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TECHNICAL MEMORANDUM

TO: Mark Schlappi, Maricopa Association of Governments

FROM: Shawn Turner, Texas Transportation Institute

SUBJECT: Accuracy Evaluation of ADOT FMS Detectors

This memo summarizes recommendations on detector locations and data collection procedures for validating vehicle traffic counts and speeds collected by the Arizona Department of Transportation (ADOT) Freeway Management System (FMS). The Maricopa Association of Governments (MAG) wants to use archived FMS detector data in their decision-making and planning processes; thus, there is a need to ensure that the detector data accuracy is within acceptable ranges.

ADOT, in cooperation with MAG, has designated 58 of the existing FMS detector locations to serve as the basis for a regional traffic monitoring system. These 58 sensors are to receive priority maintenance to ensure they provide data for traffic monitoring and annual reporting purposes. Because the traffic data from these 58 sensors will be used for decision making within MAG and other public agencies, it is desirable to verify the traffic measurement accuracy of these freeway sensors. The purpose of this task is to evaluate the accuracy of traffic count and speed data collected at a sample of these detector locations. This memo summarizes: 1) detector selection criteria; 2) selected detector locations to be evaluated; and 3) data collection and reduction protocol.

Detector Selection Criteria

The following criteria were considered in selecting detector locations for evaluation:

1. **Safety and suitability of location for data collection** – Since the evaluation in this task will require a permanent video record, safe and suitable video recording positions must be available for data collection personnel. The ideal video recording position is from the sidewalk of nearby roadway overpasses. A few roadside vantage points outside of the freeway right-of-way could also be considered; however, we have chosen to focus first on those locations with safe vantage points. We may be able to record video via ADOT's FMS CCTV cameras at several locations with no safe vantage points; however, these locations will be in addition to the ones proposed in this memo.

2. **Presence of suspect detector data** – Analysis of 2004 data at the 58 locations revealed suspect data trends; in particular, several of the detectors were providing traffic counts that resulted in lower-than-expected traffic capacity values during peak times. Several detectors were also reporting higher-than-expected truck traffic volumes.

3. **Representative coverage of freeway routes and device types** – We made an effort to ensure that detector locations were evenly represented among all freeways. Also, detector locations were selected such that both detector types (i.e., loop detectors and passive acoustic detectors) were evenly represented in the locations to be evaluated.

In selecting the detector locations to be evaluated, the first criterion (safe data collection locations) was given the highest priority. That is, all detector locations to be evaluated must have a safe and suitable vantage point from which to record video. As the next section will indicate, in nearly all cases this first criterion did not preclude us from meeting the other two criteria.

Selected Detector Locations to be Evaluated

Based upon the criteria summarized in the previous section, we have selected 30 of the 58 detector locations for accuracy evaluation purposes. Table 1 summarizes these 30 locations in terms of the freeway route and detector type. Table 2 lists each of the 30 detector locations with additional relevant information. Figure 1 shows a map of the Phoenix area with these 30 detector locations highlighted.

As indicated earlier, we believe that all three of the location selection criteria were adequately met. All 30 detector locations have nearby overpasses or vantage points from which video can be safely recorded. The 30 detector locations include most of the detectors (with the exception of 6) that appear to be producing suspect data. Finally, as Table 1 shows, the 30 detector locations are distributed evenly across the freeway routes and detector types.

Table 1. Number of Detector Locations to be Evaluated by Freeway and Detector Type

	Number of locations to be evaluated (% of available locations)		
Freeway	Loop detectors	Passive acoustic detectors	**Subtotal**
I-10	6 (50%)	4 (50%)	10 (50%)
I-17	2 (50%)	4 (67%)	6 (60%)
Loop 101	2 (50%)	None available	2 (50%)
Loop 202	2 (50%)	None available	2 (50%)
SR 143	0 (0%)	None available	0 (0%)
SR 51	4 (100%)	2 (33%)	6 (60%)
SR 60	None available	4 (50%)	4 (50%)
Subtotal	16 (53%)	14 (50%)	30 (52%)

