Mark Swanson • GES 392 • Spring 2010 • Prof. Mihir

# SERVICE AREA ANALYSIS FOR FIRE STATIONS IN EVANSTON, ILLINOIS

# Introduction

- Service Area Analysis can be used to calculate travel times along a network from one or more service locations
- Common application: response times for fire trucks and other emergency vehicles

# Service Area Considerations

- What types of services are delivered by the fire department?
- What is a reasonable travel time for the community?
- What is the size of the area being served and the type and amount of resources available?
- What level of risk is the community willing to accept?

Source: ESRI

# Fire and Response Time Standards

- Fire reaches critical stage ("flashover") in about **8 to 10 minutes**
- National Fire Protection Association (NFPA) recommends that the first fire engine reaches a fire within **6 minutes**
- Total response time
  = Dispatch time + turnout time + travel time
  = 1 minute + 1 minute + 4 minutes

# Calculating Response Times in ArcGIS

- Total response time
  = Dispatch time + turnout time + **travel time**
  = 1 minute + 1 minute + **X**
- "Response Time" in my ArcGIS maps refers specifically to **travel time** (**X**)

# Evanston, Illinois

- General Information
  - Population: 74,239 (2000 Census)
  - Area: 7.8 sq. miles
  - Miles of Streets: 147
  - Miles of Alleys: 76
- Fire Protection
  - Number of Firefighters: 107
  - Number of Stations: 5
  - Responses in 2006: 8,099 (3,364 Fire + 4,735 EMS)


Evanston, Illinois
Lake Michigan
N
Wilmette
Evanston Boundary
What if only **one** fire station serviced the entire city?
Chicago
0 0.25 0.5 1 Miles

# The Shapefile Data

1. Obtain TIGER/Line shapefiles for Illinois, Cook County, and county subdivisions
   - Select Evanston area
   - Remove non-road “edges” (railroads, “El” tracks, rivers, shorelines, etc.)
   - Prepare a cost field
2. Obtain tract and block census data for Cook County
   - Select data for Evanston area
3. Create point shapefile for Evanston fire station locations

# The “Travel Time” Cost Field

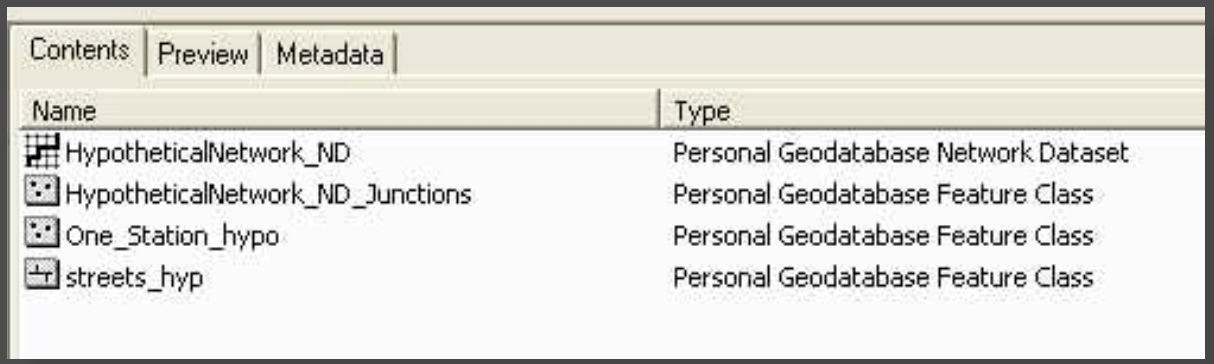
- Travel Time = length / (speed limit * 5280 / 60)

Attributes of evanston_edges_export

| FULLNAME | length (feet) | speed limit (mph | travel time (min) | S |
|---|---|---|---|---|
| Alley | 110 | 15 | 0.083 | 32 |
| Wesley Ave | 108 | 25 | 0.049 | 32 |
| Greenleaf St | 309 | 25 | 0.141 | 32 |
| Alley | 435 | 15 | 0.33 | 32 |
| Alley | 140 | 15 | 0.106 | 32 |
| Emerson St | 204 | 25 | 0.093 | 32 |
| Alley | 206 | 15 | 0.156 | 32 |
| Alley | 209 | 15 | 0.158 | 32 |
| Church St | 450 | 25 | 0.205 | 32 |
| Church St | 205 | 25 | 0.093 | 32 |
| Davis St | 198 | 25 | 0.09 | 32 |

# Creating a Network Dataset (in ArcCatalog)

1. Create a Personal Geodatabase
2. Create Feature Dataset
3. Import street data from TIGER/Line shapefile
4. Import fire station(s)
5. Create a Network Dataset

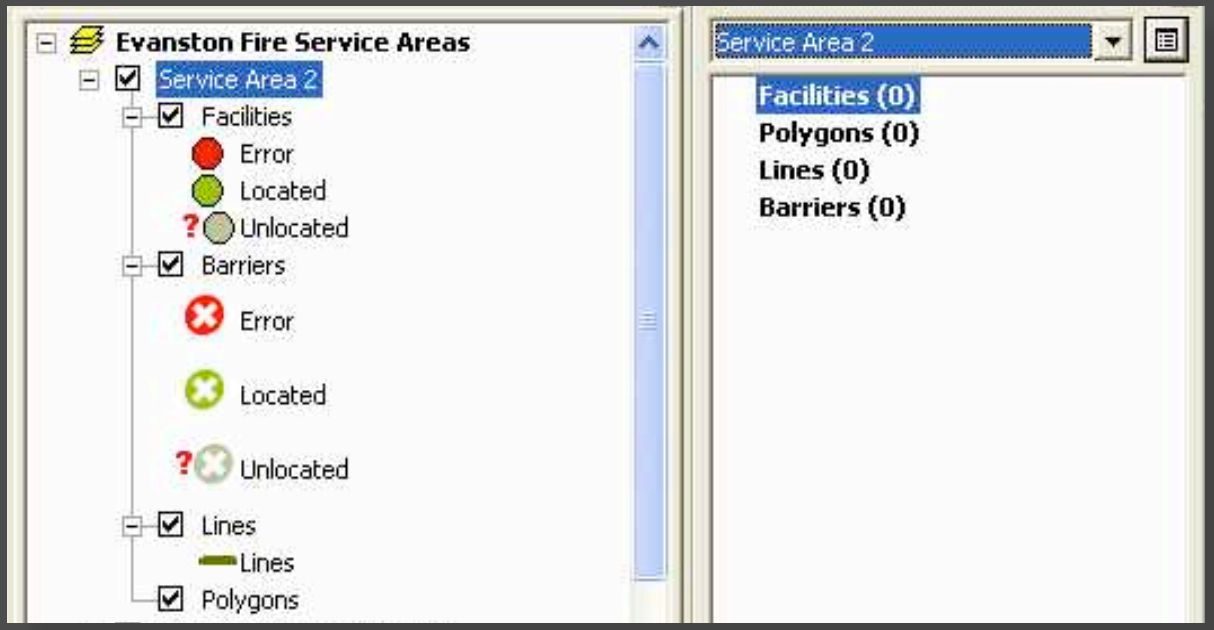


# Creating a Service Area Map (in ArcMap)

1. Import the Network Dataset and related files

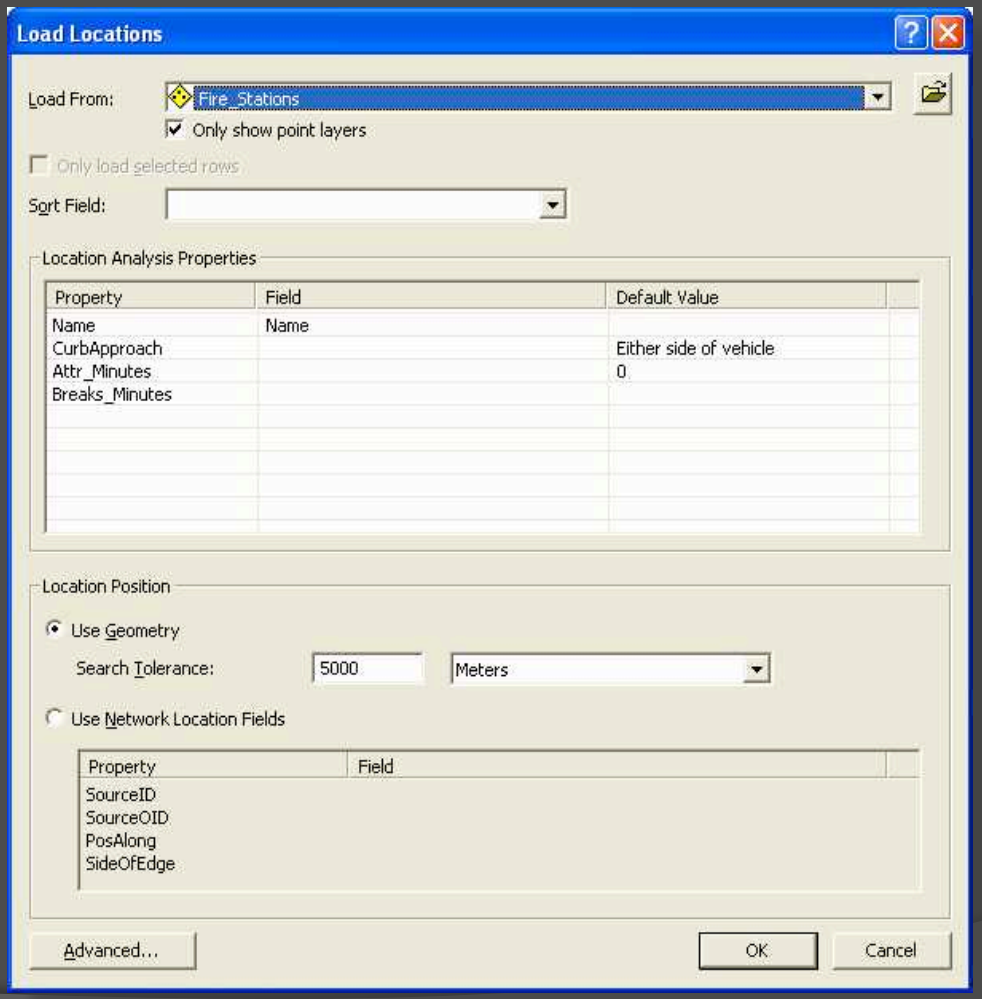
# Creating a Service Area Map (in ArcMap)

