Station Location Study

Lincolnshire Riverwoods Fire Protection District

2018

Created by: Illinois Fire Chiefs Association

Lincolnshire Riverwoods Mission Statement:

The Lincolnshire-Riverwoods Fire Protection District is dedicated to providing extraordinary **SERVICE** to those in need, through the highest levels of professional **COMPETENCY**, doing all things with **INTEGRITY** while focusing on providing exceptional **VALUE**.

Terms of Use

Our Mission:

The IFCA Consulting Team's mission is to support your organization's mission by providing you with a forward-looking perspective.

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The Illinois Fire Chiefs Association created the following Station Location Analysis to provide statements of findings for the Lincolnshire Riverwoods Fire Protection District (LRFPD). By using nationally recognized and accepted standards for data collection and analysis, the report findings are of quantitative data allowing the Lincolnshire Riverwoods Fire Protection District to make strategic data-driven decisions and recommendations. Historical incident data was used to measure the agency's emergency services performance and compare it to NFPA 1710 standards, ISO standards, and CPSE recommendations as well as project performance in a fire station relocation scenario.

The IFCA Team analyzed the 8,025 responses within the Total Response Area (TRA). The data provided insight into the call volume distribution for each fire station. Station 51 responds to sixty-one percent of the total call volume for the TRA, with Station 52 at twenty-two percent and Station 53 at seventeen percent. Although Station 51 responds to a large percentage of overall calls for the District, its unit hour utilization (UHU) falls well within the standard at the ninetieth percentile of commit times at 0.23.

Theoretically, the LRFPD (in the current station configuration) is capable of reaching only 67 percent of its calls for service in their TRA within the NFPA standard of four minutes drive time. However, of the sixty-seven percent, they are arriving on the scene within the four-minute standard ninety-three percent of the time for fire response and eighty-nine percent of the time for EMS.

The IFCA applied modeling tools to identify ideal station locations for the TRA. Based upon the evaluation of response data it is recommended that the LRFPD maintain a three fire station response model to maximize efficient response to all incidents occurring within the TRA. Several models were used to determine the most optimum locations for fire station placement. The data revealed several options for the LRFPD to consider if (when) relocating fire stations. The recommendation identify the most efficient overall performance.

<u>Model #1</u> (Station 52 Relocation West)
Relocating Fire Station 52 west to an available site and maintaining the current location of Stations 51 and 53. This model would bring Station 52 back into the LRFPD boundaries and improve the total incidents served within Station 52's AOR from sixty-seven percent to seventy-eight percent within the NFPA time standard of 4-minute travel standard. All incident response times for the entire TRA would improve (decrease) as well at the ninetieth percentile by 1 minute and 14 seconds, from 7:17 to 6:43. Analyzing the new location and response area of Station 52 realizes an improvement of 1:27 seconds at the ninetieth percentile.

Model # 2 (Station 51 relocation South on Milwaukee Avenue just North of Estonian Lane; Station 52 and 53 remain in current location.)

This model configuration increases the 4-minute coverage area by just under 1 square mile. Therefore, encompassing 8% more incidents (636 more requests for service than leaving Station 51 in its current location). Historically, there is an improvement in response times for all incidents within the TRA with this configuration over leaving Station 53 and 52 in place (1:08). However, relocating Station 51 south from its current location yields a slight increase in response time (0.06). Predicted fire response times increase by almost 1 minute, while EMS response times remain relatively unchanged.

Model Recommendation

After analyzing the data of the two models, the IFCA Consulting Team recommends **Model #1** station configuration - relocating Station 52 west to the available site on Milwaukee Ave would improve the response times and coverage as well as bringing the Station back into the LRFPD boundaries, illustrating the increased efficiency of the LRFPD to respond to more incidents in less time.

The following report is an evaluation of the station locations by the Illinois Fire Chiefs Association Consulting Team. This report serves as a brief snapshot of ongoing service delivery to the citizens and visitors of the community. Our assessment will provide a guide to measure progress towards nationally recognized standards of service.

While standards exist, it is the commitment and resources of the community that must be evaluated against the threat of risk within the community. There are three concepts that come into play: adequacy, reasonable costs and acceptable risk. Each agency and community will define this for its own locale.

First, adequate fire protection should look at "optimal" levels which consider need and funding, versus "minimal" which may not meet needs, and "maximal" which may not be affordable.

Second, in defining reasonable costs, the community must look not only at the cost of the fire department but also at the cost of fire losses (deaths, injuries, property, tax revenues) and built-in fire protection (sprinklers) and EMS services. Costs beyond what the community is willing to bear can be deferred to property owners.

Third, and maybe most importantly, each agency and community must define its "acceptable level of risk" or the loss it will accept because resources are not unlimited. To adequately define the level of risk, the agency should develop a written Standards of Cover for service. This will be explained later in this report.

When evaluating service levels, the Team looks at the most common functions of fire protection agencies:

- Fire suppression and life safety
- Emergency Medical Services (ALS, BLS, First Responder)
- Specialized emergency and disaster services (Rescue, Hazardous Materials, Water Rescue, Technical Rescue)

In November 2017, the Lincolnshire Riverwoods Fire Protection District (LRFPD) contracted the Illinois Fire Chiefs Association Consulting Service ("TEAM") for an independent study to determine the efficacy of the current fire station locations within the boundaries of LRFPD and to project "potential" location changes and service delivery outcomes related to those changes.

The purpose of this project is to conduct a station location and performance analysis to determine the feasibility of adding or moving fire station locations and staffing needs for the purposes of increasing the effectiveness and efficiency of fire, emergency medical and specialty response services' delivery for the LRFPD.

The Consulting Team worked with various department heads for the LRFPD to collect data and to further identify additional departmental resources related to the study. With their assistance and the support of their administrative staff, the Team collected both soft information and hard data to evaluate against national standards. Staff expressed their opinions and judgments relating to the issues being studied by the Team.

The Consulting Team commends the LRFPD team for their open access and high level of support in providing the requested information in a timely manner.

This study will achieve multiple objectives:

1. Identification of strengths and weaknesses of current station locations.
2. Determining adequacy of fire station location and future placement of fire facilities. This validated the best possible fire/EMS response based on location to the nearest station. It will guide the District with future plans on response deployment efficiencies.
3. The performance of the response districts in correlation to the call density for optimum performance.

Organization Of The Fire Department

The Lincolnshire Riverwoods Fire Protection District has three staffed stations located throughout the district. The department's current staffing level is 41 career personnel; 39 of those are assigned to a 24/48 hour shift.

Station 51 (Headquarters Station)
115 Schelter Road, Lincolnshire
Staffing (full)
Battalion Chief
A51: 2 personnel
A51(R): 2 personnel
T51: 2-3 personnel

Fire Station 52
855 Saunders Road, Riverwoods
Staffing (full)
E 52: 2 personnel
A52: 2 personnel

Fire Station 53
671 Woodlands, Vernon Hills
Staffing (full)
E 53: 2-3 personnel

Over the past 100 years, various methods have been used to evaluate fire protection agencies. The majority of these originated with the insurance industry to protect property due to the devastating fires of the late 1880s. Insurance ratings started with the National Board of Fire Underwriters and the American Insurance Association, which merged in 1971 into the Insurance Services Offices, Inc. (ISO).

In evaluating a fire protection agency, the IFCA Consulting Team looks at applicable federal, state and local regulations and nationally recognized standards. The purpose of this is to follow guidelines that meet the latest protocols on fire protection to have legally defensible positions. National standards are "minimum" standards and should be defined as the least needed to be done. It is certainly responsible and practical to consider the actual community needs and go beyond the minimum recommendations when necessary.

The IFCA Consulting Team typically would use three (3) nationally recognized models, as well as the current National Fire Incident Reporting System (NFIRS) data for evaluation of fire department. These are the Insurance Services Office (ISO), the National Fire Protection Association (NFPA), the Center for Public Safety Excellence (CPSE). They each offer a unique but complementary prism to view effective fire department operations.

Response time is a calculated measurement used to determine fire department effectiveness in responding to emergencies. There is a direct correlation between response times to fires and the outcome of those fires on life and property loss.

Response times to EMS incidents are just as important as they constitute approximately 70% of calls to which the fire department responds. Generally, EMS response time parameters are based on recommendations issued by organizations such as the American Heart Association (AHA), American Medical Association (AMA) and American Association for the Surgery of Trauma (AAST). These organizations recommend the initial arrival of EMS within six minutes. According to the AHA, brain death begins to occur within four to six minutes after an individual stops breathing or sustains cardiac arrest. It is also indicated that a patient's chance for survival decreases 7 to 10% for every minute that passes without medical intervention in these instances.

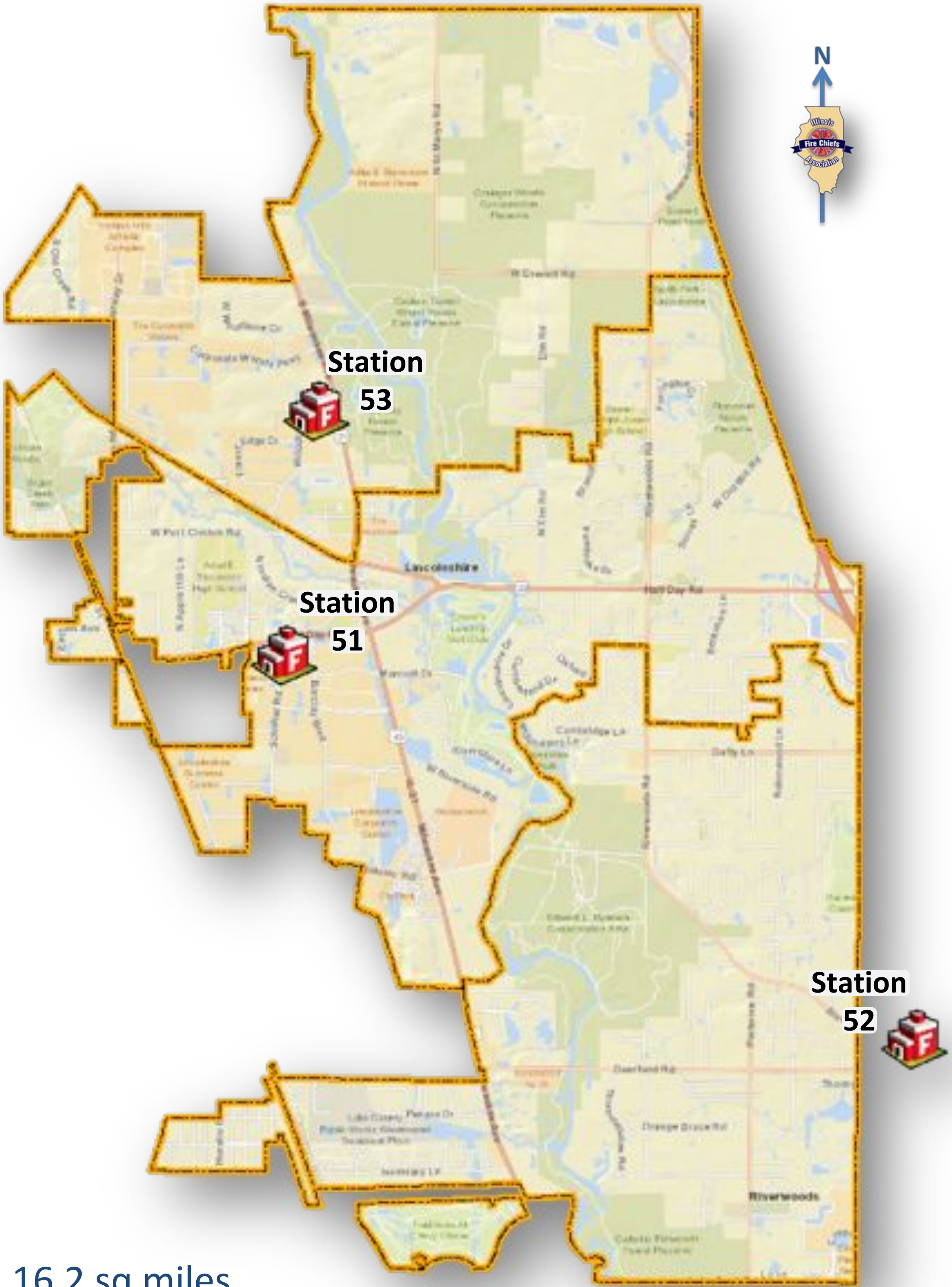
An effective response force as defined by CPSE, is the minimum amount of staff and equipment that must reach a specific emergency zone within a maximum prescribed travel or driving time that is capable of initial fire suppression, EMS and /or mitigation. Key time factors used to study the response are: alarm notification, call processing, turnout, travel, arrival on scene, initiation of action, and termination of incident. Each of these components is measurable and is used to objectively and quantitatively analyze the relationship between existing and new fire station locations.

National Fire Protection Association Standard 1710 (*Standard for the Organization and Deployment of Fire Suppression and Emergency Medical Operations, 2004 edition*) recommends the Fire Department should establish time objectives that include tracking ***Response Time*** using the sum of ***Turnout Time + Travel Time.*** The Standard also recommends that the department should identify a performance objective of not less than 90 percent for the achievement of each response time objective.

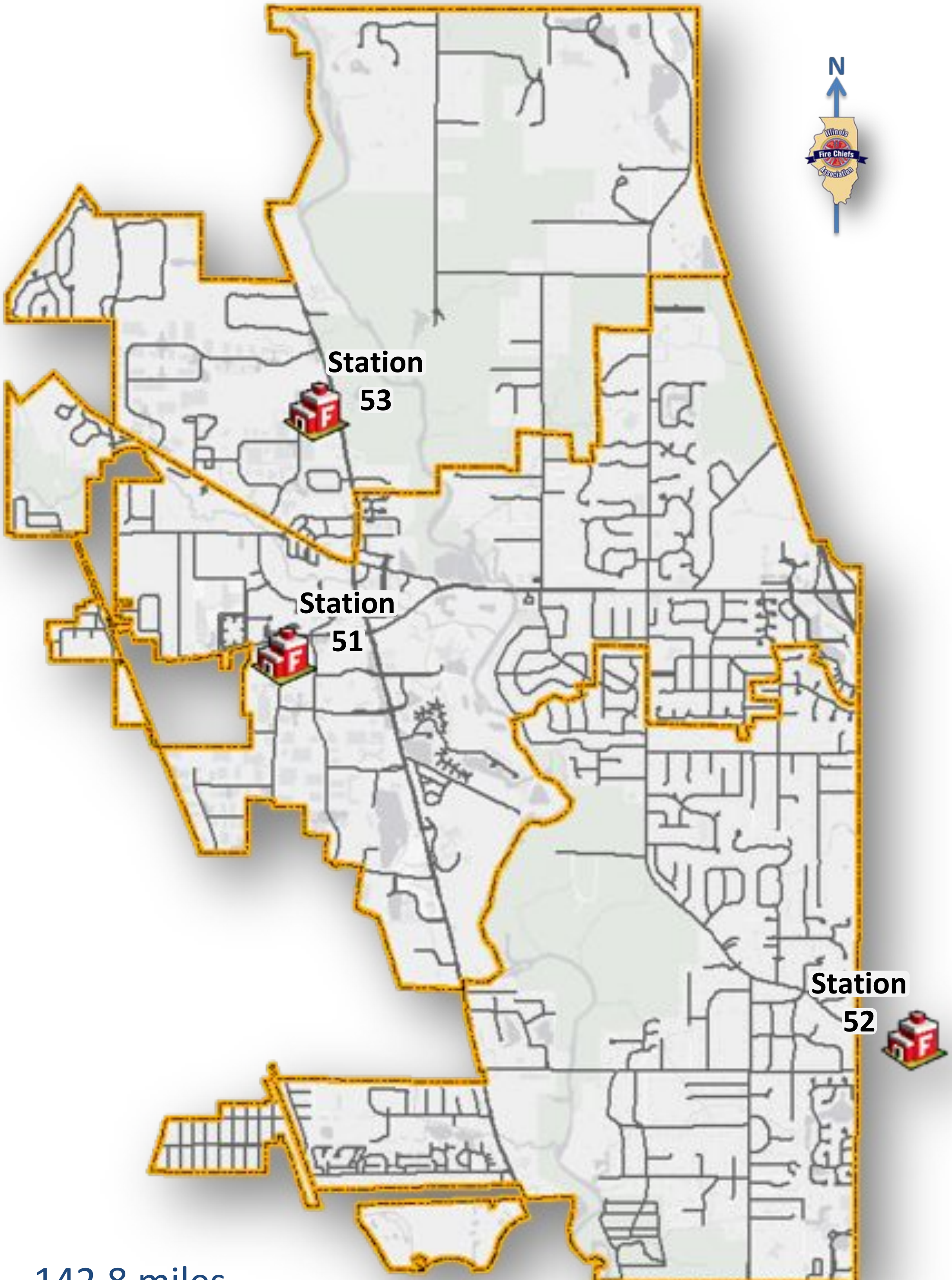
In support of NFPA 1710, but more detailed in their calculation of response time, the Center for Public Safety Excellence (CPSE) identifies a third element in the calculation of the overall response time. The Commission recommends that the sum of the response time include the **Alarm Processing Time**, which is the time it takes for the dispatcher to answer the 911 emergency call to the point at which the responding agency is notified (i.e., "toned out"). In many incidents, dispatchers are not moving the information in a timely manner to the responding agency, which increases the chance of losing lives and property. Dispatch processing time and turnout time can add an additional two to three minutes. Consequently, the unit's response time may be two to three minutes longer from the point when the call for assistance was received. Therefore, the Commission identifies ***Response Time*** to include the ***Alarm Processing Time + Turnout Time + Travel Time*** to the point when the unit arrives on the scene**.**

Fire Station Basics and Response Evaluations

Jurisdiction Area
Transportation



TRA: 16.2 sq miles
Station 51: 6.0 sq. miles
Station 52: 5.2 sq. miles
Station 53: 5.0 sq. miles



TRA: 142.8 miles
Station 51: 65.3 miles
Station 52: 48.5 miles
Station 53: 29.0 miles

Area Served by Drive Time

TRA 4 & 8 Minute Catchment

Streets Covered by Drive Time

Station 51 Area and Streets by Time

TRA Coverage - Station 51

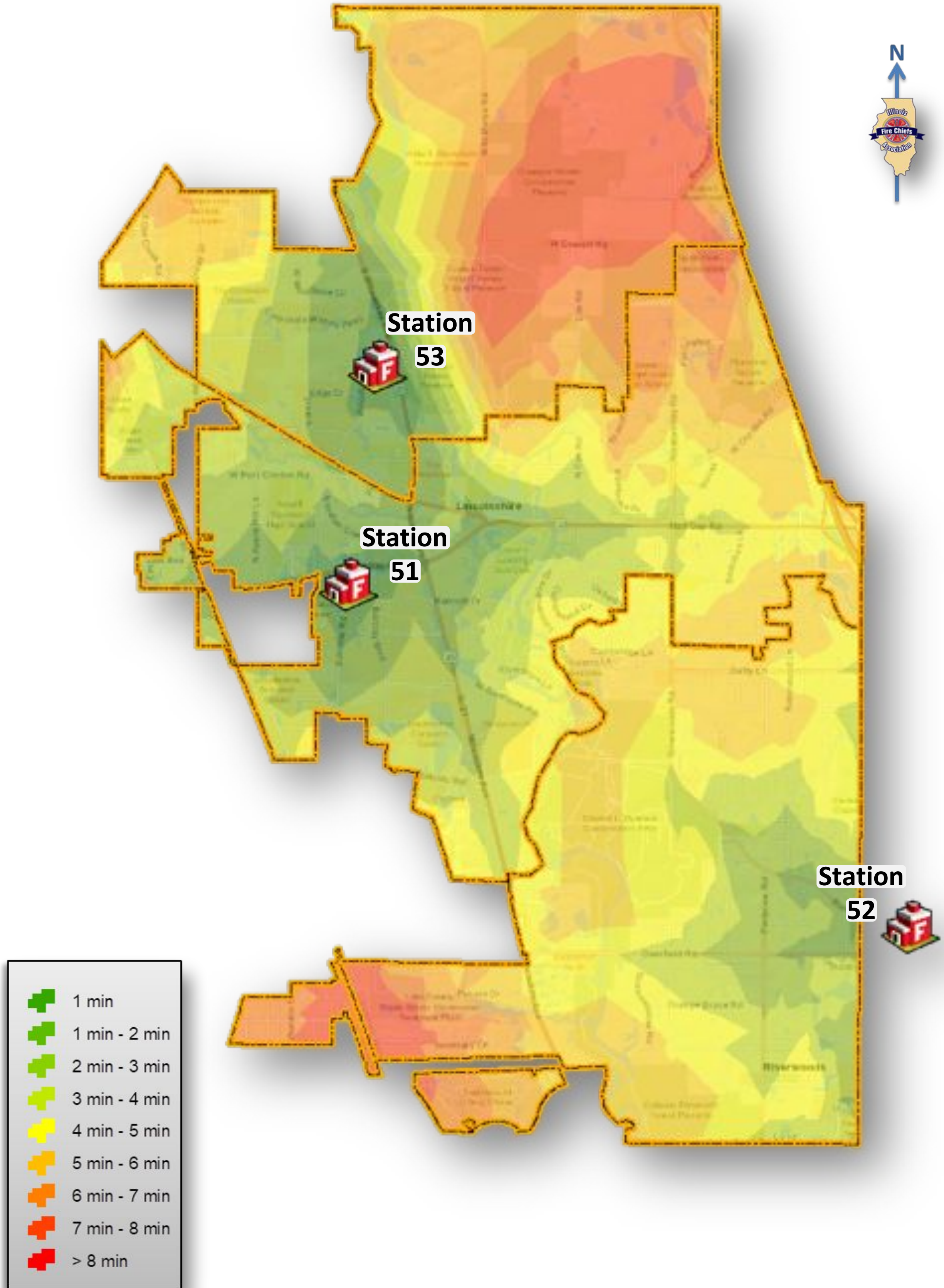
Station 52 Area and Streets by Time

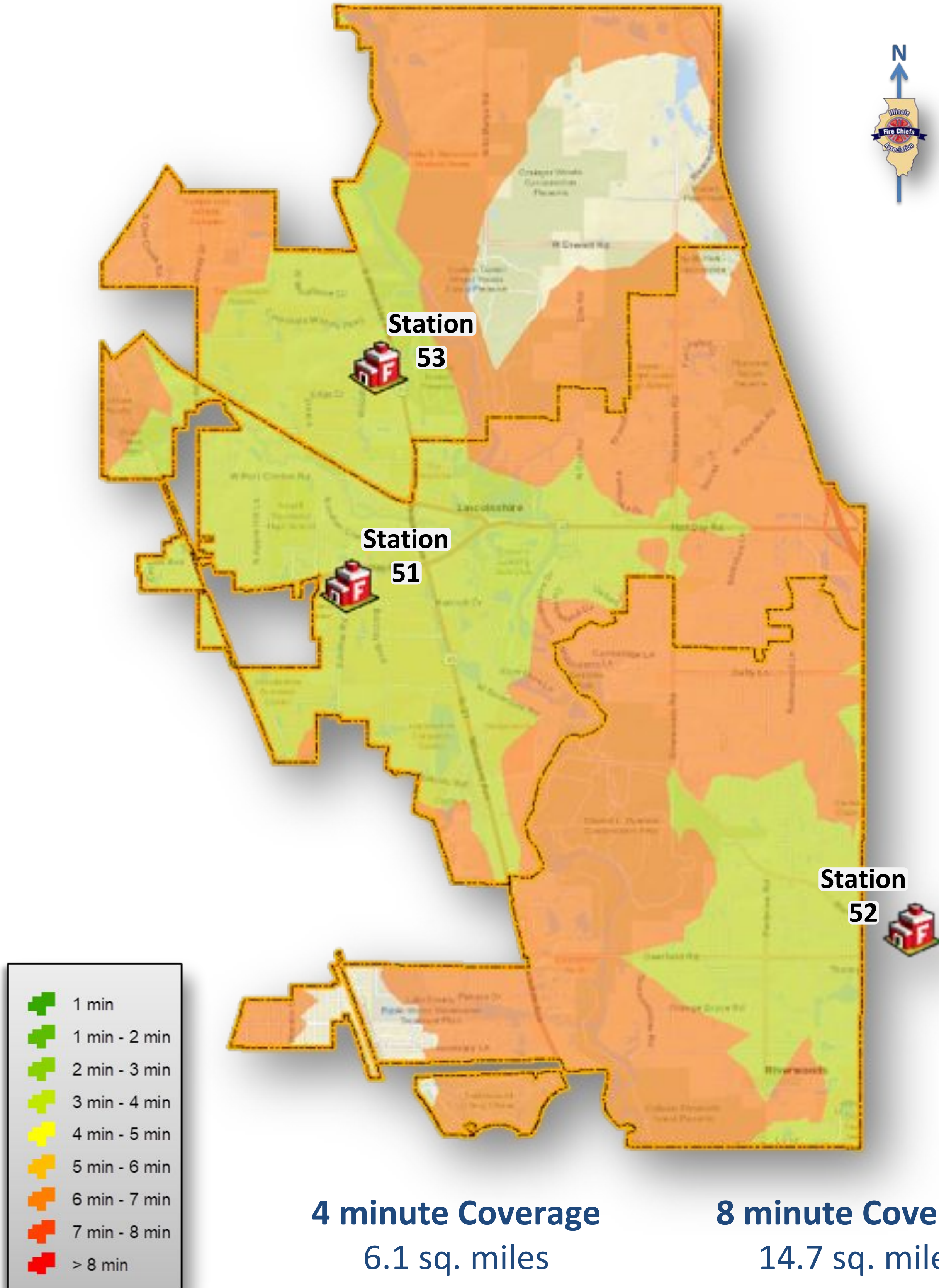
TRA Coverage - Station 52

Station 53 Area and Streets by Time

TRA Coverage - Station 53

Area Overview


N
Station 53
Station 51
Station 52
1 min
1 min - 2 min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min



