on the sides and on the refuge island, especially at night.
- ✧ While a crash reduction factor for the combination of RRFBs and median refuge islands has not been developed, it is reasonable to assume that it would be higher than either of the crash reduction factors for these devices alone.

Type E – Marked Crosswalk with Pedestrian Hybrid Beacon (PHB), Traffic Signal or Grade Separated Crossing – This crossing treatment represents either a crossing that is controlled by a red light or a grade-separated crossing. There are circumstances where the speed of vehicles, the geometry of the roadway and/or the volume of traffic create enough complexity that uncontrolled crossing treatments, which rely on a driver to see a person in a crosswalk and yield to them, may not be safe to use.

- The MUTCD provides guidance (warrants) on when it is appropriate to use traffic control devices like Hawk Beacons (PHBs), pedestrian signals and intersection traffic signals. **It is recommended that these warrants be considered before a determination is made about using these traffic control devices as a pedestrian crossing treatment.** However, it should also be noted that engineering judgment may be needed to decide whether to install such treatments even if they do not meet MUTCD warrants versus not providing a safe crossing treatment at all.

- A Type E alternative to a controlled crossing treatment is the construction of a grade separated crossing (underpass or overpass). Such treatments allow people to cross the roadway without being in conflict with a motor vehicle. It is understood that the cost of grade separated crossings is considerably more than other crossing treatments and that this can preclude their use.

- The literature research suggests that controlled crossing treatments should be used when the speed limit is higher than 40 mph.

Step 7 Prioritization

A way to prioritize the importance of identified pedestrian crossing treatment installations can be helpful if the cost for installing needed treatments is greater than the resources available. The following is a recommended approach which prioritizes dollars spent against the potential for conflict.

Step 1: Determine the type of pedestrian crossing treatment and the conceptual details of its installation. Using this information, obtain a cost estimate for the installation.

Step 2: Multiply the number of people observed during the peak period by ten (10) to obtain a rough estimate of daily crossing activity. Multiply this value with the ADT (rounded to the nearest 100 vpd) to obtain an estimate of the potential number of conflicts per day.

Step 3: Divide the above cross-product by the cost estimate to obtain a value in “potential crossings impacted per dollar spent (pcipds)”. Prioritize the higher values.

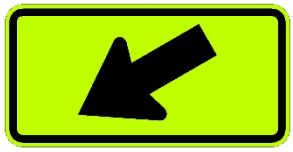
For example, a crossing which had 20 people observed crossing in an hour and an ADT of 5,000 vpd and a cost estimate of $20K would yield a value of 5.0 pcipds.

Typical Signs That May Be Used at Pedestrian Crossings:

W11-20

S1-1

W16-7P



W16-7P

R1-6

Special "State Law"

R1-5

2.2 Additional Evaluation Considerations

The following additional information should be considered by the user of these guidelines when determining the appropriate pedestrian crossing treatment:

2.2.1 Minimum Width for a Median Refuge Island

A median refuge island is a useful tool in increasing the safety and efficiency of a pedestrian crossing. A raised median at a mid-block pedestrian crossing can only be considered as a refuge if it is at least 6 feet wide (preferably 8 feet wide) and includes curb ramps or a walkway at grade through the median. A median of this width will:

- allow over two feet on each side for splash protection; and
- store a group of pedestrians; and
- accommodate the storage of a bicycle without it overhanging into the traffic lanes.

Pedestrian Refuge, NYC Source: NACTO

A raised median nose at an intersection (next to a left-turn bay for example) may be considered a pedestrian refuge for the adjacent crosswalk if the median is at least 4 feet wide AND the left-turn volume is less than 20 vehicles per hour. This low left-turn volume means that during most pedestrian crossings there will not be a vehicle in the left-turn lane and the pedestrian will be "shadowed" by the width of the median and the adjacent turn lane as they cross the street.

A painted center median or a painted turn lane alone is never considered a median refuge island.

