Determining Traffic Volumes Using Video Imagery Obtained from Transit Buses in Regular Service: Research, Education, and Outreach

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MOTIVATION

- Traditional traffic data collection is based on automatic or human counters observing traffic at a **fixed location** on a roadway segment over a **long time period**. As a result of limited resources, few segments can be monitored and can only be monitored infrequently.

- **Transit buses** are presently equipped with video cameras for safety, security, and liability purposes and cover most major urban roadways on a **repeated basis**.

- This project seeks to **develop and validate** an approach to take advantage of presently available, public sector platforms (transit buses) and sensors (video cameras) to obtain traffic volumes over urban roadways, to apply the approach in an **operational setting**, and to use developments to enhance graduate and undergraduate engineering **education**.
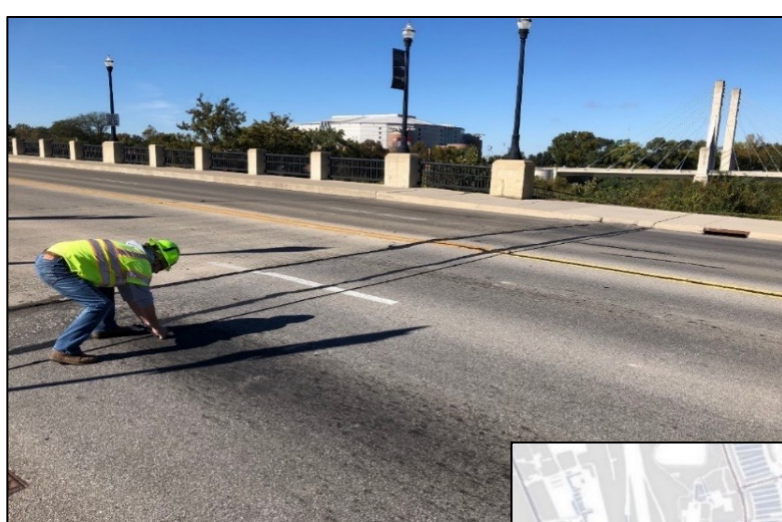
RESEARCH METHODOLOGY

- The underlying methodology developed consists of two major components:
  - Modification of the **"moving observer"** method to determine volumes from one-direction **bus passes**.
  - Refining and aggregating volumes estimated from individual bus passes into **volume estimates for time-of-day periods**.

$$V^h = \int_{t \in h} q(t)dt \qquad q(t_1) = \frac{n^{veh}}{t_1+t_2}$$

$$V^{7:30-8:30}$$
392 vehicles
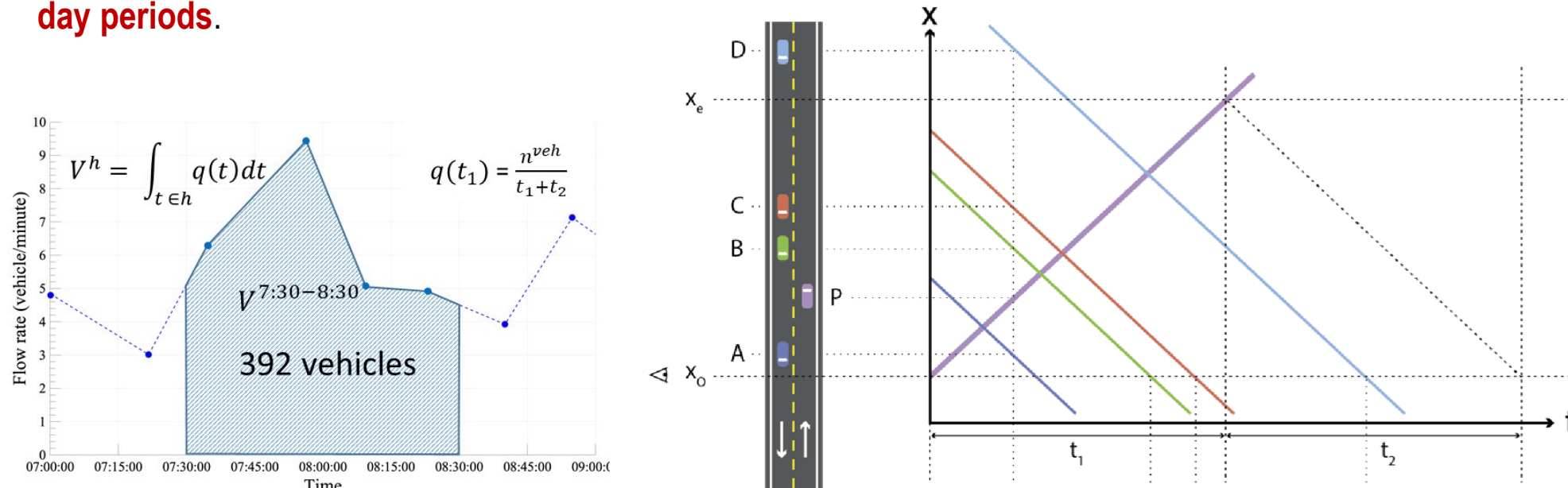
RESEARCH VALIDATION

