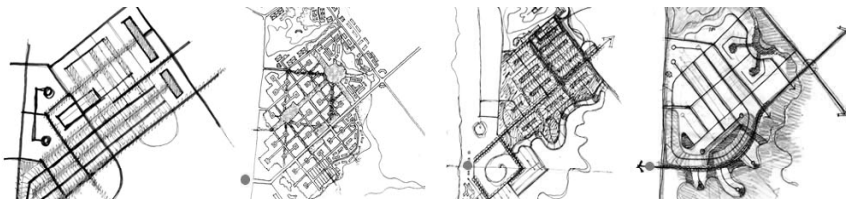


# GIS and the Built Environment



GIS Workshop  
Active Living Research Conference

February 9, 2010



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University of Washington  
Chanam Lee, Ph.D.,  
Texas A&M University



# OBJECTIVES

## Objective 1

Learn what and how to acquire, develop, and process GIS data for ALR

## Objective 2

Learn about a spatial sampling approach that considers environmental characteristics during the sampling process

## Objective 3

Understand ways to import and analyze data from external devices, such as GPS and accelerometer

## Objective 4

Learn and discuss about geospatial analyses to measure and model the environment or behaviors



# Workshop limitations

- Review spatial data appropriate to capture the immediate built environment
- Review approaches to and methods of spatial analysis that support the quantification of the physical environment to model health-related behaviors in space
- We will NOT address directly issues related to using GIS software in this presentation, but may cover some of these issues in the Q&A time period

# Objective 1

Learn what and how to acquire, develop, and process GIS data for ALR

# The Role of GIS-Based Spatial Analysis in Epidemiology

- Epidemiology and public health are interested in population-wide effects
- Population-wide effects are ascertained from individual-level measurements
- Spatial analyses in GIS allow the measurement of individual characteristics within an explicitly spatial context
- If location is an important factor in public health, GIS should be incorporated as a data management and analysis tool

# What is GIS?

- A measurement framework
- A system for representation of real-world objects (abstraction)
- A data repository
- An analytical framework
- GIS allows the user to store measurements of environmental objects and processes



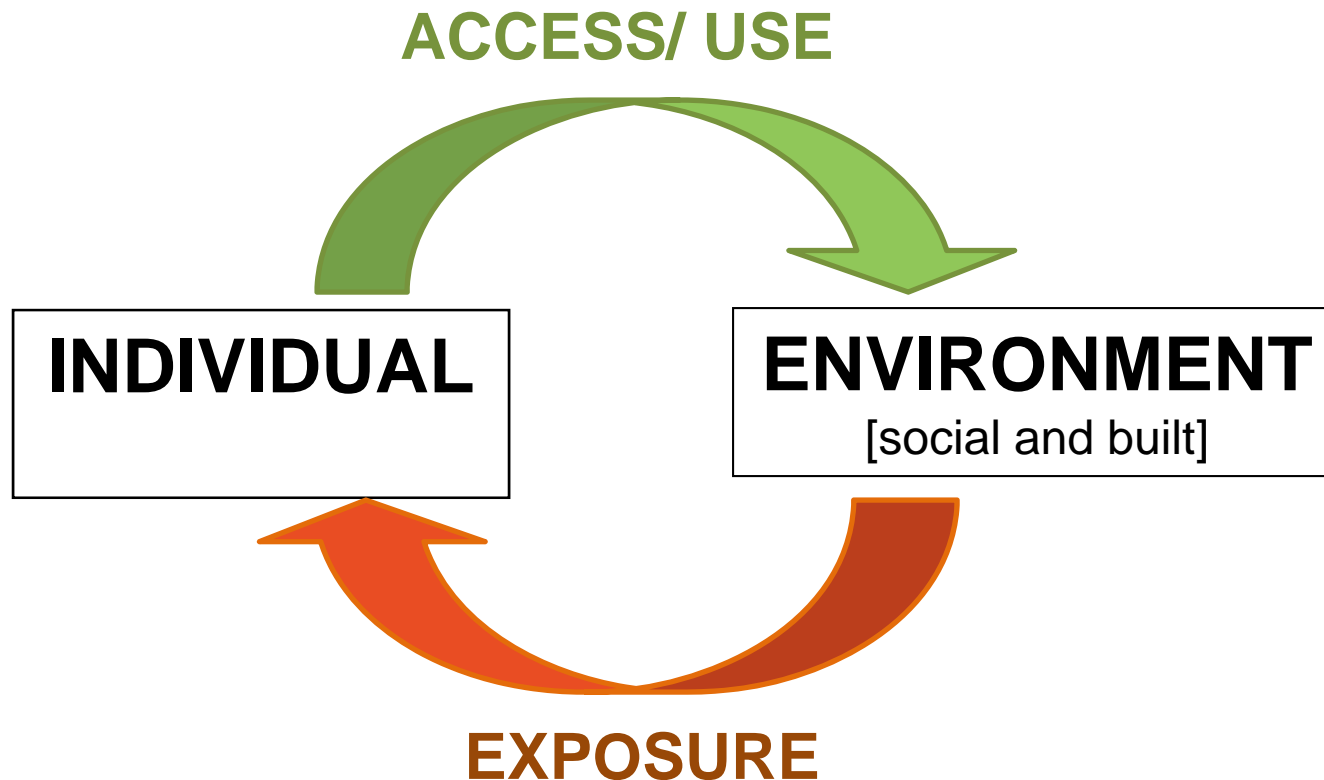
# Secondary Data Sources for GIS Data

- Local Jurisdiction (Interactive GIS website, GIS Division, Planning & Development, Public Works, Department of Transportation)
- County Tax Assessors Office (detailed land use, property value, etc.)
- Metropolitan Transportation Organization
- Transit Agency
- Police Department (traffic crashes, crimes, etc.)
- Development Permit Package (site plans, architectural designs, etc.)
- Local Development Ordinances and Design Guidelines

Interactions between the individual and his/her environment

## A Conceptual model

Exposure (passive) and Access/use (active)





Using Geographic Information Systems (GIS) for Active Living Research

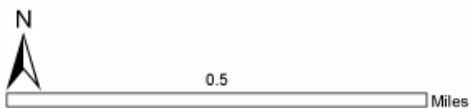
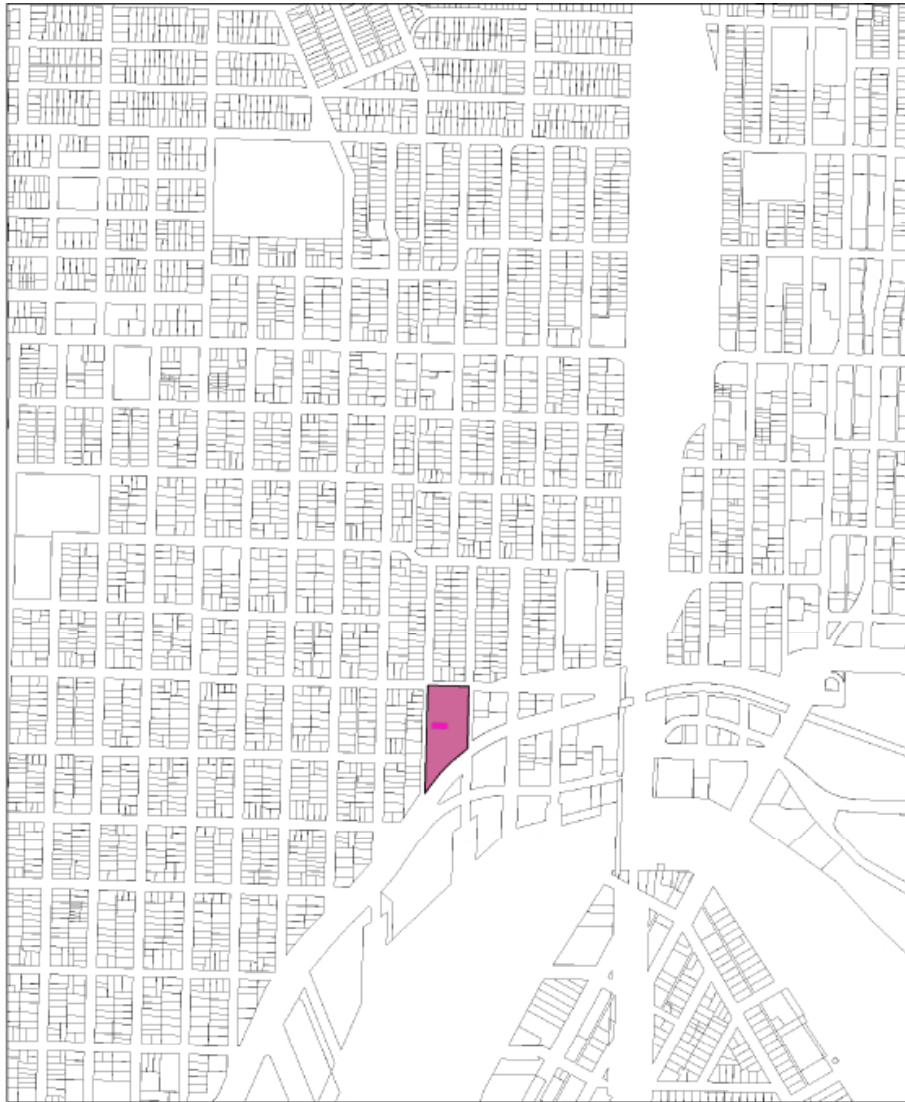
## Need for fine-grained environmental data

- Defining “My Neighborhood” in GIS

by Ms. Tang, Graduate Student UW

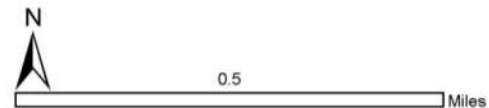
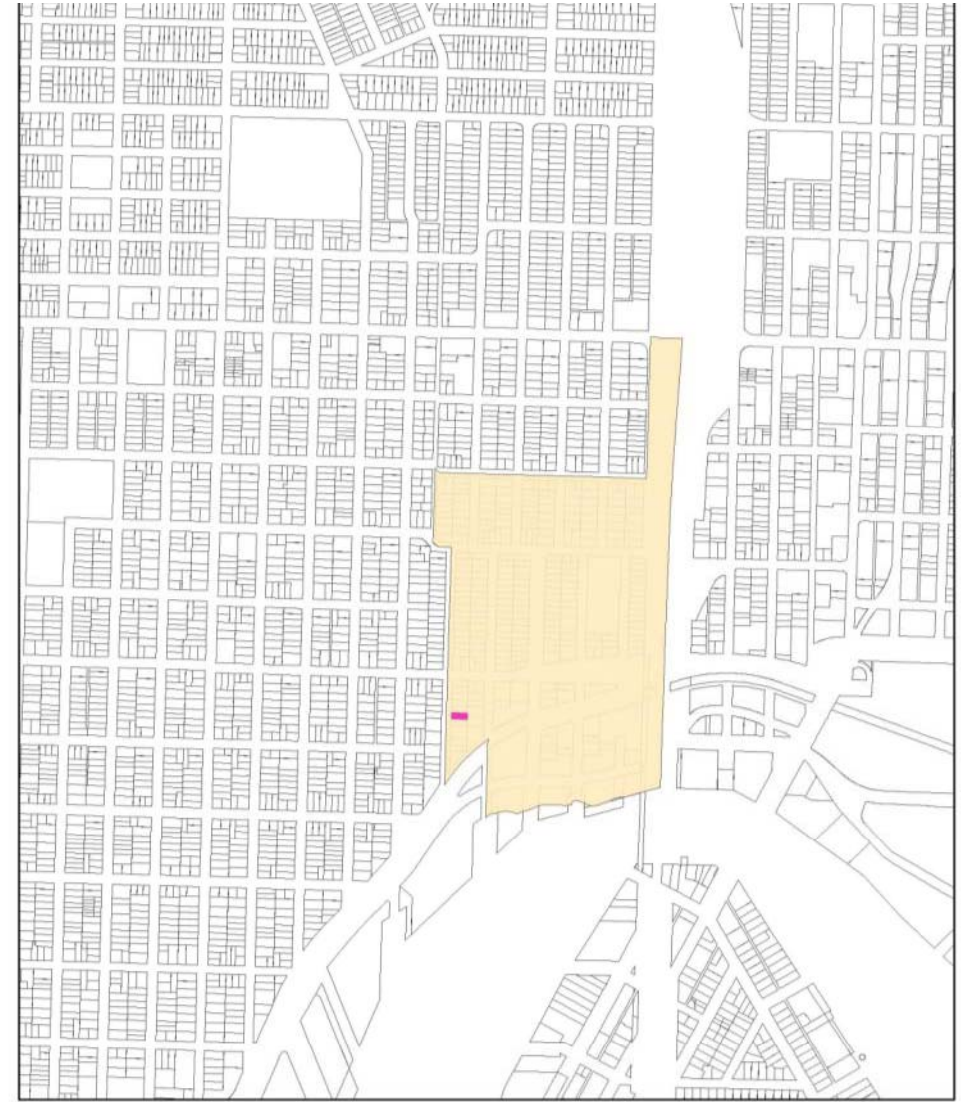


