



Accessibility as the Lens for Integrated Land Use and Transportation Planning?

TRB Committee ADD30
January 12, 2015



RENAISSANCE PLANNING GROUP

Background

- Long-standing interest in TR + LU connection
- Dabbled in 3D's models (BMC, SCAG, AzDOT)
- Selected to do NCHRP 08-78: Bike-Ped Demand
- Connected with Renaissance: GIS-assisted city planning
- Found new ways to use GIS to capture bike-ped relationships
- Opens a much broader platform for land use and multimodal planning

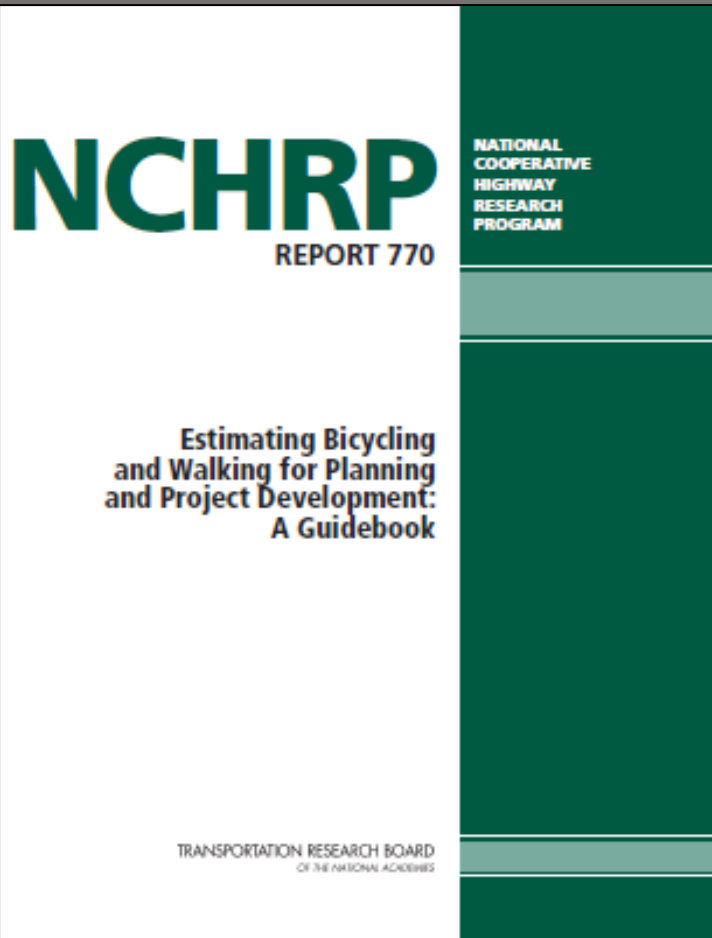


Discussion Focus

- Brief overview of NCHRP 8-78 (Report 770)
- Highlight GIS-accessibility model developed & tested in Arlington VA
- Share recent pilot test at regional corridor level for Maryland DOT
- New applications underway



NCHRP 8-78/Report 770



- **Purpose:** Develop responsive tools for estimating bike/walk demand
- **Major Needs/Concerns:**
 - Effect of Land Use
 - Role of Facilities
 - Impact on motorized travel
- **Response:**
 - Need finer geographic resolution
 - Major role for GIS data/tools



Guidebook Tools: A “Best Practices” Compendium

Entirely New

Arlington GIS
Walk Accessibility
Model
(walk only)

Seattle Tour
Generation &
Mode Choice
(walk & bike)

Seattle Enhanced
4-Step Model
(walk & bike)

Tool Selection Keyed To:

- Problem application
- Geographic Scale
- Accuracy requirements
- Key variables
- Data resources
- Skill level

Useful Pre-Existing

Walk Models:
➤ Ped Context
➤ MoPeD
➤ Portland (PIE)

Bike Route Choice:
➤ Portland State
➤ San Francisco
(SFCTA)

Facility Demand:
➤ Santa Monica
➤ Seamless Travel



Overview of New Tools

Seattle/Puget Sound

Tour-Generation & Mode Choice*

Estimates number of daily “tours” and mode choice by purpose

Modes: walk, bike, transit, auto

Key Variables:

- Demographics
- Land use
- Facility characteristics
- Accessibility

Enhanced Trip- Based (TAZ) Model

Sensitizes each model step to land use; keeps walk & bike alive into mode choice step

Key Variables:

- Demographics
- Land use
- Accessibility

Arlington, VA

GIS Accessibility Approach*

Uses GIS data and tools to calculate modal accessibility scores

Score relationships tied to mode choice

Key Variables:

- Land use
- Transport networks
- Accessibility

* = Spreadsheet version of model on CD-ROM



Arlington GIS Accessibility Model

Goal:

- Emulate intuitive appeal of **Walk Score**
- Apply transportation and land use knowledge to put theory behind the measures
- Build on earlier discovery experience at BMC with a “Walk Opportunities Index” using GIS to create a comprehensive measure of local **accessibility**
- Use GIS as a central part of the methodology, but also to add greater **visualization** to planning process



Arlington GIS Accessibility Model

Goal:

- Intuitive appeal of Walk Score
- Apply transportation and land use knowledge Push capability outside regional 4-step models
- Take advantage of modern GIS capabilities
- Use GIS to calculate Accessibility Scores (like Walk Score)
 - link to travel behavior
- *Accessibility* incorporates both Land Use and Transportation
- Add greater visualization to planning process



A Simple but Elegant Framework

ACCESSIBILITY =

What opportunities can I reach within a given travel time by each mode?

Land Use

Opportunities

- Number
- Variety
- Proximity

Transportation Network

Travel Time

- Connectivity
- Directness
- Safety



Data and Tools (all from MWCOCG)

- Land Use:
 - **InfoUSA** Employment & # establishments by NAICs
 - Exact x,y location
- Travel Networks:
 - MWCOCG highway and transit skims
 - All streets **NAVTEQ** network, enhanced to include walk/bike facilities
 - Path selection – **Network Analyst** (ArcGIS)
- Travel Behavior:
 - **Regional HH Travel Survey**



Using GIS to Calculate Relationships

Land Use & Network Overlay



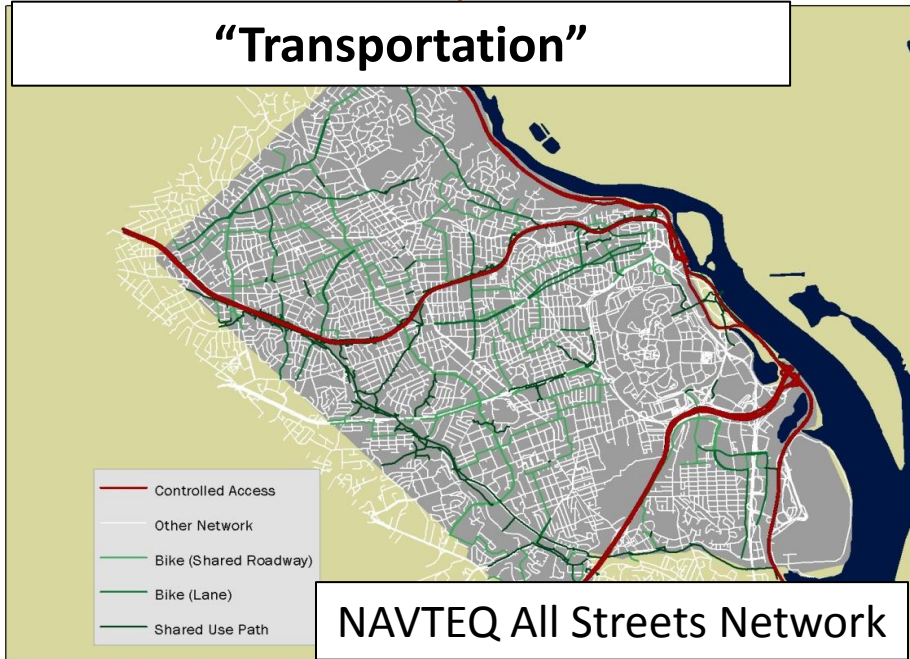
ARLINGTON EMPLOYMENT ACTIVITY, 2007

County Overview

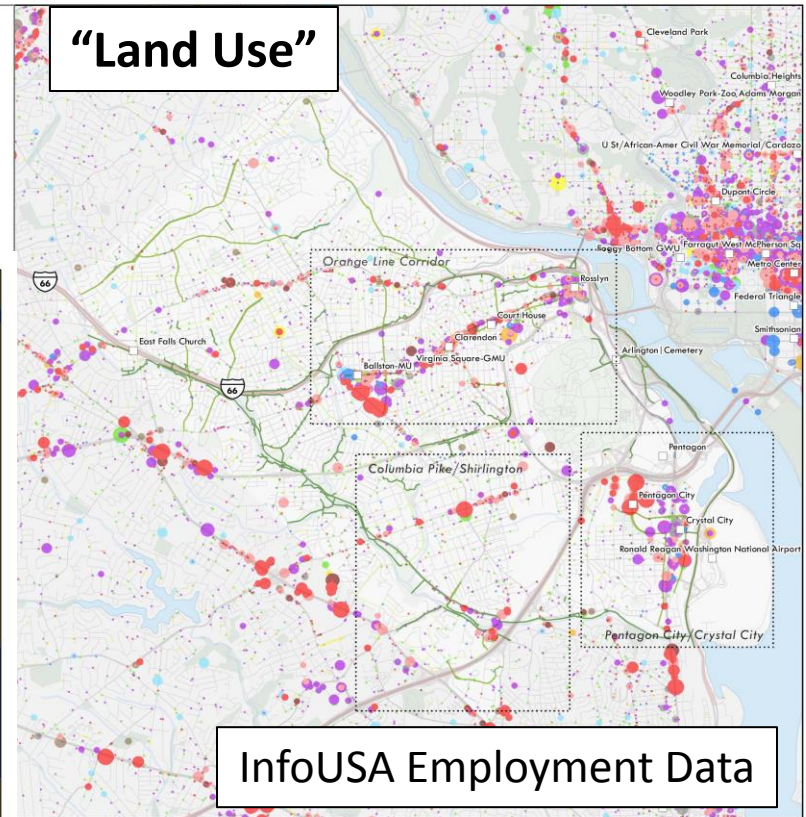
Employer Type

- Retail
- Retail (Grocery)
- Retail (Restaurant)
- GOVT/PUBLIC

“Transportation”



“Land Use”



Calculating Accessibility Scores

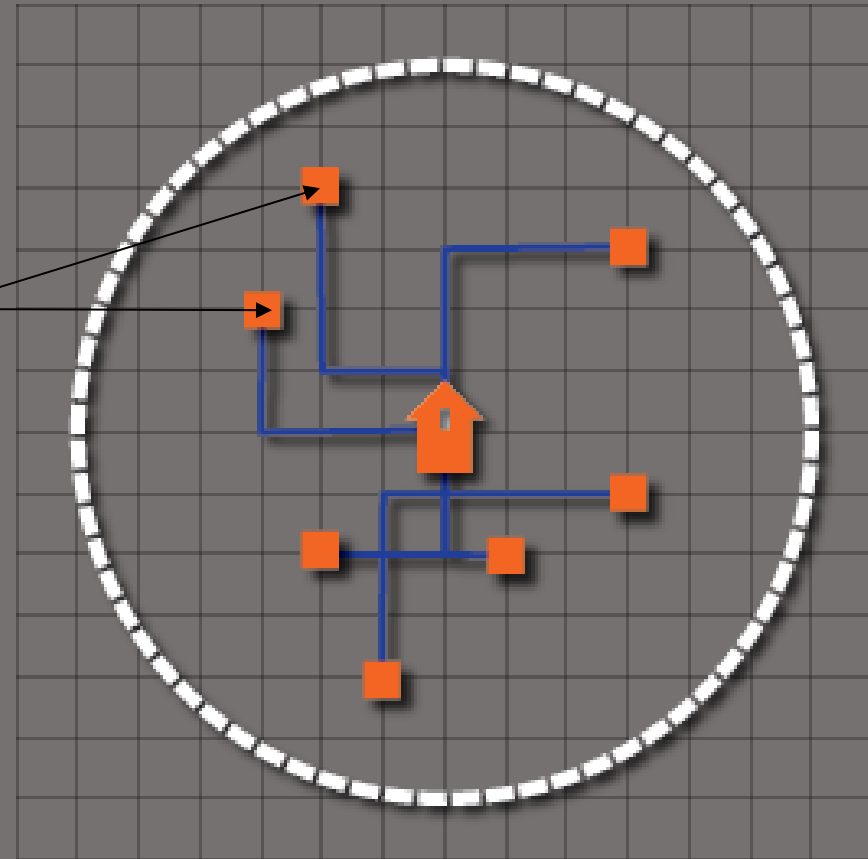
$$\text{Accessibility} = \sum \frac{\text{Opportunity}}{\text{Travel Time} * \text{Decay}}$$

Where:

