CASE STUDY

Conversion of Solar-Powered Rectangular Rapid Flash Beacon (RRFB) to a Solar-Powered HAWK Signal or Pedestrian Hybrid Beacon (PHB)

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Case Study Background

In April 2024, a meeting was held with the town of Sahuarita, Arizona concerning pedestrian crossing safety at a marked crossing with an (RRFB) Rectangular Rapid Flash Beacon on a four-lane divided street. The meeting was attended by the town's public works operations manager and signal technician personnel along with the traffic enforcement sergeant.

Sahuarita is a town in Pima County, Arizona, United States. Sahuarita is located south of the Tohono O'odham Indian Nation and abuts the north end of Green Valley, 15 miles south of Tucson. The 2022 population estimate was 35,638. Sahuarita is one of Arizona's fastest-growing communities and is located roughly 20 minutes south of Central Tucson on Interstate 19 and was incorporated in 1994.

S. Rancho Sahuarita Blvd and S. Avenida Mitla is today an intersection with a marked RRFB pedestrian crossing on the northeast side that originally had low AADT and pedestrian crossing activity. However, the area is growing significantly with the addition of Parque del Rio/Safari Park, expanded housing, business and schools serving the area. The roadway is posted at 30 mph with a properly designed horizontal and vertical curve however, which leaves little leeway for crossing pedestrians to be seen by approaching drivers in order to stop, especially if they are traveling above the posted 30mph speed limit. The crosswalk is also used as a school bus loading/stopping point in the morning and afternoon and parents wait for the children on the side streets for the bus to arrive.

The town had installed an RRFB flashing yellow crossing warning system a number of years ago to assist pedestrians in crossing the roadway, as well as an advance RRFB warning beacon. The YELLOW beacons have been working only just at a satisfactory level up to the present day in attempting to get drivers to yield to the crossing pedestrians. The town officials reported receiving several citizen complaints recently expressing their concerns regarding drivers frequently failing to stop for crossing pedestrians, especially under the current higher traffic volumes, and increased crossing demands.

Comments from city staff:

"… residents have told me that they will not use this crossing because of perceived safety issues." *City of Sahuarita, Operations Division Manager*

Fortunately, there have been minimal (3) motor vehicle crashes and no pedestrian crashes over the last five years, the majority being run off the road type crashes due to high speed and or drivers under the influence, most likely. However, the town examined the intersection for the need for a full traffic signal at the public's request. The warrant study noted the traffic, and pedestrian conditions were nowhere near the national and state warranting levels. Further, the warrant studies noted a full signal could be expected to increase crashes such as angle, rear-end and/or side-swipe type crashes, rather than improve the total safety performance at the intersection.

The citizen concerns and the observation of conflicts along with the ADOT pedestrian crossing countermeasures guidance has led to the consideration of upgrading the RRFB pedestrian crossing to a HAWK beacon type operation. A HAWK crossing device provides drivers with a significant indication of a requirement to stop for the crossing pedestrian with a RED stop light indication, rather than the existing flashing YELLOW warning light indication. The citizens seemed to have felt the RED meant STOP, while the flashing YELLOW does not.

Since the traffic conditions have changed significantly, the town had desired to consider an alternative crossing device called a (PHB) Pedestrian Crossing Hybrid Beacon or HAWK and still use the existing RRFB equipment as much as possible. The town reviewed the concept of using a solar powered HAWK operation to replace the solar powered RRFB operation.

The study found that the two traffic control devices are technically interchangeable on identical foundations and poles. New solar and signal LED technology helped make the conversion possible. In addition, the HAWK RED lights increased the driver's yielding to the crossing pedestrians with minimal increase in operational and installation costs when compared to a traditional commercially powered PHB traffic control device. Further the LED pedestrian signal gave a positive indication to the pedestrians when to cross.

Observations

The intersection was viewed by both Gabe Thum, PAG Transportation Safety Program Manager and Richard Nassi, PAG Consulting Services, the morning and afternoon of April 16, 2024, and again on September 14, 2024, two weeks after the HAWK beacon was installed. The initial and matching after-viewing times were selected by the town since it was felt that that time would provide the heaviest traffic and pedestrian movements on S. Rancho Sahuarita and S. Avenida Mitla. In addition, the intersection was videoed for two weeks before a after the traffic control modifications.

Crosswalk and Driver Observations with RRFB: See Appendix Pictures B1-6 Intersection Observations.

As previously mentioned, the town installed a video camera to study and record the driver and pedestrian behaviors before and after at the crossing with an RRFB, Rectangular Rapid Flash Beacon, YELLOW light and then the HAWK RED light operation.

The "before" videos generally showed a large variation in the yielding behavior of the drivers. Of particular significance and concern with the RRFB showed young children attempting to cross, then running to clear the crosswalk to get away from a very hard breaking vehicle trying to stop.

The reviewers noted that RRFB traffic control devices were:

a) Properly designed, well timed and maintained
b) Signs and Markings were well maintained and visible
c) An advance RRFB warning flasher with the crosswalk warning sign was properly placed and was activated when the RRFB units were in operation

d) Roadway Lighting is present, seems adequate (owned by another authority), see Appendix Photos C6, 7
e) Traffic conditions have changed significantly since the installation of the RRFB constituting the need for other higher level traffic control devices to be considered
f) Speed limit signs are installed at frequent intervals and visible. However, drivers were still observed traveling above the posted 30 mph speed limit, though not to a level that would meet enforcement policy/court levels, but could be to a level that may begin to reach the upper limit of the horizontal and vertical curve design levels

Pedestrian Observations with RRFB

a) Pedestrians crossing at the intersection activated the RRFB flashers consistently during observations times and crossed in the crosswalk area
b) There were no violations by the pedestrians noted during the review times
c) Several observations were made of the drivers stopping very late to avoid multiple - threat type conflicts with crossing pedestrians: there were some observations of pedestrians turning back or running to avoid conflicts with vehicles

Driver Observations after Conversion to a HAWK Beacon: See Appendix C-1 through C7

The HAWK beacon was installed on the existing poles that once supported the RRFB units. The review noted that the new TCD was:

a) Properly designed and installed
b) Signs and marking were present and very visible
c) The advance RRFB warning flasher with the crosswalk warning sign was still in position and was still activated when the HAWK units were in operation
d) Roadway lighting was still present
e) The HAWK beacon was operated with a “HOT” button operation giving an immediate response to the pedestrian call and was well obeyed by the pedestrians.