- Extensive comparisons are conducted over years between **video-based** estimates and **road tube** measured volumes and network-wide **vehicle miles traveled (VMT)** considering **published growth factors** and **known traffic patterns** on The Ohio State University campus (Campus Transportation Lab).
- Similar comparisons are made using volume estimates from a popular **Location-based Service (LBS)** data aggregator and supplier.

FC	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
R 1	2.404%	3.50%	2.10%	2.20%	1.00%	0.50%	-18.10%	16.60%
R 2	1.885%	3.30%	4.30%	5.10%	0.00%	1.00%	-14.90%	14.80%
R 3	1.163%	3.60%	3.20%	3.40%	0.50%	1.10%	-12.20%	11.80%
R 4	0.862%	2.60%	1.10%	2.10%	0.00%	2.20%	-11.10%	9.20%
R5	1.687%	1.50%	2.60%	1.00%	0.50%	0.50%	-8.00%	5.70%
R 6 & 7	-0.785%	4.40%	2.50%	0.00%	0.30%	1.60%	-3.70%	1.10%
U 1	0.482%	2.90%	2.00%	1.80%	1.00%	0.30%	-18.10%	13.60%
U 2	1.615%	2.70%	2.40%	2.90%	1.40%	2.40%	-15.20%	11.80%
U 3	0.663%	1.90%	2.10%	0.00%	0.00%	1.00%	-12.40%	9.90%
U4	-2.540%	1.10%	4.20%	2.70%	0.90%	0.70%	-7.40%	4.80%
U 5 & 6 & 7	1.460%	3.30%	5.00%	2.80%	1.20%	1.50%	-9.80%	7.20%

Ohio DOT Annual Adjustment Factors for ADT: 2014 – 2021
https://www.transportation.ohio.gov/programs/technical-services/tech-services-respository/annual-adjustment-factors-thru-year

Road Tubes
Compliments of Mid-Ohio Regional Planning Commission

OSU Comparison Network
40 Segment-Directions
6.3 Dir-Mi

RESEARCH VALIDATION (CONT.)

- Estimates of segment-hour-direction volume estimates, 10-hour VMT, and time-of-day patterns determined from bus-based volumes are **much closer to road tube-based results** (ground truth) than are estimates determined from LBS data.

Segment-hour-direction volumes (ARD: Absolute value of relative difference from road tube based values)

	Video-based volumes	LBS-based volumes
No. of Seg-dir-hr (sample size)	280	280
ARD mean	0.2070	1.1566
ARD std	0.1957	1.6110
ARD median	0.1565	0.5680
ARD 10th percentile	0.0278	0.1029
ARD 90th percentile	0.7392	6.8811

10-hour network Vehicle Miles Traveled (VMT)

Year	Video VMT	LBS VMT	Tube VMT	Video vs. Tube ARD	LBS vs. Tube ARD
2018	7,592	13,445	7,610	0.23%	76.68%
2019	5,570	6,914	5,054	10.21%	36.80%
2020	5,210	11,039	4,929	5.72%	123.96%

2018

2019

Proportion of 10-hour VMT carried in hour by data source

2020

- **Year-to-year changes** in 10-hour Vehicle Miles Traveled and time-of-day patterns determined from bus-based volumes **correspond to published Ohio DOT growth factors** and known local traffic patterns **much better** and with much better precision than do **changes determined from LBS data**.

