



INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Final Report

PERFORMANCE METRICS FOR FREEWAY SENSORS

Introduction

Performance measures play a critical role in the operation of Intelligent Transportation Systems (ITS), because they provide feedback to the operators regarding system operations and efficiency. Traffic management systems use archived data, provided by various sensors, as a basis for describing normal conditions and predicting traffic conditions that may be expected at a particular time and place in the highway system.

However, one of the primary concerns of ITS data users is how to assess the quality of the data. Although detectors are usually tested immediately

after installation, they operate under very difficult conditions and are susceptible to degradation in accuracy or complete failure. Therefore, the development of data quality control procedures to screen erroneous data has become a critical issue.

This report proposes a set of quality control metrics for the Indiana Department of Transportation to use for ensuring high quality data is provided by all sensors. The quality control program provides a tool for assessing the quality of traffic data in terms of accuracy and availability and sustaining that quality over time.

Findings

This study found that in many cases, the quality of the traffic data provided by the detection devices during the period November 2003 to February 2004, on I-80/94, was suspect. Several performance metrics such as flow continuity test, speed comparisons, data availability and average effective vehicle length test were developed and applied, revealing significant inconsistency in data quality provided by microloops and Radar Traffic Microwave Sensor (RTMS). Therefore, there is a need for implementing automatic quality control measurements immediately after sensor installation and at regular intervals to ensure the quality of the data.

The first performance test used in this study was the comparison of the volume of the vehicles captured by two closely spaced detectors with no entering or exiting ramps between them, to assess the continuity of the traffic flow. To examine the accuracy of the results, simple 24-hour graphs were plotted (Figure 1), using the total volume of the vehicles passing over the detectors in all three lanes. The generated graphs indicated that only 38% of the eight

locations reported consistent results (Table 7-1 in report).

The second performance test assessed the consistency of the speed data reported by the microloops and RTMS. For the 24-hour speed comparison tests, the expectations were the same; speed data should be consistent between two closely spaced sensors, with no entering or exiting ramps between them (Figure 2). However, in this case the analysis was performed for each lane separately as not all the lanes were expected to provide the same magnitude of speeds. The examination of the graphs indicated that 25% of the twenty-four lanes had reported consistent speeds over several hours (Table 7-2 in report).

The third performance test was performed to assess the availability of the data provided by the microloops and RTMS sensors (Figure 3). The analysis revealed data reporting frequency within expected tolerance at 71% of the ninety-nine lanes examined (Tables 7-4 and 7-5 in report).

The fourth performance test was a screening data procedure known as Average Effective Vehicle Length (AEVL) test, which examined the relationship of occupancy, volume and speed data for identifying gross inconsistencies (Figure 4). The results indicated that in 32% of the ninety-nine lanes examined, the performance of the sensors was

within the expected range (Tables 7-7 and 7-8 in report).

To maintain a high level of data accuracy, ITS data should be continuously monitored for errors and inconsistencies. Therefore, it is recommended that automatic quality control checks should be applied on a regular basis to ensure the quality of the data.

Implementation

This study has developed a quality control procedure that can be used by Indiana Department of Transportation to evaluate the performance of ITS sensors deployed to freeway arterials. Possible metrics that ensure preservation of data quality at a high level, for a long period of time are summarized as follows:

- Implement formalized procedure for vendors and contractors to provide as-built installation documentation. For microloop detection technology, a proposed as-built diagram is depicted, as well as the associated dimension table. For the RTMS technology, a proposed as-built diagram is depicted in and the associated table is illustrated.

- Apply quality control measurement immediately after sensor installation and at regular intervals to validate both the sensors and communicating infrastructure. Examples of these metrics are illustrated in Figures 1, 2, 3 and 4.
- Co-locate microloops and RTMS sensors to ensure that quality control tests can be run without massive manual data collection efforts.
- Report occupancy to one decimal to facilitate more robust average effective vehicle length estimation during periods of low volume.

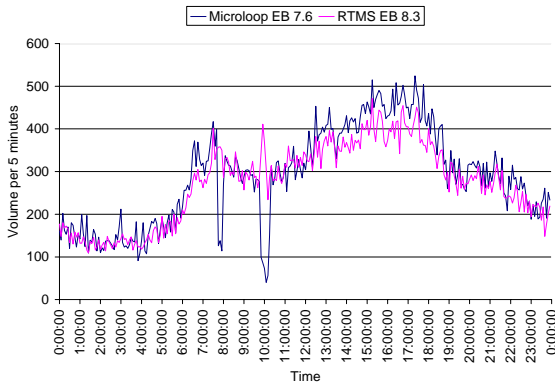
Contacts

For more information:

