Development of Standardized Models in Kentucky Using AirSage Data

CATMUG Meeting

Chicago, IL

December 7, 2016

KENTUCKY TRANSPORTATION CABINET

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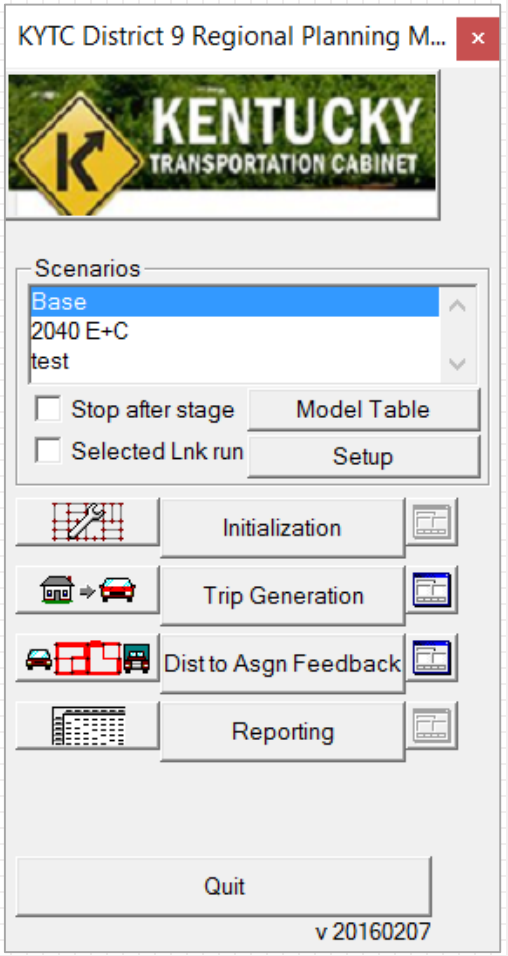
Outline

- Background
- AirSage Pre-processing & Adjustment
- AirSage Application
  - Trip Generation
  - Trip Distribution
  - Time-of-Day
  - Directional Factor
- Findings

Background

KYTC's regional TDMs

- Currently using TransCAD 5. In transition to TransCAD 6.
- Standardized organization of files, model stream, script and interface
- Trip-based, 3-step (TG, TD & TA).
- 5 auto trip purposes (HBW, HBO, NHB, HBSchool, HBUniversity).
- 3 truck trip purposes (light, medium, heavy)
- 4 time periods (AM, PM, MD, NT)
- Flexibility of using Big Data to enhance model components.



AirSage in Kentucky

- No recent HH OD survey data in KY. No NHTS add-on.
- Cell phone data (not GPS data).
- Lower cost compared to traditional HH travel surveys.
- Quick turnover.
- AirSage provides ODs by purpose and time period.
- When data collection area is large enough, external trip info. can be obtained. Good data at the edge of study area.
- KYTC first purchased AirSage data for Lexington Model (2012). Complete 5 regional models so far. All used AirSage data.
- KYTC and its consultants have gained thorough insight in using AirSage data for model development.

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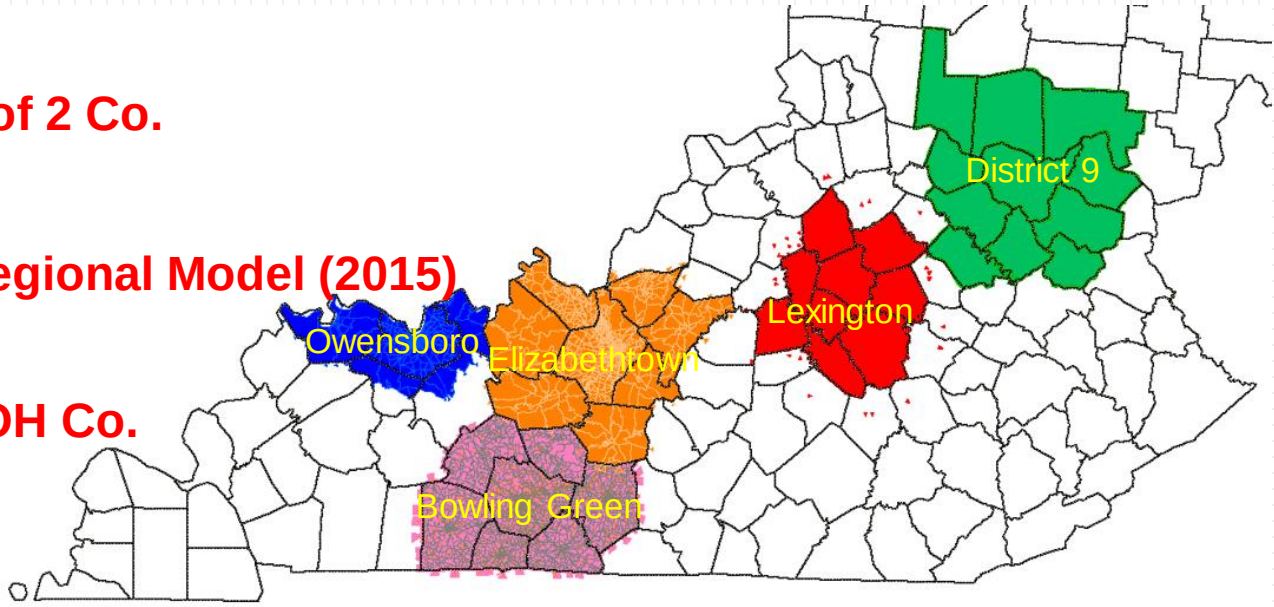
Background