Proportion of 10-hour VMT carried in hour by year

Video-based VMT

LBS-based VMT
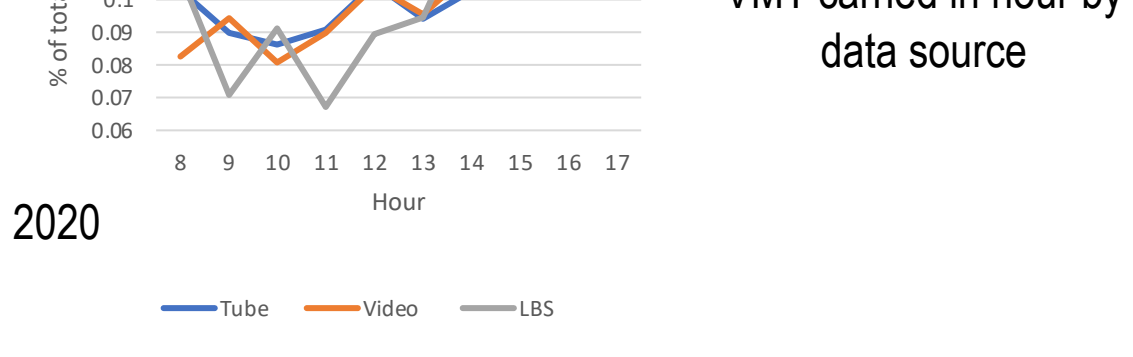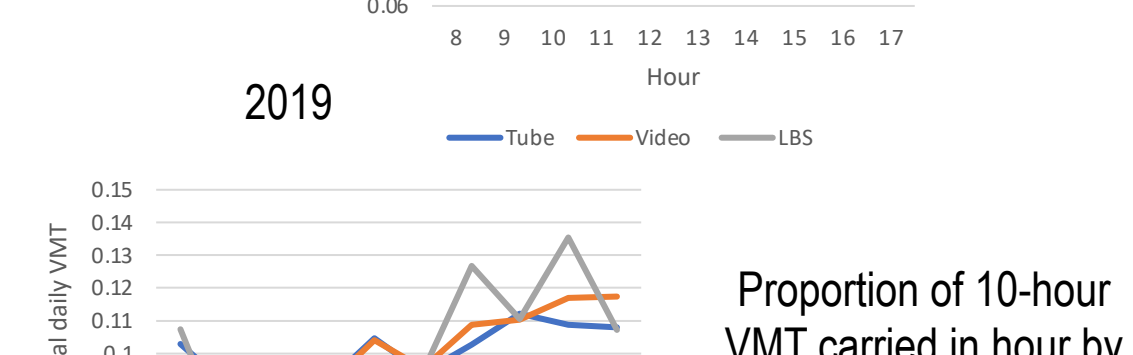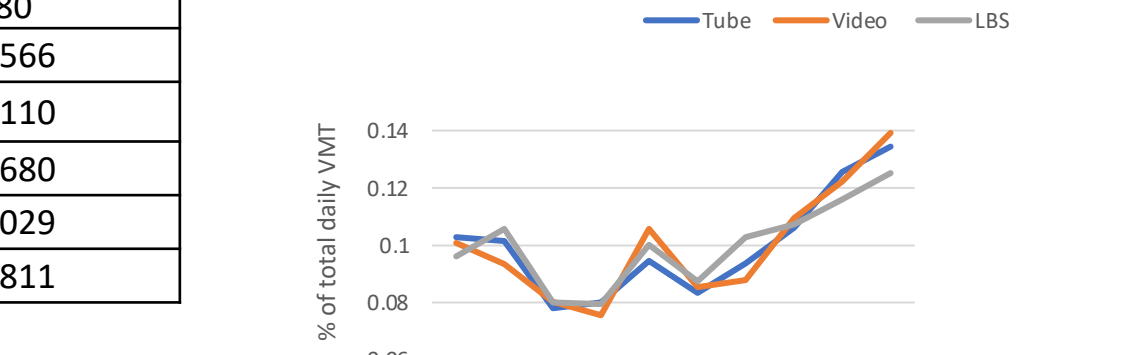