4 minute Coverage

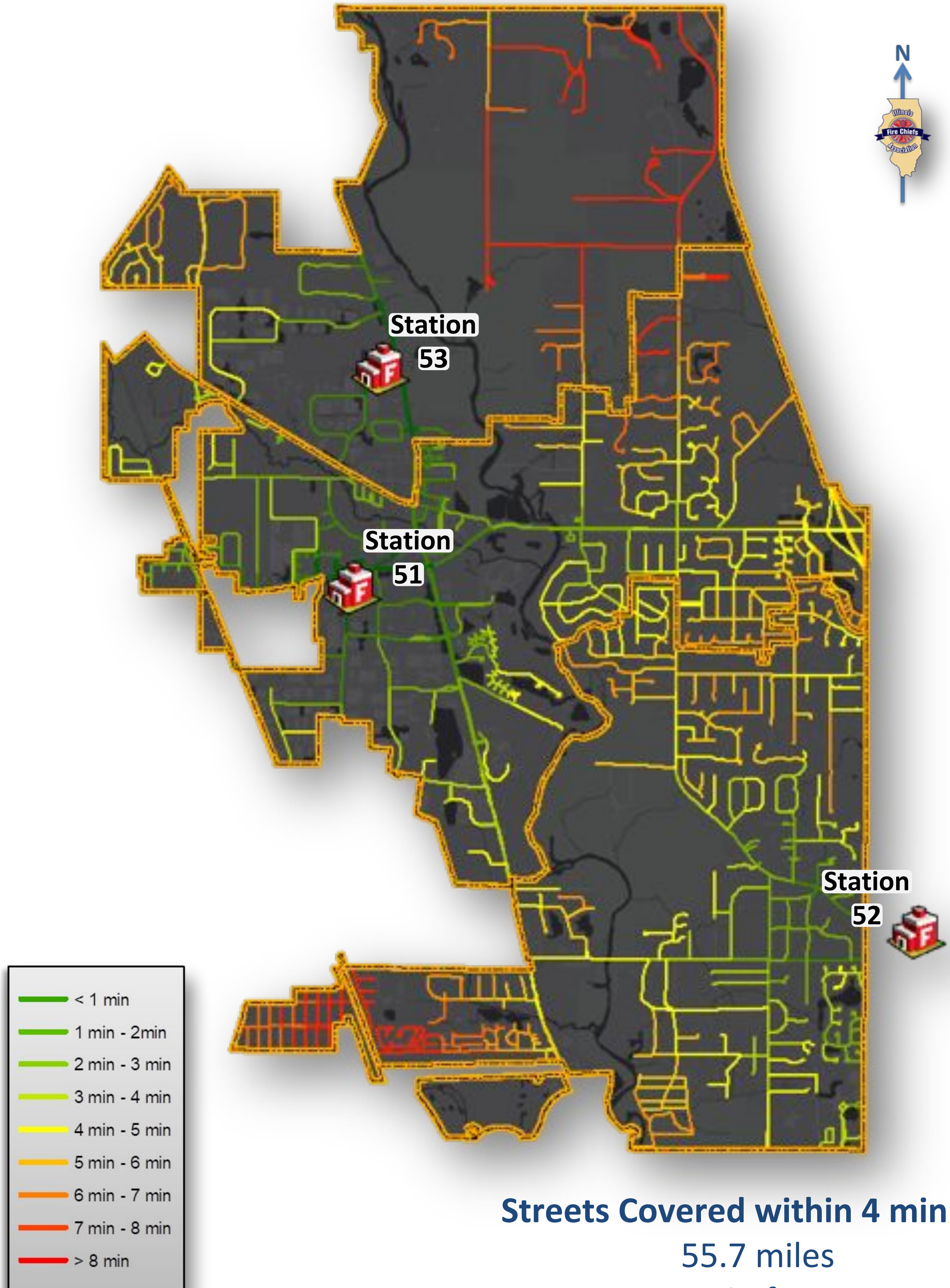
6.1 sq. miles

38% of TRA

8 minute Coverage

14.7 sq. miles

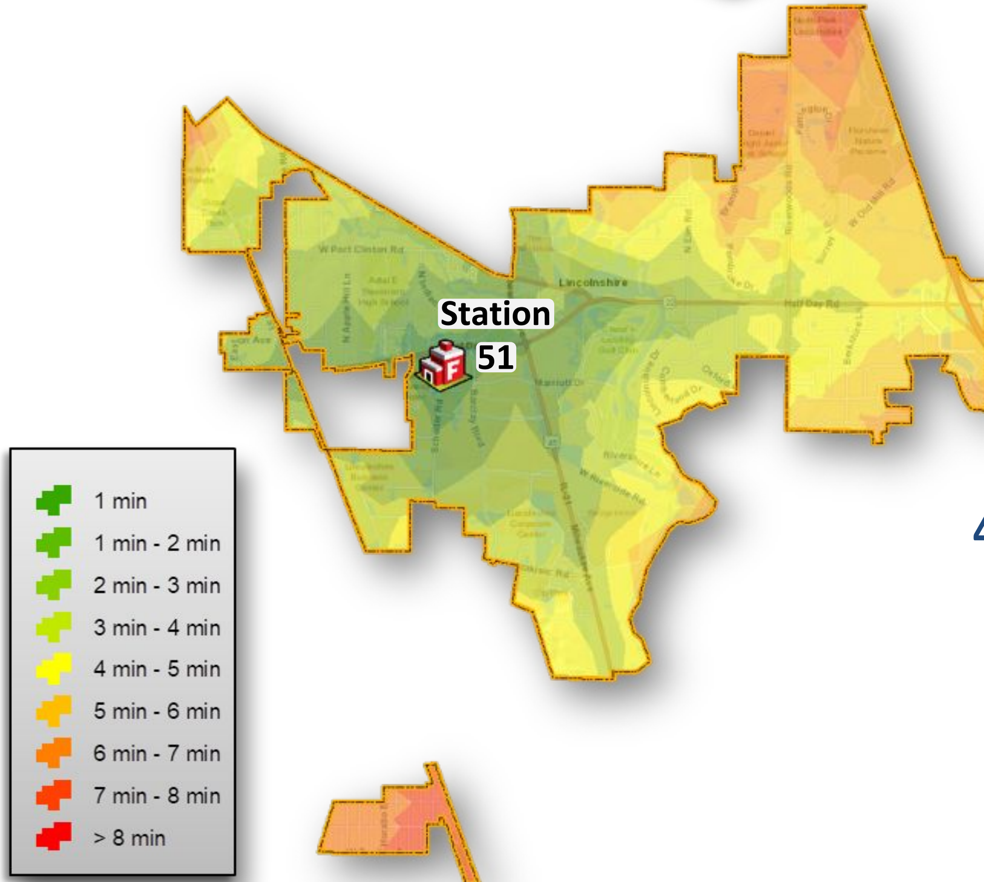
91% of TRA



Streets Covered within 4 minutes

55.7 miles

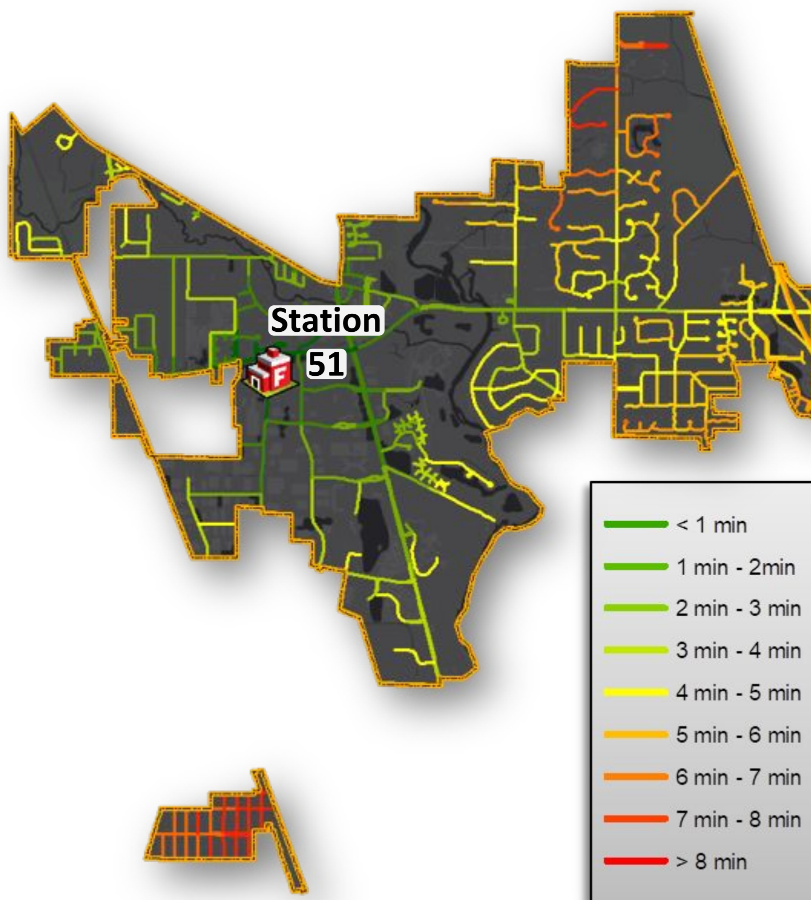
39% of TRA



4 minute Coverage

3.2 sq. miles

53% of AOR

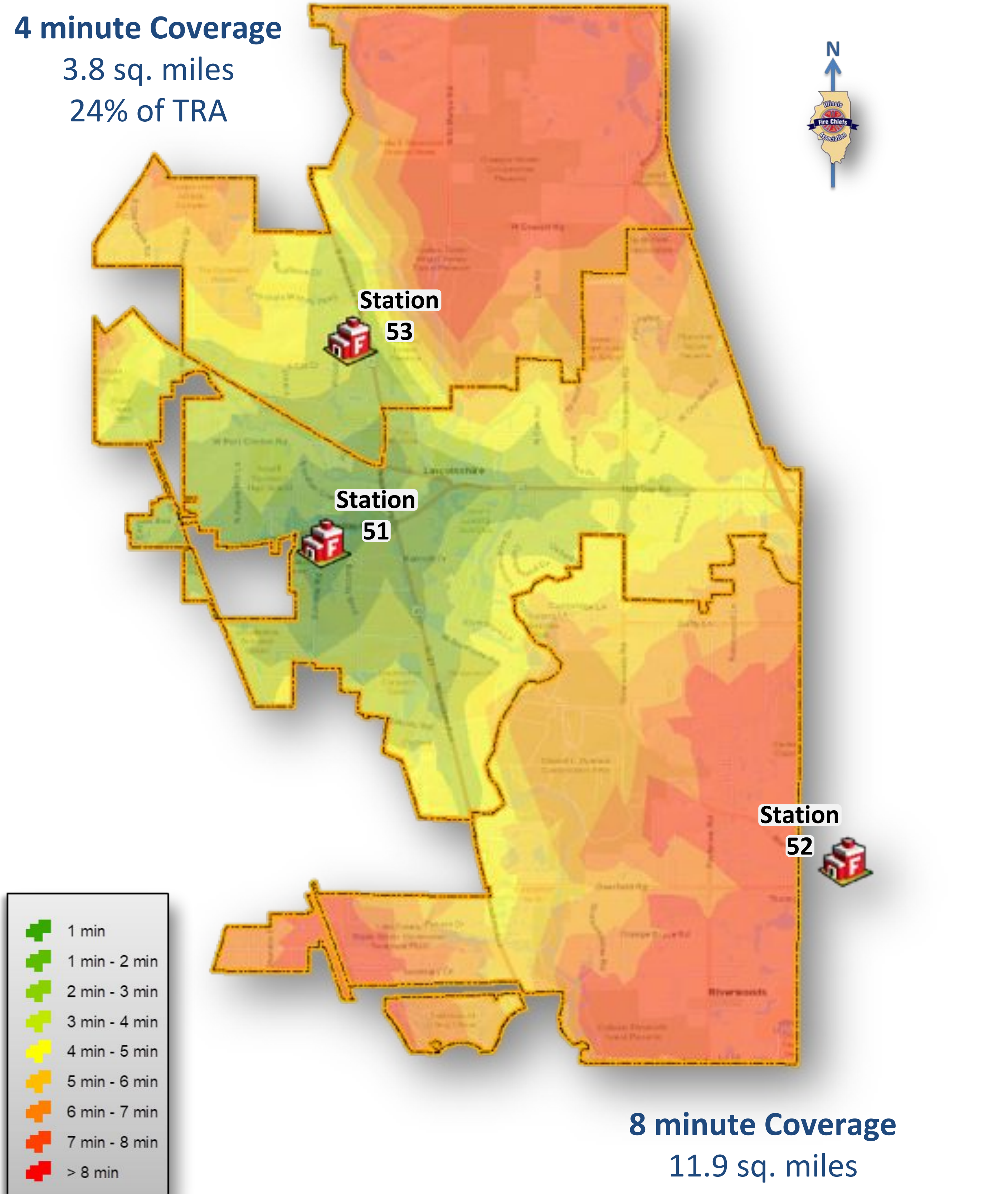


4 minute Drive

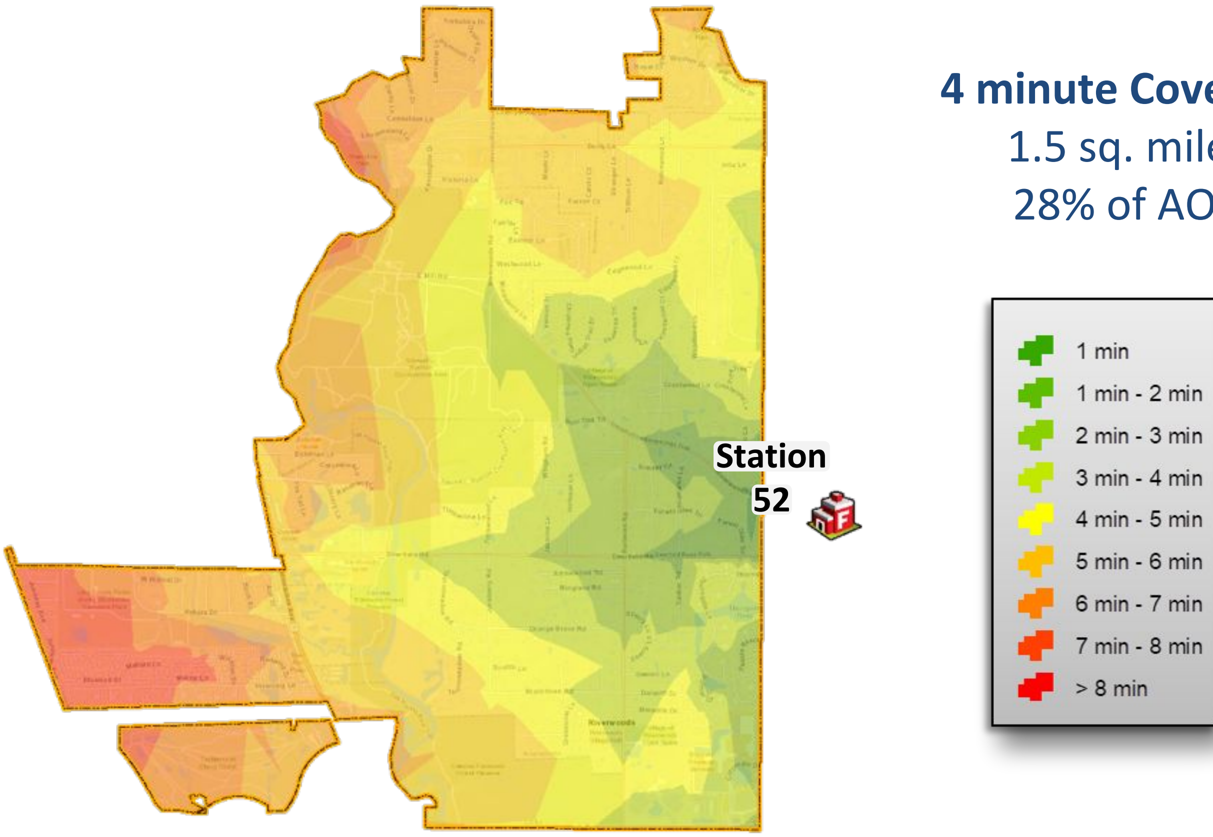
32 miles

49% of AOR

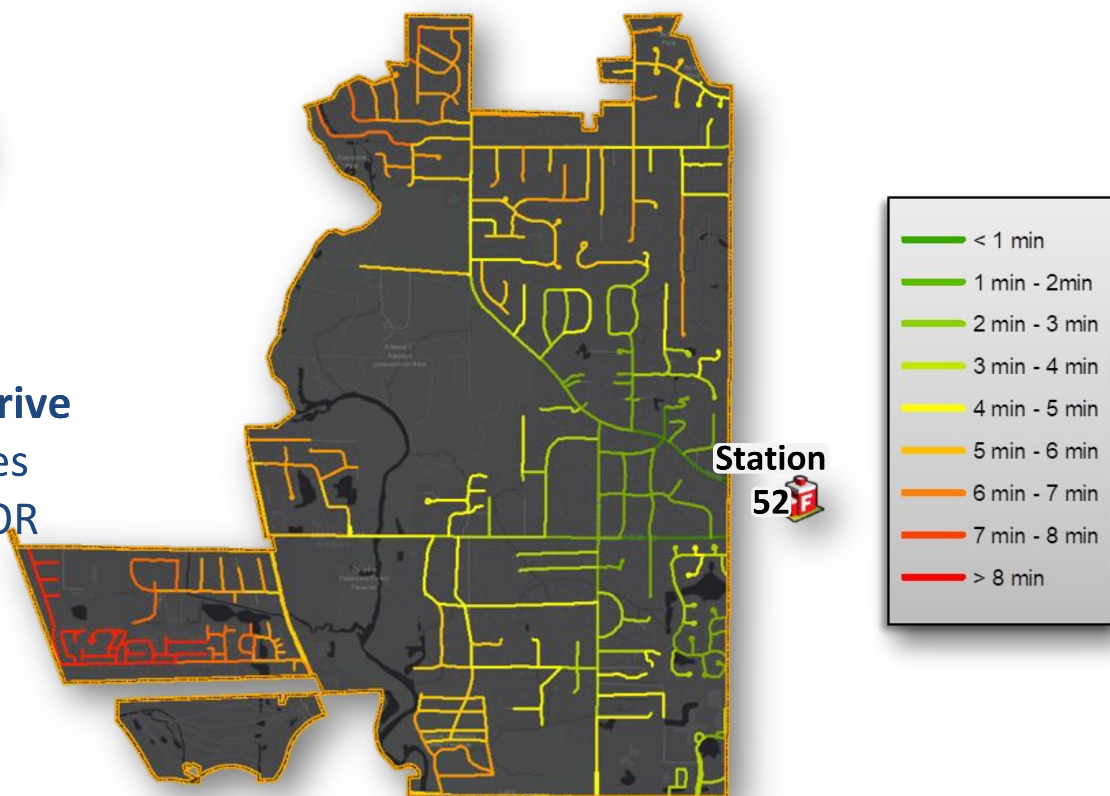
4 minute Coverage
3.8 sq. miles
24% of TRA



