Item #4

Status Report: Ongoing review of O-D cellular data for the TPB modeled area

Presentation to the Travel Forecasting Subcommittee
September 19, 2014

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National Capital Region Transportation Planning Board (TPB)
Metropolitan Washington Council of Governments (COG)

airsage
The power of where and when

Recap: June

- TPB staff purchased O-D data from AirSage (AS)
  - Intention: To use AS data as a basis for updating TPB forecasts of external, through and visitor/tourist trips
  - Opportunity: Data mined from wireless signal tracking is potentially a cost-effective data solution for analyzing exogenous markets in aggregate
  - Challenge: To assess this novel product

Recap: July-September

- Staff presented early results to the TFS in July
  - Reviewed AirSage's approach for processing mobile device data into trips
  - Showed early findings of the analysis, relating O/Ds to land activity and ground counts

- Our analysis has continued since July to date
  - AirSage transmitted an updated O/D file to COG in August
    - External and through trips were refined
  - Analysis has been more focused on comparing the updated AirSage data with land activity and modeled outputs

What are we looking for in the analysis?

- An informed understanding of the data
  - Are AS trips consistent with land activity?
  - How do AS trips compare to modeled trips?
  - Are AS trip patterns complete and reasonable?
  - What are the potential biases or limitations of the data?

For today…

- Brief recap of the AirSage data product
- Review of the data and TPB's current analysis:
  - Comparison of AirSage trips & land activity
  - Comparison of AirSage trips & modeled trips
  - Comparison of recent AirSage trips and traffic counts

AirSage Technology

- Collection: Wireless carrier (Verizon, Sprint) signals are securely captured
- Analytics: Multiple stages of statistical analysis are performed on several weeks of data to assess the location and temporal profiles of mobile devices
- O/D samples: Trip purposes and traveler subclasses of O/Ds are inferred based on daytime and nighttime location clustering
- The analysis results in a highly sampled trip file of *aggregate* O/D movements that may be assigned to any predefined level of geography

Key AS trip record attributes

- Origin, destination (O/D) identifier
- "Subscriber classes" (6)
- Trip purpose codes (9)
- Time of day codes (5)
- Weighted trips

Thus, AirSage essentially provides:

- 54 **daily** trip tables (6 subscriber classes by 9 trip purposes)
- 270 **time period** trip tables (54 trip tables by 5 time periods)

O/D matrix specifications

Parameter	Specification	Notes / Details
O/D geography	3722 TAZs	Includes external station O/D “groups”
Year/month timeframe	1	April 2014
Day of week timeframe	Average weekdays	Tuesday, Wednesday, Thursday only
Time of Day Periods	Early AM / 12mid. -6AM	Time periods consistent with those used in the existing 2.3 traffic assignment process
	AM Peak/ 6-9AM	
	Midday/ 9AM- 3PM	
	PM Peak / 3PM-7PM	
	Night/ 7PM-12mid.	

O/D matrix specifications, cont.

AirSage's trip purpose classifications (9):

	Purpose:
1	Home-to-Work (H-W)
2	Home-to-Other (H-O)
3	Home-to-Home (H-H)
4	Work-to-Home (W-H)
5	Work-to-Other (W-O)
6	Work-Work (W-W)
7	Other-to-Home (O-H)
8	Other-Work (O-W)
9	Other-Other (O-O)

- The "home", "work" and "other" designations are inferred based on locational and temporal clustering of device locations
- AS purposes are based on directional movements (i.e., not in P/A format)

O/D matrix specifications, cont

AirSage's traveler subscriber classes (6):

	Subclass	Description
1	Resident Worker	Resident, daytime & nighttime location clusters are different & inside study area
2	Home Worker	Resident, daytime & nighttime location clusters are similar
3	Inbound Commuter	Non-resident, daytime cluster is inside the study area
4	Outbound Commuter	Resident, daytime cluster is outside of the study area
5	Short Term Visitor	Non-resident, in the study area two weeks or less
6	Long Term Visitor	Non-resident, in the study area more than two weeks

AirSage trips vs. surveyed trips

Trip attributes	AirSage	HTS Trips
Trip detection	Based on aggregate device movements	Reported by HH member
Trip linking	Unknown	Reported by HH member
Trip maker information	Unknown	Reported by HH member
Trip purpose	Inferred by TOD /location “clustering“	Reported by HH member
Trip mode	Unknown	Reported by HH Member
Auto occupancy	Unknown	Reported by HH member
Trip Weighting	Based on Census Population-based expansion at tract level	Based on Census expansion that considers jurisdictional, household, and person level dimensions

Trip table summary of weighted AirSage purpose and subclass codes

Weighted Daily AirSage Trip Summary (April 2014 / Avg. Weekday)

Trips by AirSage Purpose and Subclass

	Subclass						
Purpose	RES_WORKER	HOME_WORKER	INB_COMMUTER	OUTB_COMMUTER	SHRTTM_VISITR	LONGTM_VISITR	TOTAL
H_H:	1,994,758	2,058,895	3,393	137,643	8,890	287	4,203,866
H_O:	1,476,206	1,567,904	33,007	107,379	87,937	3,672	3,276,105
H_W:	3,075,407	0	103,607	64,614	4,941	0	3,248,570
W_W:	470,913	0	22,886	602	608	0	495,009
W_H:	2,586,034	0	85,150	56,091	5,232	0	2,732,507
W_O:	807,156	0	31,363	11,838	7,568	0	857,925
O_O:	786,883	588,627	28,250	83,036	237,994	891,602	2,616,392
O_H:	1,859,124	1,530,171	39,077	125,735	84,288	3,550	3,641,946
O_W:	363,648	0	13,990	6,023	5,187	0	388,849
Sum:	13,420,130	5,745,598	360,723	592,961	442,647	899,111	21,461,170

- Above table reflects all (internal, external and through) movements
- Trip anomalies do exist, e.g.:
  - an internal “inbound commuter” trip with a “Home” origin
  - an internal “outbound commuter” trip with “Work” origin

