TECHNICAL REPORT

IMPLEMENTATION EFFORTS PERTAINING TO A STATEWIDE TRAFFIC MONITORING EQUIPMENT EVALUATION AND DEMONSTRATION FACILITY

Report 5-4664-01-1

Prepared for:

TxDOT Project 5-4664-01:
Deployment of a Statewide Traffic Monitoring Equipment Evaluation and Demonstration Facility

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INTRODUCTION

The Transportation Planning and Programming (TPP) Division of the Texas Department of Transportation (TxDOT) routinely tests a wide variety of devices for counting axles or vehicles; measuring vehicle speed, headway, and gap; classifying vehicles by length and/or axle spacing; and weighing vehicles in-motion. However, TPP needs a traffic monitoring equipment evaluation facility to enhance its capabilities in conducting these tests, in facilitating training, and in allowing vendor comparisons and demonstrations. This project investigated funding sources, design options, and viable locations for this traffic monitoring equipment evaluation facility. The project provided research and development to design a generic facility to evaluate traffic data collection equipment and sensors and perform traffic data collection research. The report that concluded the research portion of this project covered the entirety of the 2-year research project, identifying potential funding sources and candidate sites for further consideration, developing site design aspects for the two most promising sites, and evaluating Kistler Lineas Quartz weigh-in-motion sensors *(1)*. The most prominent funding sources are construction funds (include the site as part of a TxDOT construction project) and State Planning and Research (SPR) funds. The most promising sites identified were on I-35 north of Georgetown near the Bell County line.

BACKGROUND

At the conclusion of the research portion of Research Project 0-4664 in August 2005, TxDOT initiated an implementation project to begin in September 2005 to provide ongoing support to the Transportation Planning and Programming Division as construction of the equipment evaluation facility in Bell County got underway. This plan included funding for involvement of personnel from the Texas Transportation Institute (TTI) for the next three fiscal years, FY 06, FY 07, and FY 08. Besides funding a modest budget to support TTI activities, TxDOT also earmarked construction funds to be used from the I-35 reconstruction project to be applied toward the traffic monitoring equipment evaluation facility.

The TTI research team, consisting also of researchers from the Center for Transportation Research (CTR) at The University of Texas at Austin, had identified a site in southern Bell County for this facility. Besides recommending the site location, the research team also developed a conceptual layout of the site, identified components that should be included, developed cost components to formulate an estimated budget, and attended meetings with Waco District and other personnel to help maintain interest in successfully completing the project.

IMPLEMENTATION PROJECT 5-4664-01

The intent of the implementation project was for TTI to provide ongoing technical support to TPP related to the test facility. Since the timing of the I-35 reconstruction project was still somewhat uncertain, one option was to conduct some of the testing at the TTI S.H. 6 test facility in College Station. TPP personnel had expressed interest not only in the weigh-in-motion (WIM) components installed there but also in some of the non-intrusive detectors that might meet some of the traffic monitoring needs served by TPP. Therefore, the TTI site incorporated some of the features that could be useful to TPP until the I-35 facility could be completed.

Figure 1 indicates some of the features of this site and its general layout. Typical weekday traffic (both directions) on S.H. 6 at this location is approximately 35,000 to 40,000 vehicles per day with 10 percent trucks (FHWA Class 5 and above). Traffic conditions are almost always free-flow, but the noise level and the dispersion of vehicles are at desirable levels for many activities such as group demonstrations and studies that need isolated vehicles. This site has ample parking and area for growth, as well as much of the infrastructure for adding new test systems. It is within a 5 minute drive of Texas A&M University, especially important for employees and students, and is within 10 minutes of the TxDOT Bryan District offices. Equipment installed on the west side of S.H. 6 includes:

