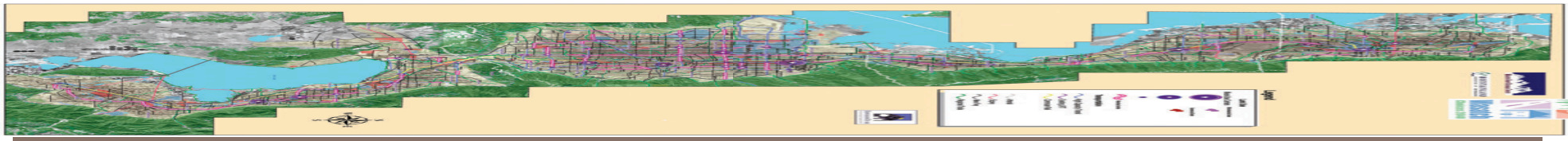
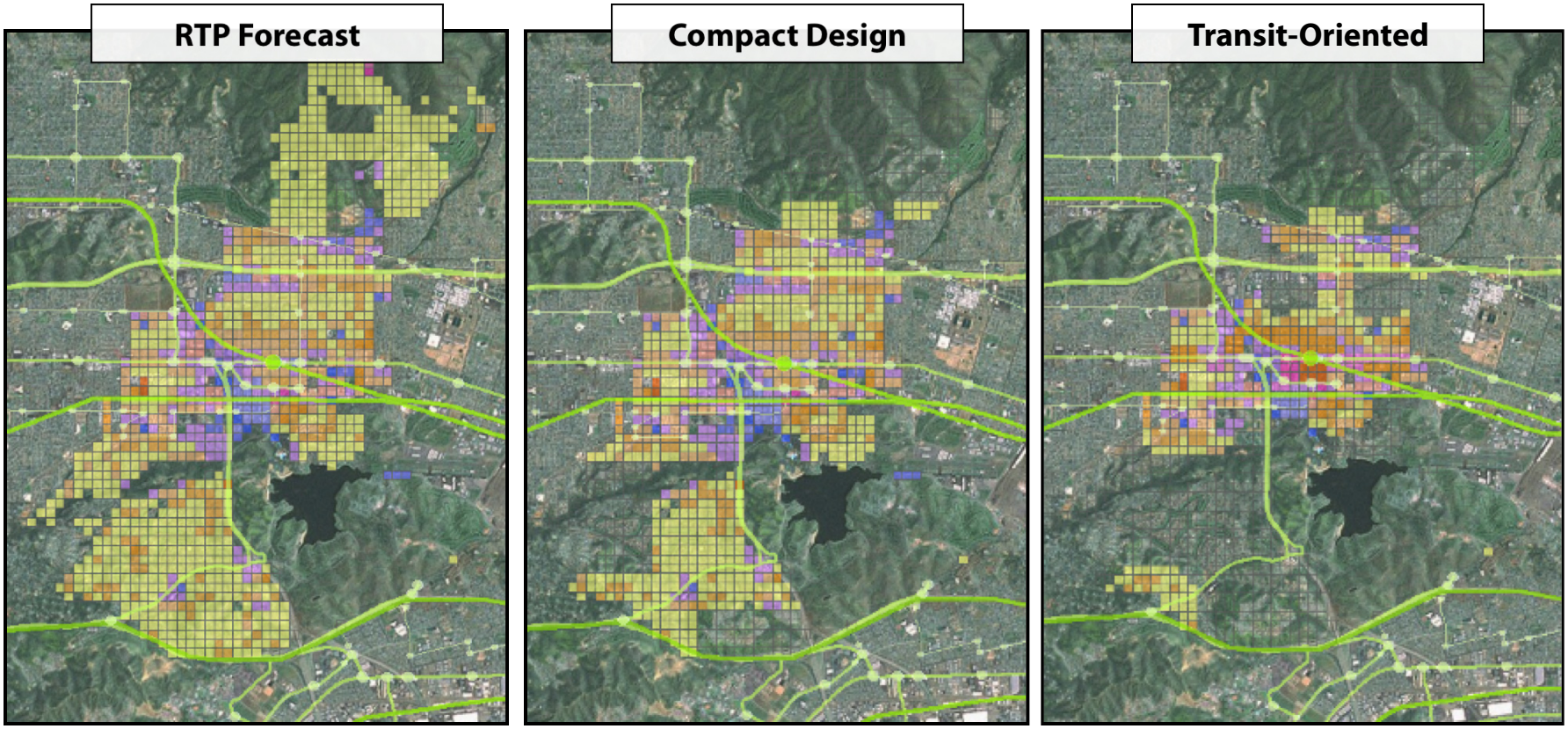


ET+

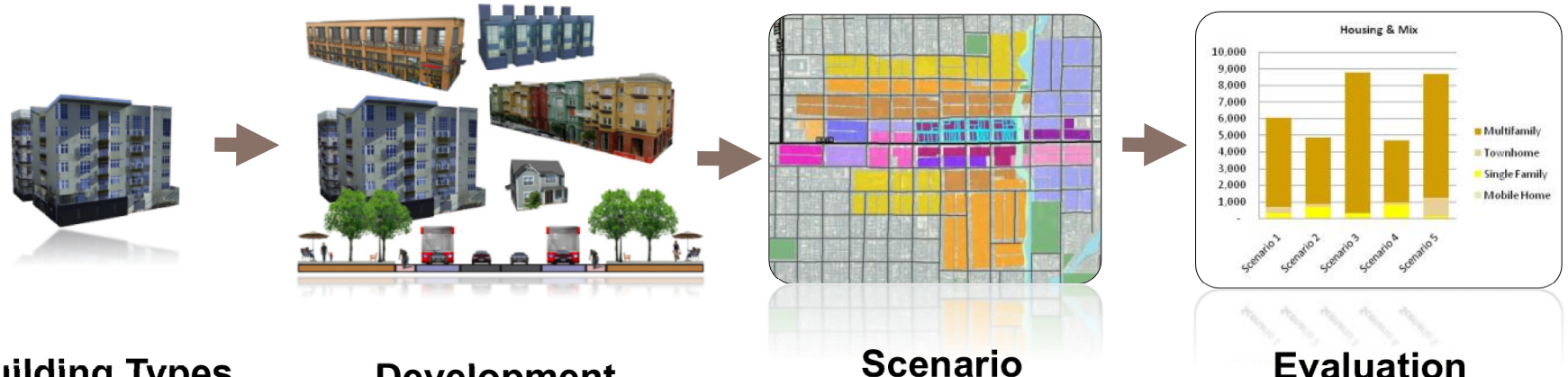
Metropolitan Research Center – University of Utah
Fregonese Associates
Envision Utah
Salt Lake County
Wasatch Front Regional Council