KYTC's Completed Regional Models

- Lexington/Central KY Region (2012)
- Bowling Green/Warren Co. (2014)
- E-town/Hardin Co./Meade Co. (2014)
- Owensboro/Daviess Co. Region (2014)
  - 160K pop
  - 3 Co. + parts of 2 Co.
  - Small MPO
- KYTC District 9 Regional Model (2015)
  - 300K pop
  - 8 KY Co. + 3 OH Co.
  - Rural



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AirSage Data Pre-processing

Example of AirSage Data (.CSV)

Origin_Zone	Destination_Zone	Start_Date	End_Date	Aggregation	Subscriber_Class	Purpose	Time_of_Day	Count
74	286	20150415	20150514	WD	Resident	OH	H1800:H2400	12.47
315	225	20150415	20150514	WD	Visitor	OO	H0900:H1500	5.9
432	433	20150415	20150514	WD	Resident	WH	H0900:H1500	11.84

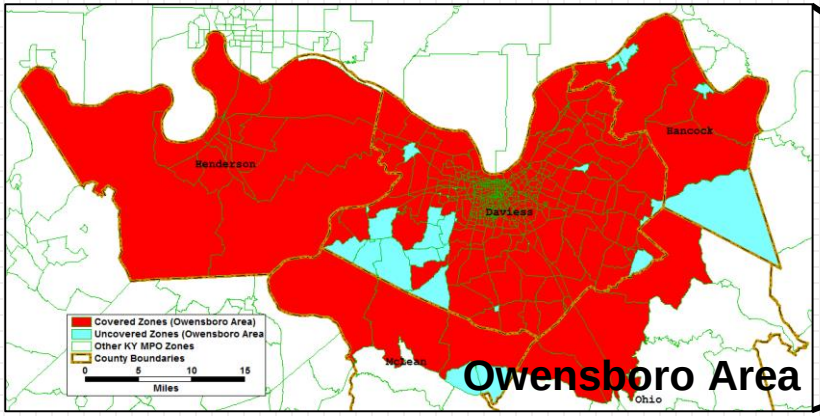
- Must provide pre-defined TAZ polygons to AirSage. AirSage has resolution limit (0.25 square mile grid).
- AirSage provided “expanded” data which matches census population by carriers.
- When multiple carriers exist (e.g., Owensboro Model), averaging data sets minimizes data bias.

AirSage Data Pre-processing

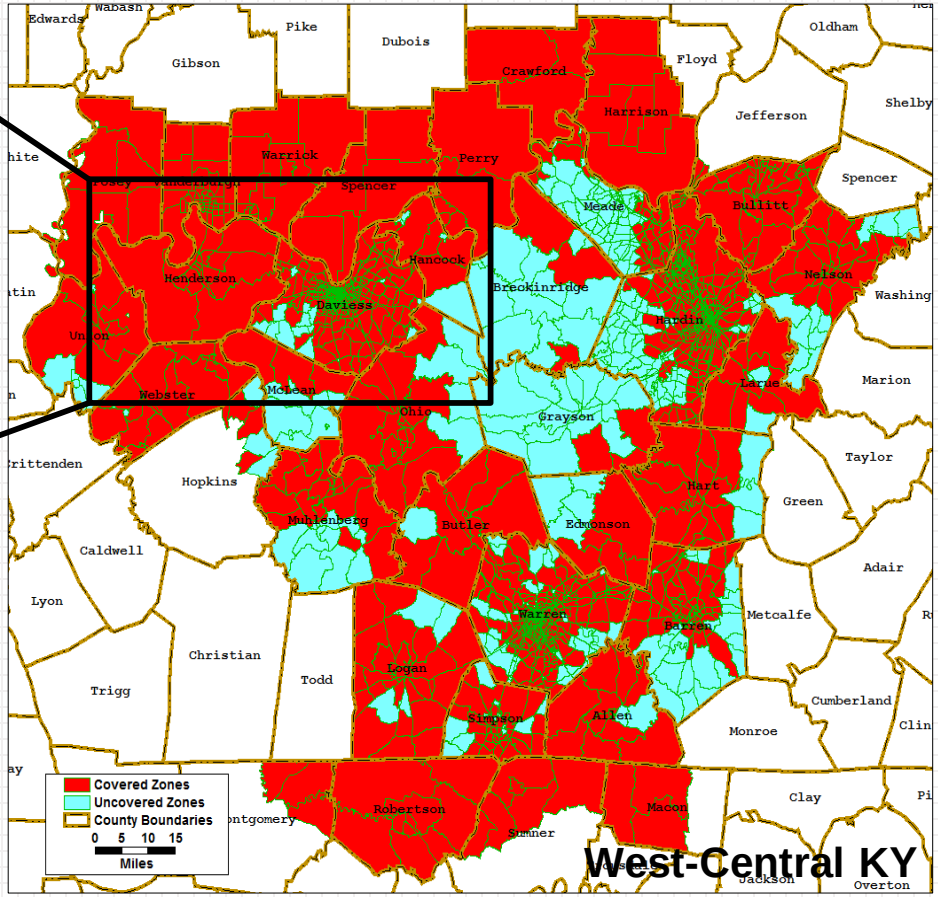
- **Day Parts (can be customized to match model)**
  - AM peak = 6:00-9:00
  - Mid-day = 9:00-15:00
  - PM peak = 15:00-18:00
  - Night = 18:00-24:00 & 0:00-6:00
- **Trip Purpose: (H-home, W-work, O=other)**
  - HBW = HW, WH
  - HBO = HO, OH, HH
  - NHB = WO, OW, WW, OO
- **Convert .CSV file to OD matrix (3 purposes x 4 periods)**

