

China Planning Network: Urban Transportation Congress

July 19, 2008

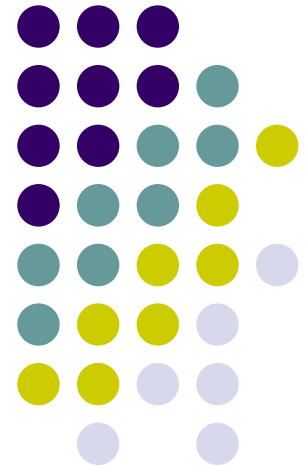
Beijing

Estimating the Vehicle-Miles-Traveled Implications of Alternative Metropolitan Growth Strategies

Prof. Joseph Ferreira, Jr.

Head, Urban Information Systems

MIT Urban Studies & Planning Department



Talk Outline

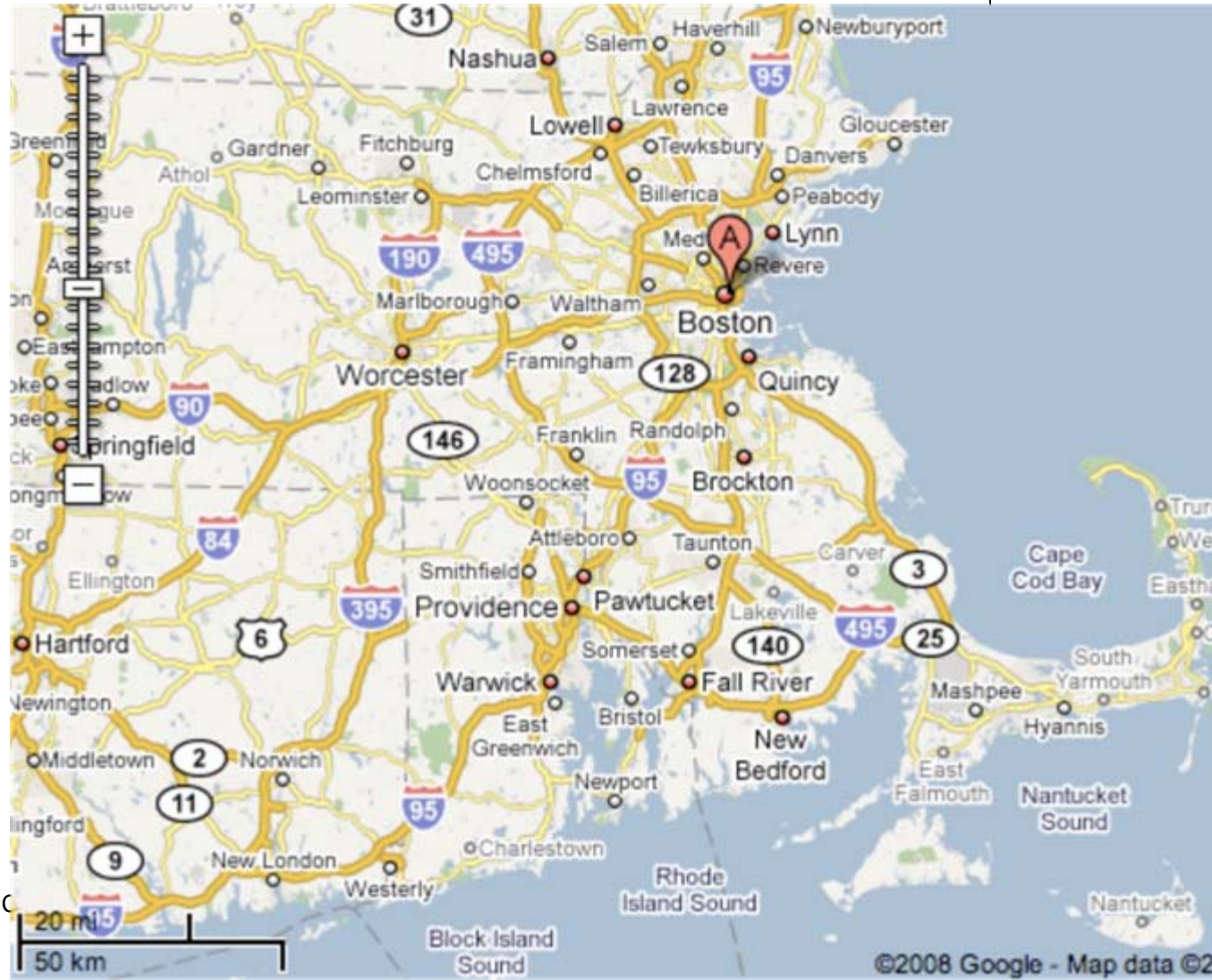
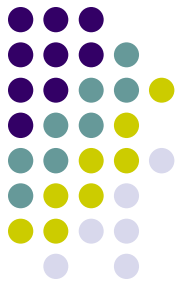


- Metro-Boston Growth Management Setting
- Addressing a New Priority
 - ‘Climate Roadmap’: Responding to Gas Price Impacts and Green House Gas Emissions
 - Class project: Estimate VMT Impacts of Alternative Growth Scenarios
- Implications for Urban Growth Models

Metro Boston

164 municipalities (with local land use control)

United States → Massachusetts → Boston



Metro-Boston Regional Planning

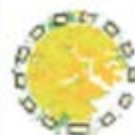
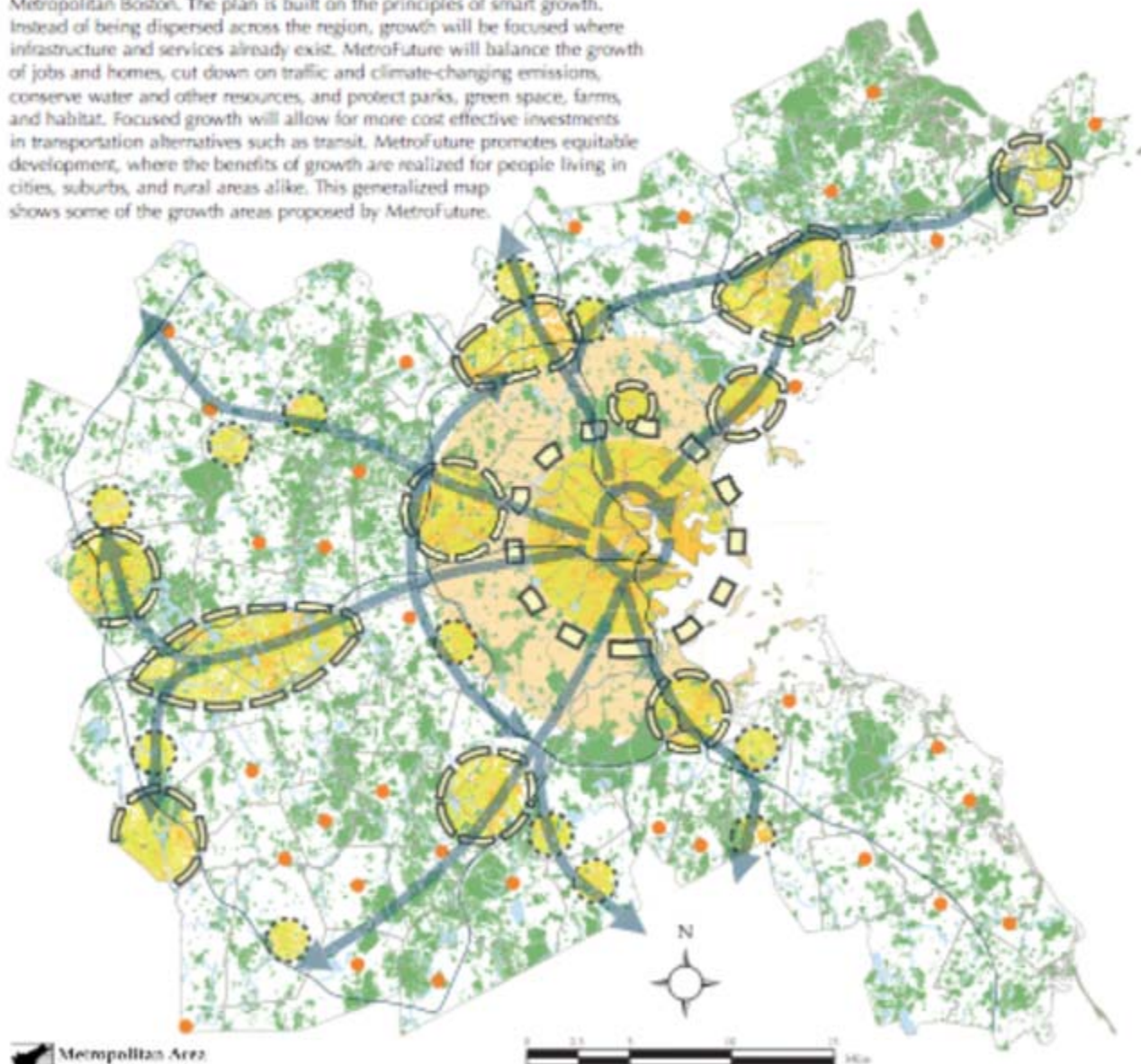


Key Agencies

- State: **New Governor** in 2007
 - Exec. Office of Energy & Environmental Affairs (EOEEA)
 - State GIS agency: **MassGIS**
- Metropolitan Area Planning Council (**MAPC**)
 - Regional planning part of Boston Metro Planning Organization (MPO)
 - 101 member Municipalities
 - MetroFuture - ongoing regional planning for 2030
- Central Transportation Planning Staff (**CTPS**)
 - Transportation planning part of Boston MPO
 - Transportation and policy analysis support for Metro Boston

MetroFuture Growth Areas, 2000 – 2030

MetroFuture is the regional plan for development and preservation in Metropolitan Boston. The plan is built on the principles of smart growth. Instead of being dispersed across the region, growth will be focused where infrastructure and services already exist. MetroFuture will balance the growth of jobs and homes, cut down on traffic and climate-changing emissions, conserve water and other resources, and protect parks, green space, farms, and habitat. Focused growth will allow for more cost effective investments in transportation alternatives such as transit. MetroFuture promotes equitable development, where the benefits of growth are realized for people living in cities, suburbs, and rural areas alike. This generalized map shows some of the growth areas proposed by MetroFuture.