Compare Multiple Scenarios

- Test land use policies
- Experiment with new development patterns



Scenario Building Process



Building Types | **Development Types** | **Scenario Development** | **Evaluation**

Step 4: Compare the scenarios and monitor the impact of land use decisions in real-time.

Scenario Indicators:

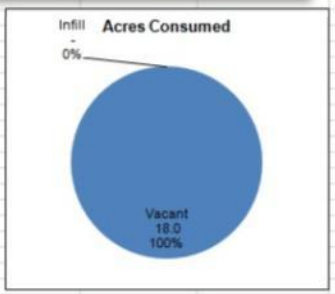
- *Anything we can know about a building, we can know about a scenario…*
  - Housing and Jobs: mix and density
  - Jobs-Housing Balance
  - Land Consumption: vacant, agricultural, infill
  - Impervious Surface
  - Open Space
  - Housing Affordability
  - Resource Usage: energy and water
  - Waste Production: water, solid, carbon
  - Transportation: travel mode choice, vehicle miles traveled
  - Fiscal Impact: local revenue and infrastructure costs
  - Balanced Housing Index: how scenario housing mix matches expected future demographic profile

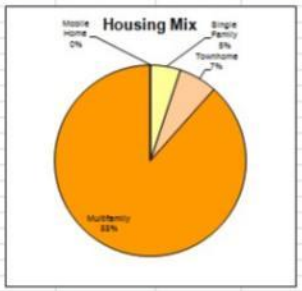
Monitor Indicators in Real-time

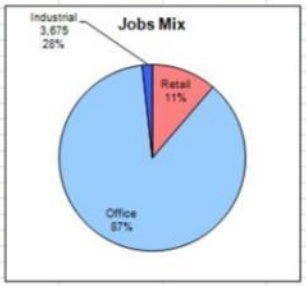
Detailed Tables

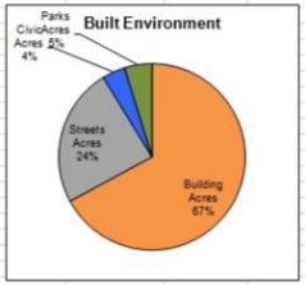
Enter Scenario Name or Theme	Acres Consumed			Total Acres	Total Housing Units	Housing Mix				Total Jobs	Employment Mix			Built Environment			
Dev type	Total Vacant Acres	Total Developed Acres	Discounted Developed Acres (*Redev %)			Single Family	Townhome	Multifamily	Mobile Home		Retail	Office	Industrial	Building Acres	Streets Acres	Civic Acres	Parks Ac
Urban Core	13.6	-	-	13.6	2,179	-	-	2,179	-	11,838	888	10,950	-	9.26	3.40	0.54	
City Center	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Town Center	3.4	-	-	3.4	343	-	-	343	-	121	121	-	-	2.32	0.85	0.14	
Village Center	3.2	-	-	3.2	132	-	-	132	-	113	113	-	-	2.17	0.80	0.13	
Mixed-Use Corridor	5.7	-	-	5.7	149	-	-	149	-	199	199	-	-	3.80	1.42	0.23	
Main Street	4.0	-	-	4.0	2,567	-	-	2,567	-	-	-	-	-	2.65	0.99	0.16	
City Neighborhood	24.5	-	-	24.5	344	-	344	-	-	-	-	-	-	16.44	6.14	0.98	
Town Neighborhood	4.0	-	-	4.0	50	-	50	-	-	-	-	-	-	2.67	1.00	0.16	
Village Neighborhood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Suburban Residential	35.9	-	-	35.9	210	210	-	-	-	-	-	-	-	24.07	8.62	1.44	
Rural Residential	34.3	-	-	34.3	100	100	-	-	-	-	-	-	-	22.96	8.23	1.37	
Office Park	1.9	-	-	1.9	-	-	-	-	-	487	-	487	-	1.30	0.47	0.08	
Regional Retail	5.6	-	-	5.6	-	-	-	-	-	98	98	-	-	3.74	1.28	0.22	
Strip Commercial	2.1	-	-	2.1	-	-	-	-	-	62	62	-	-	1.42	0.49	0.08	
Flex Park	3.7	-	-	3.7	-	-	-	-	-	27	-	-	27	2.51	0.86	0.15	
Industrial Park	27.5	-	-	27.5	-	-	-	-	-	201	-	-	201	18.42	6.32	1.10	
Totals	169.5	-	-	**169.5**	**6,073**	310	394	5,370	-	**13,145**	1,480	11,437	228	**114**	**41**	**7**	
			0%			5.1%	6.5%	88.4%	0.0%		11.3%	87.0%	1.7%	67.1%	24.1%	4.0%	
			0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