AirSage Data Coverage Assessment

Owensboro/Daviess Co.



Owensboro Area



West-Central KY

- Data collected for west-central KY
- 95% of 566 Owensboro zones had data
- 94% Pop & 97% Emp are covered
- Lack of data in adjacent rural counties with poor cellar service. No impact on external trips (0.2% of Owensboro work flows - CTPP).

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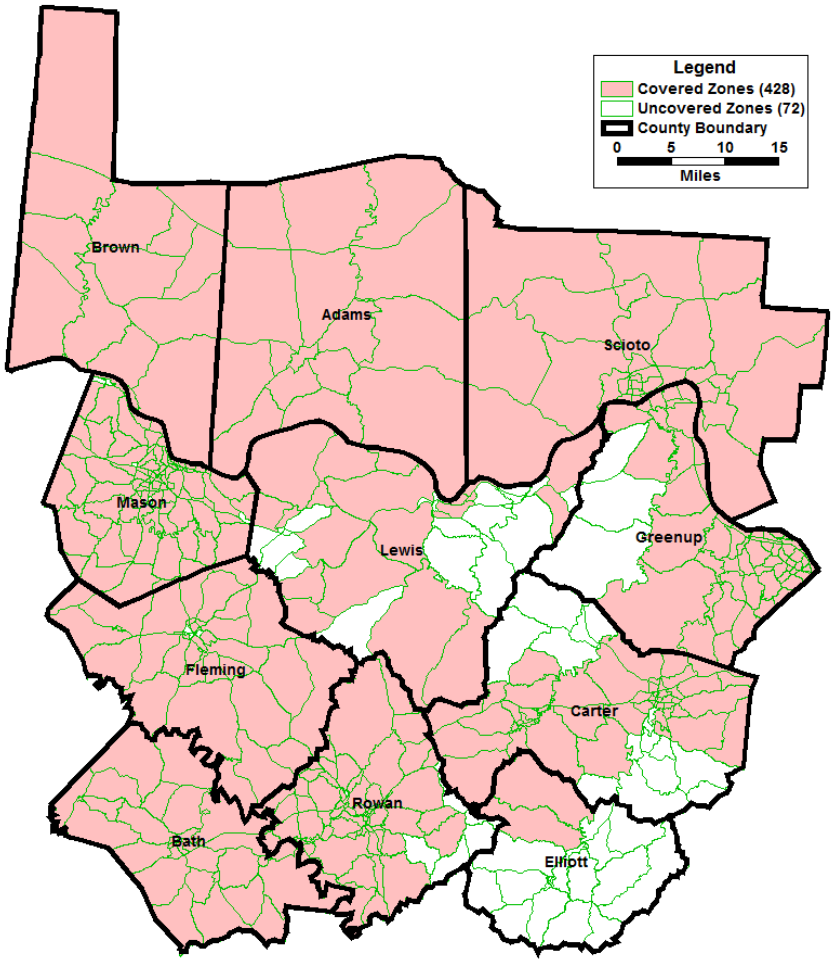
AirSage Data Coverage Assessment

KYTC District 9 Area



- Data collected only for D9 area
- A 500-zone structure was used for AirSage data acquisition.
- 85% of 500 zones had data.
- 92% Pop & 93% Emp are covered
- Uncovered zones are very rural, sparsely populated areas
- A refined 620 zones (final model TAZ) was used for friction factor development.