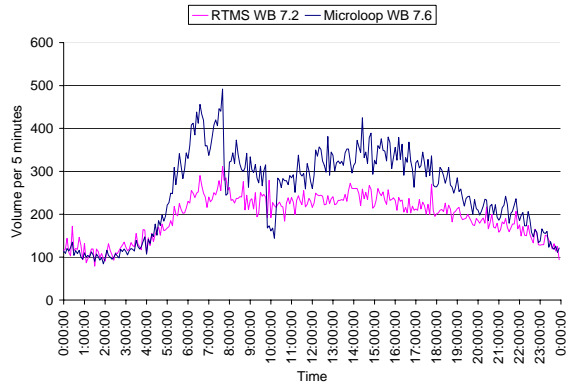
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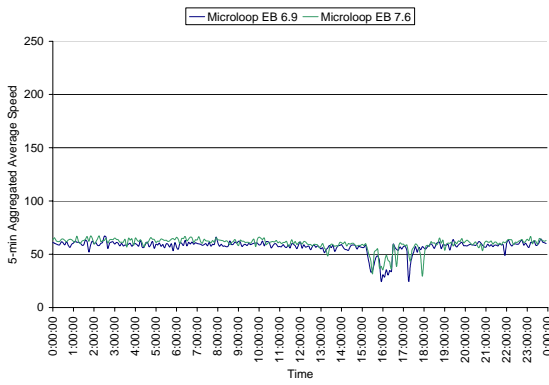