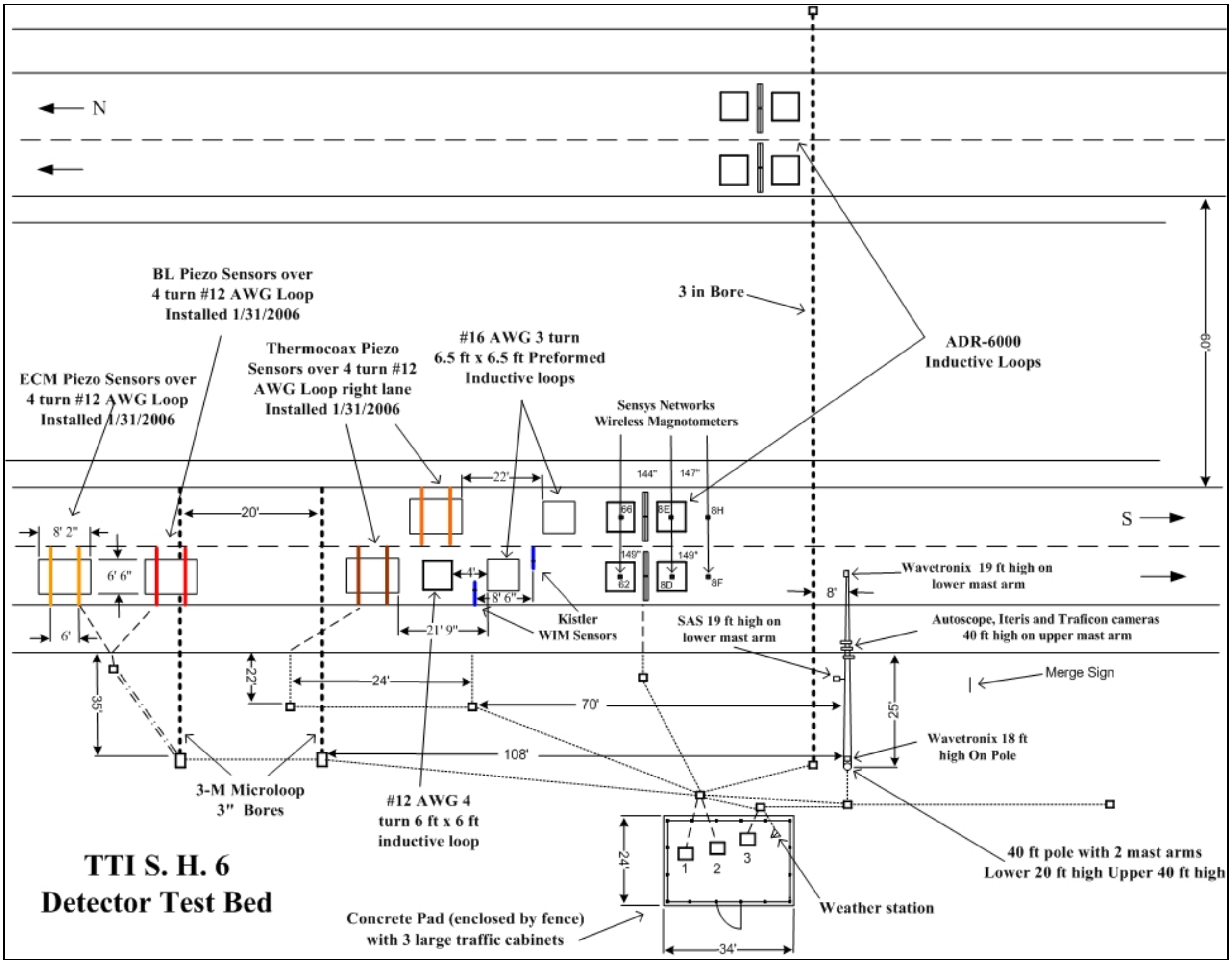
- three Type P equipment cabinets;
- an enclosed fenced concrete pad;
- a Campbell Scientific weather station;
- a 40-ft pole with two mast arms, one at 20 ft over the road and another at 40 ft;
- pan-tilt-zoom (PTZ) surveillance cameras; and
- roadway sensors that serve as part of the baseline system.

Sensors in or under the roadway include inductive loops, 3M microloops, Class I piezoelectric sensors, and Kistler quartz WIM sensors. A Peek ADR-6000 with inductive loops monitoring both the northbound and southbound directions serves as the baseline system for vehicle classification and counts. Communication elements include a 768 kb symmetrical digital subscriber line (DSL) for high-speed communication for data and live video. Non-intrusive detectors installed at the site besides the 3M microloop (magnetic) detection system include two SmartSensor (radar) detectors, an Autoscope Solo Pro video detector, and an Autoscope Terra video detector. There is a weigh station with static scales about 10 miles to the north on S.H. 6, which is available for WIM verification purposes at the test bed site. Figure 2 is a photograph of this site, looking southward.

At the conclusion of the research portion of Project 0-4664, the Waco District was making progress on developing reconstruction plans for I-35. TPP was working in partnership with the district to include the site plans developed in this research project as part of the I-35 reconstruction project. TPP had also set aside money to be used for construction of the test facility.