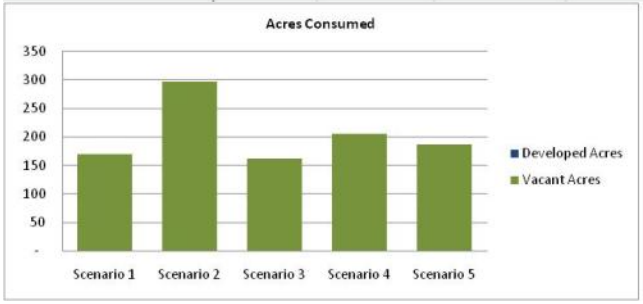
Quick Reference Graphs

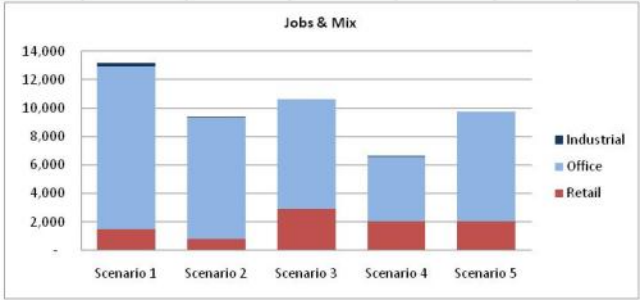












Apps (requiring travel inputs in green)

- Predictive Growth Model
- Building and Land Use Types
- Building Energy Consumption
- 7D Transportation Impacts
- Return of Investment
- H + T Costs
- Air Quality and Climate Impacts
- Fiscal Impact
- Public Health

Apps (requiring travel inputs in green)

- Employment Growth
- Employment Resilience
- Development Capital
- Redevelopment Timing
- Water Consumption
- Transportation Safety
- Workforce Housing
- LEED-ND Application
- Public Assets

7D App

Through pioneering research, University of Utah faculty have modeled the effects of ***density*** (built space per acre), ***diversity*** (land-use mix), ***distance*** to transit, ***destination*** accessibility, land-use connectivity through ***design, development*** scale, and ***demographics*** – the 7Ds, on internal capture of trips within mixed-use developments (MXDs); external trips by walking, transit, and private vehicle; and vehicle miles traveled (VMT).

ET+ will be expanded to include all trips and will develop interactive coefficients to calculate internal capture, walk, transit, and private vehicle trips, and VMT for comparison to current conditions and future scenarios advancing 7D interactions.

7D Analysis - Innovations

- Pooled household travel data for MXDs in six diverse regions
- Identified 239 MXDs through a bottom-up survey process
- Included internal capture, mode choice for external trips, and trip length as travel outcome measures

Additional Innovations

- Estimated large number of 7D variables consistently across regions
- Modeled travel relationships hierarchically
- Validated results through comparison to traffic generation counts at an independent set of mixed use sites in various parts of the U.S.

Six Diverse Regions

- Atlanta
- Boston
- Houston
- Portland
- Sacramento
- Seattle

Regions Based on Data Availability

- Provide XY coordinates for trip ends, so we could zero in on individual sites when studying travel patterns to, from, and within MXDs
- Provide individual parcel data, so we could study land-use mix down to the parcel level

Identifying MXDs

- Top-Down GIS-Based Approach
- vs.
- Bottom-Up Expert-Based Approach

New MXD Definition

- …A ***mixed-use development*** or district consists of two or more land uses between which trips can be made using local streets, without having to use major streets. The uses may include residential, retail, office, and/or entertainment. There may be walk trips between the uses.

Example – RiverPlace (Portland)

Internal capture = 36%
Walking – 14%
Transit – 9%
Auto Trips – 7.7 miles

239 MXDs

Metro	Survey Year	MXDs	Mean Acreage per MXD	Total Trip Ends	Mean Trip Ends per MXD
Atlanta	2001	24	287	6,167	257
Boston	1991	59	175	3,578	61
Houston	1995	34	401	1,584	47
Portland	1994	53	116	6,146	116
Sacramento	2000	25	179	2,487	99
Seattle	1999	44	207	15,915	362
Total		239	211	35,877	150

Multiple Outcome Measures

- INTERNAL – Dummy variable indicating that the trip remained within the development
- WALK – Dummy variable indicating that the travel mode on a trip is walking (1=walk mode, 0=other)
- TRANSIT - Dummy variable indicating that the travel mode on a trip is public bus or rail (1=transit, 0=other)
- TDIST - Network trip distance between origin and destination locations for an external private vehicle trip, in miles

7D variables consistently defined

- Density
- Diversity
- Design
- Destination Accessibility
- Distance to Transit
- Development Scale
- Demographics

Individual Level Variables

- HHSIZE – Number of members of the household
- VEHCAP – Number of motorized vehicles per person in the household
- BUSSTOP – Dummy variable indicating that the household lives within ¼ mile of a bus stop (1=yes, 0=no)