TPB staff is communicating with AirSage about these types of occurrences

Conversion of AirSage trips into modeled purpose trip tables

- 54 daily trip tables are too many to analyze!
- Staff thought about how best to transform AS data into a form that could be compared to modeled trips
- AirSage trip tables were consolidated by modeled purpose (as closely as possible) to expedite analysis
  - 54 AirSage trip tables were collapsed into 5 trip tables: HBW, HBNW, NHW, NHO and Non-Resident trips
  - O/D TAZs of "to-Home" AirSage trips were transposed to arrive at trip tables in P/A format

Equivalence of modeled purposes to AirSage purposes/subclasses

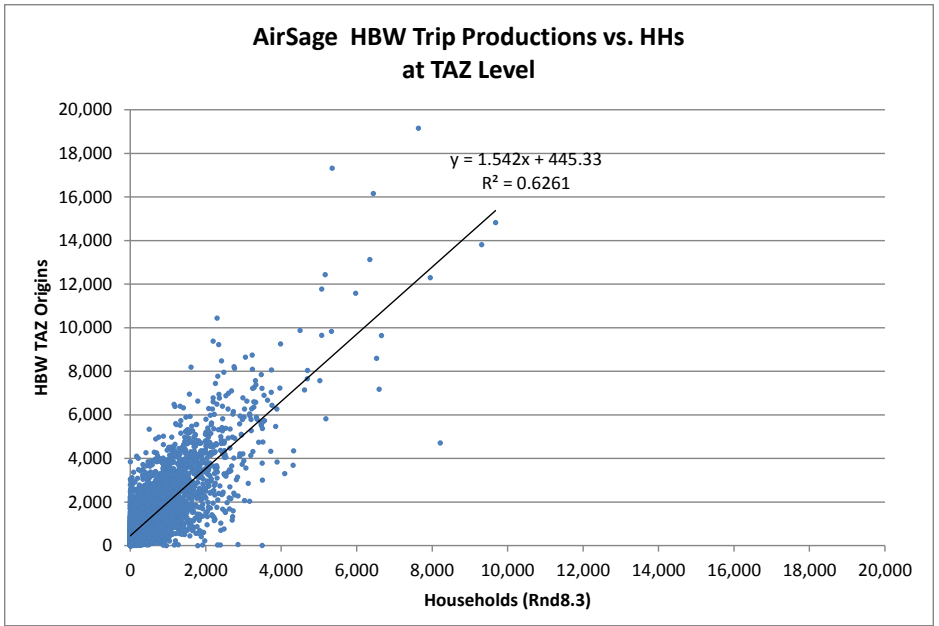
AirSage Purpose	AirSage Subscriber Class-->					
	Resident Worker	Home Worker	Outbnd. Commuter	Inbnd. Commuter	Short Term Visitor	Long Term Visitor
H-H * H-O O-H *	Home-Based Non-Work (HBNW)			Non-Resident		
H-W W-H *	Home-Based-Work (HBW)					
W-W W-O O-W	Non-Home-Based Work-Related (NHW)					
O-O	Non-Home-Based Non-Work (NHO)					