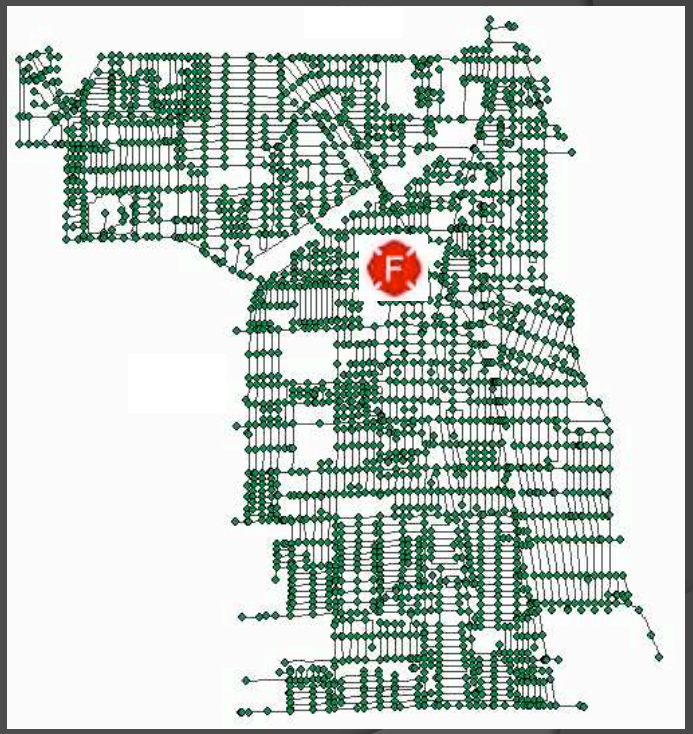
2. Start Network Analyst extension
3. Create a new Service Area



# Creating a Service Area Map (in ArcMap)

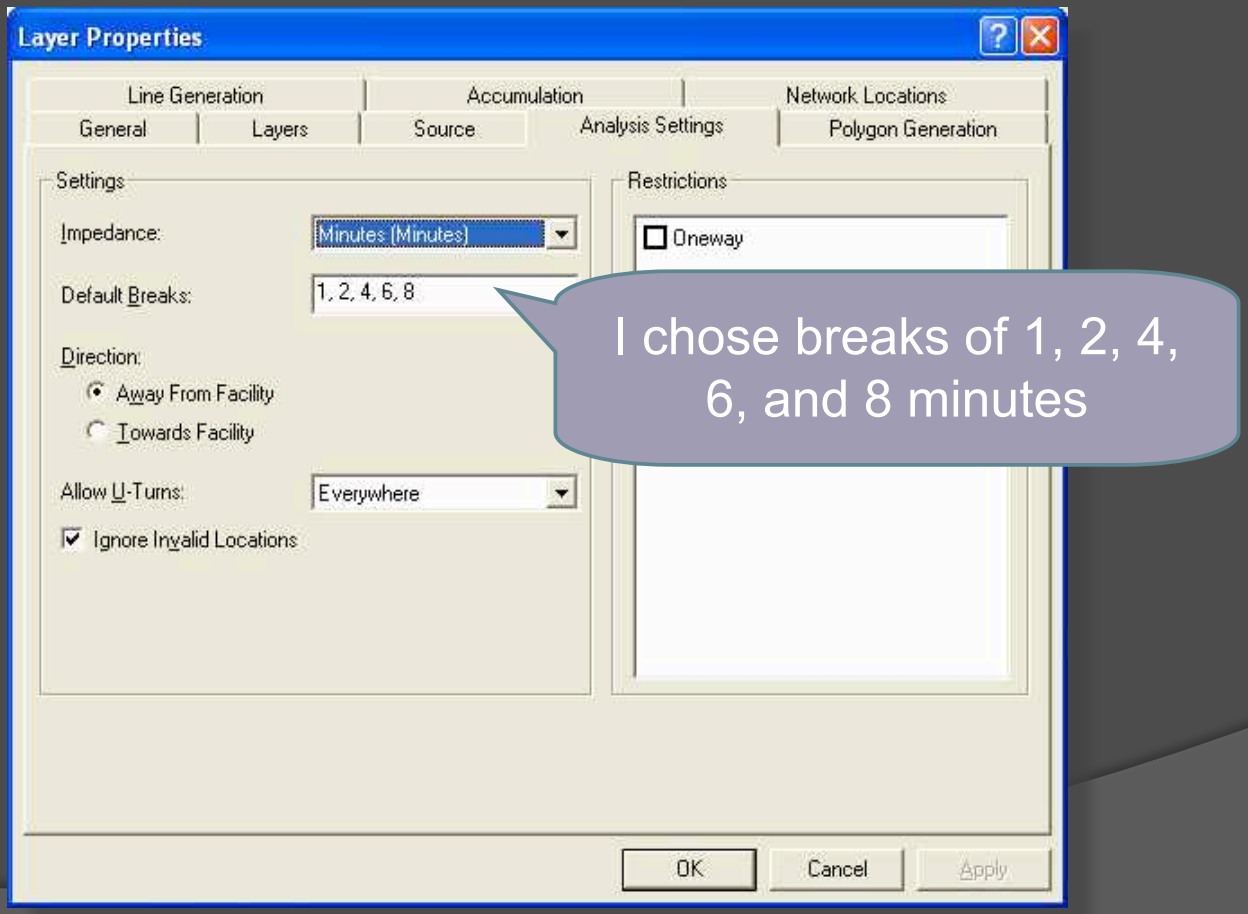
4. Load Locations (the fire stations)



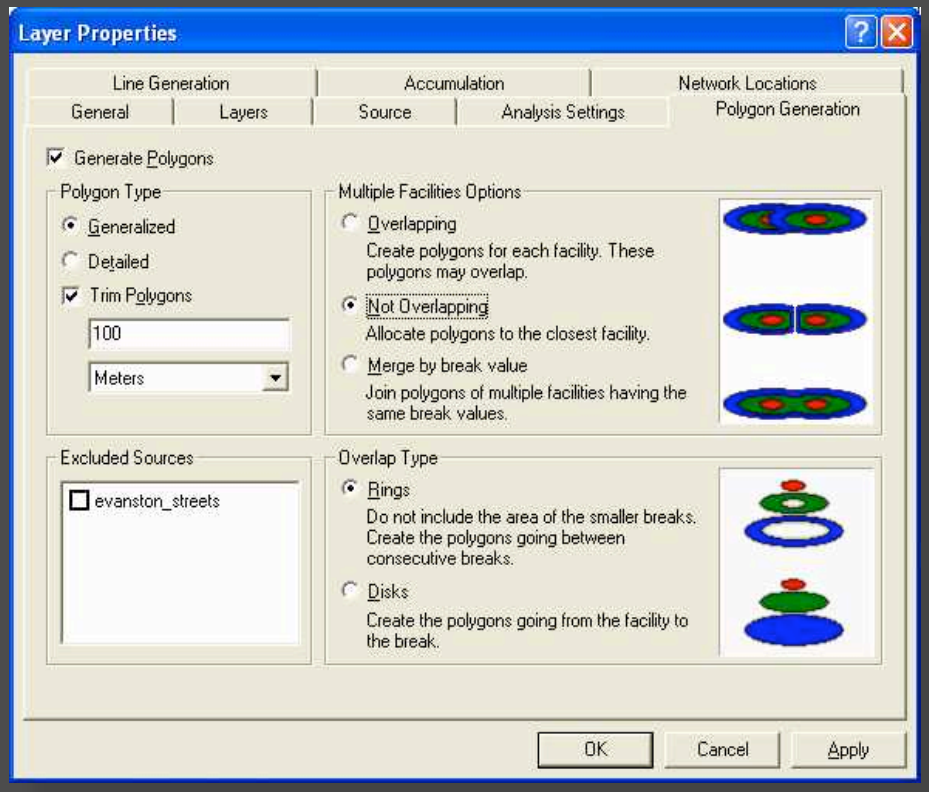
# Creating a Service Area Map (in ArcMap)