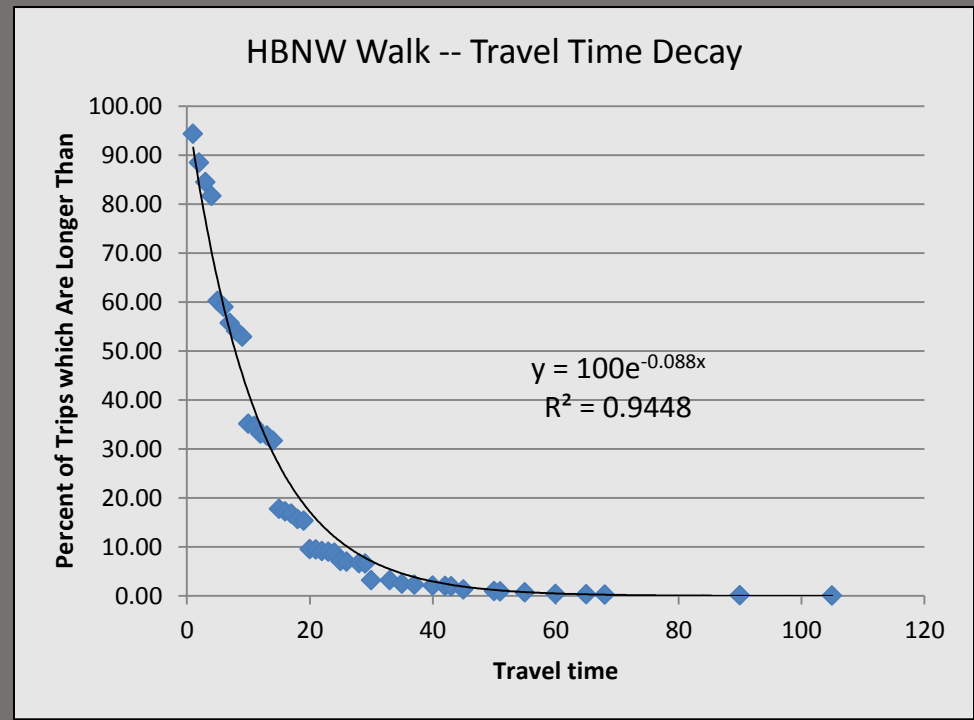
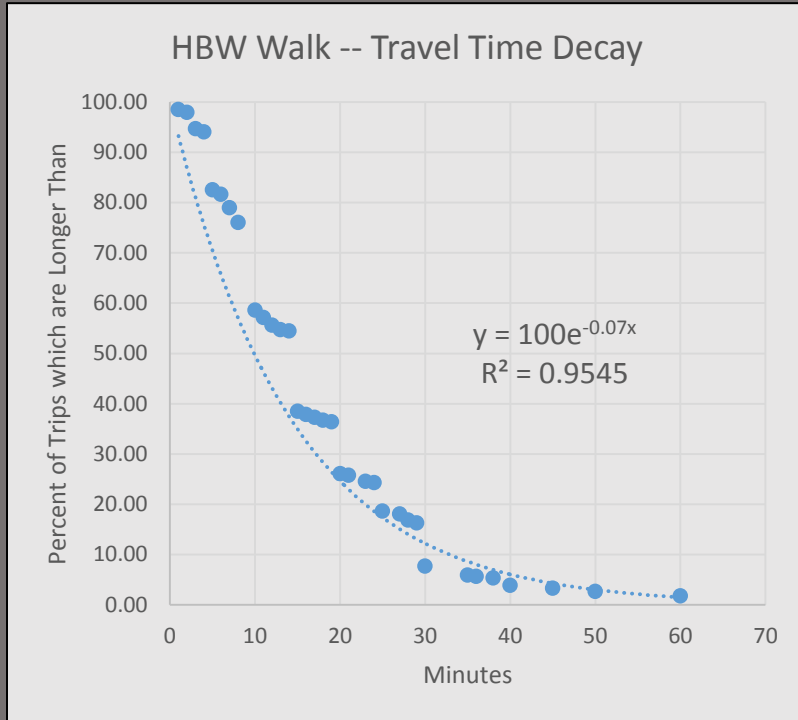
Opportunities = Number of Jobs (HBW) or Number of Retail/Service Establishments (HBNW)

Travel Time = Time to reach opportunity over *actual network* (Network Analyst)

Decay = Factor reflecting decrease in value of opportunities that are farther away



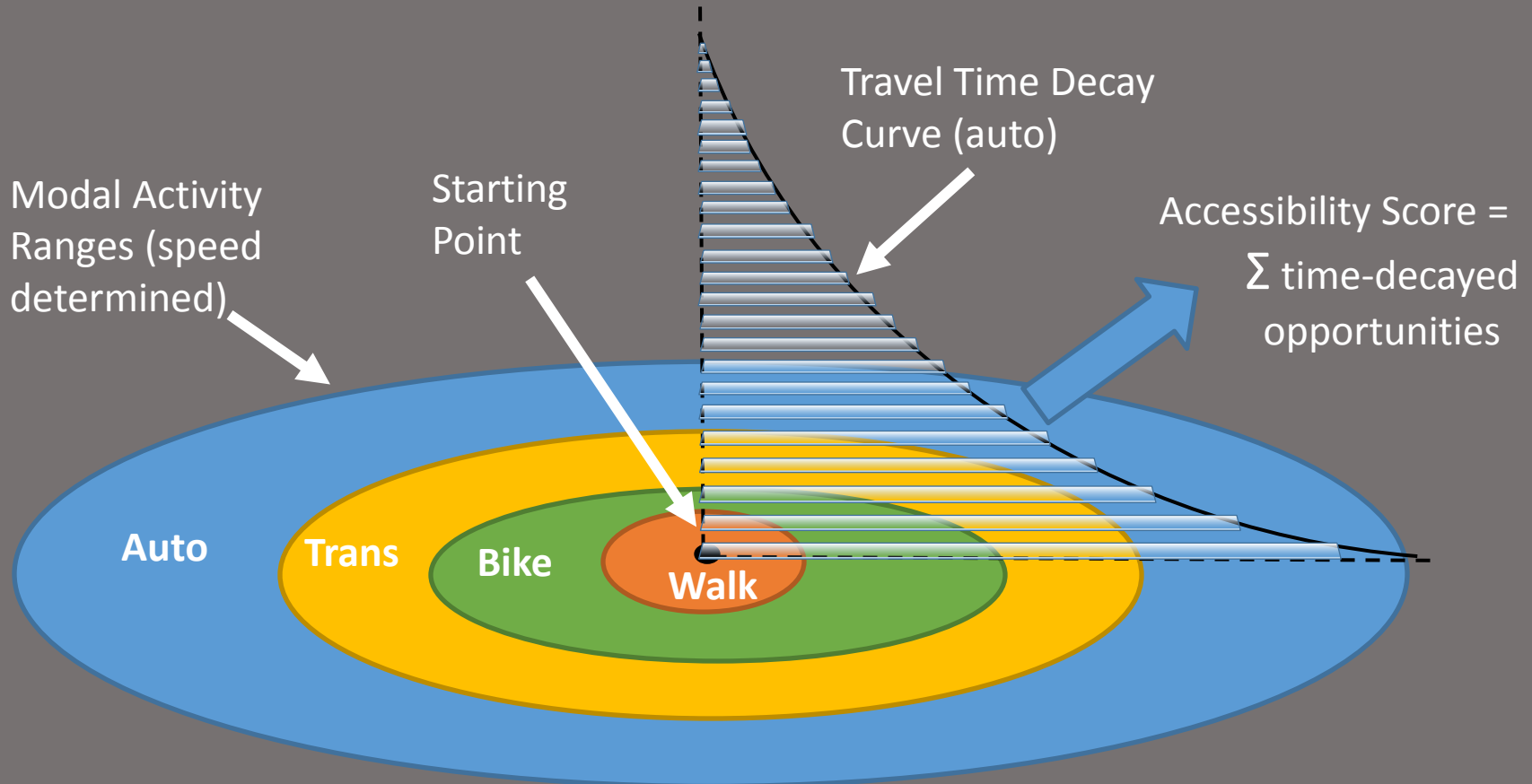
Distance-Decay Relationships (derived from travel survey trip distributions)



Calculated for all modes and travel purposes



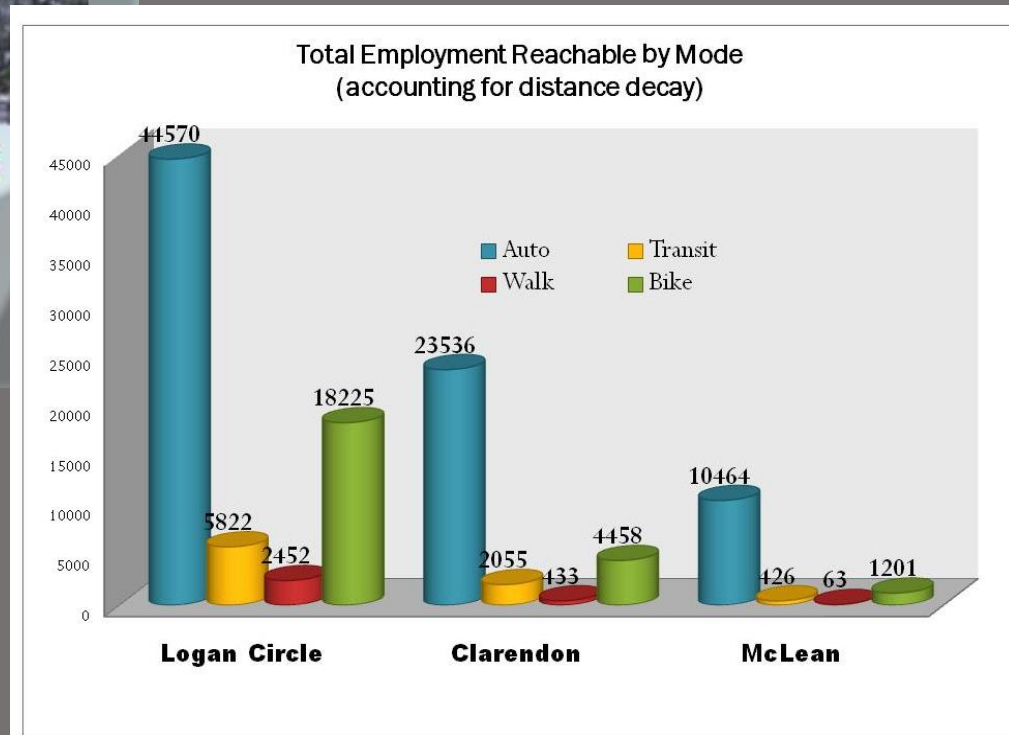
Scores Calculated for Each Mode



What We Do with the Scores

- **Accessibility Maps:** Readily show patterns in accessibility by mode across areas, scenarios
- **Travel Demand Models:** Use scores to explain mode choice
- **Forecasting:** Predicting mode choice from existing conditions or alternative scenarios

Comparing Accessibility Scores for Different Settings



Accessibility's Influence on Mode Choice

Comparative Accessibilities			
	Logan Circle	Clarendon	McLean
Auto	4.26	2.25	1.0
Transit	13.6	4.82	1.0
Bike	15.17	3.71	1.0
Walk	38.9	6.9	1.0

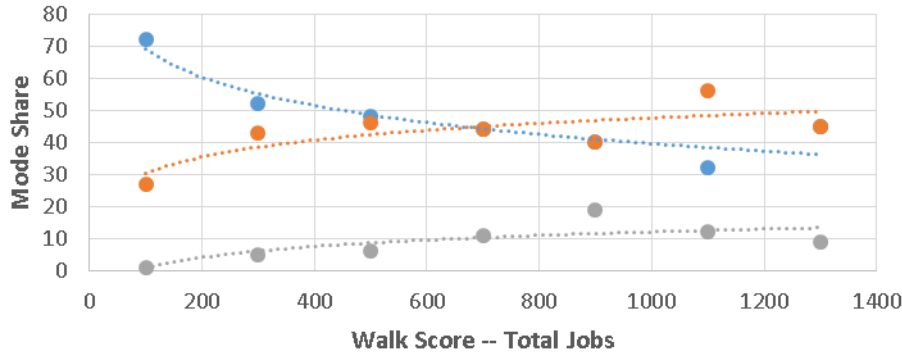


Non-Motorized Mode Share (HH survey)	
Logan Circle	41%
Clarendon	21%
McLean	8%

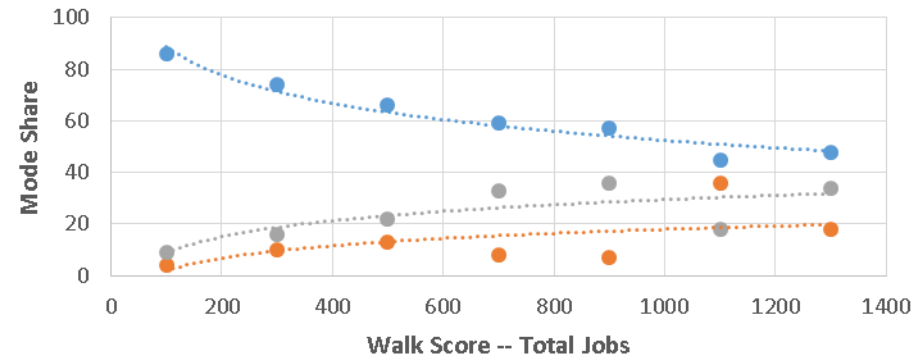


Statistically Linking Accessibility Scores with Mode Choice Patterns in Travel Survey

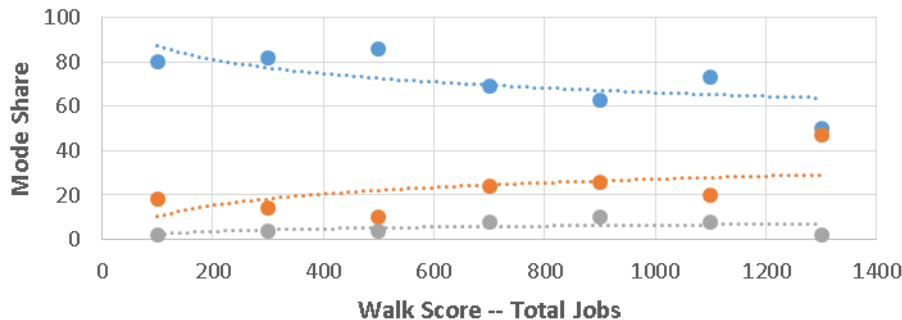
Mode Choice in Relation to Walk Score
(HBW, Origin)



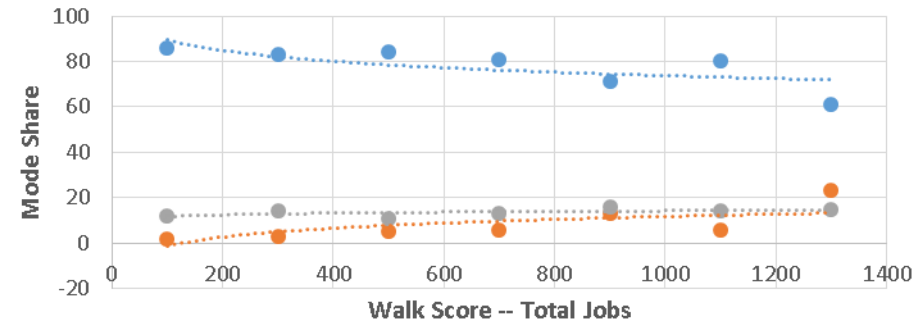
Mode Choice in Relation to Walk Score
(HBNW, Origin)



Mode Choice in Relation to Walk Score
(HBW, Destination)



Mode Choice in Relation to Walk Score
(HBNW, Destination)



● Auto ● Transit ● Walk
⋯ Log. (Auto) ⋯ Log. (Transit) ⋯ Log. (Walk)

● Auto ● Transit ● Walk
⋯ Log. (Auto) ⋯ Log. (Transit) ⋯ Log. (Walk)



Report 770 Walk Accessibility Model

WALC TRIPS XL

Accessibility-based analysis of non-motorized trip-making

The WALC TRIPS XL spreadsheet tool facilitates analyses and forecasts of pedestrian travel based on accessibility as described by a walk accessibility location criterion (WALC) score. The tool is comprised of two principal analytical tracks. The model development track (left side of this screen) allows users to examine travel survey records and the accessibility profiles of individual trip ends to develop relationships that describe travel behavior - specifically the choice to make a walking trip - with respect to local walk accessibility values. The model application track (right side of this screen) enables users to apply the relationships derived from the model development track to a specific site, corridor, or subarea to forecast pedestrian flows generated by various land use and non-motorized travel network configurations. The resulting walk trip forecasts can be used to update TAZ trip tables, tying the analysis of pedestrian trips back to the regional travel demand model, or exported for mapping or other analytical and presentation purposes.