The Federal Highway Administration (FHWA) notes the prime objective of a HAWK is to provide pedestrians with safer crossing opportunities using a RED signal. As such, a reduction in pedestrian crash risk would be expected to be associated with the HAWK, since a statistically significant reduction in pedestrian crashes was found in nationwide studies, even better than traditional traffic signals. The installation of the HAWK was also found to be associated with a statistically significant reduction in total crashes. The driver’s behavior at this location matched the national study’s findings.

The before-after evaluation by FHWA was as follows:

- 29 percent reduction in total crashes
- 69 percent reduction in pedestrian crashes
- There was a 15 percent reduction in severe crashes

https://www.fhwa.dot.gov/publications/research/safety/10045/

The "after" HAWK videos show the orderly and consistent stopping for the crossing children with no multiple-threat type conflict behavior recorded.

Application in town of Sahuarita, AZ

ADOT has developed an interactive guide to assist agencies in selecting the most appropriate pedestrian crossing assistance measures given the condition at a particular location. In this case, given the past and current conditions, the ADOT recommendation would historically support the RRFB and now the HAWK beacon. The current levels of AADT (greater than 15,000) and considering the actual speed (not the posted speed) of 35mph, the guidelines no longer recommend the RRFB for consideration but recommend **only** the HAWK installation which the town had taken steps to install.

https://azdot.gov/business/tsmo/operational-and-traffic-safety/az-step/four-lanes-with-raised-median

Recommendations for Conversion to HAWK Crossing Beacon

- Attached are the Pima County/ City of Tucson Guidelines, Appendix Figure A,
- The drivers approaching the new HAWK beacon were observed to be stopping properly without signs at the new stop bars. Appendix Photo D. (If the town considers R1-5b STOP HERE FOR PEDESTRIANS (Symbolic) on both the median and side of the road due to the horizontal and vertical elements of the road, it is critical to ensure the placement of the signs do not block the view of the curb side HAWK beacons as a vehicle approaches in the curb lane.)
- Consider lengthening the solid white wide lane lines to the longer distances
- Consideration may be given to modifying the existing advance activated flasher to normal round signal heads to further improve visibility, if necessary, in follow-up reviews
- Legally close the southern unmarked crosswalk area and guide all pedestrians to the HAWK.
- If the roadway remains at two lanes in each direction, mast arms may be considered for beacon(s) over the roadway. Observations of the driver's response indicate the side mount units are quite adequate.

  MUTCD 4J.02 Design of Pedestrian Hybrid Beacons

  "On multi-lane approaches having posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway."

Solar HAWK Installation Notes

A solar HAWK installation is a very unique concept and the Tempe, Arizona manufacturer of solar traffic control equipment that installed the RRFB years earlier was contacted to design and install the solar HAWK conversion equipment. PHB or HAWK installations are generally considered to be significantly more expensive (frequently in the $150,000+ range) than the traditional RRFB flasher units. However, the town chose a technique of using a solar powered HAWK operation that directly fits on the exact same foundation and support equipment as the current RRBF installation.

Comparative Safety Benefits

Driver Yielding Rate: FHWA comparison studies of flashing beacon done by Texas A & M University, Texas Transportation Institute, for FHWA, have shown that the existing yellow flashers (RRFB) only have an average of a **57% driver yielding rate, with an extremely large variation in driver compliance**, some yielding rates as low as in the teens. Further, RRFBs do not provide a pedestrian signal indication when they are in operation and this particular crossing is a school bus stop. In comparison, the HAWK beacons have a consistent average always in the **97% driver yielding rate with minimal variation** and are frequently at higher yielding levels on higher speed streets. Further, the HAWK beacon provides pedestrian signaling thus, providing the pedestrian with a clear indication of when to cross in greater potential safety, which is an MUTCD for consideration for school signaling crossings.

***Cost Conversion Comparison*:** The town provided the comparison costs of the two systems in current-day 2024 dollars. The additional initial cost for the upgraded HAWK crossing compared to an RRFB crossing was only **$13,712** more using the new technology on existing support equipment.

The initial cost for the RRFB was calculated to be $15,558 in 2024 dollars, excluding the existing poles and foundations. The additional cost for the upgrade to a HAWK beacon operation was only $13,712 in 2024 dollars. The manufactured has a controller, called "Micro-HAWK" made specifically for HAWK operations, not requiring a more expensive controller that is mainly designed to operate a normal traffic signal. The HAWK controller has the standard controller type fail-safe type monitor so the WALK indication would not be displayed unless the RED units were illuminated and a fail-safe system that would place the unit into the flashing YELLOW mode if there was a problem with the equipment as the MUTCD requires. Further, the manufacturer has available alerting equipment that could be installed in the solar equipment, if the client desired, to place a call to the traffic operations group alerting the technician to an equipment failure.

More important than the cost of the installation is the fact that drivers' yielding rate has now increased from a large variation range averaging only 57% to a consistent average of 97%, thus providing a significant increase in potential pedestrian safety for only a slight increase in equipment cost. A recent article in Florida Today, February 28, 2020, questioned whether *Flashing Yellow Crosswalks give a False Sense of Security* especially to children.

Flashing yellow crosswalks give a false sense of security; why are we still using them? | Rangel

Isadora Rangel
Florida Today

Published 10:08 a.m. ET Feb. 28, 2020

Sophia Nelson did what she was instructed to do: She activated the flashing yellow light on SR A1A in what was supposed to be a command for drivers to stop and let pedestrians cross. She waited for cars to pass and stepped into the crosswalk in Satellite Beach.

The 83-year-old driver in this incident didn't stop. And I have a feeling she's not the first and won't be the last one to fail to do so at these confusing flashing-beacon crosswalks. For many drivers, including yours truly, a flashing yellow means "slow down" — not "come to a full stop."