# My Neighborhood using arial units



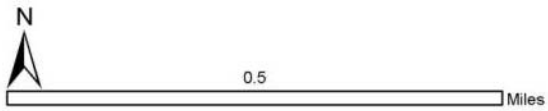
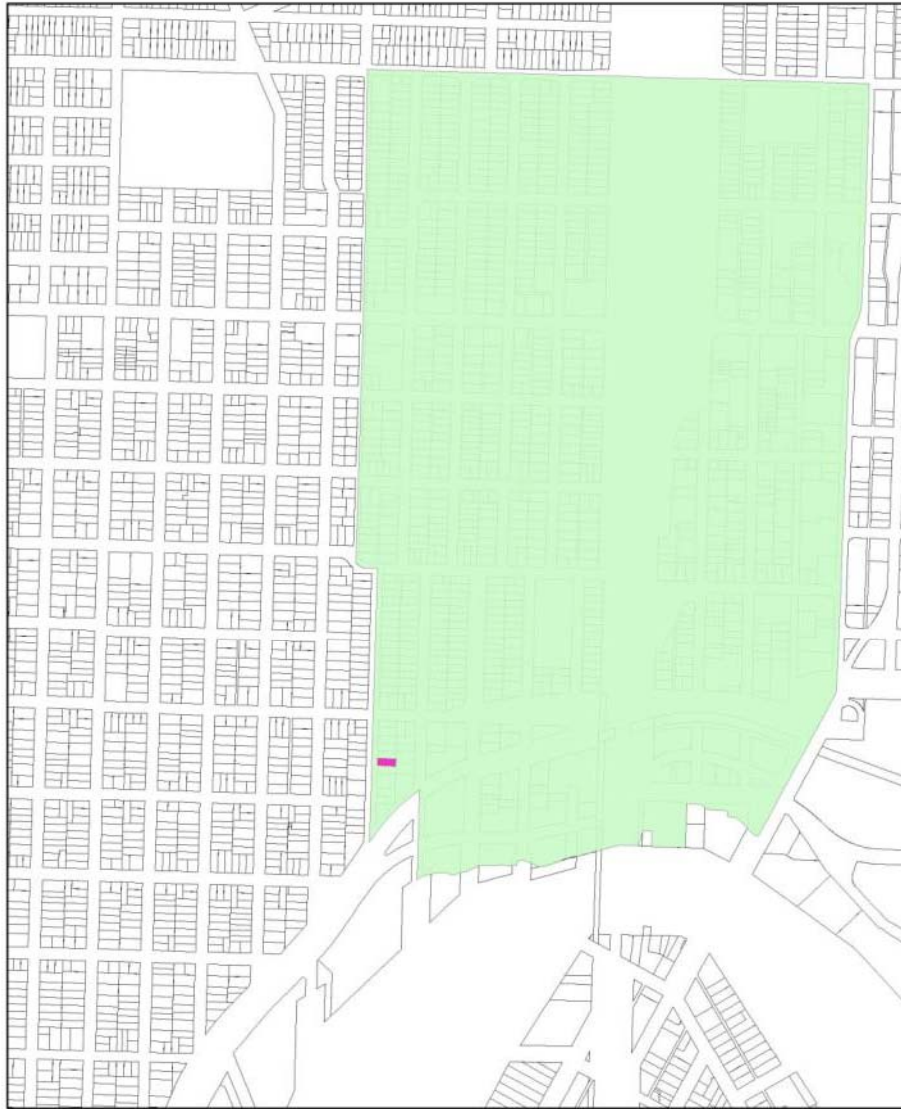
**My "Census Block" Neighborhood**

- My House
- My Block



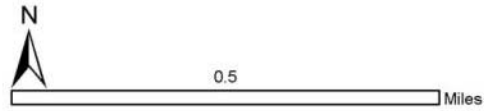
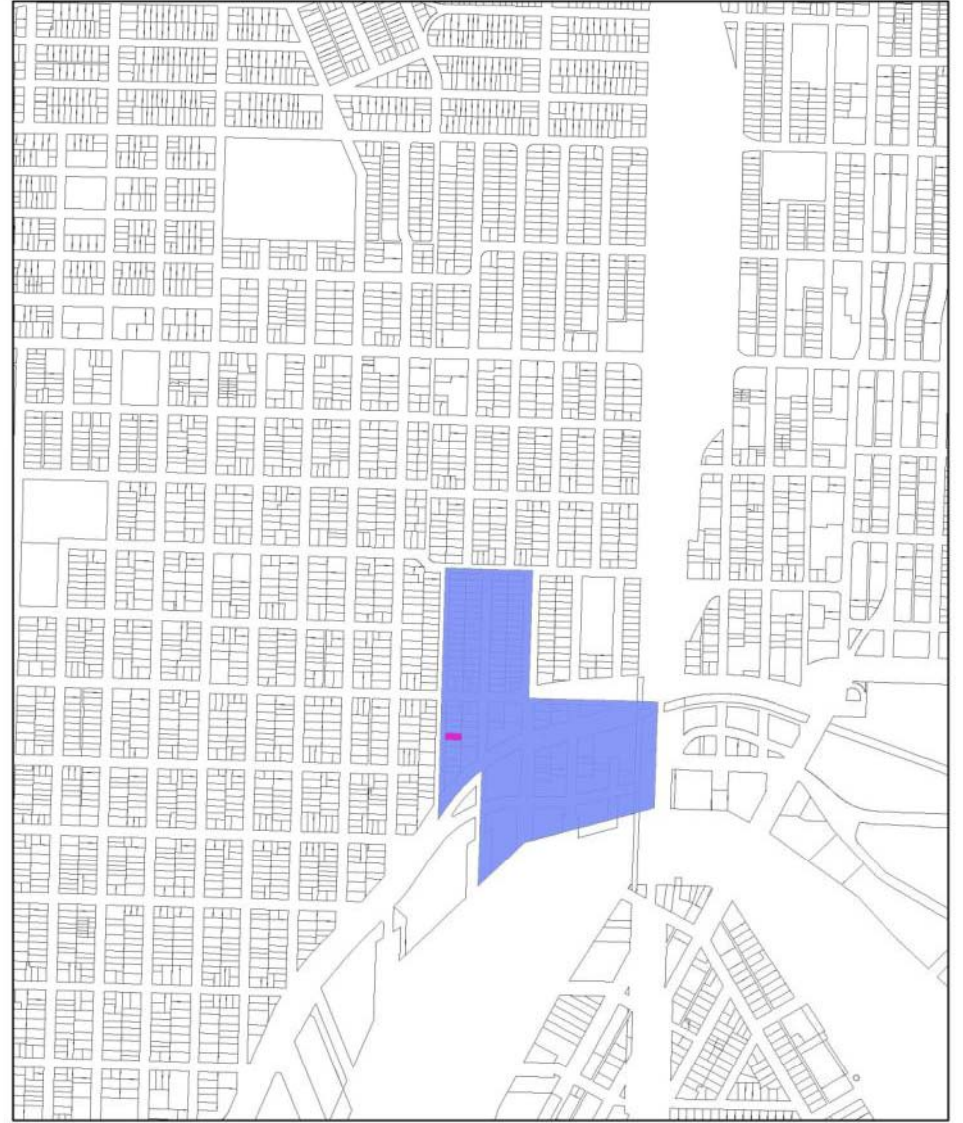
**My "Block Group" Neighborhood**

- My House
- My Block Group



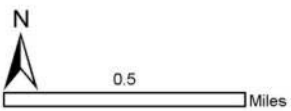
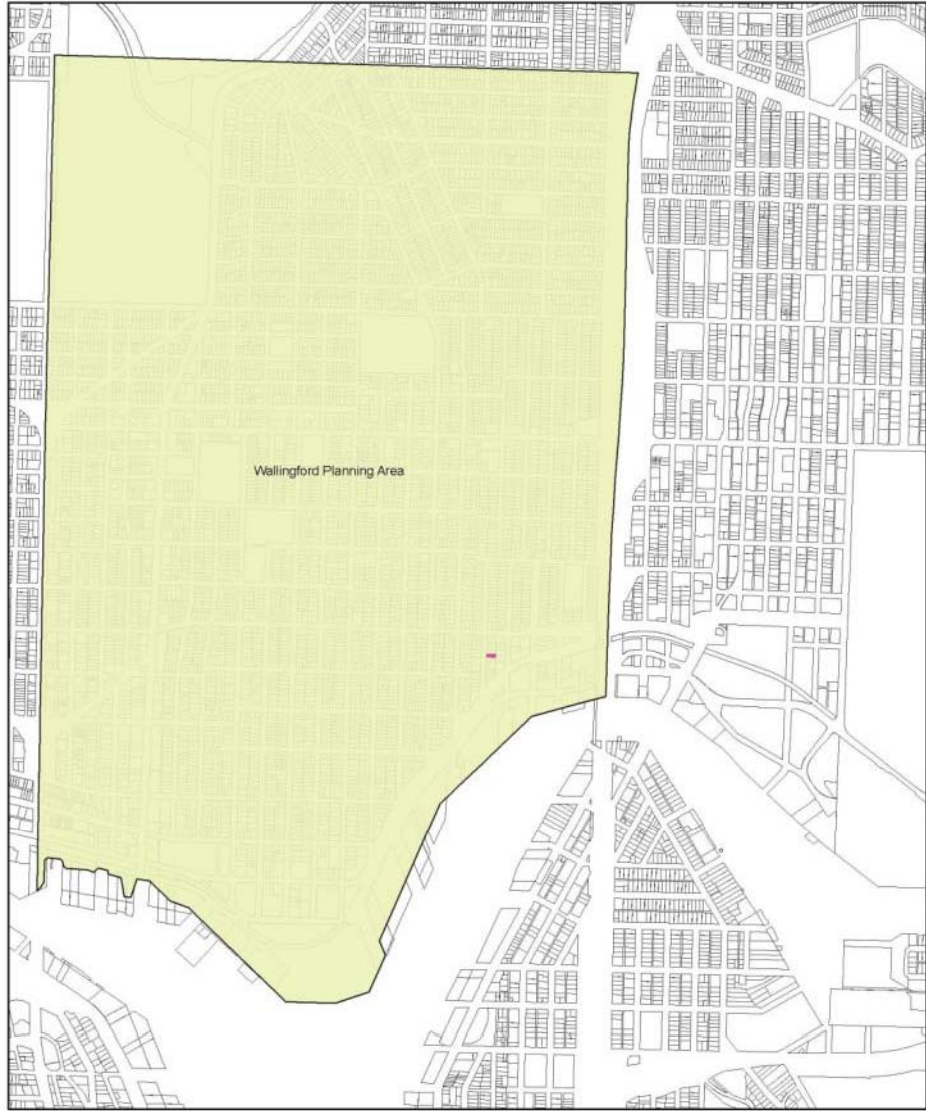
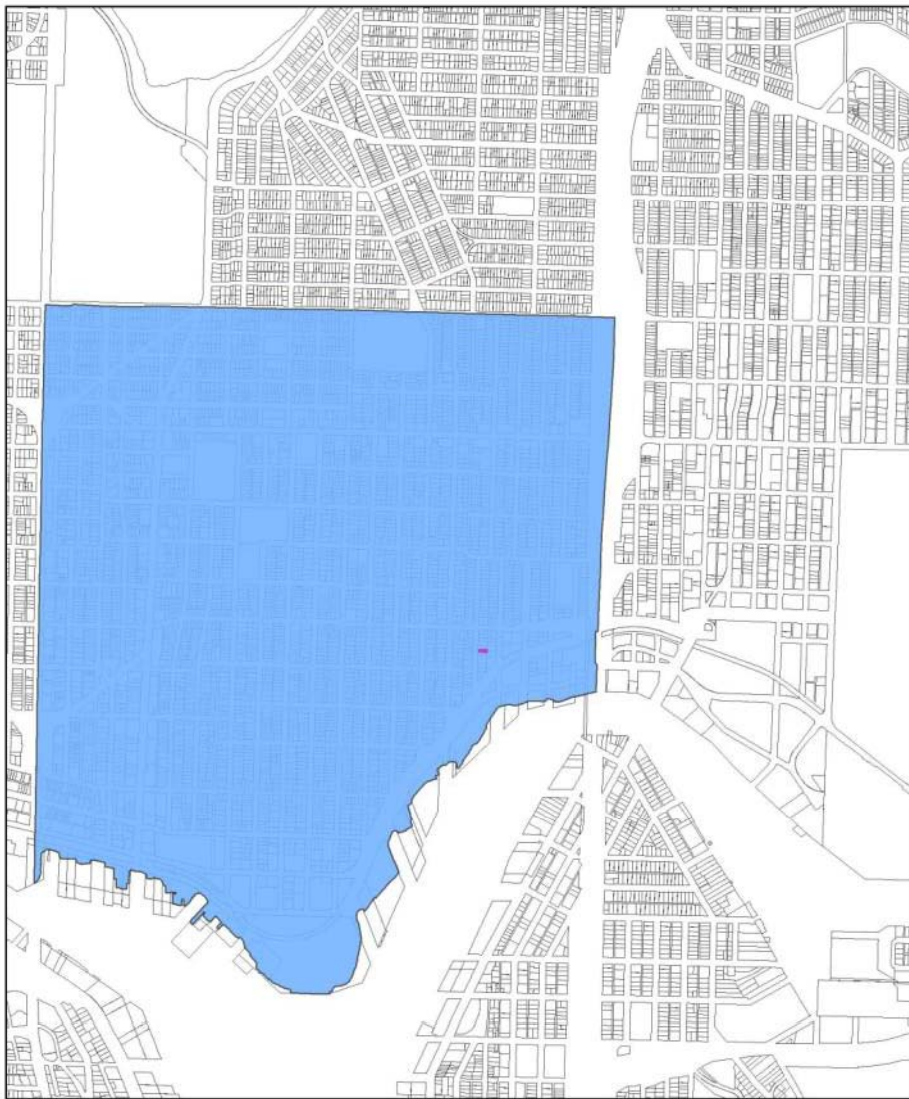
**My "Census Tract" Neighborhood**