Metropolitan Core

- Job growth built around medical and educational institutions, and other major industries
- Improved schools, safety, parks attract families and retirees
- Build on role as the "hub" of the regional transportation network



Regional Hubs

- Rebirth of industrial cities and downtowns
- Focused growth in major suburban economic centers
- Best prospects for new transit outside of Metro Core



Suburban Centers

- Maximize potential of major town centers and existing transit
- Mixed-use growth expands housing choice and tax revenue
- New local bus connections and bike/pedestrian paths



Village Districts

- New growth clustered in and around existing centers
- "Infill" development reinforces historic community character
- Clustered services and retail reduce auto dependence



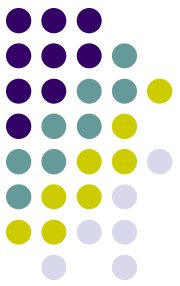
Transportation Corridors

- Multi-modal investments to support growth
- New transit allows people to circulate around Metro Core, as well as in and out.



Priority Conservation Areas

- Areas with significant natural, scenic, agricultural, and recreational values



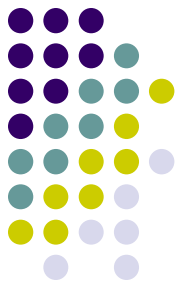
Planning Data and Analytic Models

Metropolitan Area Planning Council (MAPC)

- Population and employment forecasts
- MetroFuture ‘Alternative Scenario’ modeling for 2030
 - “Let It Be” versus “Winds of Change” scenarios
 - Task forces & public forums for education, tuning, choice
 - ArcGIS + Community Viz for modeling and visualization
 - Town and TAZ-level projections (2727 traffic analysis zones)

Central Transportation Planning Services (CTPS)

- Support for highway and transit agencies
- Origin/Destination (O/D) travel times (by TAZ)
- Journey-to-Work counts by mode (TAZ to TAZ)
- EMME/2 multi-mode travel network allocation model



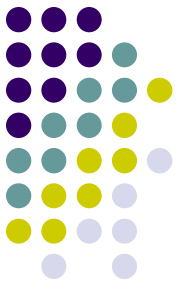
Planning Data and Analytic Models

Part 2

MassGIS - basemaps and derived datasets

- Standard GIS ‘framework’ layers
 - Land use, roads, terrain, water, political, census, ...
 - Online (downloadable with web services & metadata)
- Activity locations:
 - Schools, hospitals, churches, businesses, ...
 - From municipal data, InfoUSA business locations, ...
- Development constraints:
 - zoning, environmental limits, ...
 - Derived layers from earlier ‘buildout analysis’

Analyzing a New Priority

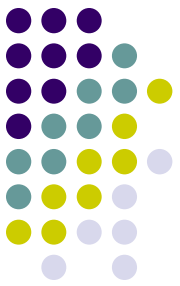


State Request of EOEEA: Develop 'Climate Roadmap'

- What can be done to mitigate impact of:
 - CO2 emissions and Gas price increases

One Analysis: Forecast travel patterns

- Estimate spatial pattern of travel (VMT) for various metro growth scenarios
- Integrate basemaps, travel data, and MAPC scenarios
 - Estimate VMT patterns for current households
 - Residences from Census and land use data
 - Destinations from job and business location data
 - VMT from proximity calculations
 - Get housing growth locations from MetroFuture scenarios
 - Let-It-Be (LIB) scenario - business as usual
 - Wind-of-Change (WOC) scenario - corridor and activity center emphasis
 - And prior 'buildout analysis' of development constraints
 - Assume new growth has VMT behavior of neighbors

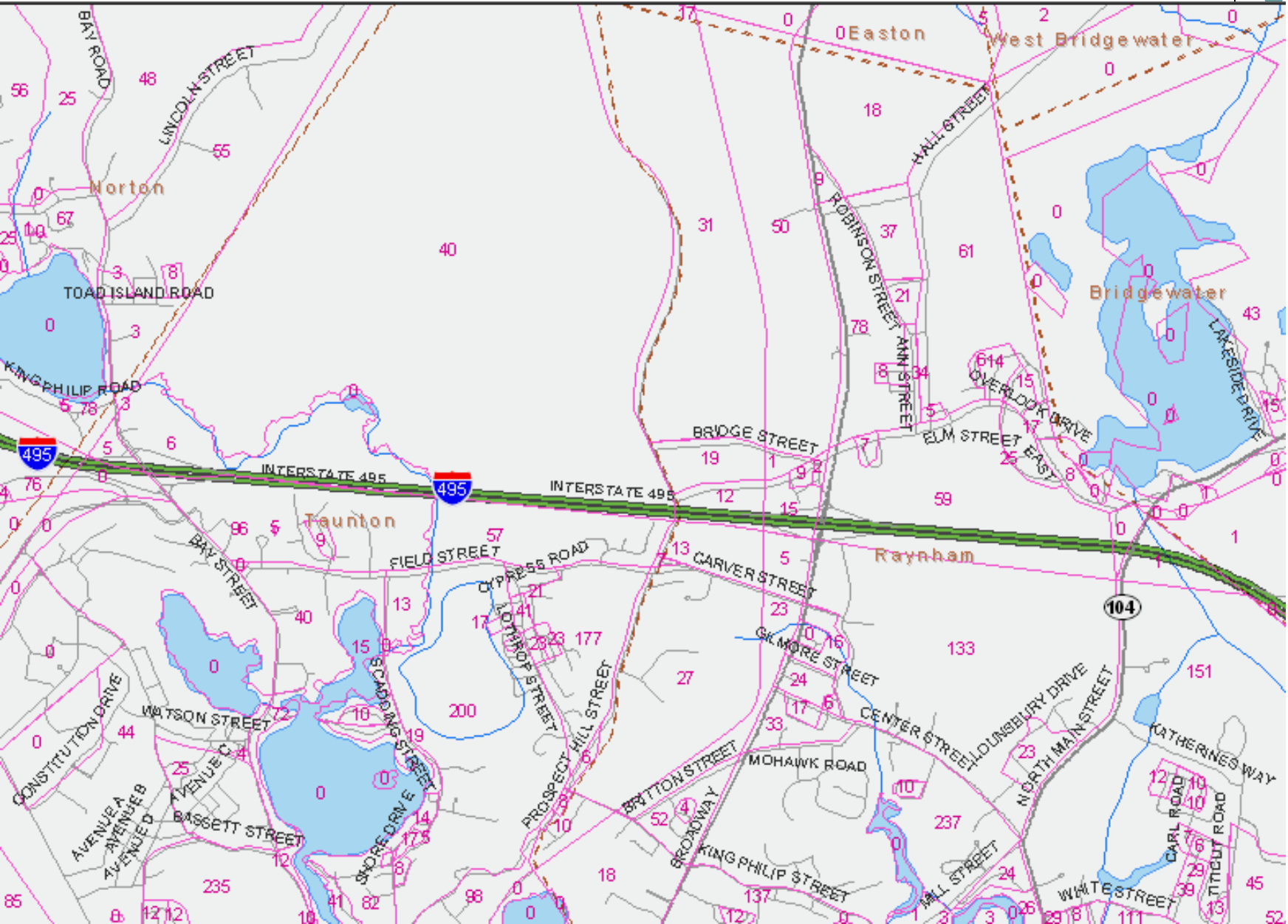


New Grid Layer from MassGIS

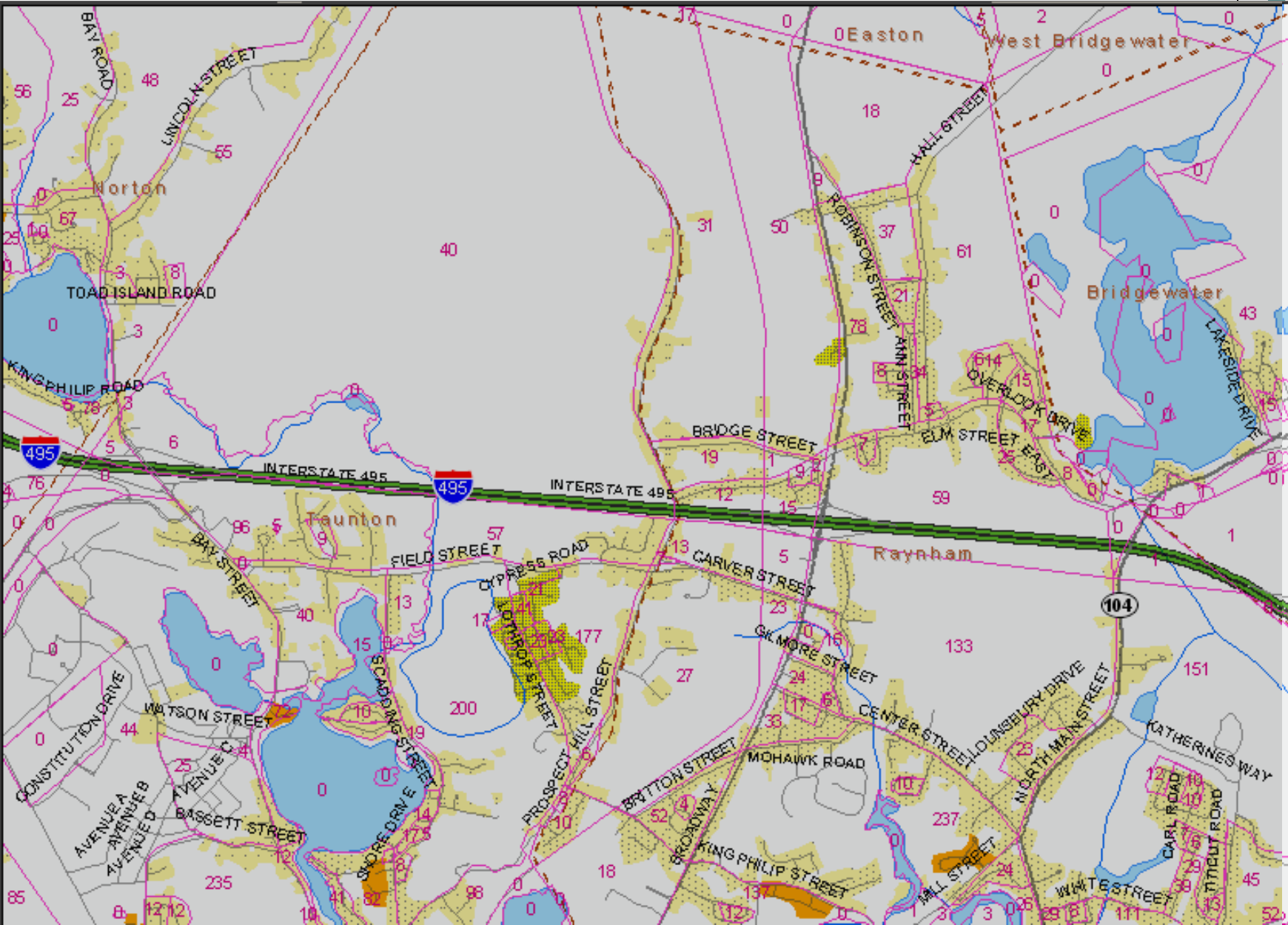
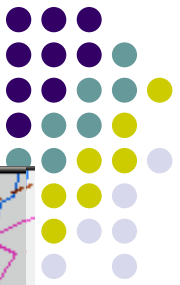
Integrate detailed data to get new derived layer