BEFORE: RRFB Crossing installation (cost $15,558 in 2024 dollars) excluding poles and foundations

AFTER: Conversion to a HAWK Crossing (cost $29,270 in 2024 dollars) using existing poles and foundations from original RRFB installation

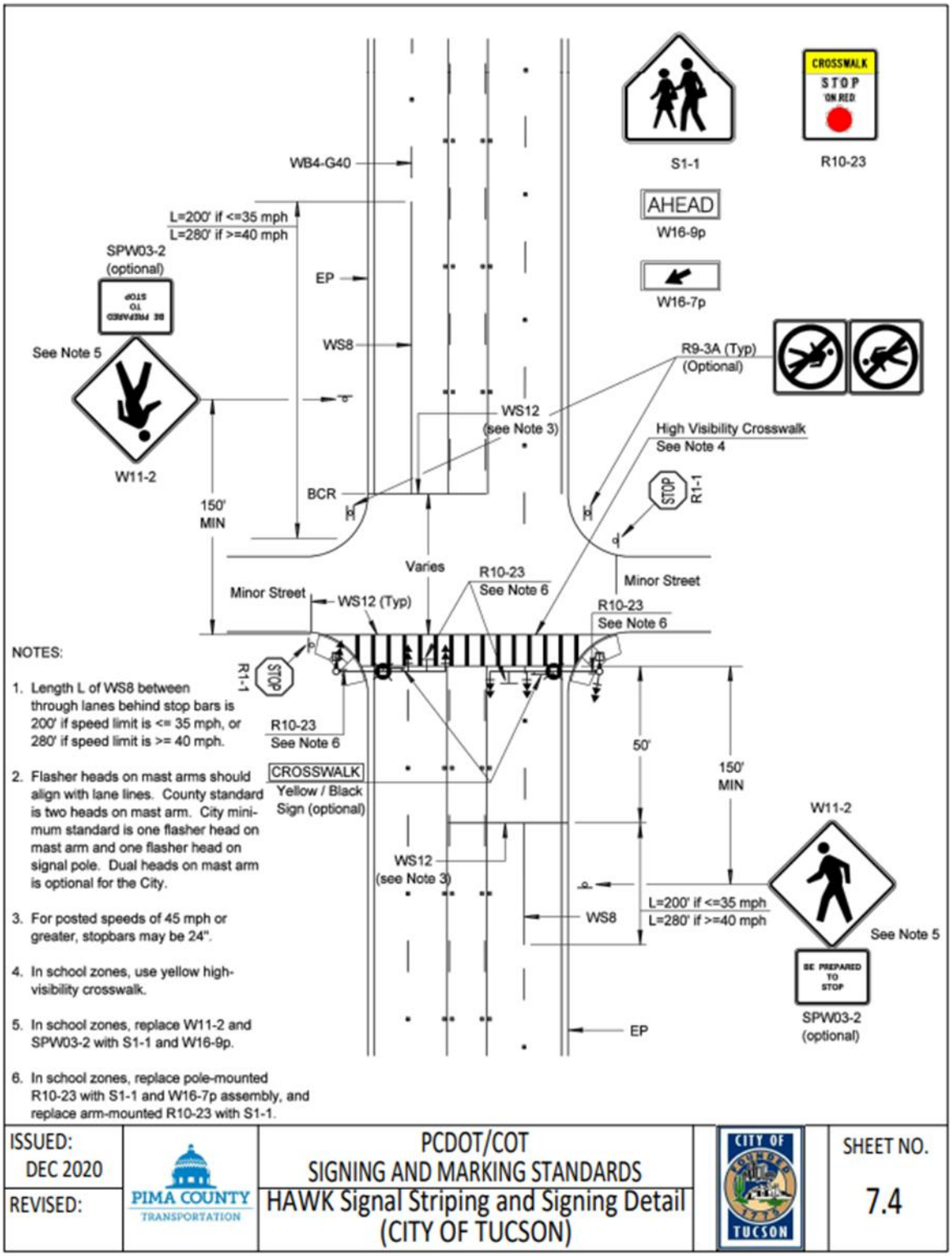
SUMMARY

The town not only improved the safety at this crosswalk, but also at another school crosswalk in the town on a narrow street with lower speeds by relocating the RRFB equipment (onto new supports) which was more suitable for that particular location and traffic conditions. This project provided a total gain in crosswalk safely townwide. This traffic control change was done more efficiently than typical installations due to utilizing a solar-powered operation as opposed to a traditional utility installation.

The town's selection of a solar crosswalk traffic control system allows the traffic control devices to be independent of the power grid and associated electrical power boxes, meters, conduits or blackouts which can become a problem during the sever desert summer storms. The children's safety continues even when the power goes out.

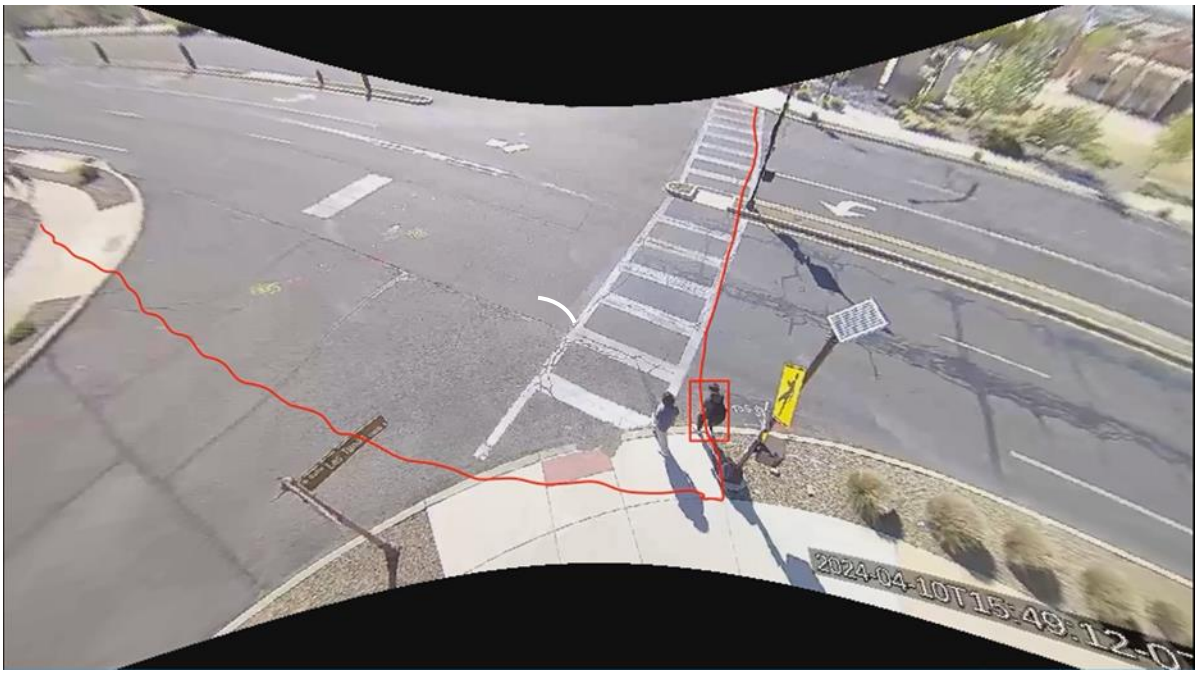
Another saving factor is that there can be less maintenance because modern electronics, batteries and LED technology are becoming highly reliable, and a properly designed system will run by itself for years. There are a few items that need to be checked periodically. You will need to check the batteries every three to five years and check the height of trees around the site for as they grow, they could impair a system's full functioning by casting shade on the solar module(s). Basically, routine tree and sign/signal maintenance is like what the town needs to do with any other traditional traffic sign and signal installation to ensure the (TCD) traffic control device is not blocked by vegetation.