- My House
- My Census Tract



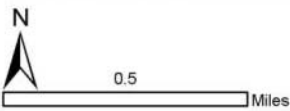
**My "Voter District" Neighborhood**

- My House
- My Voter District



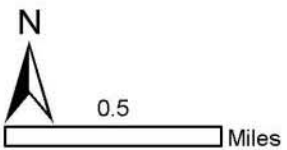
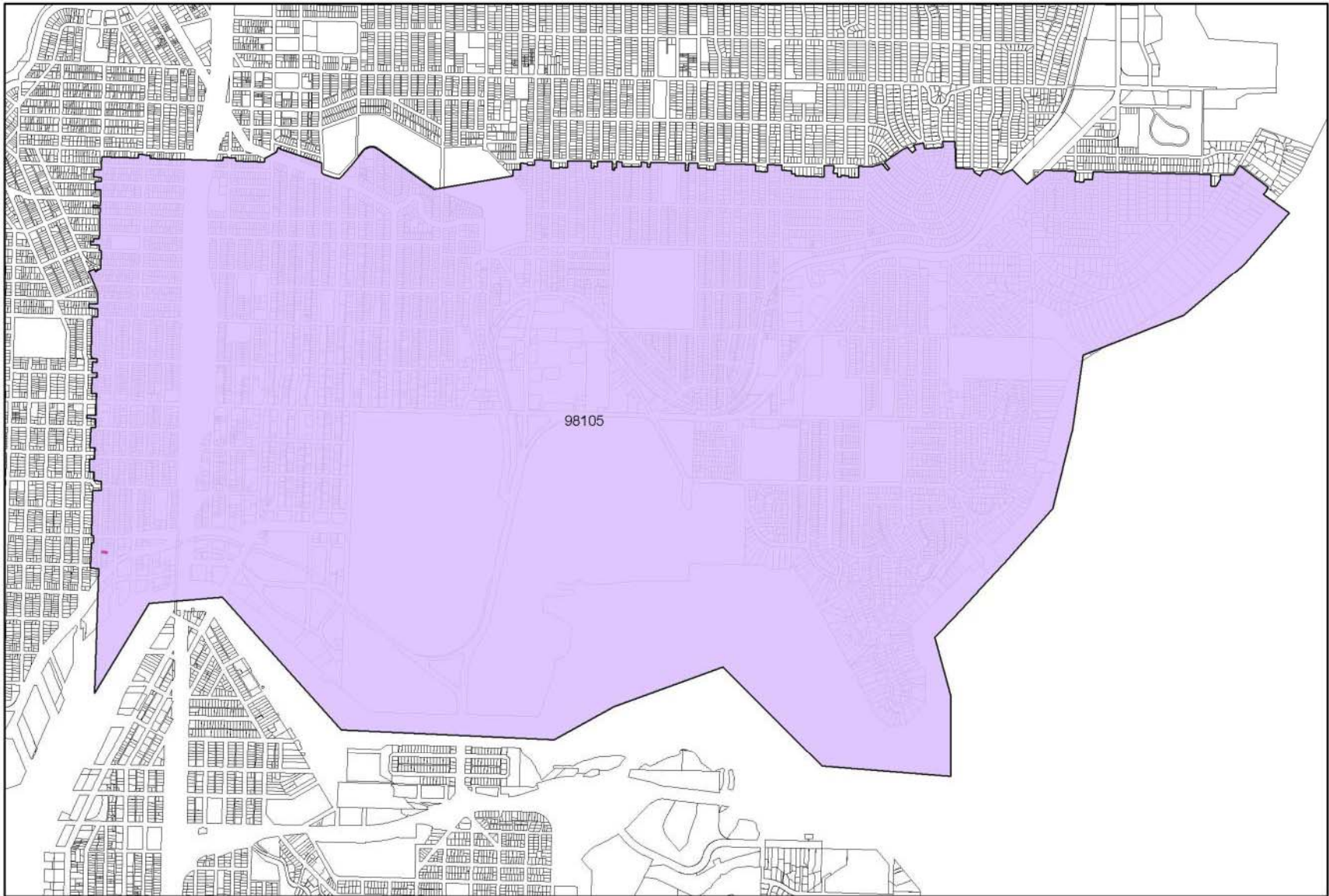
**My "Police Beat" Neighborhood**