Table 2. Listing of 30 Detector Locations to be Evaluated

Station #	Location	Suspect Data?	Detector Type	Vantage Point
2	I-10 EB: E of 83rd Ave	YES	1 SAS PAD	Look east from 79th Ave overpass
4	I-10 WB: W of 75th Ave		1 SAS PAD	Look east from 79th Ave overpass
68	I-10 EB: E of 35th Ave	YES	1 SAS PAD	Look west from 31st Ave overpass
73	I-10 WB: W of 27th Ave		2 SAS PADs	Look east from 31st Ave overpass
85	I-10 EB: E of 7th St		loops	Look west(?) from pedestrian overpass between 7th and 12th St
139	I-10 WB: W of 16th St		loops	Look west from 16th St overpass or use 12th St overpass
64	I-10 EB: E of 48th St		loops	Look south from Broadway overpass?
66	I-10 WB: N of Southern Ave		loops	No assessment
406	I-10 EB: S of Warner		loops	Look south from Warner overpass
411	I-10 WB: S of Elliot		loops	Look north from Ray Rd overpass
155	I-17 NB: N of Buckeye		loops	Look north from Buckeye overpass
118	I-17 SB: S of Van Buren		loops	Look north from Buckeye overpass
337	I-17 NB: N of Thomas	YES	1 SAS PAD	Look north from Thomas overpass
376	I-17 SB: S of Indian School		1 SAS PAD	Look south from Indian School overpass
346	I-17 NB: S of Glendale	YES	1 SAS PAD	Look north from Bethany Home overpass
367	I-17 SB: S of Glendale	YES	1 SAS PAD	Look south from Glendale overpass
264	Loop 101 NB: N of Southern	YES	loops	No overpass – use nearby CCTV
261	Loop 101 SB: S of Broadway		loops	Look south from Broadway overpass
246	Loop 202 EB: W of Priest		loops	Look east from Priest/Center Pkwy overpass
278	Loop 202 WB: W of Scottsdale		loops	No overpass - use CCTV located to the east
203	SR 51 NB: N of McDowell	YES	1 SAS PAD	Look south from pedestrian overpass between Thomas and McDowell
190	SR 51 SB: S of Thomas	YES	1 SAS PAD	Look north from pedestrian overpass between Thomas and McDowell
325	SR 51 NB: N of Shea		loops	Look south from Cholla overpass
303	SR 51 SB: S of Cactus		loops	Look north from Cholla overpass
334	SR 51 NB: N of Greenway	YES	loops	Look south from pedestrian overpass north of Greenway entrance ramp
312	SR 51 SB: S of Bell	YES	loops	Look north from pedestrian overpass south of Bell entrance ramp
444	US 60 EB: E of Dobson		2 SAS PADs	Look west from Longmore overpass
485	US 60 WB: W of Alma School	YES	2 SAS PADs	Look east from Longmore overpass
453	US 60 EB: E of Mesa Dr	YES	2 SAS PADs	Look west from Horne overpass
476	US 60 WB: W of Stapley		2 SAS PADs	Look east from Horne overpass