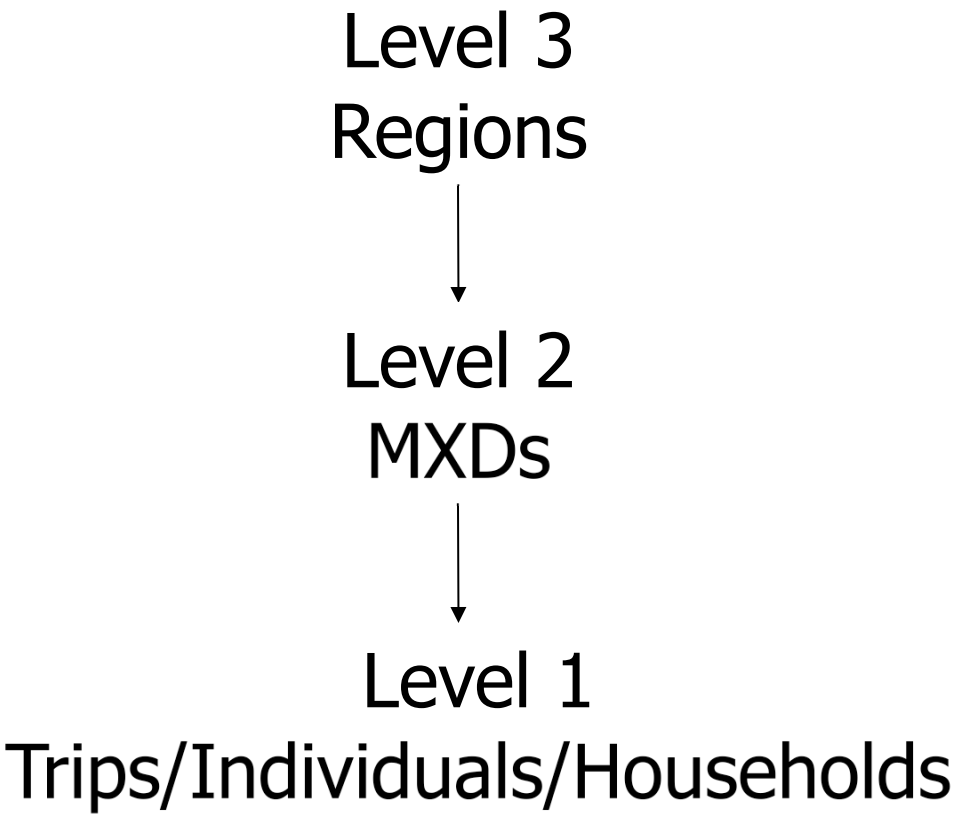
MXD Level Variables

- ACTDEN – Population + employment density per square mile
- JOBPOP – Balance of jobs to population within the MXD
- LANDMIX – Entropy index that captures the variety of land uses based on acreage
- INTDEN - Number of intersections within the MXD per square mile of gross area
- EMPMILE – Total employment within one mile of the traffic analysis zones intersecting the MXD
- EMP30T – Total employment within 30 minutes by transit of traffic analysis zones intersecting the MXD
- STOPDEN – Number of bus stops within the MXD per square mile of gross area
- RAIL – Rail station located within the MXD (1 = yes, 0=no)

Region Level Variables

- REGPOP – Population within the region
- REGEMP – Employment within the region
- REGACT – Activity within the region (population + employment)
- SPRAWL – Measure of overall regional sprawl from same source

Hierarchical Modeling



Log odds of internal capture (log-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value
constant	-1.75			-2.43			-5.72		
EMP							0.208	3.28	0.002
AREA				0.486	3.61	0.001	0.468	4.58	<0.001
JOBPOP	0.389	2.62	0.010	0.399	4.55	<0.001			
INTDEN				0.385	1.92	0.055	0.638	4.95	<0.001
HHSIZE	-1.33	-6.03	<0.001	-0.867	-13.0	<0.001	-0.237	-4.54	<0.001
VEHCAP	-0.990	-4.15	<0.001	-0.590	-8.19	<0.001	-0.163	-3.00	0.003
pseudo-R2		0.01			0.20			0.30	

Log odds of walking on external trips (log-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value
constant	-5.55			-10.96			-15.09		
AREA				-0.415	-4.27	<0.001			
ACTDEN				0.370	2.74	0.007	0.377	3.12	0.003
JOBPOP	0.226	2.46	0.015	0.219	3.83	<0.001			
INTDEN							0.803	5.05	<0.001
EMPMILE	0.385	3.12	0.002	0.450	5.05	<0.001	0.440	5.09	<0.001
HHSIZE	-1.57	-6.29	<0.001	-0.486	-5.05	<0.001	-0.281	-2.59	0.010
VEHCAP	-1.84	-7.00	<0.001	-0.768	-7.62	<0.001	-0.242	-2.13	0.033
pseudo-R2	0.19			0.51			0.64		

Log odds of using transit on external trips (log-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value
constant	-4.32			-6.08			-2.69		
ACTDEN				0.324	2.89	0.005			
INTDEN	1.12	4.44	<0.001						
EMP30T	0.209	2.98	0.004				0.134	3.29	0.002
HHSIZE	-1.14	-6.31	<0.001	-0.958	-8.48	<0.001			
VEHCAP	-1.68	-8.56	<0.001	-1.09	-8.24	<0.001	-0.340	-3.74	<0.001
BUSSTOP	0.357	2.08	0.037	0.467	4.04	<0.001			
pseudo-R2	0.47			NA			NA		

Distance of external automobile trips (semi-log form)

	Home-Based Work			Home-Based Other			Non-Home Based		
	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value	Coeff	t-ratio	p-value
constant	6.54			4.33			8.99		
AREA	1.07	2.92	0.004						
JOBPOP	-0.298	-1.88	0.061	-0.356	-2.38	0.018	-0.282	-2.05	0.041
INTDEN							-0.832	-2.06	0.041
EMP20A				-0.697	-4.79	<0.001	-0.823	-5.69	<0.001
EMP30A	-1.19	-6.05	<0.001						
HHSIZE	2.76	8.08	<0.001	0.772	5.06	<0.001	0.520	2.58	0.010
VEHCAP	2.76	7.26	<0.001	1.48	9.22	<0.001	1.06	5.12	<0.001
pseudo-R2	0.11			0.03			0.05		

Primary Determinants of Reduction in External Auto Trips

- The total and the relative amounts of population and employment on the site
- The site size and activity density
- The amount of employment within walking distance of the site
- The pedestrian-friendliness of the site (small block size)
- The access to employment within a 30 minute transit ride of the site.
- The size of households and their auto ownership