- My House
- My Police Beat



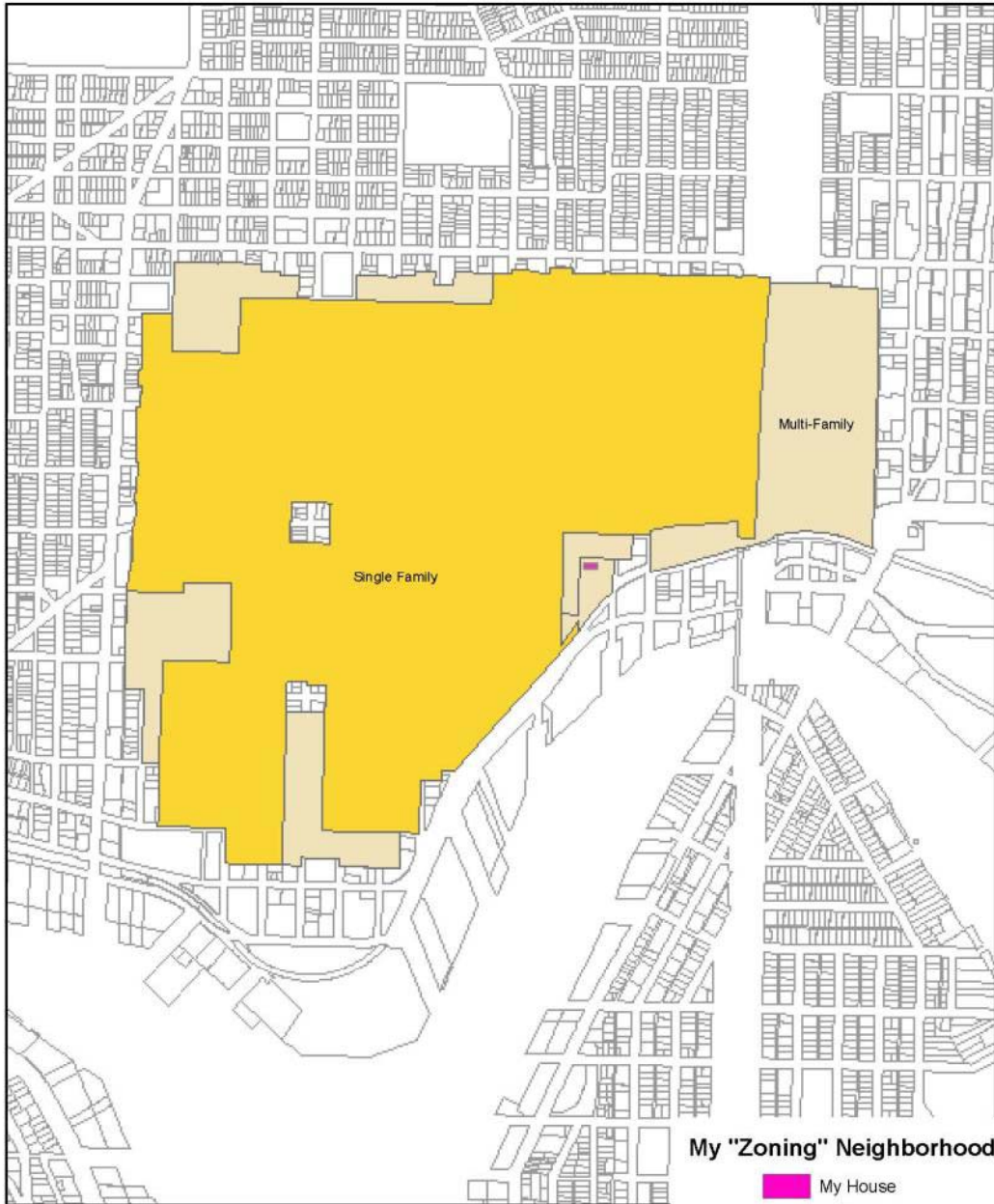
**My "City-Defined" Neighborhood**

- My House
- My City-defined neighborhood



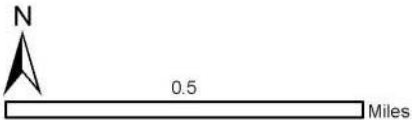
**My "Zip Code" Neighborhood**

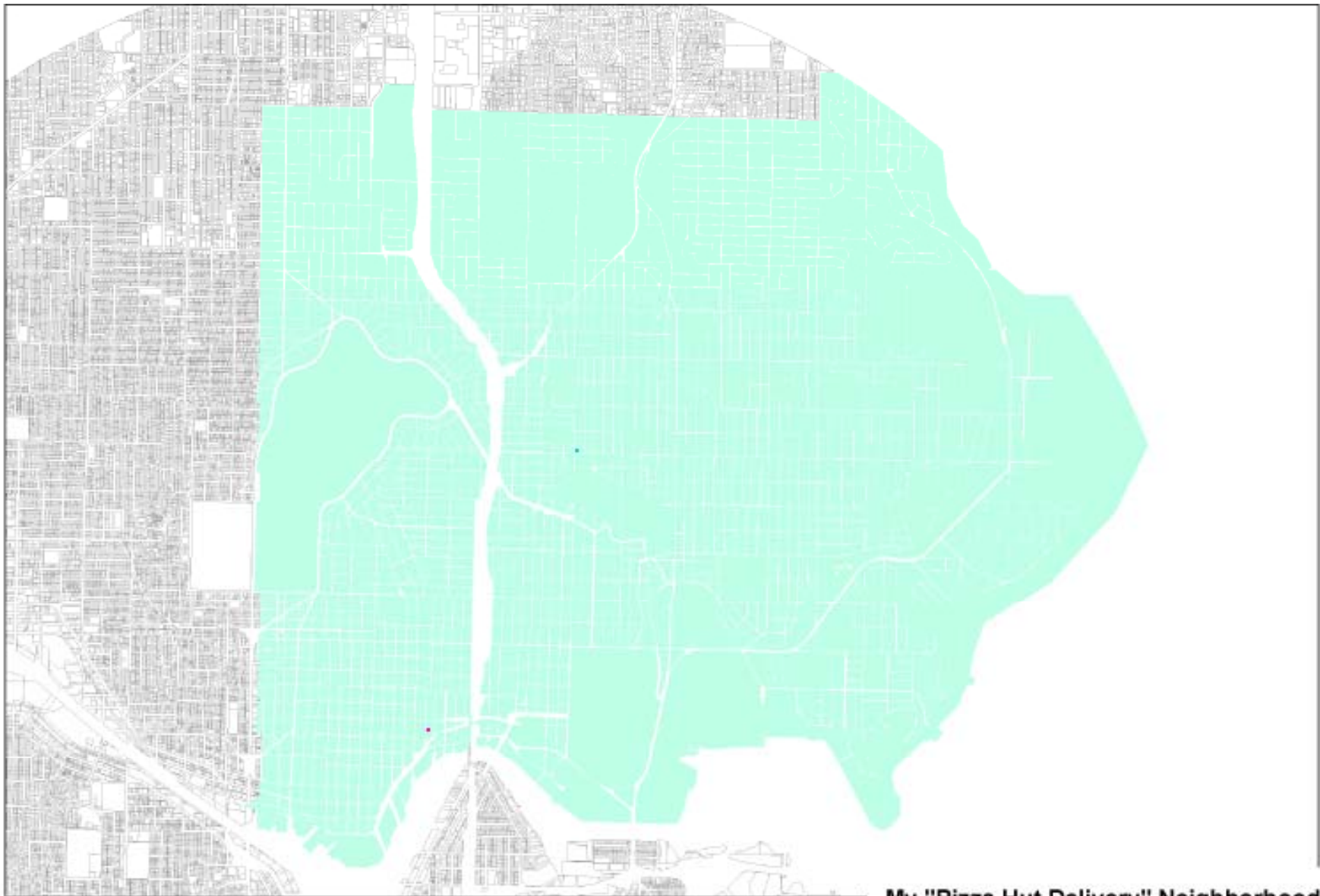
-  My House
-  My zipcode



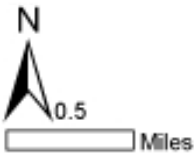
**My "Zoning" Neighborhood**

- My House
- My Zoning**
- CLASS\_DESC**
- Multi-Family
- Single Family





**My "Pizza Hut Delivery" Neighborhood**



- My House
- Pizza Hut Delivery Area
- PizzaHut



0.5

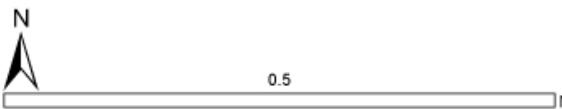
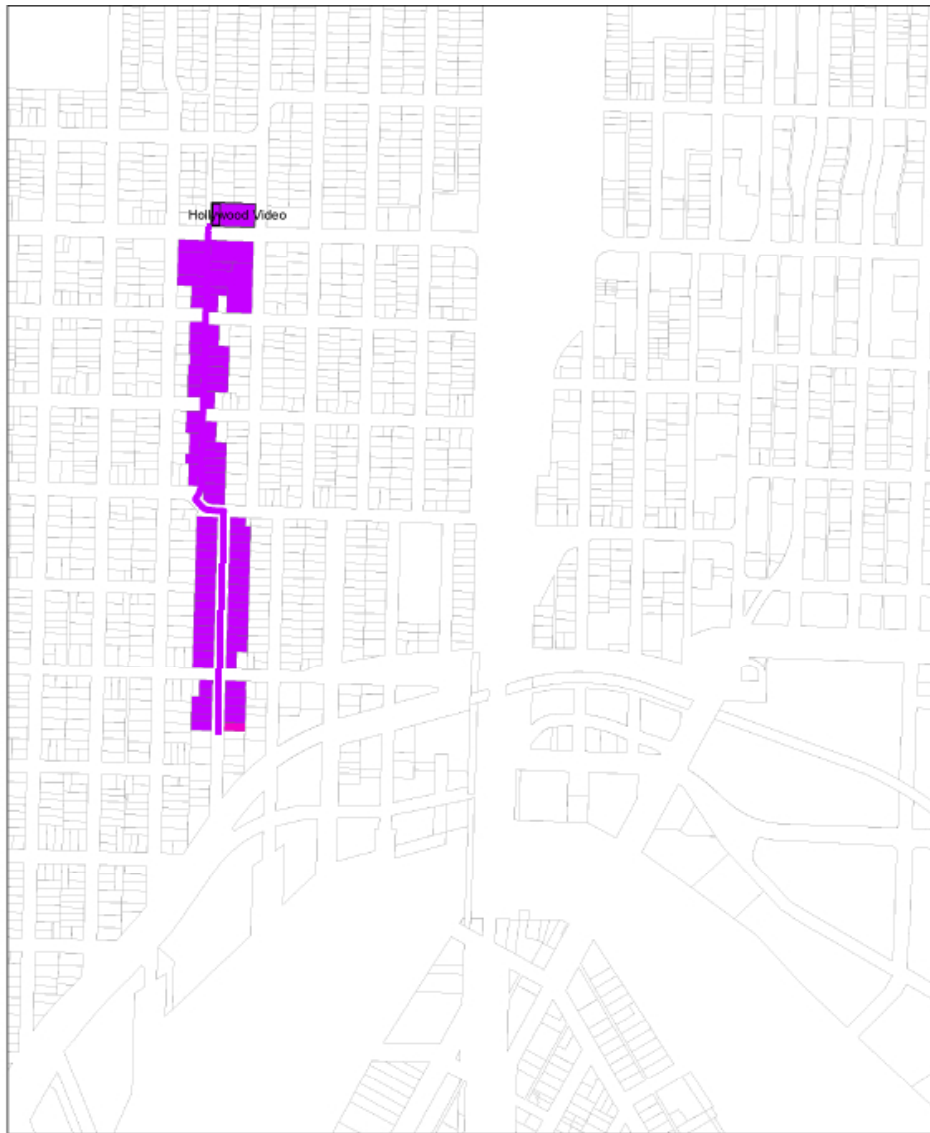
Miles

### My "Night Ride" Neighborhood

-  My House
-  Night Ride

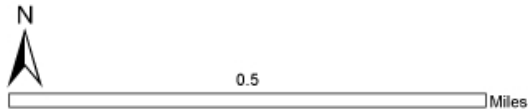
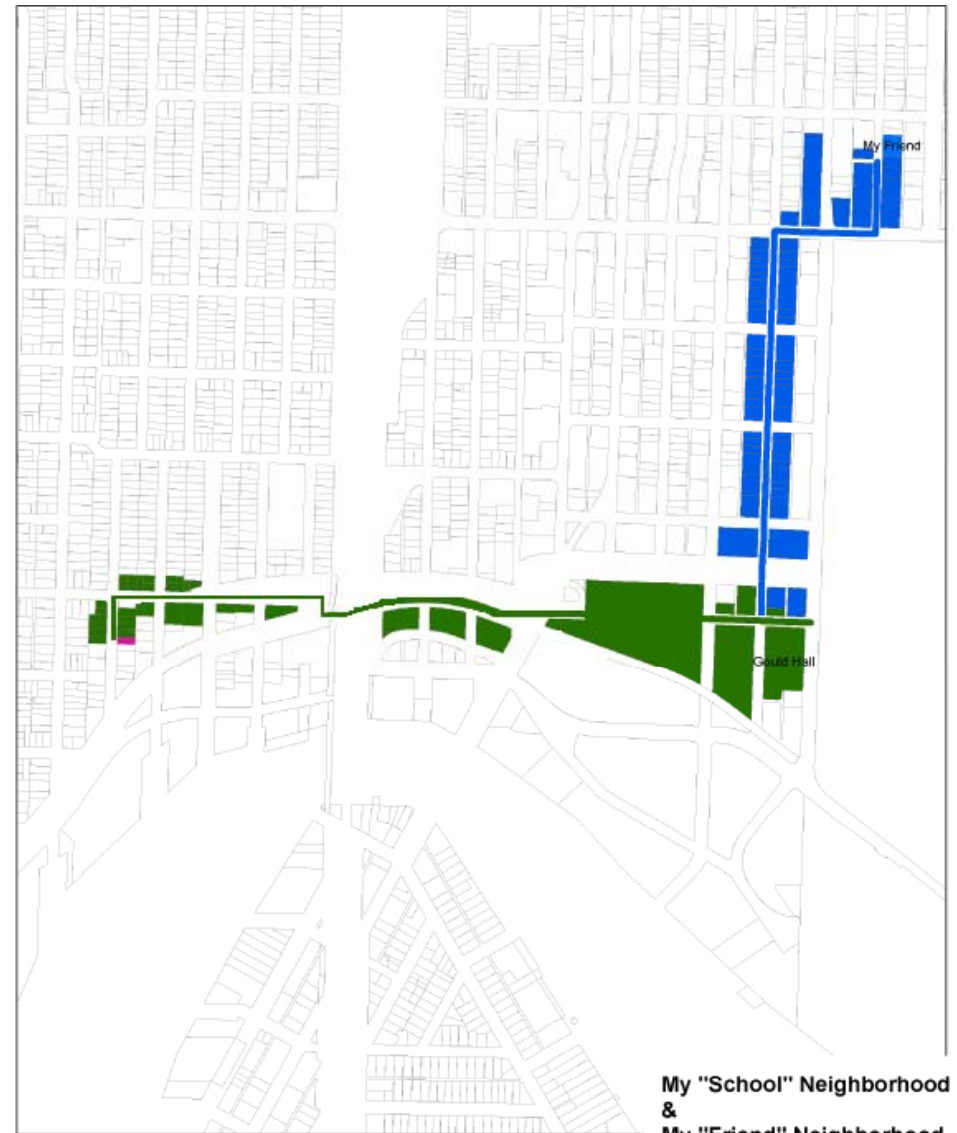


# My Neighborhood using routes and parcels



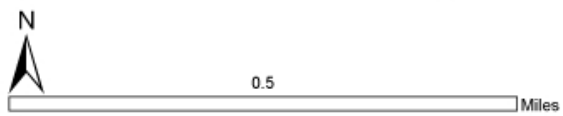
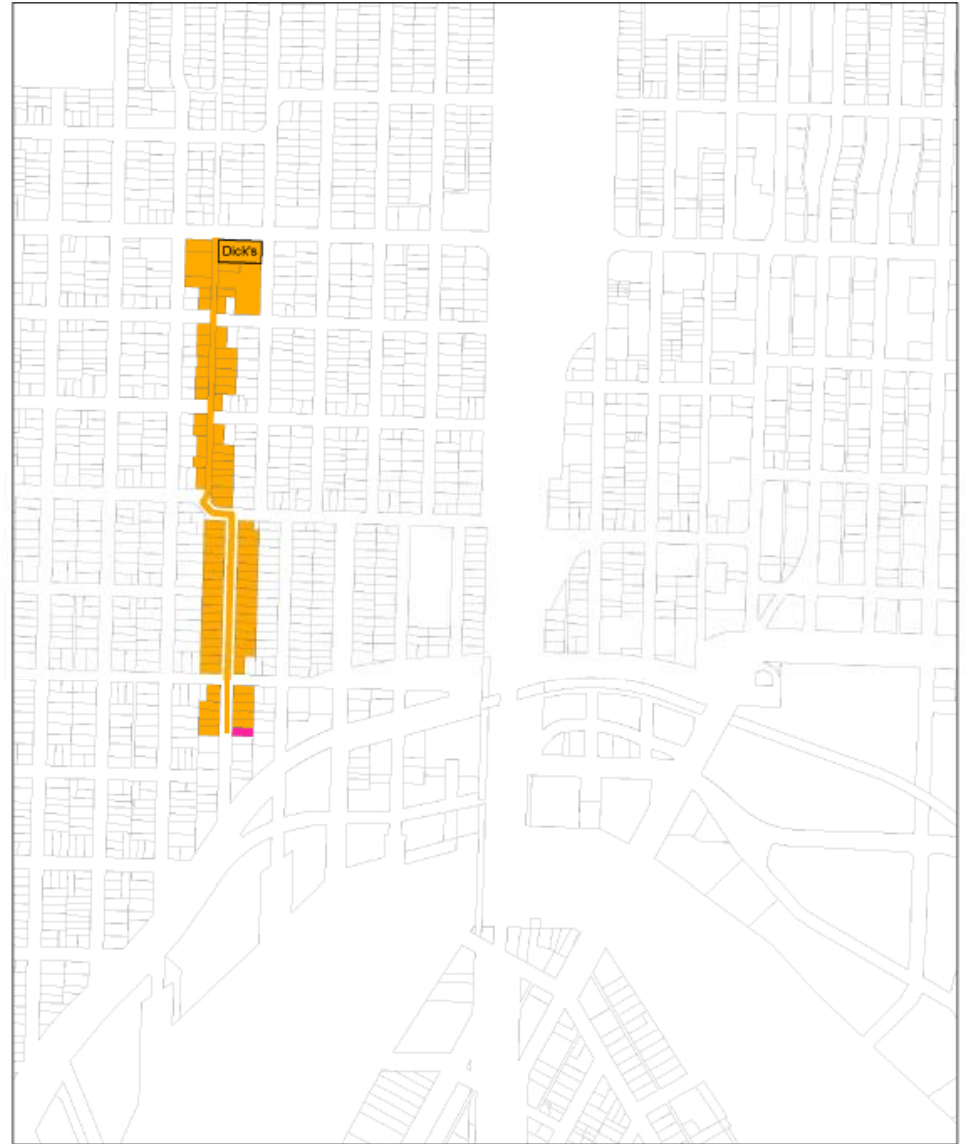
**My "Video Rental" Neighborhood**