APPENDIX

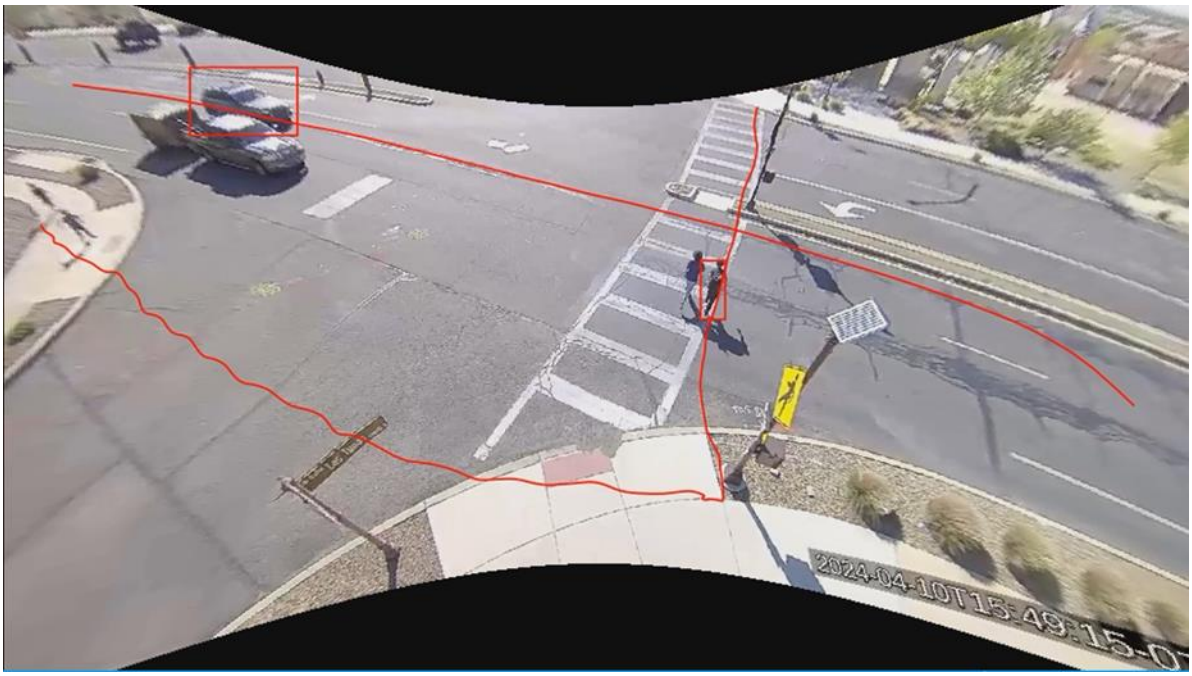

S1-1
CROSSWALK
STOP
ON RED
R10-23
WB4-G40
AHEAD
W16-9p
W16-7p
L=200' if <=35 mph
L=280' if >=40 mph
SPW03-2
(optional)
BE PREPARED TO STOP
EP
WS8
See Note 5
W11-2
R9-3A (Typ)
(Optional)
WS12
(see Note 3)
High Visibility Crosswalk
See Note 4
BCR
150'
MIN
STOP
R1-1
Varies
R10-23
See Note 6
Minor Street
WS12 (Typ)
NOTES:
1. Length L of WS8 between through lanes behind stop bars is 200' if speed limit is <= 35 mph, or 280' if speed limit is >= 40 mph.
2. Flasher heads on mast arms should align with lane lines. County standard is two heads on mast arm. City minimum standard is one flasher head on mast arm and one flasher head on signal pole. Dual heads on mast arm is optional for the City.
3. For posted speeds of 45 mph or greater, stopbars may be 24".
4. In school zones, use yellow high-visibility crosswalk.
5. In school zones, replace W11-2 and SPW03-2 with S1-1 and W16-9p.
6. In school zones, replace pole-mounted R10-23 with S1-1 and W16-7p assembly, and replace arm-mounted R10-23 with S1-1.
CROSSWALK
Yellow / Black
Sign (optional)
50'
150'
MIN
ISSUED:
DEC 2020
REVISED:
PIMA COUNTY
TRANSPORTATION
PCDOT/COT
SIGNING AND MARKING STANDARDS
HAWK Signal Striping and Signing Detail
(CITY OF TUCSON)
CITY OF TUCSON
SHEET NO.
7.4

Appendix Figure A: Notes 2,4,5,6 are not applicable. Lighting is under the responsibility of another agency other than the town

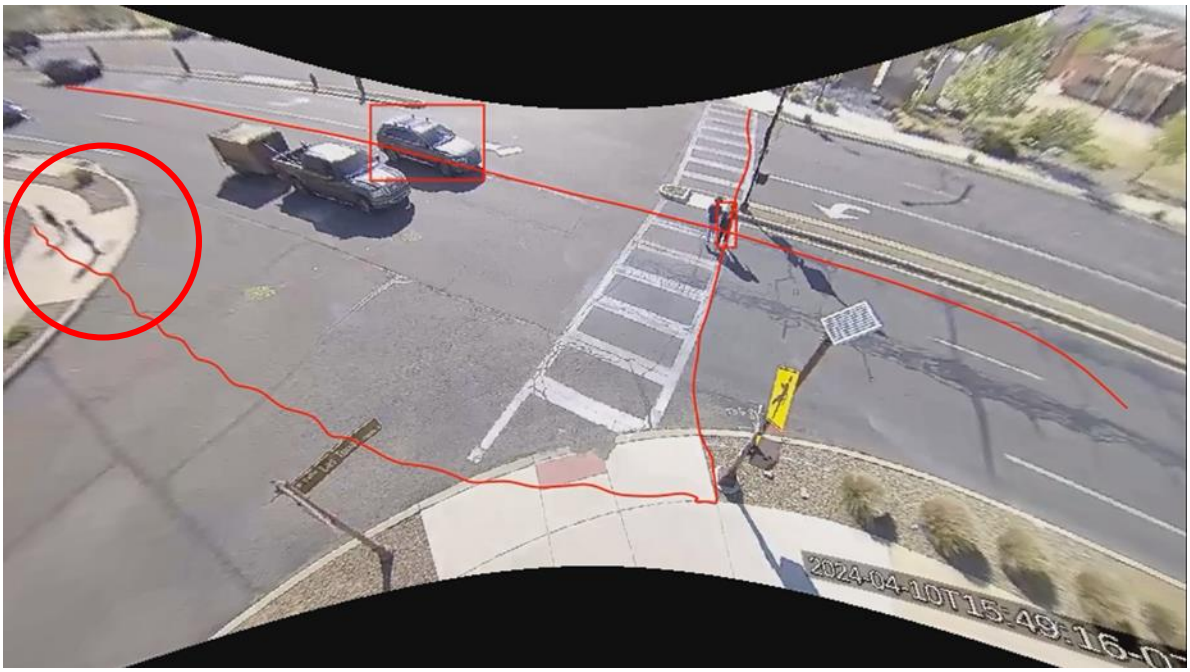
Appendix B: BEFORE Study with RRFB Crossing YELLOW Flasher