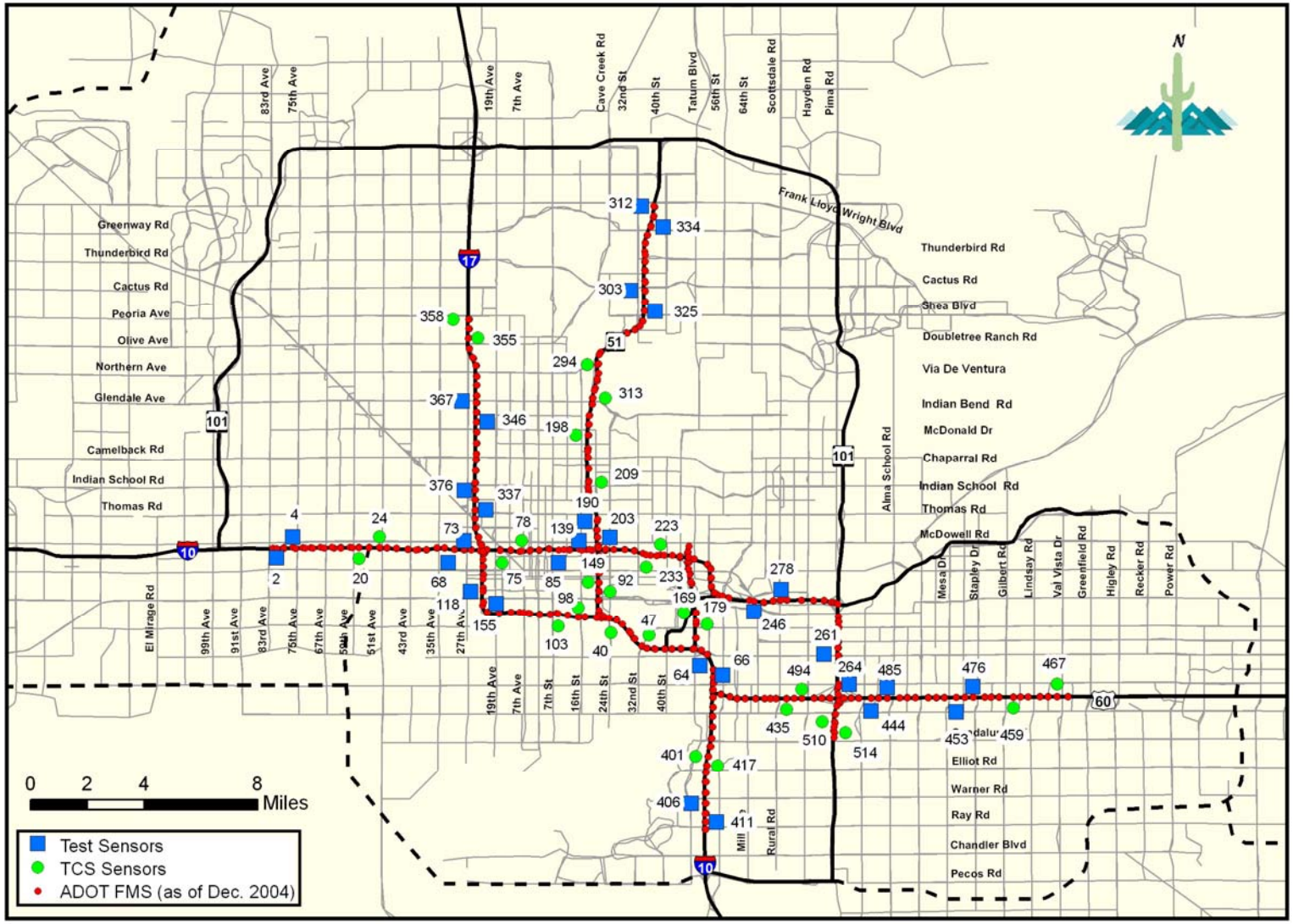

Figure 1. Map Highlighting 30 Detector Locations to be Evaluated

Data Collection and Reduction Protocols

The following procedures and guidelines will be used for data collection:

- Video will be recorded at each detector location and will serve as the authoritative record of traffic conditions by which to evaluation detector accuracy.
- A minimum of 120 minutes of video will be recorded at each detector location. A minimum of 60 minutes of video will be recorded for each of two separate time periods: off-peak (light traffic flow with speeds greater than 45 mph) and peak (heavy traffic flow with speeds less than 30 to 45 mph). Some detector locations may not have vehicle speeds below 30 mph for the entire 60-minute test period; however, there must be at least 15 minutes during the peak test period in which vehicles are traveling at less than free-flow speeds. Ultimately, engineering judgment will be used to determine the timing and acceptance of these time periods.
- Video will be recorded with a field-of-view to include all freeway through-traffic lanes. If possible, the entrance ramps will also be included in the field-of-view; however, there are several detector locations at which the entrance ramp may not be visible from the designated safe vantage point. Video cameras will be positioned above the traffic and aligned approximately parallel to the traffic stream to reduce occlusion by large vehicles.
- Once video recording has begun, data collection staff will use laser speed measurement devices (LIDAR) to collect reference data on traffic speeds. This speed data collection will occur during the allotted 60 minutes of video recording.
- All clocks on video cameras will be synchronized daily using the NIST Internet or telephone time service (http://tf.nist.gov/timefreq/index.html).

The following procedures will be used for data reduction:

- The video will be reduced by manually counting and classifying the traffic later in the office. A “double-blind” manual counting and classifying procedure will be used, which means that the traffic will be counted twice, with the second person counting having no information from the first count. If both manual counts agree to within 2.5 percent, then the manual reference count is complete and is calculated as the average of both counts. If the counts differ by more than 2.5 percent, then the traffic will be counted a third time, with no information from the first two counts. If the third count agrees to one of the first two counts to within 2.5 percent, then those two counts are averaged and the manual counting is complete.
- The manual reference counts will be performed by lane and divided into equal 15-minute periods. The final comparisons to FMS detector data may be at an aggregate level, but it is desirable to have manual reference counts at a disaggregate level.
- The manual reference counts will classify vehicles into the following three vehicle types: 1) passenger car and motorcycle; 2) trucks with length greater than or equal to 30 feet and less than 55 feet; 3) trucks with length greater than or equal to 55 feet. Since we will not be able to ascertain exact vehicle length from video, we will focus on total truck traffic, with some attempt to distinguish between small box trucks and larger tractor-trailer combinations.