- My House
- My Video Rental Route



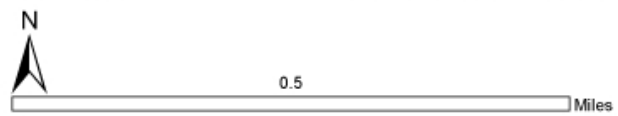
**My "School" Neighborhood & My "Friend" Neighborhood**

- My House
- Friend Route
- My School Route



**My "Park" Neighborhood**

- My House
- Park Route

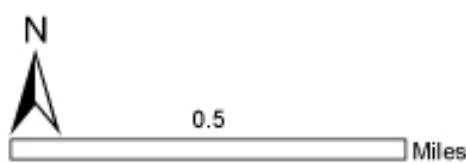


**My "Fast Food" Neighborhood**

- My House
- Fast Food Route

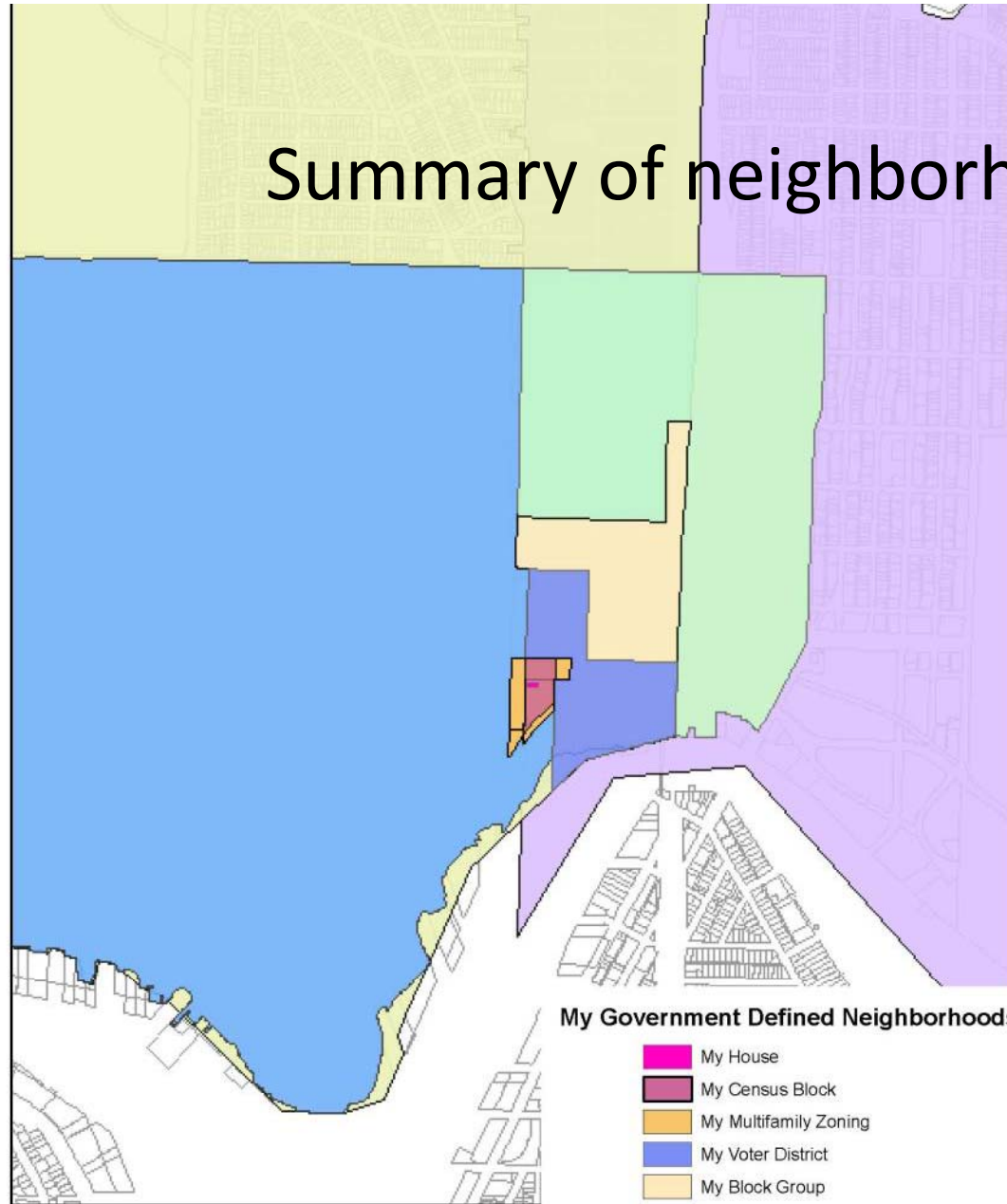


**My "Grocery Store" Neighborhood**



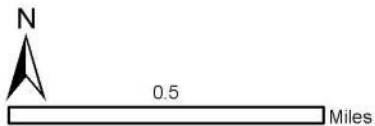
- My House
- Grocery Route

# Summary of neighborhood arial units

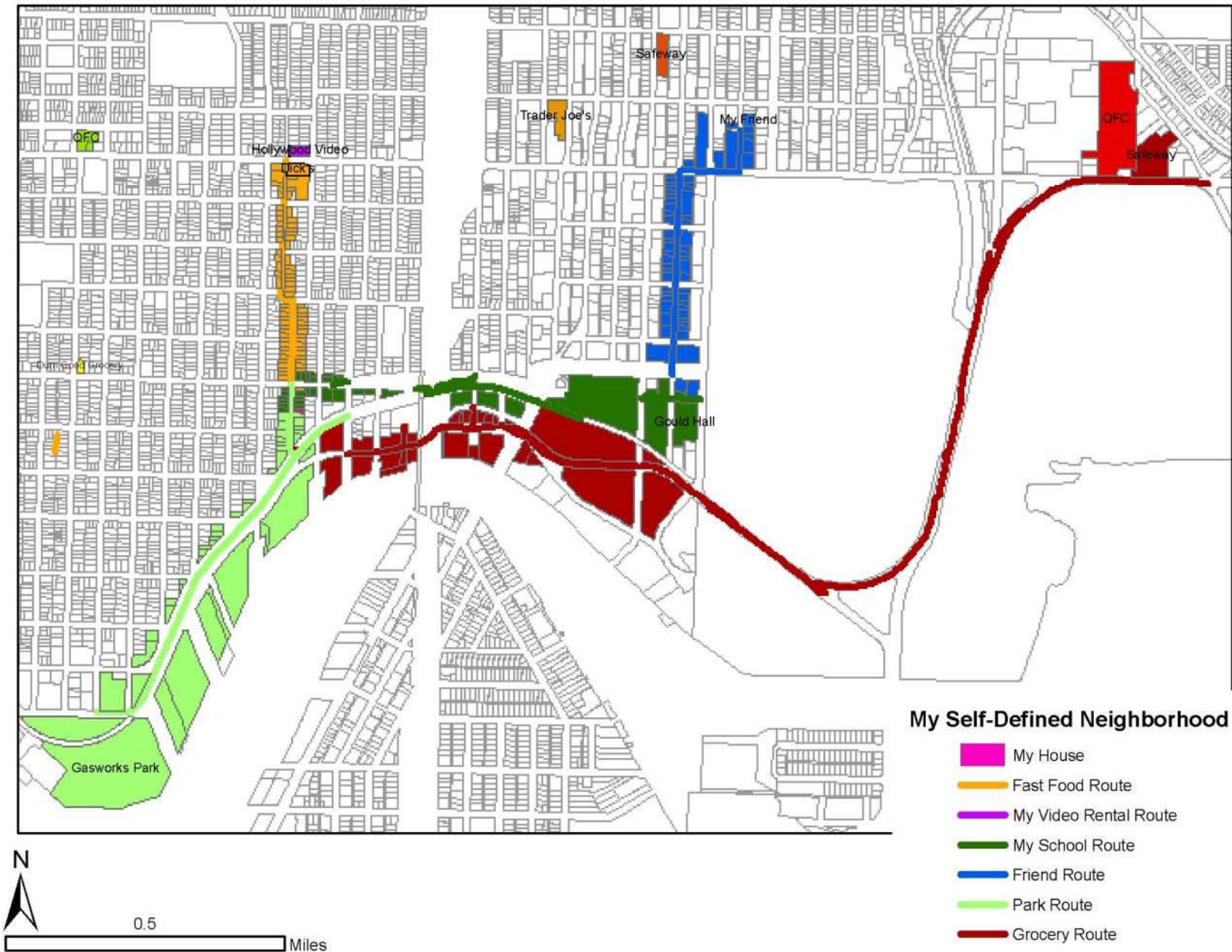


## My Government Defined Neighborhoods

- My House
- My Census Block
- My Multifamily Zoning
- My Voter District
- My Block Group
- My Census Tract
- My Police Beat
- My City-defined neighborhood
- My Zipcode

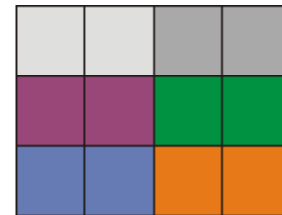
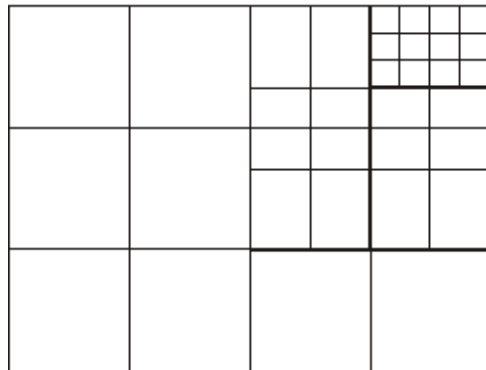