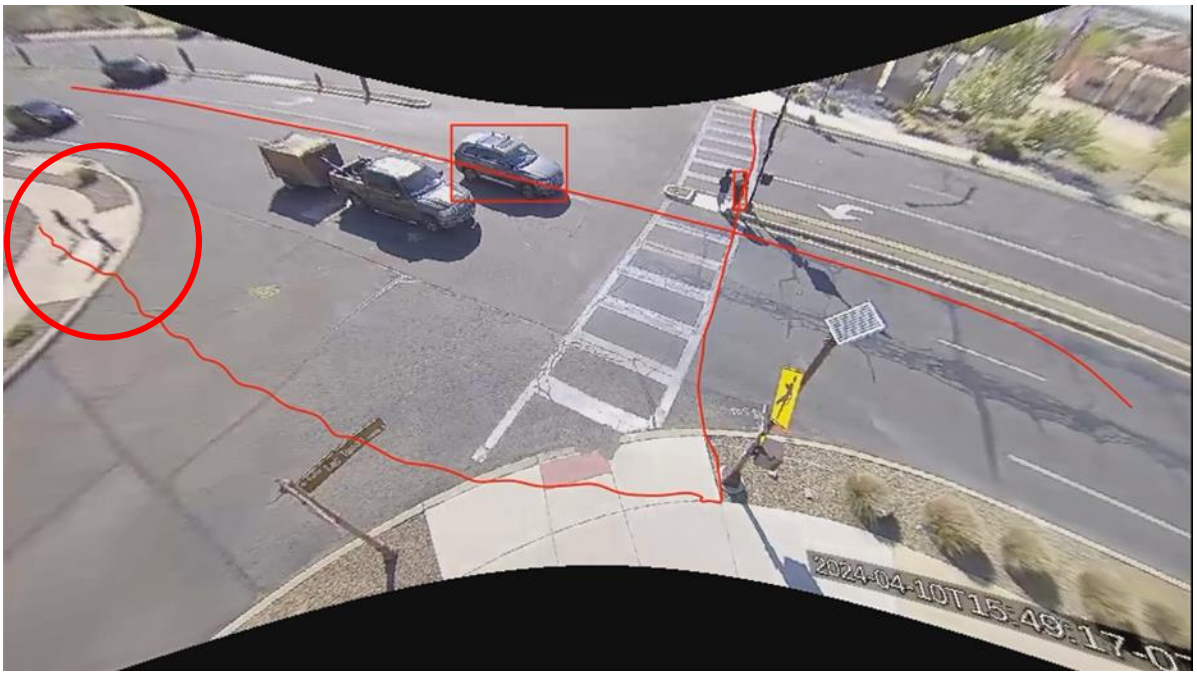
Appendix Photo B1: Children activate YELLOW flashers



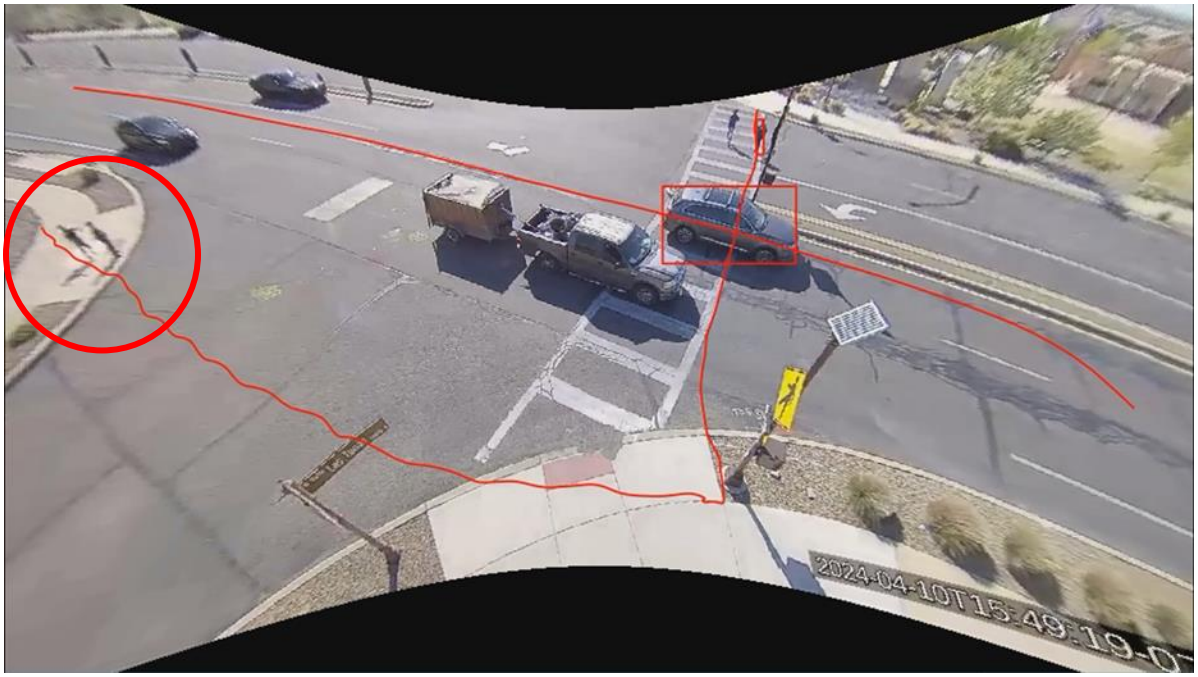
Appendix Photo B2: Children begin crossing. The curb lane driver sees and yields to children on the crosswalk. The median driver seems to fail to see the crossing children and proceeds to pass the yielding vehicle illegally and then begins hard braking so as to not strike the children.