5. Enter desired default breaks for travel time ("response time") in the Layer Properties dialog

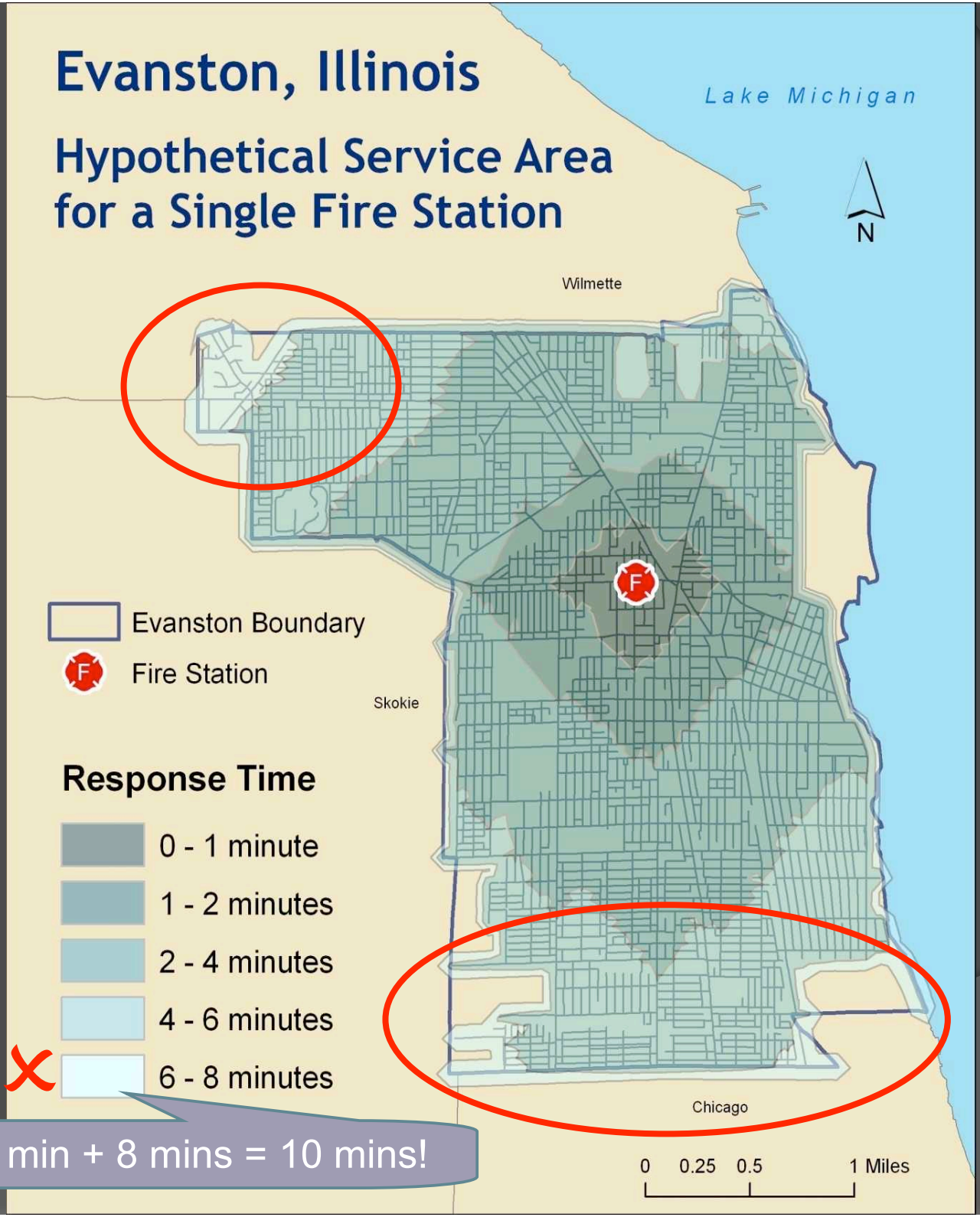


# Creating a Service Area Map (in ArcMap)

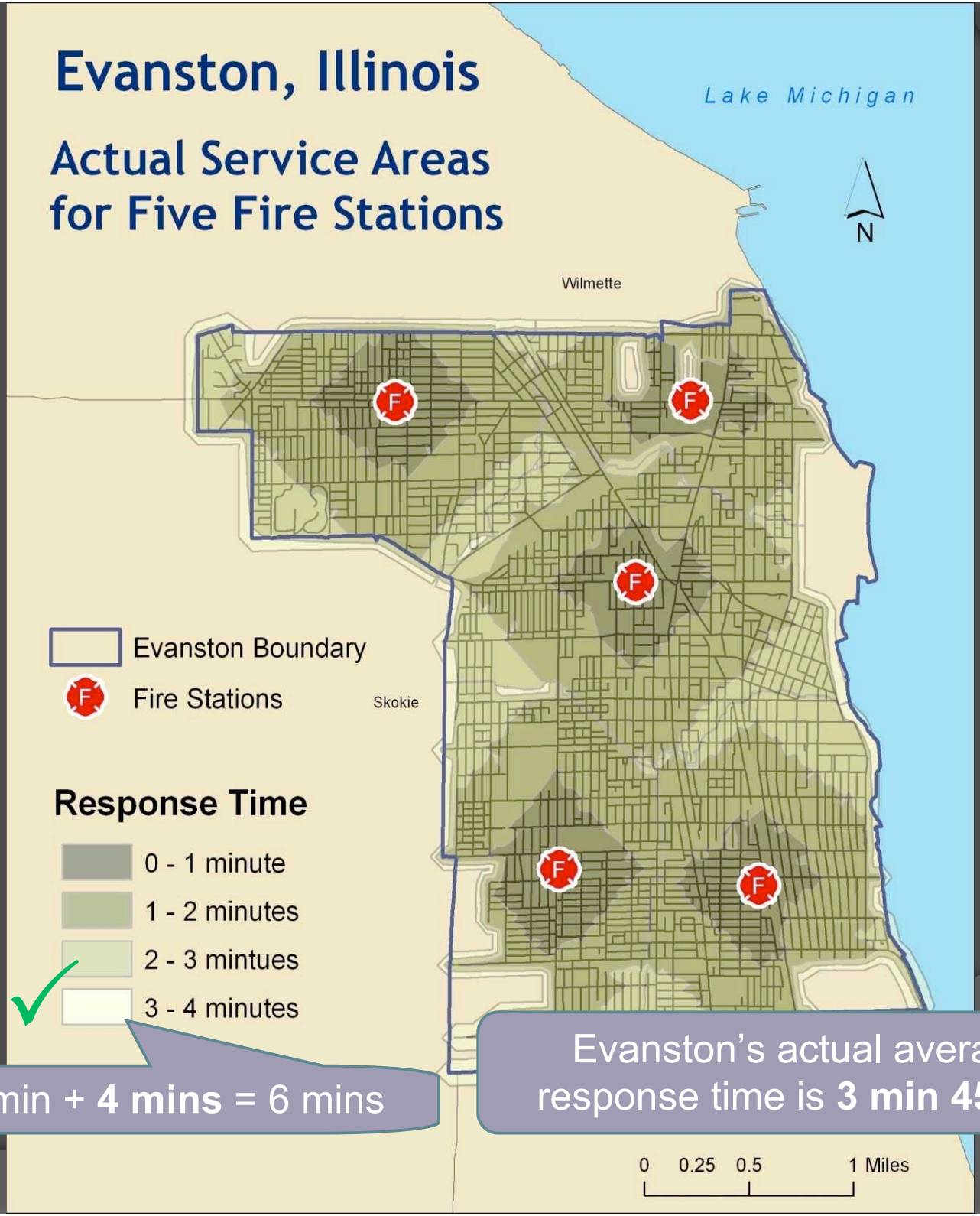
6. Adjust polygon properties (overlapping, etc.) in the Layer Properties dialog




7. Solve the Network!


Evanston, Illinois
Hypothetical Service Area for a Single Fire Station
Lake Michigan
N
Wilmette
Evanston Boundary
Fire Station
Skokie
Response Time
0 - 1 minute
1 - 2 minutes
2 - 4 minutes
4 - 6 minutes
6 - 8 minutes
Chicago
0 0.25 0.5 1 Miles
1 min + 1 min + 8 mins = 10 mins!