Model Validation

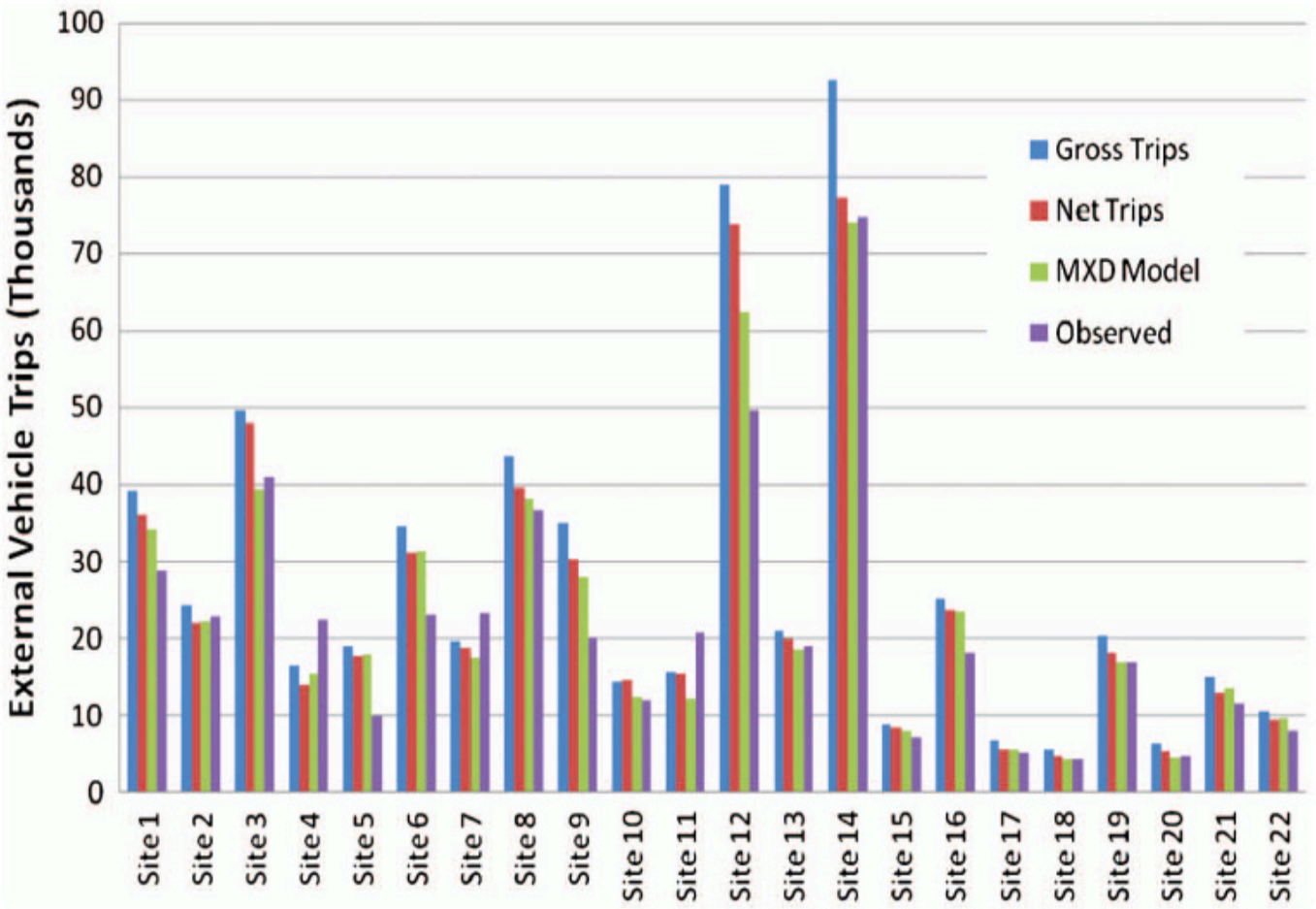


Fig. 5. (Color) Comparison of external vehicle trips across methods

New Tasks

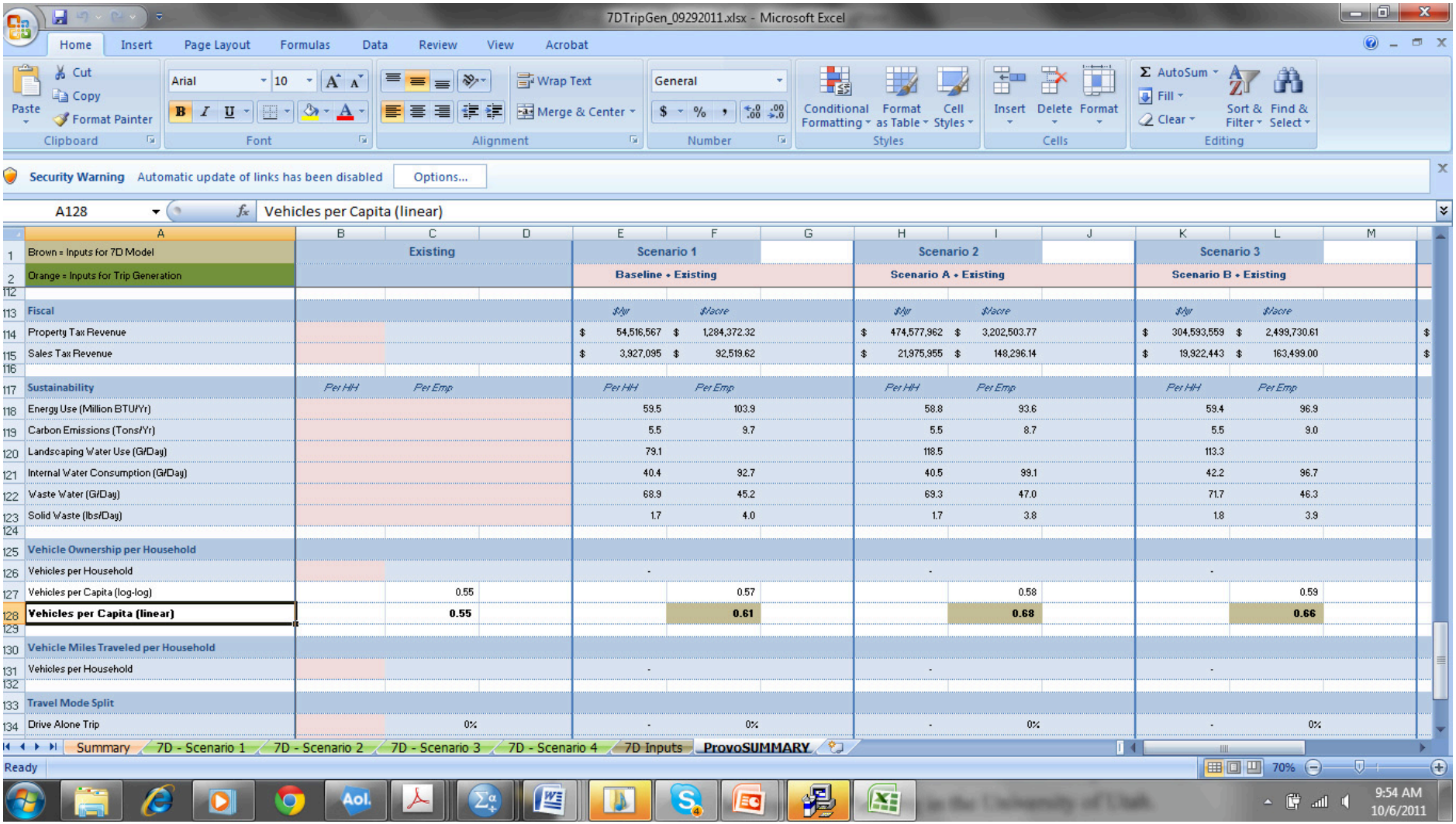
Extension of 7D Analysis to Austin, Minneapolis, and Salt Lake Regions

Include All Trips from All Regions in Final Modeling Exercise

Linked Spreadsheets for Traffic Impact App

Totally Transparent

Extract D Variables from ET Output



7DTripGen_09292011.xlsx - Microsoft Excel

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A128: Vehicles per Capita (linear)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Brown = Inputs for 7D Model		Existing		Scenario 1			Scenario 2			Scenario 3		
2	Orange = Inputs for Trip Generation				Baseline - Existing			Scenario A - Existing			Scenario B - Existing		
112													
113	Fiscal				$/Hr	$/Acre		$/Hr	$/Acre		$/Hr	$/Acre	
114	Property Tax Revenue				$ 54,516,567	$ 1,284,372.32		$ 474,577,962	$ 3,202,503.77		$ 304,593,559	$ 2,499,730.61	$
