



Research Connection Presentation

Hosted by Division of Research, Innovation and System Information (DRISI)

Improving Traffic Census and Highway Performance Monitoring System Data at Caltrans

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Presentation Summary

- *Discover the benefits of a data collection plan, collection methods, data collection cycles, and estimated costs.*
- *Identify and evaluate count locations for motorized traffic data collection on public roads in California*
- *Improve data reports from Caltrans to FHWA*
- *Review and summarize emerging traffic data collection technologies appropriate for Census reporting purposes.*



Outline

- **Presentation Summary**
- **Highway Performance Monitoring System (HPMS)**
 - **Segment selection**
 - **Count schedule and budget**
 - **Sample adequacy and maintenance**
 - **Recommendations**
- **Traffic Census**
 - **Mainline census and PeMS stations**
 - **Recommendations**
- **Emerging Data Collection Technologies**
 - **Current Status**
 - **Recommendations**



I. HPMS Study: Objective & Methodology

BACKGROUND

- **Highway Performance Monitoring System (HPMS):** all roads open to public travel are reported in HPMS
- Caltrans is required to collect volumes at 3 to 6 year cycles for most roads and report VMT to FHWA in a summary table format.
- One of Caltrans main concerns regarding HPMS data collection and reporting is the lack of traffic data on 119,142 miles of Local roadways (FC=7) due to lack of resources.

STUDY OBJECTIVE

- **Develop a data collection implementation plan that contains data collection methods, data collection cycles, sampling site selection and estimated costs for local roadways (FC=7) in California**



Public Roadways in California (2018)

Area Type	Interstate	Principal Arterial (Freeway or Expressway)	Principal Arterial (Other)	Minor Arterial	Major Collector	Minor Collector	Local	2018 Total Distance (miles)
	FC = 1 (miles)	FC = 2 (miles)	FC = 3 (miles)	FC = 4 (miles)	FC = 5 (miles)	FC = 6 (miles)	FC = 7 (miles)	
Rural On-System	1,186	369	3,070	4,891	743	-	-	10,259
Rural Off-System	-	-	194	1,249	11,289	7,487	40,797	61,016
Urban On-System	1,270	1,549	1,382	563	69	-	-	4,833
Urban Off-System	-	1	5,313	10,398	12,544	368	70,858	99,482
Total	2,456	1,919	9,960	17,100	24,645	7,854	111,655	175,959

On-System roadways are owned and maintained by Caltrans

Off-System roadways are owned and maintained by other government agencies or private authorities



HPMS software provides randomly selected count locations for:

Urban and Small Urban areas:

- Interstate (FC=1)
- Principal Arterial (FC=2 and FC=3)
- Minor Arterial (FC=4)
- Major Collector (FC=5)
- Minor Collector (FC=6)

No Local (FC=7)
for Small Urban

Rural areas:

- Interstate (FC=1)
- Principal Arterial (FC=2 and FC=3)
- Minor Arterial (FC=4)
- Major Collector (FC=5)

No Minor Collector (FC=6)
or Local (FC=7)
for Rural



HPMS Samples

The size of HPMS samples are based on three components:

1. Variability (coefficient of variance of AADT)
2. Functional system confidence interval and precision level
3. Number of TOPS sections in a volume group

Sample-size estimation formula:
$$n = \frac{\left(\frac{z^2 c^2}{d^2}\right)}{1 + \left(\frac{1}{N}\right)\left(\left(\frac{z^2 c^2}{d^2}\right) - 1\right)}$$

Where:

n = Required sample size

Z = Standard normal statistic for an alpha confidence level (two-sided)

C = AADT coefficient of variation from State's AADT data

d = Desired precision rate (from HPMS Table 6.2)

N = Number TOPS sections available for sampling in a volume group



Required (New) Samples by Caltrans District and Roadway Functional Classification Type

Caltrans District	Urbanized Area and Roadway Functional Classification Types				
	Urban	Small Urban	Rural	Rural	All Facility Types
	Local (FC=7)	Local (FC=7)	Minor Collector (FC=6)	Local (FC=7)	
1	-	7	4	5	16
2	1	2	13	15	31
3	6	14	13	12	45
4	14	3	4	3	24
5	-	4	5	4	13
6	4	21	14	19	58
7	25	1	3	1	30
8	12	10	2	7	31
9	0	1	2	3	6
10	4	5	10	10	29
11	7	1	7	5	20
12	1	-	-	-	1
CA-Statewide	74	69	77	84	304