- About residences-jobs and proximity to activities
- Create 250x250 meter grid cell layer
 - 125K cells for metro Boston
- Allocate census population to residential grid cells
- Locate job/business destinations
- Compute 'accessibility' of every grid cell
 - Inverse of estimated daily car travel for
 - Journey-to-work (by car)
 - Local shopping and non-work trips (by car)

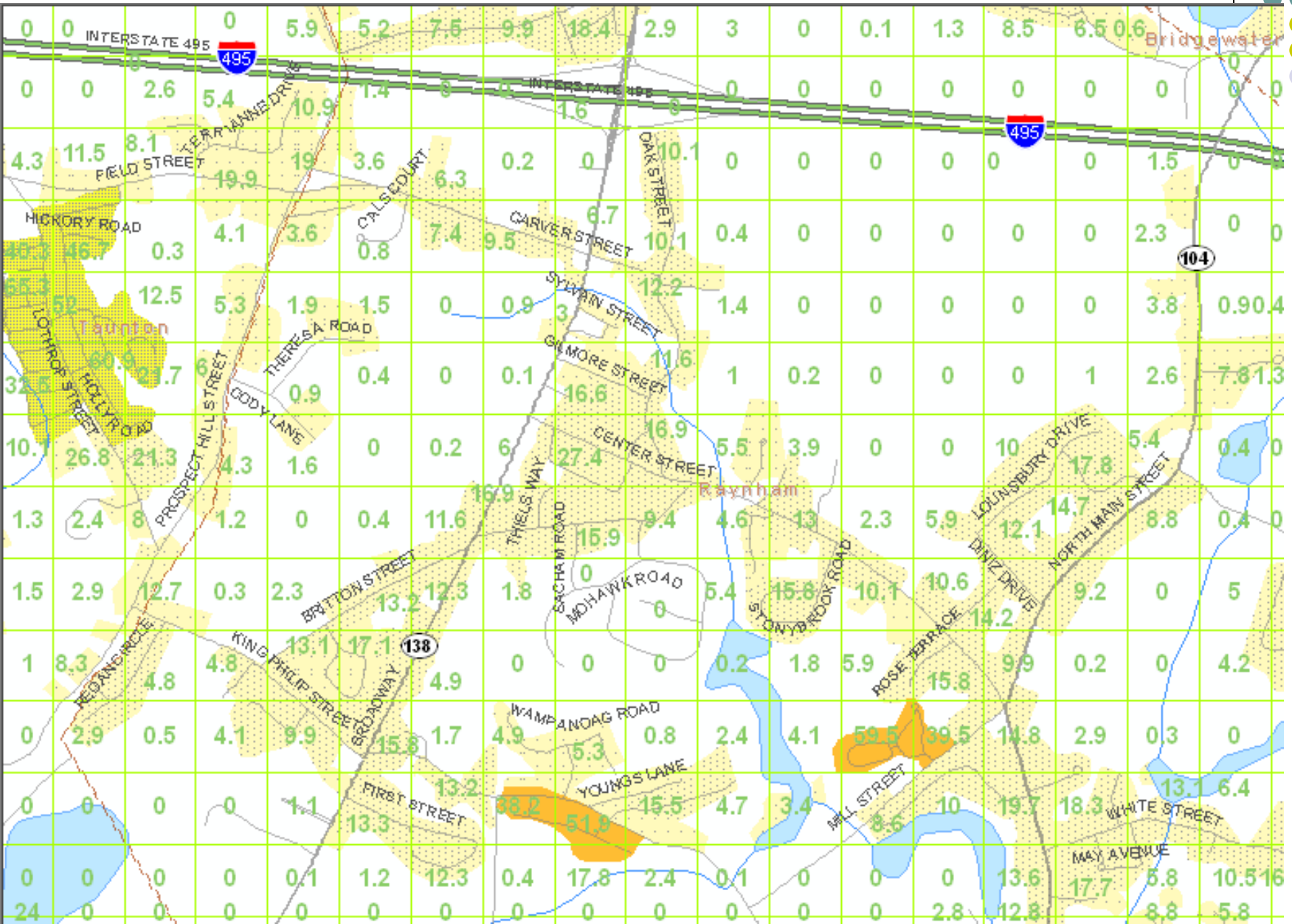
Census Population Counts on MassGIS Basemap in SE Mass



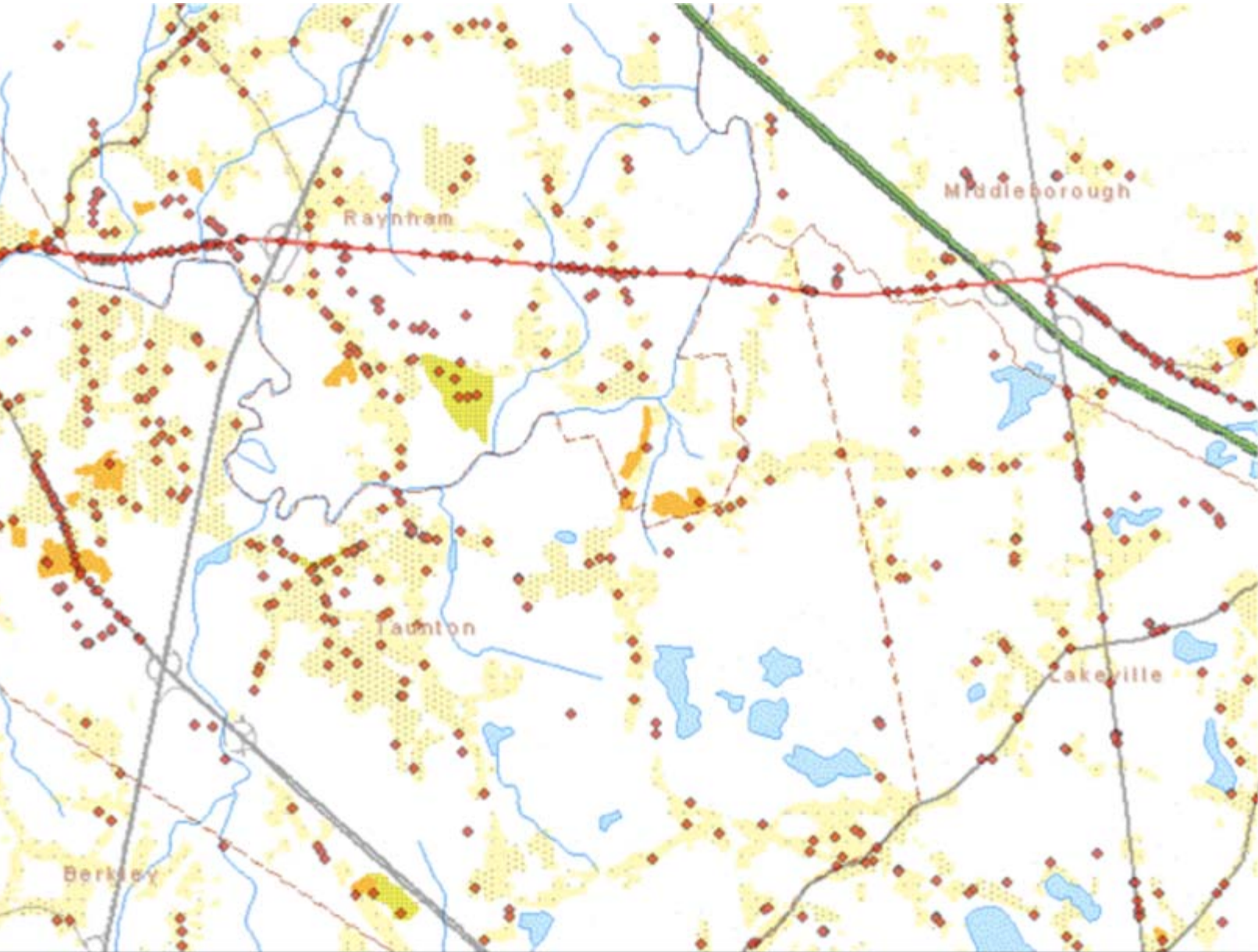
Census Population Counts on MassGIS Basemap in SE Mass ...with Land Use