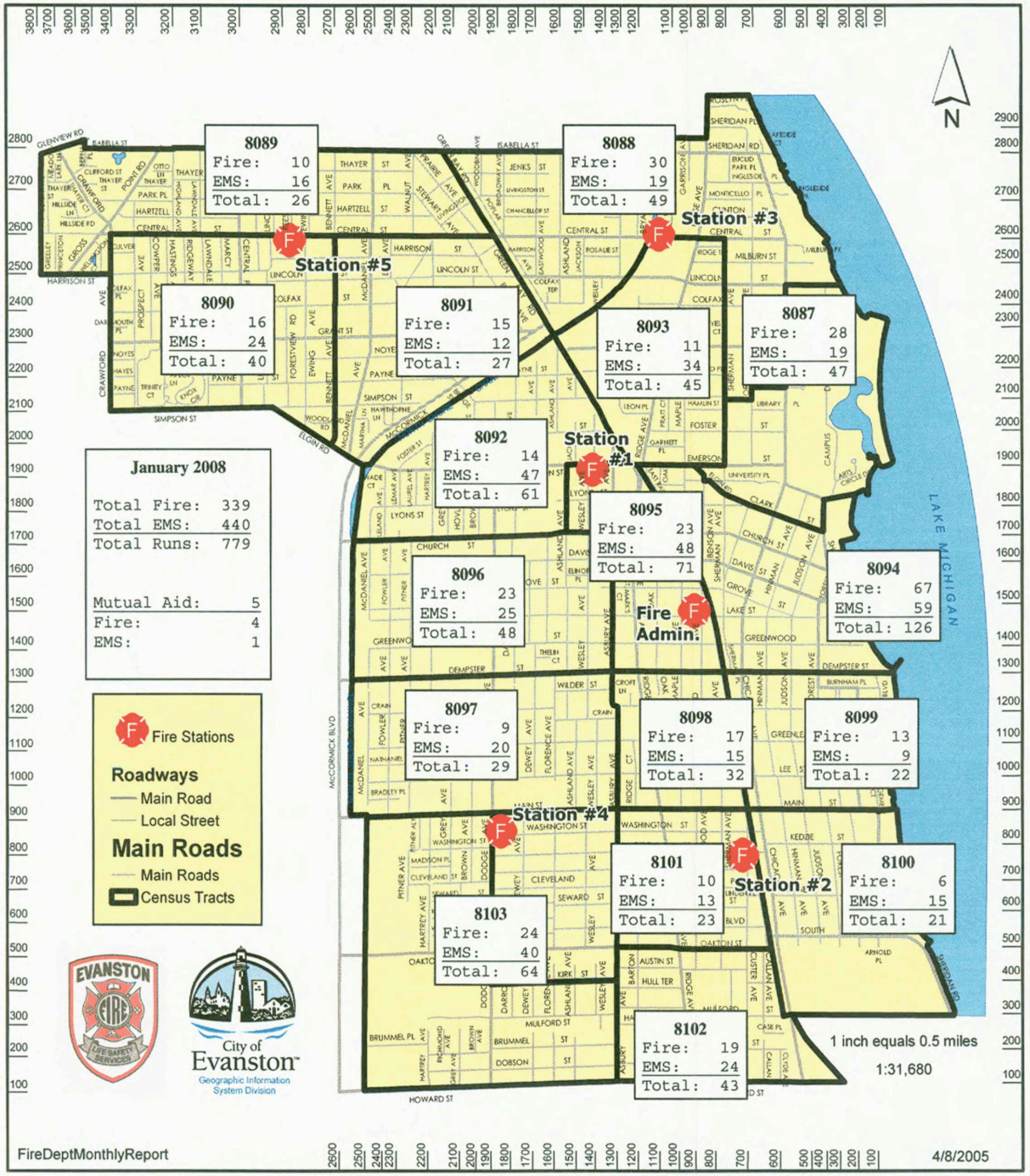

Evanston, Illinois
Fire Station Locations
Lake Michigan
N
Wilmette
Station 5
Station 3
Station 1
Station 4
Station 2
Evanston Boundary
Fire Stations
Skokie
Chicago
0 0.25 0.5 1 Miles


Evanston, Illinois
Actual Service Areas
for Five Fire Stations
Lake Michigan
N
Wilmette
Skokie
Evanston Boundary
Fire Stations
Response Time
0 - 1 minute
1 - 2 minutes
2 - 3 mintues
3 - 4 minutes
1 min + 1 min + **4 mins** = 6 mins
Evanston's actual average response time is **3 min 45 sec**
0 0.25 0.5 1 Miles

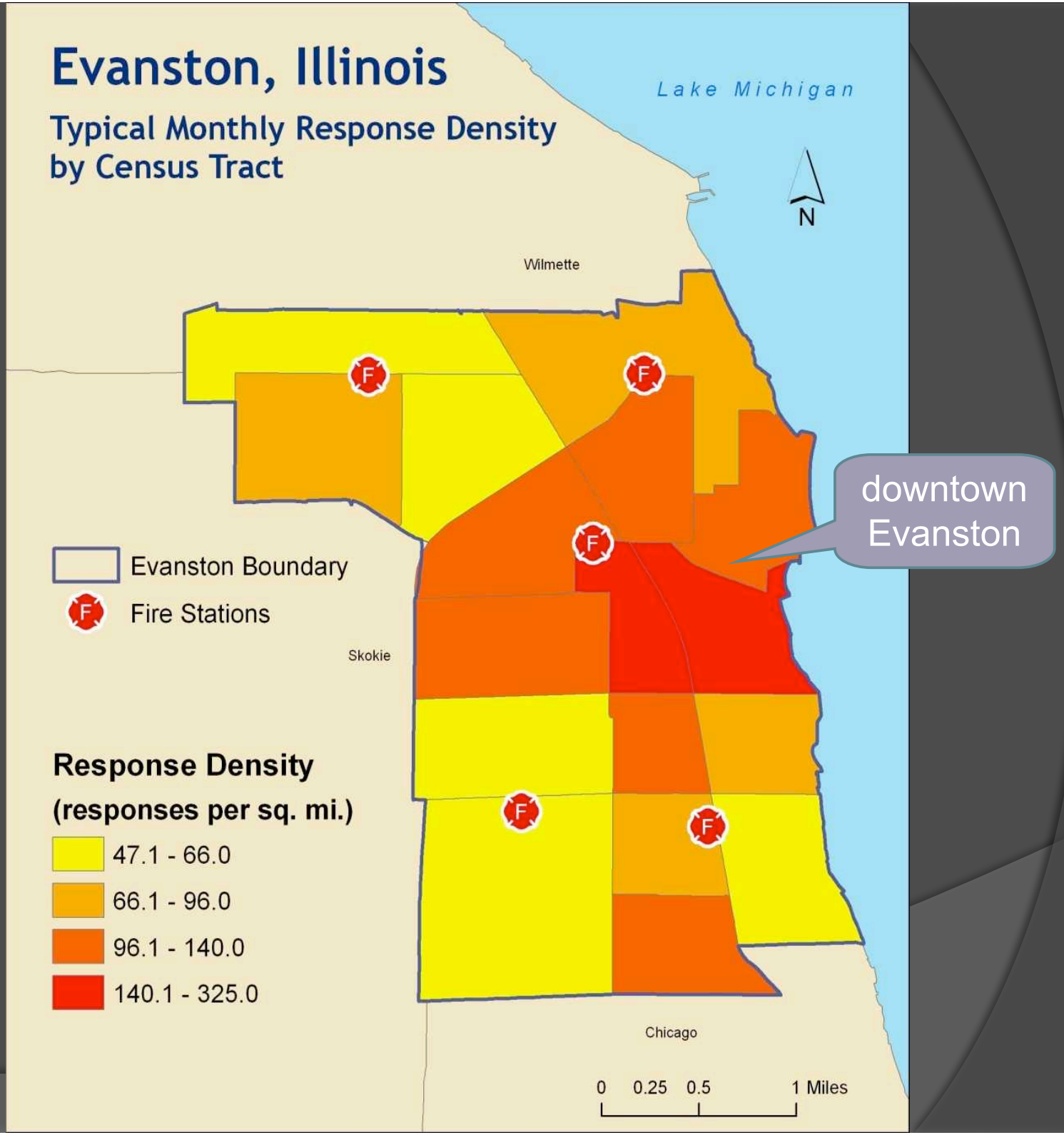
# Other Factors to Consider for Fire Station Service Areas

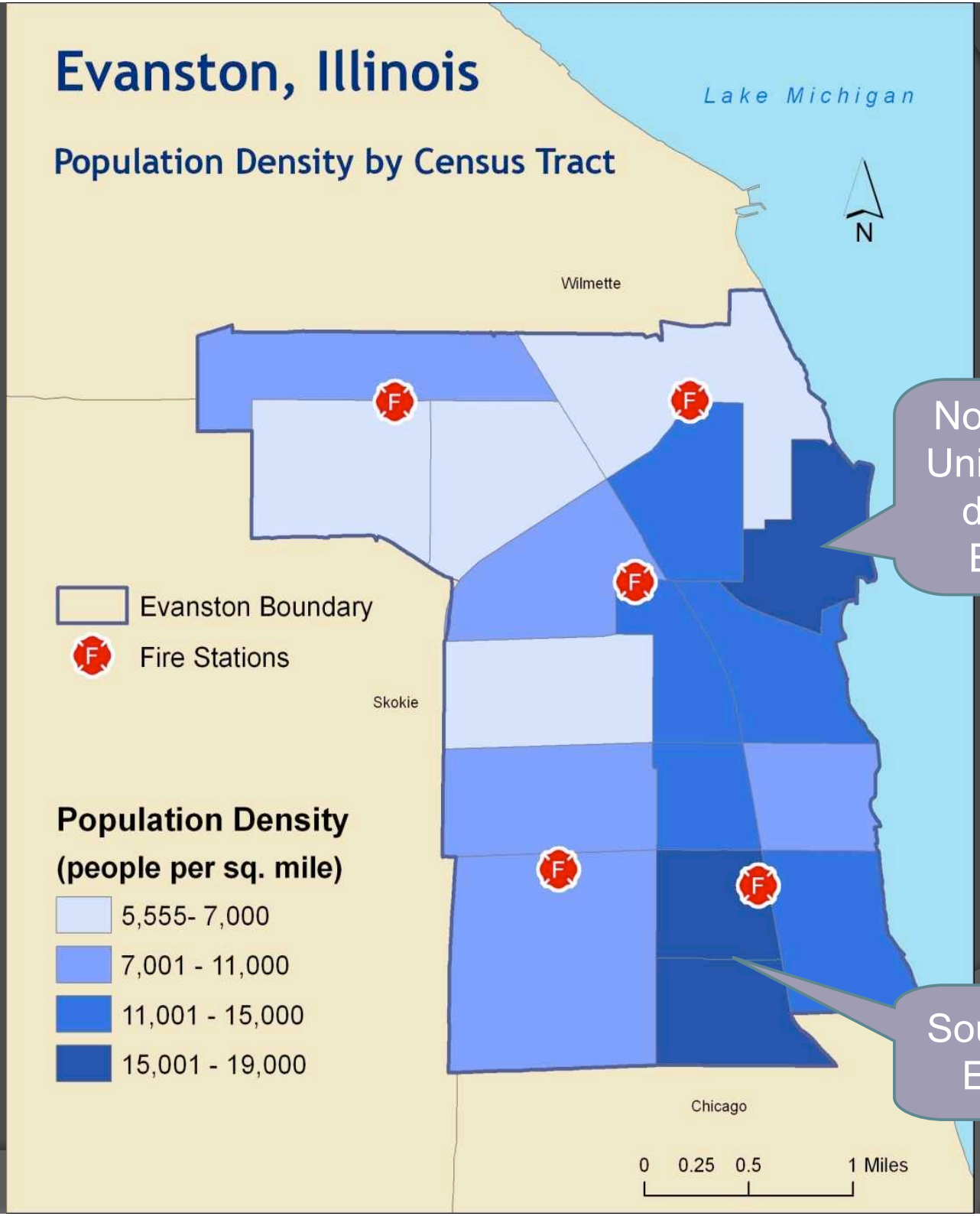
- Response time information is just one aspect of a service area
- Other factors we might consider to fully understand a service area:
  - Population statistics
  - Number of fire/emergency responses
  - Staff and equipment availability