HPMS Segment Selection Process Repeated for FC=6 and FC=7 Roadways

- Random locations (segments) were selected using the Caltrans Linear Referencing System (LRS) shapefile for Off-System roadways.
- The random location selection process was weighted by Caltrans LRS segment lengths, to create an unbiased selection process.
- With that, a two-mile roadway segment was four times more likely to be selected than a half-mile roadway segment.
- Randomly generated count locations in final [report's Appendix A](#)



New Count Schedule and Budget

Count Cycle (Year)	Caltrans Districts	Number of Counts
Year-1	1, 2	47
Year-2	3	45
Year-3	4, 5, 9	43
Year-4	8, 10	60
Year-5	7, 11, 12	51
Year-6	6	58
CA-Statewide	Total	304

Number of Lanes	Class / Non-Class	Current Bid Rate
1 to 2	Class	\$75.00
3 to 4	Class	\$325.00
5 to 6	Class	\$550.00
7 to 8	Class	\$925.00
1 to 2	Non-Class	\$55.00
3 to 4	Non-Class	\$80.00
5 to 6	Non-Class	\$105.00
7 to 8	Non-Class	\$125.00

For roadways that are not on the State Highway System, the Caltrans Traffic Count Guidelines states:

“It is recommended that two-thirds of the HPMS counts be volume counts, and that one-third be classification counts.”

Annual costs: approximately \$3,145

- 304 additional count stations,
- 6-year count cycle,
- 1/3 classification counts



HPMS Sample Adequacy & Maintenance (1)

2018 TOPS Samples Outside HPMS Recommended Section Length Ranges

HPMS Field Manual Recommended TOPS Section Quality Check	Number of Caltrans 2018 TOPS Samples Exceeding Threshold
Rural Sections (Urban Code=99999) with length < 0.3 miles	121 (16.3%)
Rural Sections (Urban Code=99999) with length > 10.0 miles	5 (0.7%)
Urban Access Controlled Facility Sections (FC=1 or FC=2) with length > 5.0 miles	3 (0.3%)
Other Urban Sections (FC=3 through FC=6) with length < 0.1 mile	3,356 (40.9%)
Other Urban Sections (FC=3 through FC=6) with length > 3.0 miles	67 (0.8%)



HPMS Sample Adequacy & Maintenance (2)

Count of 2018 TOPS Samples with Expansion Factor > 100

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
4681	-	-	8	-	11	-	n/a	19
33328	-	-	3	-	-	-	n/a	3
50527	-	-	3	-	-	-	n/a	3
51445	3	-	24	48	50	-	n/a	125
66673	-	-	3	-	-	-	n/a	3
73774	-	-	-	3	7	-	n/a	10
75340	-	-	3	5	8	-	n/a	16
77068	-	-	17	-	-	-	n/a	17
78310	-	-	-	-	3	-	n/a	3
78661	3	-	-	5	28	-	n/a	36
78904	-	-	23	19	44	-	n/a	86
79039	-	-	18	19	7	-	n/a	44
79309	-	-	6	-	-	-	n/a	6
79417	-	-	-	-	3	-	n/a	3
99998	-	-	-	21	38	-	n/a	59
99999	-	-	-	21	53	n/a	n/a	74
State Wide	6	0	108	141	252	0	n/a	507



HPMS: Recommendations

Add the 304 newly identified FC=6 & FC=7 count stations to the HPMS count locations.

Many of the TOPS samples with an expansion factor > 100 are shorter than the HPMS recommended section length.

- **Caltrans review to determine if the section lengths can be increased or if (longer) adjacent sections could serve as HPMS TOPS samples in lieu of these short sample sections.**

Currently Caltrans does not have any year-round count stations on the off-system SHWY roadway sections (for developing seasonal correction factors).