Allocation of Population to 250x260m MassGIS Grid Cells

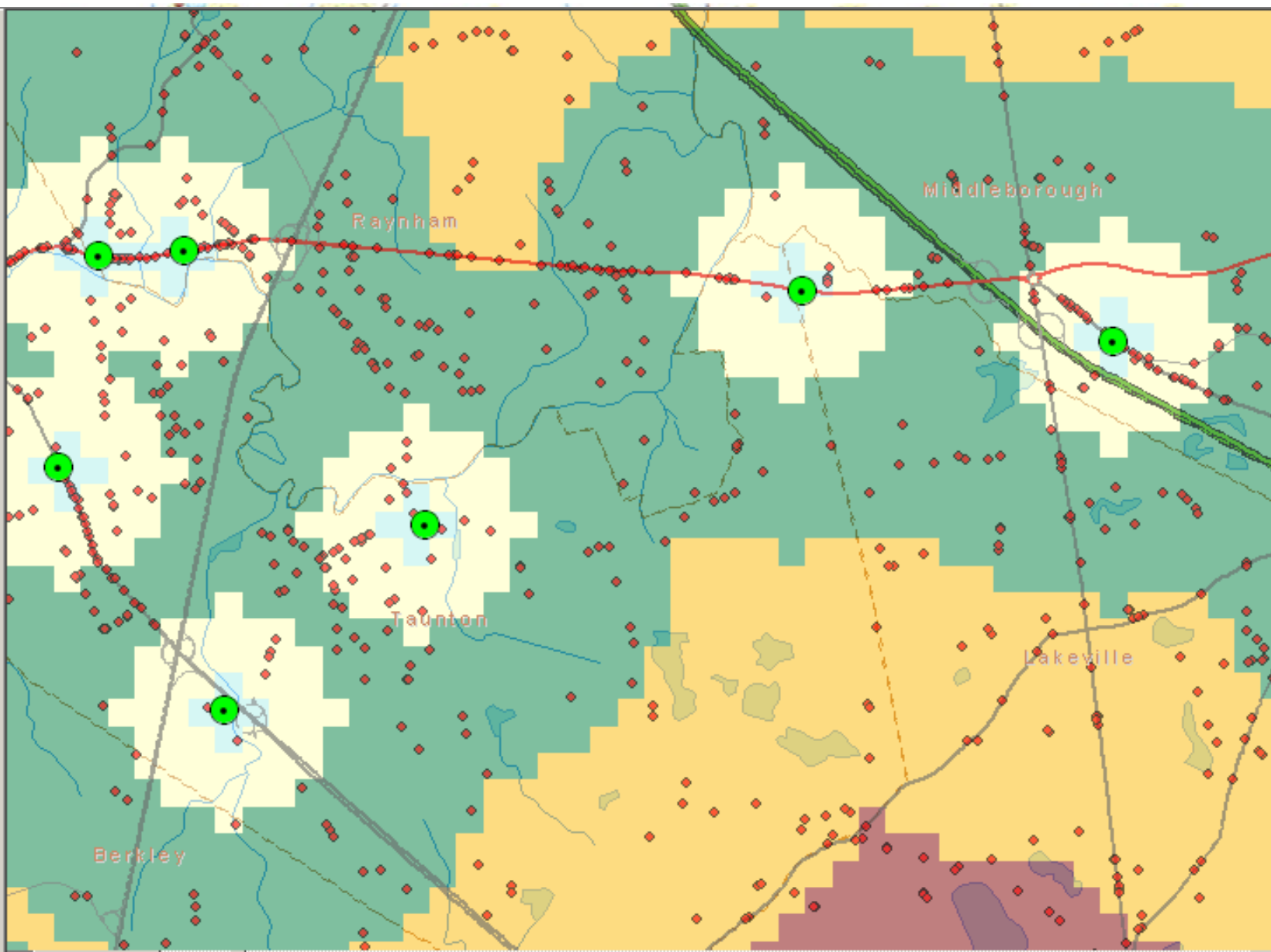


Business Locations

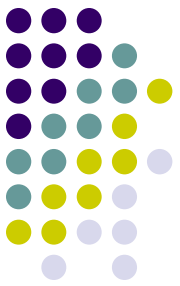


Business Locations

...with Euclidean Distance from Grocery Stores to Grid Cells



Class project with MAPC and MassGIS

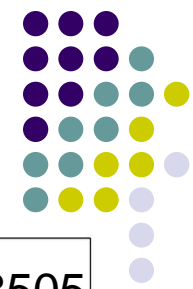


Estimate VMT Impacts of Alternative MetroFuture Growth Scenarios (Let-It-Be & Winds-Of-Change)

- Utilize new MassGIS 250x250m grid cell **derived** data
- Compare VMT implications of new household locations under LIB and WOC scenarios

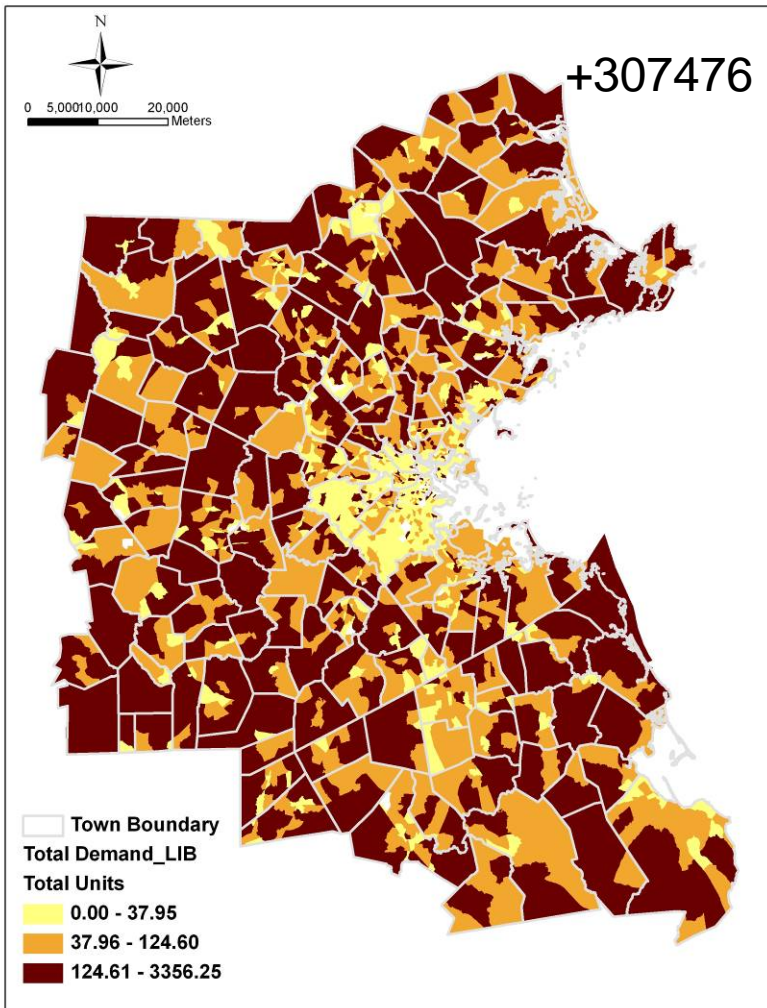
Half-semester project in Advanced GIS class

- PhD and MCP students who worked on project:
Wanli Fang, Paul Green, Lissa Harris, Shan Jiang,
Masayoshi Oka, Abner Oliveira, Yi Zhu
- Co-instructor for project: Dr. Fabio Carrera
- Maps below are from student work

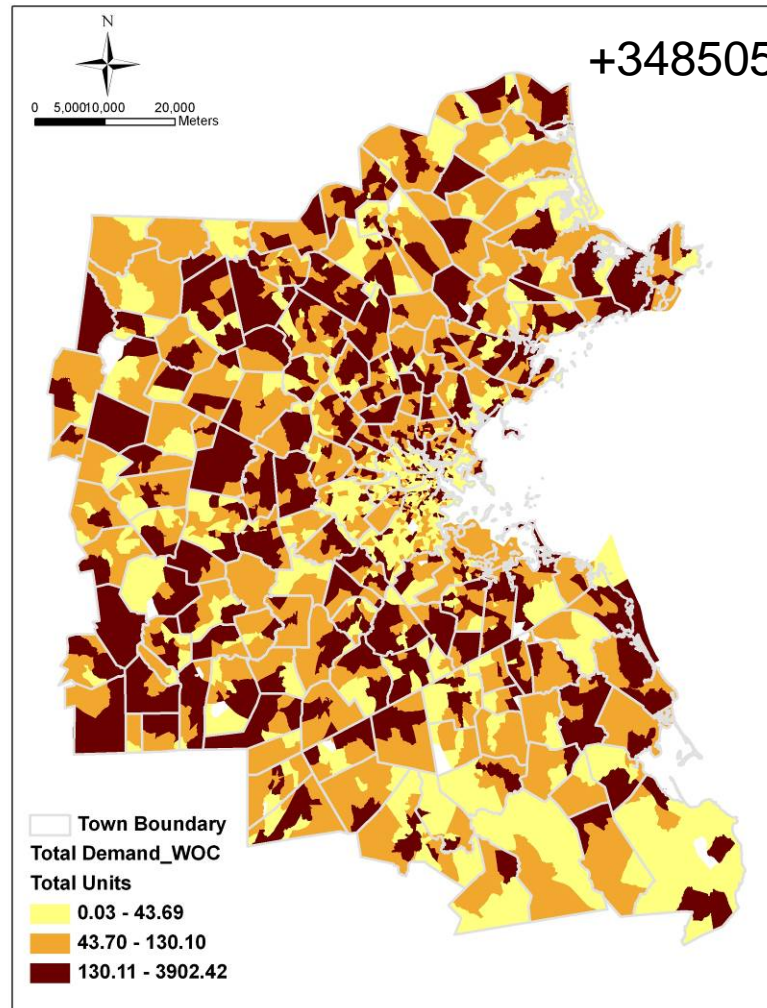


Demand for New Housing Units (by TAZ)