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Power of Big Data

- **HH survey: 11% of total zones (an Indiana example)**
- **AirSage: 85 ~ 95% of total zones**

  (Owensboro – 28,085 OD pairs with data)

  (District 9 – 22,111 OD pairs with data)

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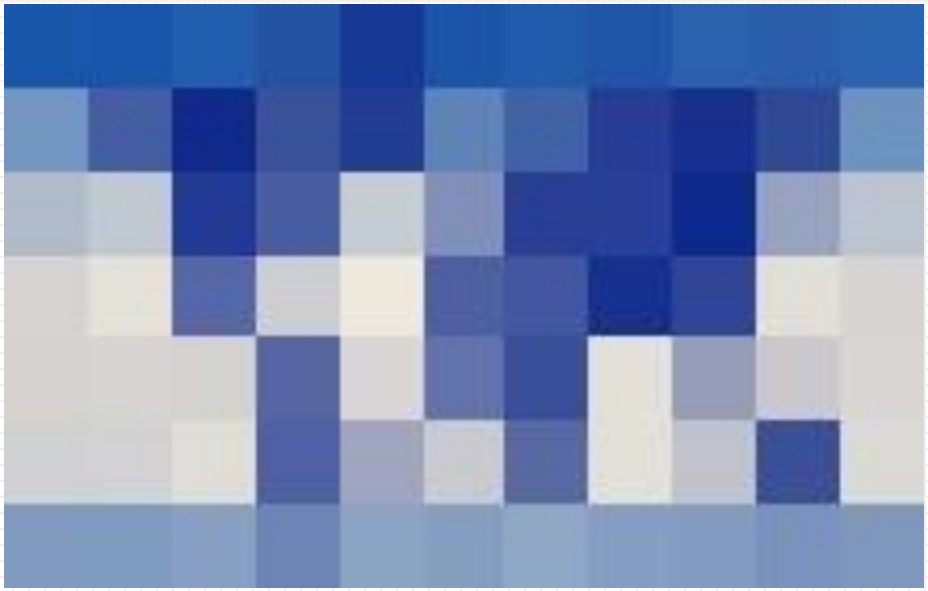
Power of Big Data

What can we see based on 11%?



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Power of Big Data

How about based on 90%?

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Power of Big Data

Big Data = Insight

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AirSage Data Adjustments (Intrazonals)

Owensboro

Purpose	Total	Intrazonal	Intrazonal %
HBW	150,012	1,951	1.3%
HBO	330,101	89,822	27.2%
NHB	95,250	29,640	31.1%
Total	**575,363**	**121,413**	**21.1%**

Note: Data is from raw AirSage (all trips)

District 9

Purpose	Total	Intrazonal	Intrazonal %
HBW	118,429	5,339	4.5%
HBO	654,781	324,717	49.6%
NHB	355,881	109,520	30.8%
Total	**1,129,090**	**439,576**	**38.9%**

Note: Data is from raw AirSage (all trips)

- **Except for HBW trips, intrazonal trip percentages seem too high**
- **HBO & NHB introzonals were reduced to more conventional levels before developing friction factors.**

Trip Generation - Trip Rates

- Previous experience indicates AirSage may not be suitable for directly determining trip generation rates. Analysis is limited due to aggregated data & resolution limits.
- Owensboro (small MPO) has too few NHB trips. Home-based additional trips or short-distance trips may not be captured.
- D9 region (rural area) generally has more trips.
- Not much improvement by ODME

Owensboro

Purpose	AirSage		Calibrated Model	
	Internal P's	%	Internal P's	%
HBW	104,628	24%	100,543	20%
HBO	262,339	60%	262,892	52%
NHB	72,025	16%	140,013	28%
Total	438,992	100%	503,448	100%
Trip Rates	**6.8**		**7.7**	

District 9

Purpose	AirSage		Calibrated Model	
	Internal P's	%	Internal P's	%
HBW	118,429	10%	160,704	18%
HBO	654,781	58%	466,274	53%
NHB	355,881	32%	258,846	29%
Total	1,129,090	100%	885,824	100%
Trip Rates	**9.6**		**7.6**	

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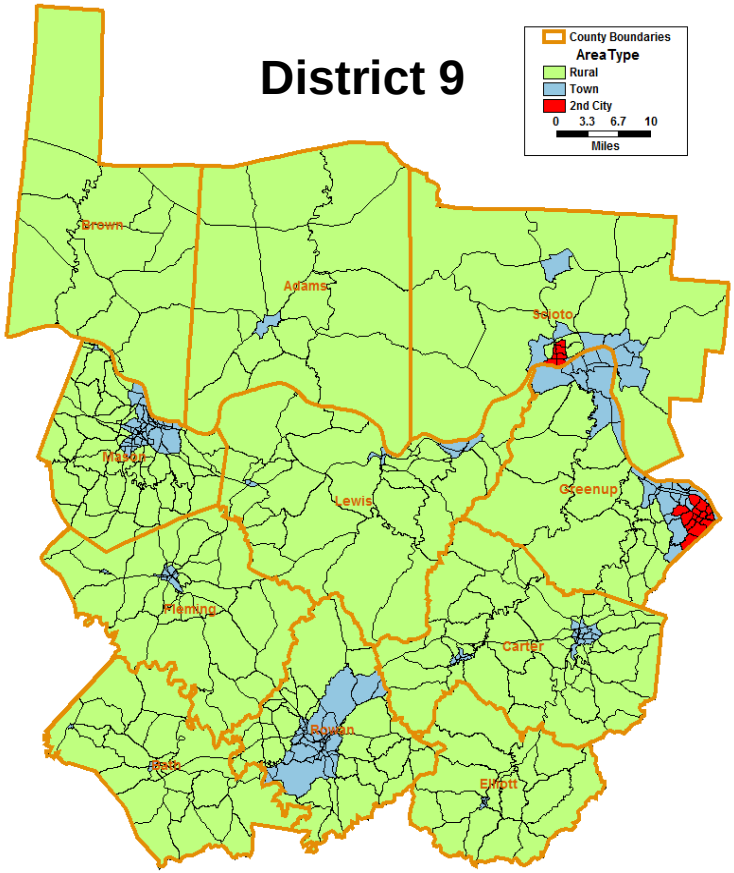
Trip Generation - Area Type Factors