2.2.2 Signal Progression and Traffic Operation Considerations

The installation of RRFBs, HAWK beacons, or pedestrian traffic signals can all have a significant impact on the automobile traffic operation in a corridor. When selecting the crossing treatment type and how it will be operated, consider the:

- ✧ Automobile volume
- ✧ Pedestrian crossing volume
- ✧ Spacing to the adjacent signalized intersections
- ✧ Type of pedestrian population (high school students, elementary students, elderly, a mix)

Where practical, HAWK beacons and pedestrian traffic signals should be coordinated with the signal progression in the corridor to minimize the impact of the new traffic signal on corridor traffic flow. However, coordinated signals may be less responsive to pedestrian actuation, and the delay in pedestrian service may result in some pedestrians crossing against the signal rather than

waiting. Not coordinating the pedestrian crossing signals may result in unacceptable increases in automobile congestion and delay.

RRFBs used at high volume pedestrian crossings in congested roadway corridors can also have a significant impact on automobile congestion and compromise effective signal progression.

Once again, engineering judgment will need to be applied to reach the best compromise for all involved.

2.2.3 Differential Vehicle Queue Lengths and Pedestrian Safety

A pedestrian crossing of a roadway with two or more lanes in a single direction has the potential for "multiple threat" type crashes.

> *Definition: A multiple threat accident is when one lane of traffic stops for a pedestrian and obscures the view of the crossing pedestrian to a motorist in the adjacent travel lane.*

The result is that a pedestrian can step in front of a vehicle that is approaching too fast to stop. This condition is exacerbated when there are vehicle queues that back across the pedestrian crossing. If the queue in one lane backs into the crossing and is much longer than the queue in the adjacent lane, a motorist would commonly assume that the stopped traffic in one lane is the result of the queuing (which may usually be the case). Now if a vehicle in one lane stops for a pedestrian, instead of the queue, there is an even greater chance for a multiple threat crash.

> Therefore, it is important for the engineer to be aware of the formation of queues to and across the pedestrian crossing from a downstream intersection. It is even more important for the engineer to be aware of routine occurrence of one queue longer than the other across the pedestrian crossing.

When deciding to install an uncontrolled crossing treatment (or not), the engineer should consider if differential vehicle queue lengths is an issue. If so, can the queue be mitigated (say by signal timing adjustments at the downstream intersection). If differential queues cannot be minimized, it may be reason to not install an unprotected crossing treatment (Crossing Types A, B, C or D).

2.2.4 Unmarked Pedestrian Crossing Facilitation

There may be locations where pedestrians regularly cross higher speed arterial roadways, yet the number of people crossing is below the minimum thresholds noted in Step 5, and engineering judgment does not suggest installation of the types of enhanced crossing treatments detailed in **Table 1**. These locations typically occur on multi-lane roadways and are often identified by informal pathways (social trails) to and from the roadway.

In some cases, subject to engineering judgment, it may be appropriate to install treatments that facilitate people crossing but stop short of the signed and marked crossing treatments defined in **Table 1**. This type of treatment or pedestrian facilitation may include curb ramps and/or a raised median refuge, but no signing or marking is used to attract pedestrians to this crossing or to create a legal requirement for a driver to stop and yield for a pedestrian.

The treatments simply acknowledge the fewer but regular number of people crossing that occurs at a location. Installing these treatments does not endorse the use of the crossing nor attempt to attract new users to the crossing. The treatment simply acknowledges that the crossing is occurring, will not likely go away, and some level of facilitation can make it safer for people crossing already.

These treatments should only be considered if the location is more than 300 feet from the nearest signed and marked pedestrian crossing (whether it is controlled or uncontrolled), and it is believed that there is little potential to redirect pedestrians to a more defined crossing location.

2.2.5 In-Street Pedestrian Crossing Signs and School Crossings

Literature research suggests that on two-lane roadways with speed limits of 25-30 mph, in-street pedestrian crossing signs encourage “relatively high yielding rates” by drivers at crosswalks.