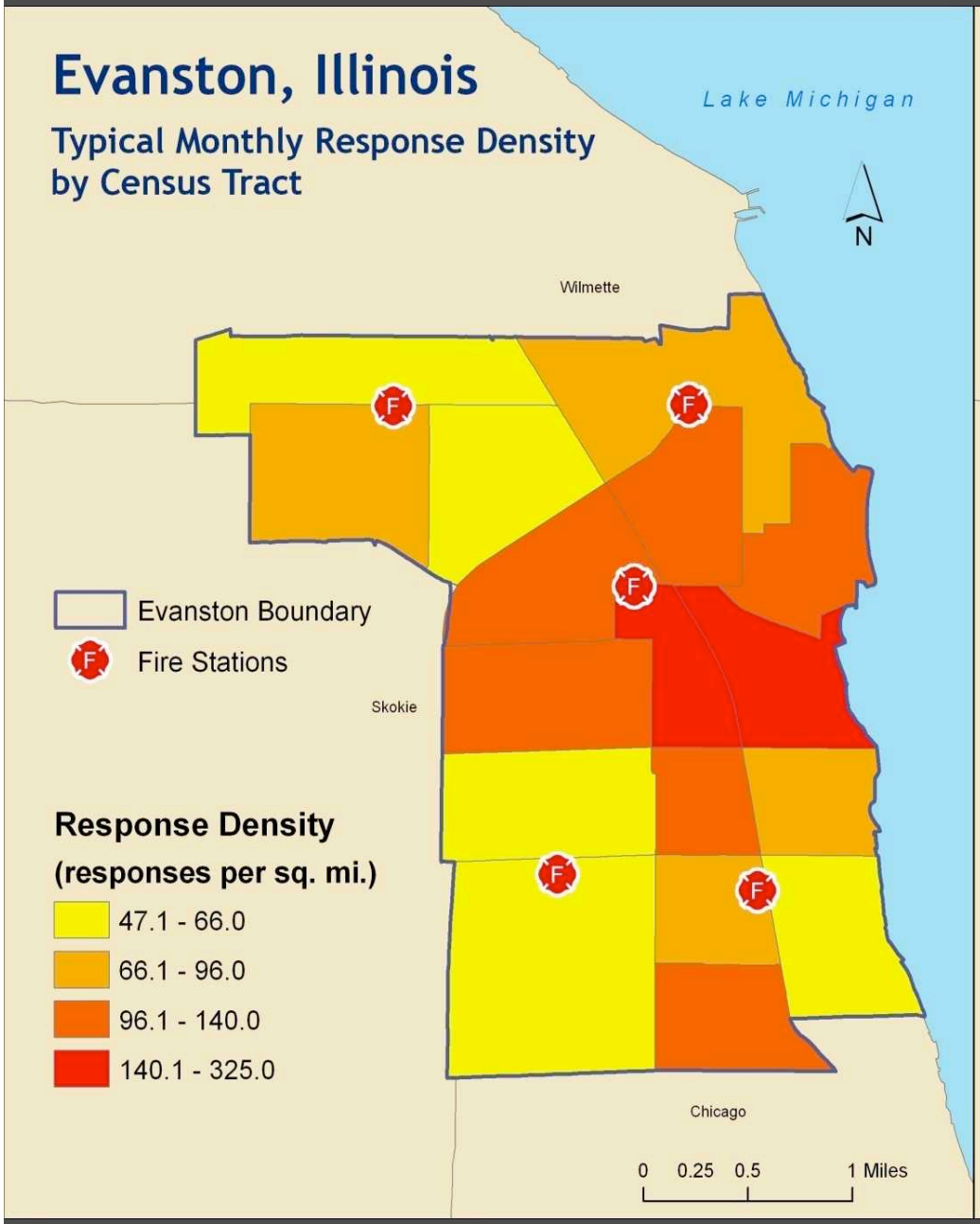
# Evanston Fire and Life Safety Services
# Responses by Census Tract
# January 2008




This map is provided "as is" without warranties of any kind. See www.cityofevanston.org/mapdisclaimers.html for more information.


Evanston, Illinois
Typical Monthly Response Density by Census Tract
Lake Michigan
N
Wilmette
Skokie
Chicago
Evanston Boundary
Fire Stations
Response Density
(responses per sq. mi.)
47.1 - 66.0
66.1 - 96.0
96.1 - 140.0
140.1 - 325.0
0 0.25 0.5 1 Miles
downtown Evanston