MODEL DEVELOPMENT/AREAWIDE TRENDS

MODEL APPLICATION/SELECTED STUDY AREA ANALYSIS

Input Data

Travel survey records and associated location accessibility data drive the model development steps. Default data from Arlington County, VA are pre-loaded into the tool, but these can be replaced with local data to analyze trends for any area.

Travel Survey Data

- Import travel survey data
- Manage active accessibility variable

Default data from Arlington County, VA
MWCOG Travel Survey, 2007

View/Manage Survey Data

Location Accessibility Data

- Import trip end location accessibility data (linked to travel survey data)

Default data from Arlington County, VA
NCHRP 08-78 Research Analysis, 2013

View/Manage Accessibility Data

Input Data

Land use and walk travel time data for a selected study area can be imported to develop various planning scenarios.

Land Use Data

- Import land use data reflecting the amounts and types of activities (jobs, housing, etc.) found at each geographic analysis unit

View/Manage LU Data

Study Area Walk Skims

- Import walk travel time skims for various network scenarios.

View/Manage Walk Skims Data

Analyze Data

The second phase of model development focuses on analyzing trends in the input data to find the relationships that best describe trip-making in the region. In these worksheets, users can explore patterns of trip-making with respect to accessibility values at either trip end. Based on these patterns, users can modify the relationships in the model to best suit local conditions.

Distance Decay

- Explore travel time characteristics of trips by each major mode
- Update the distance decay function used to model walk accessibility values

View/Manage Distance Decay Rates

Mode Split Analysis

- Test the power of the active accessibility score to predict mode shares by purpose
- Update the mode split estimation curves used in the model

Analyze Mode Split Patterns

Trip Distributions by Accessibility Values

- Examine the distributions of trips by mode and purpose with respect to walk accessibility values
- Modify groupings of accessibility values used in the model

View/Manage Distribution Bins

Model Relationships

- Review all active formulas working in the model
- Create a custom trip generation routine

View Relationships

Test Scenarios

Combine land use and walk skims data into various scenarios and apply the formulas from the model development track to estimate pedestrian activity for the study area and measure the impact of land use and/or walk network interventions on walk activity. Compare scenarios at-a-glance and update TAZ trip tables based on pedestrian flows. Export scenario outputs to map pedestrian flows, updated trip table matrices, map walk trip generation, and more.

Setup and Run Scenarios

- Define scenarios as combined land use and network configurations
- Run scenario analysis

Setup/Run Scenarios

Update Zonal Tables

- View distributions of walk trips between TAZ OD pairs by purpose for each scenario

View Zone to Zone Walk Trips

View Results

- Summary of study area walk mode share
- Comparisons of walk trip-making by scenario

View Scenario Results

Export Output Data

- Export the results of the scenario analyses to tabular format for mapping, visualization, and further analysis.

Export Data

Model Development vs Application

Model Setup & Calibration

Travel Survey Trips



Calculate Accessibilities for Each Trip End



Develop Mode Choice Equations (curve fitting)



Model Application

Apply to Census Blocks



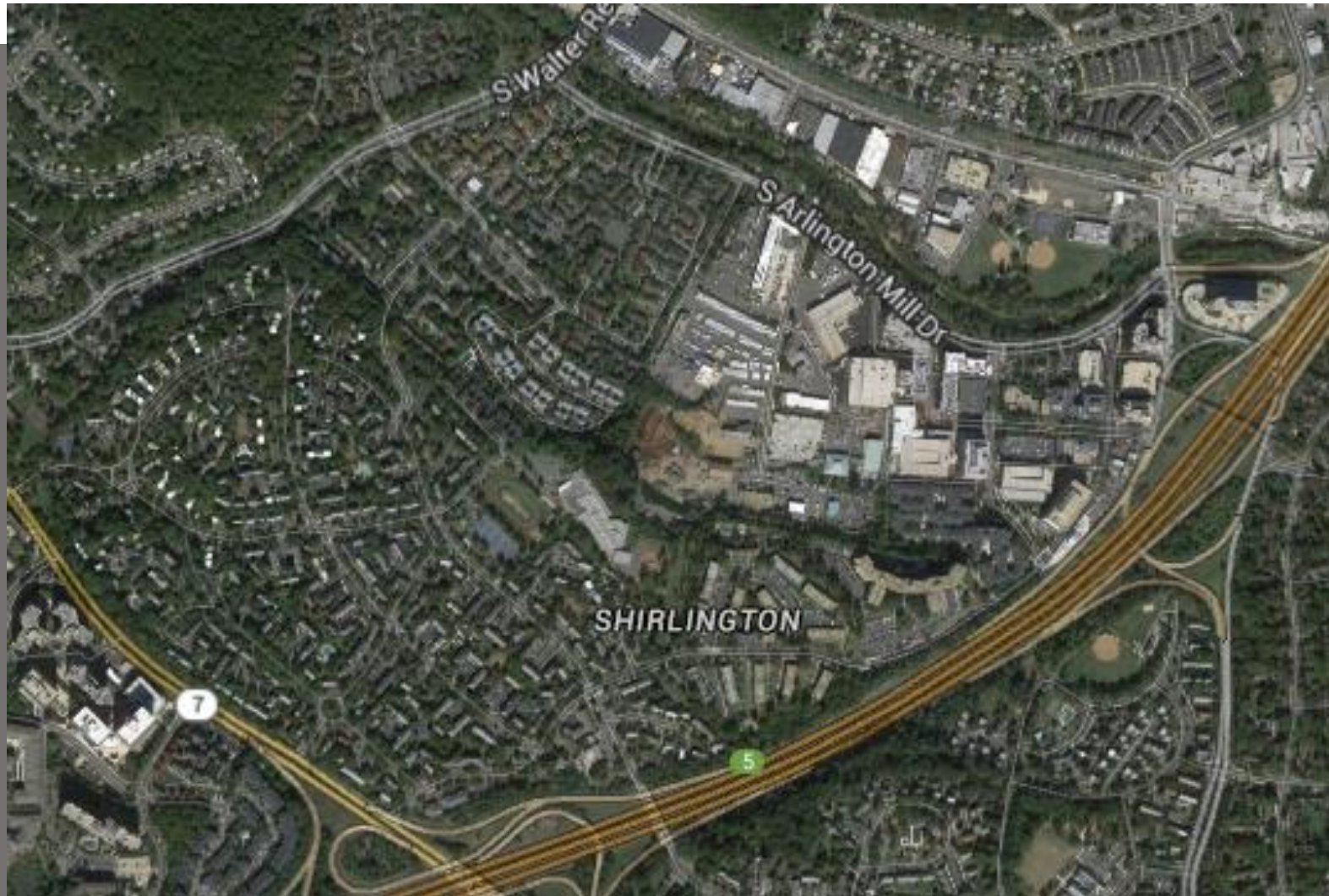
Calculate Accessibilities for Each Block



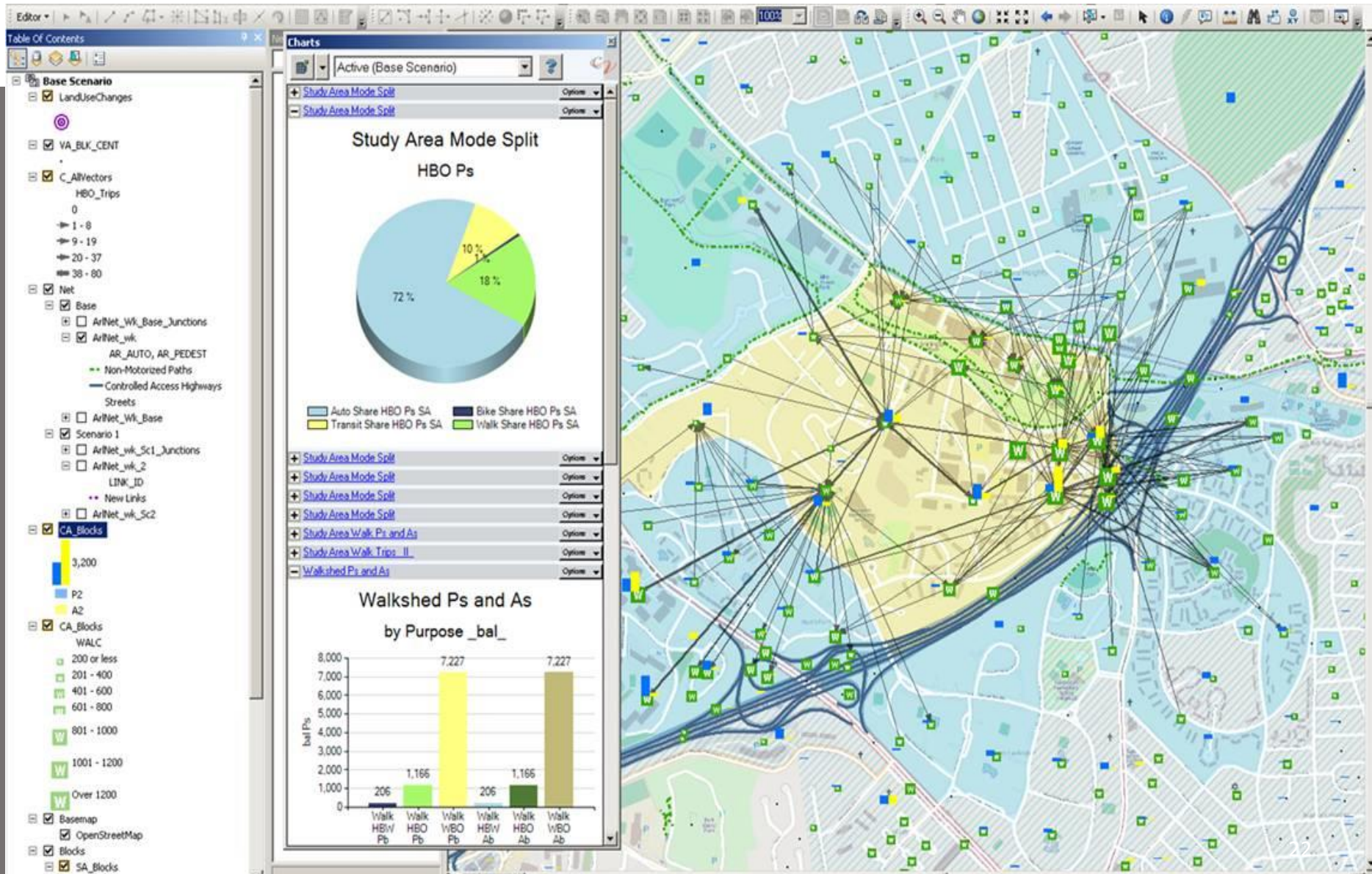
Use Equations to Estimate Walk Ps & As, create trip table