# Summary of My Neighborhood using routes and parcels



# Modifiable Areal Unit Problem

- MAUP is an issue of
  - Scale / Aggregation
  - Grouping / Zoning

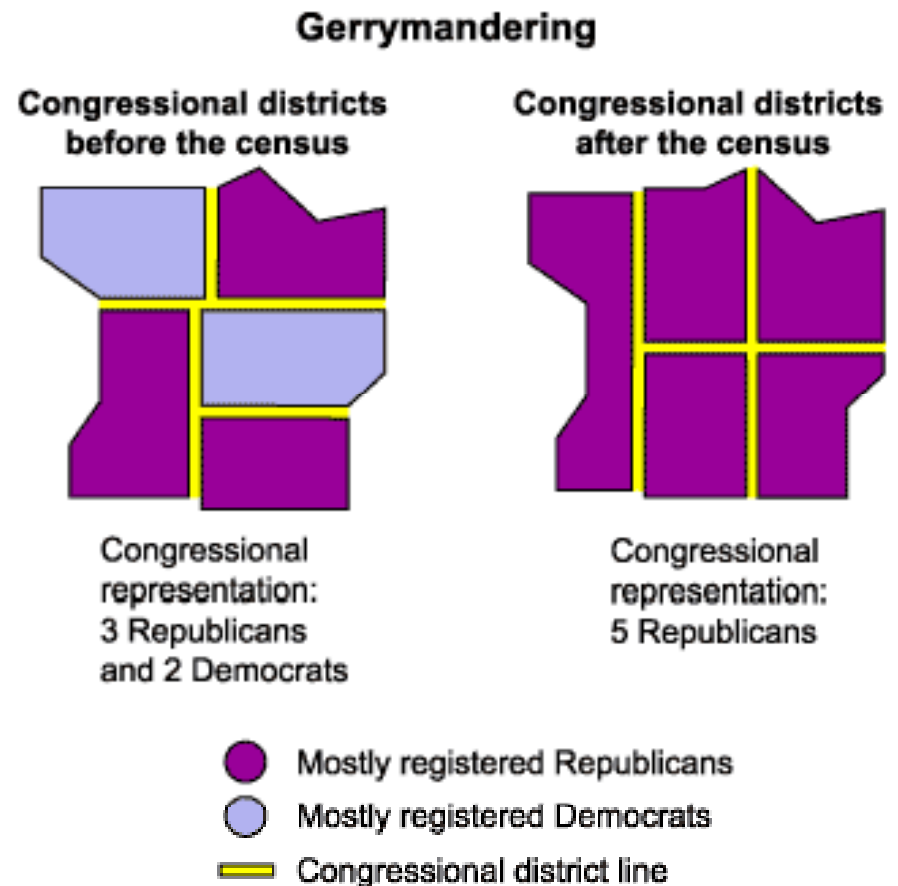


Zoning

# Gerrymandering

E. Berke

- Conclusions (votes) change if units are aggregated from one defined set of districts to another
- Still within the same area

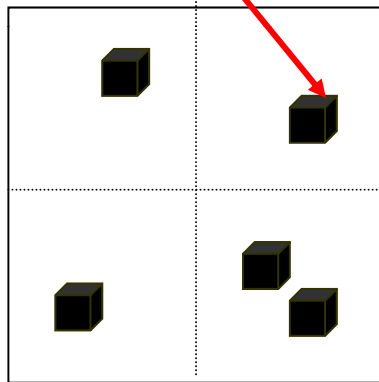


# Modifiable Aerial Unit Problem (MAUP)

## Effect of size of spatial unit of data capture on density measures

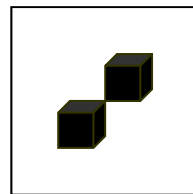
Same living conditions, different spatial units of analysis

100 people per unit



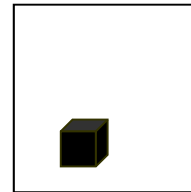
SPATIAL UNIT 40 acres

DENSITY 12.5 people/a



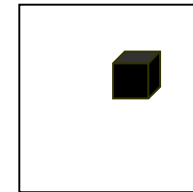
10 acres

20 p/a



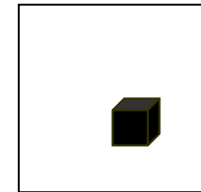
10 acres

10 p/a



10 acre

10 p/a



10 acres

10 p/a

**No one at 20 p/a 200 people at 20 p/a**

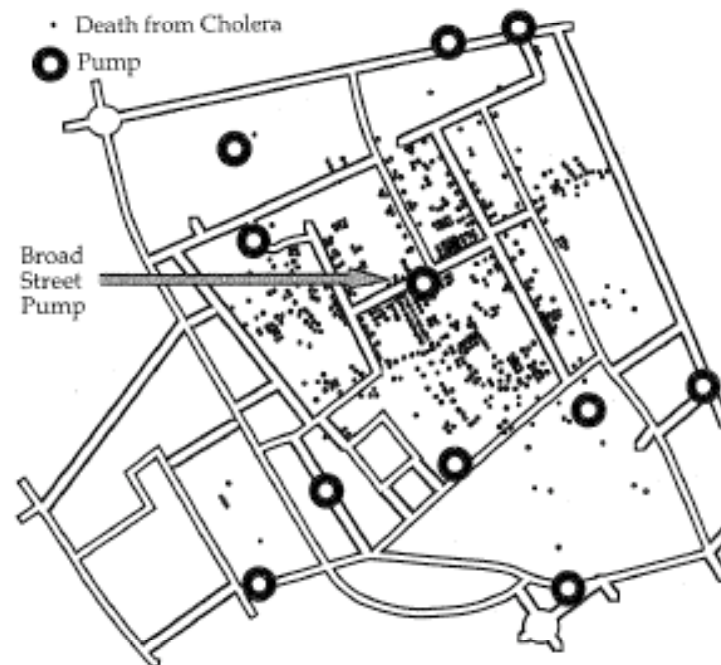


# MAUP

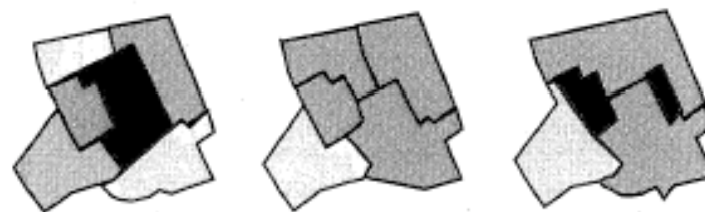
E. Berke

- If Snow used aggregate data there might or might not have been a detected outbreak
- Aggregation runs the risk of missing highly concentrated local clusters

Snow's Dot Map



Areal Aggregations and Density Symbols



Source: Monmonier M. How to Lie with Maps, 2ed. 1996.

# MAUP

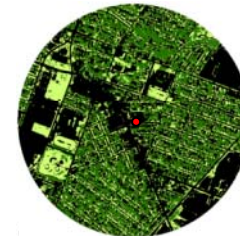
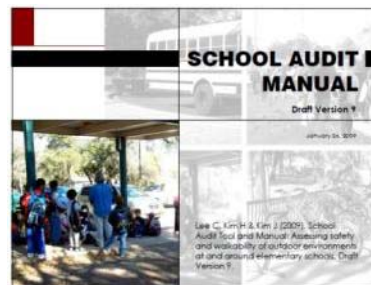
- Effect on:
  - correlation coefficient
  - variance
  - multivariate regression
  - spatial autocorrelation statistics
  - hierarchical models
  - Poisson regression
  - Others...

# MAUP Solution

- Be aware of the problem
- Acknowledge it in your work
- Refrain from making individual-level inference from aggregate data
- Consider your choice of statistics
  - Scale independent statistics
  - Remove geographic coordinates
- Try to use individual-level data OR...
- Perform analysis at multiple scales and zones

# Objective 2

Understand ways to import and analyze data from external devices or sources  
(GPS, accelerometer, audit, etc.)

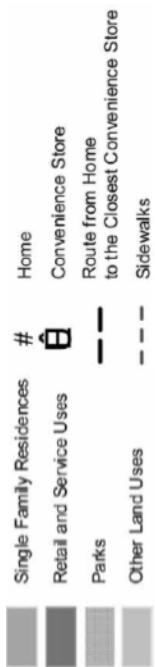
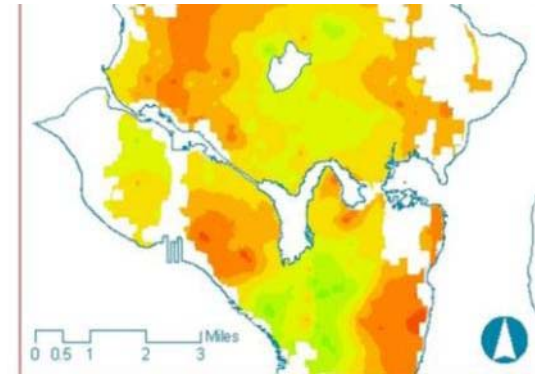


Density & Land Use ---- Site Layout ---- Architectural Design  
Macro ----- Meso ----- Micro  
GIS ----- Aerial Photo ----- Audit

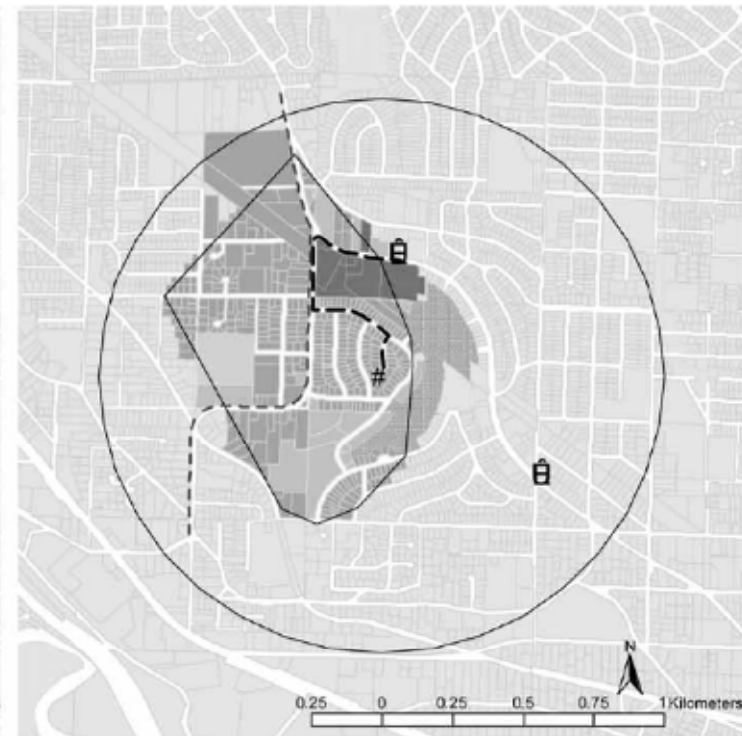




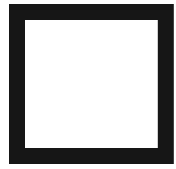
# Geographic Information System



**1 km Airline Buffer**  
defined by straight-line distances



**1 km Network Buffer**  
defined by street network distances



# Common External Devices & Resources

- ▣ Audit
- ▣ Survey & secondary data
- ▣ Satellite Imagery
- ▣ GPS Units (Global Positioning System)
- ▣ Accelerometers

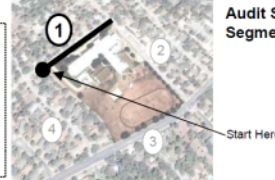
•

# Audit: Line, Point and Polygon

School Name: Highland Park Elementary Date: Time started: ended: Weather:  sunny  cloudy Auditor ID:

## STREET SEGMENT 1: Fairview Dr.

Note:



Audit Street Segment ID ①

### Land use (check all that is immediately along the street segment)

#### Residential:

- Single family home
- Multifamily housing (e.g., apartment, condominium, duplex, 4-plex)
- Mobile home

#### Commercial:

- Fast food restaurant
- Buffet restaurant
- Regular sit-down restaurant / taqueria
- Supermarket / grocery store
- Convenience store with gas station
- Convenience store without gas station
- Gas station with no convenience store
- CD / DVD / video game store or rental
- Mall / strip mall / big box retail (e.g., Wal-mart, Home Depot, IKEA, Toys "R" Us)

#### Educational, Office & Service:

- Boys & girls club / YMCA
- School / kindergarten / daycare center

### Number of lanes (both directions):

If no marked lanes, estimate based on roadway width or driving behaviors.

#### Number of driveways & street intersections (both sides)

- 0  1-3  4-10  11+

#### Number of street lights

- (both sides of the street, sidewalk, street shoulder and/or bike lane)
- 0  1-3  4-10  11+

#### Traffic calming devices (check all that apply)

- Reduced speed sign (excluding school zone speed sign)
- Speed bump or hump
- Median island
- Roundabout
- Curb extension / bulb-out
- Pavement change / pavement marking

### Maintenance of streets & sidewalks

(free of cracks, holes, overgrown grass/weeds, etc.)

- Poor Fair Good Very Good Excellent

### Cleanliness of streets & sidewalks

(free of litter, rubbish, broken glass, discarded items, etc.)