- Let It Be

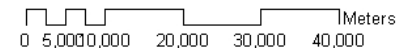
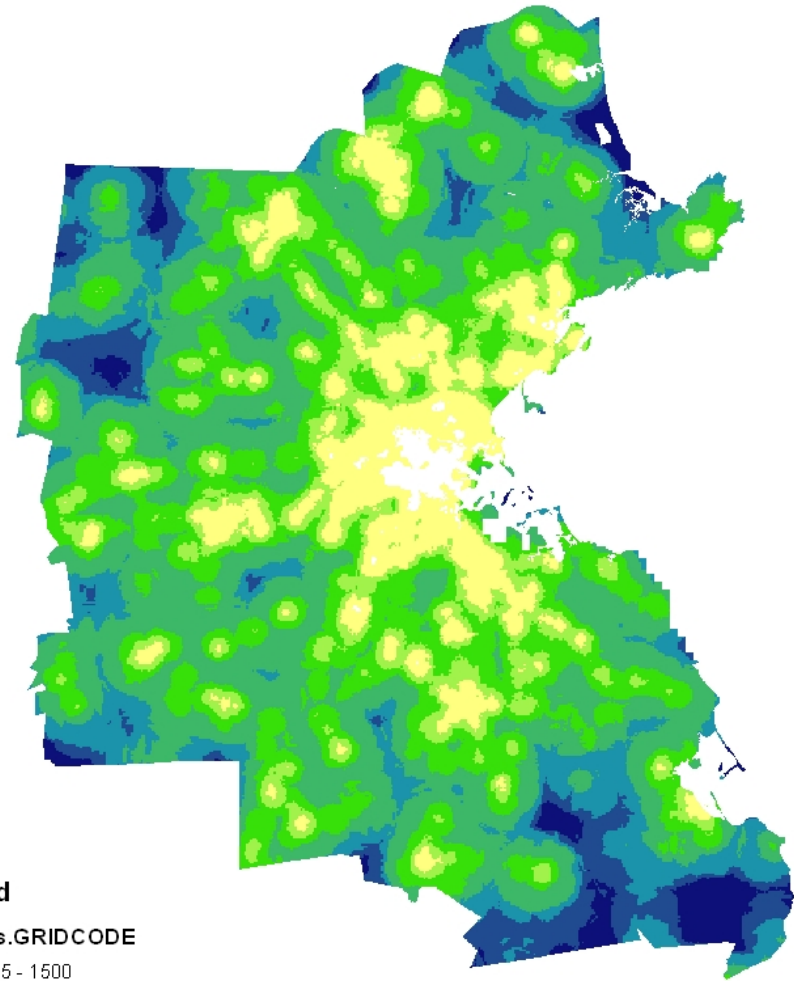
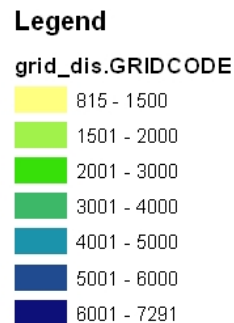


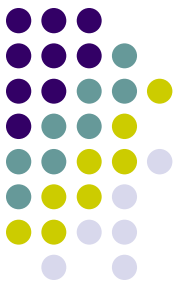
- Winds of Change



VMT Estimation

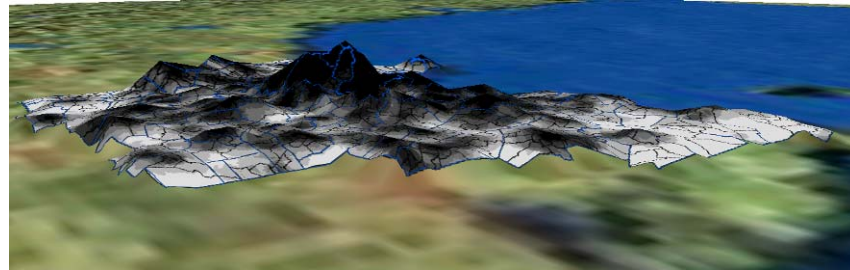
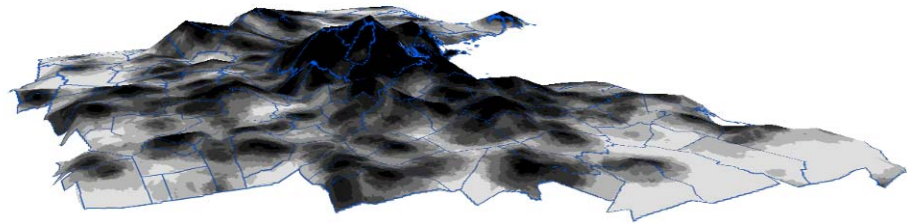
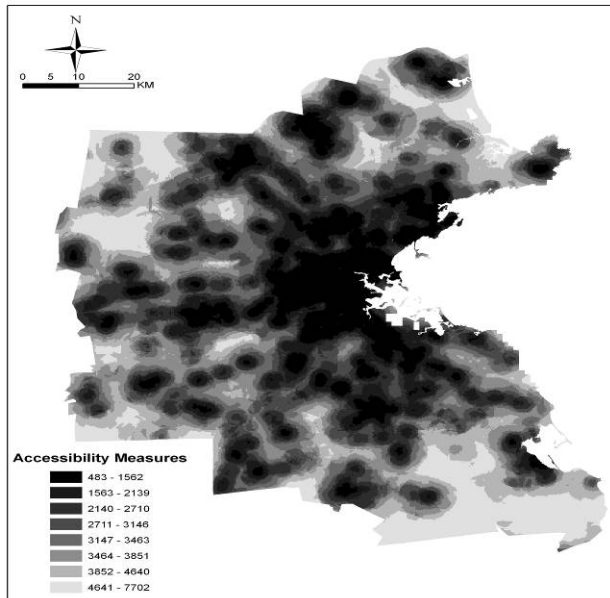
- Each cell in the grid has a value representative of the total meters traveled one-way for an “average” (non-work) trip for a single household.
- **Non-Work VMT = Average Non work trip distance (tripmerge) * No of households (hshlds_250m) * 4.18 trips/household**





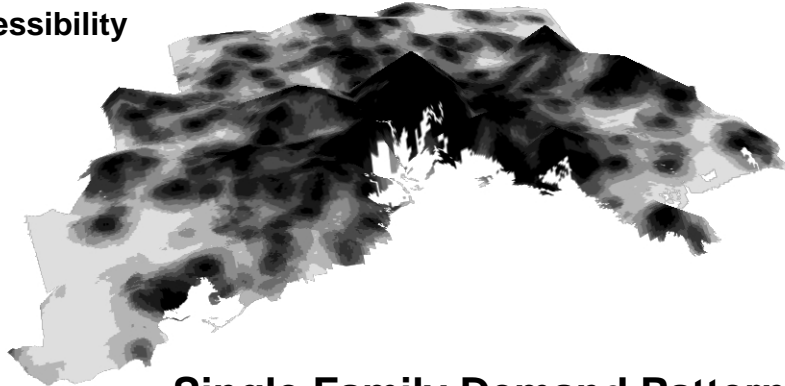
Accessibility Measurement at Grid Level

- Accessibility measurement
- The darker in color, the higher in accessibility (with lower non-work VMT value)

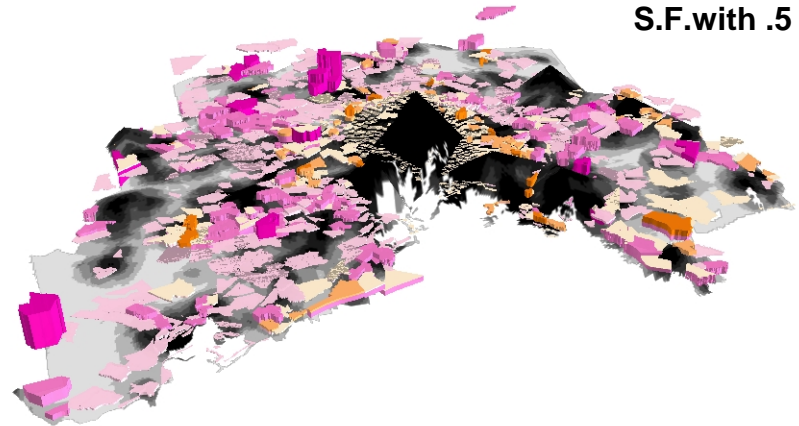


Development Demand on Buildable Non-Wetland: Let-It-Be Demand Pattern

Accessibility



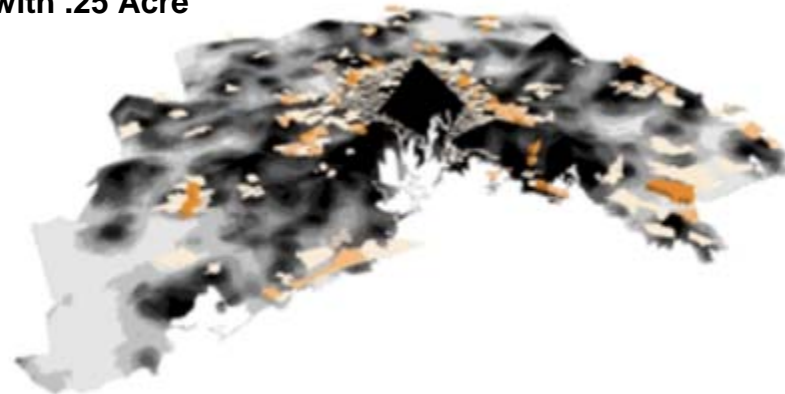
S.F.with .5 Acre



Single Family Demand Pattern

- Most Single Families with .25 Acre lot locate in inner areas
- Most Single Families with .5 Acre lot locate in intermediate areas
- Most Single Families with 1 Acre lot locate in outer areas