TTI Activities Supporting TPP

Over the three years of this implementation project, TTI activities have been mostly in response to TPP requests – either for information, advice, or support for equipment installed at the S.H. 6 test facility. Most of the information was conveyed by telephone or by in-person conversations. Some of the activities were a result of TTI initiatives to monitor or repair equipment at the S.H. 6 test facility. Activities can be categorized as WIM activities, non-intrusive detector evaluations, and motorcycle detection.



Source: Texas Transportation Institute.

Figure 1. Layout of S.H. 6 College Station Test Bed.

WIM Activities

TTI conducted periodic checks of the Electronique Contrôle Mesure (ECM) WIM system at S.H. 6 in College Station. The three sets of WIM sensors were previously installed at the test facility primarily because the I-35 site would not be available for several months. TxDOT provided an ECM Hestia WIM system for TTI to monitor the three sets of WIM sensors. At that point in time, TPP was most interested in the Kistler Lineas quartz sensors. One of the problems with the WIM electronics required removing the unit and taking it to the ECM distributor in Buda, Texas for repair. The distributor identified the problem as being a failed power supply and another board failure that might have been caused by a lightning strike in the immediate area of the test facility. Following the repair, an ECM technician assisted TTI in getting the unit ready for continued use.

Source: Texas Transportation Institute.

Figure 2. View of S.H. 6 Test Site Looking Southward.

Non-Intrusive Detector Evaluations

TTI also either investigated topics of need via phone conversations with other departments of transportation (DOTs) or installed detectors at the test facility for monitoring. TTI personnel talked to Minnesota Department of Transportation (MnDOT) and other DOTs regarding length-based classification using non-intrusive detectors. Many non-intrusive detectors have the ability to monitor vehicle lengths in four or five length bins. The Federal Highway Administration (FHWA) allows such use of these detectors, but it still requires states to correlate these bins with the FHWA Scheme F classification scheme. Knowing the capabilities of the equipment and their accuracy might allow TPP to replace failed in-road detectors, at least on a short-term basis.

In previous TxDOT-sponsored research, TTI found that the Wavetronix SmartSensor High Definition (HD) was a reasonably accurate detector for speeds and counts, covering as many as 10 lanes in sidefire orientation. However, TTI had not tested it for length accuracy. Therefore, TTI and a representative from Paradigm (Texas distributor) installed a Wavetronix High Definition detector at the S.H. 6 facility to begin establishing its performance characteristics compared to the Peek ADR-6000. In the meantime, MnDOT had sponsored research on this topic, so TTI did not conduct a full evaluation of the detector's length measurement. However, Tables 1 and 2 provide a snapshot of accuracy, based on data from the TTI test site provided by Wavetronix engineers. Bold and italic fonts in these tables represent the numbers and percentages for each length bin that the HD detector correctly classified. Figure 3 includes two scatter plots from the MnDOT research, indicating reasonably good results from the

HD. TPP was beginning to show interest in non-intrusive detectors for at least short-term replacements of inductive loops where vehicle counts were needed. Whether these detectors would be used for length-based classification was uncertain, but TPP was at least considering these detectors for Automatic Traffic Recorder (ATR) counts. Figure 4 indicates some of the length bins being used at the time this work was done, indicating that length bins varied by agency and had not been standardized.

Table 1. Wavetronix SmartSensor HD Classification Matrix.