- Poor Fair Good Very Good Excellent

### Overall visual quality

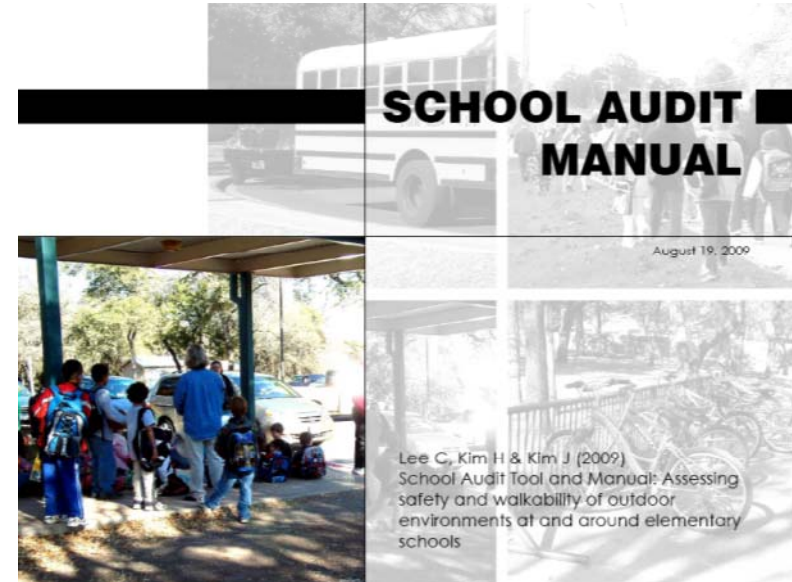
- Poor Fair Good Very Good Excellent

### Safety in walking

- Poor Fair Good Very Good Excellent

### Safety in bicycling

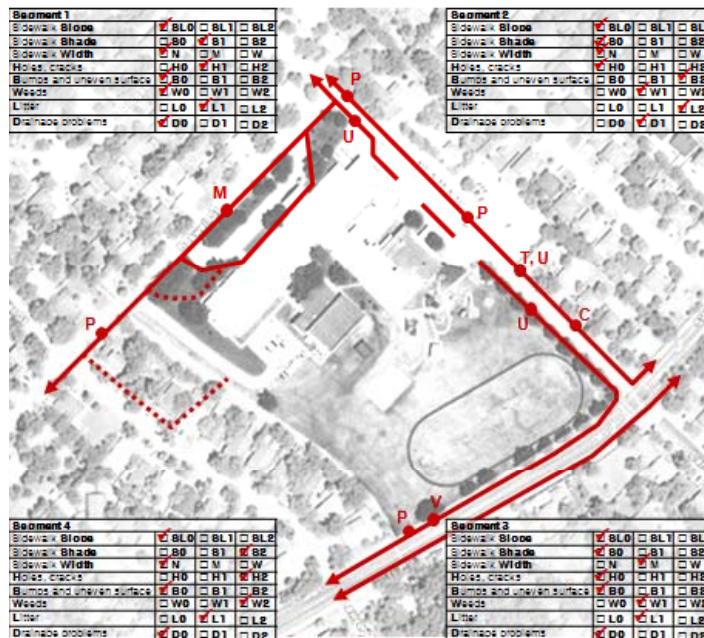
- Poor Fair Good Very Good Excellent



## SCHOOL AUDIT MANUAL

August 19, 2009

Lee C, Kim H & Kim J (2009) School Audit Tool and Manual: Assessing safety and walkability of outdoor environments at and around elementary schools



## Traffic Calming Devices

[Check all that apply]

- Reduced speed sign (excluding school zone speed sign)



- Speed bump or hump



- Median island



A median island, usually appearing as a landscaped strip, is used to separate the traffic from two directions.



- Round about

A roundabout is a type of road junction at which traffic enters a one-way stream around a central island. It is used to slow traffic.



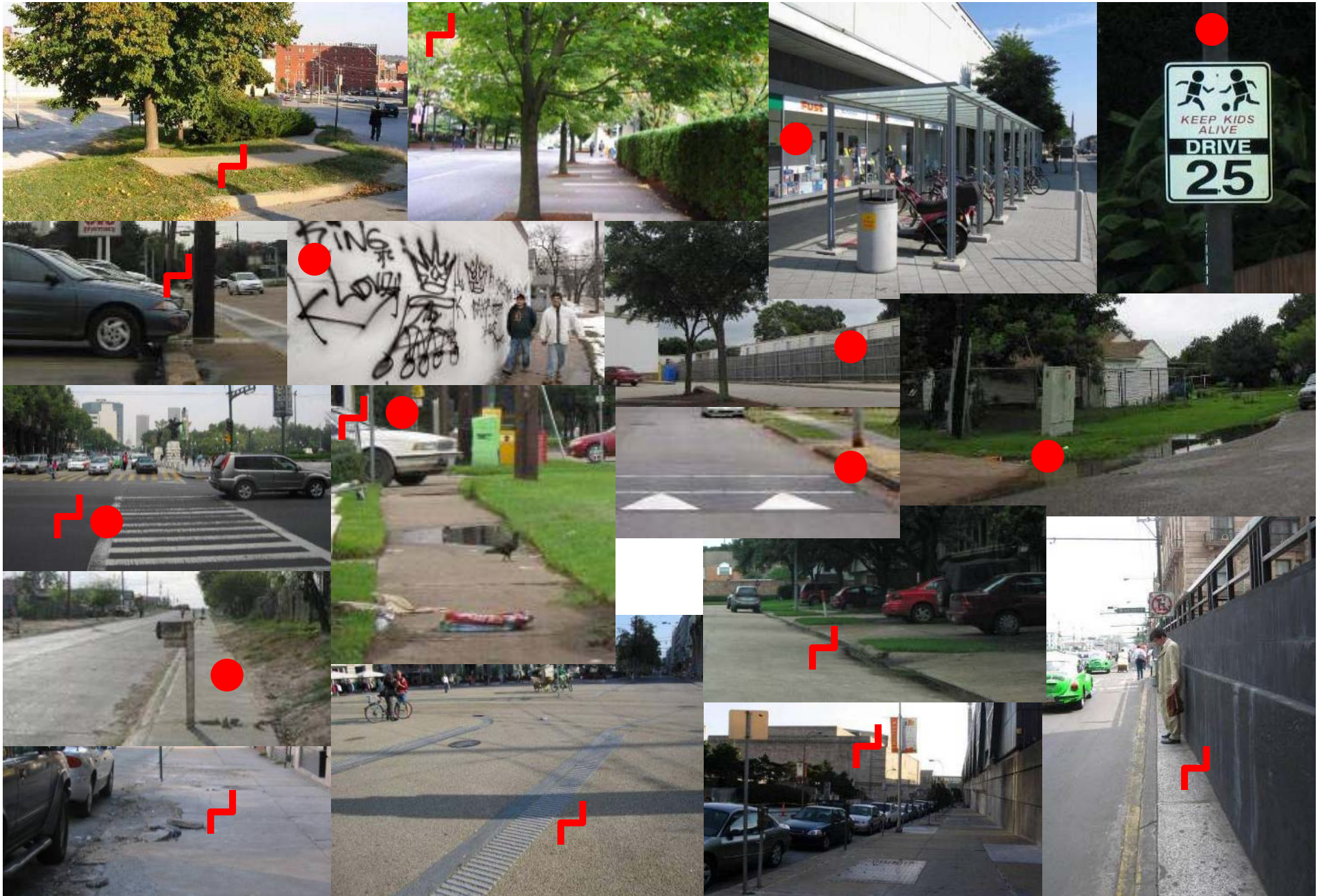
[1] <http://www.ci.huntsville.al.us/Engineering/TrafficEng/Images/speed30table.jpg>

[2] [http://www.celestary.com.au/images/photos/speedbumps\\_b.jpg](http://www.celestary.com.au/images/photos/speedbumps_b.jpg)