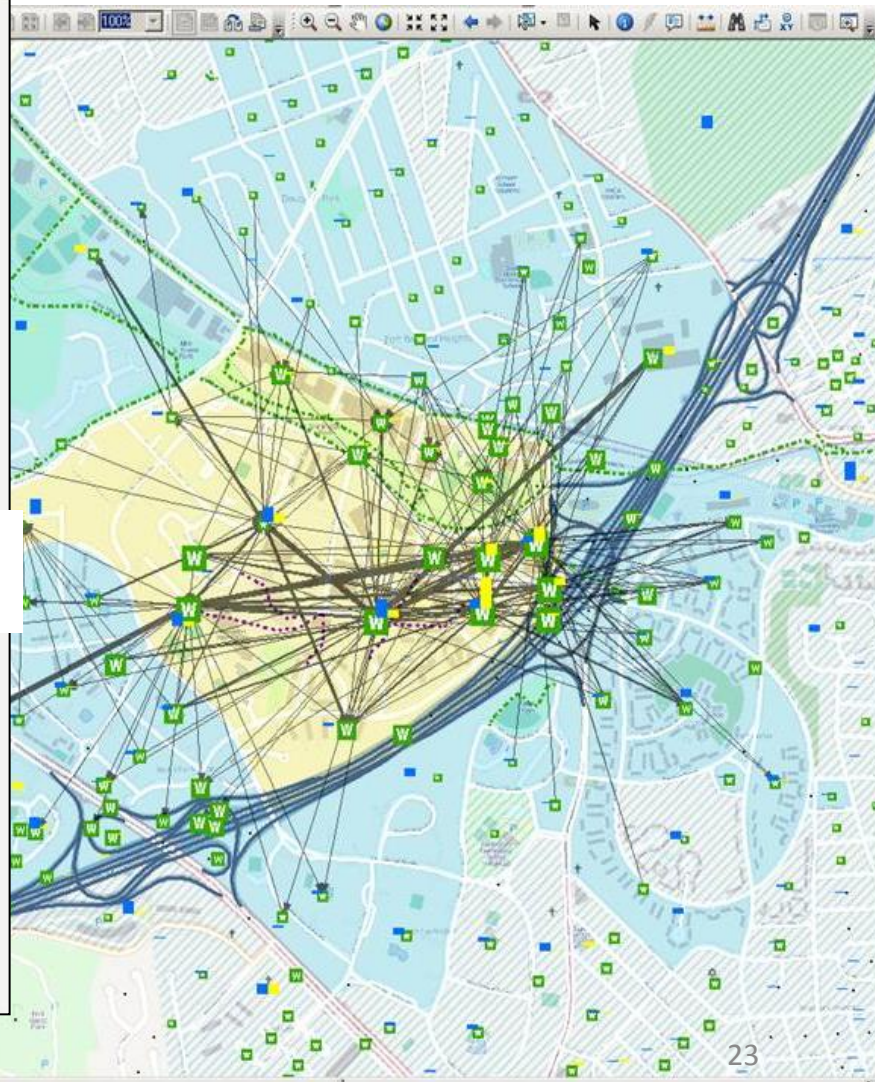
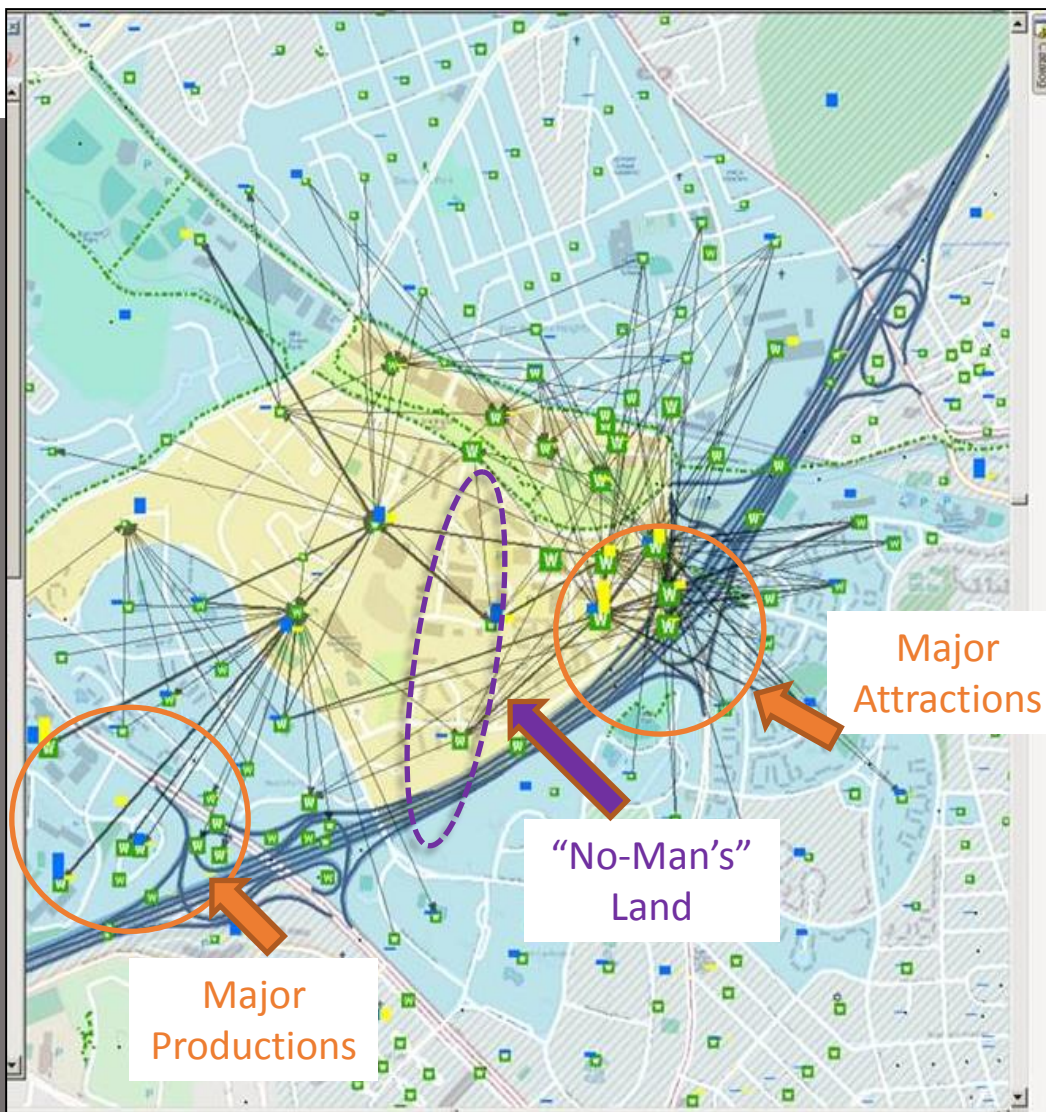
Test Application to Shirlington



Using Model to Estimate Walk Trip Flows (WALC model available in NCHRP Report 770)



Identifying Unmet Walk Opportunities



Maryland Department of Transportation: Analytic Tool Support

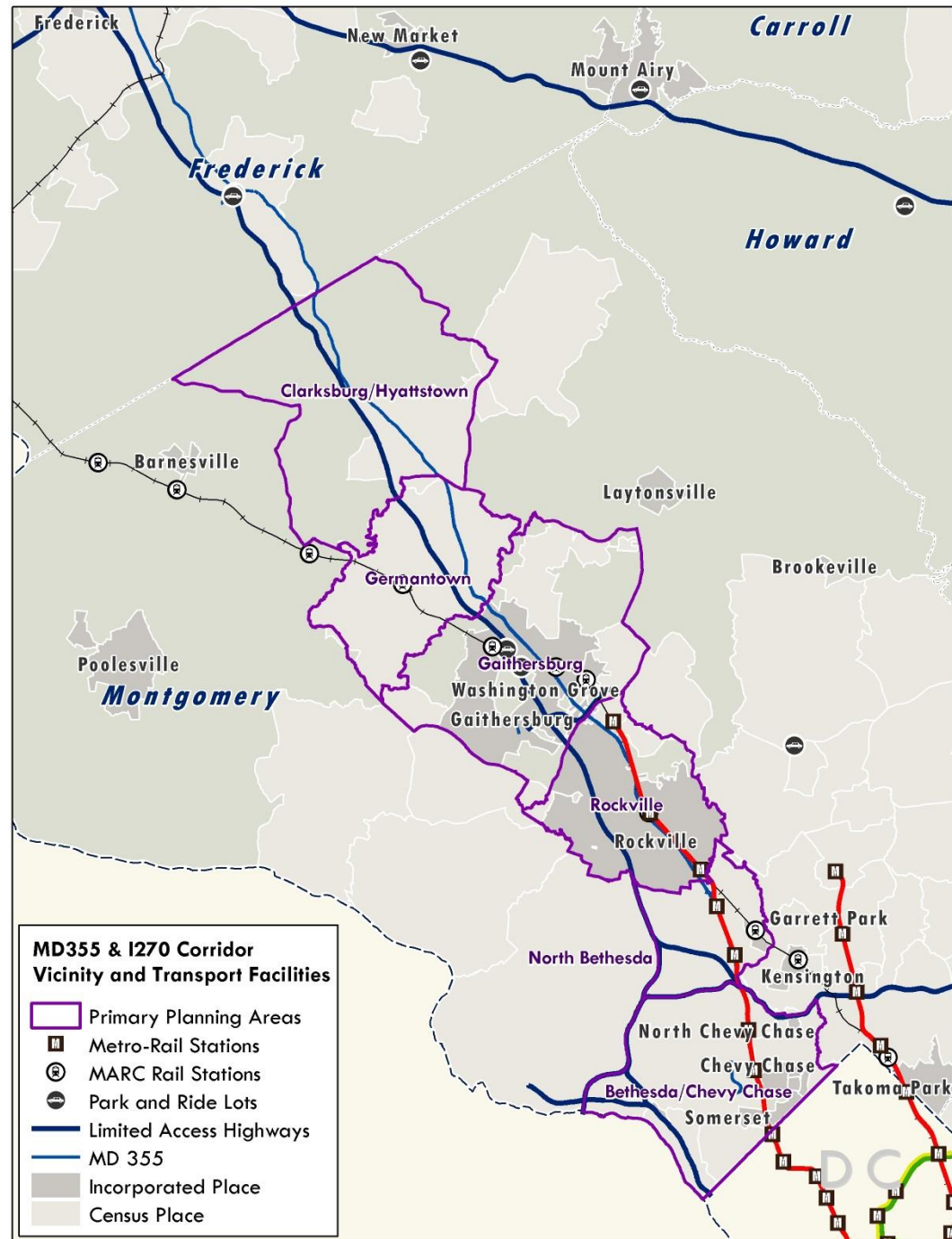
- Want more sensitivity in planning tools
- Policies and evaluation criteria more complex
- Want to account for land use and non-motorized
- Visualization for working with jurisdictions

➤ *Recommend **pilot study** of Arlington approach in major corridor*

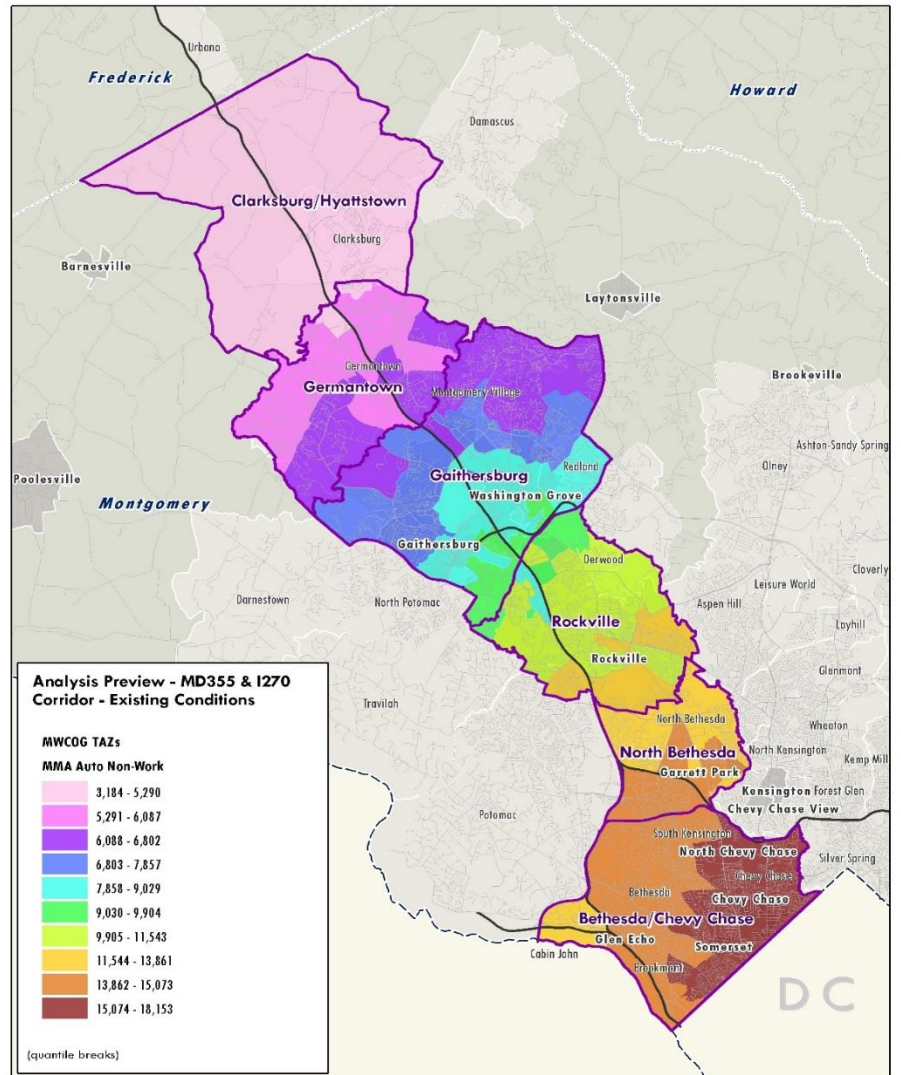
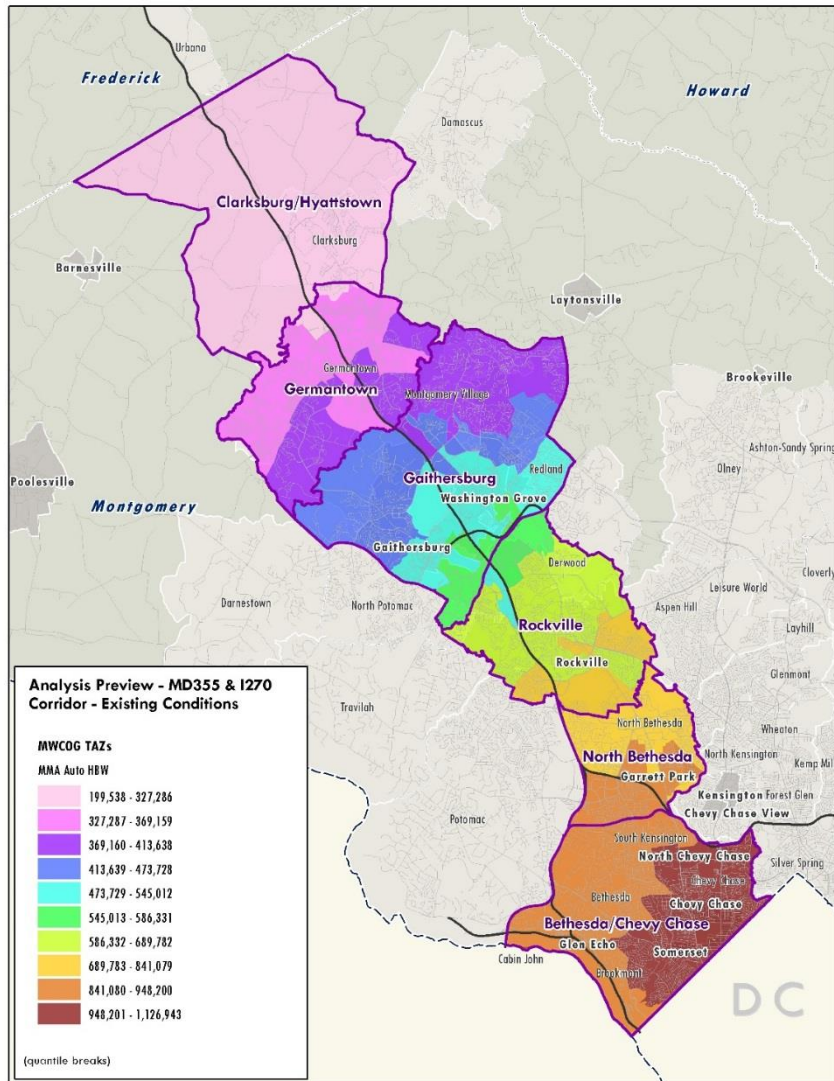