115	Sales Tax Revenue				$ 3,927,095	$ 92,519.62		$ 21,975,955	$ 148,296.14		$ 19,922,443	$ 163,499.00	$
116													
117	Sustainability	Per HH	Per Emp		Per HH	Per Emp		Per HH	Per Emp		Per HH	Per Emp	
118	Energy Use (Million BTU/Yr)				59.5	103.9		58.8	93.6		59.4	96.9	
119	Carbon Emissions (Tons/Yr)				5.5	9.7		5.5	8.7		5.5	9.0	
120	Landscaping Water Use (G/Day)				79.1			118.5			113.3		
121	Internal Water Consumption (G/Day)				40.4	92.7		40.5	99.1		42.2	96.7	
122	Waste Water (G/Day)				68.9	45.2		69.3	47.0		71.7	46.3	
123	Solid Waste (lbs/Day)				1.7	4.0		1.7	3.8		1.8	3.9	
124													
125	Vehicle Ownership per Household												
126	Vehicles per Household				-			-			-		
127	Vehicles per Capita (log-log)		0.55			0.57			0.58			0.59	
128	**Vehicles per Capita (linear)**		**0.55**			**0.61**			**0.68**			**0.66**	
129													
130	Vehicle Miles Traveled per Household												
131	Vehicles per Household				-			-			-		
132													
133	Travel Mode Split												
134	Drive Alone Trip		0%		-	0%		-	0%		-	0%	