[3] Better Streets, San Francisco

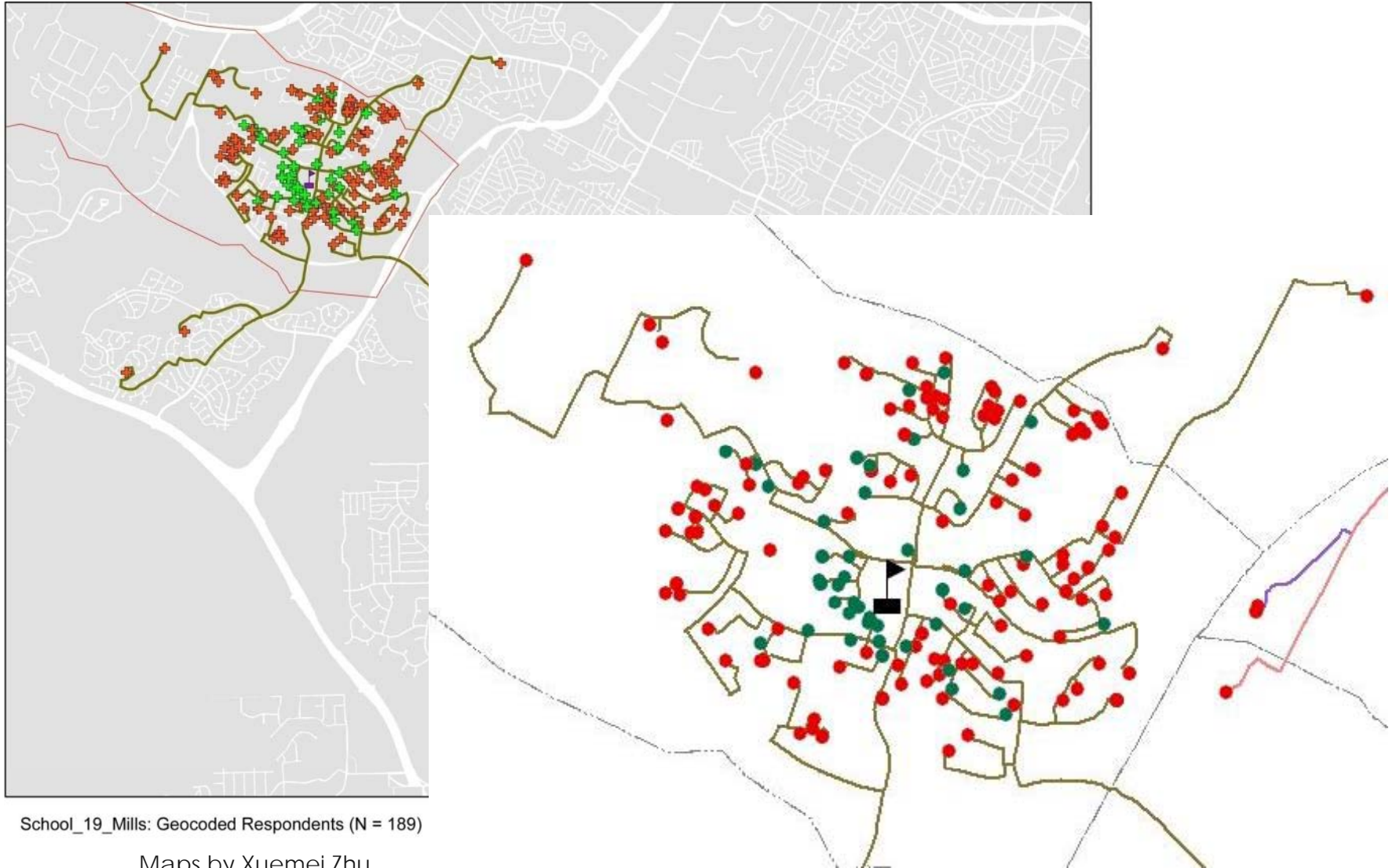


# Audit examples: Line and Point data



# □ Survey

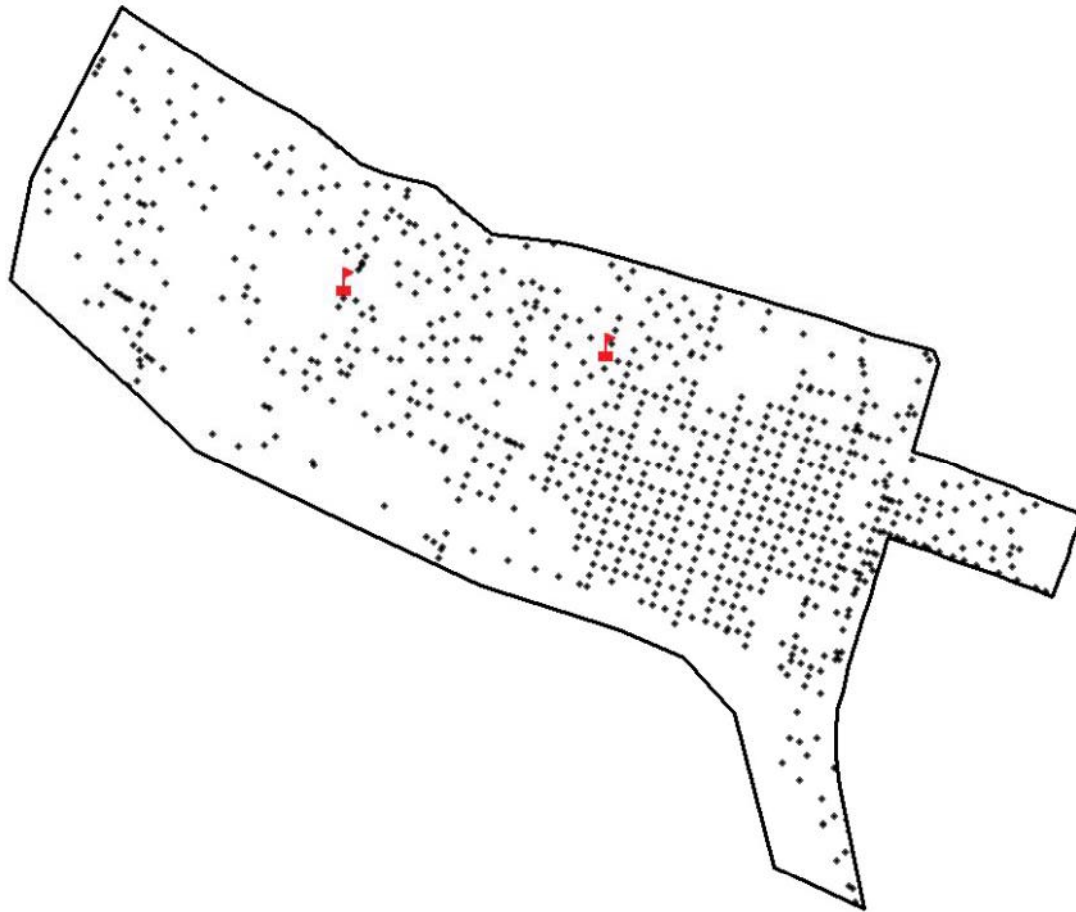
e.g. school travel modes (walking vs. others)





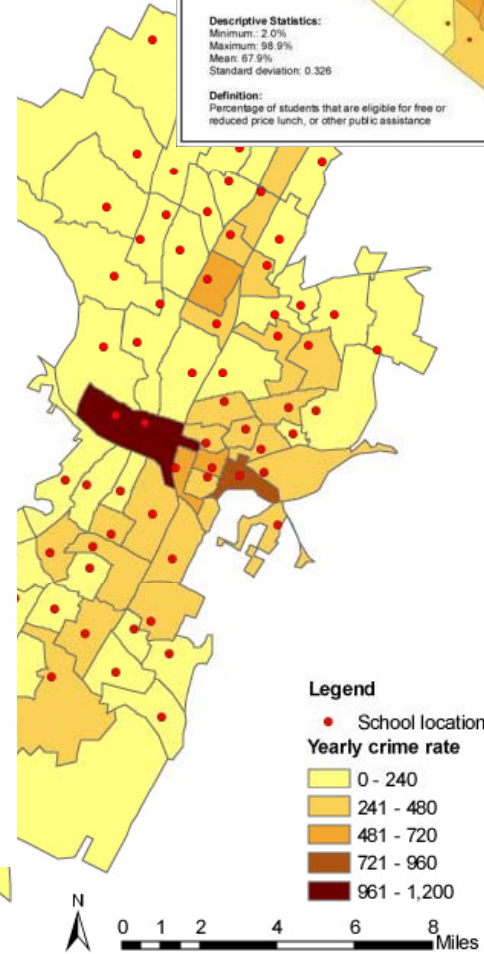
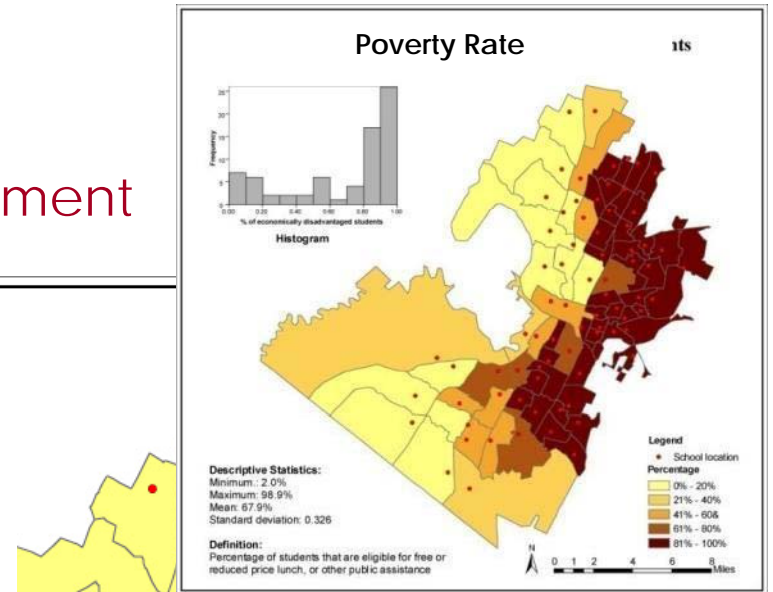
# Secondary data:

e.g., crime data from police department



Maps by Xuemei Zhu

**Definition:**  
(Number of offenses in year 2004 and 2005 \* 1000) / (total population \* 2)



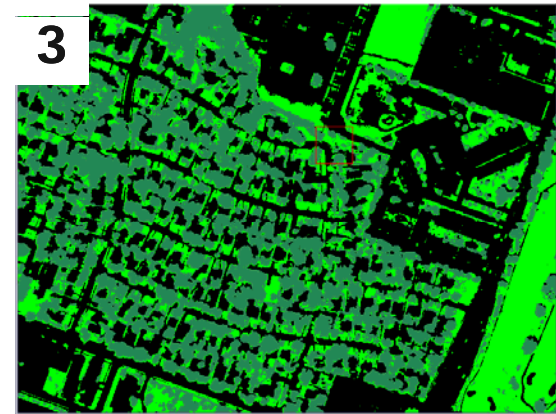
# ☐ Satellite Imagery: Raster (scale, resolution)



The Original DOQQ (Digital Ortho Quarter Quads)

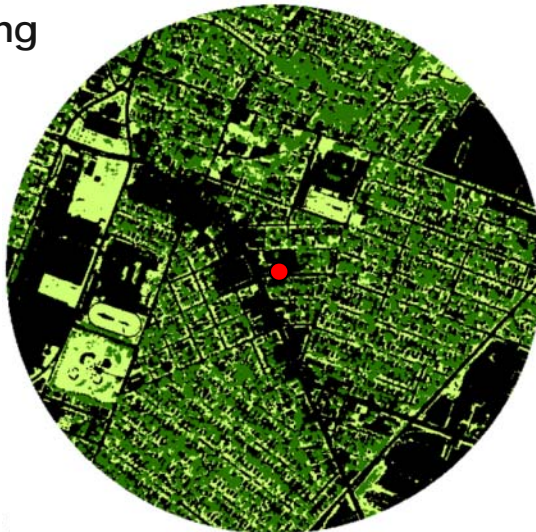
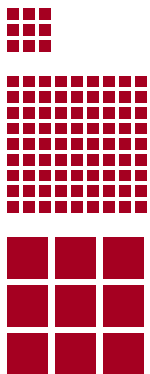


Classified Imagery using the Unsupervised Classification Process



Final Output Categorized with Three Land Cover Types

4 Post-classification Processing (remove isolated cells)



# □ Wearable Global Positioning System: A few examples

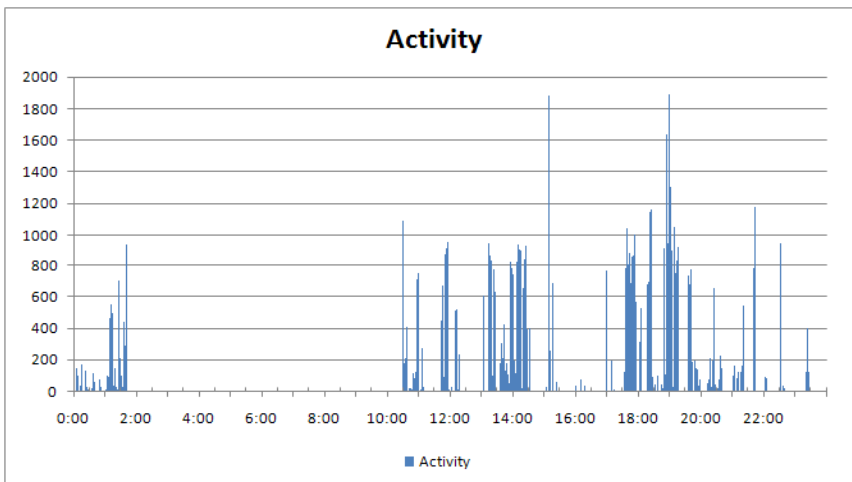
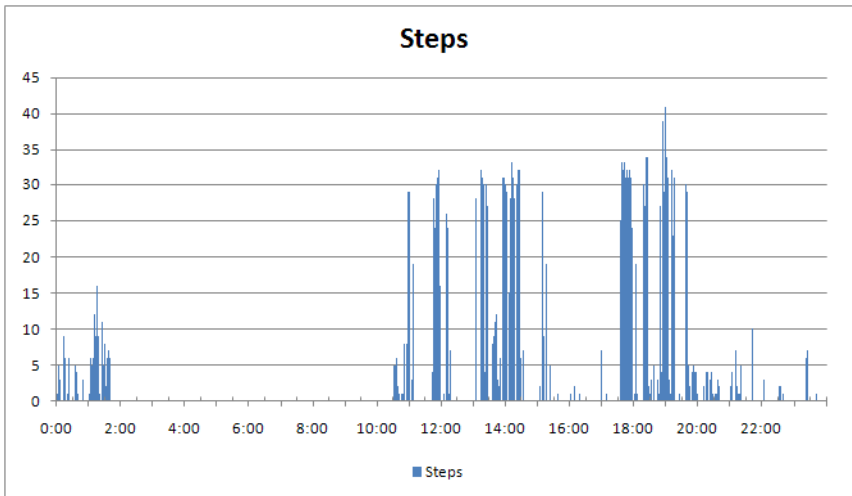


	Garmin Foretrex		Garmin Forerunner		Global Sat DG-100		Wintec Easy Showily	
	Rating	% Correct	Rating	% Correct	Rating	% Correct	Rating	% Correct
Points Correctly plotted on sidewalk	○	67.1%	+	76.0%	+	74.9%	-	57.2 %
Points Correctly plotted on the correct side of the road	○	78.9%	+	98.8%	+	100%	○	85.4%
Points on course	-	71.6%	+	80.7%	+	80.49	-	71.8%
Points on course with tree coverage	-	73.0%	+	100%	○	82.80%	+	100%
Points on course while indoors**	+	100%	+	100%	-	46.1%	+	100%

Wieters M, Kim J and Lee C (2008). Assessment of available research instruments for measuring physical activity. *Association of Collegiate Schools of Planning, Chicago, IL*



# Accelerometers: examples



Date	Time	Activity	Activity (Horizontal)	3rd Axis	Steps
6/30/2009	8:13:00	0	0	4	0
6/30/2009	8:13:30	33	103	47	3
6/30/2009	8:14:00	225	228	149	7
6/30/2009	8:14:30	91	114	56	3
6/30/2009	8:15:00	378	165	198	13
6/30/2009	8:15:30	21	118	437	0
6/30/2009	8:16:00	887	1108	1535	33
6/30/2009	8:16:30	753	1008	1248	29
6/30/2009	8:17:00	942	1110	1414	37
6/30/2009	8:17:30	194	509	548	6
6/30/2009	8:18:00	209	239	540	2
6/30/2009	8:18:30	14	78	66	1
6/30/2009	8:19:00	227	260	541	2
6/30/2009	8:19:30	98	156	312	2
6/30/2009	8:20:00	36	126	127	1
6/30/2009	8:20:30	0	23	109	0
6/30/2009	8:21:00	0	18	24	0
6/30/2009	8:21:30	0	3	0	0
6/30/2009	8:22:00	0	21	2	0