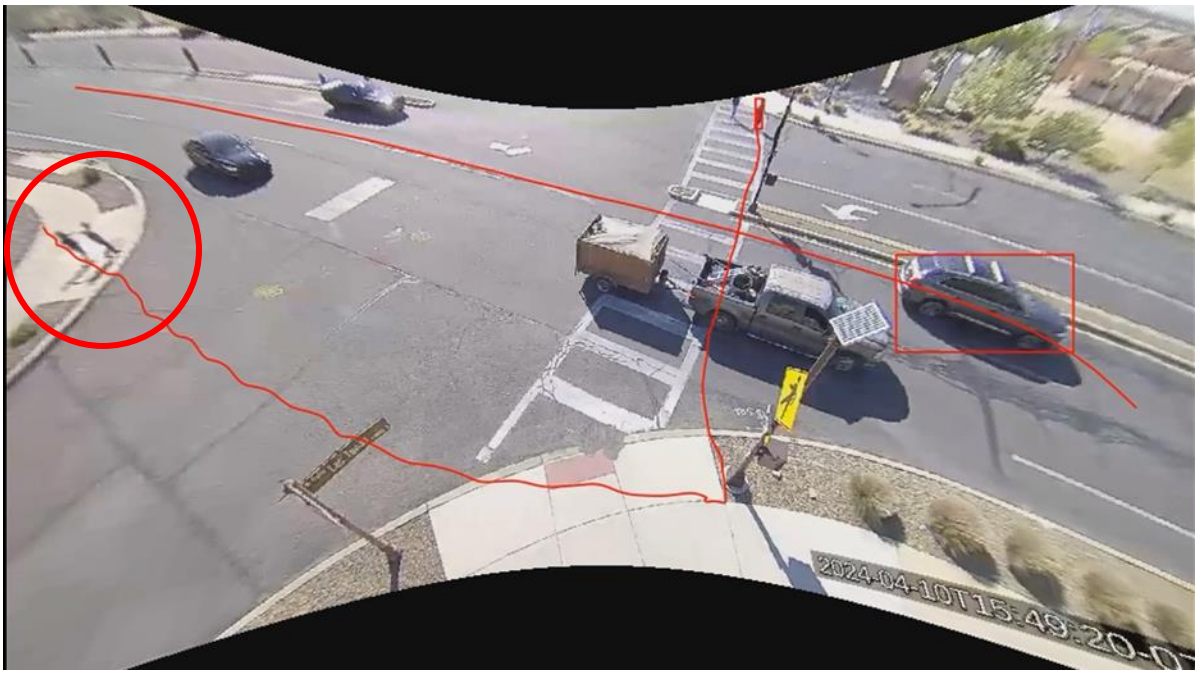
Appendix Photo B3: Median driver sees children and attempts to stop immediately. Children run to the median to get out of the street and to a point of greater safety. Notice the children in the southeast corner seeing and most likely hearing the traffic commotion and looking toward the vehicles



Appendix Photo B4: Crossing children leave island and run across the other half of the crossing to get away. The median lane driver is still trying to stop. Children on the southeast corner, realizing the danger, react to the situation and one friend begins to pull the other back from the curb.

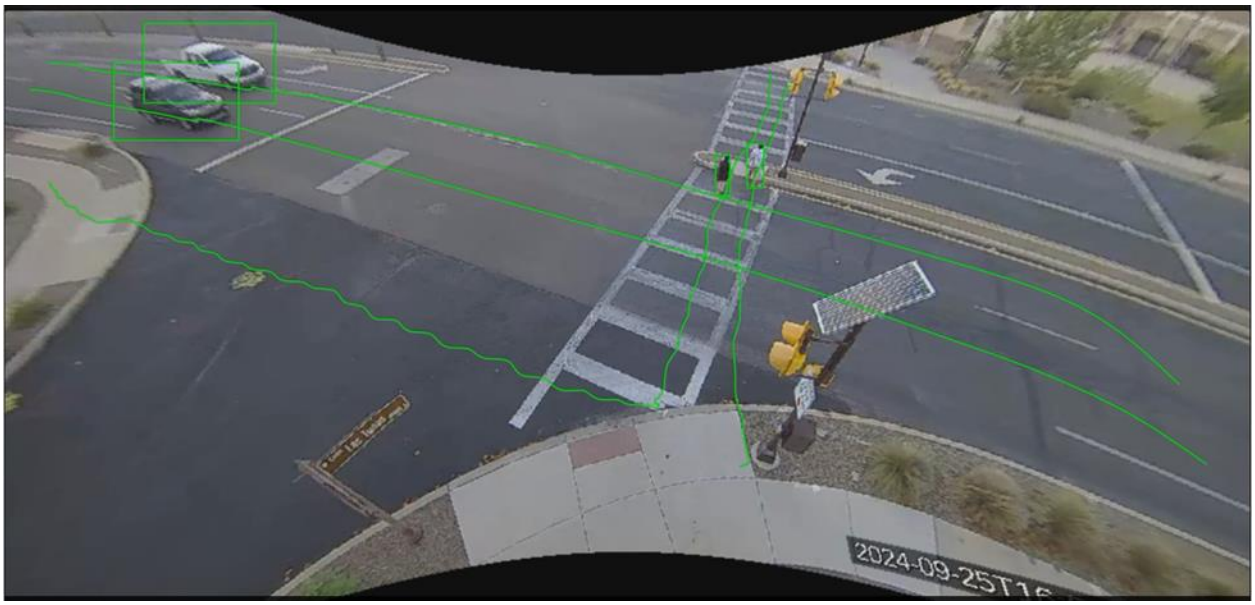


Appendix Photo B5: Crossing children run to the far curb to safety. The median driver is not able to come to a complete stop and passes through the crosswalk. The concerned child friend on the southeast curb was still holding on to his friend pulling him back from traffic.