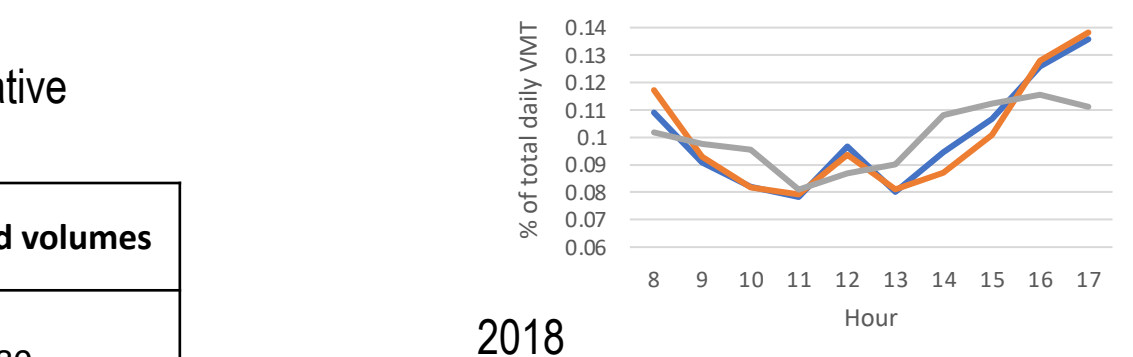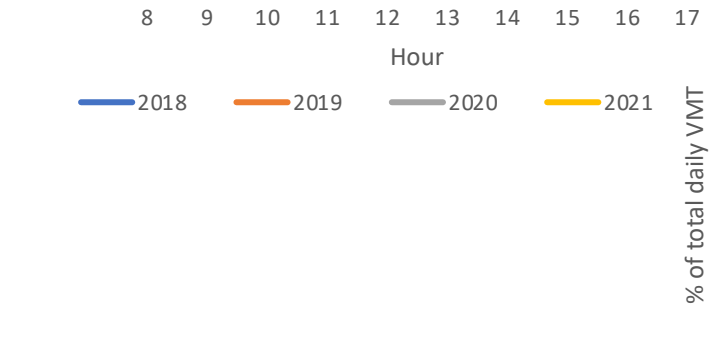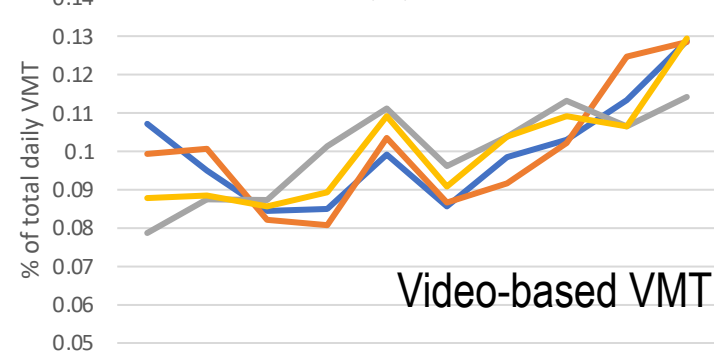
10-hour network Vehicles Miles Traveled (VMT) by year and Growth Factors (GF) using 2018 as reference