8 minute Coverage
11.9 sq. miles
73% of TRA



4 minute Coverage
1.5 sq. miles
28% of AOR

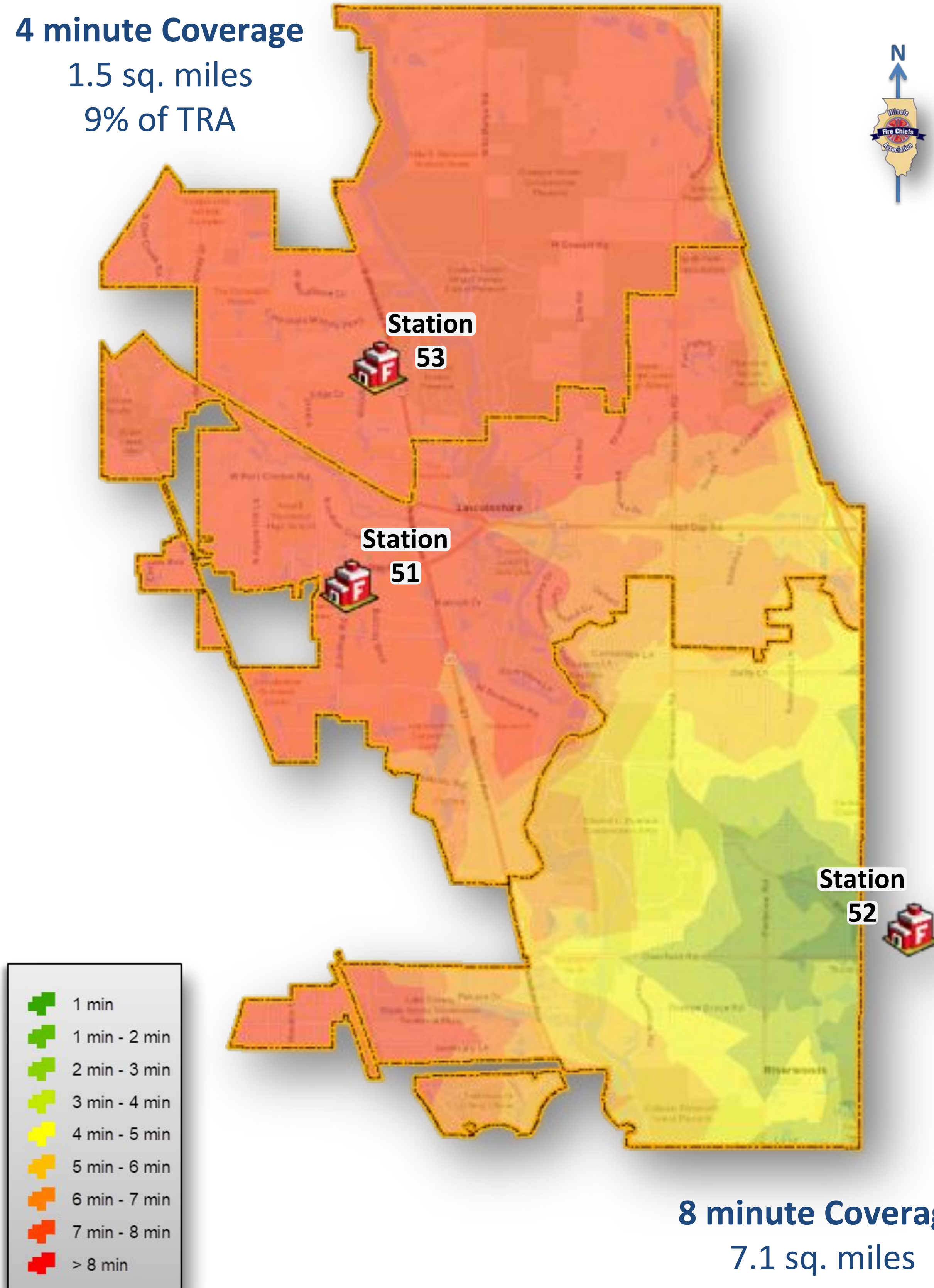


4 minute Drive
15.4 miles
32% of AOR

4 minute Coverage

1.5 sq. miles

9% of TRA

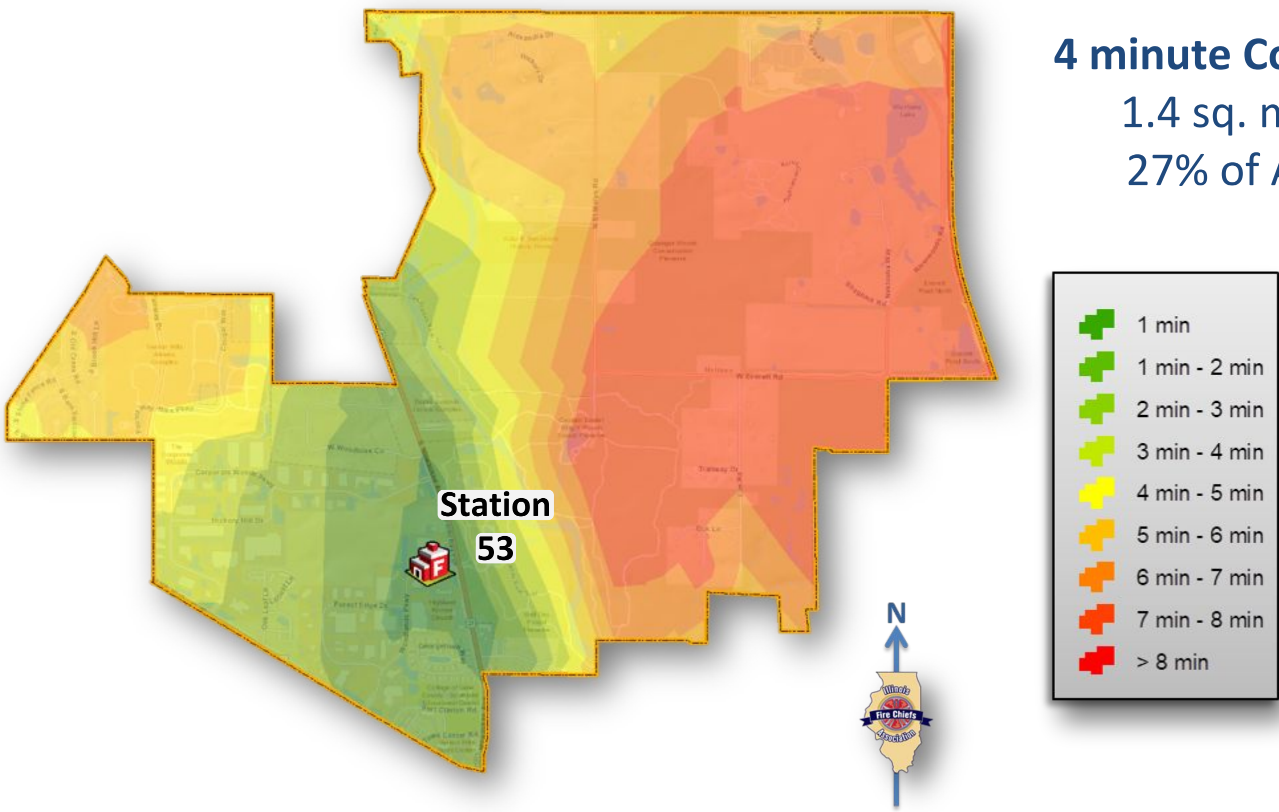


8 minute Coverage

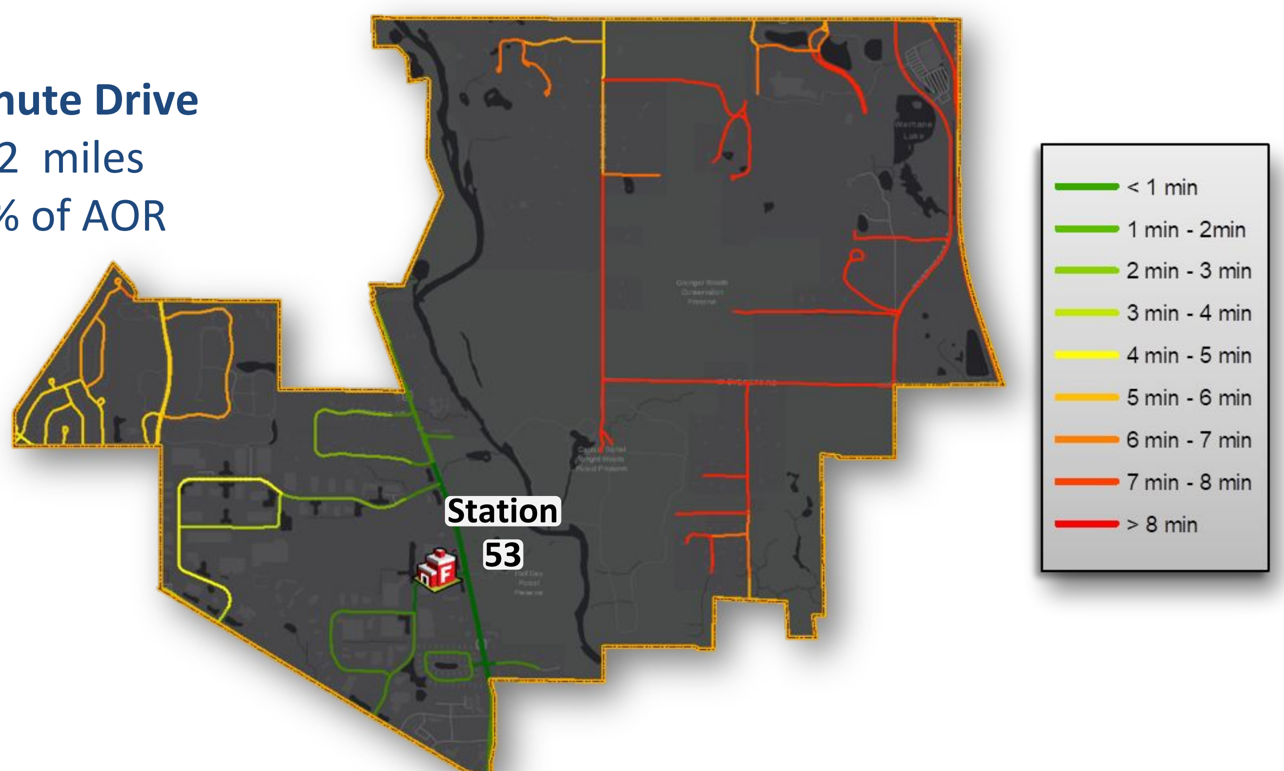
7.1 sq. miles

44% of TRA

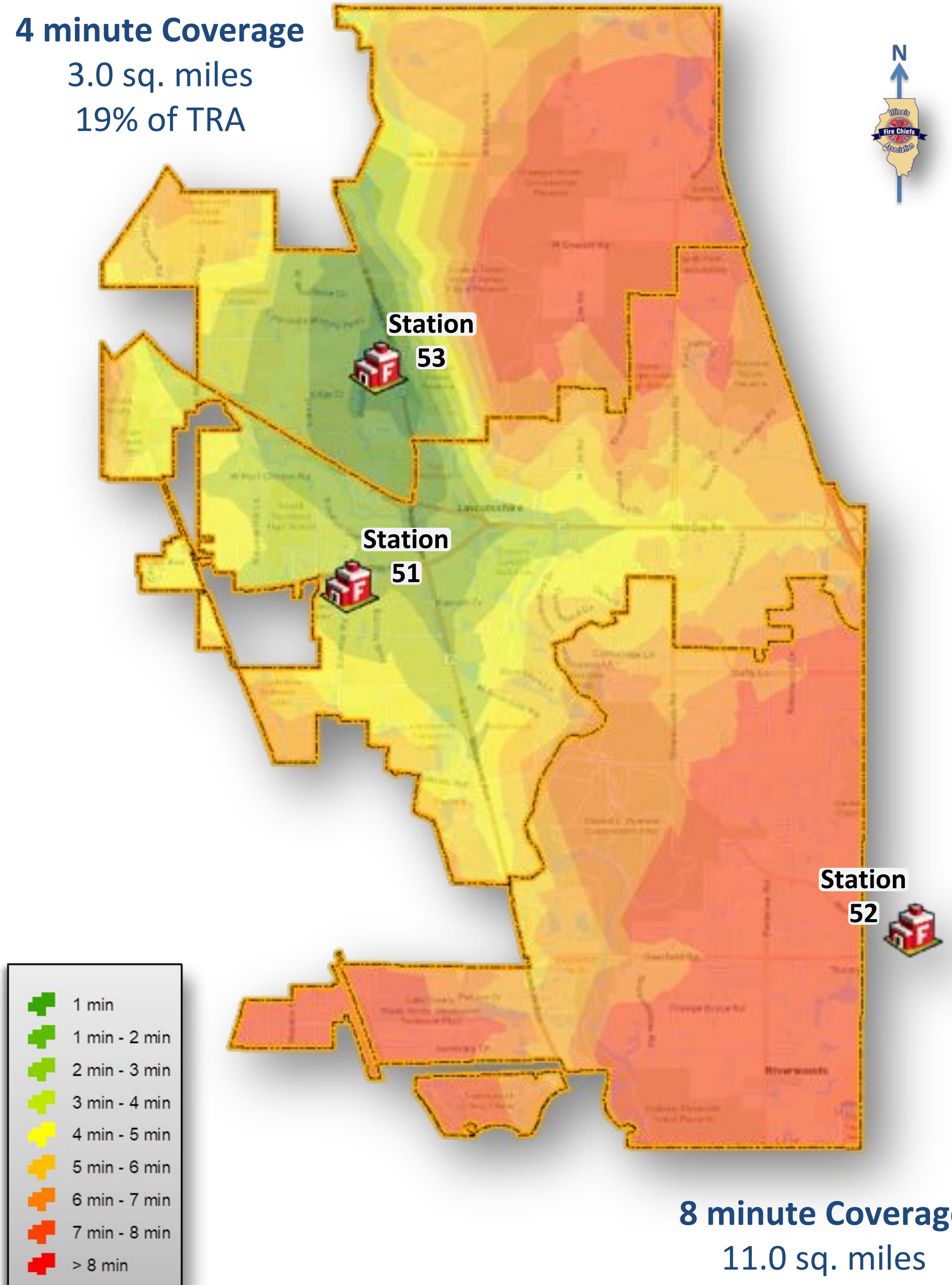
4 minute Coverage
1.4 sq. miles
27% of AOR



4 minute Drive
8.2 miles
28% of AOR



4 minute Coverage
3.0 sq. miles
19% of TRA



8 minute Coverage
11.0 sq. miles
68% of TRA

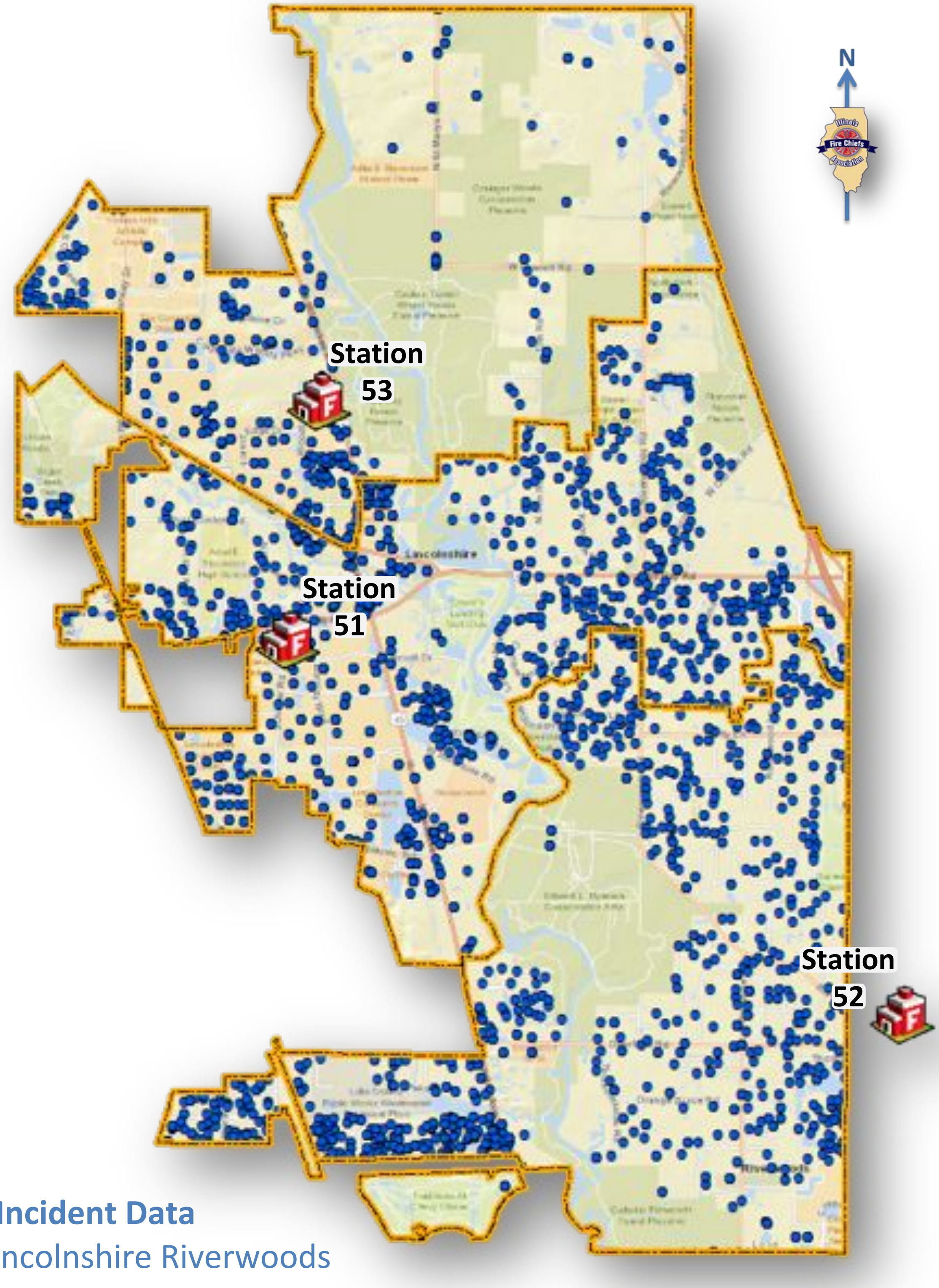
	Area Sq. Miles	% of Area w/in 4 min	Street Miles	% of Streets w/in 4 min
TRA	16.2	38%	142.8	39%
Station 51	6.0	53%	65.3	49%
Station 52	5.2	28%	48.5	32%
Station 53	5.0	27%	29.0	28%

All Incidents
Incidents by Year

NFIRS Group 100 - Fire
NFIRS Group 200 - Overpressure, Explosion, Overheat (No Fire)
NFIRS Group 300 - Rescue and Emergency Medical Service (EMS)
NFIRS Group 400 - Hazardous Condition (No Fire)
NFIRS Group 500 - Service Call
NFIRS Group 600 - Good Intent Call
NFIRS Group 700 - False Alarm
NFIRS Group 800 - Sever Weather and Natural Disaster
NFIRS Group 900 - Special Incident Type

All Incidents

Study Incidents



Incident Data

Source: Lincolnshire Riverwoods
Protection District

Time Period: Jan 2015 – Dec 2017

Total Incidents: 9,943

Incidents Inside District: 8,025

All Incident

	2015	2016	2017
In District	2,470	2,699	2,856
Outside District	608	683	627

Incident by Class In District

	2015	2016	2017
Fire	44	41	30
EMS	1,598	1,674	1,845
Other	828	984	981

Incident by Class Outside District

	2015	2016	2017
Fire	43	36	40
EMS	245	244	260
Other	320	403	327

Incident Classes:
Fire: All NFIRS group 100
EMS: All NFIRS group 300
Other: All NFIRS groups excluding groups 100 and 300

Fire

Brush or brush-and-grass mixture fire	7
Building fire	20
Chimney or flue fire, confined to chimney or flue	2
Cooking fire, confined to container	10
Dumpster or other outside trash receptacle fire	1
Fire, other	24
Fires in structure other than in a building	10
Forest, woods or wildland fire	2
Mobile property (vehicle) fire, other	3
Natural vegetation fire, other	6
Outside equipment fire	1
Outside rubbish fire, other	6
Outside rubbish, trash or waste fire	14
Outside storage fire	1
Passenger vehicle fire	3
Road freight or transport vehicle fire	2
Special outside fire, other	2
Trash or rubbish fire, contained	1
	115

Overpressure Rupture Explosion Overheat No Fire

Excessive heat, scorch burns with no ignition	16
Overpressure rupture, explosion, overheat other	1
	17

Rescue EMS

Emergency medical service incident, other	23
EMS call, excluding vehicle accident with injury	4,662
Extrication of victim(s) from machinery	1
Extrication, rescue, other	1
Medical assist, assist EMS crew	12
Motor vehicle accident with injuries	338
Motor vehicle accident with no injuries.	36
Motor vehicle/pedestrian accident (MV Ped)	12
Removal of victim(s) from stalled elevator	13
Rescue, EMS incident, other	14
Water & ice-related rescue, other	5
Grand Total	**5,117**

Hazardous Condition No Fire

Accident, potential accident, other	1
Arcing, shorted electrical equipment	16
Attempted burning, illegal action, other	1
Breakdown of light ballast	2
Carbon monoxide incident	30
Chemical hazard (no spill or leak)	2
Chemical spill or leak	5
Combustible/flammable gas/liquid condition, other	4
Electrical wiring/equipment problem, other	38
Gas leak (natural gas or LPG)	77
Gasoline or other flammable liquid spill	9
Hazardous condition, other	11
Heat from short circuit (wiring), defective/worn	2
Oil or other combustible liquid spill	1
Overheated motor	15
Power line down	36
Toxic condition, other	2
	252

Service Calls

Animal problem, other	4
Animal rescue	8
Assist invalid	135
Assist police or other governmental agency	8
Defective elevator, no occupants	22
Lock-out	20
Person in distress, other	5
Police matter	3
Public service	9
Public service assistance, other	25
Service Call, other	377
Smoke or odor removal	20
Unauthorized burning	9
Water or steam leak	22
Water problem, other	14
	681

Canceled Good Intent

Authorized controlled burning	17
Biological hazard investigation, none found	1
Dispatched & canceled en route	96
Good intent call, other	70
HazMat release investigation w/no HazMat	10
No incident found on arrival at dispatch address	33
Prescribed fire	5
Smoke from barbecue, tar kettle	3
Smoke scare, odor of smoke	35
Steam, other gas mistaken for smoke, other	2
Steam, vapor, fog or dust thought to be smoke	3
Wrong location	1
	276

False Alarm False Call

Alarm system activation, no fire - unintentional	205
Alarm system sounded due to malfunction	29
Carbon monoxide detector activation, no CO	18
Central station, malicious false alarm	1
CO detector activation due to malfunction	19
Detector activation, no fire - unintentional	61
Extinguishing system activation	5
False alarm or false call, other	199
Heat detector activation due to malfunction	3
Malicious, mischievous false call, other	6
Municipal alarm system, malicious false alarm	1
Smoke detector activation due to malfunction	31
Smoke detector activation, no fire - unintentional	264
Sprinkler activation due to malfunction	7
Sprinkler activation, no fire - unintentional	16
System malfunction, other	58
Unintentional transmission of alarm, other	638
	1,561