Evanston, Illinois
Population Density by Census Tract
Lake Michigan
N
Wilmette
Skokie
Chicago
Evanston Boundary
Fire Stations
Population Density
(people per sq. mile)
5,555- 7,000
7,001 - 11,000
11,001 - 15,000
15,001 - 19,000
0 0.25 0.5 1 Miles
Northwestern University and downtown Evanston
South-central Evanston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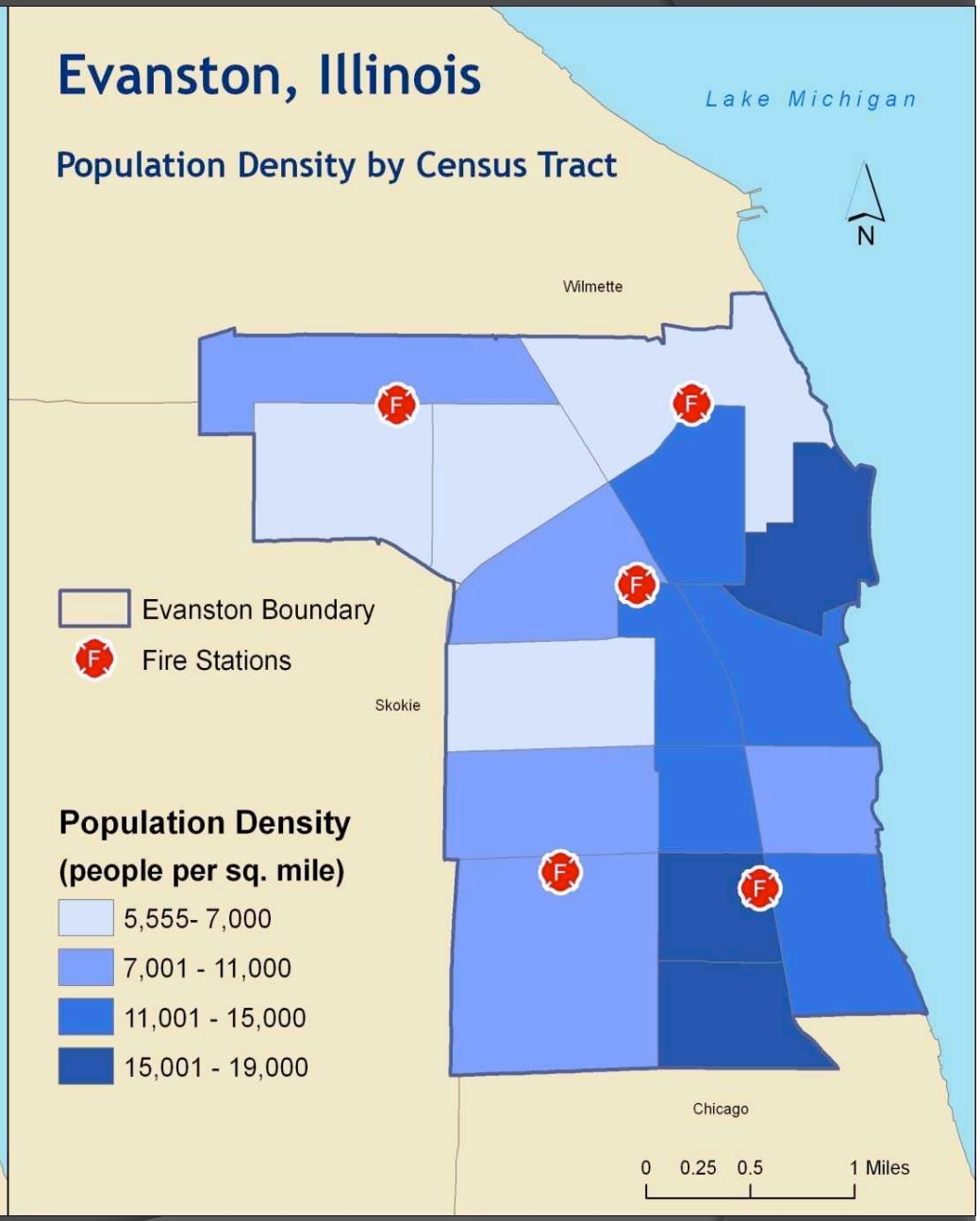
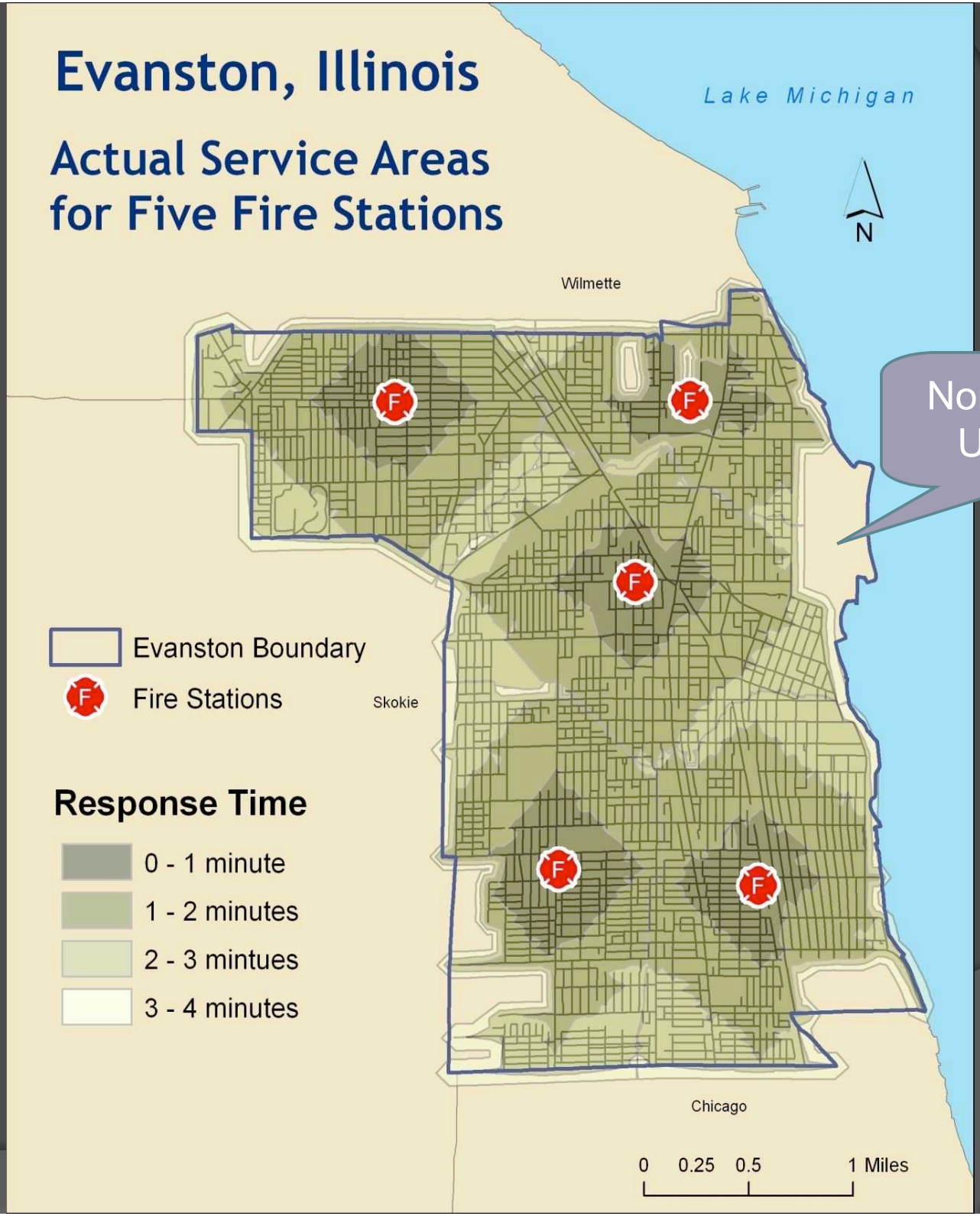
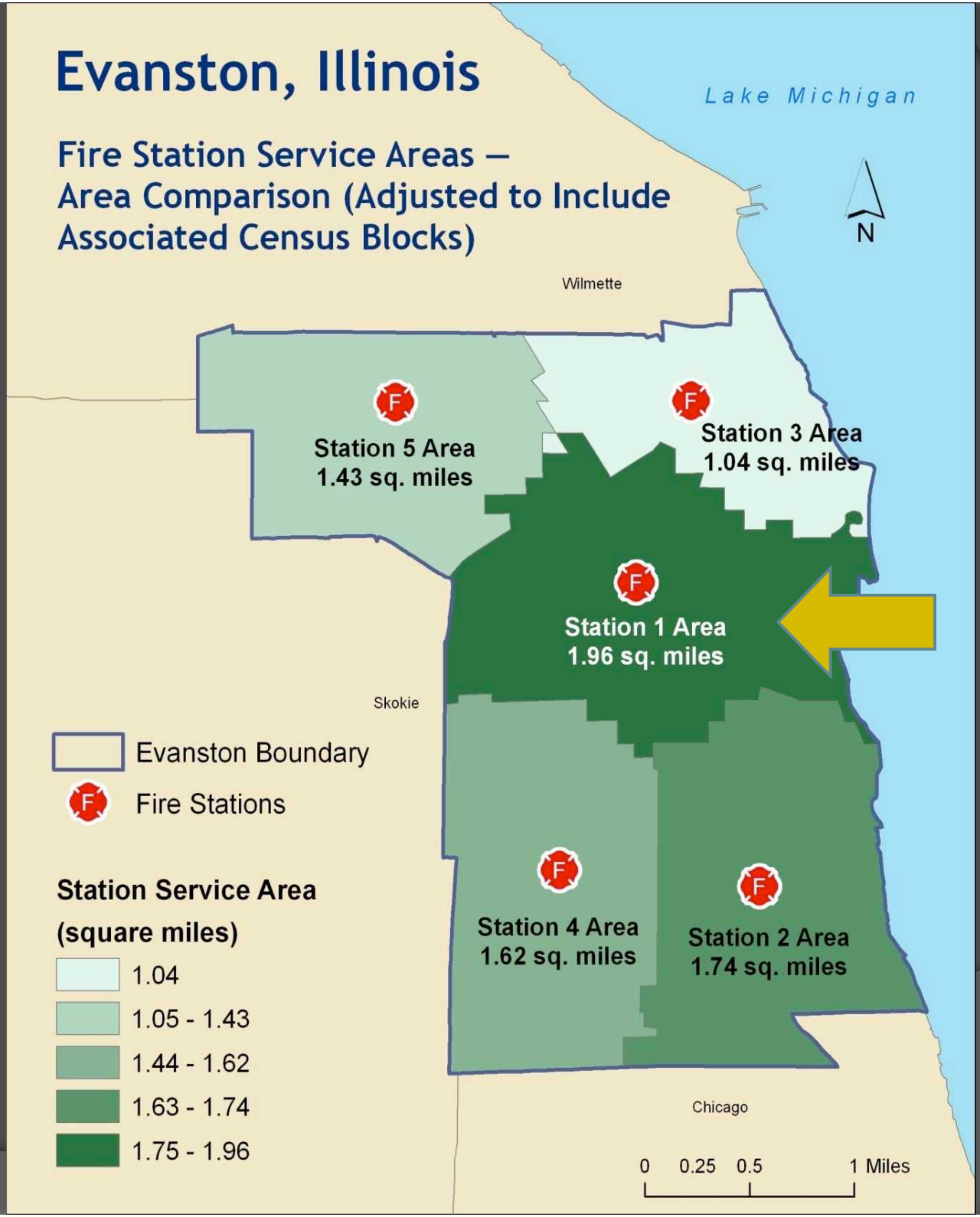
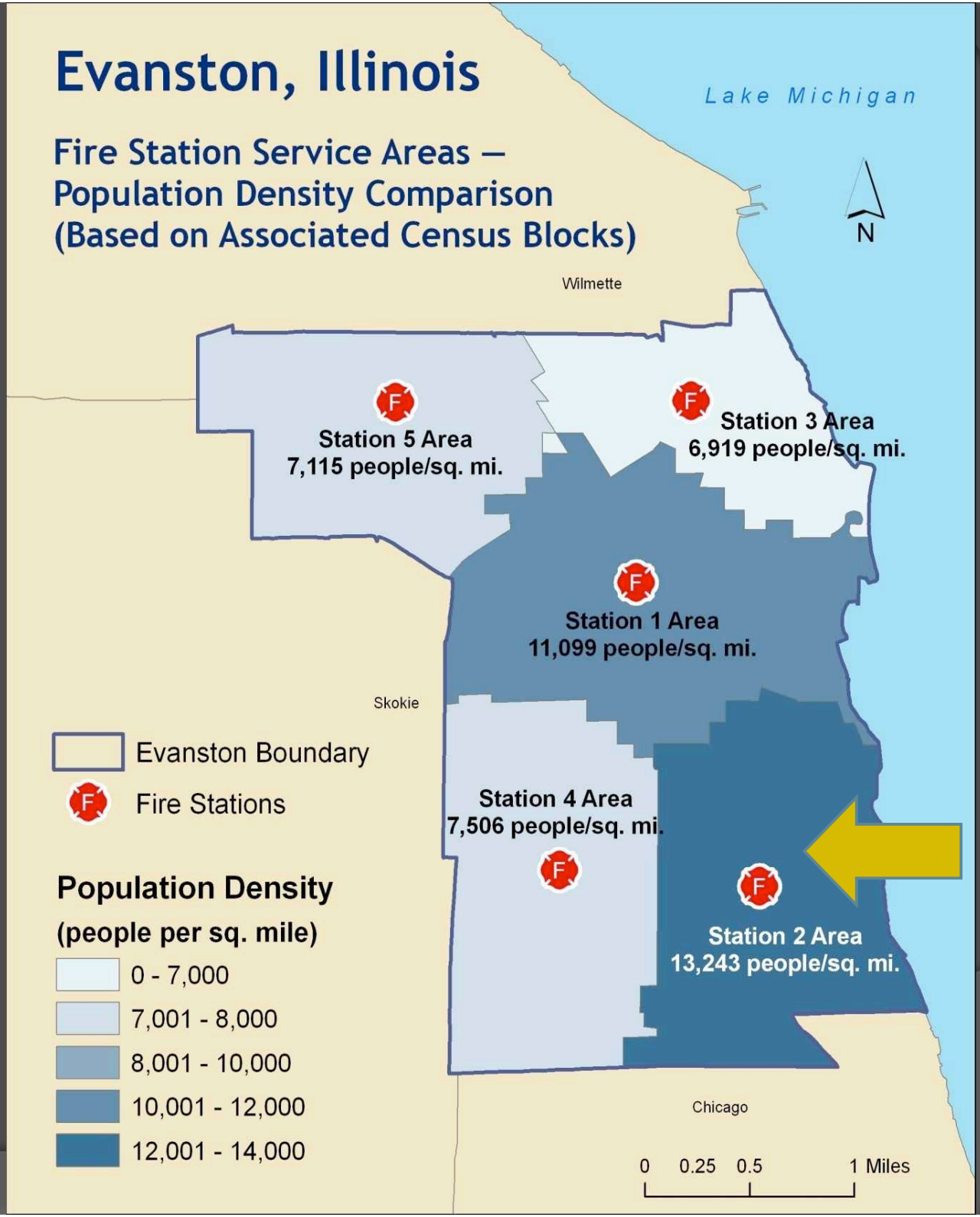
Typical Monthly Response Density by Census Tract
Lake Michigan
N
Wilmette
Evanston Boundary
Fire Stations
Skokie
Response Density
(responses per sq. mi.)
47.1 - 66.0
66.1 - 96.0
96.1 - 140.0
140.1 - 325.0
Chicago
0 0.25 0.5 1 Miles