From an installation standpoint, in-street pedestrian crossing signs can be a highly cost-effective way to increase driver yielding at crosswalks. However, in-street pedestrian crossing signs are exposed to vehicles and are relatively fragile compared to other crossing treatments. This can create significant maintenance concerns which is likely why they are not used or limited in use in many communities.

School crossings are a distinct type of pedestrian crossing location. They often have very little crossing activity across much of the day with a few times of the day when school age children are crossing the roadway in large numbers.

It is important that, in these circumstances, drivers receive crossing treatment queues which encourage them to yield to these children in the crosswalk. Therefore, it is recommended that consideration be given to using in-street pedestrian crossing signs at higher volume school crossings. If a school crossing is supported by a crossing guard, it may be possible for the in-street sign to be placed by the crossing guard at the start of a crossing time period and then removed when it is complete.

A PCTG Evaluation Checklist" has been created to assist Town Staff in summarizing the key findings in the consideration of a pedestrian crossing treatment at a location. This Evaluation Checklist is provided on the following page.

STEP 1 – Identification and Description of Crossing Location

Posted Speed Limit: _____ mph *Obtain this information during the engineer's initial site visit.*
Location Description: _____
_____

STEP 2 – Initial Evaluation

Adequate SSD: ☐ Yes ☐ No
If no, what actions can be taken to provide adequate SSD? _____
_____

Adequate Street Lighting: ☐ Yes ☐ No
If no, what actions can be taken to provide adequate street lighting? _____
_____

STEP 3 – Assess Need Based on Gaps in Traffic

Is the ADT of the roadway being crossed less than 1,000 ADT? ☐ Yes ☐ No

STEP 4 – Assess Latent Demand/Existing Crossing Treatments

Is there latent demand for a crossing treatment based on activity generator land uses and/or connectivity considerations?
☐ Yes ☐ No *If yes*, then skip to Step 6.