Year	Video VMT	LBS VMT	Video GF	LBS GF	ODOT GF
2018	18,268	34,269			
2019	18,303	38,230	1.02	1.12	1.02
2020	9,431	32,883	0.53	0.96	0.92
2021	14,378	37,322	0.80	1.09	0.98

Average Absolute Value of Differences (AAD) in time-of-day patterns for consecutive years

Year, Year + 1	Video AAD	LBS AAD
2018-2019	0.0044	0.0110
2019-2020	0.0132	0.0130
2020-2021	0.0051	0.0114

EDUCATION

- **Graduate** students are involved with conceptual developments, empirical analysis, software developments, data collection, and processing.
- **Undergraduate** students are involved with organization, supervision, and implementation of data collection, and with data processing.


EDUCATION (CONT.)

- An annual **graduate/undergraduate class** (CIVILEN 5720 – Transportation Data Studies) complements traditional traffic data collection with project developments in a group term project.

CE 5720
**Transportation Engineering Data Collection Studies**
Autumn 2021
Term Project: Estimating Campus Segment Volumes and VMT Using Data from Multiple Sources
Group 3: Cassidy Beharry, Hayleigh Coppenger, Kenneth Harvey, Harsh Shah
**Date:** December 9, 2021
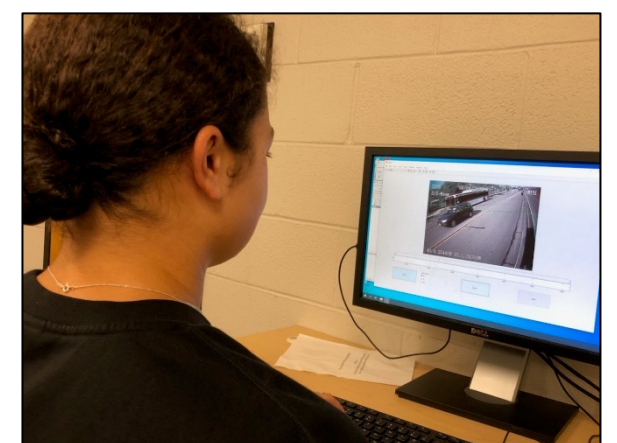