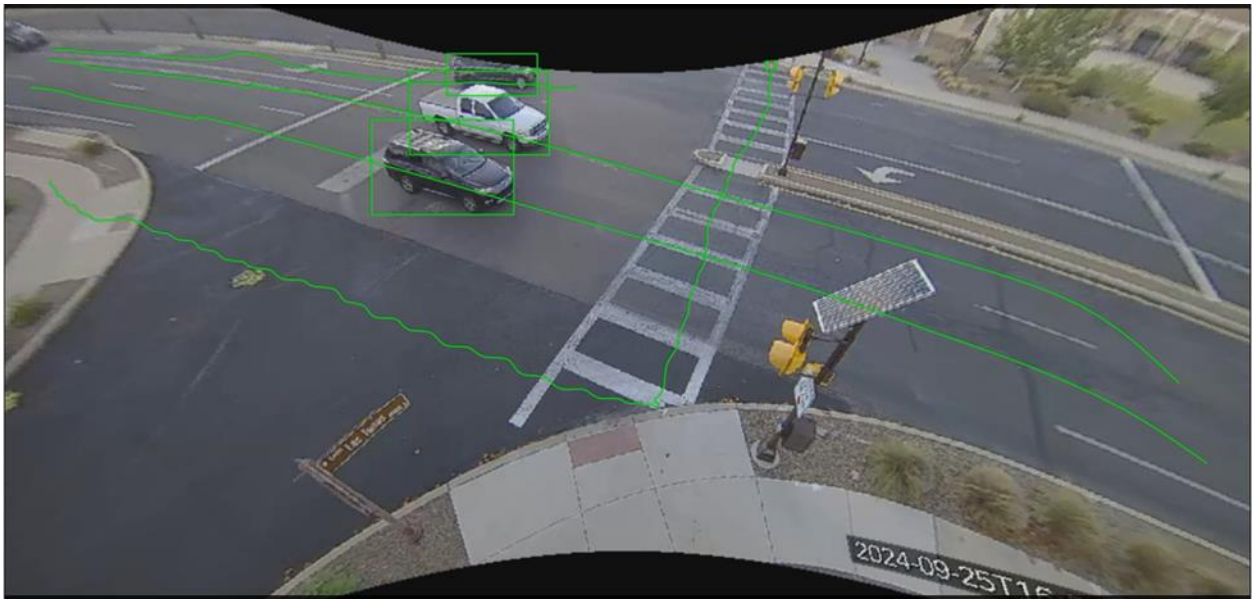


Appendix Photo B6: The median driver never fully stops. Crossing children are now completely safe on the far side of the street. The traffic is moving through or past the crosswalk and the friend is still holding onto the other's shirt still continuing to pull him back from the street

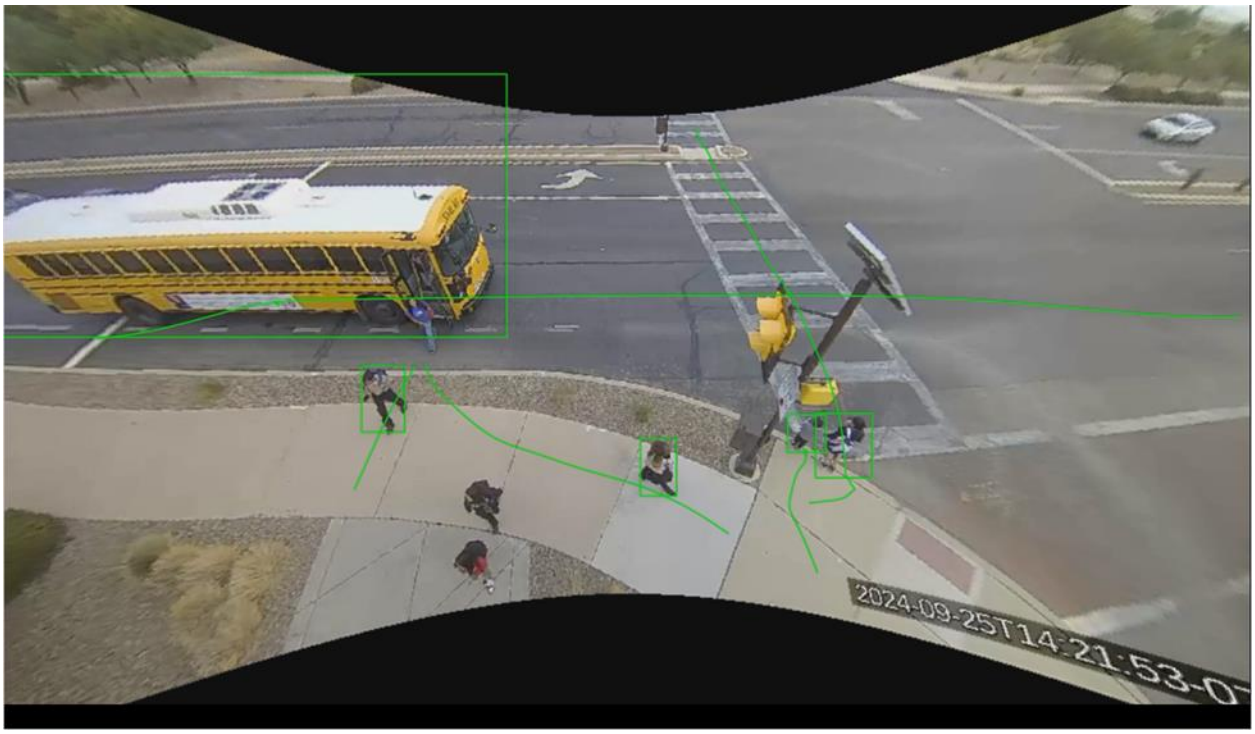
APPENDIX C: AFTER STUDY with HAWK Crossing