a) Consistent

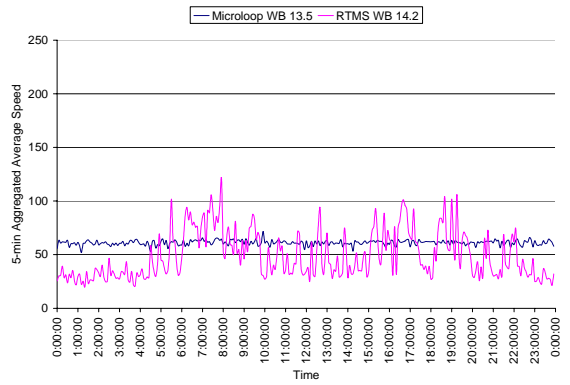


b) Inconsistent

Figure 1. Flow Continuity test, I-80/94, February 25, 2004

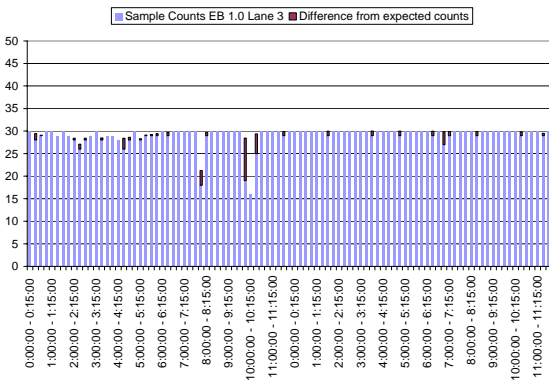


a) Consistent

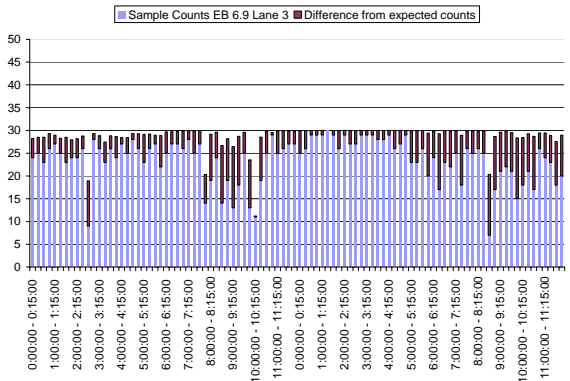


b) Inconsistent

Figure 2. Speed Comparison test, I-80/94, February 25, 2004

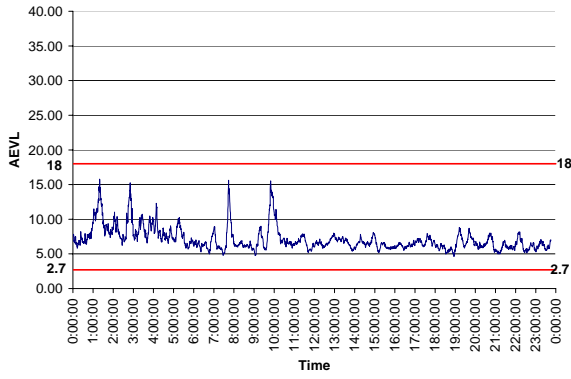


a) Regular data reporting

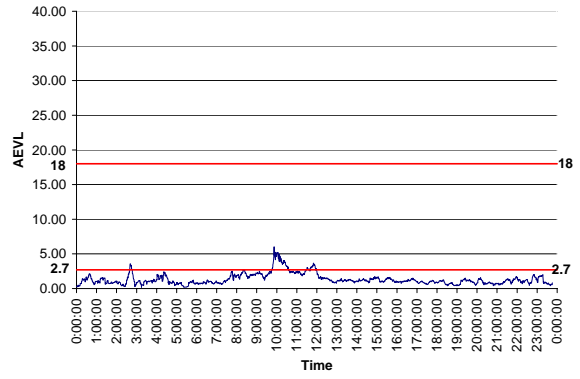


b) Irregular data reporting

Figure 3. Data Availability test, I-80/94, February 25, 2004



a) Values within expected range



b) Values out of expected range

Figure 4. Average Effective Vehicle Length (AEVL) test, I-80/94, February 25, 2004