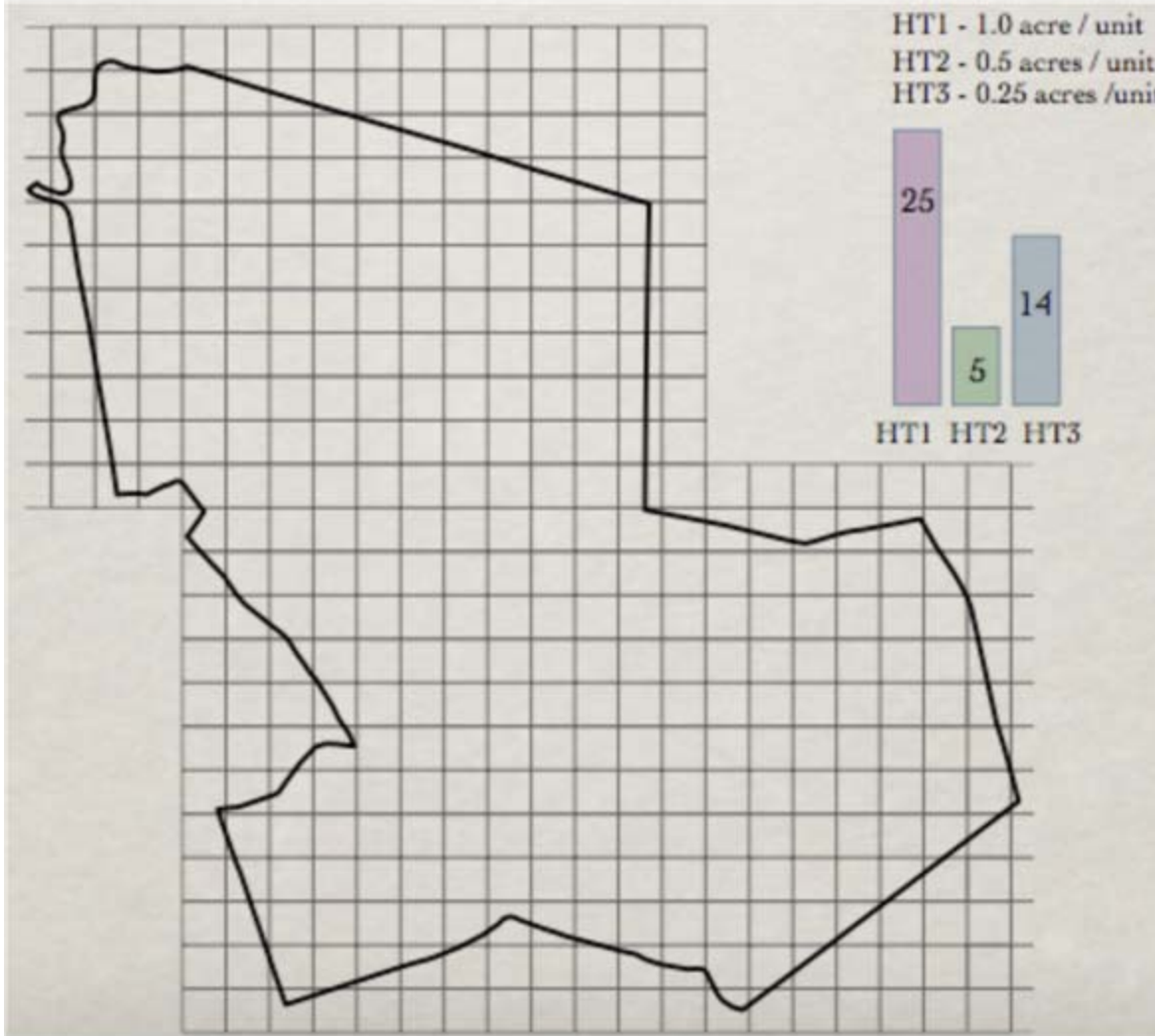
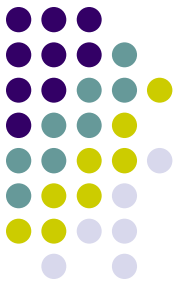
S.F.with .25 Acre



S.F.with 1 Acre

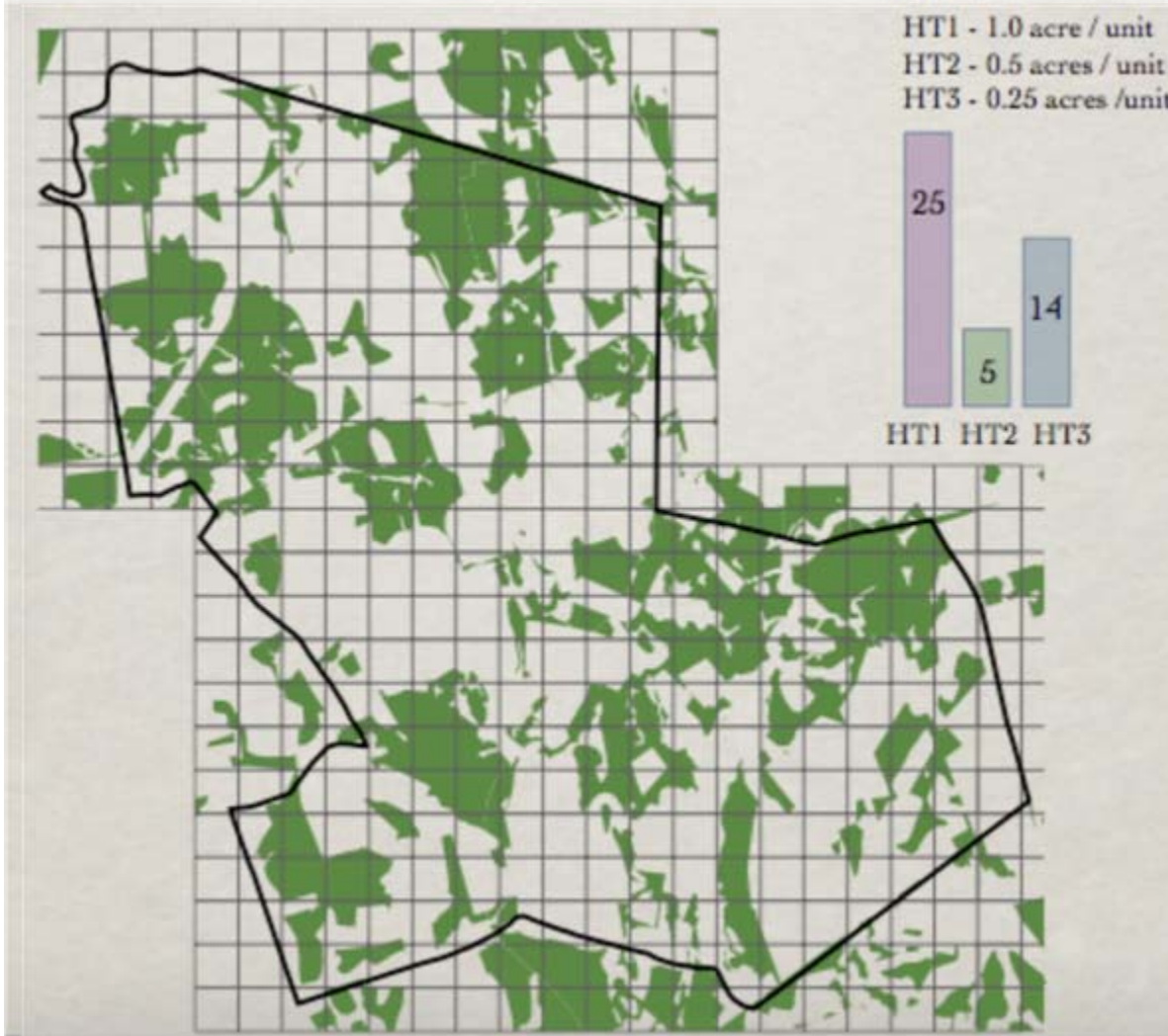


Grids Cells within 1 of 3 TAZ in Suburb of Hopkington



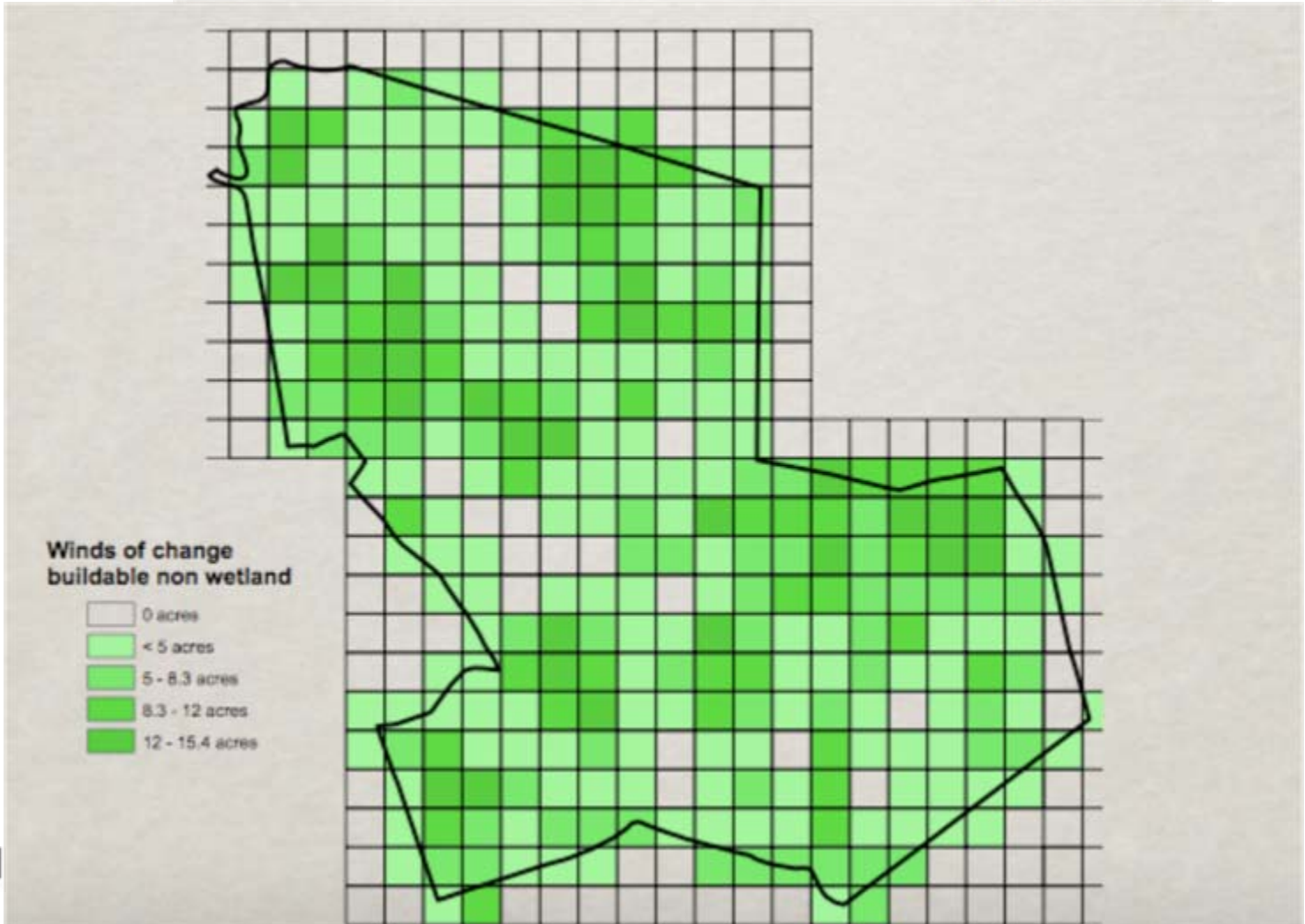
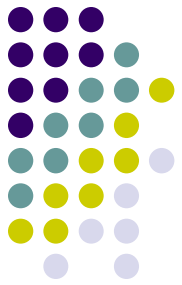
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington

...showing Buildable Non-Wetland Area



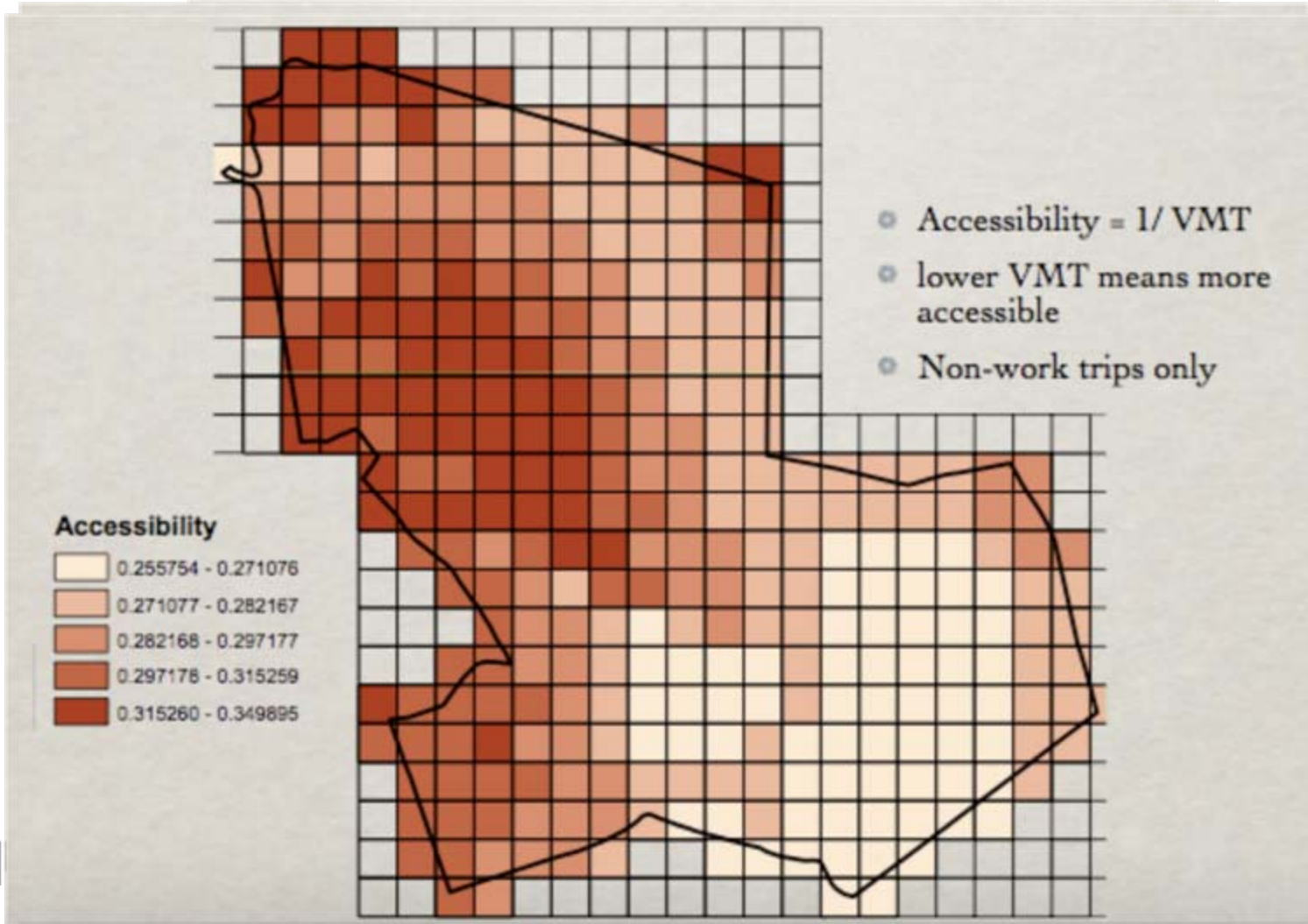
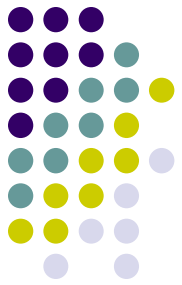
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington

...showing Buildable Non-Wetland Area ...Raterized



Grids Cells within 1 of 3 TAZ in Suburb of Hopkington

...showing Buildable Non-Wetland Area ...Raterized
...compared with 1/VMT Accessibility Measure

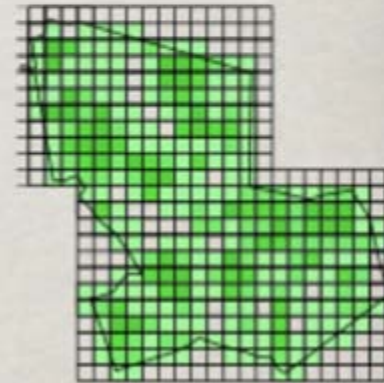


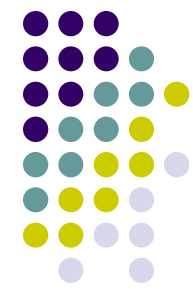


Allocation Goals and Requirements

ALLOCATION GOALS AND REQUIREMENTS

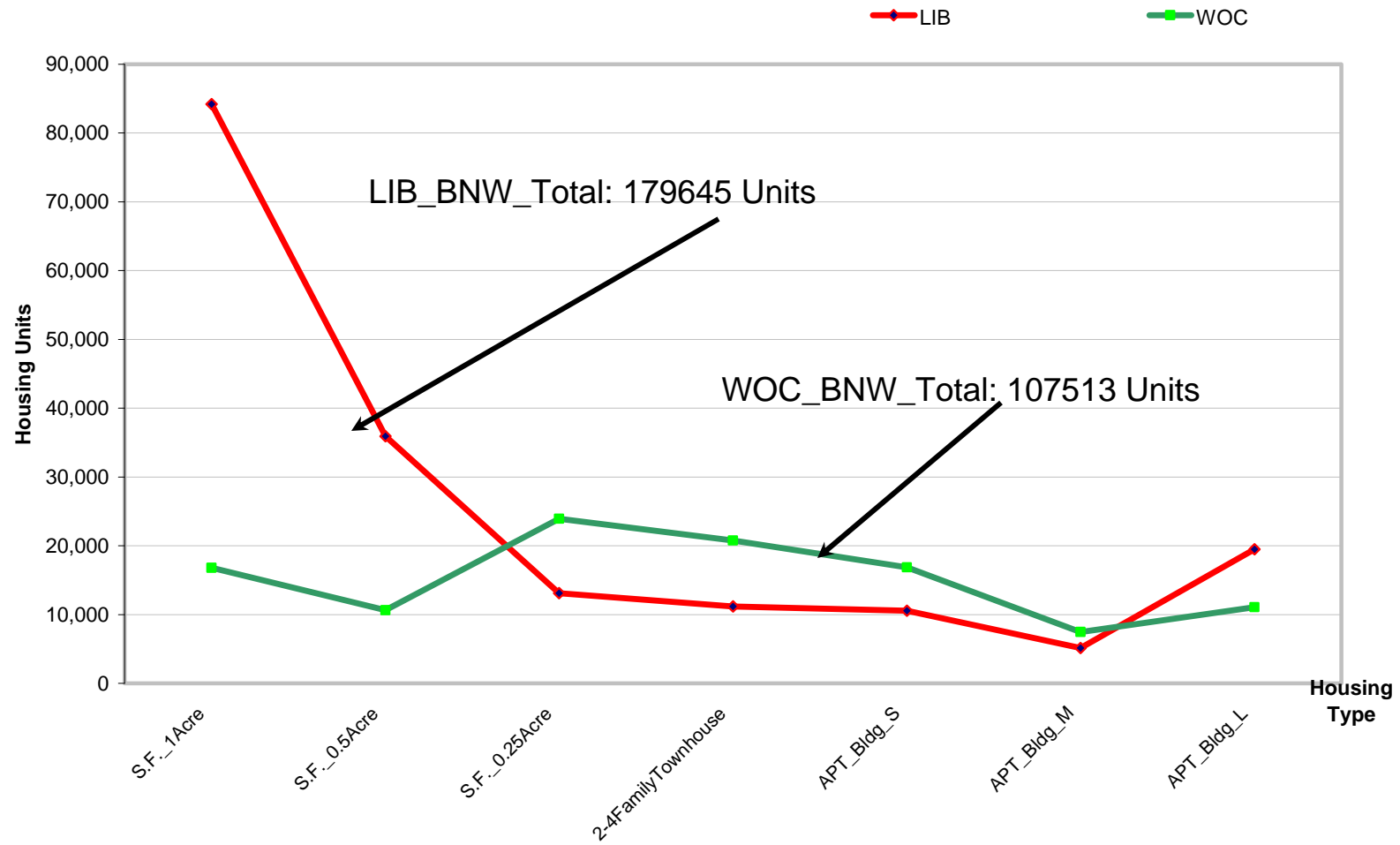
- Allocate all units demanded by MAPC model (or as many as possible)
- Several housing types compete for the same land
- Secondary Goal: Minimize Vehicle Miles Traveled (VMT) per household