Severe Weather and natural Disaster

Flood assessment	1
Lightning strike (no fire)	1
	2

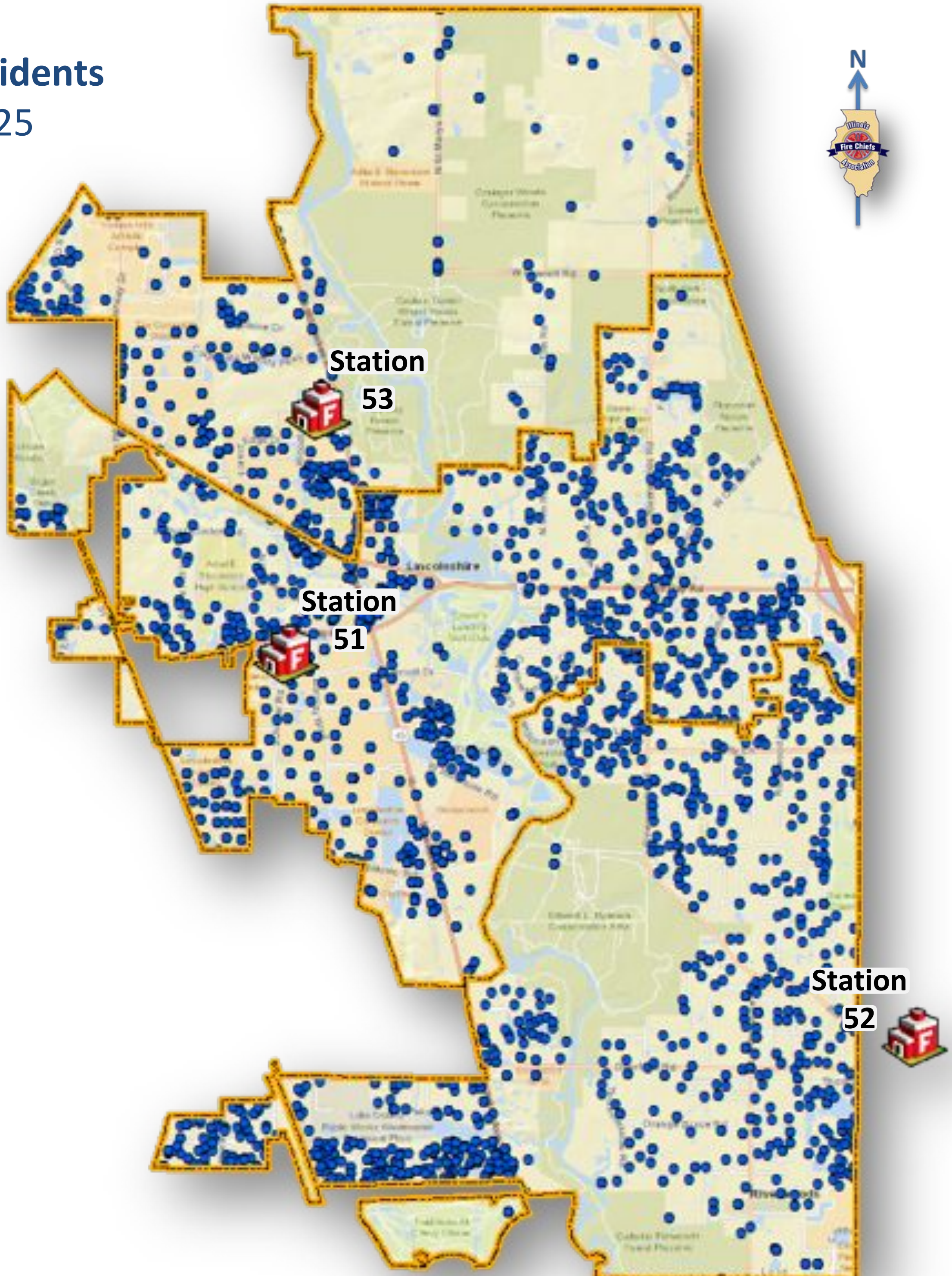
Special Incident Type

Citizen complaint	1
	1

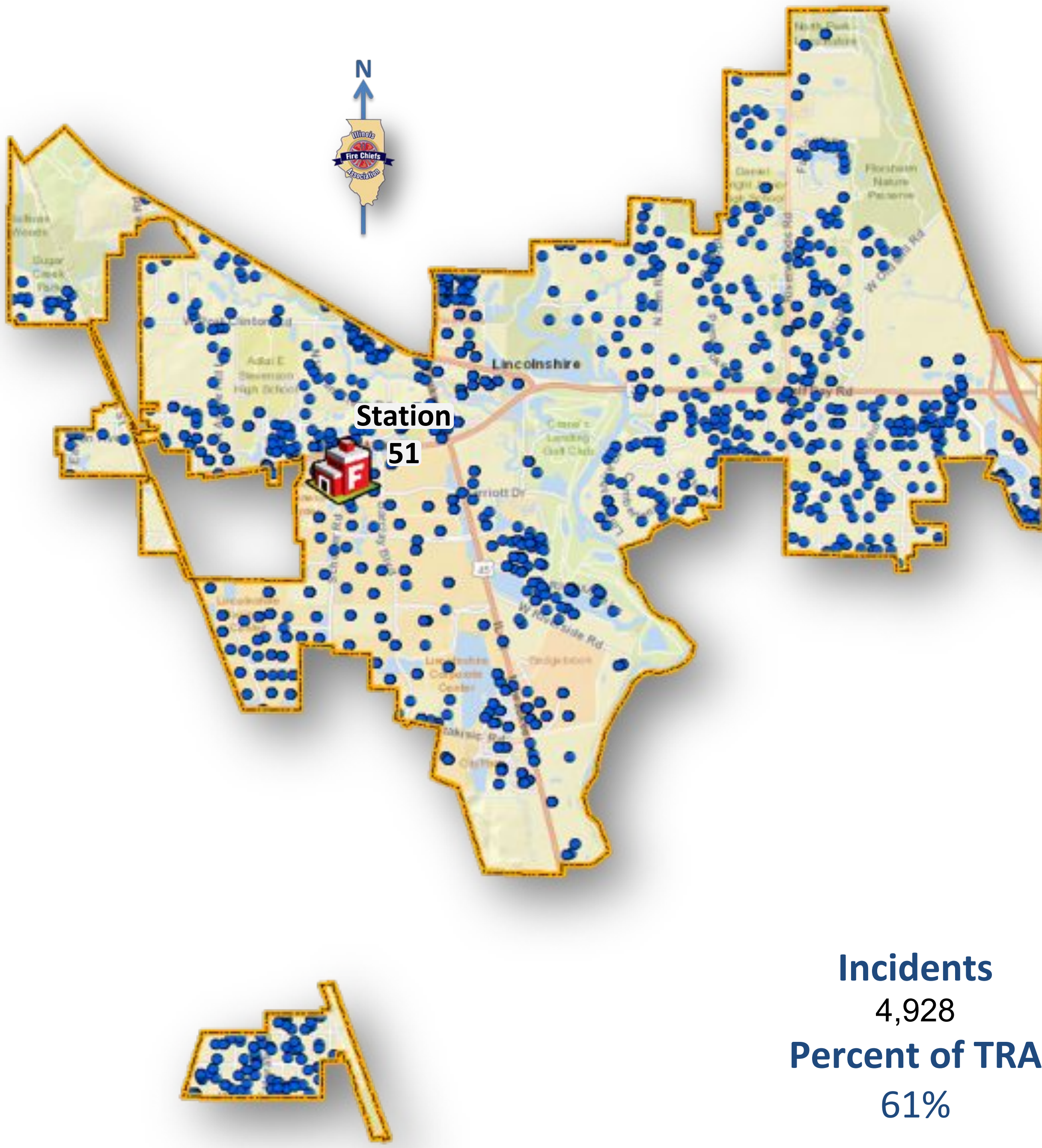
TRA

Station 51
Station 52
Station 53

TRA Incidents
8,025



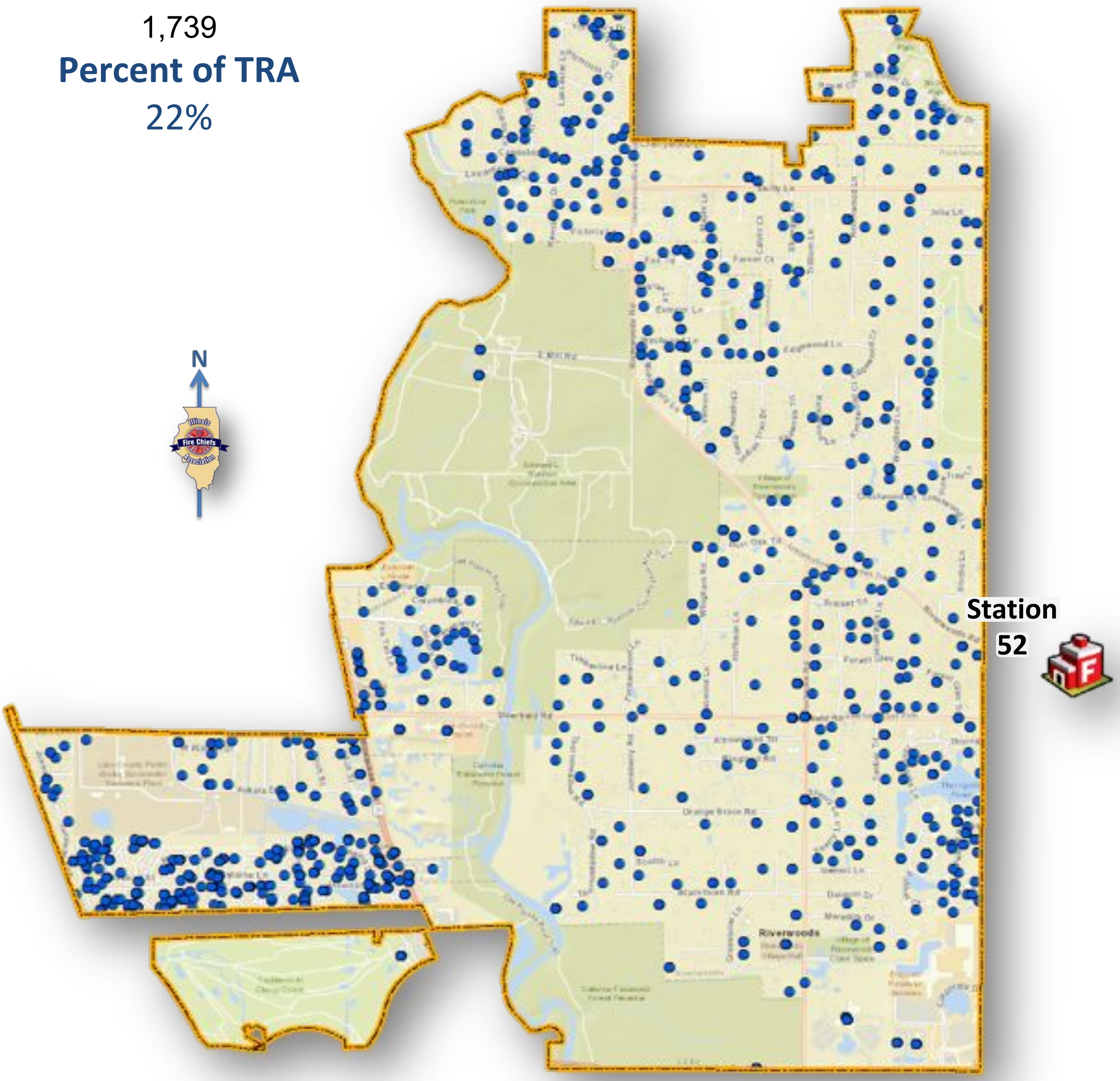
100	200	300	400	500	600	700	800	900
115	17	5,117	252	681	276	1,561	2	1
1.4%	0.2%	63.8%	3.1%	8.5%	3.4%	19.5%	0.0%	0.0%



Incidents
4,928
Percent of TRA
61%

100	200	300	400	500	600	700	800	900
73	7	3,295	107	382	152	910	1	1
1.5%	0.1%	66.9%	2.2%	7.8%	3.1%	18.5%	0.0%	0.0%

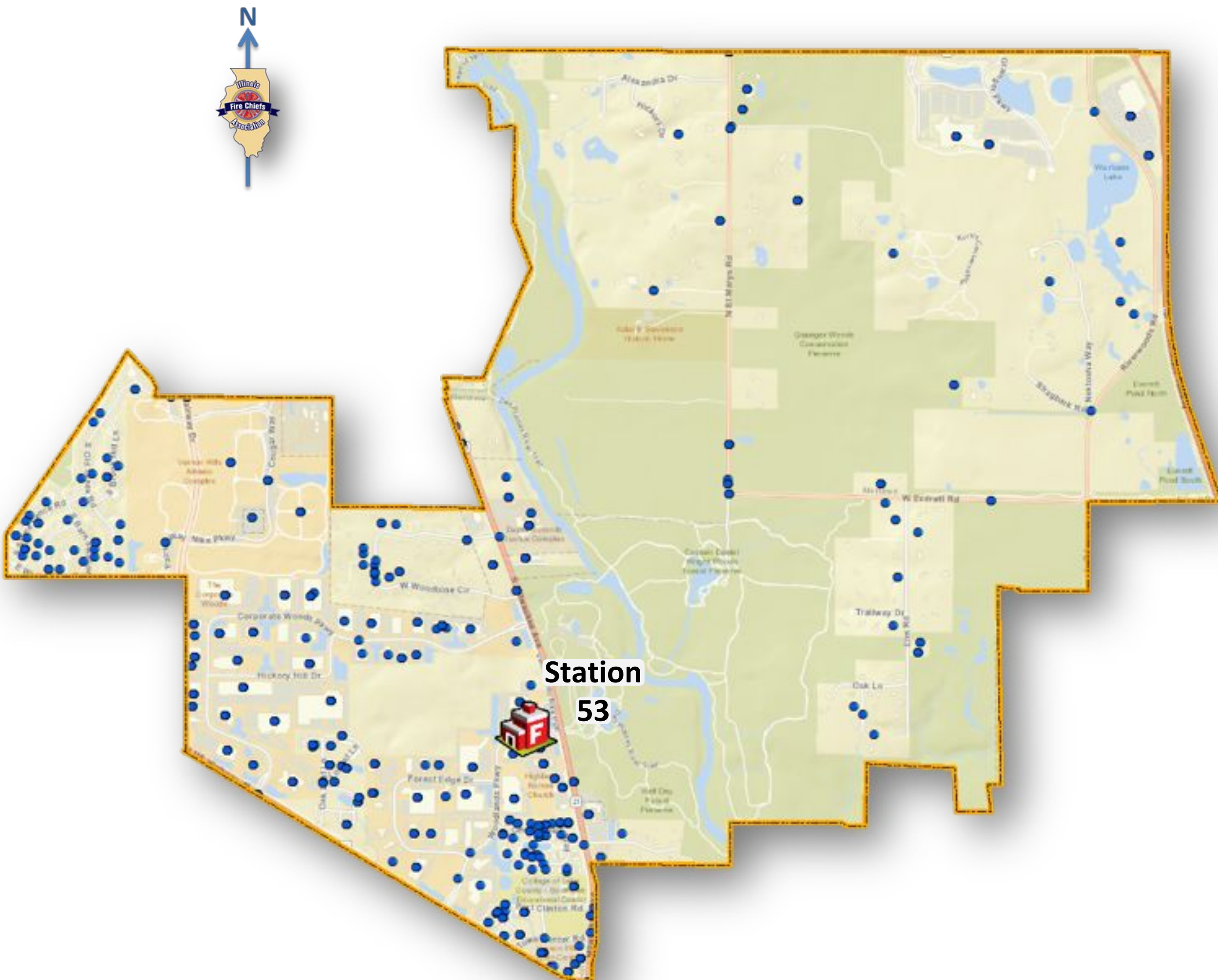
Incidents
1,739
Percent of TRA
22%



100	200	300	400	500	600	700	800
24	7	1,086	115	177	67	262	1
1.4%	0.4%	62.4%	6.6%	10.2%	3.9%	15.1%	0.1%

Incidents
1,355

Percent of TRA
17%

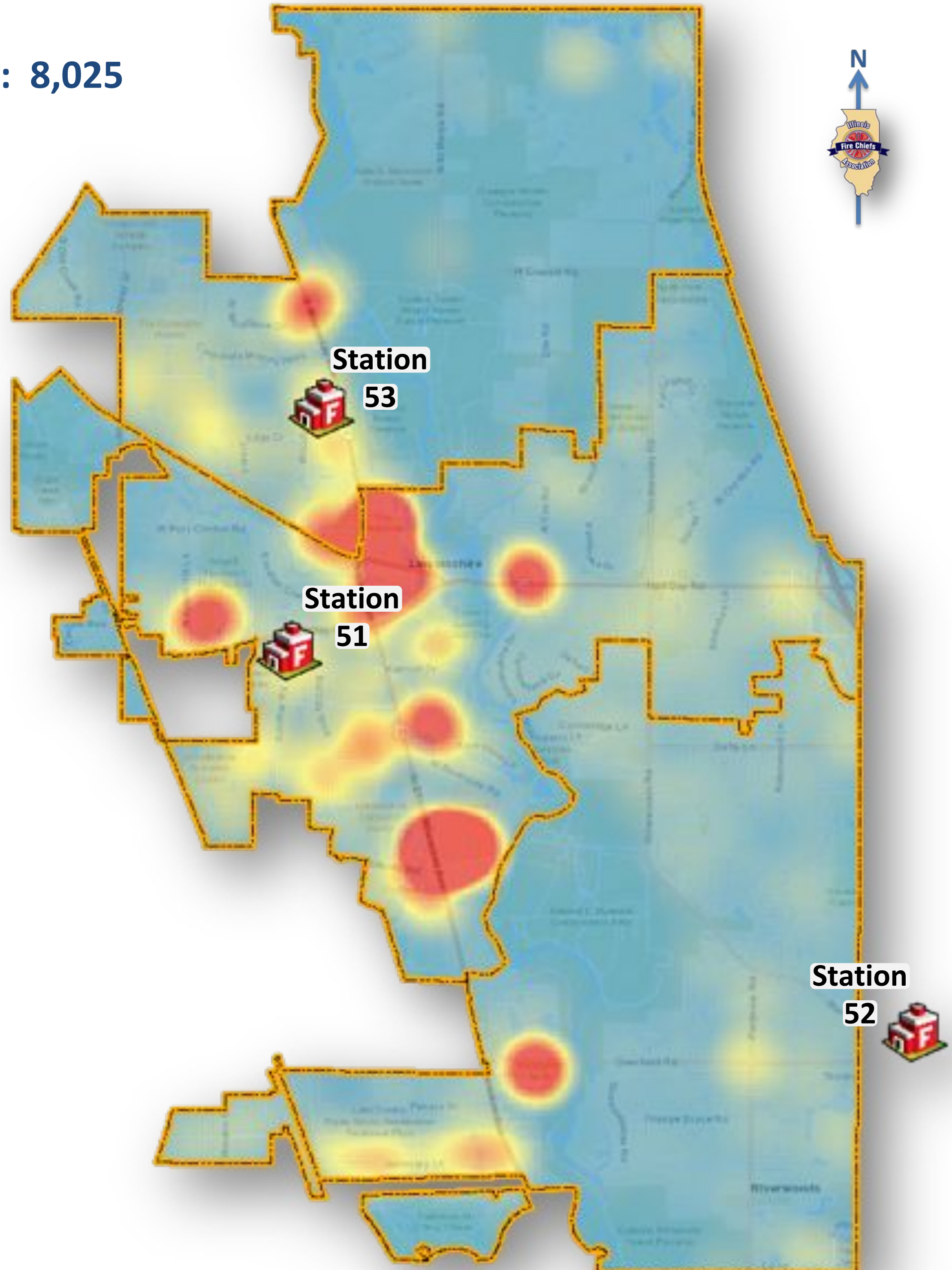


100	200	300	400	500	600	700
18	3	736	30	122	57	389
1.3%	0.2%	54.3%	2.2%	9.0%	4.2%	28.7%

All Incidents Mapping

NFIRS Group 100 - Fire
NFIRS Group 200 - Overpressure, Explosion, Overheat (No Fire)
NFIRS Group 300 - Rescue and Emergency Medical Service (EMS)
NFIRS Group 400 - Hazardous Condition (No Fire)
NFIRS Group 500 - Service Call
NFIRS Group 600 - Good Intent Call
NFIRS Group 700 - False Alarm
NFIRS Group 800 - Sever Weather and Natural Disaster
NFIRS Group 900 - Special Incident Type