STEP 5 – Assess the Current Crossing Demand

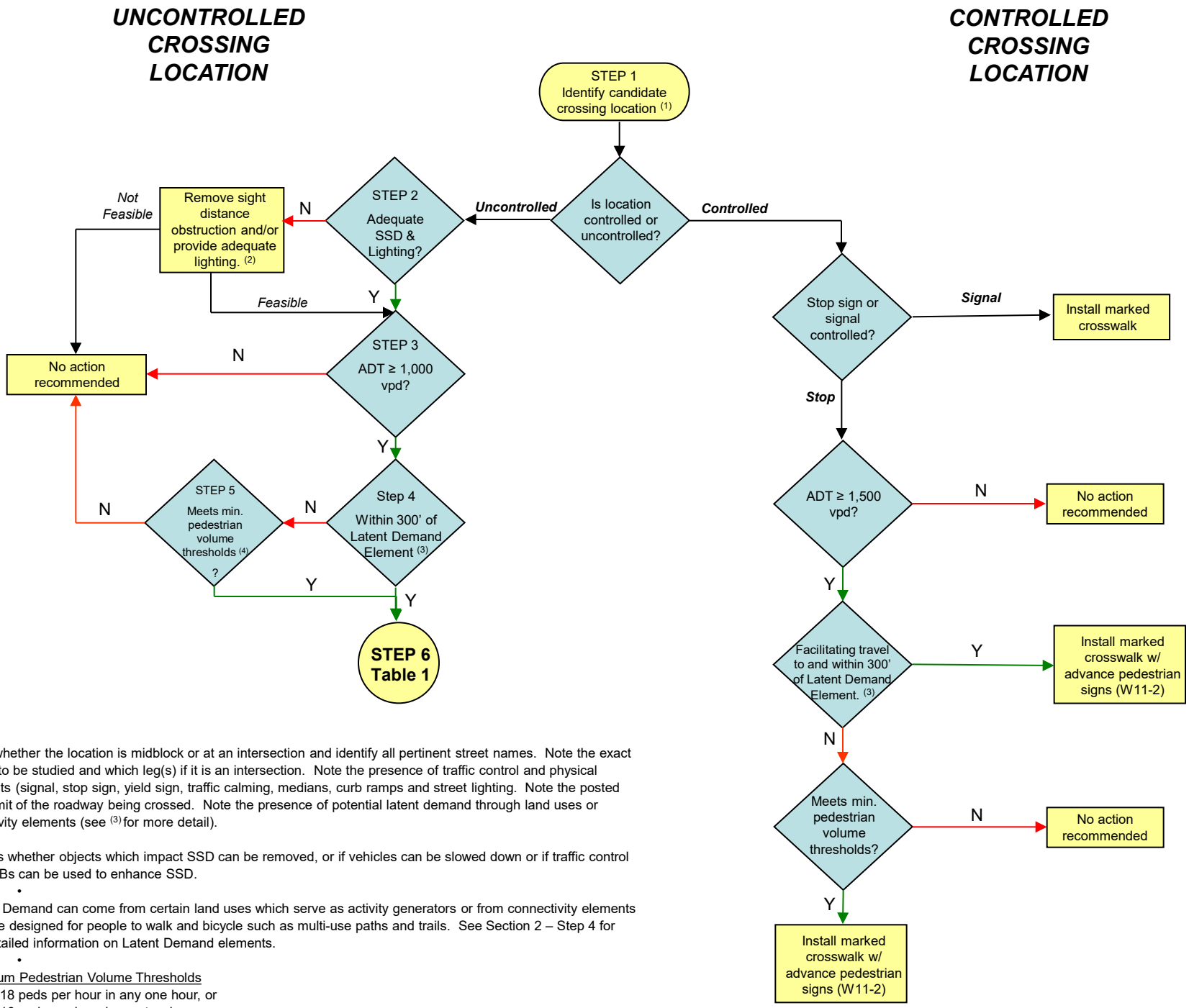
Pedestrian Crossing Volumes/Bicycle Crossing Volumes:

	AM	Mid-Day	PM	Other
Time:				
Date/Day of Week:				
Major Street Vehicular Volume (Hourly):				
# of Transit Boardings (if applicable)				
# of Young Peds/Bicyclists				
# of Elderly Peds				
# of Disabled Peds				
# of Non-Y/E/D Peds/Bicyclists				
TOTAL PEDS (Actual) (Include All Bicyclists in Total Sum)				
TOTAL PEDS (Adjusted for 2x Y/E/D)				

Major Street Vehicular Volume (**Daily**): ADT = _____ veh/day

STEP 6 – Determine Appropriate Crossing Treatment Type

Recommended Treatment (s):_____
_____
_____



(1) Note whether the location is midblock or at an intersection and identify all pertinent street names. Note the exact location to be studied and which leg(s) if it is an intersection. Note the presence of traffic control and physical treatments (signal, stop sign, yield sign, traffic calming, medians, curb ramps and street lighting. Note the posted speed limit of the roadway being crossed. Note the presence of potential latent demand through land uses or connectivity elements (see (3) for more detail).

(2) Assess whether objects which impact SSD can be removed, or if vehicles can be slowed down or if traffic control like RRFBs can be used to enhance SSD.

•

(3) Latent Demand can come from certain land uses which serve as activity generators or from connectivity elements which are designed for people to walk and bicycle such as multi-use paths and trails. See Section 2 – Step 4 for more detailed information on Latent Demand elements.

•

(4) Minimum Pedestrian Volume Thresholds

- 18 peds per hour in any one hour, or
- 16 peds per hour in any two hours, or
- 12 peds per hour in any three hours

* Young, elderly and disabled pedestrians count 2x towards volume thresholds.