MD 355/I-270 Pilot Study Corridor

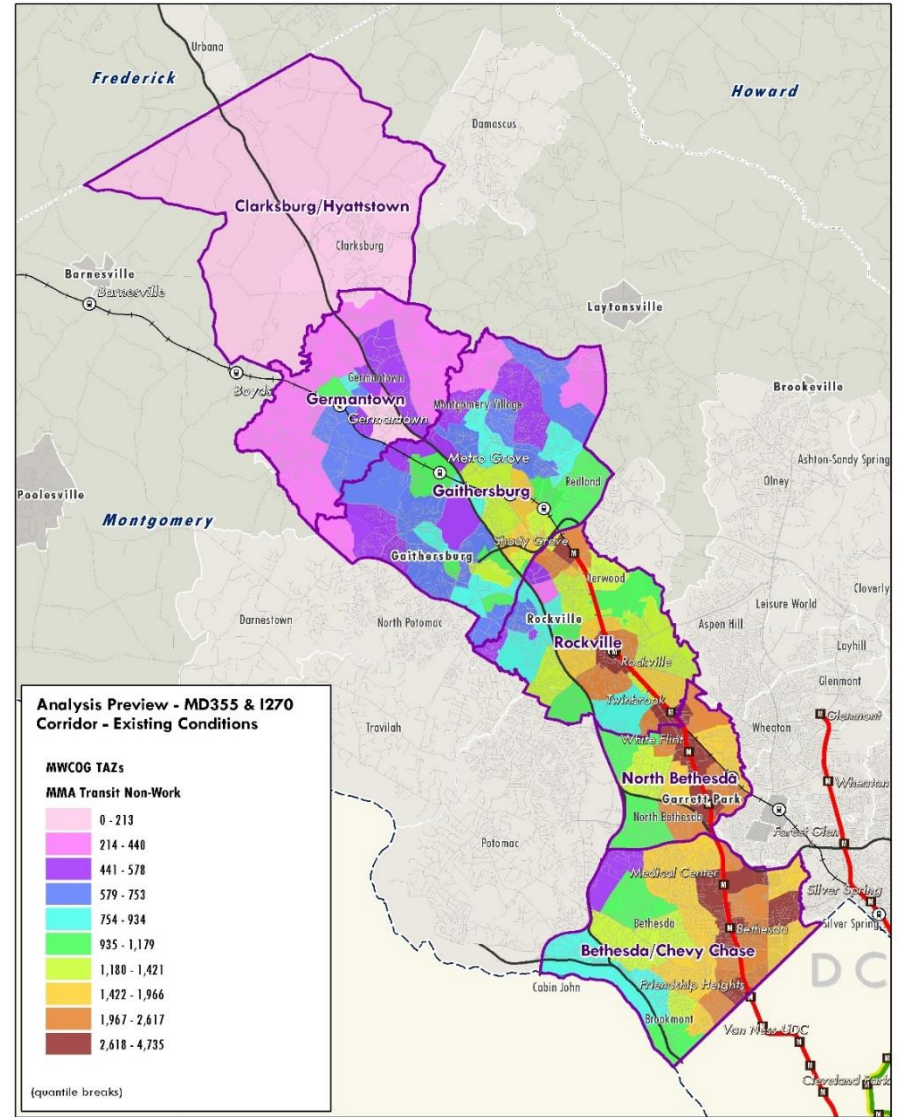
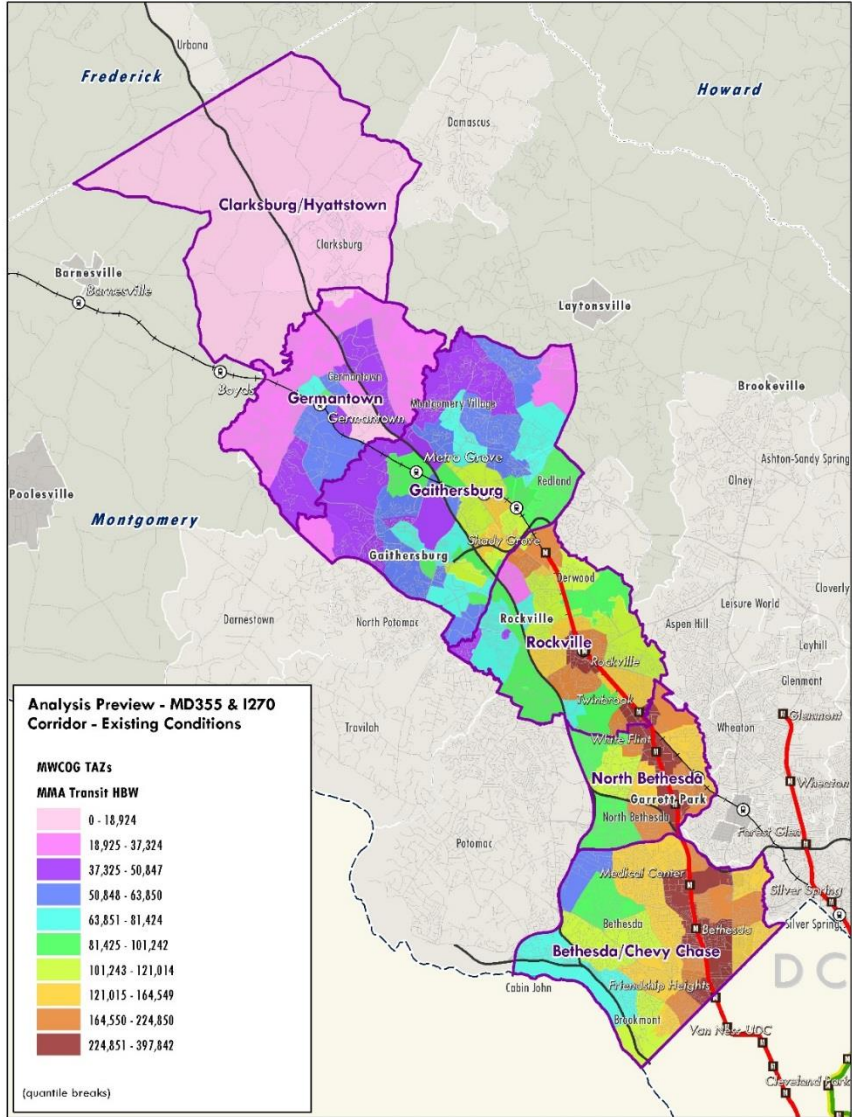
- 26 miles
- I-270 makes MD 355 more of a “Main Street”
- Multimodal: Metrorail & MARC, BRT under study
- Still very auto-oriented
- Concerns about impact of planned growth on transport sustainability



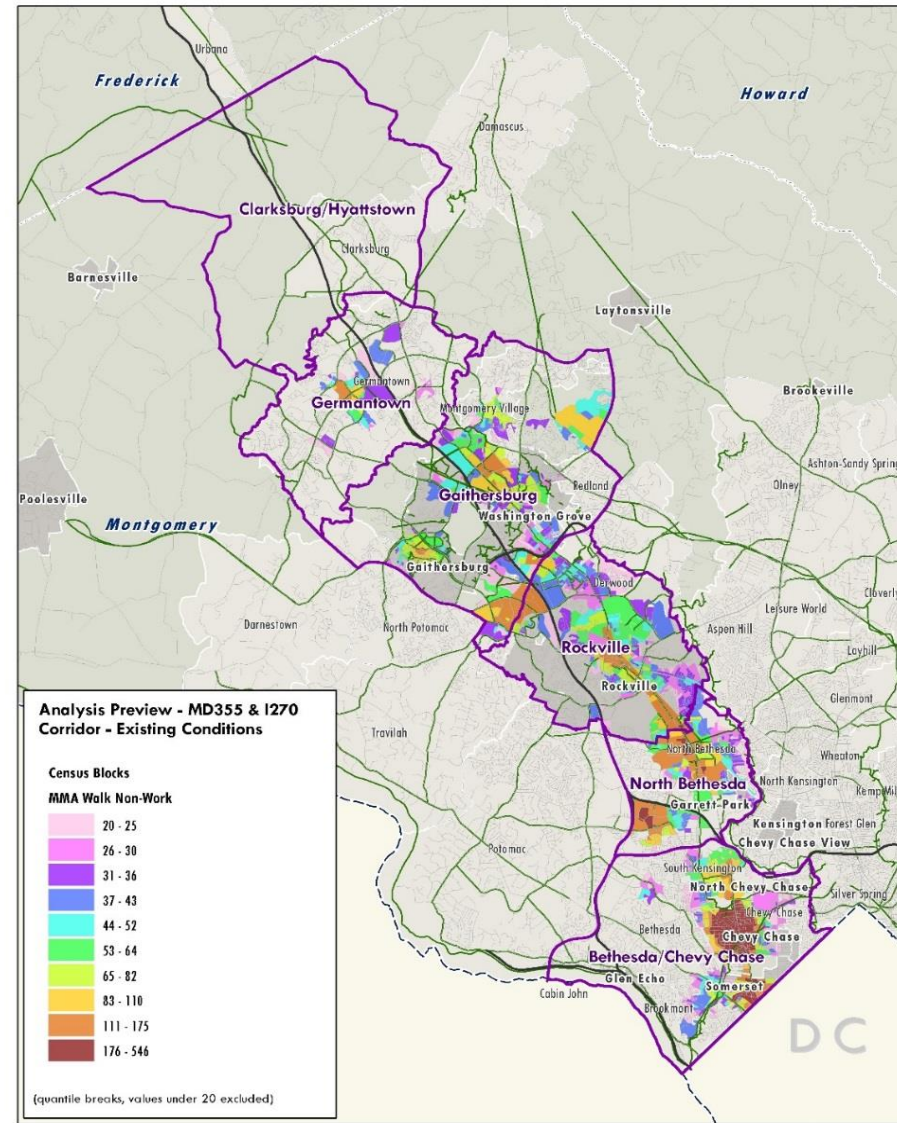
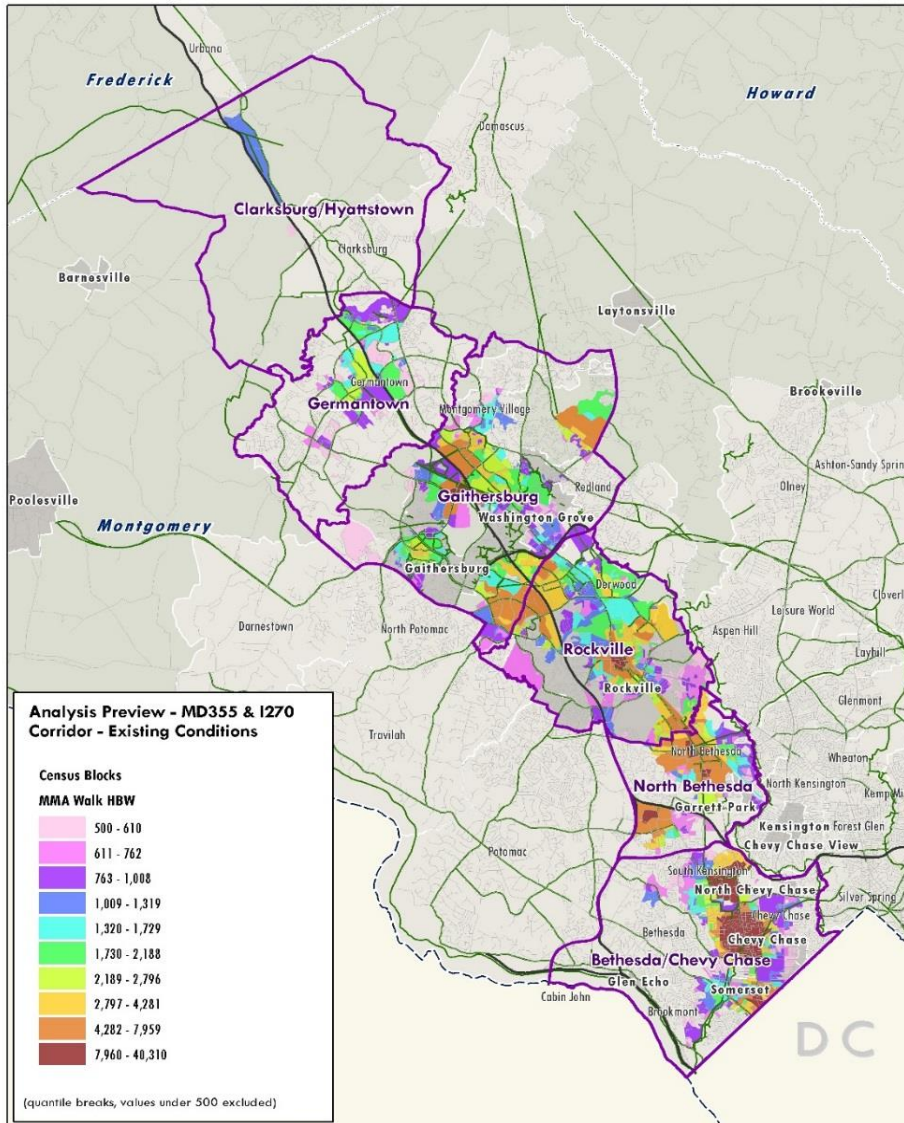
Auto Accessibilities: Work & Non-Work (TAZ)



