9-1529-TM 1.6

TECHNICAL MEMORANDUM

LOW-COST SAFETY SOLUTIONS, PAVEMENT PRESERVATION AND MAINTENANCE PRACTICES FOR RURAL HIGHWAYS

Prepared for:

TxDOT Project 9-1529 – Task 1.6

INNOVATIVE LOW-COST SAFETY SOLUTIONS FOR RURAL HIGHWAYS

LIMITED USE DOCUMENT

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January 28, 2014

INTRODUCTION

In the United States, intersections constitute a small portion of the highway system, yet intersection related crashes constitute more than 50% of all crashes in urban areas 30 percent in rural areas. In Texas, about one-third of all crashes on rural highways occur at intersections. As population and development increases, traffic at unsignalized intersections grows resulting in more number of crashes. This is particularly the case in rural intersections which are characterized by high speeds. The combination of high speeds and complex guidance and navigational choices at rural intersections complicate the driving task and increase the potential for a severe crash. Various design and traffic control device (TCD) improvements are implemented to decrease the likelihood of a crash.

The objective of this project is to develop and demonstrate innovative low-cost solutions to improve safety at stop controlled intersections. TTI researchers met with TxDOT project panel and obtained some feedback about potential solutions that the panel wanted TTI to investigate. Preliminary directives from panel were as follows:

1. Focus on treatments on minor street approach and not necessarily on major street approach.
2. Develop solutions to improve the ability of the motorist to perceive the intersection as well as the related traffic control devices as they approach the intersection.
3. Investigate solutions that are active in nature. i.e., have beacons come on when a vehicle arrives or when a vehicle is not slowing down.

The emphasis in this project is on testing and demonstrating newer and innovative solutions. These may include solutions that are not readily available in the market but can be configured relatively easily using off the shelf equipment. The following list Technical Memoranda document the progress made by the research team in the development of such devices.

February 2011 - Technical Memorandum documented various traffic control device alternatives to improve safety at rural intersections.

May 2012 - Technical Memorandum identified three alternatives of treatments that were to be considered as potential treatments.

Alternative 3 from among these treatments was finally selected to be installed at the Pecos test track as it had the most potential for making a difference in motorist behavior while minimizing introduction of unfamiliar traffic control devices like K&K STOP signs or TAPCO STOP signs which were evaluated in another TxDOT research project (0-6462).

June 2013 - Technical memorandum documented the installation of a treatment at the Pecos test track.

July 2013 - Technical memorandum documented the visit by TxDOT Expert Panel to review the treatment installed and documented the comments and suggestions provided by the review team.

The current technical memorandum describes the installation of the treatment demonstrated at the Pecos test track at an intersection in the Odessa District.

TREATMENT INSTALLED AT PECOS TEST TRACK

Pecos test track facility has a 2000 feet two lane road at the entrance of the facility. TTI researchers visited the Pecos test track and selected this stretch of the test track to install the treatment. This stretch of the test track is illustrated in Figure 1.