City of Timnath Pedestrian Crossing Guidelines

Figure 1 – Pedestrian Crossing Treatment Flowchart

Roadway Type (Number of Travel Lanes)	Vehicle ADT >1000 to 6000				Vehicle ADT 6001 to 9000				Vehicle ADT 9001 to 12000				Vehicle ADT 12001 to 15000				Vehicle ADT Greater than 15000			
	Actual Travel Speeds (85th%ile speeds obtained from data collection)																			
	≤ 32 MPH	33-37 MPH	38-42 MPH	≥ 43 MPH	≤ 32 MPH	33-37 MPH	38-42 MPH	≥ 43 MPH	≤ 32 MPH	33-37 MPH	38-42 MPH	≥ 43 MPH	≤ 32 MPH	33-37 MPH	38-42 MPH	≥ 43 MPH	≤ 32 MPH	33-37 MPH	38-42 MPH	≥ 43 MPH
2 Lanes	A	A	B	D	A	B	B	E	A	B	D	E	B	C	E	E	C	C	E	E
3 Lanes	A	A	B	D	A	B	D	E	B	B	D	E	B	D	E	E	D	D	E	E
4 Lanes	C (1)	C (1)	C (1)	D (1)	C (1)	C (1)	D (1)	E	C (1)	D (1)	D (1)	E	D (1)	D (1)	E	E	D (1)	D (1)	E	E
5 Lanes	D (1)	D (1)	D (1)	D (1)	D (1)	D (1)	D (1)	E	D (1)	D (1)	D (1)	E	D (1)	D (1)	E	E	D (1)	D (1)	E	E
≥6 Lanes	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

LEGEND	
A	Marked Crosswalk
B	Marked Crosswalk with Median Refuge Island *
C	Marked Crosswalk with Rectangular Rapid Flash Beacons (RRFBs)
D	Marked Crosswalk with Median Refuge Island and RRFBs**
E	Marked Crosswalk with Pedestrian Hybrid Beacon (PHB), Traffic Signal or Grade Separated Crossing

NOTES	
(1)	RRFBs on multi-lane roadways should have advanced yeld lines and advanced yield signing
*	If geometry precludes median use RRFB instead
**	If geometry precludes median use PHB or signal instead

3.0 SUPPLEMENTAL POLICIES

This section contains discussion of supplemental policies to guide the installation of crossing treatments in the Town of Timnath.

3.1 Crosswalk Lighting

The FHWA recommends that adequate nighttime lighting should be provided at marked crosswalks to enhance the safety of pedestrians crossing at night. Crosswalk lighting will be provided at all crosswalks utilizing traffic signals, HAWK beacons and RRFBs. Crosswalk lighting should be considered at all other marked crosswalks, unless engineering judgement suggests crosswalk lighting is not needed. The placement and level of crosswalk lighting will be determined by engineering judgement at all crossing treatments.

3.2 Avoiding Overuse of Crossing Treatments

FHWA recommends that overuse of crosswalk markings should be avoided to maximize their effectiveness. Crossing treatments should be used discriminately within the Town of Timnath so that the effectiveness of these treatments is not deteriorated by overuse. Although these treatments may be effective at individual locations, overuse of these treatments may lead to a decrease in their value as drivers become desensitized to them. Minimum pedestrian and vehicular volume criteria have been established in this document with this in mind.

3.3 Textured and Colored Pavement Treatments

Textured, brick, and/or colored pavement treatments should typically not be used in lieu of a marked crosswalk. When such treatments are used they are often aesthetic and not considered traffic control devices. Retroreflective pavement markings are required at any location serving as a marked crosswalk. Exceptions are granted for crossings controlled by stop signs or traffic signals and for multi-use path crossings at driveways and unsignalized intersections where the Town has developed other treatments designed to call attention to the crossings.

3.5 Accessible Crosswalks

It is the goal of the Town of Timnath that all crosswalks installed will comply with the Americans with Disabilities Act (ADA) to maximize mobility for all users. Where a new crosswalk is installed in a curbed roadway, curb ramps with a detectable warning surface will be included.