* - indicates transposition of O/D codes to reflect P/A format

Correlation between AirSage HBW productions and Round 8.3 land activity

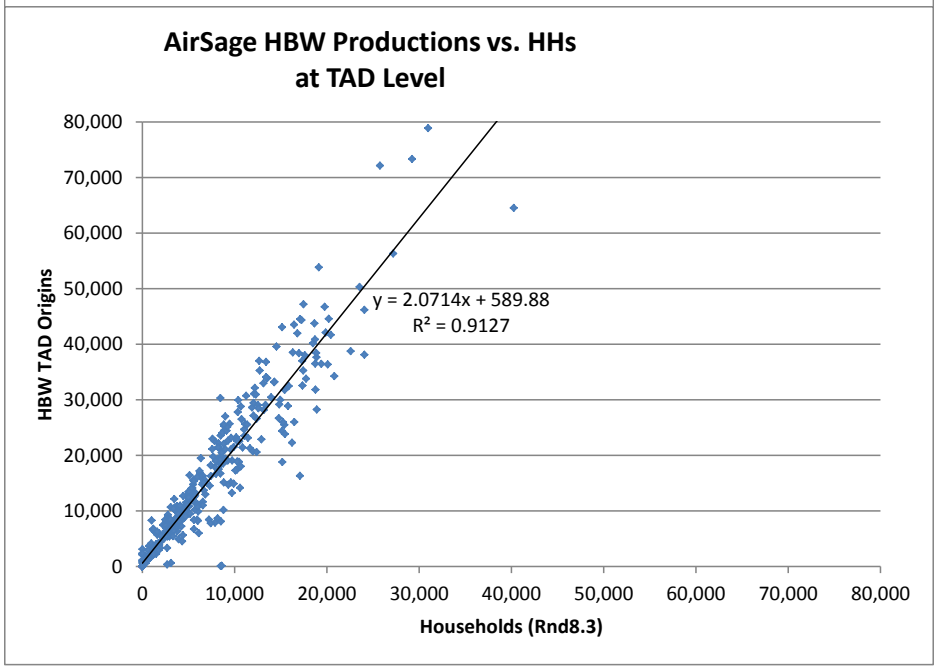
Zone level comparison

Substantial scatter



District level comparison

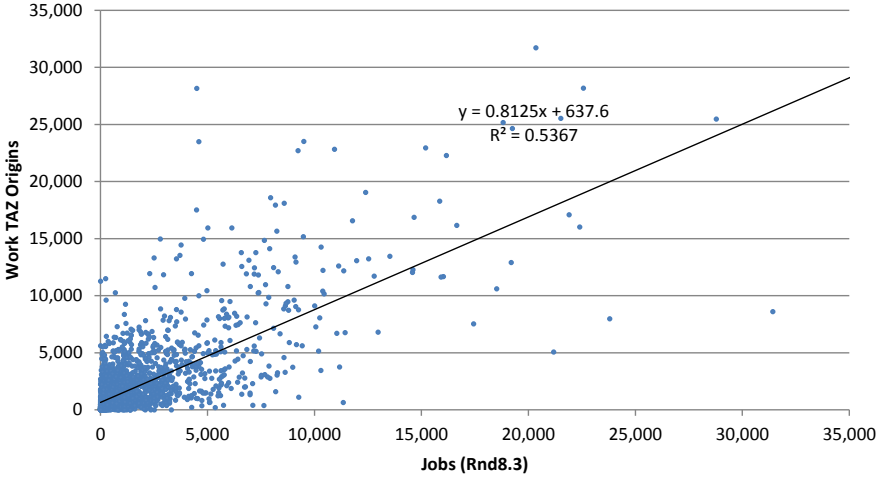
Much reduced scatter



Correlation between AirSage HBW attractions and Round 8.3 land activity

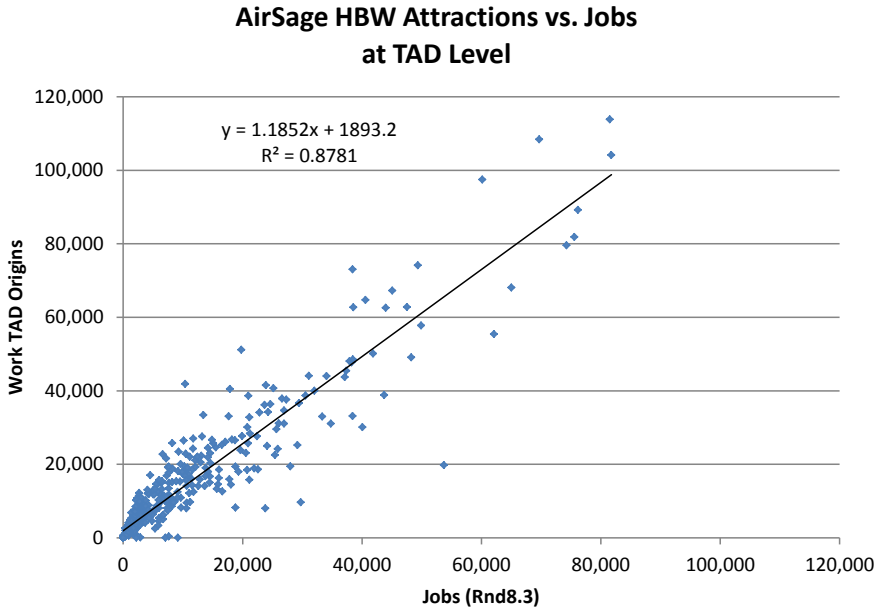
Zone level comparison

Considerable scatter



District level comparison

Much reduced scatter, but outliers still prevalent



Comparison of internal (I-I) trips by purpose: 2014 AirSage vs. 2015 TPB Model

	AirSage vs. TPB Model Internal-Resident Trip Comparison				
	(A)	(B)	(C)		
		TPB Modeled Trips			
		Motorized	Motorized &		
Purpose	AirSage	Person	Non-Motr Psn	(A) / (B)	(A) / (C)
HBW	5,656,000	3,991,300	4,148,700	1.42	1.36
HBNW	10,641,700	10,333,500	11,592,600	1.03	0.92
NHW	1,619,700	1,664,900	2,150,900	0.97	0.75
NHO	1,413,200	3,332,300	3,709,600	0.42	0.38
ALL	19,330,600	19,322,100	21,601,700	1.00	0.89

Findings:

- AS trips match modeled motorized person trips well, overall
- AS trips are less than motorized and non-motorized person trips by 11%
- AS HBW trips are substantially higher than modeled motorized HBW trips
- AS NHO trip are substantially less than modeled motorized NHO trips

Modeled trips are from a 2015 simulation (R8.3, Version, 2.3.57 Model, 2014 CLRP)
AirSage trips reflect weekday average for April 2014

Comparison of internal (I-I) trips generation rates by purpose: 2014 AirSage vs. 2015 TPB Model

	Daily Person Trips		Trips/HH		Trips/Job	
Purpose	AirSage	TPB Model	AirSage	TPB Model	AirSage	TPB Model
HBW	5,656,000	4,148,700	2.17	1.59	1.39	1.02
HBNW	10,641,700	11,592,600	4.08	4.45	2.61	2.84
NHW	1,619,700	2,150,900	0.62	0.83	0.40	0.53
NHO	1,413,200	3,709,600	0.54	1.42	0.35	0.91
ALL	19,330,600	21,601,700	7.42	8.29	4.74	5.30

- Trips shown are internal only (I-I)
- TPB trips shown above include motorized & non-motorized trips
- Trip rates shown are based on 2014 Rnd. 8.3 land activity

Comparison of internal (I-I) trip lengths by purpose: 2014 AirSage vs. 2015 TPB Model

	Daily Person Trips		Avg. Time (min)			Distance (mi)		
Purpose	AirSage	TPB Model	AirSage	TPB Model	Ratio (A/T)	AirSage	TPB Model	Ratio (A/T)
HBW	5,656,000	3,991,300	40	49	0.82	13	15	0.87
HBNW	10,641,700	10,333,500	18	16	1.13	8	7	1.14
NHW	1,619,700	1,664,900	21	19	1.11	10	8	1.25
NHO	1,413,200	3,332,300	21	14	1.50	10	5	2.00
ALL	19,330,600	19,322,100	24	22	1.09	9	8	1.13

Findings:

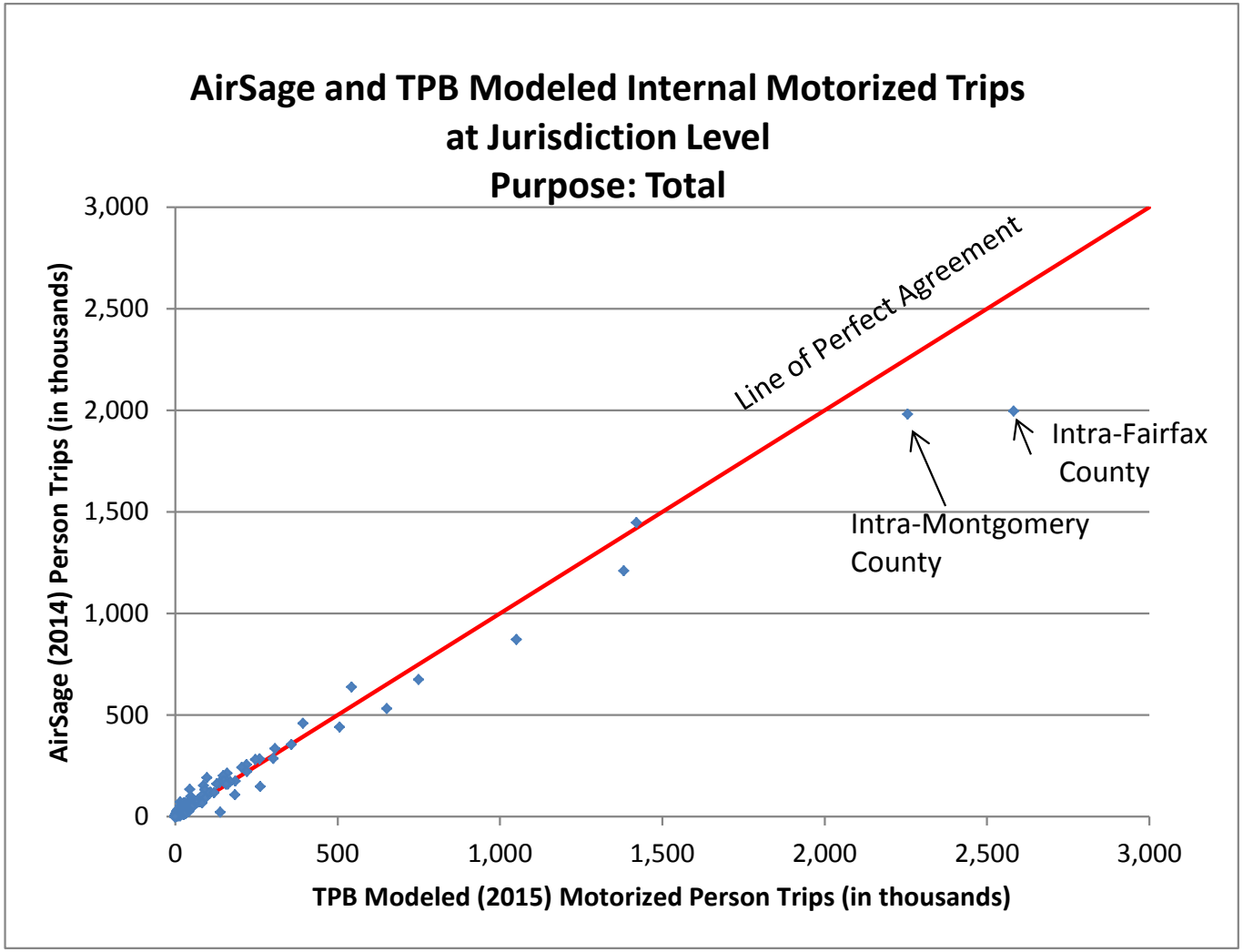
- Total time and distances lengths are in reasonable agreement
- HBW and NHO average trip times are more notably different
- HBNW and NHW average trip times are within +/- 2 minutes

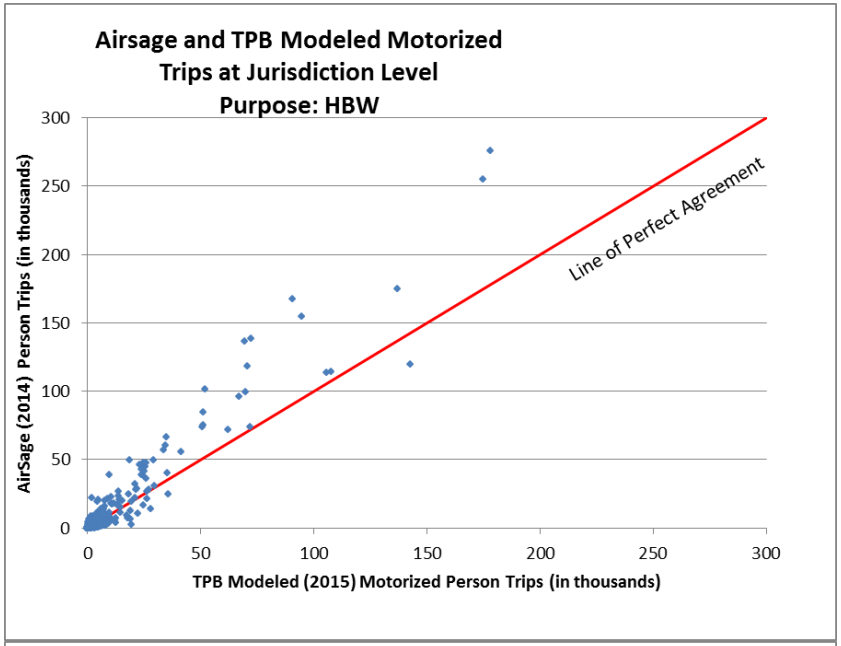
TPB trips shown are internal, resident motorized person trips

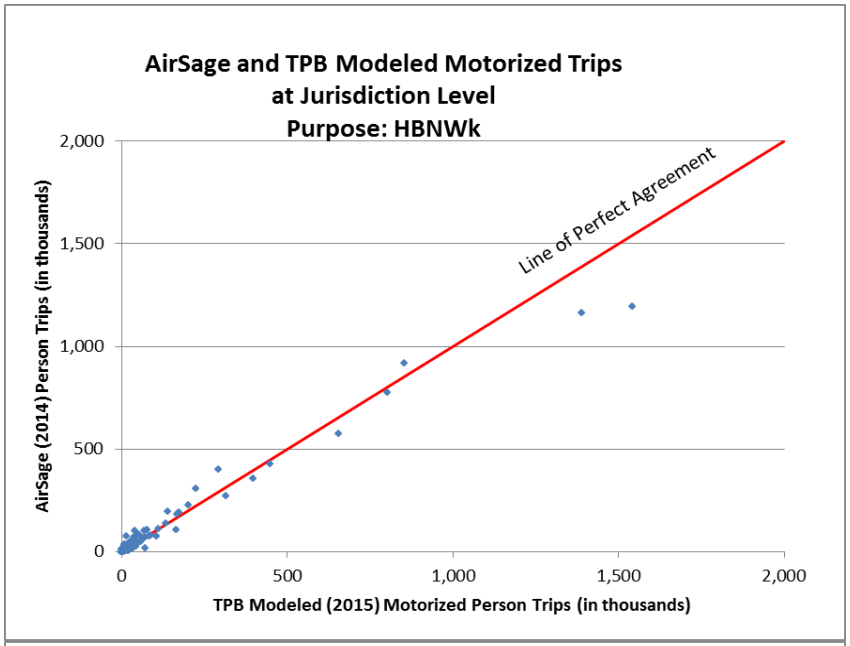
Modeled trips are from a 2015 simulation (R8.3, Version, 2.3.57 Model, 2014 CLRP)