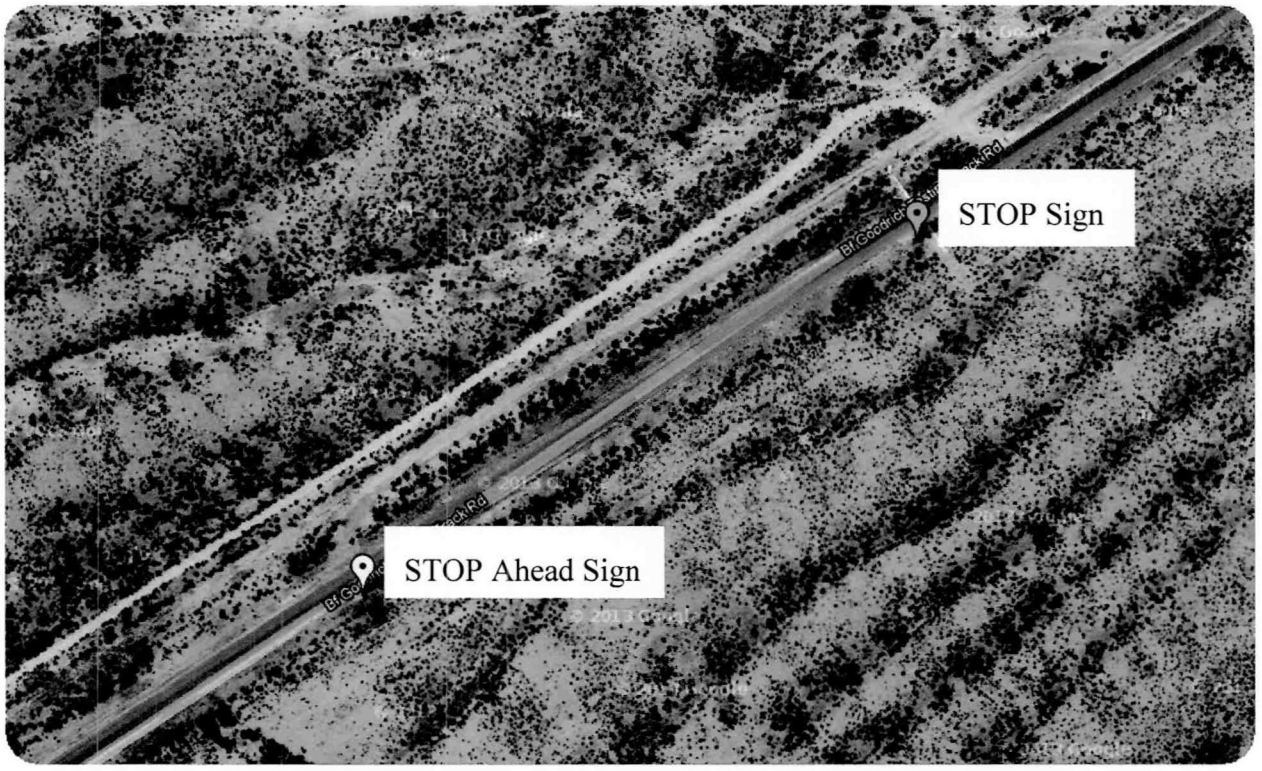

Figure 1. Layout of the Pecos test track where the treatment has been installed (Courtesy Google Maps).

The treatment installed comprised a typical 36 inch STOP sign with beacons and a 36 inch STOP Ahead sign with beacons. The STOP Ahead sign located upstream of the STOP Sign at a distance of 435 feet upstream of the TOP Sign as illustrated in Figure 2. For field implementations, it is recommended that the STOP Ahead Sign's location is dictated by TxDOT's Sign Crew Field Book (2009). The beacons on the STOP sign and on the STOP Ahead sign operate in an active manner, i.e., the beacons on both the signs will activate only when a vehicle is approaching the intersection and travels over the wireless sensors located upstream of the intersection. The objective is for the beacons to start flashing (being active) when a vehicle actuates the sensors. These distances can be changed based on intersection approach layout and approach speeds. The beacons on the STOP Ahead sign are aimed at the pavement near the sensor location. The hypothesis is that an active signs have a higher attention value due to the active nature of the beacons. The beacons on the STOP Ahead sign will continue to flash for a period of time till the vehicle has passed the STOP Ahead sign. A sensor placed upstream of the STOP Sign activates the beacons on the STOP sign when a vehicle passes over it. Two wireless sensors were placed at the STOP bar so that the beacons will continue to flash as long as a vehicle is stopped at the intersection.

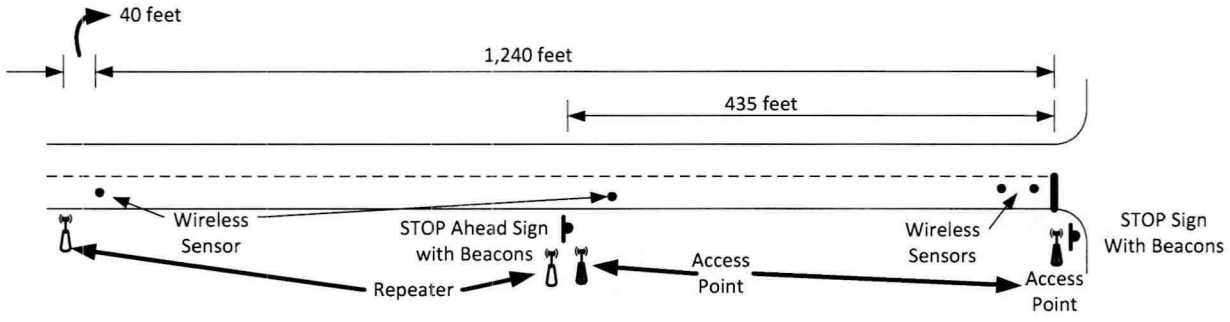

Figure 2. Active STOP Ahead Sign with Beacons with an Active STOP Sign with Beacons.

The treatment uses wireless Sensys detectors. These detectors are magnetometer in nature and transmit vehicle actuation to the access point. When the detectors are located further than 250 feet from an access point, a repeater is used to transmit the actuation to the access point as illustrated in Figure 2. The access point then triggers the beacons to flash.