Evanston, Illinois
Population Density by Census Tract
Lake Michigan
N
Wilmette
Evanston Boundary
Fire Stations
Skokie
Population Density
(people per sq. mile)
5,555- 7,000
7,001 - 11,000
11,001 - 15,000
15,001 - 19,000
Chicago
0 0.25 0.5 1 Miles

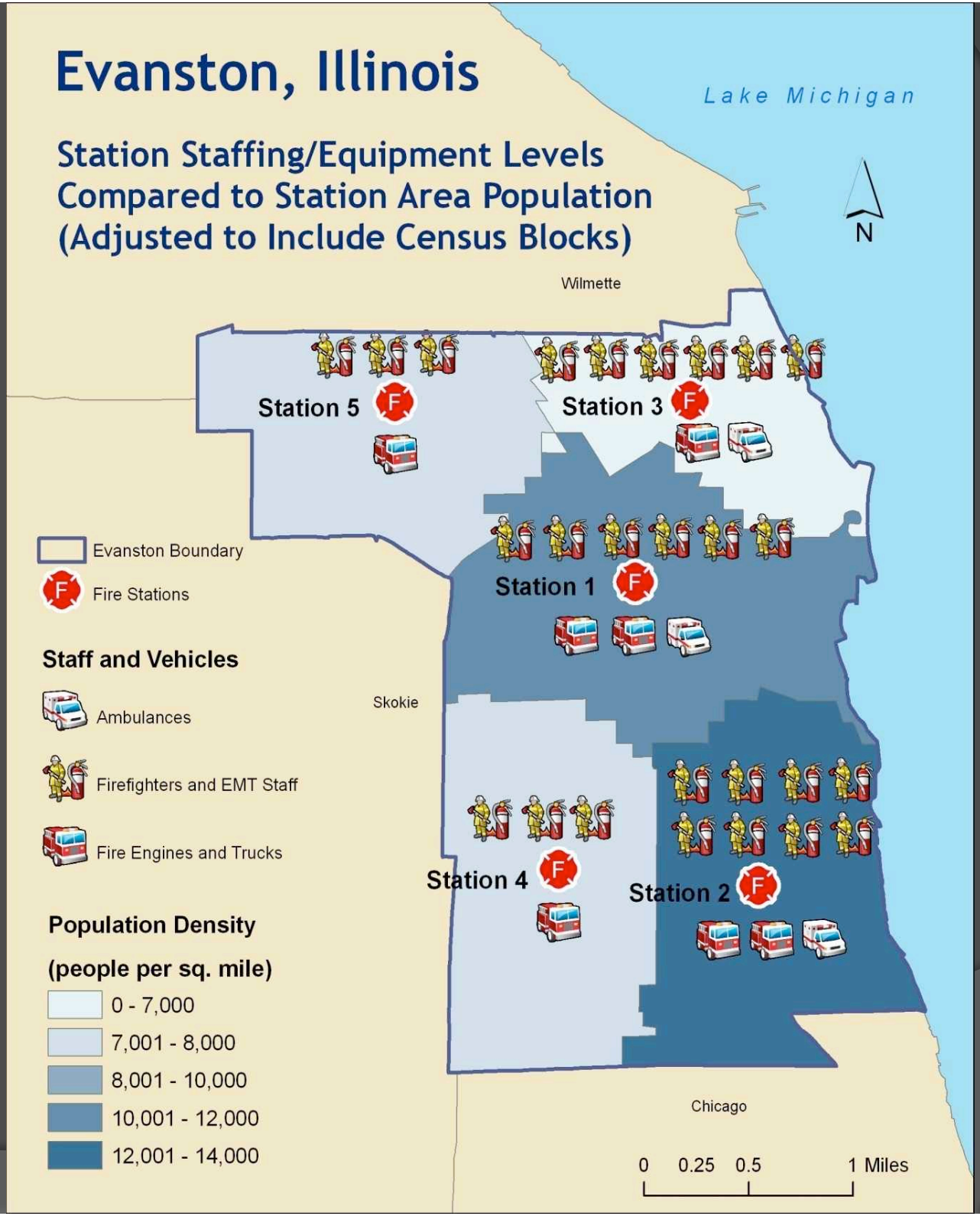

Evanston, Illinois
Actual Service Areas for Five Fire Stations
Lake Michigan
N
Wilmette
Northwestern University
Evanston Boundary
Fire Stations
Skokie
Response Time
0 - 1 minute
1 - 2 minutes
2 - 3 mintues
3 - 4 minutes
Chicago
0 0.25 0.5 1 Miles