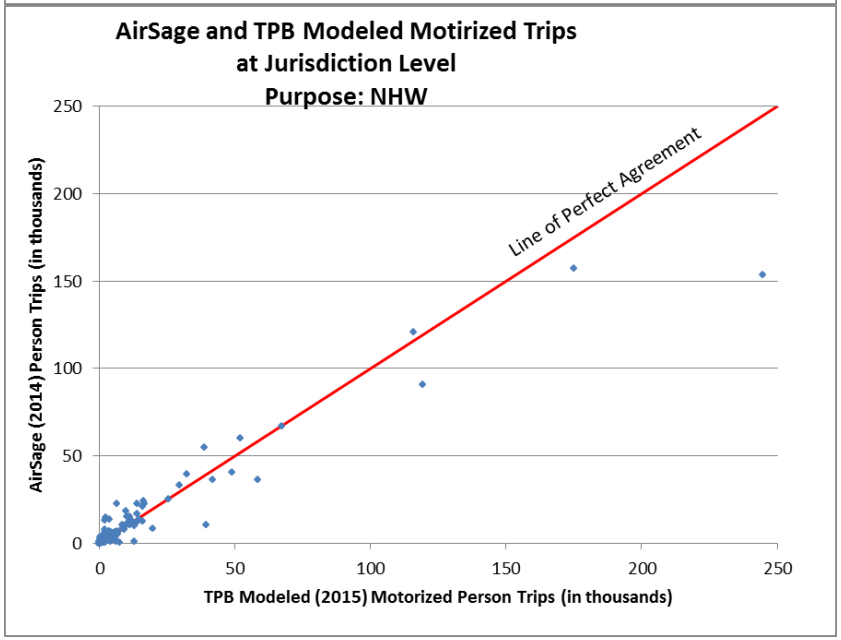
AirSage trips reflect weekday average for April 2014

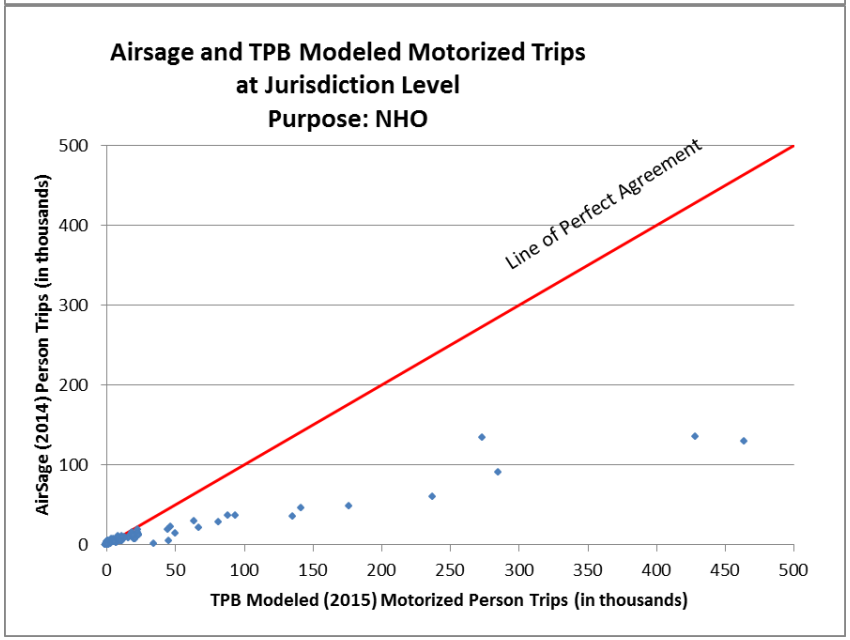
Total I-I trips at the jurisdictional level agree well, except for trips within some of the large counties




Airsage and TPB Modeled Motorized Trips at Jurisdiction Level Purpose: HBW
AirSage (2014) Person Trips (in thousands)
TPB Modeled (2015) Motorized Person Trips (in thousands)
Line of Perfect Agreement
0
50
100
150
200
250
300


AirSage and TPB Modeled Motorized Trips at Jurisdiction Level Purpose: HBNWk
AirSage (2014) Person Trips (in thousands)
TPB Modeled (2015) Motorized Person Trips (in thousands)
Line of Perfect Agreement
0
500
1,000
1,500
2,000


AirSage and TPB Modeled Motirized Trips at Jurisdiction Level Purpose: NHW
AirSage (2014) Person Trips (in thousands)
TPB Modeled (2015) Motorized Person Trips (in thousands)
Line of Perfect Agreement
0
50
100
150
200
250


Airsage and TPB Modeled Motorized Trips at Jurisdiction Level Purpose: NHO
AirSage (2014) Person Trips (in thousands)
TPB Modeled (2015) Motorized Person Trips (in thousands)
Line of Perfect Agreement
0
100
200
300
400
500