Assumption: Data bias is diminished, if not completely offset between area type samples, by a factoring process.

- Rural, Town & 2nd City
- Convert OD to PA
  - HBW = HW + Transpose(WH)
  - HBO = HO + Transpose(OH) + HH
- NHB data not used (not real P's by HH)
- AirSage P's rates (by purpose & area type)
  - Remove outliers (95% CI)



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Trip Generation - Area Type Factors

- Area Type Factors (t-test of P rates between area types)
  - If significantly different, factor = ratio of P rates
  - Otherwise, factor = 1.0
- Factors of Rural vs. Towns are reasonable (HBW=1.0, HBO=0.9)
- Factors for Rural vs. 2nd City, Towns vs. 2nd City are too large.
- Available data (KYSTM) suggests same rates for Towns & 2nd City (consolidated as Non-Rural).
- For NHB, factor (=1.0) is derived from NCHRP 716 and KYSTM.

Purpose	D9 Model Area Type Factor	
	Rural	Non-Rural
HBW	1.0	1.0
HBO	0.9	1.0
NHB	1.0	1.0

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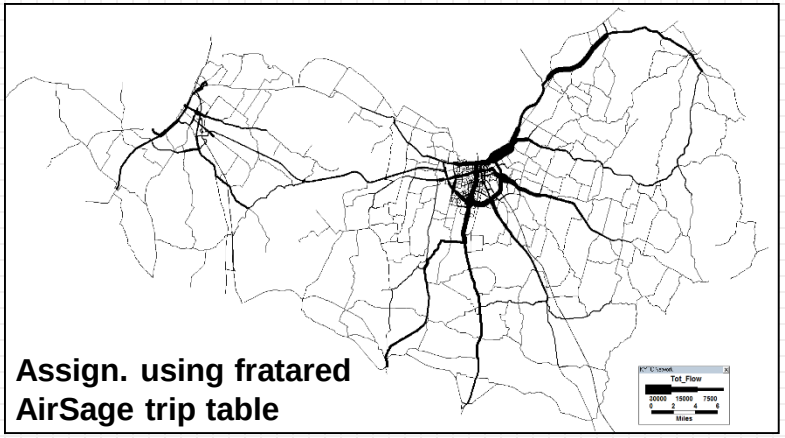
Trip Distribution – Friction Factors

Owensboro Method

- AirSage PA tables (internal, by purpose) are fratared to match default target P's (NCHRP 716) and A's (NCHRP 365).
- Fratared trip tables work better than raw data



Assign. using fratared AirSage trip table

Traffic Assignment	Total Traffic (Count Links)	Avg. Dev % from Counts *
AirSage (raw)	907,259	-59.2%
AirSage (fratared)	1,397,946	-19.8%
Traffic Counts	2,275,196	

* Simple average error, not RMSE

- Friction factors were developed using TransCAD gravity model calibration function. Further adjustment in model calibration.