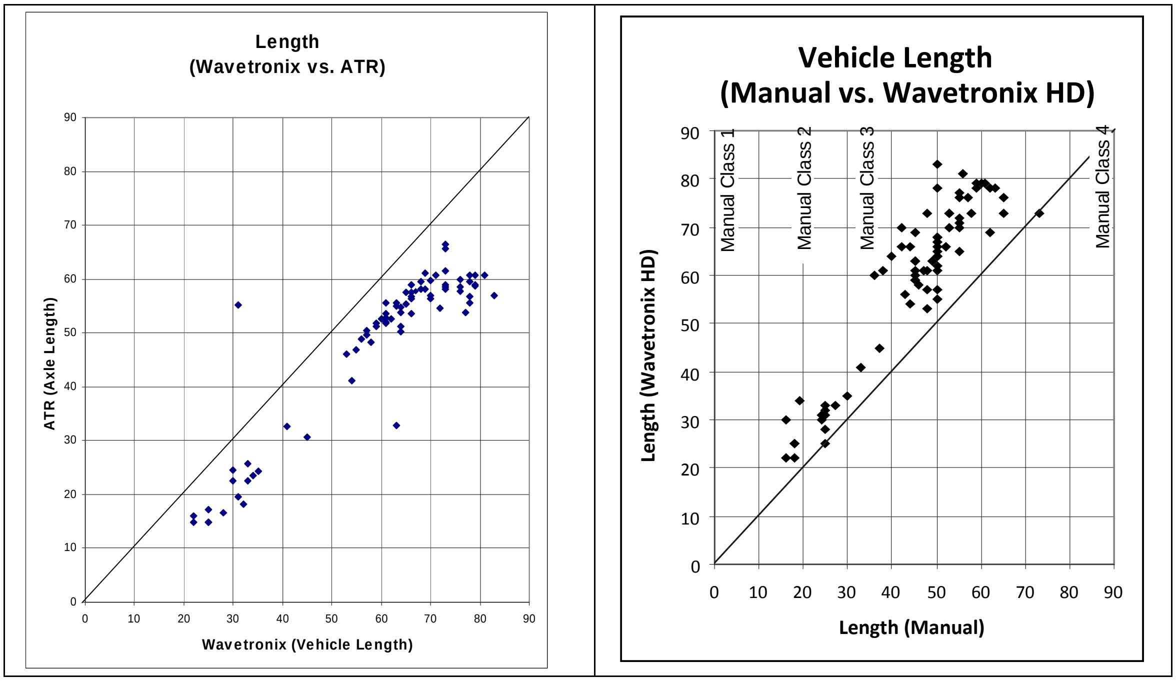
HD Class	Length Bin	ADR6000 Class			
		1	2-3	4,5,6	7-13
1	0-12 ft	***55***	12	0	0
2	12-21 ft	4	***13,569***	16	1
3	21-37 ft	0	2260	***525***	10
4	37-256 ft	1	177	107	**696**
Total		60	16,018	648	707

Table 2. Wavetronix SmartSensor HD Classification Percentage Matrix.

HD Class	Length Bin	ADR6000 Class			
		1	2-3	4,5,6	7-13
1	0-12 ft	**91.7**%	0.1%	0.0%	0.0%
2	12-21 ft	6.7%	**84.7**%	2.5%	0.1%
3	21-37 ft	0.0%	14.1%	**81.0**%	1.4%
4	37-256 ft	1.7%	1.1%	16.5%	**98.4**%

Motorcycle Detection

TTI used the detectors that were available at the S.H. 6 test facility to monitor their detection accuracy for motorcycles. The FHWA was beginning to push states to provide better data for motorcycle detection and calculation of vehicle-miles traveled (VMT). Motorcycle fatalities had shown an increasing trend, but according to data states were submitting to FHWA, motorcycle VMT was not increasing at a commensurate rate. Dividing the number of fatalities by VMT provides the fatality rate, and if VMT was being under-reported, it would suggest a higher than actual fatality rate. FHWA was justified in its concern and its desire to determine if VMT was changing more than the data showed and the reason(s) for the error. TPP was as anxious as the FHWA was to identify the right technologies for being able to accurately count motorcycles, so TTI conducted some short-term counts to determine some answers.



Source: SRF Consulting.

(a) (b)

Figure 3. Scatter Plot of Wavetronix HD Vehicle Length.

(a) Against ATR axle spacing (r^2=0.85), (b) Against Manual Length Measurements (r^2=0.86).