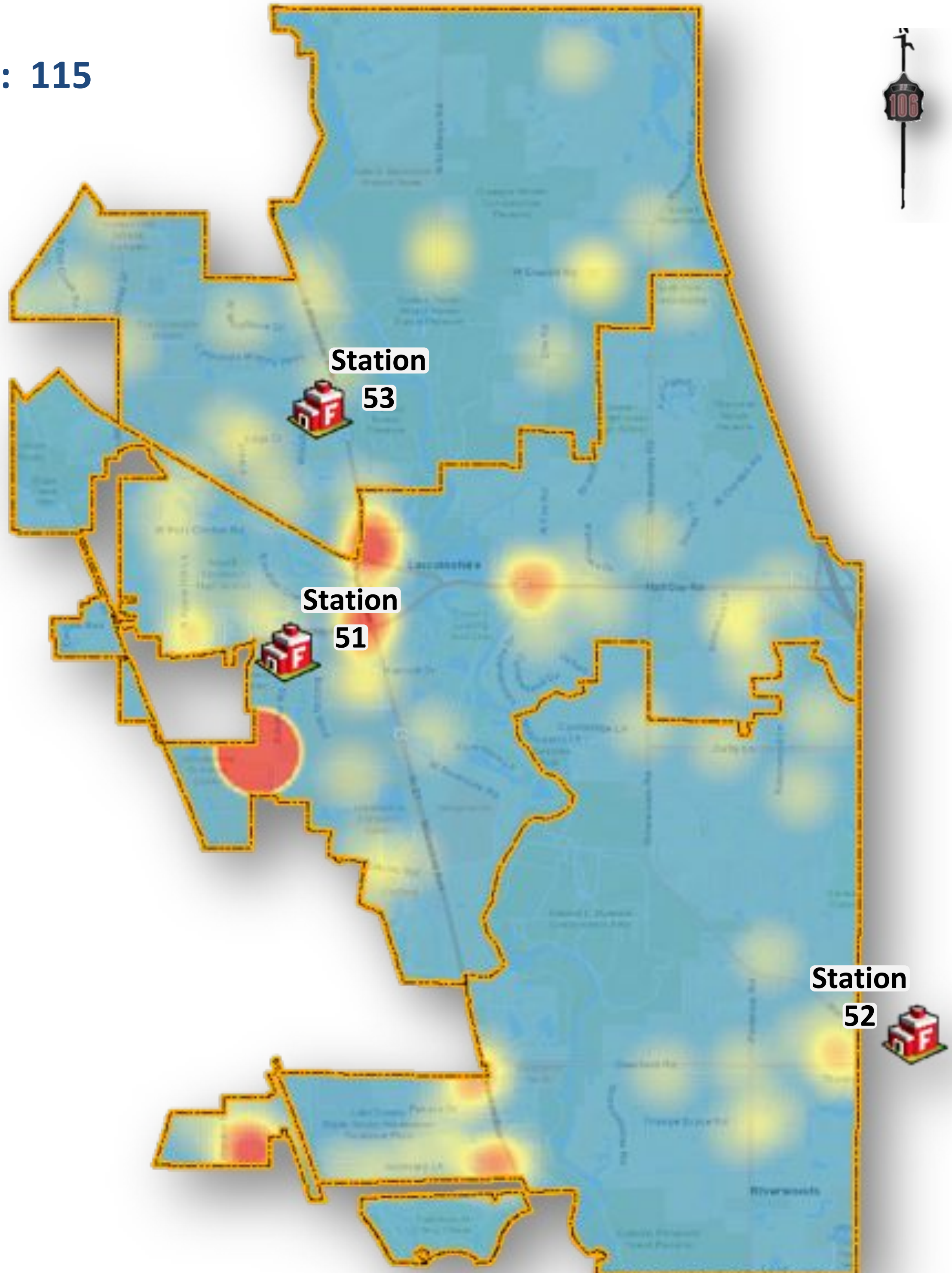
Total: 8,025



Percentage of TRA Incidents

Station 51: 61%
Station 52: 22%
Station 53: 17%

Total: 115

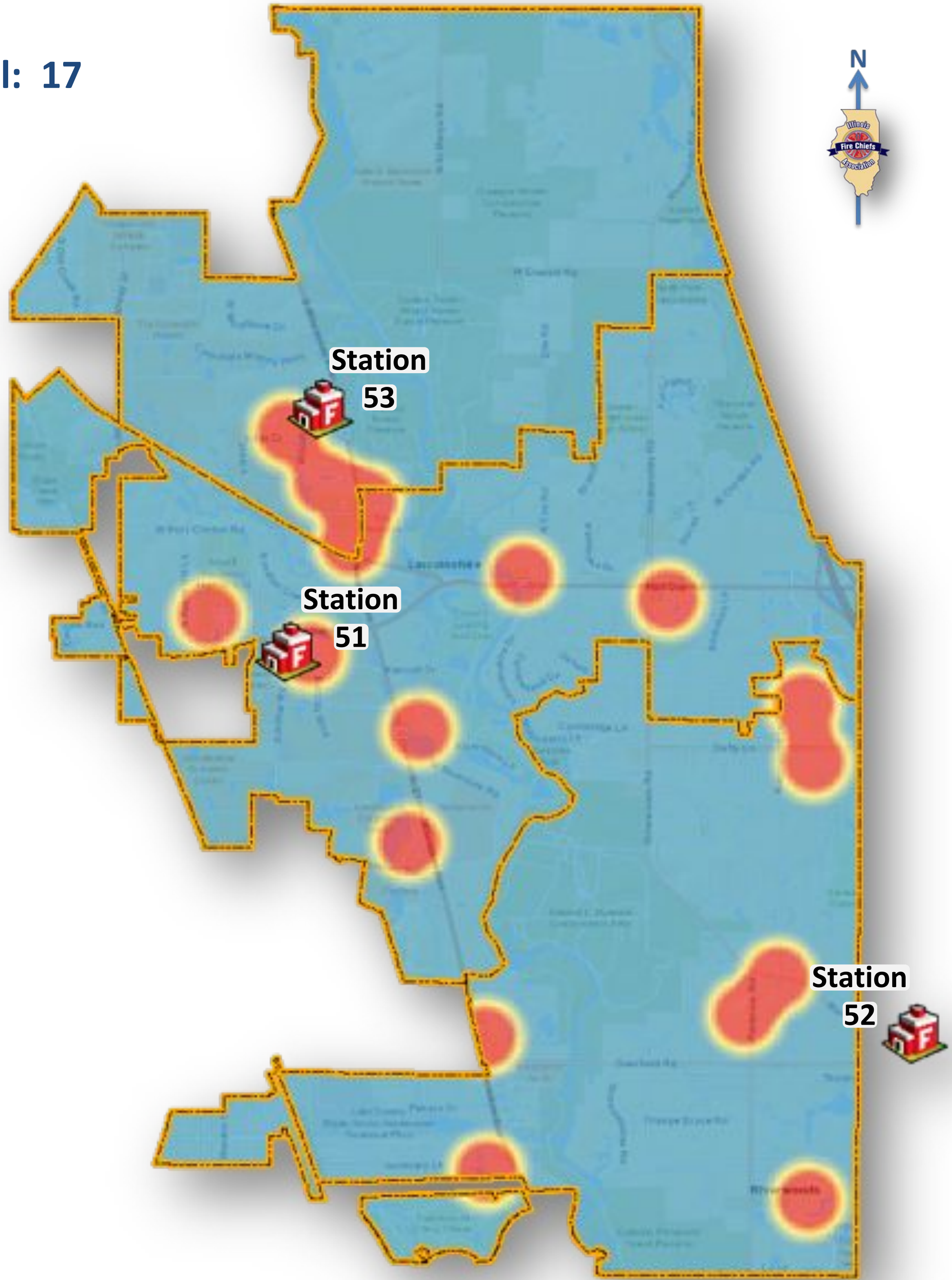


Percentage of TRA Incidents

Station 51: 63%
Station 52: 21%
Station 53: 16%

NFIRS 100: Fire

Total: 17

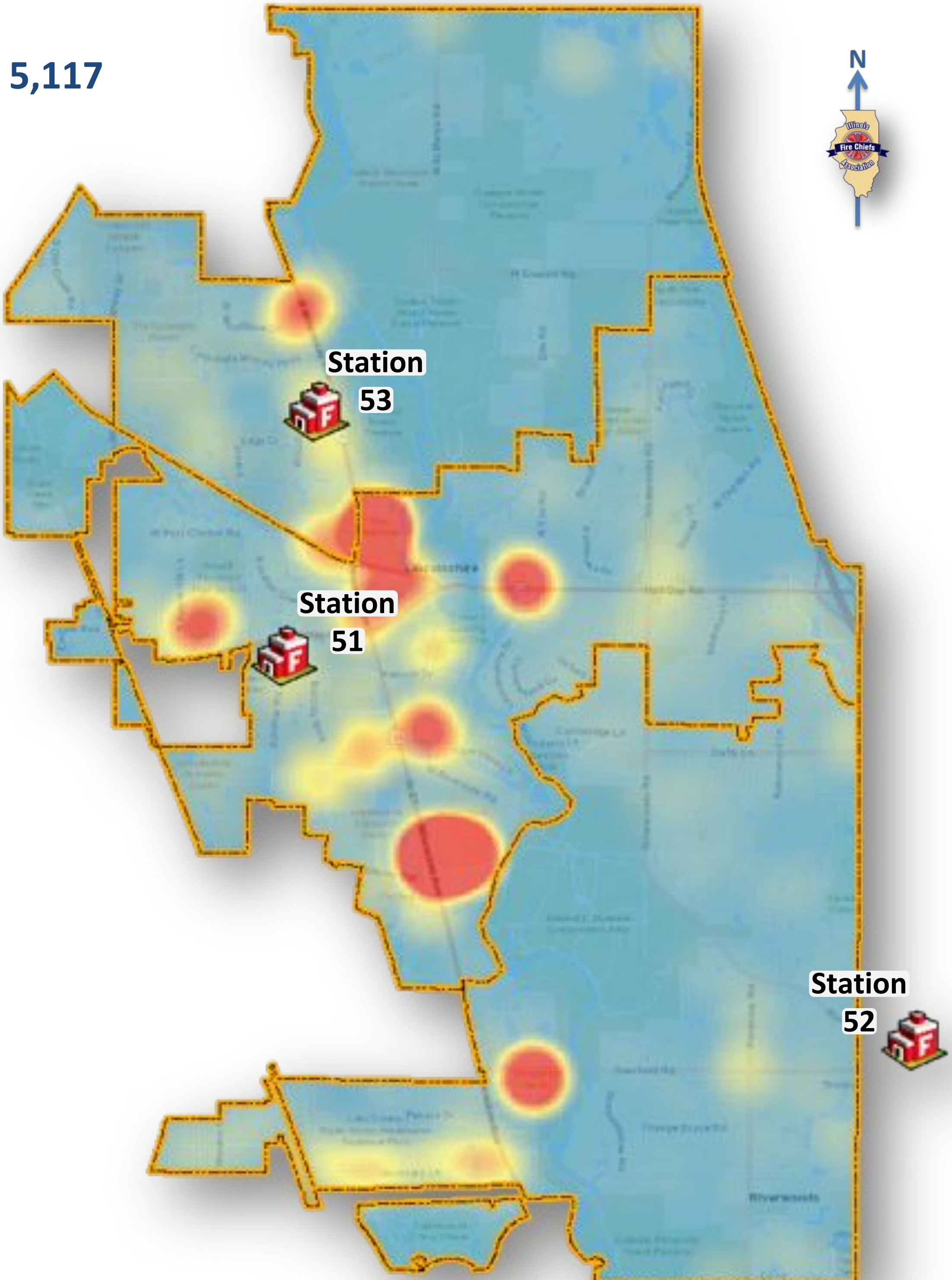


Percentage of TRA Incidents

Station 51: 41%
Station 52: 41%
Station 53: 18%

NFIRS 200: Overpressure Rupture Explosion Overheat No Fire

Total: 5,117

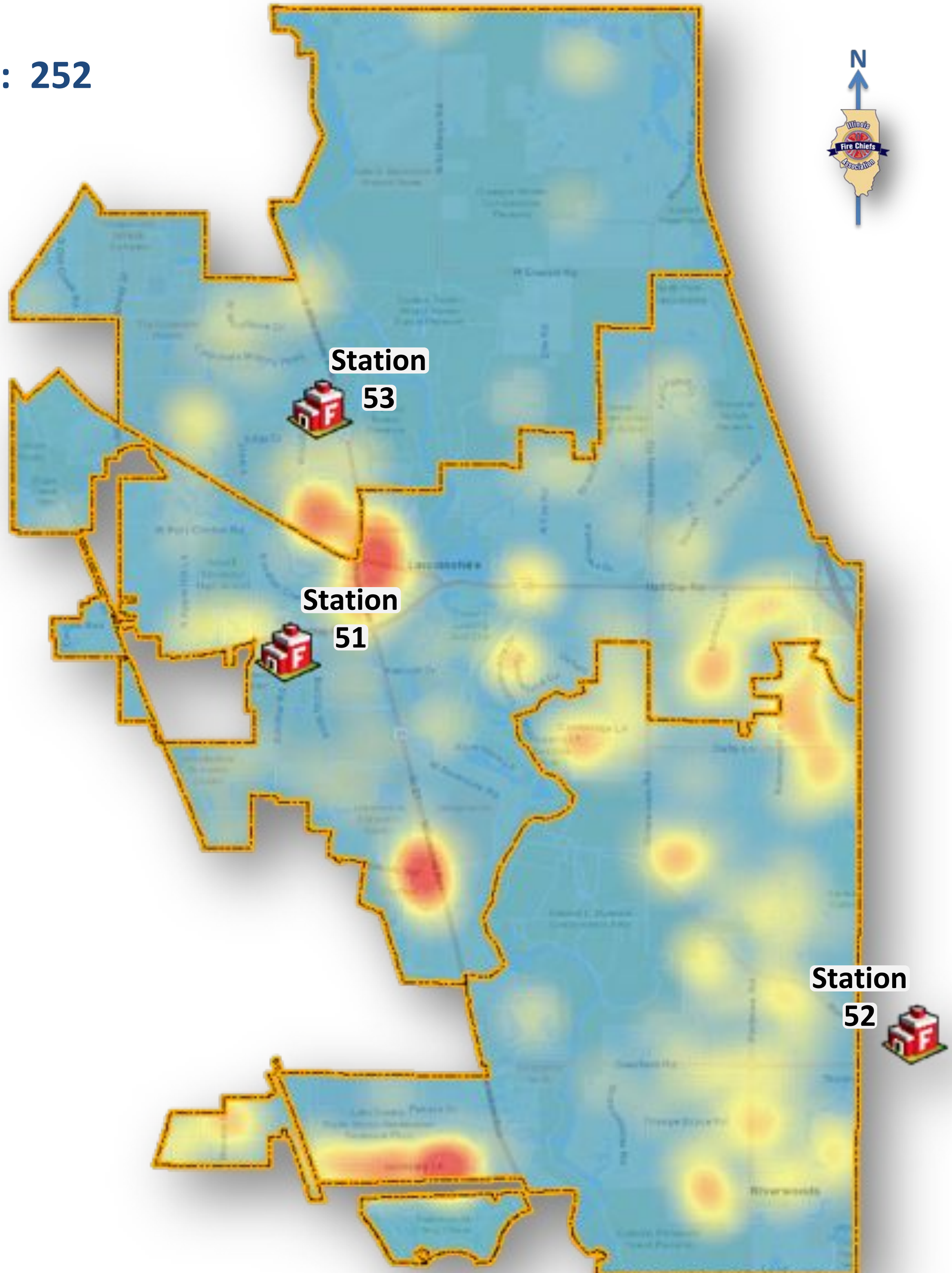


Percentage of TRA Incidents

Station 51: 64%
Station 52: 21%
Station 53: 14%

NFIRS 300: Rescue EMS

Total: 252

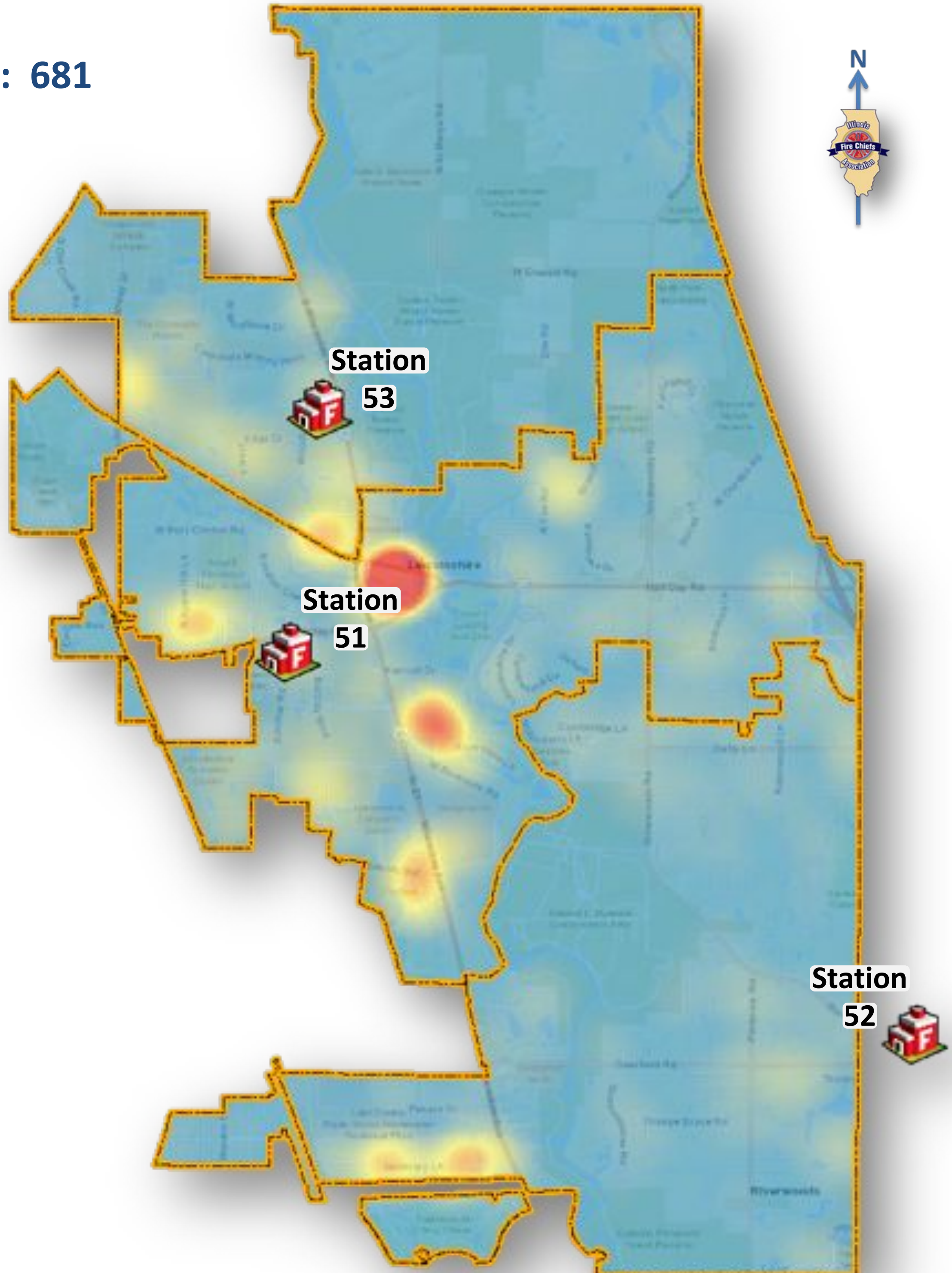


Percentage of TRA Incidents

Station 51: 42%
Station 52: 46%
Station 53: 12%

NFIRS 400: Hazardous Condition No Fire

Total: 681

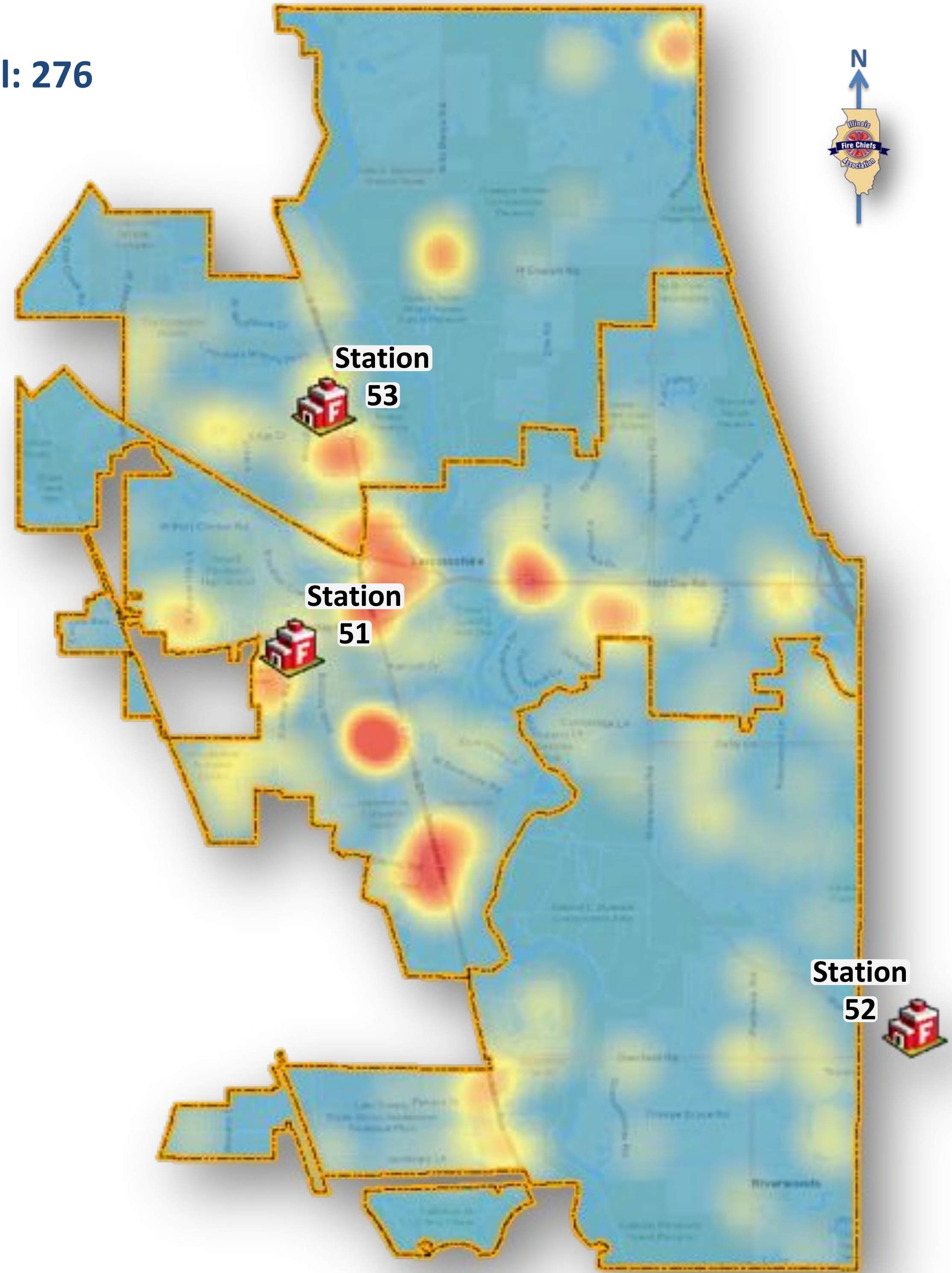


Percentage of TRA Incidents

Station 51: 56%
Station 52: 26%
Station 53: 18%

NFIRS 500: Service Calls

Total: 276



Percentage of TRA Incidents

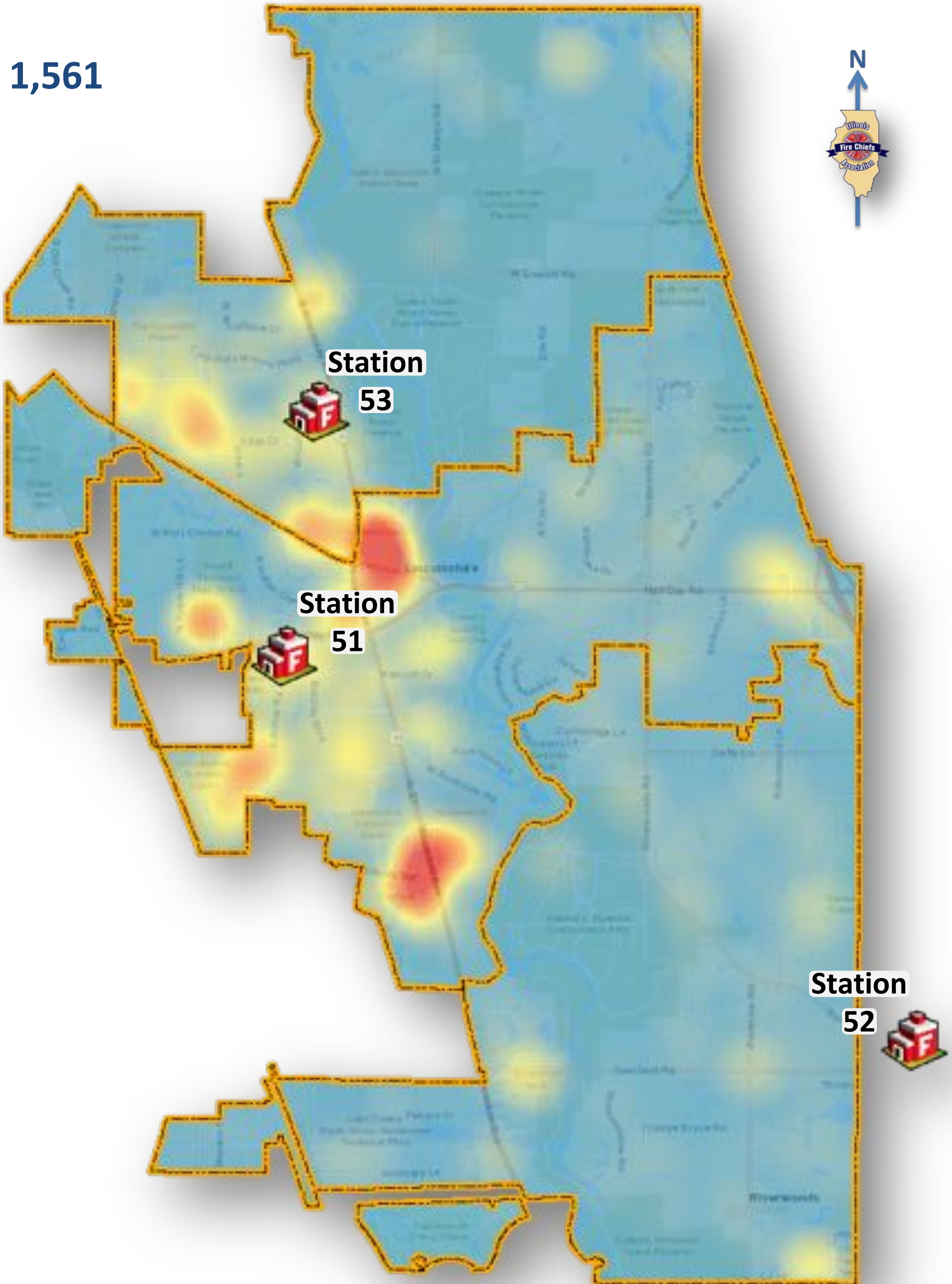
Station 51: 55%

Station 52: 24%

Station 53: 21%

NFIRS 600: Canceled Good Intent

Total: 1,561

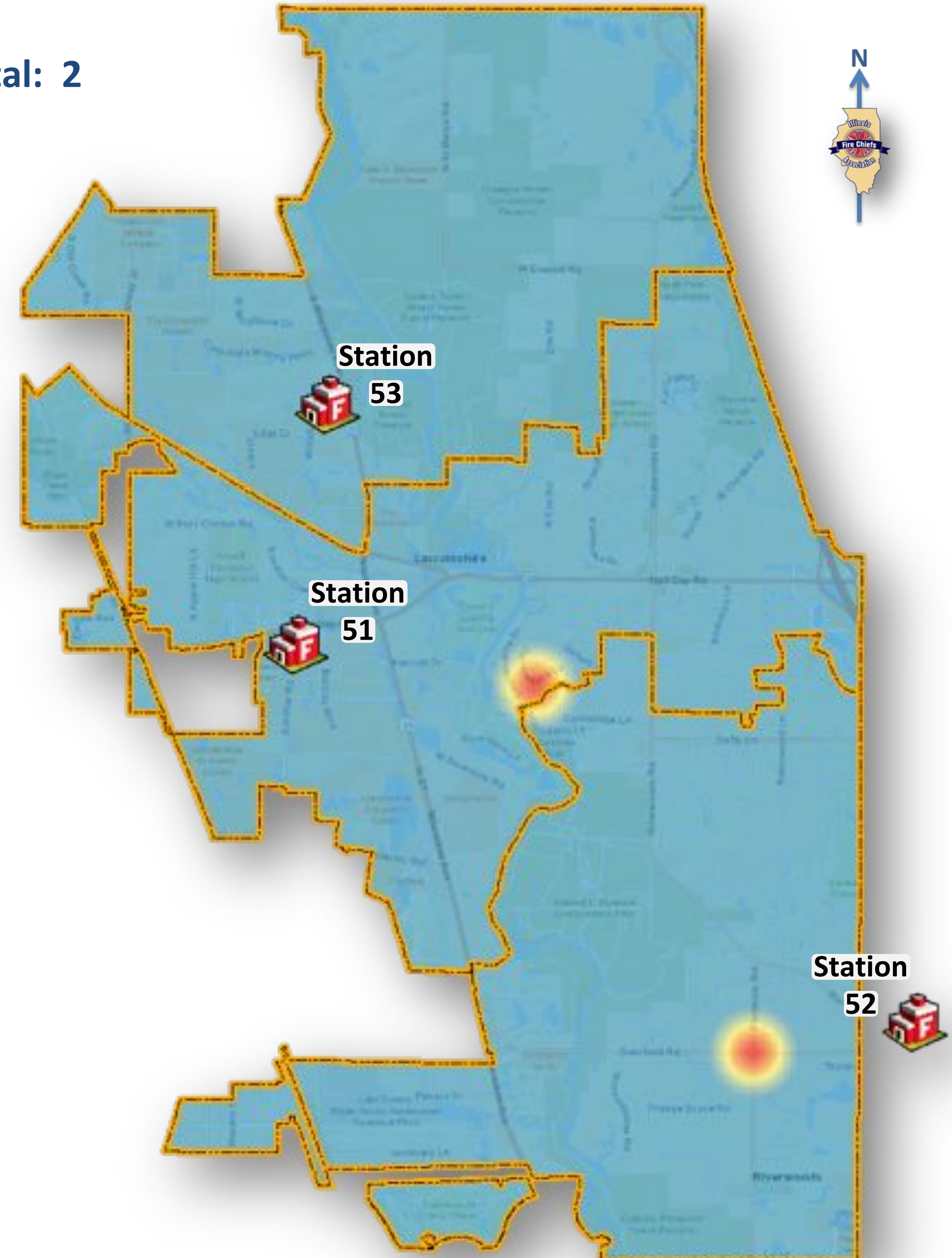


Percentage of TRA Incidents

Station 51: 58%
Station 52: 17%
Station 53: 25%

NFIRS 700: False Alarm False Call

Total: 2

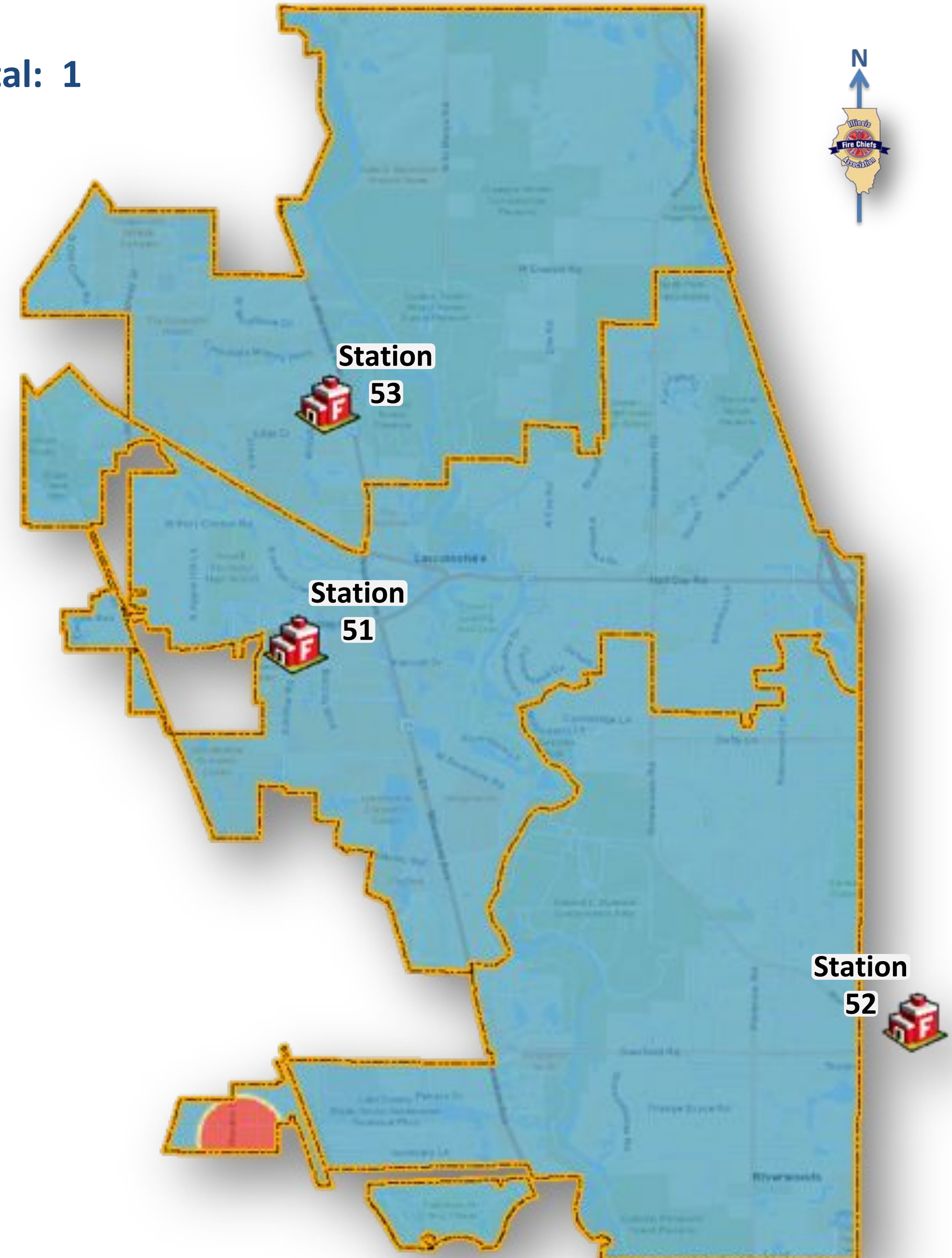


Percentage of TRA Incidents

Station 51: 50%
Station 52: 50%
Station 53: 0%

NFIRS 800: Severe Weather and natural Disaster

Total: 1



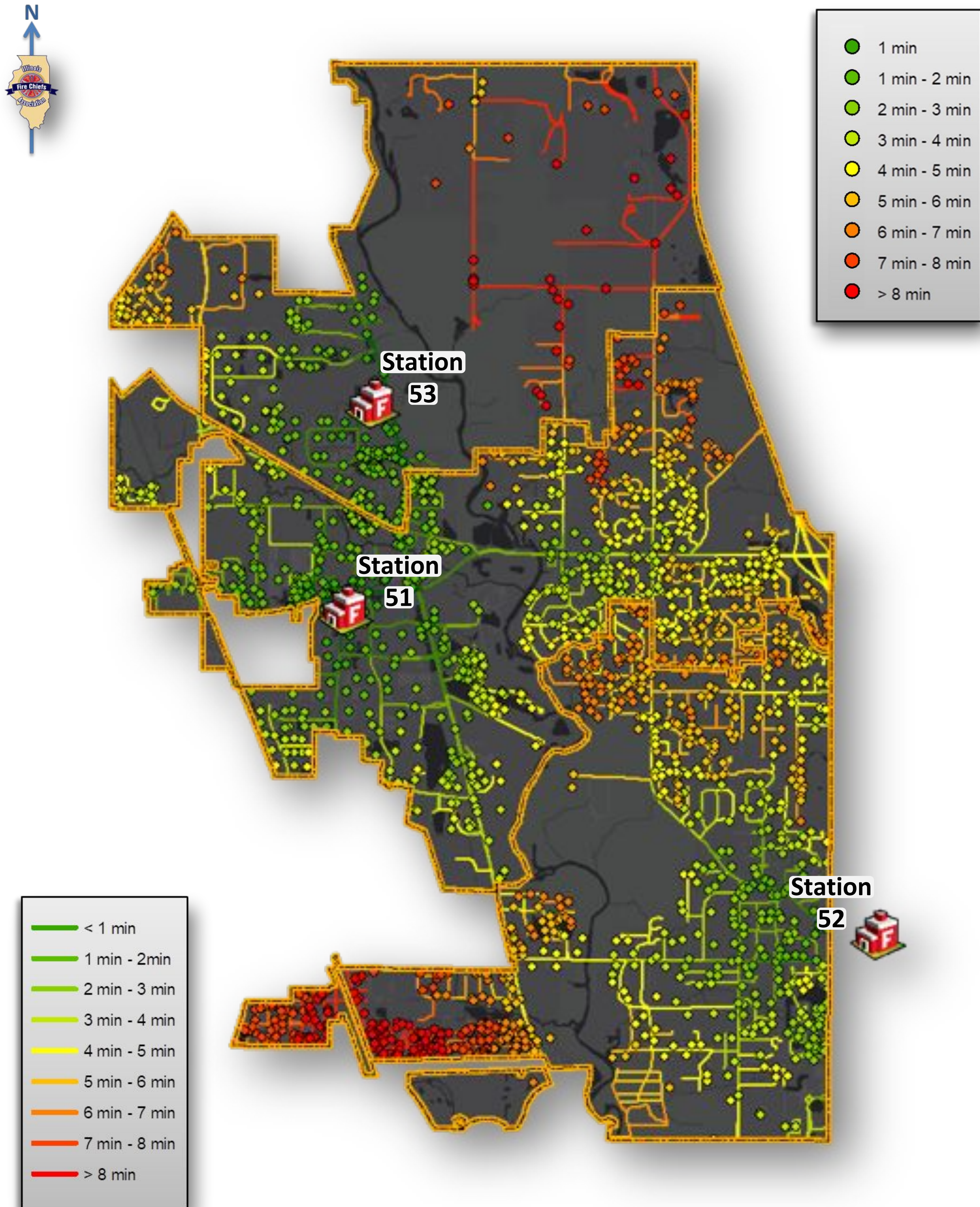
Percentage of TRA Incidents

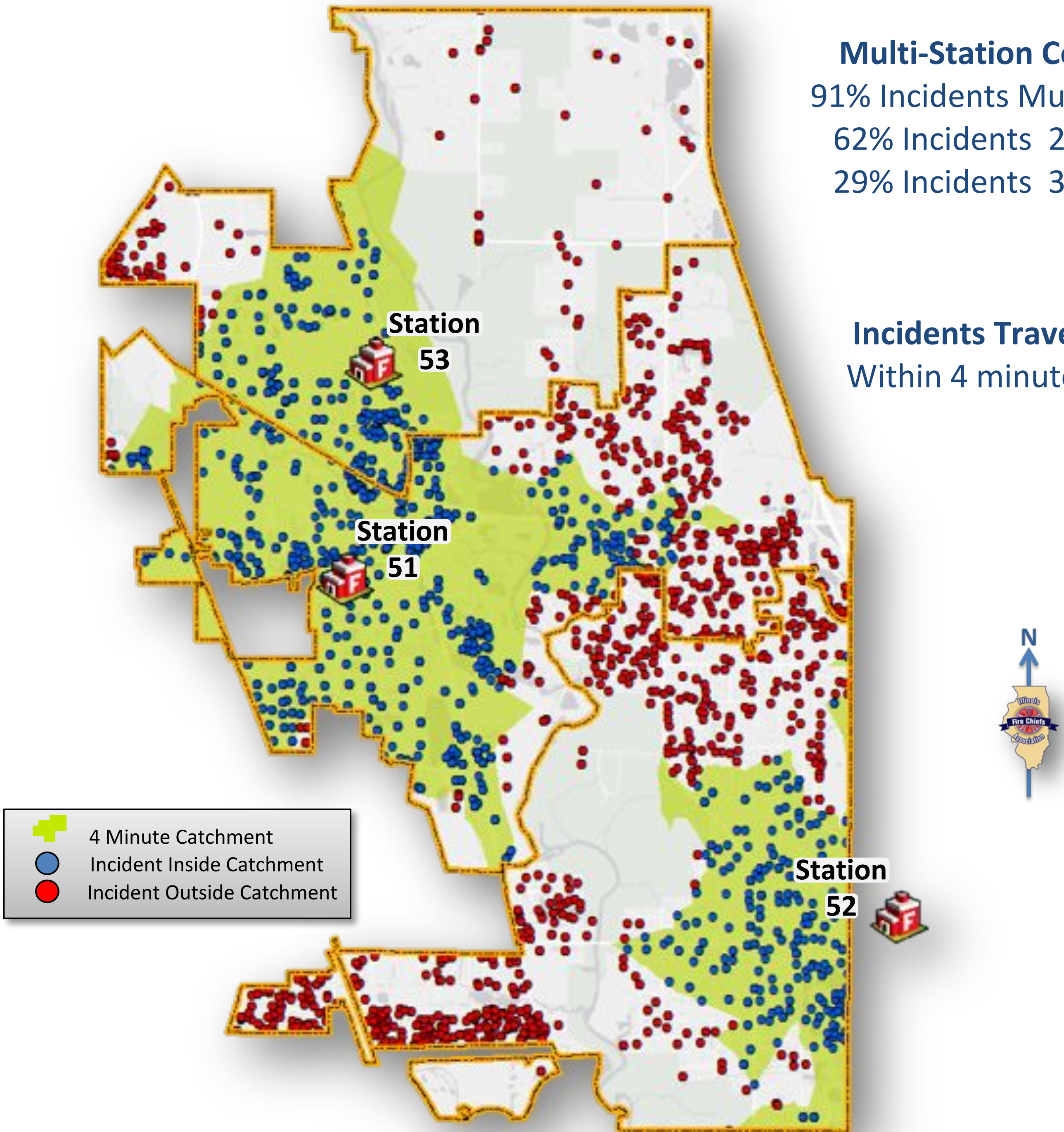
Station 51: 100%

Station 52: 0%

Station 53: 0%

NFIRS 900: Special Incident Type


N
Station 53
Station 51
Station 52
1 min
1 min - 2 min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min
< 1 min
1 min - 2min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min



Multi-Station Coverage

91% Incidents Multi-Station

62% Incidents 2 Station

29% Incidents 3 Station

Incidents Travel Time

Within 4 minutes: 67%

Historic Incidents w/in NFPA Response Time Standards

Complete TRA: Fires 74% EMS 76%

Within 4 Minute Catchment: Fires 93% EMS 89%

Historic Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
All	0:07:17	0:06:12	0:05:27	0:04:55	0:04:28
Fire	0:07:28	0:05:49	0:05:07	0:04:20	0:03:49
EMS	0:06:38	0:05:40	0:05:04	0:04:38	0:04:14

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:07:24	0:05:49	0:05:09	0:04:37	0:04:09
Historic	0:07:17	0:06:12	0:05:27	0:04:55	0:04:28

Fire Incidents Response Time (h:mm:ss)

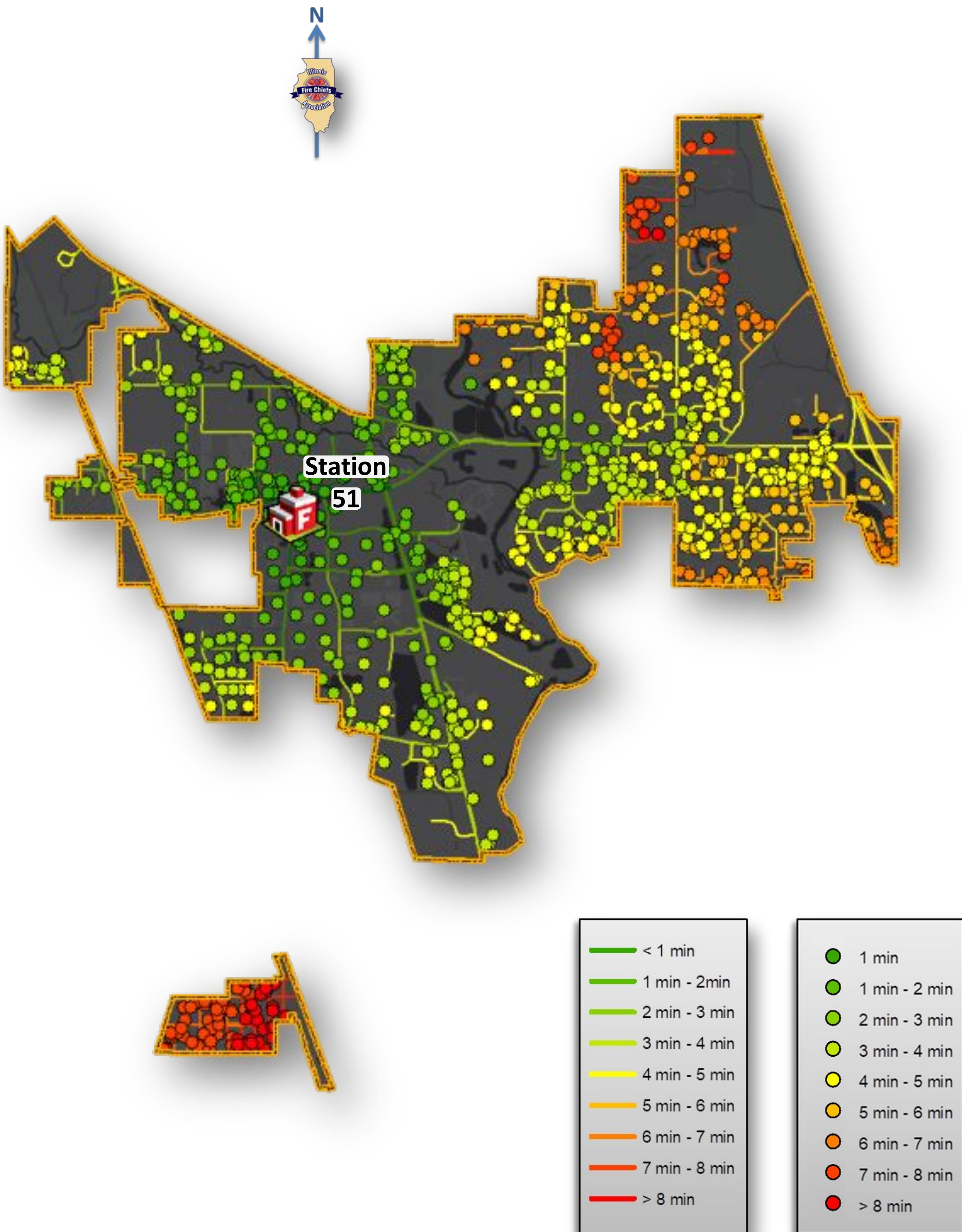