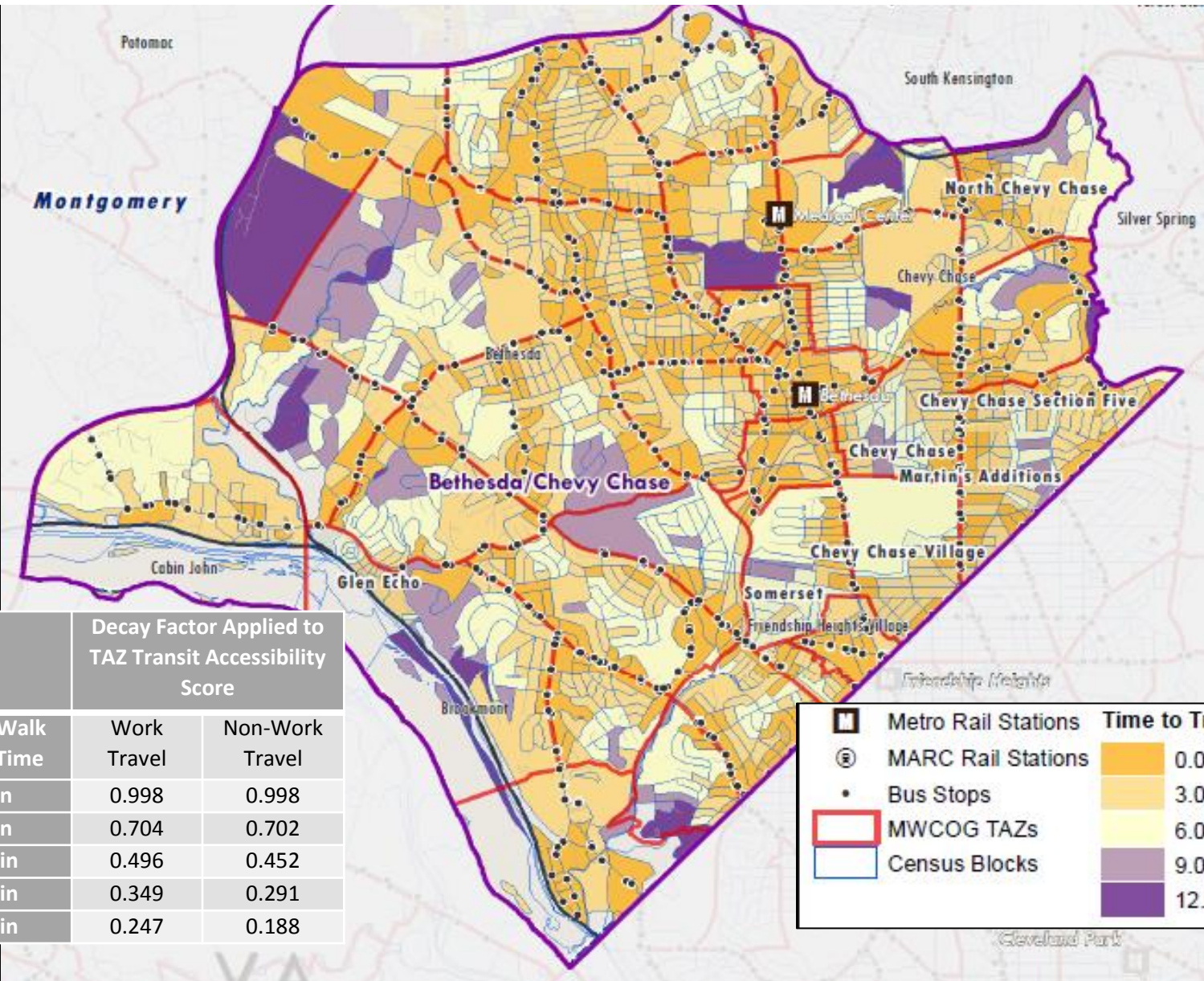
Transit Accessibilities: Work & Non-Work (TAZ)



Walk Accessibilities: Work & Non-Work (Block)



Bringing Transit Accessibility Down to Block Level

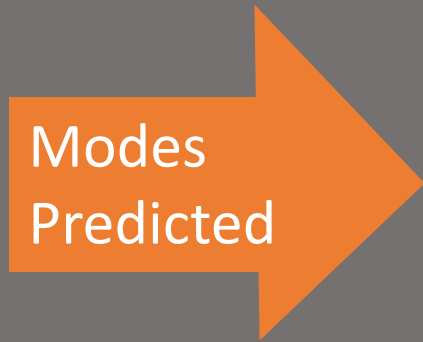


Transit Walk Access Time	Decay Factor Applied to TAZ Transit Accessibility Score	
	Work Travel	Non-Work Travel
1 min	0.998	0.998
5 min	0.704	0.702
10 min	0.496	0.452
15 min	0.349	0.291
20 min	0.247	0.188

	Metro Rail Stations		0.00 - 3.00
	MARC Rail Stations		3.01 - 6.00
	Bus Stops		6.01 - 9.00
	MWCOG TAZs		9.01 - 12.00
	Census Blocks		12.01 - 15.00

Converting MMA Scores to Mode Shares

$$\text{Mode Share} = f(\text{MMA-A}, \text{MMA-T}, \text{MMA-W})$$



HBW	HBO
Auto Driver	Auto Driver
Drive-Transit	Auto Passenger
Walk-Transit	Transit
Walk	Walk

Data Source: MWCOG Household Travel Survey

- Individual trips by purpose & mode
- MMA scores for each trip end (x, y address)

MWCOG Survey Sample for Corridor

Trip Purpose	Number of Trips by Purpose and Mode							Total	Pct of All Trips	Pct Less Return Home
	Transit walk or feeder access	Drive Alone	Auto Passenger	Auto Access Transit	Walk	Bicycle	Other			
Return home (not used)	349	2523	754	6	550	45	69	4296	39%	
Home to Work	206	696	39	69	28	14	7	1059	10%	16%
Home to Other	92	1503	549	20	362	33	50	2609	24%	39%
Home to School	30	66	203	2	42	8	233	584	5%	9%
Work based Other	121	628	64	7	322	9	24	1175	11%	17%
Non-home Based	<u>42</u>	<u>721</u>	<u>267</u>	<u>2</u>	<u>225</u>	<u>3</u>	<u>39</u>	<u>1299</u>	<u>12%</u>	<u>19%</u>
Total	840	6137	1876	106	1529	112	422	11022	100%	100%

Trip Purpose	Mode Shares by Trip Purpose							Total
	Transit walk or feeder access	Drive Alone	Auto Passenger	Auto Access Transit	Walk	Bicycle	Other	
Return home (not used)	8%	59%	18%	0%	13%	1%	2%	100%
Home to Work	19%	66%	4%	7%	3%	1%	1%	100%
Home to Other	4%	58%	21%	1%	14%	1%	2%	100%
Home to School	5%	11%	35%	0%	7%	1%	40%	100%
Work based Other	10%	53%	5%	1%	27%	1%	2%	100%
Non-home Based	3%	56%	21%	0%	17%	0%	3%	100%
Total	8%	56%	17%	1%	14%	1%	4%	100%

Mode Use in Relation to MMA Scores: HBW

Average MMA score for Selected Mode

Primary Mode	Origin			Destination		
	Auto MMA	Transit MMA	Walk MMA	Auto MMA	Transit MMA	Walk MMA
Transit (walk or feeder access)	898,331	203,697	4,914	868,766	252,350	19,297
Drive Alone	765,126	119,075	2,333	727,857	160,075	7,899
Auto Passenger	818,698	136,886	2,242	830,702	180,060	13,910
Transit (auto access)	703,321	92,636	1,428	819,131	240,922	21,679
Walk	949,747	237,472	8,369	937,842	281,701	13,414
Bicycle	870,642	168,220	2,848	787,965	194,222	19,798
Other	664,930	115,538	1,159	789,573	240,773	19,391
Total	794,625	138,509	2,932	759,838	178,601	9,984

Ratio of MMA score to Drive Alone (= 1.0)

Primary Mode	Origin			Destination		
	Auto MMA	Transit MMA	Walk MMA	Auto MMA	Transit MMA	Walk MMA
Transit (walk or feeder access)	1.17	1.71	2.11	1.19	1.58	2.44
Drive Alone	1.00	1.00	1.00	1.00	1.00	1.00
Auto Passenger	1.07	1.15	0.96	1.14	1.12	1.76
Transit (auto access)	0.92	0.78	0.61	1.13	1.51	2.74
Walk	1.24	1.99	3.59	1.29	1.76	1.70
Bicycle	1.14	1.41	1.22	1.08	1.21	2.51
Other	0.87	0.97	0.50	1.08	1.50	2.45
Total	1.04	1.16	1.26	1.04	1.12	1.26

Mode Split Equations: Applying MMA Scores to MWCOCG Travel Survey Data

	HBW Mode Choice			
	Auto	Drive-to-Transit	Walk-to-Transit	Walk
Constant	0.826	0.116	0.052	0.003
<i>t</i>	94.600	21.700	6.510	1.260
Auto MMA	1.38E-07	-1.21E-08	-1.23E-07	
<i>t</i>	9.350	-1.340	-8.976	
Transit MMA	-1.45E-06	-2.58E-07	1.41E-06	2.98E-07
<i>t</i>	-27.700	-8.030	29.100	16.087
Walk MMA	-6.71E-06	-1.11E-06	-1.23E-07	1.89E-06
<i>t</i>	-6.840	-1.850	-8.976	4.260
R Square	0.788	0.313	0.830	0.327
Est. Share at Mean	0.657	0.057	0.205	0.062

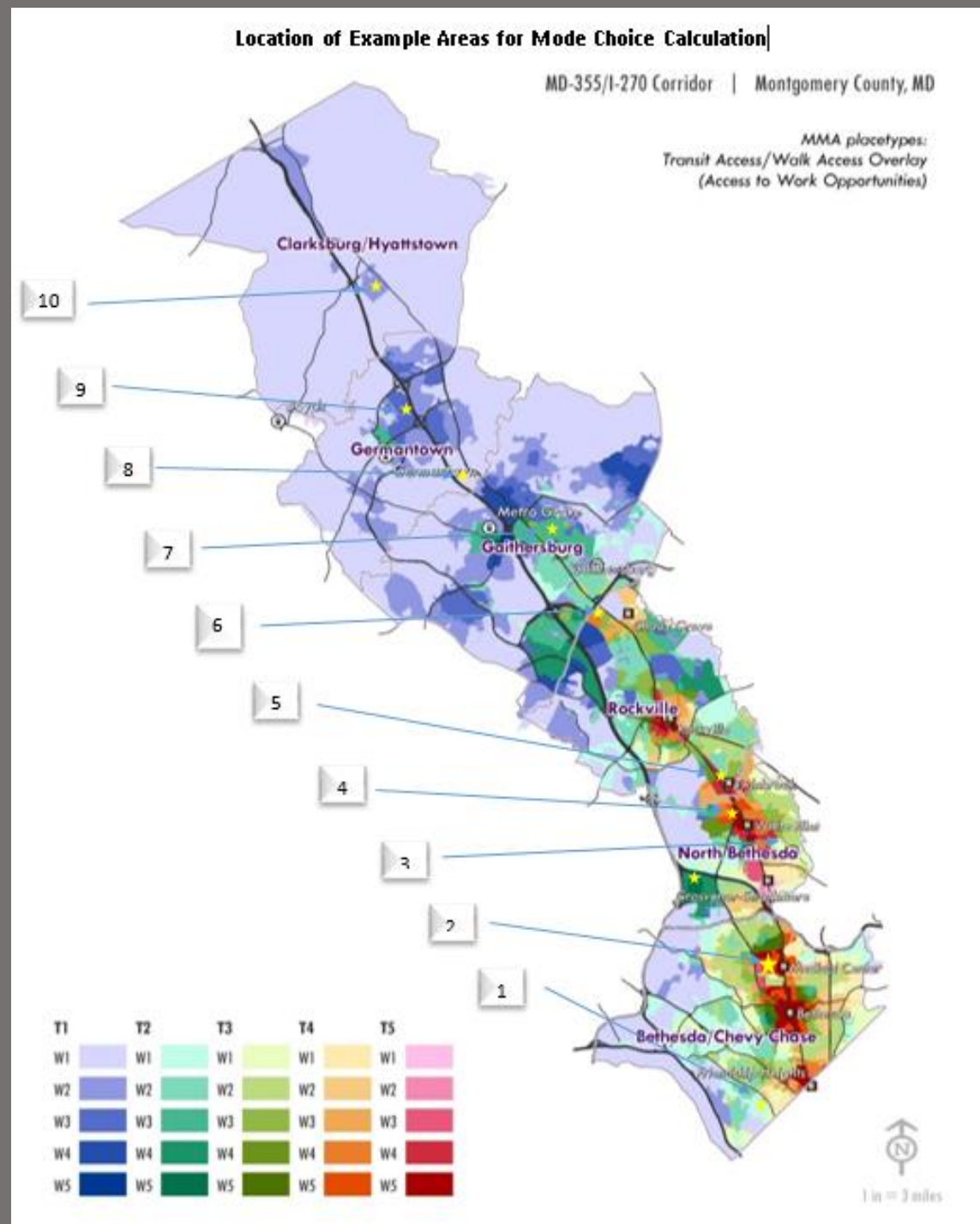
HBO Mode Choice			
Drive Alone	Auto Passenger	Transit	Walk
.589	.360	.032	.019
75.676	55.689	9.236	2.811
4.050E-06	-6.663E-06	-3.026E-06	5.639E-06
5.162	-10.218	-8.672	8.336
-2.028E-05	-1.165E-05	2.258E-05	9.357E-06
-6.005	-4.150	15.027	3.213
-5.409E-04	-2.766E-04	1.130E-04	7.045E-04
-18.456	-11.353	8.666	27.876
0.364	0.375	0.351	0.597
0.557	0.223	0.048	0.171