OUTREACH APPLICATIONS

- Annual estimates of campus roadway network vehicle miles traveled (VMT) determined from bus-based video volumes are **provided annually to OSU administrators, planners, and operators**.
- Size of network monitored has increased since initial effort.
- **Time-of-day patterns** will now be provided.
- These are the **only estimates of campus roadway VMT**.
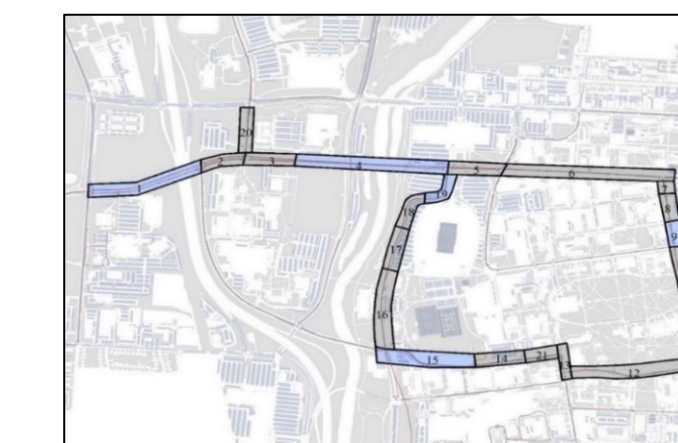
2018, 6.3 Dir-Mi, 10-hour VMT = 18.500
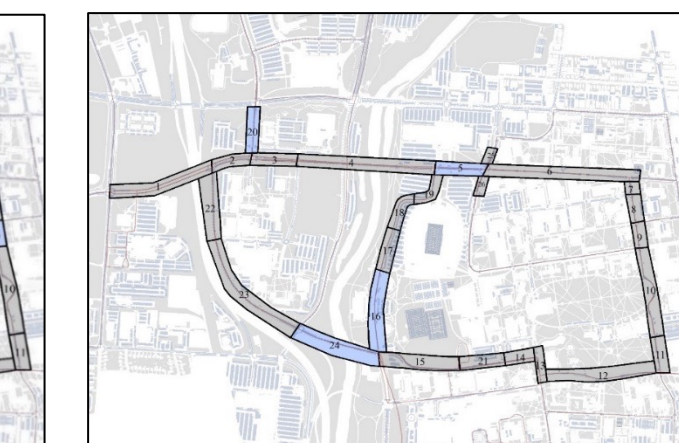
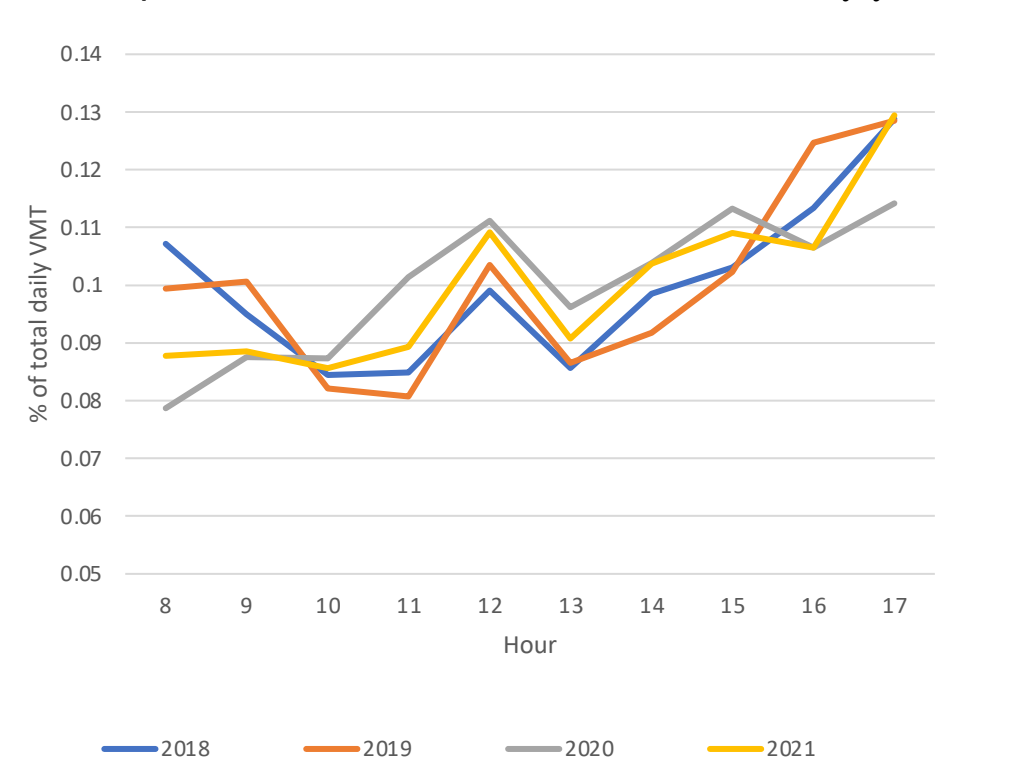2019, 7.7 Dir-Mi, 10-hour VMT = 23,300
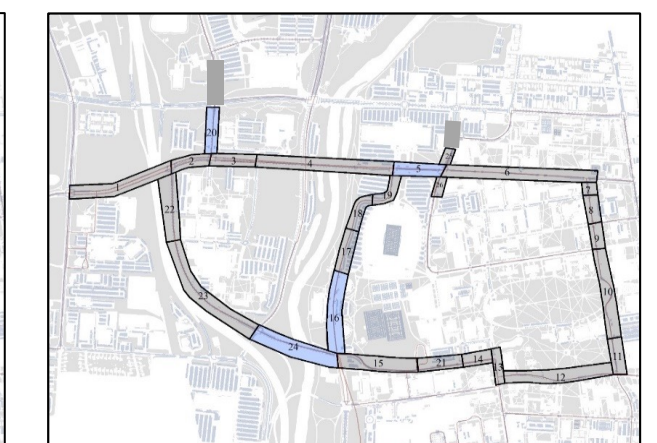
2020 / 2021, 8.0 / 7.7 Dir-Mi, 10-hour VMT = 13,500 / 17,900

10-hour VMT by year and Growth Factors (G.F.) using 2018 as base on common 6.3-direction-mile network

	VMT	G.F.
2018	18,673	---
2019	19,068	1.02
2020	10,455	0.56
2021	15,424	0.83

Proportion of 10-hour VMT carried in hour by year