	90th %	80th %	70th %	60th %	50th %
Ideal	0:09:24	0:07:15	0:05:50	0:04:24	0:03:37
Historic	0:07:28	0:05:49	0:05:07	0:04:20	0:03:49

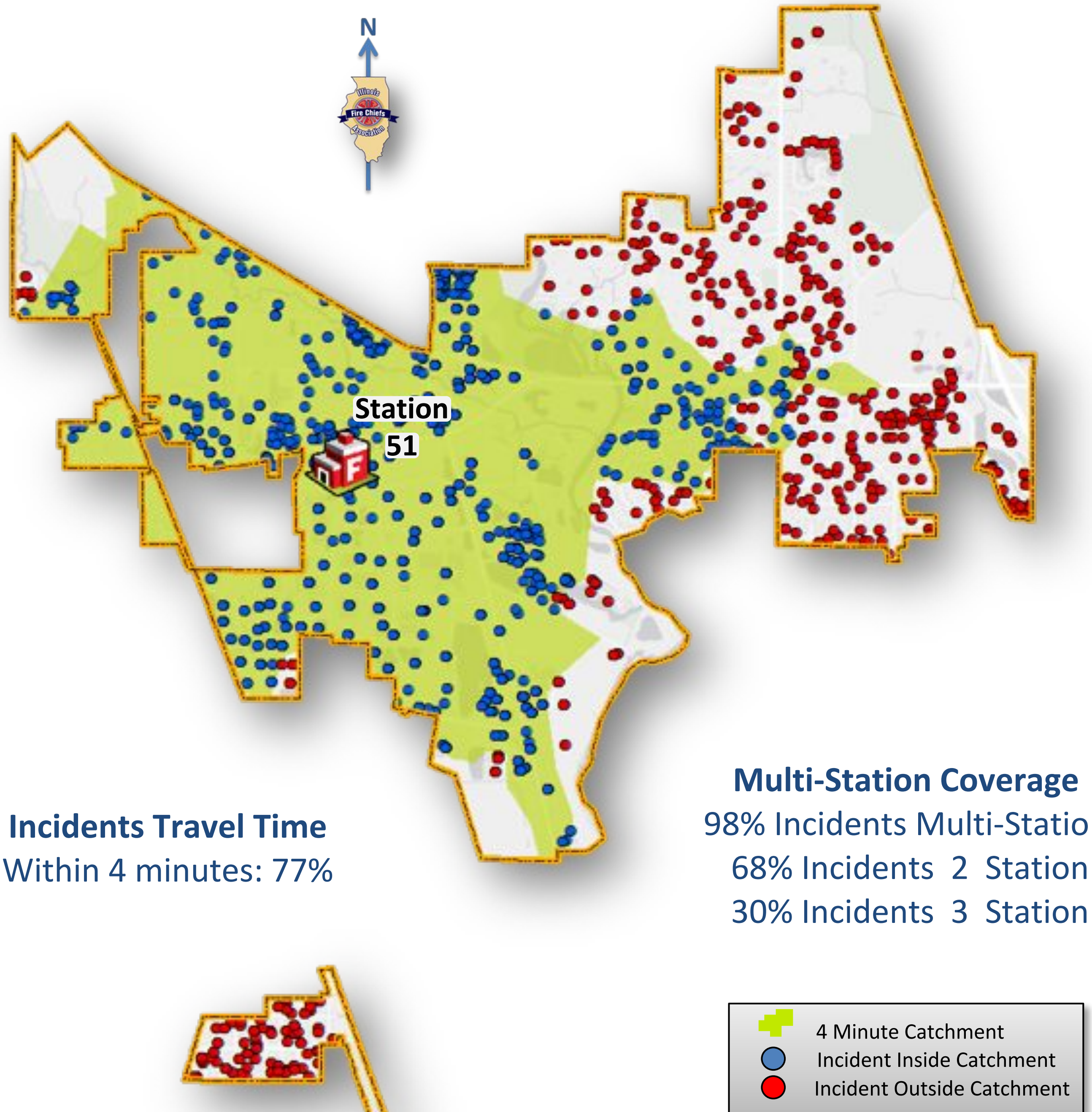
EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:07:23	0:05:41	0:05:09	0:04:38	0:04:17
Historic	0:06:38	0:05:40	0:05:04	0:04:38	0:04:14

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:07:26	0:06:03	0:05:08	0:04:33	0:03:58
Historic	0:08:33	0:07:09	0:06:19	0:05:37	0:05:02


N
Station 51
< 1 min
1 min - 2min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min
1 min
1 min - 2 min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min



Incidents Travel Time
Within 4 minutes: 77%

Multi-Station Coverage
98% Incidents Multi-Station
68% Incidents 2 Station
30% Incidents 3 Station

Historic Incidents w/in NFPA Response Time Standards

Complete TRA: Fires 84% EMS 76%

Within 4 Minute Catchment: Fires 92% EMS 89%

Historic Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
All	0:06:50	0:05:46	0:05:09	0:04:40	0:04:14
Fire	0:06:17	0:04:54	0:04:20	0:03:34	0:02:54
EMS	0:06:03	0:05:19	0:04:51	0:04:27	0:04:06

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:05:49	0:05:09	0:04:38	0:04:18	0:03:37
Historic	0:06:50	0:05:46	0:05:09	0:04:40	0:04:14

Fire Incidents Response Time (h:mm:ss)

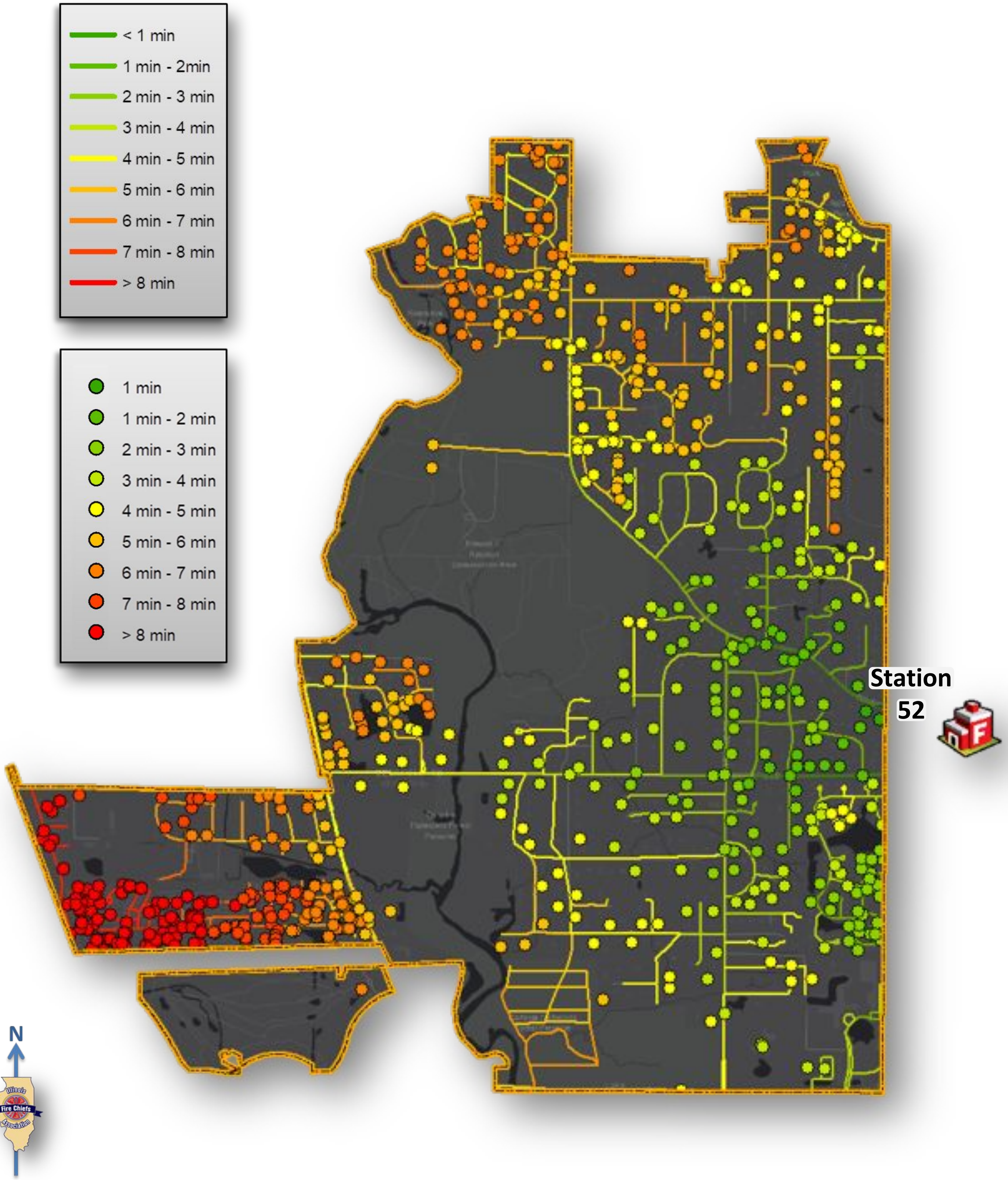
	90th %	80th %	70th %	60th %	50th %
Ideal	0:09:12	0:04:36	0:03:49	0:03:08	0:02:49
Historic	0:06:17	0:04:54	0:04:20	0:03:34	0:02:54

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:05:35	0:05:09	0:04:38	0:04:18	0:03:41
Historic	0:06:03	0:05:19	0:04:51	0:04:27	0:04:06

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:06:09	0:05:10	0:04:37	0:04:09	0:03:33
Historic	0:08:26	0:06:58	0:06:11	0:05:27	0:04:54


< 1 min
1 min - 2min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min
1 min
1 min - 2 min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min
Station 52
N

Multi-Station Coverage

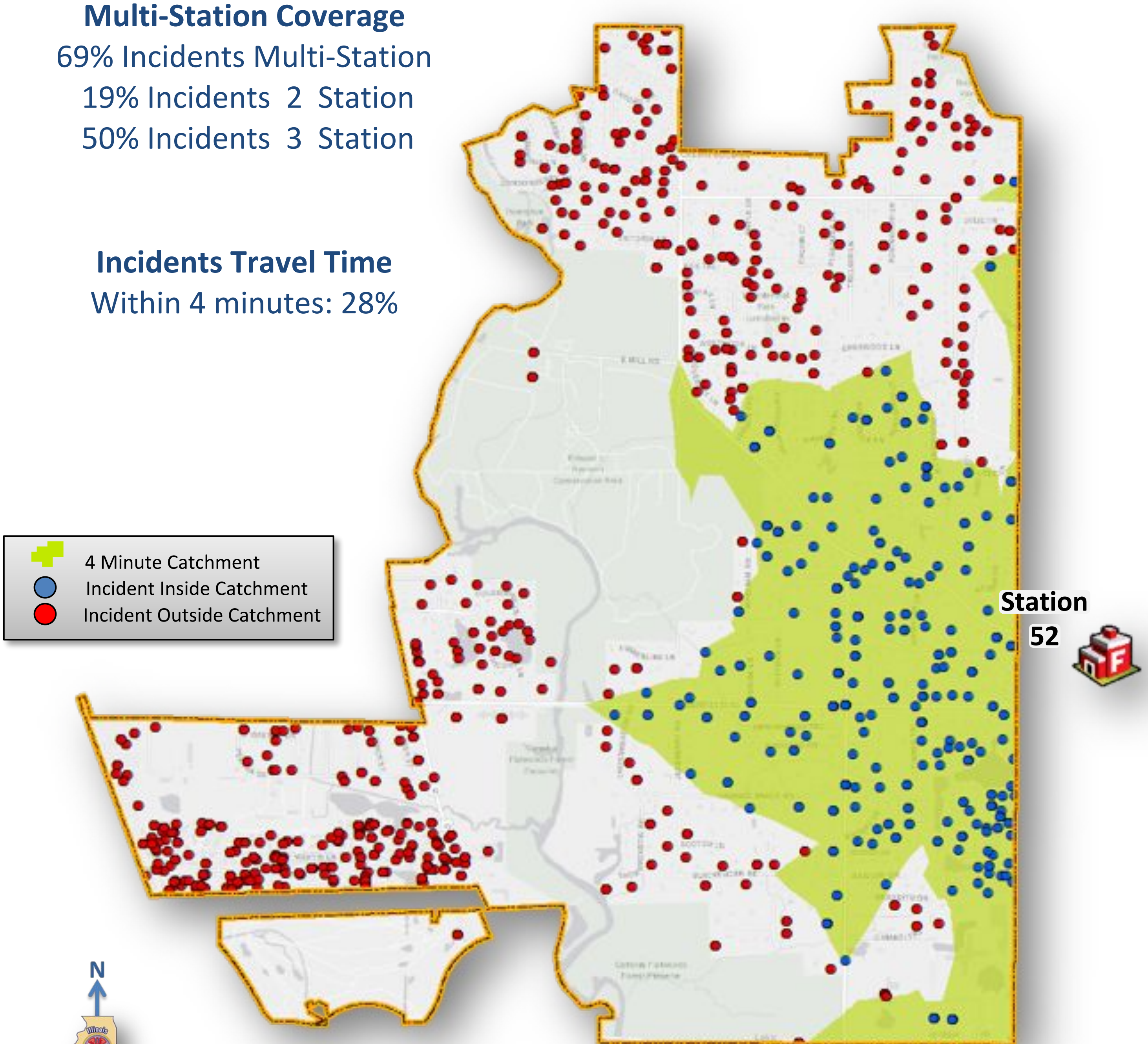
69% Incidents Multi-Station

19% Incidents 2 Station

50% Incidents 3 Station

Incidents Travel Time

Within 4 minutes: 28%



Historic Incidents w/in NFPA Response Time Standards

Complete TRA: Fires 58% EMS 60%

Within 4 Minute Catchment: Fires 100% EMS 84%

Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
All	0:07:36	0:06:48	0:06:11	0:05:39	0:05:09
Fire	0:06:39	0:05:57	0:05:40	0:05:17	0:04:47
EMS	0:07:19	0:06:38	0:05:58	0:05:31	0:05:01

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:09:31	0:07:58	0:07:19	0:06:39	0:05:55
Historic	0:07:36	0:06:48	0:06:11	0:05:39	0:05:09