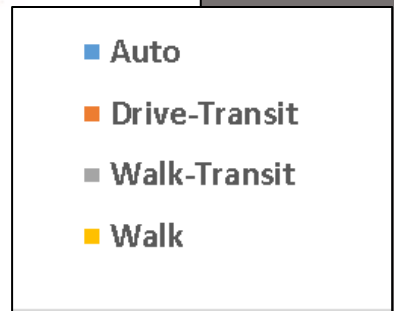
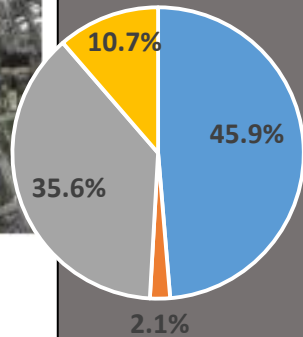
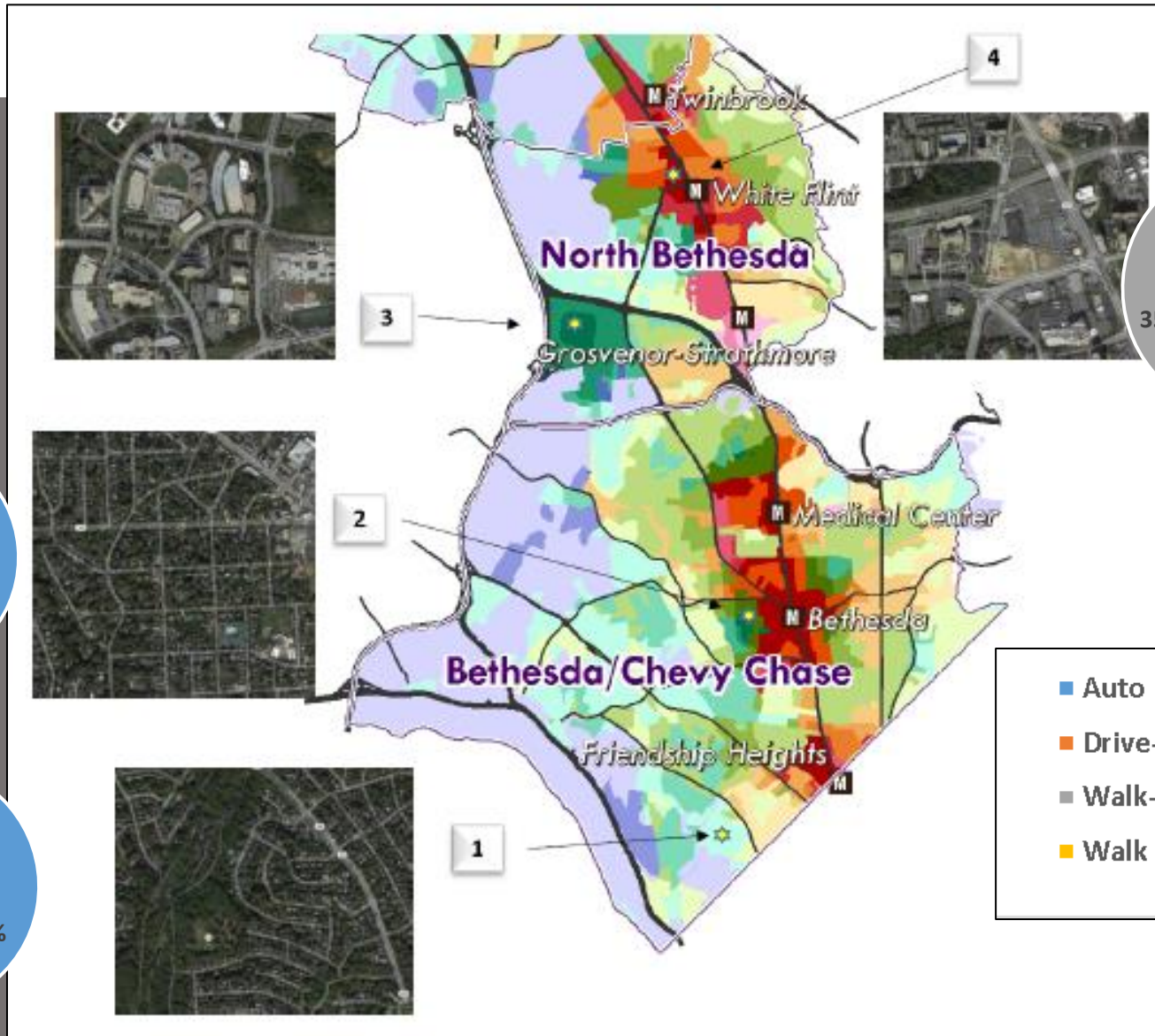
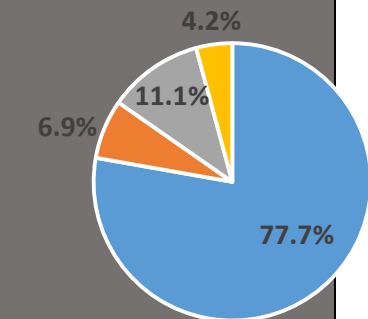
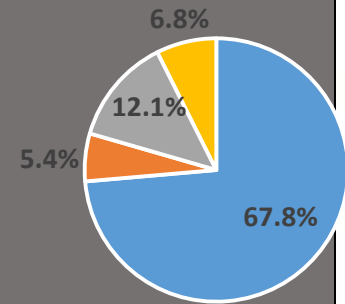
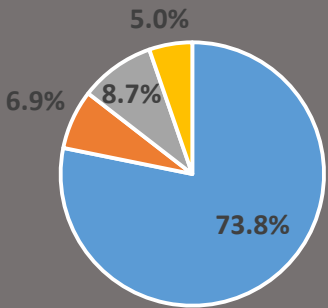
Equations Tested on Selected Areas with different combinations of Transit and Walk Score levels

Transit	
Tier	MMA Range
T1	<67k
T2	67k - 102k
T3	103k - 151k
T4	152k - 228k
T5	> 228k

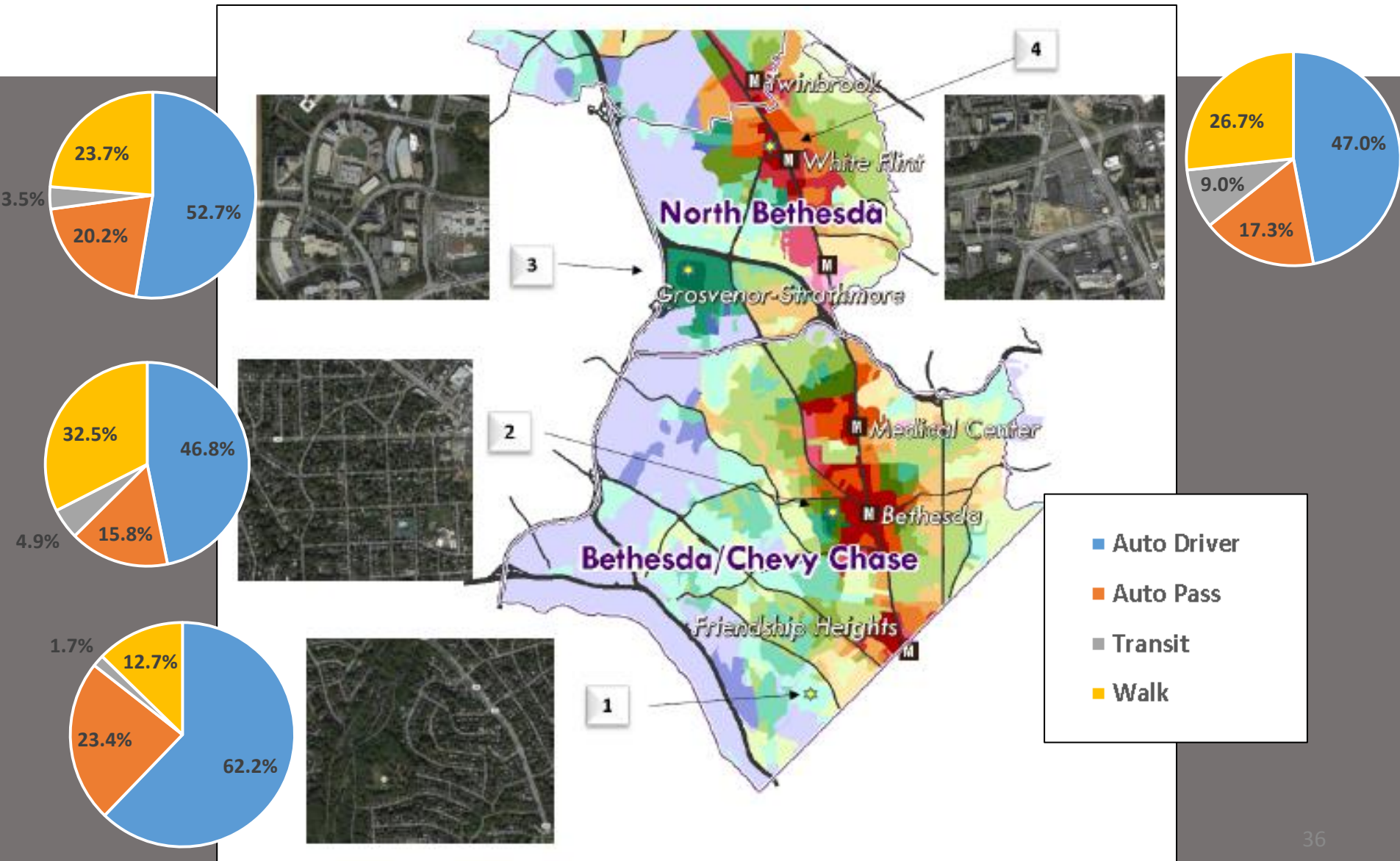
Walk	
Tier	MMA Range
W1	<329
W2	329 - 1513
W3	1514 - 3577
W4	3578 - 7607
W5	>7607



MMA Model Application to Selected Areas: Mode Shares for Home-Based Work Travel



MMA Model Application to Selected Areas: Mode Shares for Home-Based Non-Work Travel



Comparing MMA Model Estimated Mode Shares by Planning Area with MWCOG and ACS Household Surveys for Journey-to-Work

Absolute Mode Shares

		Estimated Mode Shares		
PPA		Auto	Transit	Walk
Bethesda	1	67.3%	28.3%	4.8%
N Bethesda/W Flint	2	68.5%	27.5%	4.5%
Rockville	3	73.4%	22.8%	3.6%
Gaithersburg	4	81.8%	16.2%	2.2%
Germantown	5	85.5%	13.1%	1.5%
Clarksburg	6	88.8%	10.2%	0.9%

Percentage Differences

		ACS minus COG survey		
PPA		Auto	Transit	Walk
Bethesda	1	9.4%	-9.6%	0.3%
N Bethesda/W Flint	2	4.5%	-5.8%	1.3%
Rockville	3	5.8%	-4.5%	-1.3%
Gaithersburg	4	1.7%	-3.4%	1.7%
Germantown	5	12.0%	-11.9%	-0.1%
Clarksburg	6	0.4%	-2.8%	2.4%

		MWCOG Survey Mode Shares		
PPA		Auto	Transit	Walk
Bethesda	1	62.7%	29.9%	7.4%
N Bethesda/W Flint	2	69.3%	28.4%	2.4%
Rockville	3	71.4%	24.3%	4.3%
Gaithersburg	4	84.3%	15.0%	0.7%
Germantown	5	75.3%	23.3%	1.4%
Clarksburg	6	90.0%	10.0%	0.0%

		Estimated minus ACS		
PPA		Auto	Transit	Walk
Bethesda	1	-4.8%	8.1%	-2.9%
N Bethesda/W Flint	2	-5.2%	4.9%	0.8%
Rockville	3	-3.9%	3.1%	0.6%
Gaithersburg	4	-4.2%	4.6%	-0.2%
Germantown	5	-1.9%	1.7%	0.3%
Clarksburg	6	-1.6%	3.0%	-1.5%