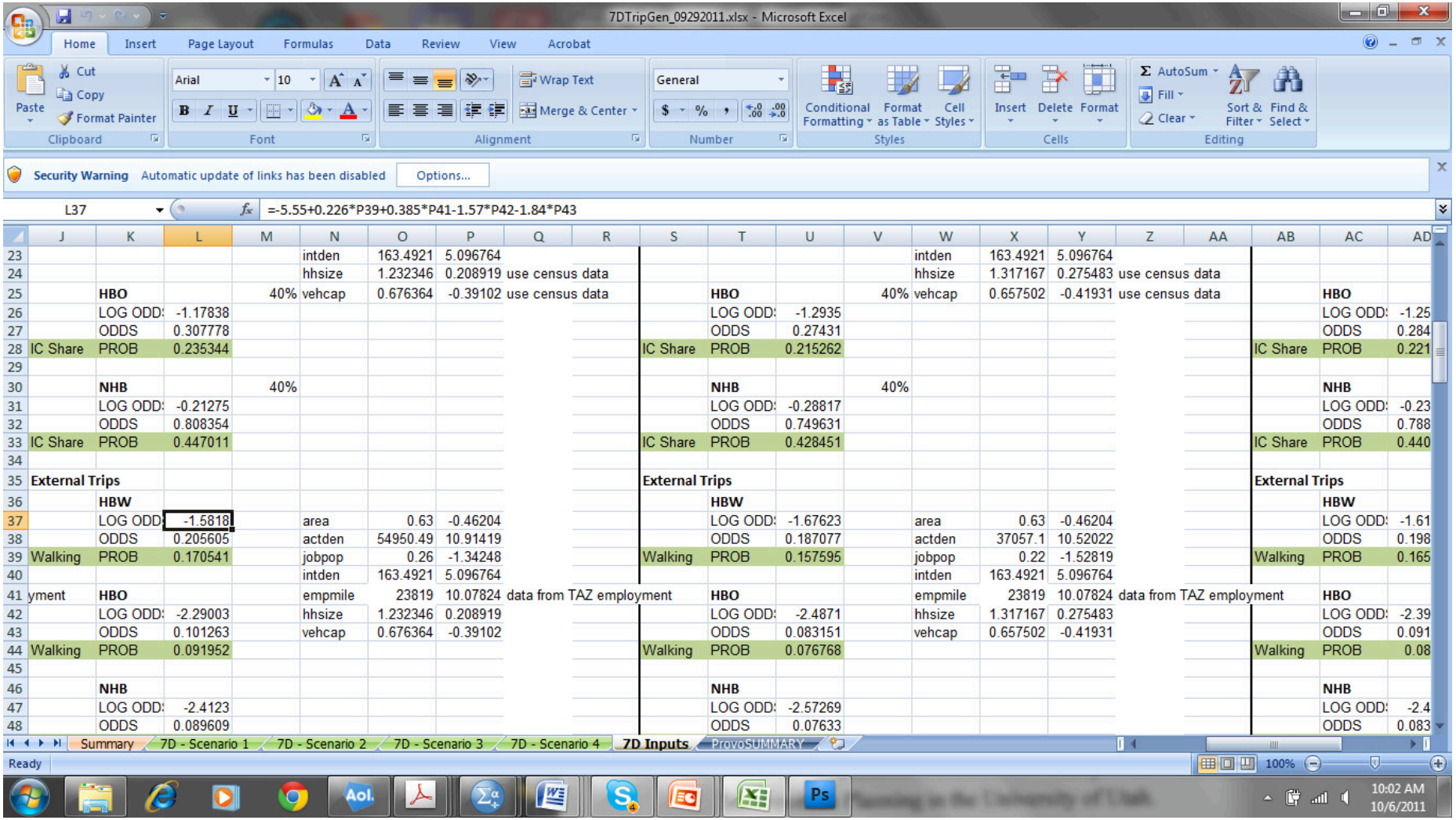
Summary | 7D - Scenario 1 | 7D - Scenario 2 | 7D - Scenario 3 | 7D - Scenario 4 | 7D Inputs | ProvoSUMMARY