Fire Incidents Response Time (h:mm:ss)

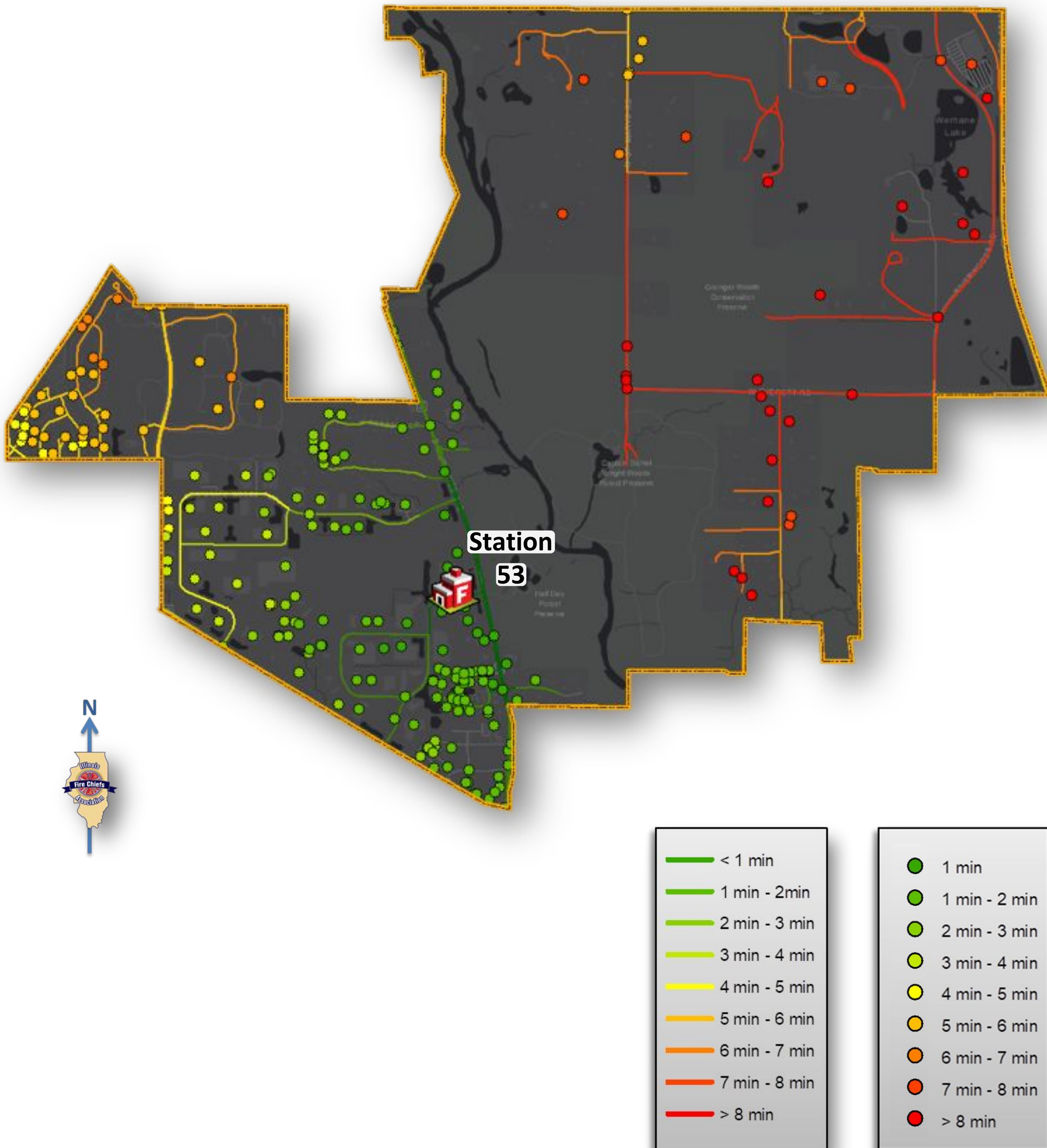
	90th %	80th %	70th %	60th %	50th %
Ideal	0:09:10	0:07:34	0:07:29	0:06:47	0:06:42
Historic	0:06:39	0:05:57	0:05:40	0:05:17	0:04:47

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:09:43	0:08:18	0:07:23	0:06:43	0:05:56
Historic	0:07:19	0:06:38	0:05:58	0:05:31	0:05:01

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:08:44	0:07:41	0:07:07	0:06:26	0:05:55
Historic	0:08:36	0:07:11	0:06:32	0:05:58	0:05:28


Station 53
N
< 1 min
1 min - 2min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min
1 min
1 min - 2 min
2 min - 3 min
3 min - 4 min
4 min - 5 min
5 min - 6 min
6 min - 7 min
7 min - 8 min
> 8 min

Incidents Travel Time

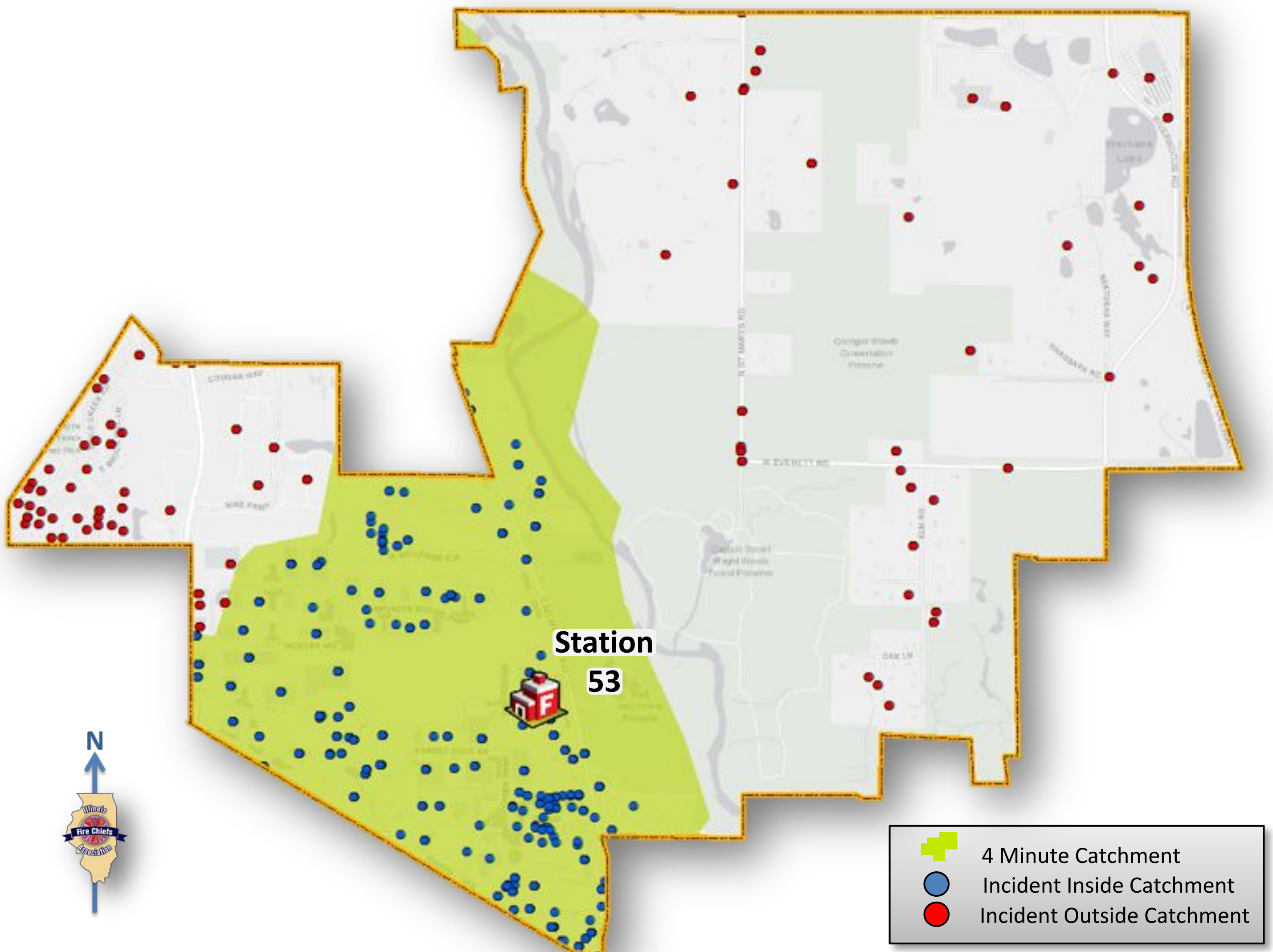
Within 4 minutes: 81%

Multi-Station Coverage

97% Incidents Multi-Station

19% Incidents 2 Station

50% Incidents 3 Station



Historic Incidents w/in NFPA Response Time Standards

Complete TRA: Fires 56% EMS 76%

Within 4 Minute Catchment: Fires 100% EMS 93%

Historic Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
All	0:08:00	0:06:41	0:05:32	0:04:46	0:04:14
Fire	0:09:07	0:08:22	0:08:16	0:05:23	0:04:47
EMS	0:07:09	0:05:50	0:04:44	0:04:13	0:03:46

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:08:10	0:04:44	0:04:04	0:03:14	0:02:45
Historic	0:08:00	0:06:41	0:05:32	0:04:46	0:04:14

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:10:53	0:09:24	0:09:16	0:06:50	0:06:02
Historic	0:09:07	0:08:22	0:08:16	0:05:23	0:04:47

EMS Incidents Response Time (h:mm:ss)

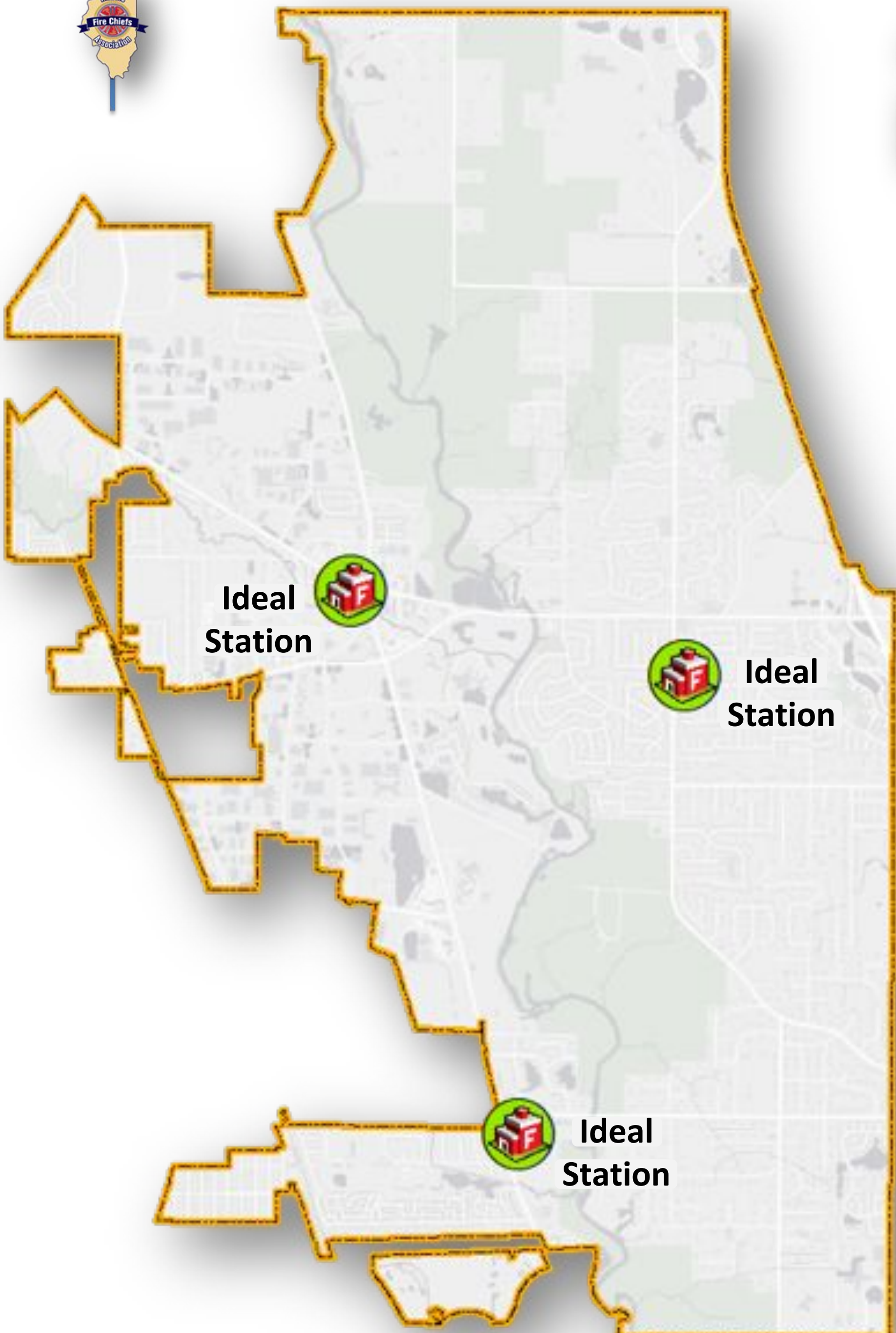
	90th %	80th %	70th %	60th %	50th %
Ideal	0:07:12	0:05:49	0:03:50	0:02:45	0:02:38
Historic	0:07:09	0:05:50	0:04:44	0:04:13	0:03:46

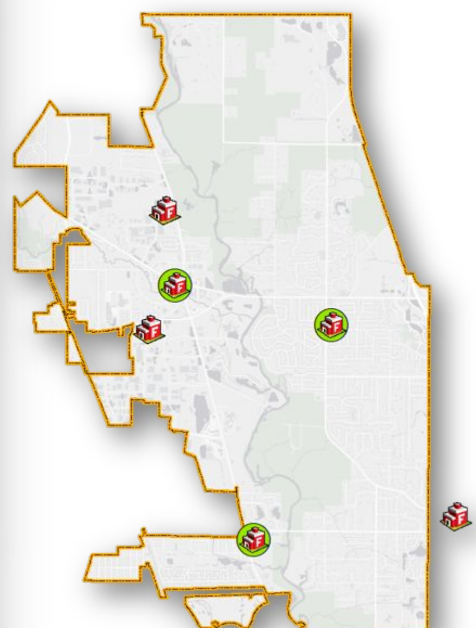
Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal	0:08:10	0:04:43	0:04:09	0:03:42	0:02:55
Historic	0:08:47	0:07:24	0:06:28	0:05:32	0:04:54

Ideal Fire Station Placement
Ideal Fire Station Location
Ideal Station with Current Stations - TRA
Comparison - 4 and 8 minute Catchment
Comparison - Incidents within 4 minutes
Hot Spots with Station 52 Relocated
Comparison - TRA Incidents
Comparison - AOR 51 Incidents
Comparison - AOR 52 Incidents
Comparison - AOR 53 Incidents
Comparison - No Station 53 4 and 8 minute Catchment
Comparison - No Station 53 Incidents within 4 minutes
Comparison - No Station 53 TRA Incidents
Comparison - No Station 53 AOR 51 Incidents
Comparison - No Station 53 AOR 52 Incidents
Fire Station 51 South Location
Comparison - Station 51 South 4 and 8 minute Catchment
Comparison - Station 51 South Incidents within 4 minutes
Comparison - Station 51 South TRA Incidents
Comparison - Station 51 South AOR 51 Incidents
Comparison - Station 51 South AOR 52 Incidents
Comparison - Station 51 South AOR 53 Incidents

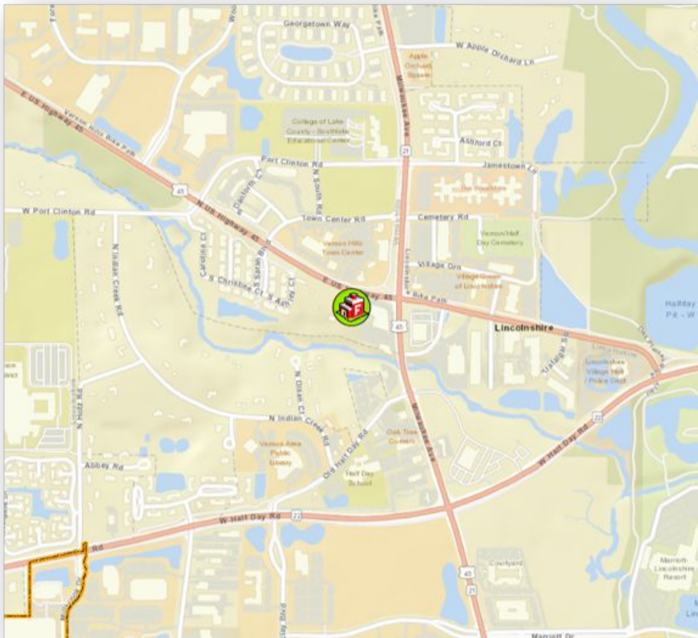
The map displays 441 possible sites.



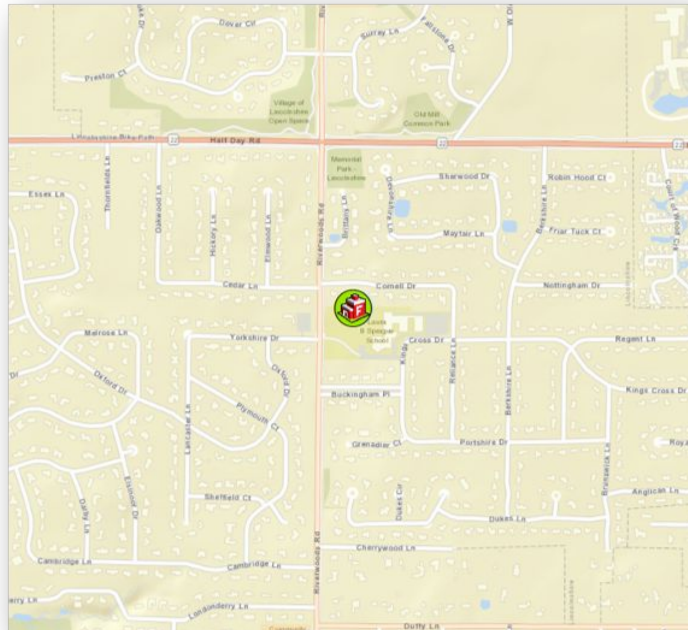


Ideal Station Location:

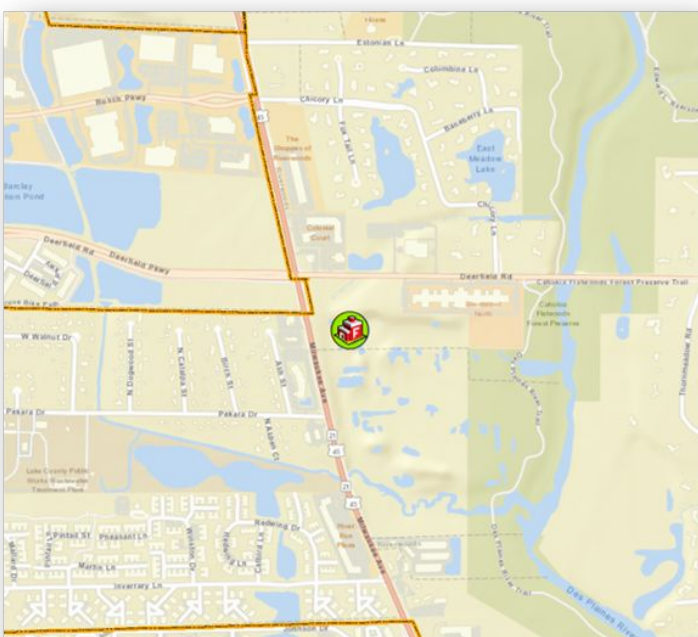
The Ideal Station Location was calculated using ESRI's Location –Allocation Analysis tool. 441 possible fire station sites were used with a 4 min drive time as the cutoff to reach as many incidents as possible.