TTI researchers worked with TxDOT Odessa district to install two roadside flashing beacon assemblies (RFBA). A STOP sign (R1-1) with red DC flashing beacons and a STOP Ahead sign (W3-1) with yellow DC flashing beacons were installed at the locations identified in Figure 1. Flasher cabinets fabricated by TTI researchers, Sensys access points, and repeaters were installed were installed on the sign posts by TxDOT technicians. The two RFBA are illustrated in Figure 3 and Figure 4. One Sensys repeater was installed in the RFBA assembly for the STOP Ahead Sign and the second one was installed on a temporary pole. Sensys sensors were placed on the pavement and vehicles driven over them. This facilitated exhibiting the functionality of the treatment and allowed TTI/TxDOT further use of the sensors in project. Solar panels were not installed as these signs were installed for a demonstration only. 12 volt batteries were used by TTI researchers to power the flasher cabinets and the beacons.

Figure 3. STOP Sign Installed at Pecos Test Track.

Figure 4. STOP Ahead Sign Installed at Pecos Test Track

EXPERT PANEL VISIT

The following expert panel visited the Pecos test track on July 8th to evaluate the treatment during daytime as well as after dark.

1. Kelli Williams, Director Traffic Operations, Odessa District
2. Roy Wright, Director Traffic Operations, Abilene District
3. Gary Tarter, General Engineering Tech, Traffic Policy and Standards Group

The following are the general draft comments received by the TTI Research team from the Panel. These comments will provide guidance for implementation of the current treatment as well as give a roadmap for improvements to the current treatment for the future.

General comments

- Overall the treatment has the potential to improve the attention value of the drivers and overall is a good beginning.
- It is simple to operate and relatively inexpensive to implement.
- It is configured by over the shelf components.
- While the treatment has marginal impact on attention value of the drivers during day time, it has a significant impact on the treatment during night time operations. However

the attention value of the beacons can potentially be improved by aiming the beacons properly.

Modifications required to the treatment demonstrated before installation at a real intersection

- The amber beacons on the STOP Ahead Sign need to be aimed properly to a spot on the roadway about 700 feet upstream of the beacons.
- The800 feet spacing between the advance detector and the amber beacons on STOP Ahead Sign is adequate for implementation.
- The 450 feet spacing between the STOP Ahead Sign and STOP Sign is too small. Normal spacing between these traffic control devices is over 1,500 feet. It is recommended to use the spacing as recommended by the TxDOT's Sign Crew Field Book. The treatment was installed in such a configuration at Pecos test track due to some physical constraints at the test track.
- The 400 feet spacing between the advance detector and the red beacons on the STOP is in adequate. The spacing should be equal to the stopping sign distance for the approach speed plus 2 seconds to account for the driver perception reaction time as well as a lag in the onset of flash in the beacon after the vehicle travels over the advance detector. The treatment was installed in such a configuration at Pecos test track due to some physical constraints at the test track and to facilitate ease of implementation.

Suggestions to improve the existing treatment

- The panel suggested considering the development of a treatment that considers the compliance of the approaching vehicle to the STOP sign by monitoring the vehicle speed and activate/escalate the warning if the vehicle is not slowing down at some thresholds.
- An option to consider it so flash the beacons ONLY if a vehicle is not slowing down.
- Another flashing beacon configuration to be consider to have top-bottom as well as a horizontal beacon arrangement at the STOP sign and have one set of beacons operate normally, but have the other pair of beacons flash if the vehicle is not slowing down.
- The panel suggested to investigate the possibility implementing dimming the beacons at night to reduce the glare.

PROJECT MODIFICATION

In August of 2013, RTI approved a request a modification for a no cost extension of this project with the following objectives.

1. Task 1.6 - Install the current treatment at an intersection recommended by TxDOT engineers.
2. Task 1.7 - Conduct a before and after study of the treatment to evaluate its effectiveness in improving attention value of the motorists.

3. Task 1.8 - Develop a new treatment that utilizes the speed of the approaching vehicle and activates the beacons if a vehicle is not complying with the treatment and not slowing down on the approach.
4. Task 1.9 – Demonstrate the new treatment to TxDOT Engineers.

This technical memorandum documents Task 1.6 which describes the installation of the treatment at an intersection.

FIELD INSTALLATION

TTI researchers approached the engineers from Odessa District to select an intersection in the district that would meet the criteria. The site required a high speed approach to a stop controlled intersection with a stop ahead sign installed on the approach. The stop sign and the stop ahead sign should have flashing beacons powered with solar panels.

Site Selected

After a thorough review TxDOT engineers in Odessa district selected the intersection of US 285 and SH 302 in Odessa district. This intersection is located about 20 miles north of I20 in Pecos as illustrated in Figure 5.