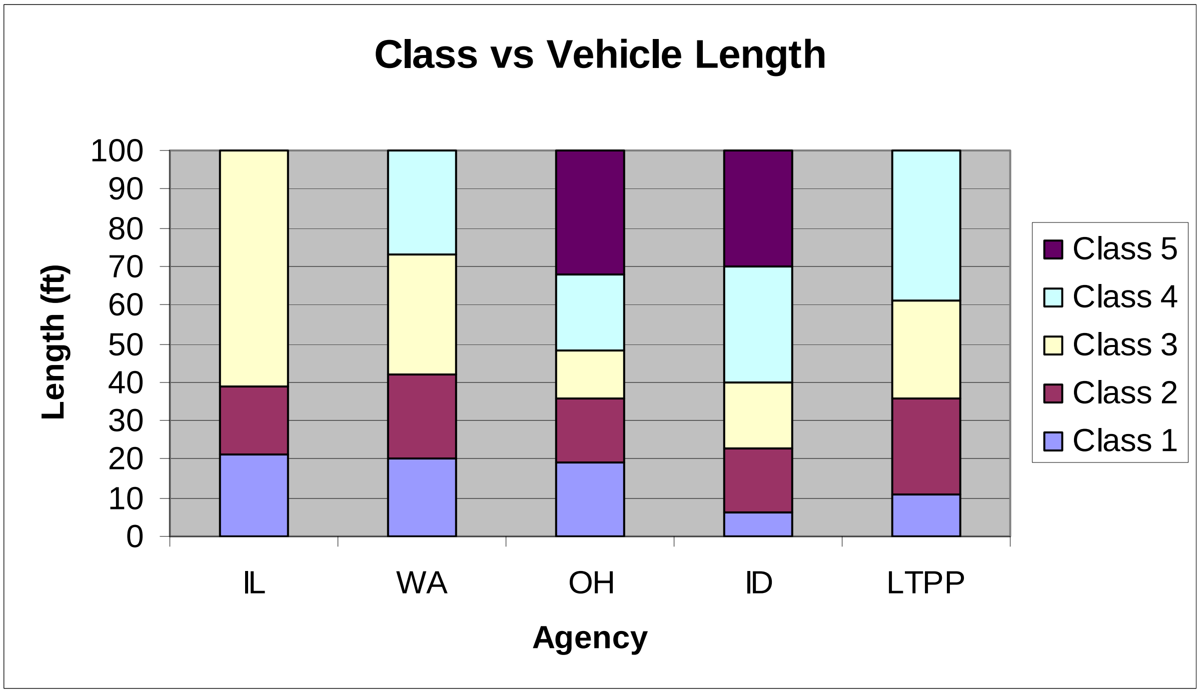


Figure 4. Length-Based Classification Bins Being Used.

TTI collected the data summarized in Tables 3, 4, and 5 in early October 2007. The FHWA had organized a motorcycle symposium to be held in Washington, D.C., and invited one of the TTI research engineers to present findings on the topic of motorcycle detection using some of the commonly available detectors. TTI presented this topic again in August, 2008 at the North American Travel Monitoring and Exposition Conference (NATMEC) in Washington, D.C. Table 6 resulted from another round of data collection, primarily to update the October results. For these tables, the following explanation of the detector types is needed: "VID" is video image detection and "Triple" refers to a triple-technology detector that mounts directly over each lane. Results clearly indicate that the currently used detectors do not detect all motorcycles. TTI did not include inductive loops or axle sensors in either round of data collection, but future research for motorcycle detection should include both types of detection. Larger motorcycles with larger amounts of metal will generally be detected better than smaller ones and sport motorcycles with less metal. Motorcycles traveling in the wheelpaths are more likely to be detected than those traveling in the center of the loop.

Table 3. Motorcycle Detections by Detector Type for October 3, 2007.

Category	VID	Radar	Magnetic	Triple
Matched:	63	47	12	31
Sample Total:	75	75	36	36
Missed:	12	28	24	5
Accuracy:	84%	63%	33%	86%

Table 4. Motorcycle Detections by Detector Type for October 4, 2007.

Category	VID	Radar	Magnetic	Triple
Matched:	55	43	13	28
Sample Total:	69	69	34	34
Missed:	14	26	21	6
Accuracy :	80%	62%	38%	82%

Table 5. Motorcycle Detections by Detector Type for October 5, 2007.

Category	VID	Radar	Magnetic	Triple
Matched:	51	54	11	15
Sample Total:	59	59	28	28
Missed:	8	5	17	13
Accuracy:	86%	92%	39%	54%

Table 6. Summary of Motorcycle Detections by Detector Type.

Date	VID	Radar	Magnetic	Triple
Oct 3	84%	63%	33%	86%
Oct 4	80%	62%	38%	82%
Oct 5	86%	92%	39%	54%
Jul-Aug, '08	82%	89%	34%	NA

These results indicate the challenge in detecting motorcycles and that detection rates in the 80 to 90 percent range are not happening often. The triple-technology detector is not widely deployed; besides it needs to be mounted directly over each lane, making it less desirable. According to these limited tests, the two best technologies are video and radar. Since radar is not affected by weather and light like video is, it is overall the best choice among the non-intrusive detectors tested for detecting motorcycles.

REFERENCE

1. Middleton, D., R. White, J. Crawford, R. Parker, J. Song, and C. Haas. *Investigation for Traffic Monitoring Equipment Evaluation Facility*. Report No. FHWA/TX-06-0-4664-3, Texas Transportation Institute, Texas A&M University, College Station, Texas, October 2005.