3.6 Coordination with Neighborhood Speed Management

Pedestrian crossing treatments are not generally effective speed management tools. However, some pedestrian crossing treatments can be an effective part of a speed management plan while also providing benefit to pedestrians. Curb extensions and median refuge islands can create friction for drivers, slowing travel speeds while also shortening crossing distances for people crossing the roadway. Raised pedestrian crossings act directly as a speed mitigation device by creating vertical deflection for motor vehicles. Raised pedestrian crossings can both slow traffic and in doing so encourage drivers to yield to people crossing the roadway.

Town staff are encouraged to consider these types of treatments when developing speed management plans, especially in areas where there are higher volumes of people crossing.

3.7 Removal of Treatments

Conditions that contribute to the need for a crosswalk or crossing treatments may change over time, and an existing crosswalk or treatment may no longer be needed. When a roadway surface is to be impacted by reconstruction or resurfacing, a review of any unprotected crosswalks should be performed to determine their use and need.

If the use of a crosswalk is less than half of that which would be required for it to be warranted based on the criteria established in these guidelines for a new installation, the crosswalk should not be replaced when the construction or resurfacing is done, and any other treatments will be removed.

In such cases, residents and property owners within 1,000 feet of walking distance to the crosswalk in question will be notified via mail. In addition, notices will be visibly posted at the crossing location to inform the public of the intent to remove them for the 30 days prior to planned removal. Town contact information will be provided on these mailings and notices. Should concerns arise from the public as a result of that mailing or from the notification sign at the crosswalk, staff may then begin a more substantial public process with concerned parties.

4.0 NEXT STEPS

The Town of Timnath is committed to providing safe and effective pedestrian crossing treatments and will continue to evaluate the criteria and treatments being used to implement safe crossings throughout the Town. Specifically, Town staff will carry out the following "Next Steps" to ensure that the pedestrian crossing program meets the goals defined in this document:

- **Collect data at crossing locations** where treatments have been requested (or as defined in the Town's Master Plans) and apply the criteria in this document to create a list of projects for implementation. Staff should then prioritize the list of projects and install these treatments based on funding availability.
- **Develop an implementation plan** to upgrade existing, qualifying crossing locations with current treatments as prescribed in this document.
- **Receive feedback** from Town of Timnath citizens with respect to various crossing treatments and the criteria established in this document to implement these treatments.
- **Stay current** with the latest pedestrian crossing research being performed at the federal, state, and municipal level. As more communities strive to increase the viability of pedestrian mode use, additional studies and new findings are being made available. The Town of Timnath should look to utilize this research to improve its own use of pedestrian crossing treatments.
- **Work with the Town Council** to incorporate these guidelines and any future amendments to this document into future town planning efforts such as Comprehensive Plans, Transportation Plans and Safety Action Plans, to promote the use of pedestrian facilities and the safety of people using them.

Appendix A

Key Findings from Peer Review and State and Federal Research

1. The general conclusions and recommendations found in the 2011 City of Boulder Pedestrian Crossing Treatment Installation Guidelines (COB PCTIG) formed the basis for most of the guidelines reviewed from other communities. Information from the COB PCTIG was also found in several of the state and federal documents reviewed.

2. When comparing the pedestrian crossing treatment guidelines from each of these different communities, there were several factors which were similar or identical. For instance, every community had a "minimum number of crossings observed to warrant a treatment" identical to or very similar to the Boulder guidelines. Other factors such as "minimum traffic volumes on the roadway" and "Minimum distance to nearby crossing treatment" were also identical or similar.

3. As noted, every community required a certain amount of crossing activity to warrant a crossing treatment, but many had at least one condition where this number of crossings per hour requirement was waived. Most front range communities waived the requirement for a continuation of a multi-use path. St. Paul / Minneapolis waived this requirement for transit stops. Clark County, Washington had a separate set of criteria for School crossings and Fort Collins would waive the requirement based on Citizen Surveys or Walkability audits. The City and County of Denver and the City of Scottsdale both developed "Latent Demand" scoring which would waive the requirement.