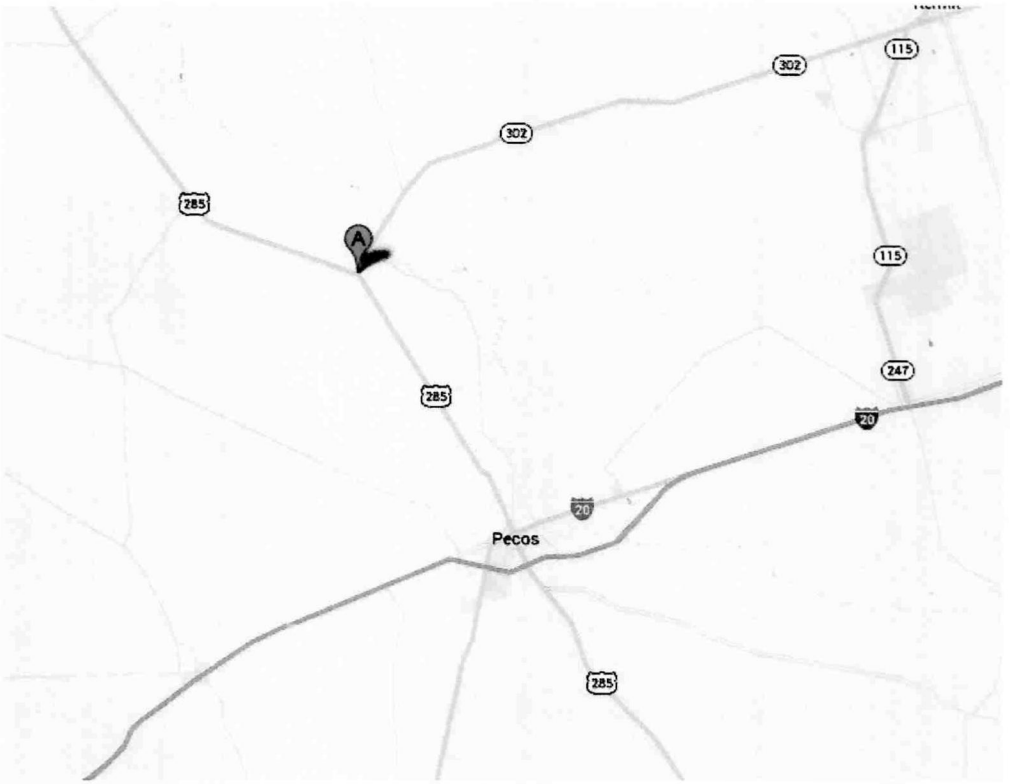

Figure 5. Installation Site Near Pecos .

System Installed

TTI researchers consulted with TxDOT engineers and had a site visit on January 6th 2014. Based on the site visit and availability of TxDOT crew, TTI researchers scheduled the installation of the

system at the site on January 22nd. TxDOT Odessa district provided three crews to assist in the installation of the system, The Kermit Area office provided traffic control to close off the approaching the intersection. A Team from the district office brought the core machine to core the pavement to install the Sensys Sensors. Finally a crew from Signal Shop in Odessa assisted TTI researchers to install the flasher cabinets and to connect the beacons to the flasher cabinets. Figure 6 illustrates the schematic of the field installation of the system.

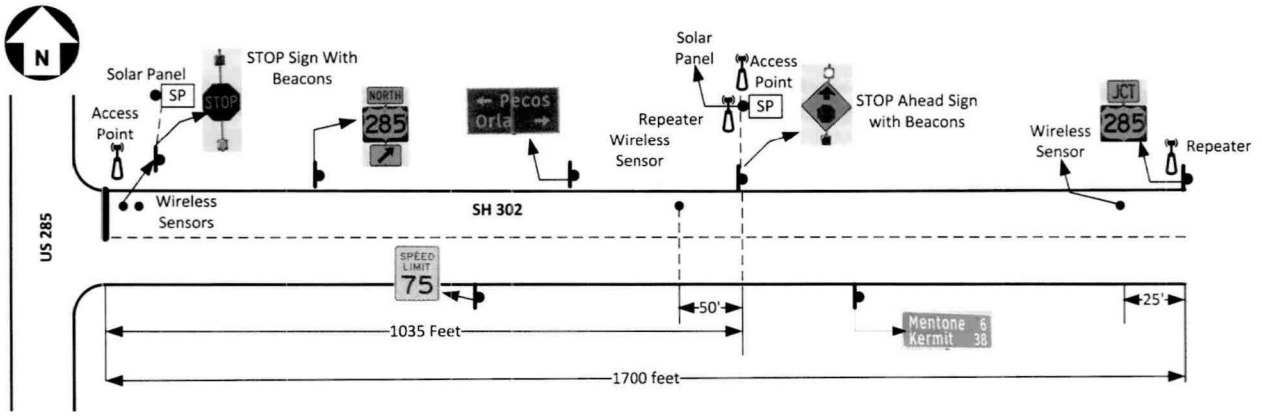

Figure 6. Schematic of the Field Installation.