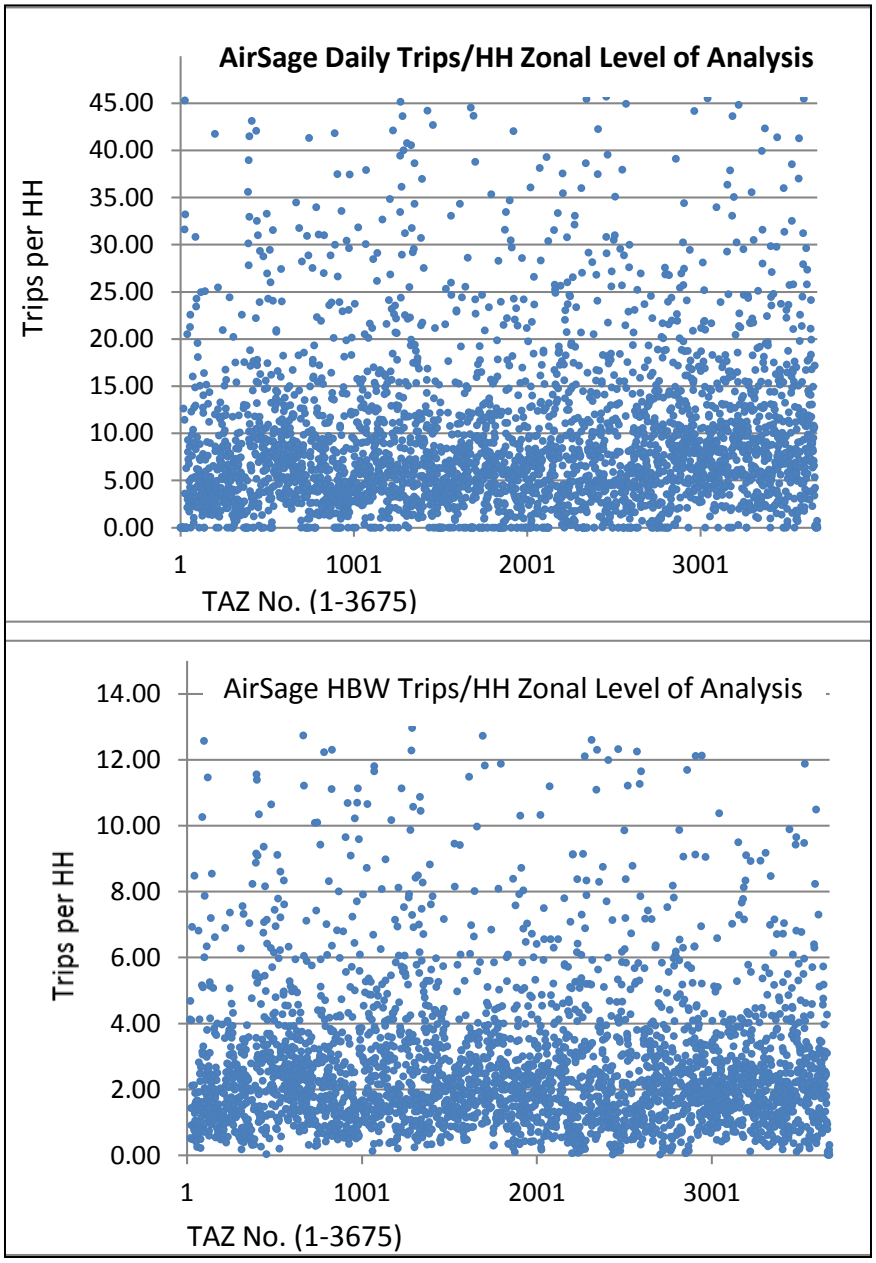
Zonal trip production rates

Scatter plot of **ZONAL** household trip rates using AirSage resident trips and Round 8.3 land activity

DAILY total purpose trips per HH

Daily HBW trips per HH

Apparent inconsistency between zone level trips and land activity yields unstable rates



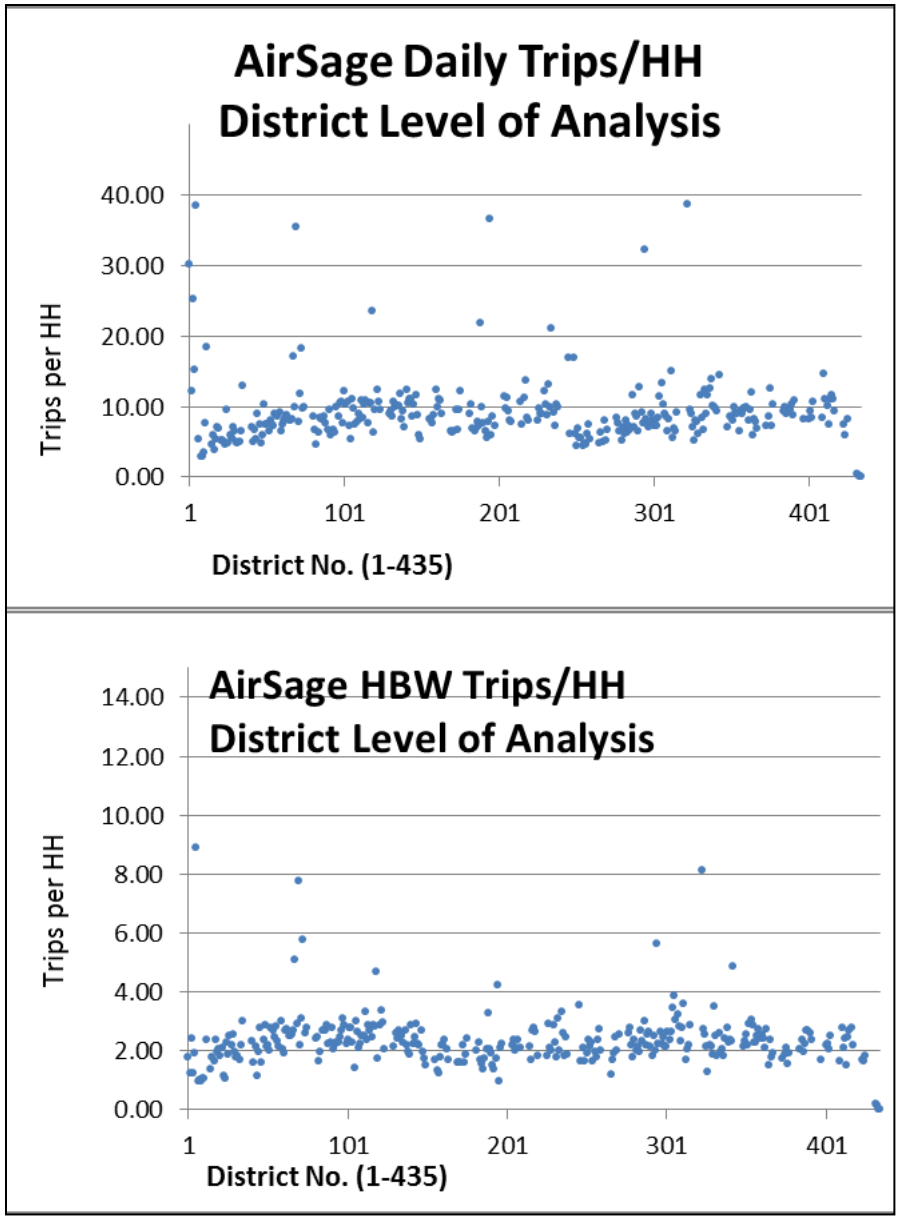
Expected Range

District trip production rates

Scatter plot of **DISTRICT** level household trip rates using AirSage resident trips and Round 8.3 land activity