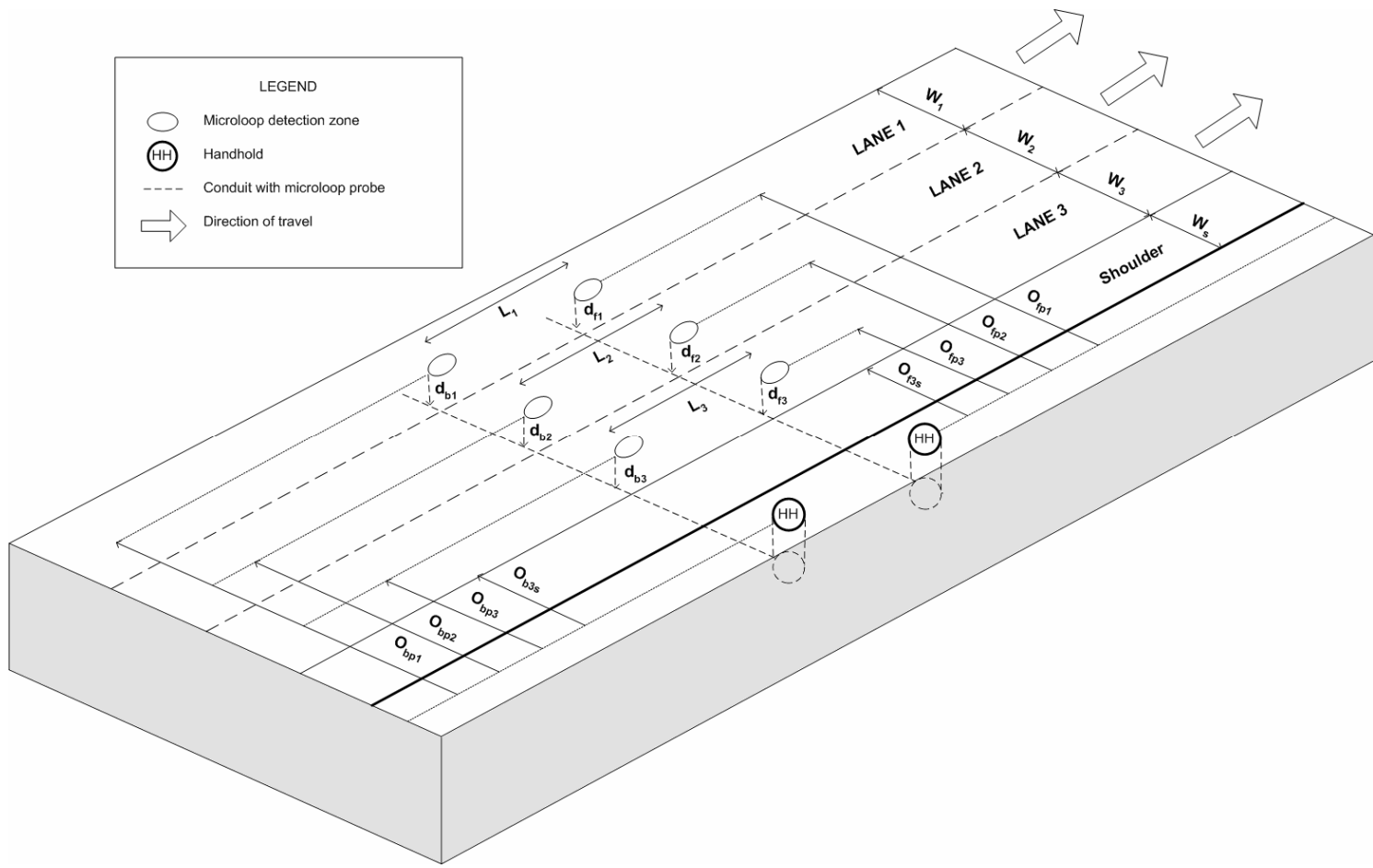


Figure 5. As-built sketch

Parameter Group	Symbol	Description	Typical Range	Manufacturer Tolerance	Actual Value
Width of lanes, shoulder and distance from edge of pavement to handhole	W_1	Lane 1 Width	11.5 - 12.5		
	W_2	Lane 2 Width	11.5 - 12.5		
	W_3	Lane 3 Width	11.5 - 12.5		
	W_s	Shoulder Width	11.5 - 12.5		
Spacing between probes	L_1	Lane 1 lead-lag spacing			
	L_2	Lane 2 lead-lag spacing			
	L_3	Lane 3 lead-lag spacing			
Depth measured from pavement surface to top of conduit	d_{b1}	Depth at back probe 1			
	d_{b2}	Depth at back probe 2			
	d_{b3}	Depth at back probe 3			
	d_{f1}	Depth at front probe 1			
	d_{f2}	Depth at front probe 2			
	d_{f3}	Depth at front probe 3			
Offset measured from edge of conduit in handhole to probe	O_{bp1}	Offset to back probe 1			
	O_{bp2}	Offset to back probe 2			
	O_{bp3}	Offset to back probe 3			
	O_{b3s}	Offset to back shoulder			
	O_{fp1}	Offset to front probe 1			
	O_{fp2}	Offset to front probe 2			
	O_{fp3}	Offset to front probe 3			
	O_{f3s}	Offset to front shoulder			
Describe any subsurface infrastructure (conduits, drains, pipes, utilities, culverts) within 25' of any probe and note on as-built sketch					

Table 1. Legend of As-built sketch

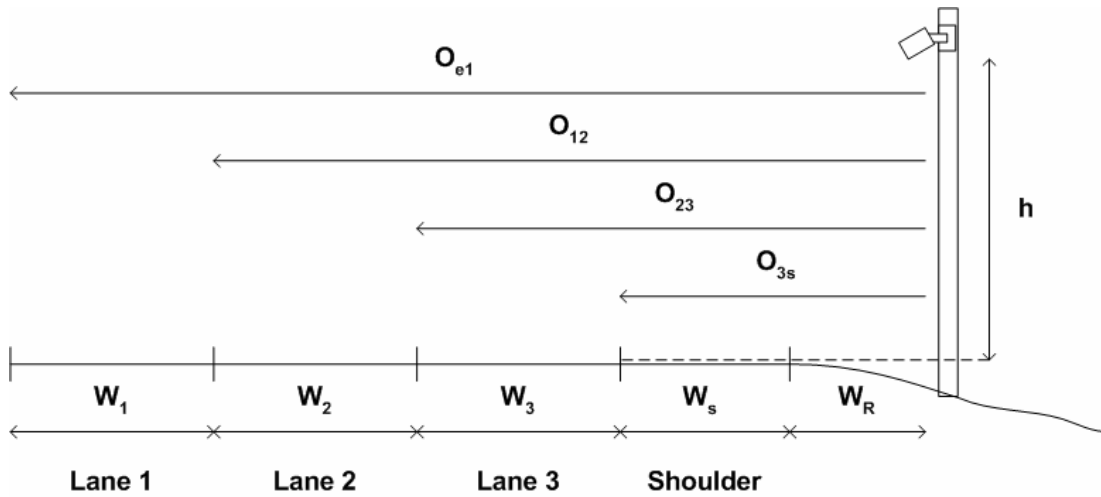


Figure 6. RTMS Offsets

Parameter Group	Symbol	Description	Expected Range	Manufacturer Tolerance	Actual Value
Width of lanes, shoulder and distance from edge of pavement to RTMS	W_1	Lane 1 Width	11.5 - 12.5'		
	W_2	Lane 2 Width	11.5 - 12.5'		
	W_3	Lane 3 Width	11.5 - 12.5'		
	W_s	Shoulder Width	11.5 - 12.5'		
	W_R	Distance from edge of pavement to RTMS			
Offset measured from RTMS to each lane	O_{e1}	Offset end-lane 1			
	O_{12}	Offset lane 1-lane 2			
	O_{23}	Offset lane 2-lane 3			
	O_{3s}	Offset lane 3-shoulder			
Height of RTMS measured from grade at edge of travel lane	h	Height of RTMS			

Table 2. Legend of RTMS offset sketch