The system consisted of two sub-systems. The first sub-system consisted of active beacons on stop ahead sign. This sub-system consisted of a wireless sensor (VSN240-F) installed at a distance of approximately 600 feet upstream of the stop ahead sign. A long life repeater (RP240-BH-LL) was installed on the back side of the sign post for JCT 285 which was located at a distance of 1700 feet from the stop bar. An Access Point (AP240) was installed on the pole on which solar panel and the cabinet with the batteries was installed near the stop ahead sign. The flasher cabinet was then installed on the same pole. Figures 7 to 10 illustrate the system being installed.

The second sub-system consisted of active beacons on the stop sign. This sub-system consisted of a wireless sensor (VSN240-F) installed about 50 feet upstream of the stop ahead sign and a long life repeater (RP240-BH-LL) installed on the pole with the solar panel near the stop ahead sign. The sub-system also had two additional wireless sensors at the stop bar (VSN240-T) and an Access Point (AP240) installed on the pole with the solar panel near the stop sign.

WORK COMPLETED

The installation of the system required by Task 1.6 has been completed. Future work will involve conducting a before and after .study of the system installed.

TXDOT ASSISTANCE

TxDOT's assistance was very much appreciated to install the system at the intersection of US 285 and SH 302.

FUTURE WORK

Sub-task 1.7 – Conduct a before and after study by March 31st 2014.

Figure 7. Core Machine preparing the Pavement to Install the Sensors.

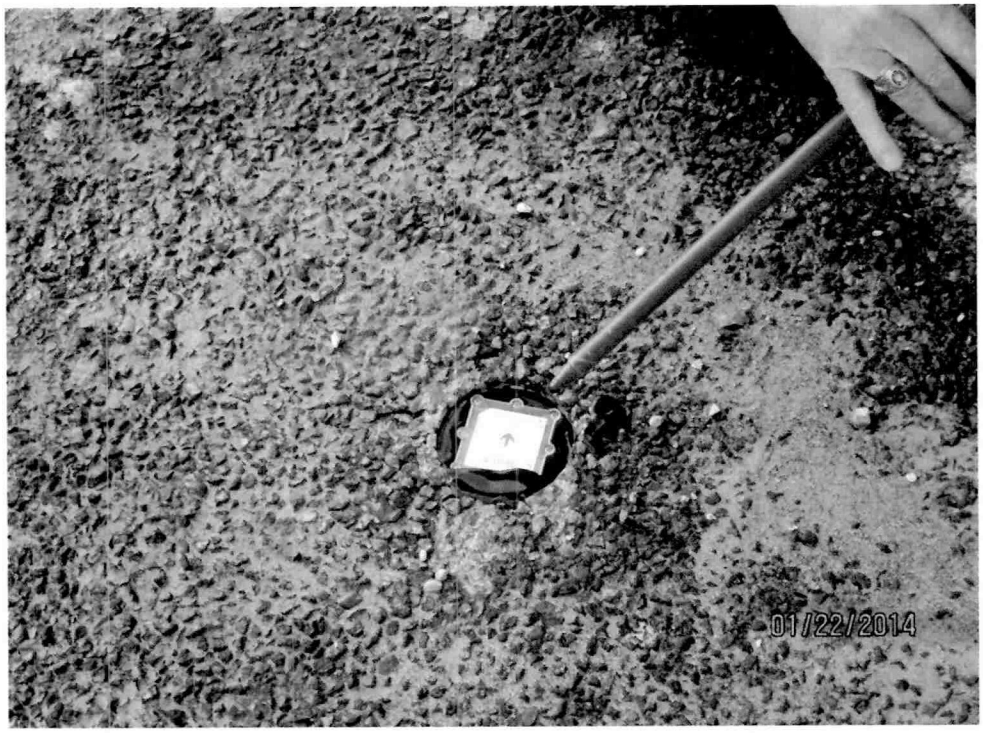

Figure 8. Wireless Sensor Installed in the Core.

Figure 9. Access Point Installation on the Solar Panel Pole.

Figure 10. Flasher Cabinet Installed on the Solar Panel Pole.