Ready

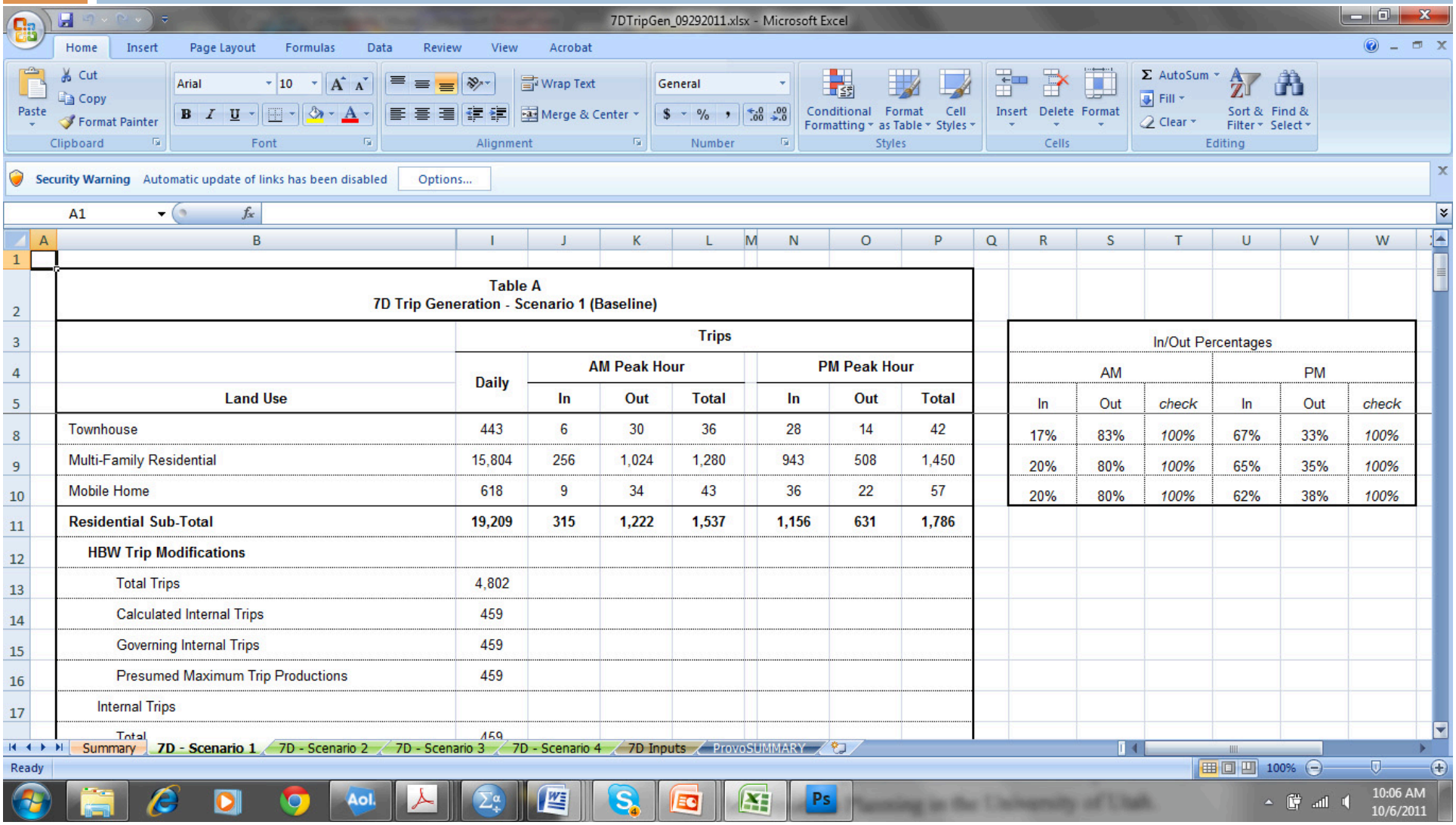
70%

9:54 AM
10/6/2011

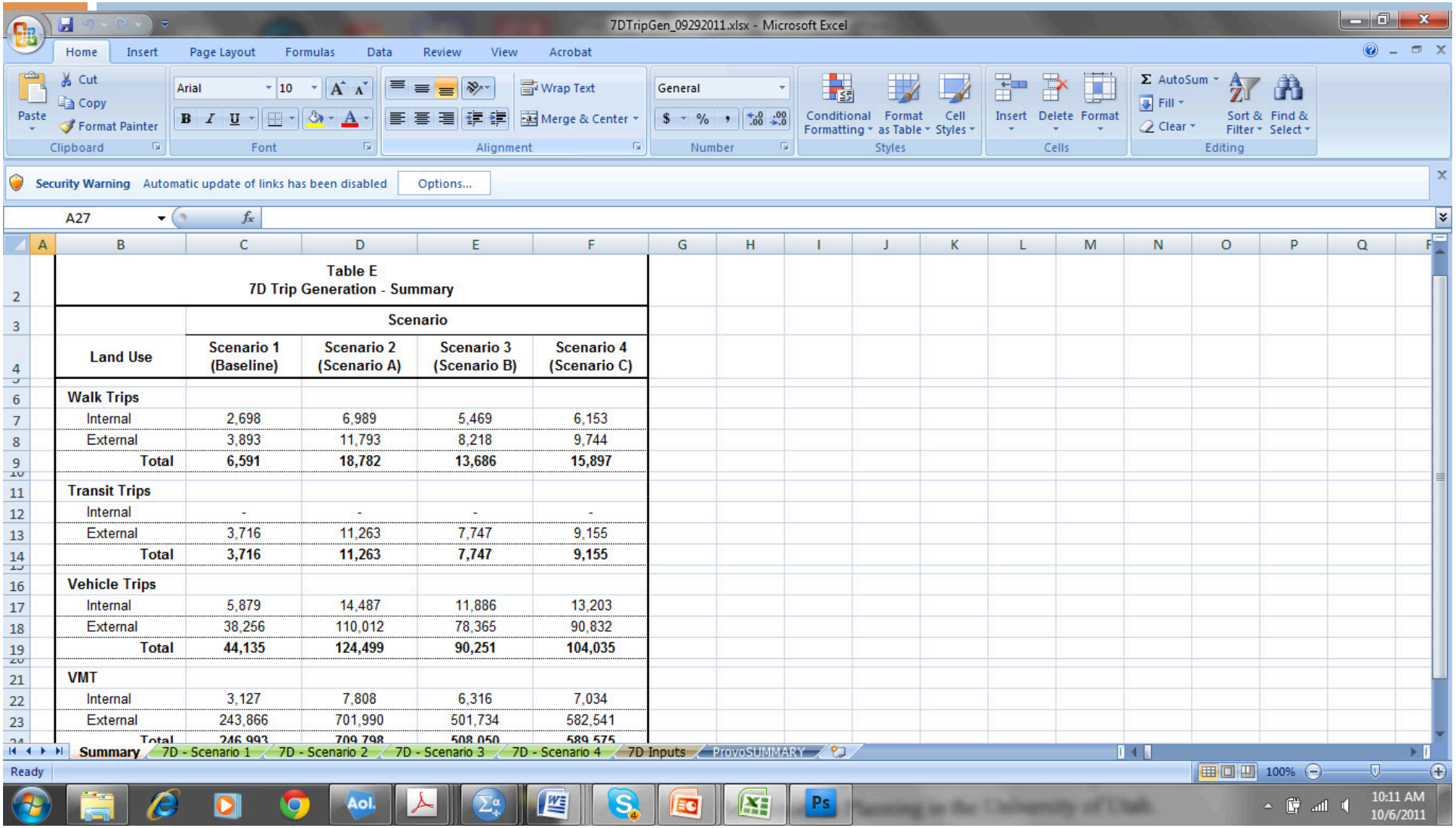
Compute Travel Outputs

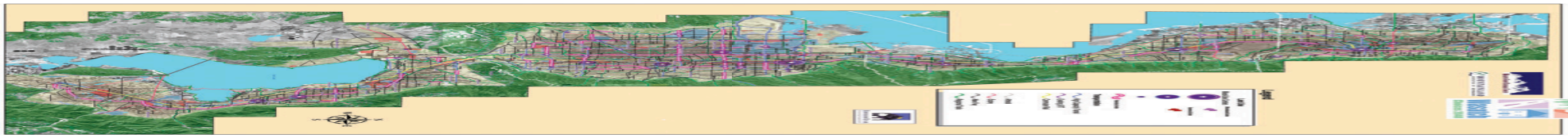


Modify ITE Trip Rates



Summarize Traffic Impacts





Outreach [T4.0]

4.00 ET+ Education and Training. We will train professionals and students in the use of ET+. Completion of the professional education course will lead to a University of Utah-issued professional education certificate. We will also incorporate ET+ into our GIS and related courses.