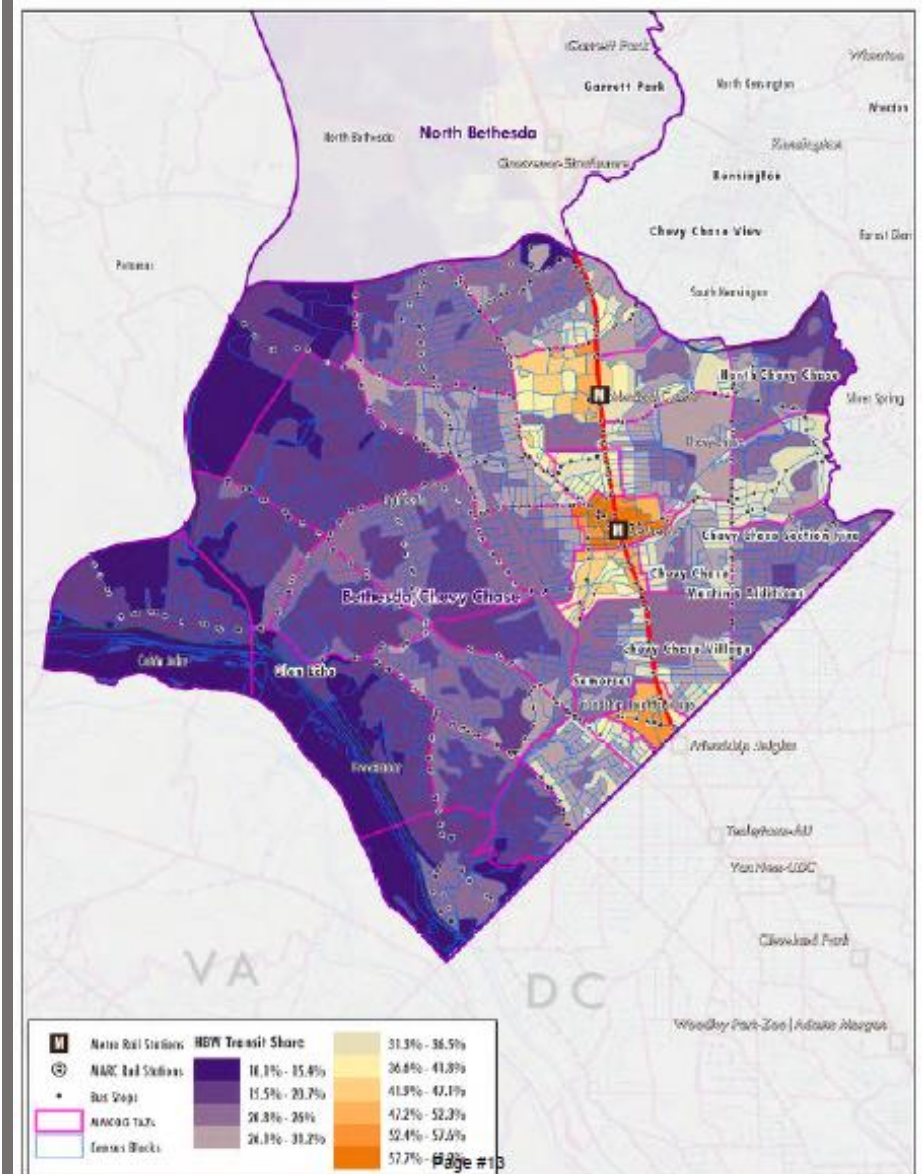
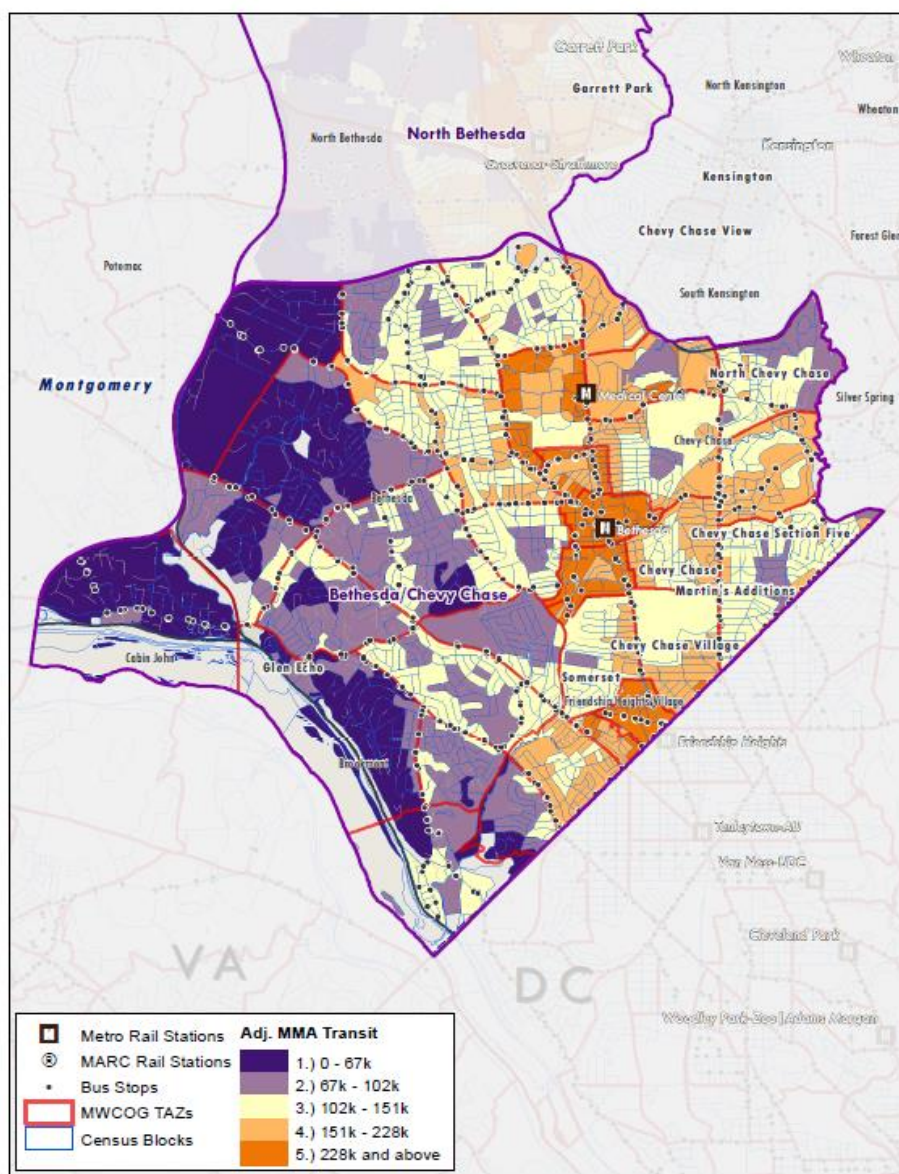
		ACS Mode Shares		
PPA		Auto	Transit	Walk
Bethesda	1	72.1%	20.2%	7.7%
N Bethesda/W Flint	2	73.7%	22.6%	3.7%
Rockville	3	77.3%	19.7%	3.0%
Gaithersburg	4	86.0%	11.6%	2.4%
Germantown	5	87.3%	11.4%	1.2%
Clarksburg	6	90.4%	7.2%	2.4%

		Estimated minus MWCOG		
PPA		Auto	Transit	Walk
Bethesda	1	4.6%	-1.5%	-2.6%
N Bethesda/W Flint	2	-0.7%	-0.8%	2.1%
Rockville	3	2.0%	-1.5%	-0.7%
Gaithersburg	4	-2.5%	1.2%	1.5%
Germantown	5	10.1%	-10.2%	0.1%
Clarksburg	6	-1.2%	0.2%	0.9%

Predicting Mode Shares at Block Level

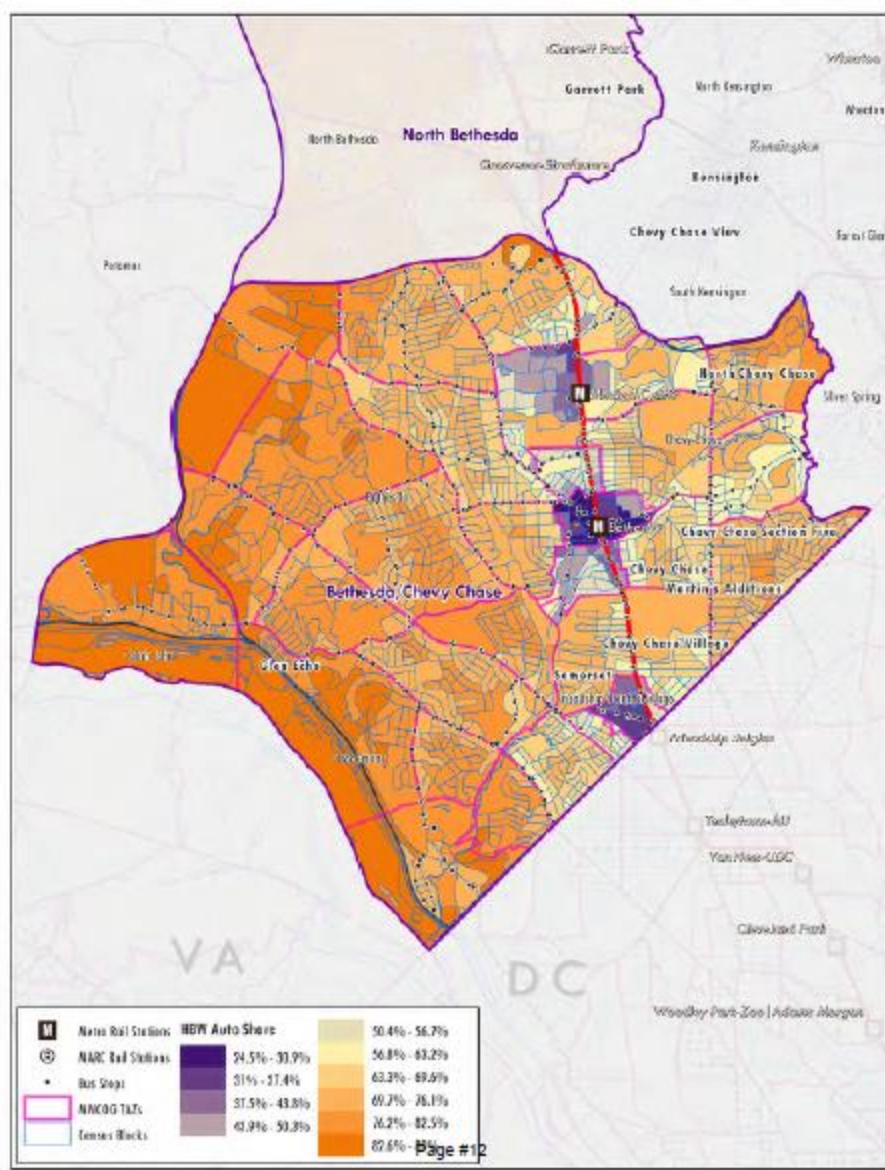
Transit Accessibility: HBW

Transit Mode Share: HBW

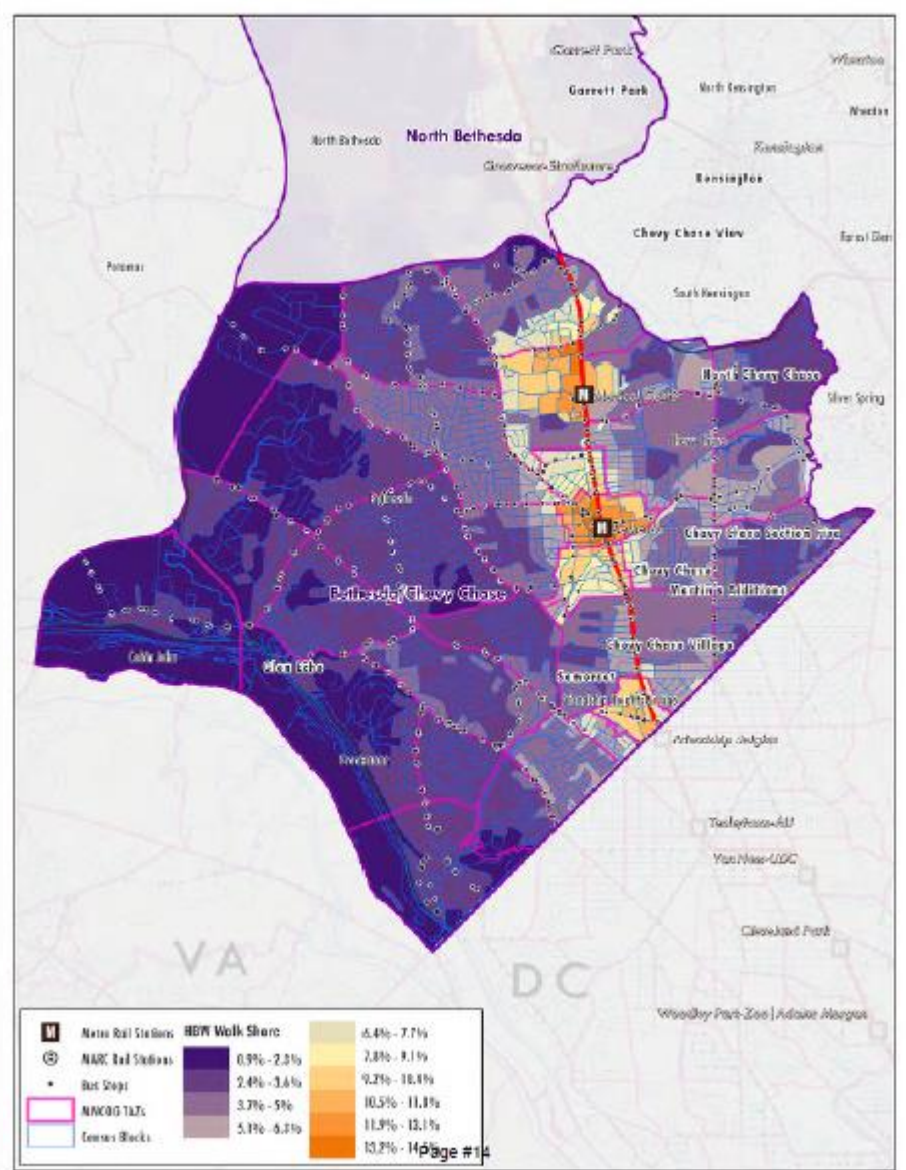


Predicting Mode Shares at Block Level

Auto HBW



Walk HBW



Findings from Work to Date

1. Surprisingly strong relationships (also used scores to develop probability choice models)
2. Including Socio-Dem variables didn't add much
3. Provides two types of products:
 - Mode split calculations for modeling
 - Illustrative patterning through maps
4. Can work independent of or in tandem with regional TAZ models



Additional Applications Under Way

1. Under contract (MDOT) to extend MMA coverage to entire Central MD region
2. Will be testing as part of upcoming BRT Purpose & Needs studies
3. Using to calculate accessibility measures for HB2 and needs assessment in Virginia
4. Supporting analysis of bike/ped improvements along Lee Highway (TLC project)
5. Will use for testing LU + TR alternatives in MWCOCG Multi-Sector Work Group GHG study