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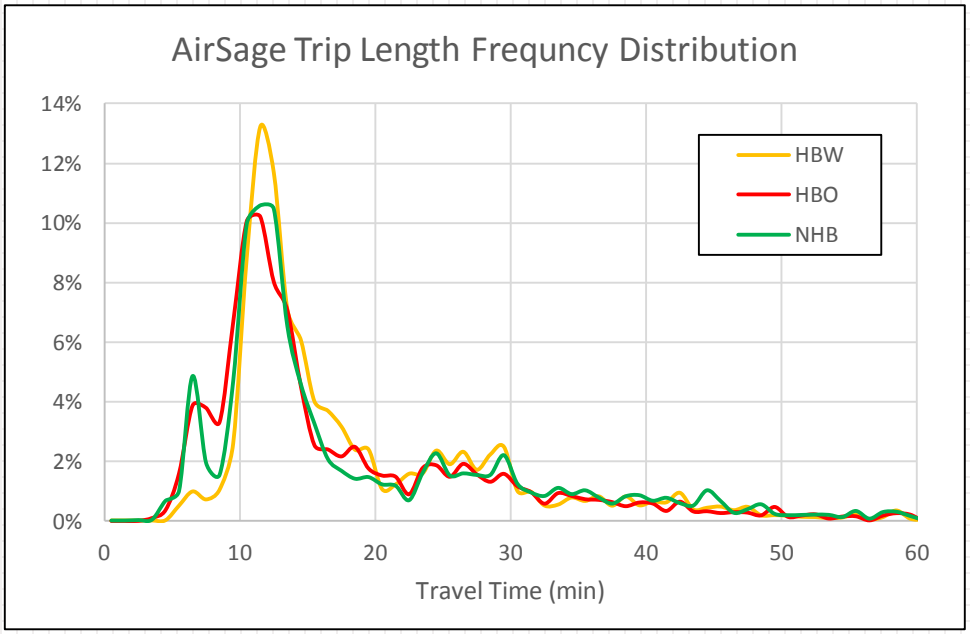
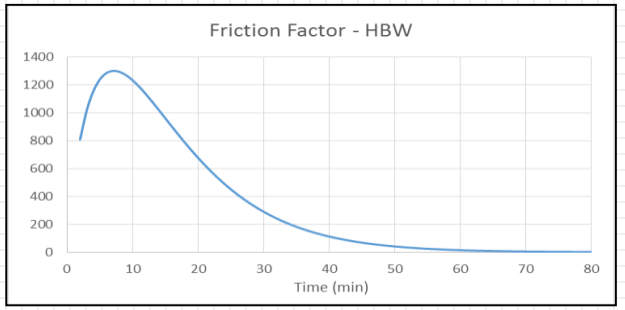
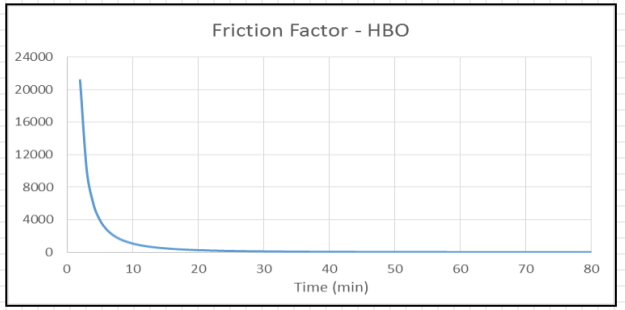
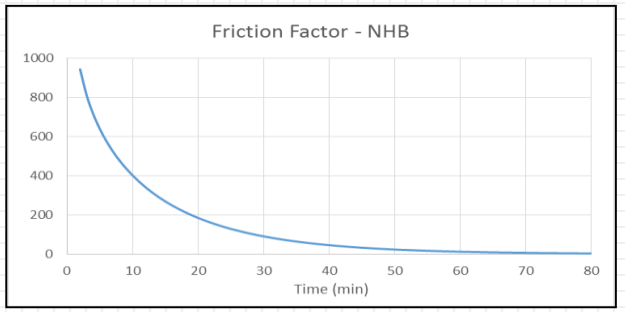
Trip Distribution – Friction Factors

Owensboro Method









Trip Purpose	Mean Trip Length (min)	
	AirSage	Calibrated Model
HBW	19.1	15.7
HBO	17.8	14.9
NHB	19.4	14.4

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Trip Distribution – Friction Factors

District 9 Method (revised approach)

- KY local trip rates usually are unknown and differ from national defaults. Calibrate AirSage OD tables to traffic counts.
- ODME

Full seed OD table = I-I + I-E/E-I + E-E

I-I	I-E/E-I	E-E
AirSage (all purpose)	Land Use Data + NCHRP 716	KYSTM extraction + Fratar

- Disaggregate ODME trip table by purpose – based on original AirSage data
- Friction factors (by purpose) were developed using TransCAD gravity model calibration function.