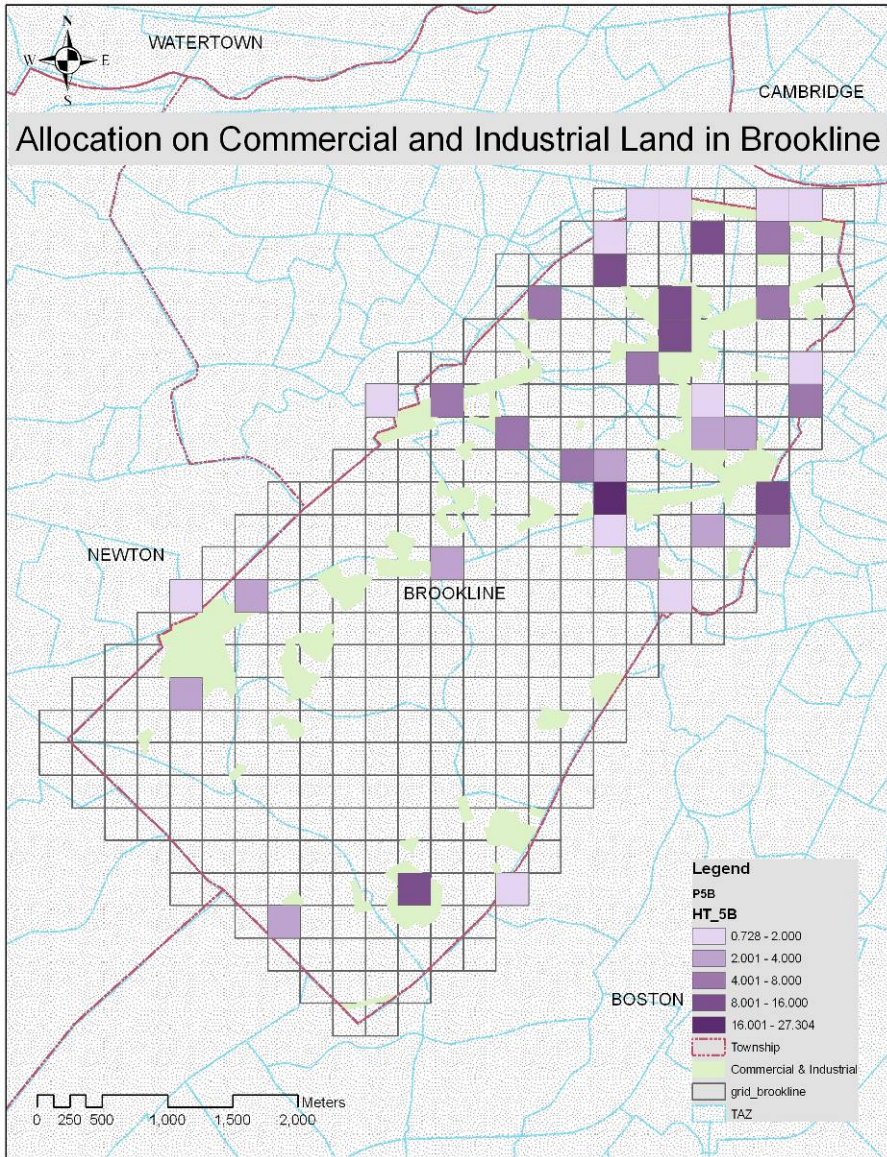


Development Demand on Buildable Non-Wet Land: LIB v.s. WOC

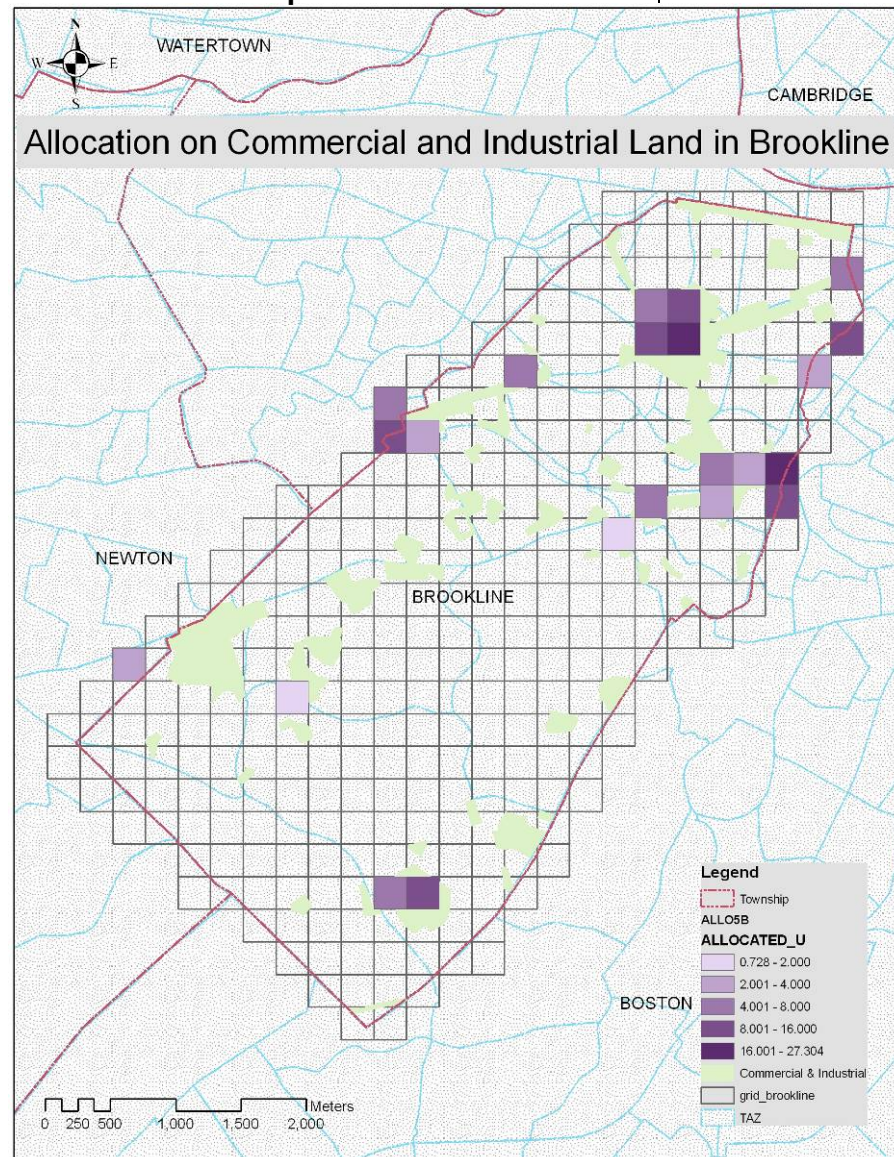
Housing Demand at TAZ Level on Buildable Non-Wet Land:
Let It Be and Winds of Change Scenarios



Allocation Strategies Within Municipalities

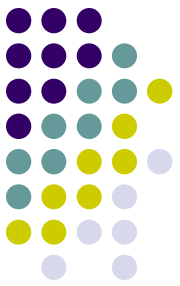


Low VMT Strategy



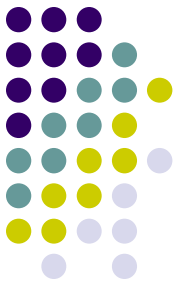
Neighborhood Emphasis Strategy

Scenario Differences in Estimated VMT



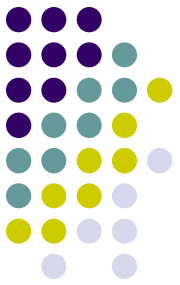
Scenario	Allocation	Average Non-Work VMT/day per new HH	Percent Increase
Winds of Change	Low VMT within TAZ	1.85 km	baseline
Let It Be	Low VMT within TAZ	2.51 km	+36 %
	Random within TAZ	2.80 km	+51 %

Conclusions



- VMT impact of growth scenarios
 - Crude assumptions but sizeable impact - 50%
 - 'Sprawl' of LIB has much bigger non-work VMT
 - Non-work VMT estimate is small - 2 km/day per HH
 - But journey-to-work and other travel follow same pattern
- Further work using new VMT data
 - Detailed 2001-2008 VMT data from safety inspection data for 6 million Mass vehicles
 - Address-match and associated with 250x250 meter grid cells

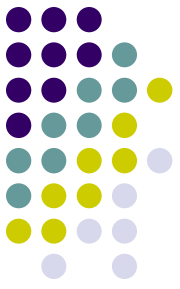
Conclusions - Part 2



Feasibility of analysis

- Quick and Practical (January-May 2008 study)
 - **IF**, basic data/models are developed/maintained
 - MassGIS: 3-months to prepare 250x250m grid cell layers
 - MAPC: had MetroFuture model (2727 TAZ projections)
 - Class: 1.5 month class GIS project
- Still complex and quasi-static
 - 16 development types, complex GIS operations, MatLab for within-TAZ allocation, ...
 - Ripple effects of development are not modeled
 - But, easily **redone, shared, explained, and visualized**
- Good institutional fit
 - MassGIS: basemaps and derived 250x250 m grids
 - MAPC: regional plan with population / job projections
 - CTPS: O/D counts / time / distance (+EMME/2 ?)

Additional Links



- MIT Department of Urban Studies & Planning
 - Department of Urban Studies & Planning (DUSP): <http://dusp.mit.edu>
 - Urban Information Systems (UIS): <http://mit.edu/dusp/uis>
- MassGIS: <http://www.mass.gov/mgis>
- MAPC: <http://mapc.org>
- Related GIS infrastructure sites:
 - Open Geospatial Consortium (OGC): <http://www.opengeospatial.org>
 - Urban and Regional Information Systems Association (URISA): <http://www.urisa.org> (conference: New Orleans, Oct. 7-10, 2008)

Thank you – Joe Ferreira, jf@mit.edu

谢谢！