DAILY total purpose trips per HH

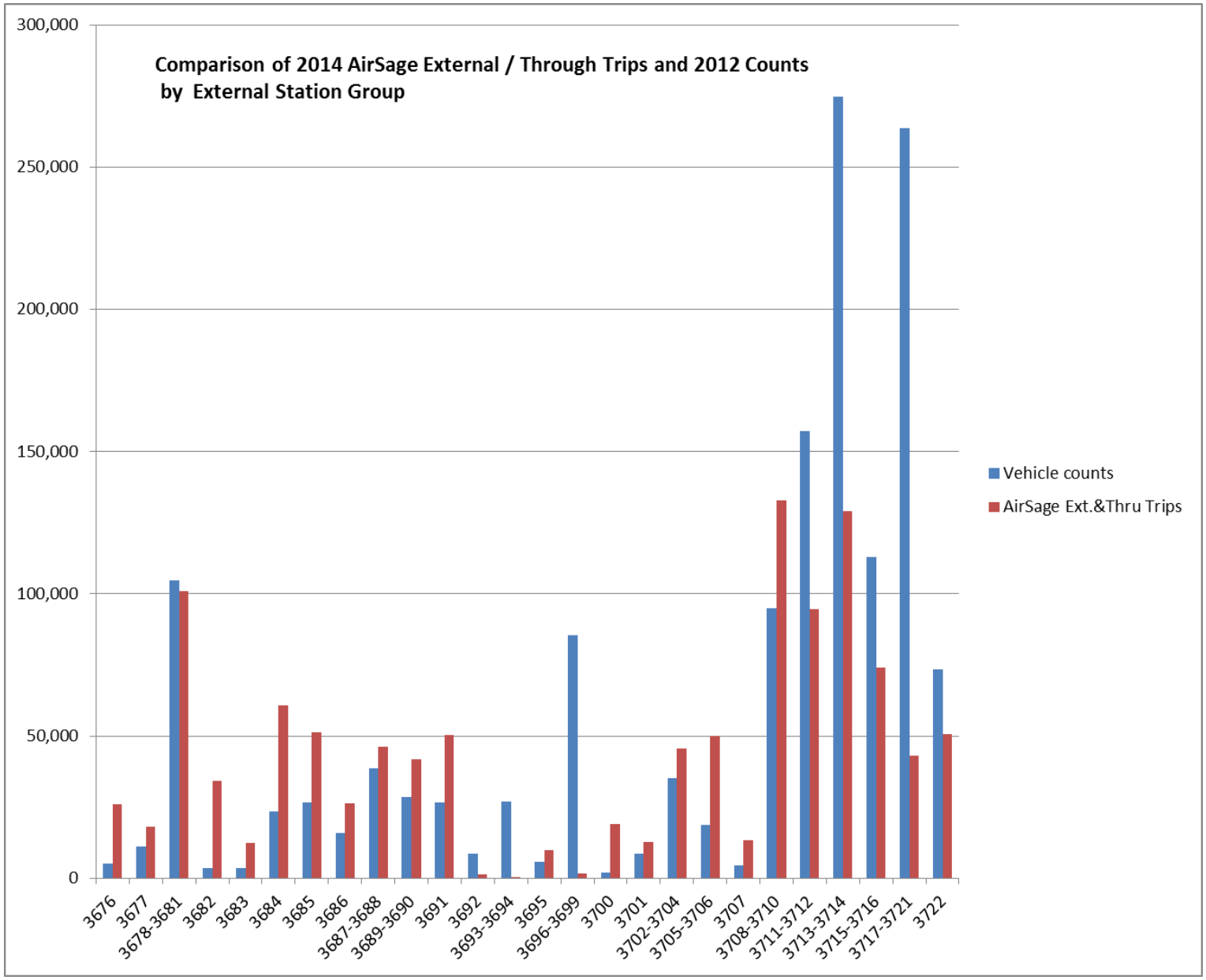
Daily HBW trips per HH

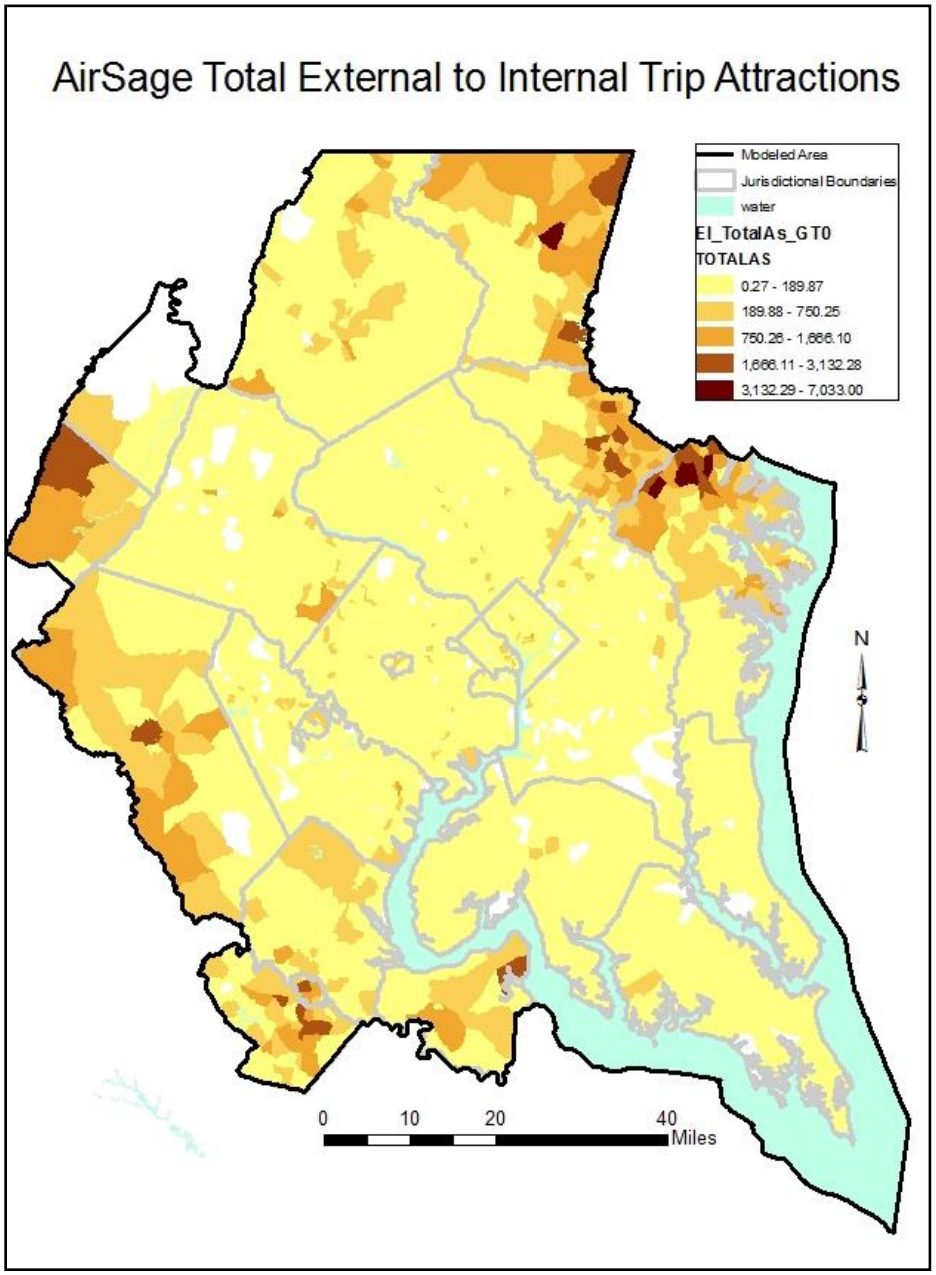


Much more stable and reasonable, with a few outliers.

Comparison of 2014 AirSage External/Through trip-ends with 2012 AAWDT Counts at External Stations

		(a)	(b)		
		Apr-14	Observed 2012		
External		AirSage Trips	Vehicle counts	Difference	Ratio
Station(s)	Facility (or Facilities)			(a - b)	(a / b)
3676	VA 3	26,088	5,000	21,088	5.22
3677	US 301	18,084	11,000	7,084	1.64
3678-3681	US 17, VA 2, I-95, and US 1	100,949	104,600	-3,651	0.97
3682	VA 208/606	34,150	3,500	30,650	9.76
3683	VA 612	12,338	3,500	8,838	3.53
3684	VA 3	60,630	23,400	37,230	2.59
3685	US 15/29	51,257	26,600	24,657	1.93
3686	US 211	26,265	16,000	10,265	1.64
3687-3688	I-66 and VA 55	46,075	38,500	7,575	1.20
3689-3690	US 340 and US 17/50	41,826	28,400	13,426	1.47
3691	VA 7	50,278	26,500	23,778	1.90
3692	WVA 51	1,486	8,500	-7,014	0.17
3693-3694	WVA 9 and WVA 45	130	26,800	-26,670	0.00
3695	WVA 480 (MD 34)	9,972	5,800	4,172	1.72
3696-3699	US 40 (Alt), I-70, US 40, and MD 77	1,629	85,400	-83,771	0.02
3700	MD 550	19,010	2,000	17,010	9.51
3701	PA 16/MD 140	12,671	8,700	3,971	1.46
3702-3704	US 15, MD 194, and MD 97	45,490	35,100	10,390	1.30
3705-3706	MD 30 and MD 86	50,066	18,800	31,266	2.66
3707	MD 88/833	13,227	4,400	8,827	3.01
3708-3710	MD 30, MD 140 /91, and MD 26	132,814	95,000	37,814	1.40
3711-3712	I-70 East and US 40 East/MD144	94,541	157,300	-62,759	0.60
3713-3714	I-95 and US 1/I-195	129,107	274,600	-145,493	0.47
3715-3716	MD-295 /BWPkwy and MD 170	73,888	112,800	-38,912	0.66