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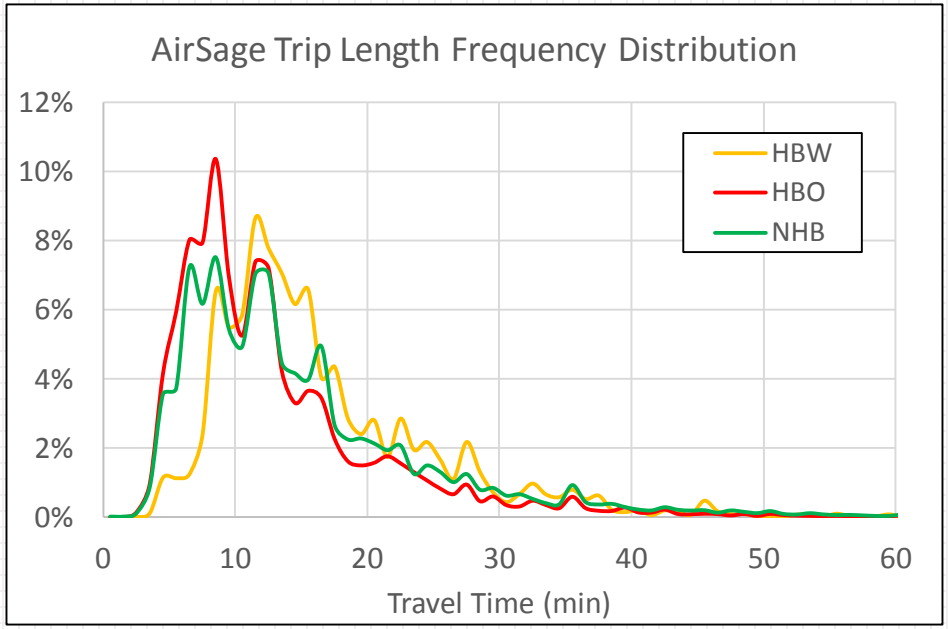
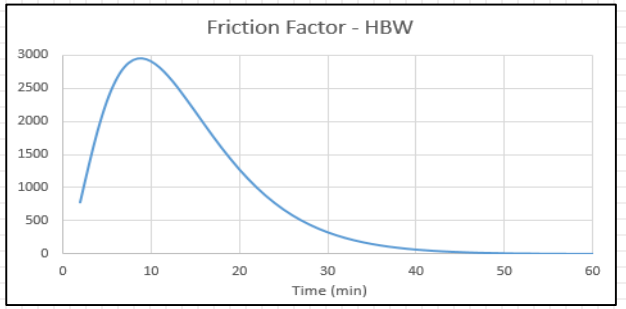
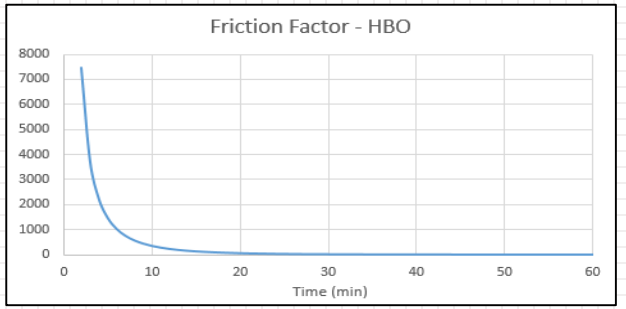
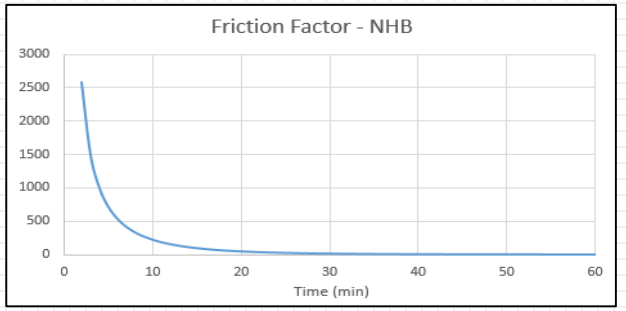
AirSage – Trip Length Distribution

District 9 Method (revised approach)









Trip Purpose	Mean Trip Length (min)	
	AirSage	Calibrated Model
HBW	16.8	17.3
HBO	13.3	12.5
NHB	15.3	13.7

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AirSage TOD & Directional Factors

Owensboro (TOD)

Purpose	AM (6-9am)	Mid-Day (9am-3pm)	PM (3-6pm)	Night (6pm-6am)
HBW	0.26	0.25	0.18	0.31
HBO	0.17	0.30	0.19	0.34
NHB	0.12	0.47	0.23	0.18
E-I Auto	0.20	0.30	0.20	0.30
E-E *	0.19	0.31	0.20	0.30

* Assumed by average of all purposes

District 9 (TOD)

Purpose	AM (6-9am)	Mid-Day (9am-3pm)	PM (3-6pm)	Night (6pm-6am)
HBW	0.28	0.27	0.19	0.26
HBO	0.17	0.30	0.19	0.34
NHB	0.19	0.37	0.22	0.22
E-E *	0.19	0.32	0.20	0.29

* Assumed by average of all purposes

Owensboro (direction – P to A)

Purpose	AM (6-9am)	Mid-day (9am-3pm)	PM (3-6pm)	Night (6pm-6am)
HBW	0.91	0.51	0.16	0.43
HBO	0.85	0.53	0.43	0.33
E-I Auto *	0.85	0.53	0.43	0.33

* Assume equal to HBO

District 9 (direction – P to A)

Purpose	AM (6-9am)	Mid-day (9am-3pm)	PM (3-6pm)	Night (6pm-6am)
HBW	0.94	0.49	0.16	0.39
HBO	0.85	0.54	0.42	0.34
E-I Auto *	0.85	0.54	0.42	0.34

* Assume equal to HBO

- **AirSage TOD / Directional factors seem reasonable.**
- **TOD factors can be adjusted further to match TOD counts in model calibration.**
- **Large data collection area = good data for external trips & at study area edges.**