- **Select a small subset of the off-system count locations in each Caltrans District and install year-round count stations at these locations.**



II. Census Study: Objective & Methodology

BACKGROUND

- Data on annual average daily traffic (AADT), truck traffic, ramp volumes, peak hour volumes. Data collected by automatic counters based on a continuous count sampling.
- Caltrans Freeway Performance Measurement System (*PeMS*) archives traffic data from 44,935 permanent vehicle detectors in all Districts (except rural Districts 1, 2 and 9).
<https://pems.dot.ca.gov/>
- Currently, Caltrans Districts only nominally leverage PeMS data for meeting their annual traffic count obligations

STUDY OBJECTIVE

- Explore the feasibility of more effectively utilizing PeMS data for fulfilling the annual Census count obligations



Number of 2019 Mainline Census Stations and Matching PeMS Stations

Caltrans District	Number of Mainline Census Stations (FWY, EXP or CON)	Number of Matching Mainline PeMS Stations			Number of Matching Mainline PeMS Stations with Matching Number of Lanes			Average Distance between Census & PeMS Stations (miles)	
		Primary Direction	Secondary Direction	Both Directions	Primary Direction	Secondary Direction	Both Directions	Primary Direction	Secondary Direction
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	383	79	87	79	11	15	11	0.10	0.12
4	371	175	165	165	45	46	45	0.14	0.13
5	144	26	23	23	6	3	3	0.13	0.15
6	365	85	88	85	8	7	7	0.17	0.17
7	306	181	181	181	34	31	31	0.16	0.16
8	236	75	72	72	22	20	20	0.15	0.14
9	-	-	-	-	-	-	-	-	-
10	214	46	46	46	8	13	8	0.13	0.12
11	253	104	110	104	7	16	7	0.14	0.15
12	100	68	67	67	38	32	32	0.12	0.11
CA Statewide	2,372	839	839	822	179	183	164	0.14	0.14

Source: Census Count Locations: Caltrans – Traffic Census Program
 PeMS Station Locations: Caltrans – PeMS
 Census-To-PeMS Matching: U.C. Berkeley ITS/PATH



Census: Recommendations

**For the 164 matching PeMS-Census locations
(with number of lanes matching):**

- **Evaluate how well the Census reported AADTs match the PeMS estimated AADTs to identify if PeMS is a suitable data source for Caltrans Census needs.**

**For the 658 matching PeMS-Census locations
(without number of lanes matching):**

- **Ascertain whether factored PeMS volumes might be useful, or maybe useful for seasonality trends (e.g., monthly adjustment factors)**



III. Emerging Data Collection Technologies: Study Objective

BACKGROUND

- Numerous transportation data providers collect all kinds of information generated from global positioning system, Bluetooth, their own subscribers, and supplemental data these providers acquire from location-based service providers.
- The reliability and validation statistics of their resulting traffic performance metrics (including their AADT estimates) has been improving significantly over time.

STUDY OBJECTIVE

- Review and evaluate the commercially available volume data as an alternate to manually collected AADTs.



Emerging Data Collection Technologies – Current Status (1)

Availability and quality of traffic count data from commercial vendors continually increasing over time; with prices dropping. And more data validation reports are being published.

Currently, multiple competing commercial vendors:

- **CITILABS Streetlytics**
- **INRIX Volume Profiles**
- **STREETLIGHT InSights**

Use of commercial count data is quickly becoming more accepted. COVID-19 pandemic accelerated use and acceptability of “big-data” traffic count estimates.



Emerging Data Collection Technologies – Current Status (2)

Currently, StreetLight Data is engaged with FHWA on a validation study for Big-Data as an alternate means for HPMS reporting.

- **Project Number: 693JJ319C000015**
- **Project Title: Non-Traditional Methods to Obtain Annual Average Daily Traffic (AADT) Evaluation and Analysis“**

At least one state DOT (Minnesota) is using StreetLight Data under the alternate methods provision currently allowed by FHWA for reporting performance metrics.



Emerging Data Collection Technologies: Recommendations

Commercial big-data has become a viable data source for HPMS/Census reporting purposes.

Commercial big-data will become even more of a pragmatic (cost-efficient and appropriate) choice as the reliability and public acceptance continue to improve.

- **Use PeMS where possible – to fulfill HPMS/Census traffic volume requirements**
- **Conduct a pilot study – using commercial big-data to fulfill HPMS/Census traffic volume requirements**



Project Final Report

<https://escholarship.org/uc/item/64g416gb>

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Questions / Comments

Thank You!