4. Most communities used a combination of traffic volumes, speeds and roadway geometry as a proxy for the delay that a pedestrian might experience crossing the roadway. However, the City and County of Denver and Burlington, Vermont both required an assessment of pedestrian delay as part of their criteria. NCHRP 562 also recommended delay assessment criteria.

5. All guidelines recognized the importance of adequate stopping sight distance (SSD) between drivers and people crossing the roadway. Some recommended using a conservative approximation of 8 times the speed limit to determine the needed SSD. Others referenced using established SSD formulas.

6. Most guidelines recognized the importance of adequate street lighting to help drivers see people crossing at night.

7. Every set of guidelines had a table which compared the roadway geometry (number of lanes being crossed), speed (usually speed limit) and the traffic volume on the roadway, and used these factors to make recommendations on the best type of crossing treatment to use for those circumstances.

8. Most guidelines acknowledged that crossings of more than one lane in each direction were especially challenging because of the potential for sight distance issues from cars in different lanes (i.e. multi-lane threat scenario). Rectangular Rapid Flash Beacons, advanced yield lines and signs and controlled treatments such as stop signs, pedestrian hybrid beacons and traffic signals are particularly valuable in those circumstances.

9. Several resources referenced pedestrian refuge islands as valuable to help people cross, especially when traffic volumes were high, causing fewer natural gaps in traffic. These islands allowed people to find gaps and cross one direction at a time.

10. Most guidelines and many resources acknowledged both the challenge for people crossing when traffic is traveling at higher speeds and the greater threat of a severe outcome from a crash at these higher speeds. Increasing amounts of enhancement were recommended as roadway speeds increased, to improve the sight distance ahead of time or to control the crossing with stop sign or red signal display. Several resources suggested that controlled crossings should be used when the speed limit was above 40 mph and one suggested that they be used when the speed limit was above 35 mph.

11. Studies have been performed about the safety benefit of different pedestrian crossing treatments. FHWA Resources noted the following potential crash reduction percentages:

    - Advance YIELD signs and markings – 25% reduction
    - Overhead street lighting – 23% reduction
    - Raised Crosswalk – All crashes - 30% reduction and ped crashes - 45% reduction
    - Pedestrian Refuge Island – 32% reduction
    - Rectangular Rapid Flash Beacons 47% reduction
    - Pedestrian Hybrid Beacons - 55% reduction

12. Some resources used driver compliance in yielding to people in a crosswalk as an indicator of safety. Research has indicated that signs which tell a driver what to do (i.e. State Law – Yield to Pedestrians signs), advanced yield lines and associated signing, and rectangular rapid flash beacons are all devices that are shown to improve compliance.

13. It was notable that most documents researched appeared to predate current industry practices on “Vision Zero” and related efforts to mitigate or eliminate fatal and severe outcome crashes. Therefore, it is unclear whether these documents considered this more recent state of practice in the development of their conclusions and recommendations.

14. It was notable that none of the guidelines or studies which were researched in this peer review effort discussed the topic of “prioritization”. It may be valuable to have a prioritization approach if resources for installing pedestrian crossing treatments are constrained.

Appendix B

FHWA Comparison of stopping sight distance requirements for various conditions

Design speed (mph)	AASHTO design stopping sight distance criteria (feet)	Estimated stopping sight distance for mean driver (feet)	Estimated stopping sight distance for dry roadway conditions (feet)
15	80	40	75
20	115	60	110
25	155	80	150
30	200	105	190
35	250	135	235
40	305	165	285
45	360	200	340
50	425	235	400
55	495	275	465
60	570	320	535
65	645	365	605
70	730	415	680
75	820	465	765
80	910	520	850