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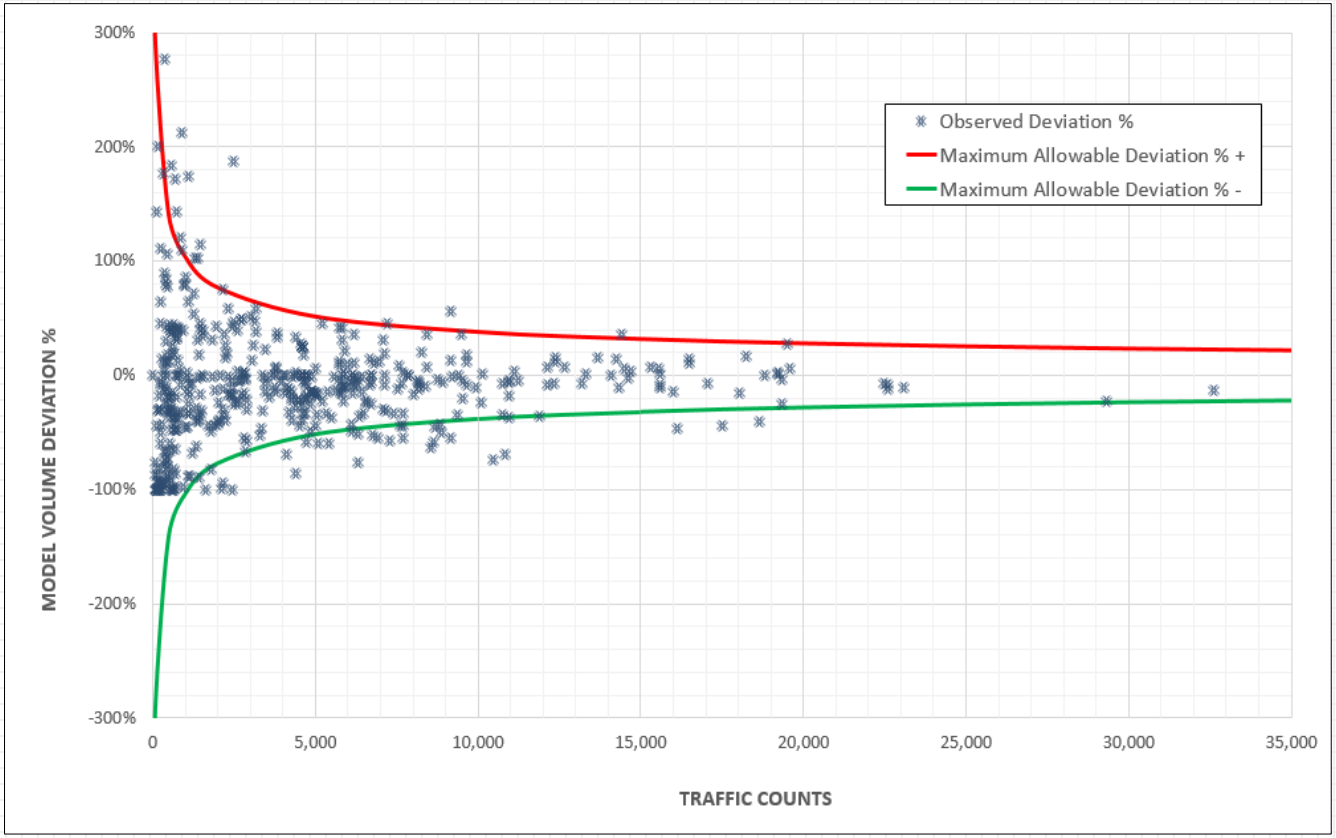
Traffic Assignment



D9 Model RMSE%:

- **Overall = 42.6% (KYTC target = 55%)**
- **Rowan County = 24.0% (KYTC target = 35%)**

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AirSage Advantages/Disadvantages

- **Advantages**
  - Very large dataset.
  - Low cost when compared to surveys. Quick turnover.
  - Trip purpose, TOD & direction are available
  - Large coverage are readily available.
  - Good data penetration / saturation
- **Disadvantages – adjustments required**
  - Everything is aggregate. Characteristics of travelers are not available.
  - Trip purpose is based on activity clusters and times of data transmissions.
  - Data transmission times may not accurately reflect when travel occurs.
  - Resolution limits & thresholds of determining device's location (5 min / 300 meters) – may miss short- dist./duration trips, i.e., small zones or urban areas.
  - Unusual results in the trip tables (intrazonal, trip rates)

Summary of Findings

- Findings are based on our understanding of the AirSage product. AirSage product is evolving, so future data may address the issues.
- AirSage data may not be suitable for directly determining trip generation rates. Analysis are limited due to resolution limit and aggregate data.
- AirSage seems to offer a way of estimating the area type impact on trip generation. Validation with other data sources are required.
- Refinement & adjustment of AirSage trip tables are essential before trip distribution analysis. An ODME process is recommended.
- AirSage seems to provide reasonable estimates of existing temporal distribution and directional patterns.
- AirSage data provides a good-starting point for estimating model parameters in small MPO and rural areas.

Questions ?

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