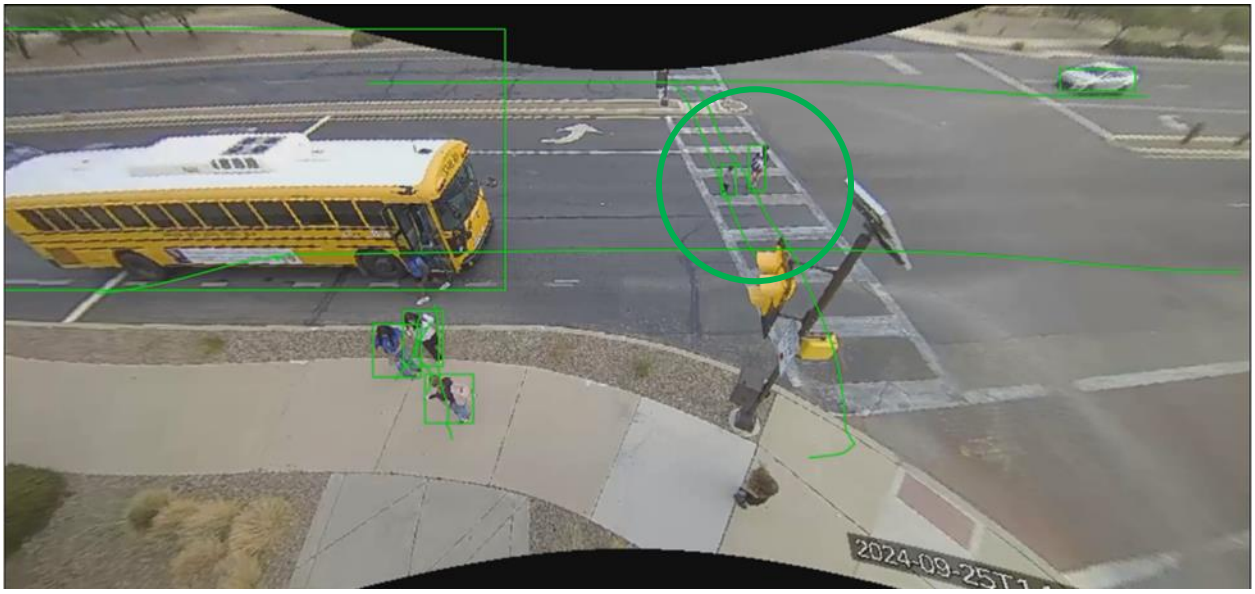
Appendix Photo C1: Both drivers are shown a HAWK Beacon solid RED indication and stop properly at the stop bar, allowing the children to cross in relative safely. This positive driver behavior is quite evident when compared to the RRFB Appendix yield B1 through 5 which shows a failure to yield to the crossing children and the driver in the median lane shows the most reluctant yielding and dangerous conflict behavior.



Appendix Photo C2: The children have now completed their crossing, and the drivers now are proceeding through the crosswalk during the flashing RED indication when it is safe to proceed. Further it is critical to note that there were no conflicts, or "close calls" noted during the video study.

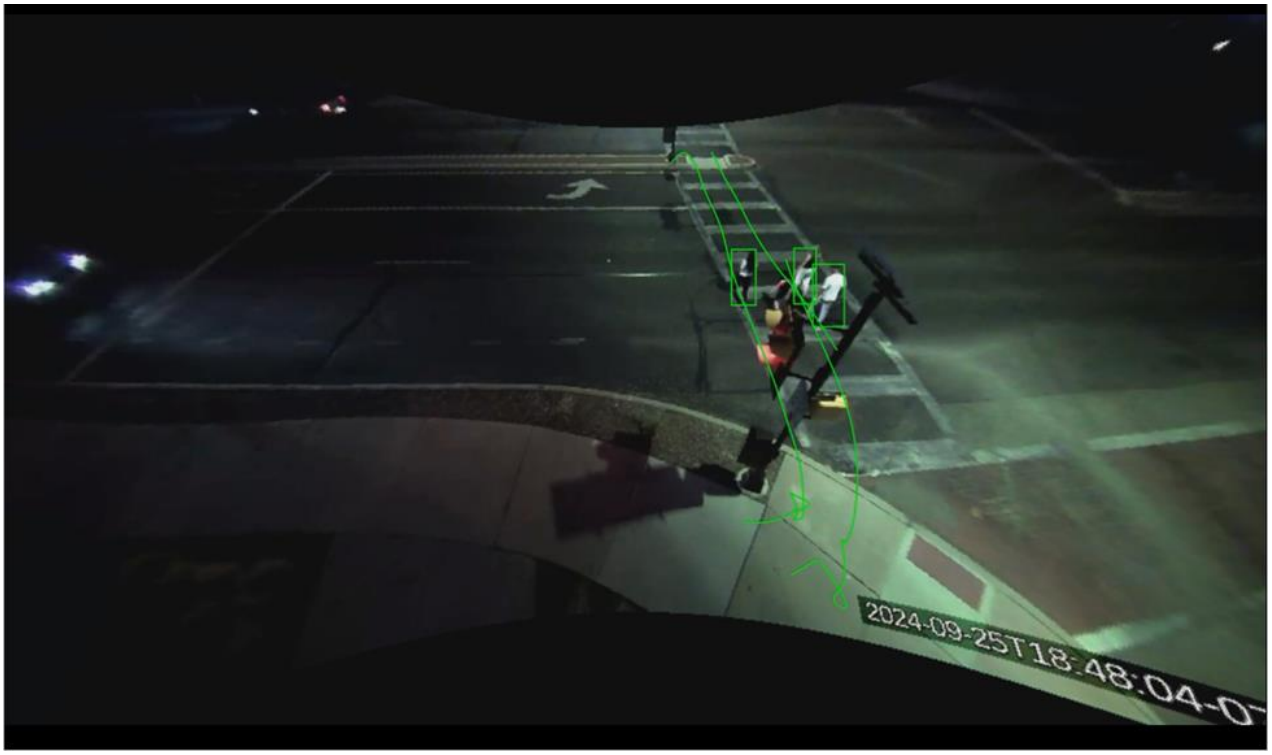


Appendix Photo C3: School Bus operations are greatly facilitated with the new HAWK crossing operation over the RRFB. The children alight/disembark and cross the street to or from their homes in greater security. The school bus lights are RED as well as the HAWK's RED lights, but as the children cross with the flashing RED lights on the school bus they do not provide protection while crossing the other half of the divided roadway. Since the roadway is divided, only the HAWK crossing beacon protects the crossing children all the way across the road. As can be seen in photos C4 and C5



Appendix Photo C4: The school bus lights are on. The west to south traffic stops at the back of the bus. However, since the road is divided, the north to east traffic is not required to stop for the bus's RED flasher. (see the white vehicle still waiting for the crossing children).

Appendix Photo C5: As the children prepare to cross the second half of the roadway, they are further protected by the HAWK RED beacon as they prepare to cross the second half of the street, since the state school bus law does not require a stop for the school bus RED lights on a divided highway under this condition. (note the white vehicle is still waiting)



Appendix Photo C6: Drivers wait at the stop bars during the RED indication. Lighting is adequate

Appendix Photo C7: Drivers pass through the crossing during the FLASHING RED indication after the crossing family has moved to a position not in conflict with the vehicle(s).

Appendix Photo D: Drivers wait at the proper location without the need for signing