3717-3721	MD 648, MD 3/I-97, MD 2, and MD 710	43,066	263,700	-220,634	0.16
3722	US 50/301	50,670	73,400	-22,730	0.69
	TOTAL:	1,145,708	1,459,300	-313,592	0.79


Comparison of 2014 AirSage External / Through Trips and 2012 Counts by External Station Group
300,000
250,000
200,000
150,000
100,000
50,000
0
3676
3677
3678-3681
3682
3683
3684
3685
3686
3687-3688
3689-3690
3691
3692
3693-3694
3695
3696-3699
3700
3701
3702-3704
3705-3706
3707
3708-3710
3711-3712
3713-3714
3715-3716
3717-3721
3722
Vehicle counts
AirSage Ext.&Thru Trips



Staff is reviewing external trip maps and will present more at the next meeting.

Conclusions

- Staff has been working with a refined set of trip tables from AirSage
- AirSage trips have been compared to land activity and TPB modeled trips by purpose
  - Substantial “noise” exists at the TAZ level
  - Noise is reduced at the TAD level; not eliminated completely
- Differences are noted in comparing AS & TPB motorized trips by purpose:
  - HBNW and NHW trips and trip lengths match reasonably
  - HBW and NHO and trip rates and trip lengths are different

Conclusions, cont.

- The match between AS external, through trips and counts at external stations has improved; AS trips are nonetheless still less than counts by about 20%. A pronounced underestimation exists for stations in the Baltimore area
- Staff will investigate locations where inconsistencies between AirSage trips and land activity exist
- For modeling purposes, AS data appears to be more stable at the district level than at the zone level
- Work will continue