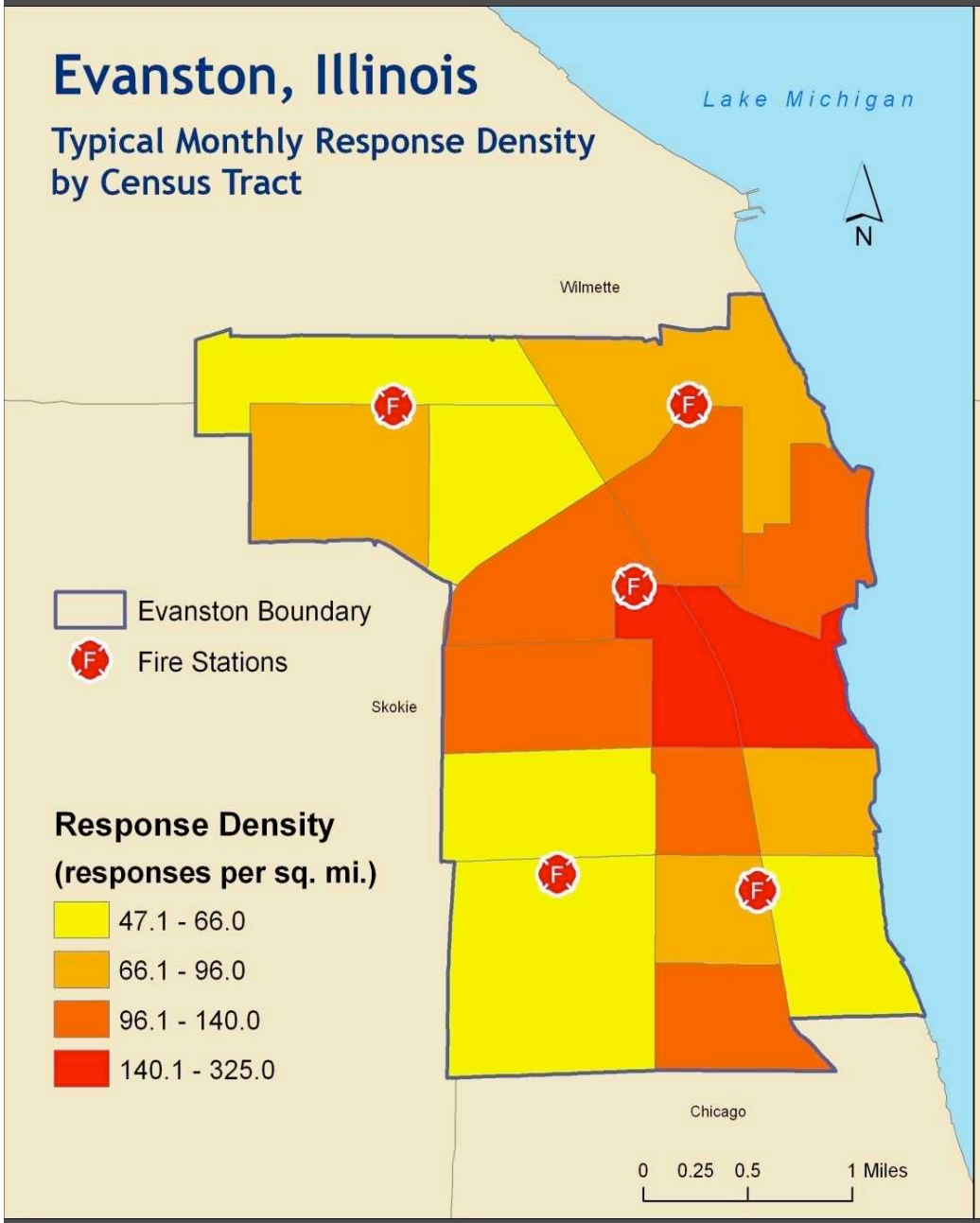

Evanston, Illinois
Fire Station Service Areas –
Area Comparison (Adjusted to Include
Associated Census Blocks)
Lake Michigan
N
Wilmette
Station 5 Area
1.43 sq. miles
Station 3 Area
1.04 sq. miles
Station 1 Area
1.96 sq. miles
Skokie
Evanston Boundary
Fire Stations
Station Service Area
(square miles)
1.04
1.05 - 1.43
1.44 - 1.62
1.63 - 1.74
1.75 - 1.96
Station 4 Area
1.62 sq. miles
Station 2 Area
1.74 sq. miles
Chicago
0 0.25 0.5 1 Miles


Evanston, Illinois
Fire Station Service Areas –
Population Density Comparison
(Based on Associated Census Blocks)
Lake Michigan
N
Wilmette
Station 5 Area
7,115 people/sq. mi.
Station 3 Area
6,919 people/sq. mi.
Station 1 Area
11,099 people/sq. mi.
Skokie
Station 4 Area
7,506 people/sq. mi.
Station 2 Area
13,243 people/sq. mi.
Chicago
Evanston Boundary
Fire Stations
Population Density
(people per sq. mile)
0 - 7,000
7,001 - 8,000
8,001 - 10,000
10,001 - 12,000
12,001 - 14,000
0 0.25 0.5 1 Miles

# Evanston, Illinois

## Station Staffing/Equipment Levels Compared to Station Area Population (Adjusted to Include Census Blocks)

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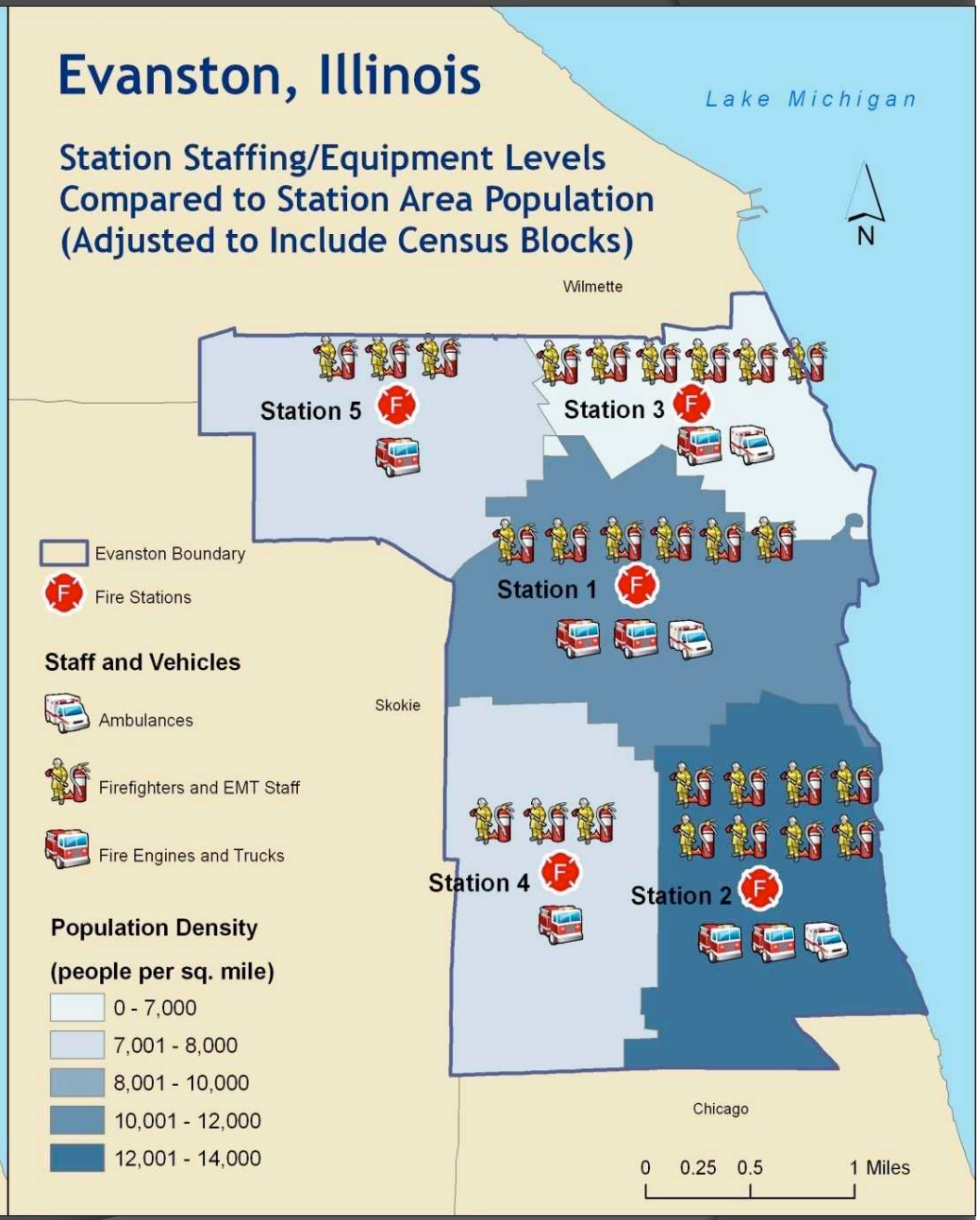
Lake Michigan
N
Wilmette
Skokie
Chicago
Evanston Boundary
Fire Stations
Response Density
(responses per sq. mi.)
47.1 - 66.0
66.1 - 96.0
96.1 - 140.0
140.1 - 325.0
0 0.25 0.5 1 Miles


Evanston, Illinois
Station Staffing/Equipment Levels Compared to Station Area Population (Adjusted to Include Census Blocks)
Lake Michigan
N
Wilmette
Skokie
Chicago
Station 5
Station 3
Station 1
Station 4
Station 2
Evanston Boundary
Fire Stations
Staff and Vehicles
Ambulances
Firefighters and EMT Staff
Fire Engines and Trucks
Population Density
(people per sq. mile)
0 - 7,000
7,001 - 8,000
8,001 - 10,000
10,001 - 12,000
12,001 - 14,000
0 0.25 0.5 1 Miles

# Implications for Service Areas

- Increases in response time could be used to justify increases in staff or equipment
- Decreases in response time might be used to justify staff cuts or even the elimination of a station
- If staff are cut, the trade off would be longer response times, so any staff reductions would be controversial

# Conclusion

- Service area analysis is a valuable tool for calculating ideal response times and station locations
- Actual response times should be logged and monitored over time to see if they vary from the ideal response times in the original plan
- Decisions about staffing and equipping fire stations can be based on response time data, but other factors should be considered (e.g., population density and distribution, community needs, neighboring services)

# Sources


- City of Evanston. 2010. http://www.cityofevanston.org/
- Dedman, Bill. 2005. “Deadly Delays: The Decline of Fire Response,” *Boston Globe*. Jan. 25, 2005.
- ESRI. 2007. “GIS for Fire Station Locations and Response Protocol.” Redlands, California: ESRI.
- FireBureau. 2010. http://www.firebureau.com/
- Park, Katie. 2010. “City, Northwestern offer incentives for completing 2010 census forms.” *The Daily Northwestern*. March 30, 2010.
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