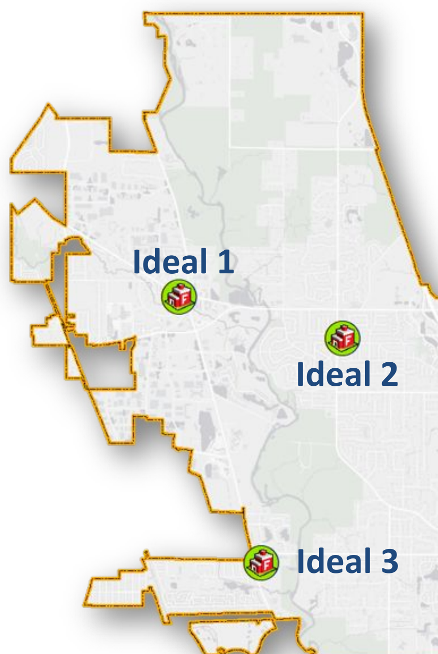
Ideal 1



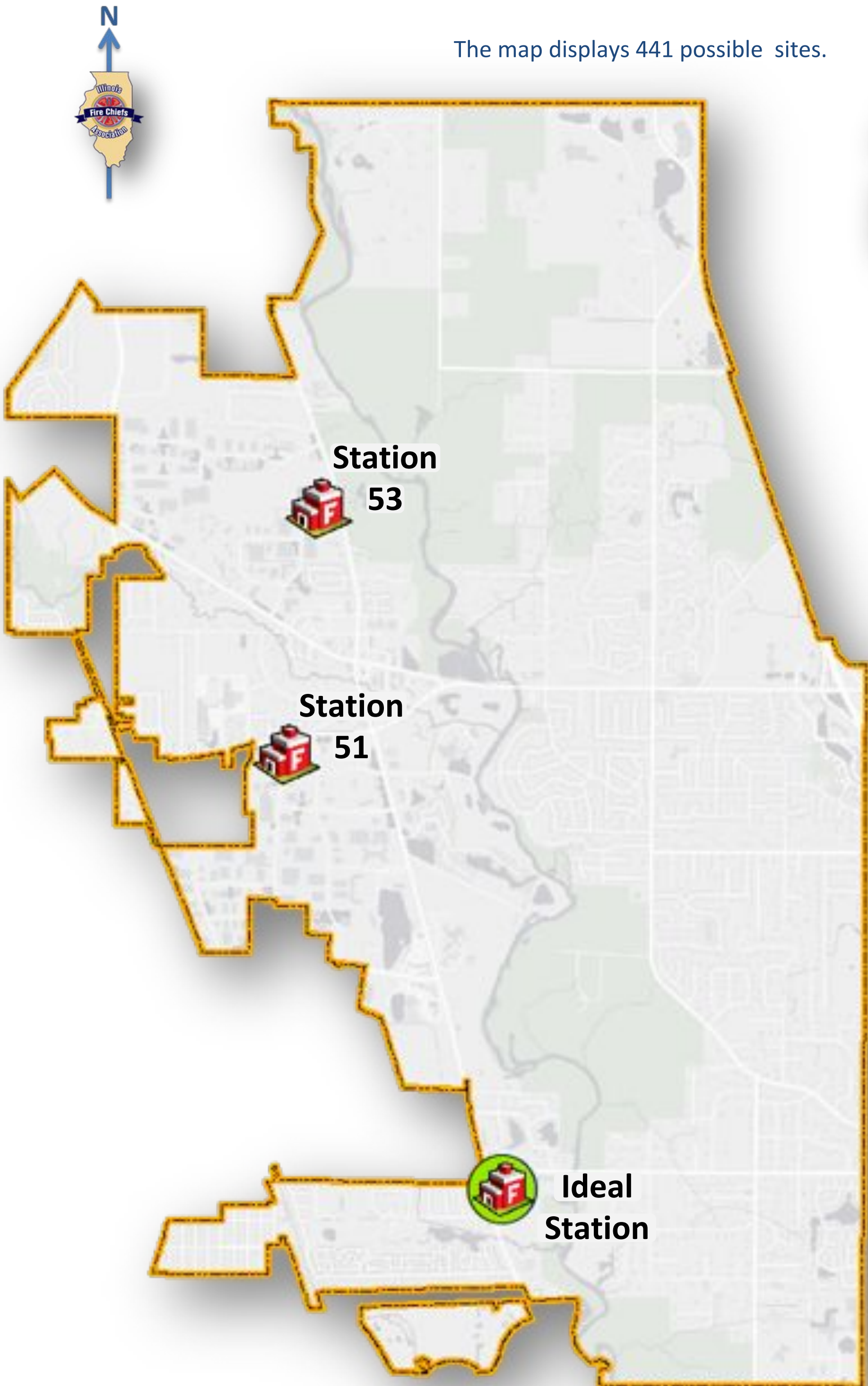
Ideal 2

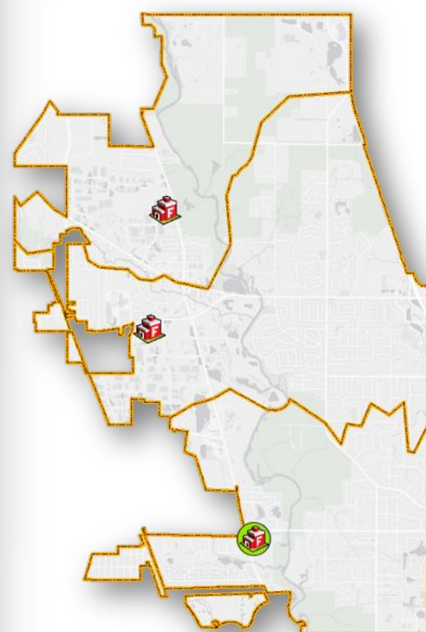


Ideal 3



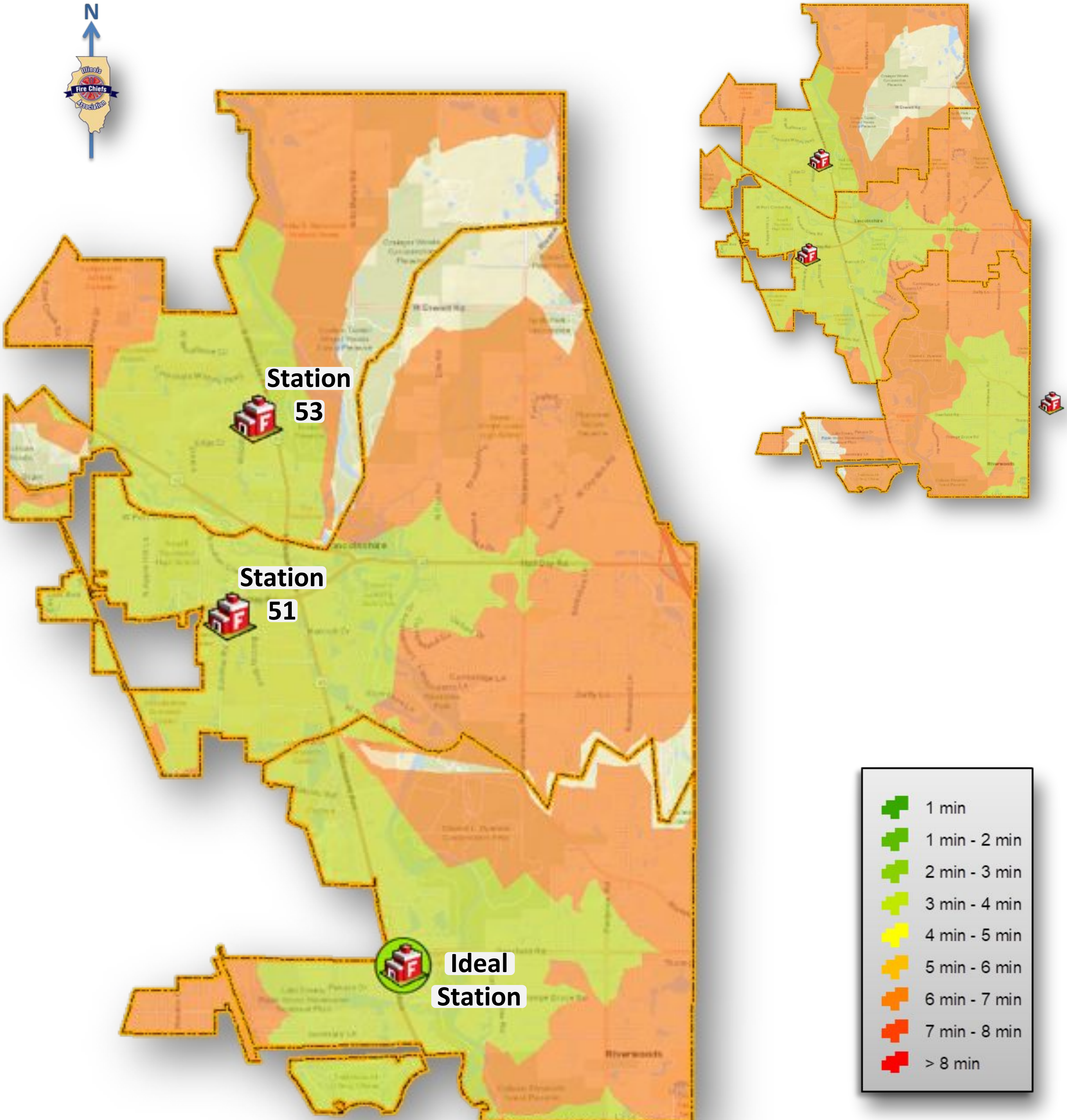
The map displays 441 possible sites.





Ideal Station Location:

The Ideal Station Location was calculated using ESRI's Location –Allocation Analysis tool. Stations 51 and 53 along with 441 possible fire station sites were used. A 4 min drive time was used as the cutoff to reach as many incidents as possible.



4 minute Coverage

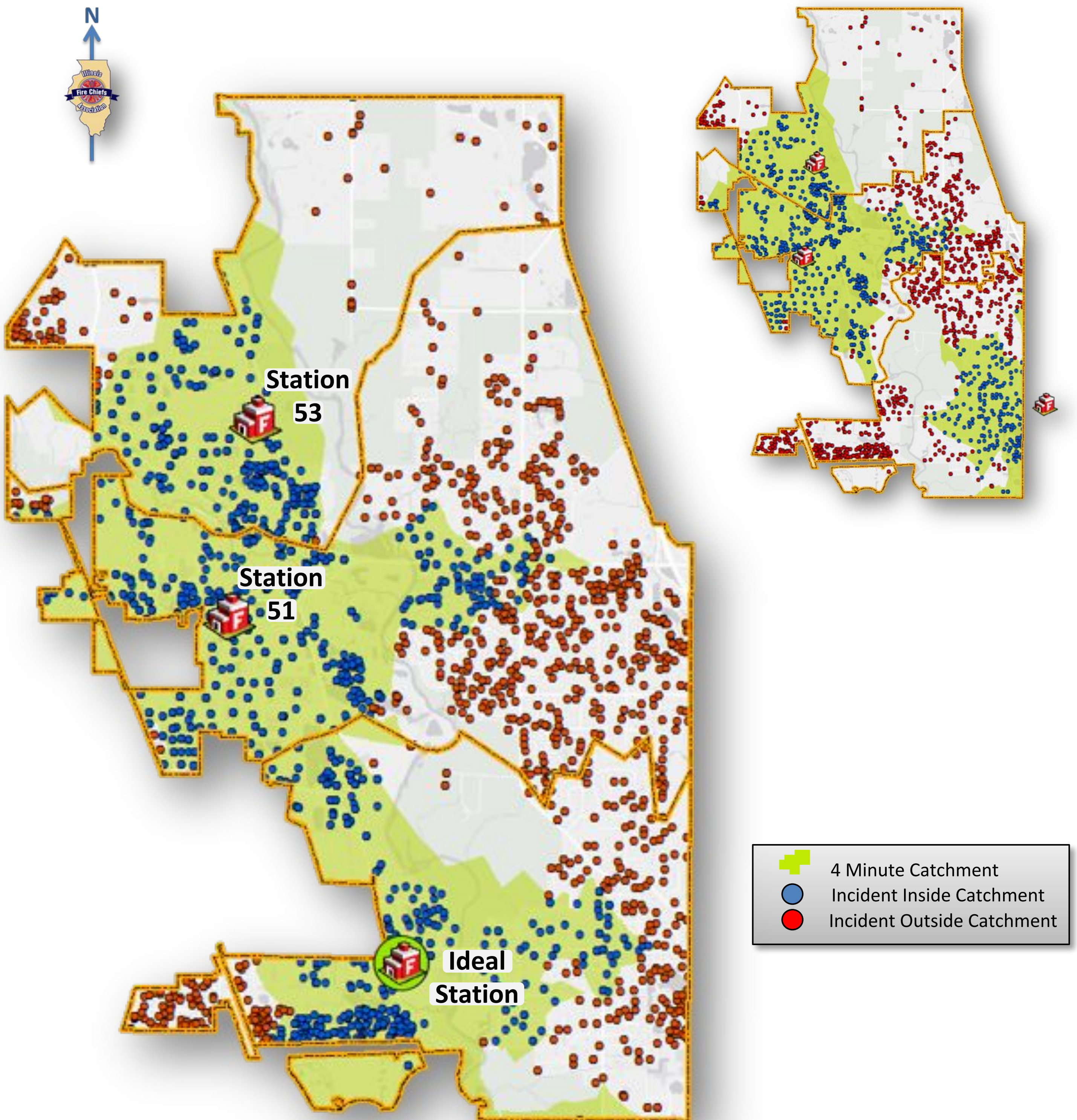
Current 6.1 sq. miles

Proposed 6.4 sq. miles

8 minute Coverage

Current 14.7 sq. miles

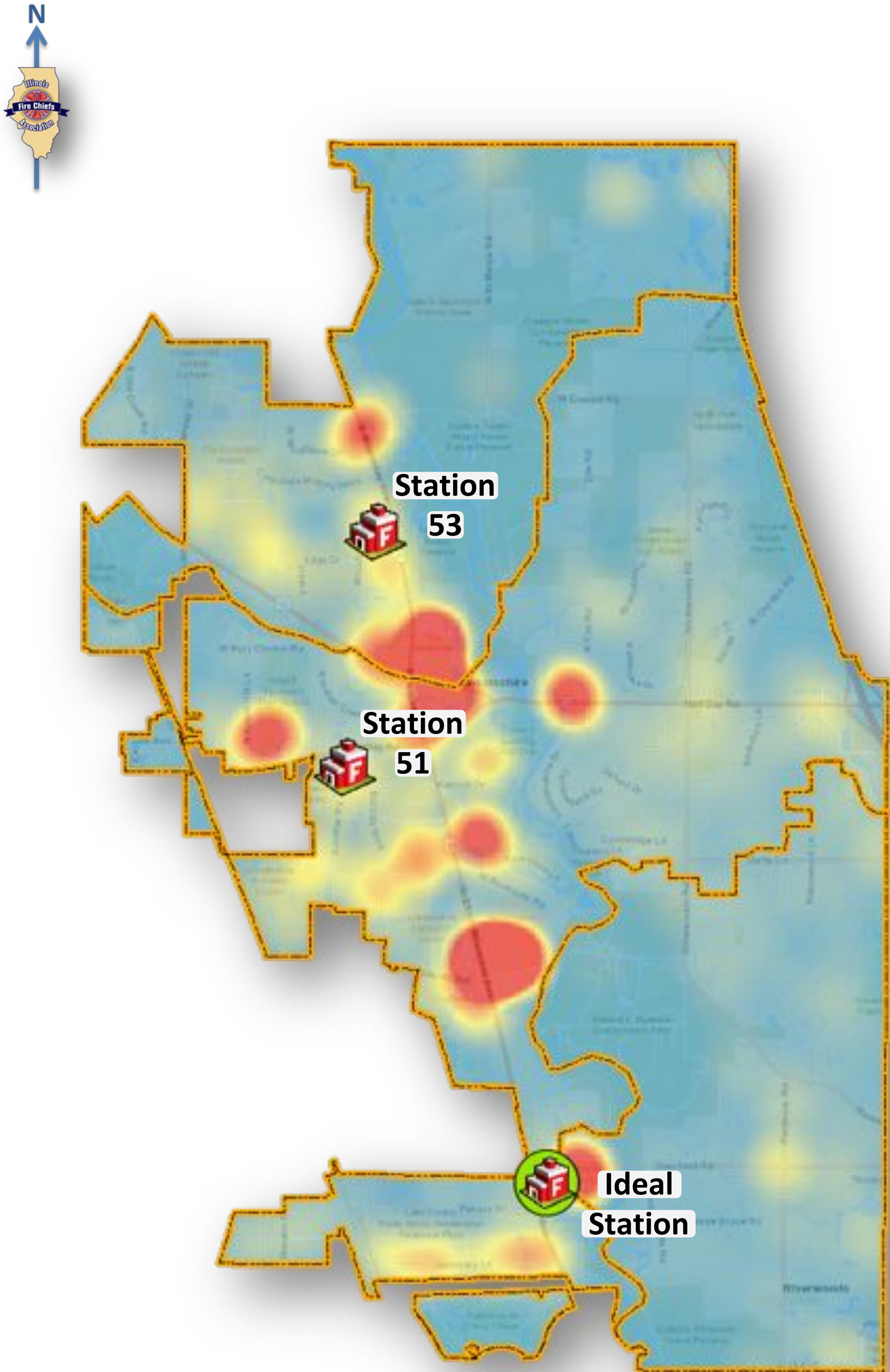
Proposed 14.3 sq. miles



Incidents Travel Time within 4 minutes:

Current 5,385 incidents, 67% of all incidents

Proposed 6234, incidents, 78% of all incidents


N
Station
53
Station
51
Ideal
Station

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:05:14	0:04:39	0:04:07	0:03:44	0:03:22
Current 2 with Ideal	0:06:43	0:05:15	0:04:37	0:03:57	0:03:31
Historic	0:07:17	0:06:12	0:05:27	0:04:55	0:04:28

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:07:13	0:05:23	0:04:22	0:04:22	0:04:22
Current 2 with Ideal	0:07:13	0:05:23	0:04:22	0:04:22	0:04:22
Historic	0:07:28	0:05:49	0:05:07	0:04:20	0:03:49

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:04:59	0:04:31	0:04:07	0:03:46	0:03:19
Current 2 with Ideal	0:06:26	0:04:53	0:04:28	0:03:57	0:03:31
Historic	0:06:38	0:05:40	0:05:04	0:04:38	0:04:14

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:05:33	0:04:47	0:04:11	0:03:37	0:03:23
Current 2 with Ideal	0:07:09	0:05:42	0:04:50	0:04:06	0:03:30
Historic	0:08:33	0:07:09	0:06:19	0:05:37	0:05:02

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:06:18	0:04:52	0:04:23	0:03:53	0:03:24
Current 2 with Ideal	0:07:04	0:05:48	0:04:54	0:03:37	0:03:27
Historic	0:06:50	0:05:46	0:05:09	0:04:40	0:04:14

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:08:19	0:07:07	0:06:38	0:04:37	0:03:32
Current 2 with Ideal	0:08:19	0:07:07	0:06:38	0:04:37	0:03:32
Historic	0:06:17	0:04:54	0:04:20	0:03:34	0:02:54

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:05:40	0:04:43	0:04:07	0:03:27	0:03:05
Current 2 with Ideal	0:06:54	0:05:39	0:04:34	0:03:37	0:03:25
Historic	0:06:03	0:05:19	0:04:51	0:04:27	0:04:06

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:07:08	0:05:21	0:04:46	0:04:18	0:03:50
Current 2 with Ideal	0:07:25	0:06:09	0:05:20	0:04:07	0:03:31
Historic	0:08:26	0:06:58	0:06:11	0:05:27	0:04:54

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:05:57	0:04:54	0:04:39	0:04:28	0:04:06
Current 2 with Ideal	0:06:09	0:04:54	0:04:39	0:04:28	0:04:00
Historic	0:07:36	0:06:48	0:06:11	0:05:39	0:05:09

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:07:44	0:07:16	0:05:52	0:05:23	0:04:28
Current 2 with Ideal	0:07:44	0:07:16	0:05:52	0:05:23	0:04:28
Historic	0:06:39	0:05:57	0:05:40	0:05:17	0:04:47

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:05:31	0:04:43	0:04:39	0:04:26	0:04:05
Current 2 with Ideal	0:05:35	0:04:43	0:04:39	0:04:27	0:04:05
Historic	0:07:19	0:06:38	0:05:58	0:05:31	0:05:01

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:06:33	0:05:25	0:04:58	0:04:39	0:04:06
Current 2 with Ideal	0:06:53	0:05:35	0:05:01	0:04:39	0:03:56
Historic	0:08:36	0:07:11	0:06:32	0:05:58	0:05:28

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:04:26	0:03:45	0:03:25	0:03:15	0:03:05
Current 2 with Ideal	0:06:26	0:04:16	0:03:23	0:02:54	0:02:42
Historic	0:08:00	0:06:41	0:05:32	0:04:46	0:04:14

Fire Incidents Response Time (h:mm:ss)

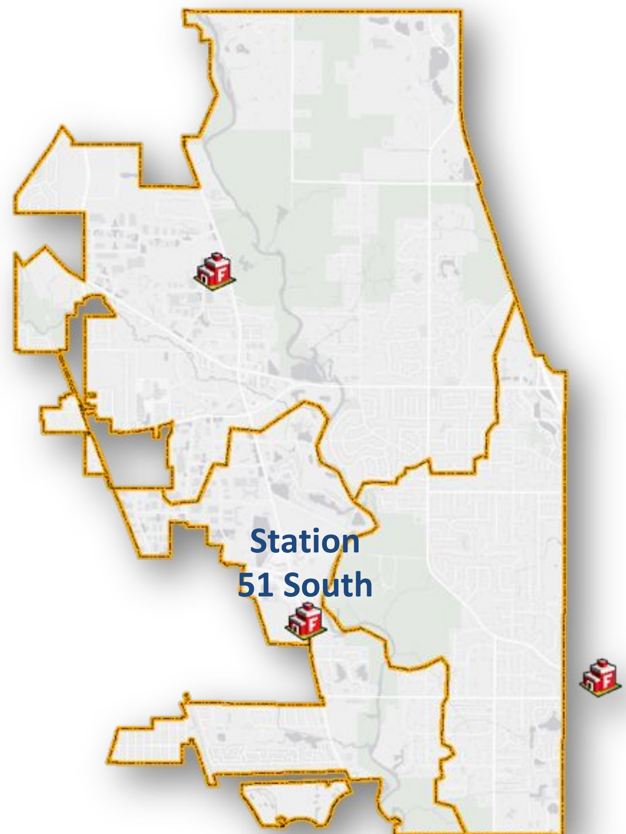
	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:04:22	0:04:22	0:04:22	0:04:22	0:04:22
Current 2 with Ideal	0:04:22	0:04:22	0:04:22	0:04:22	0:04:22
Historic	0:09:07	0:08:22	0:08:16	0:05:23	0:04:47

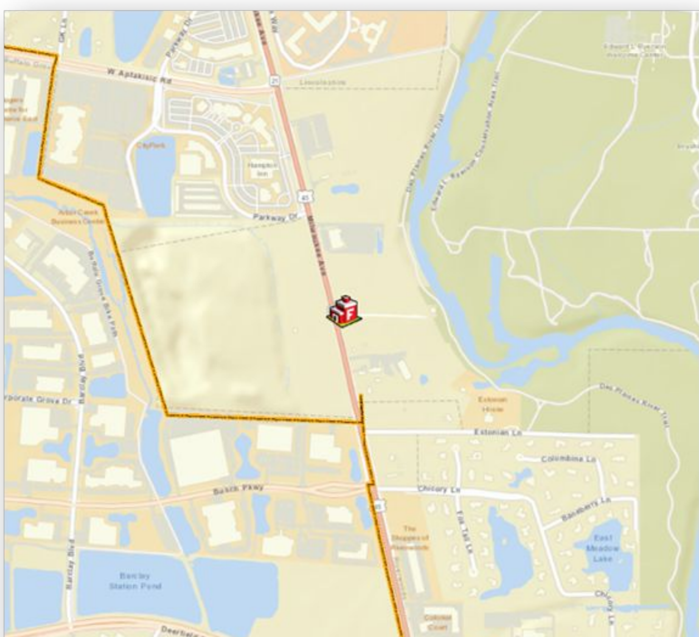
EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:04:24	0:03:29	0:03:23	0:03:13	0:02:59
Current 2 with Ideal	0:06:26	0:03:55	0:02:57	0:02:42	0:02:42
Historic	0:07:09	0:05:50	0:04:44	0:04:13	0:03:46

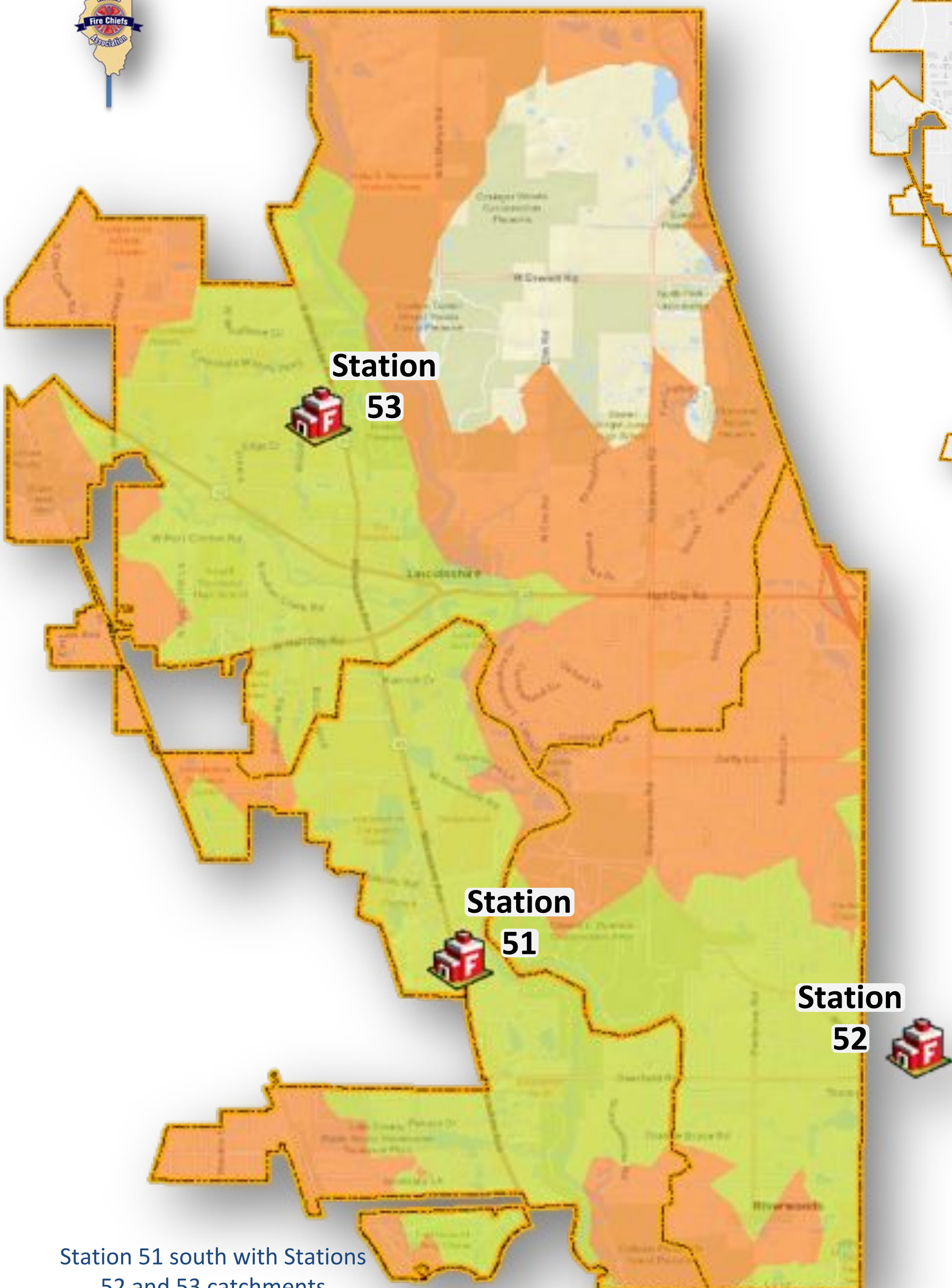
Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Ideal Station	0:04:32	0:03:53	0:03:26	0:03:17	0:03:07
Current 2 with Ideal	0:06:49	0:04:38	0:04:00	0:03:23	0:02:54
Historic	0:08:47	0:07:24	0:06:28	0:05:32	0:04:54

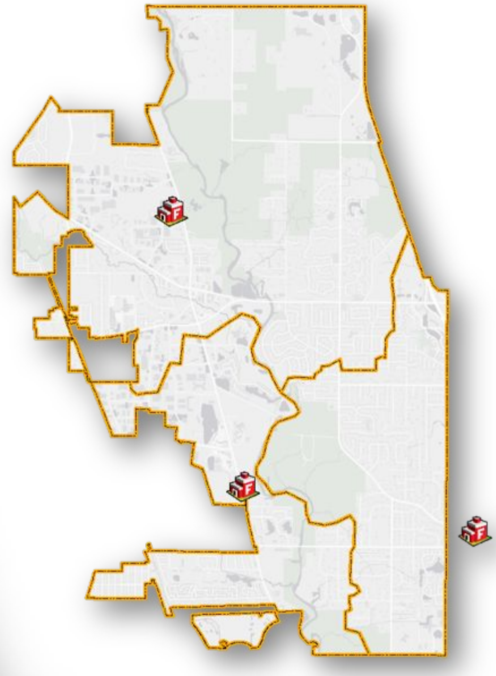




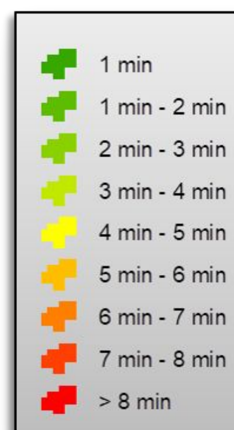
Station 51 South



Station 51 south with Stations 52 and 53 catchments



Station 51 south and Stations 52 and 53 AORs



4 minute Coverage

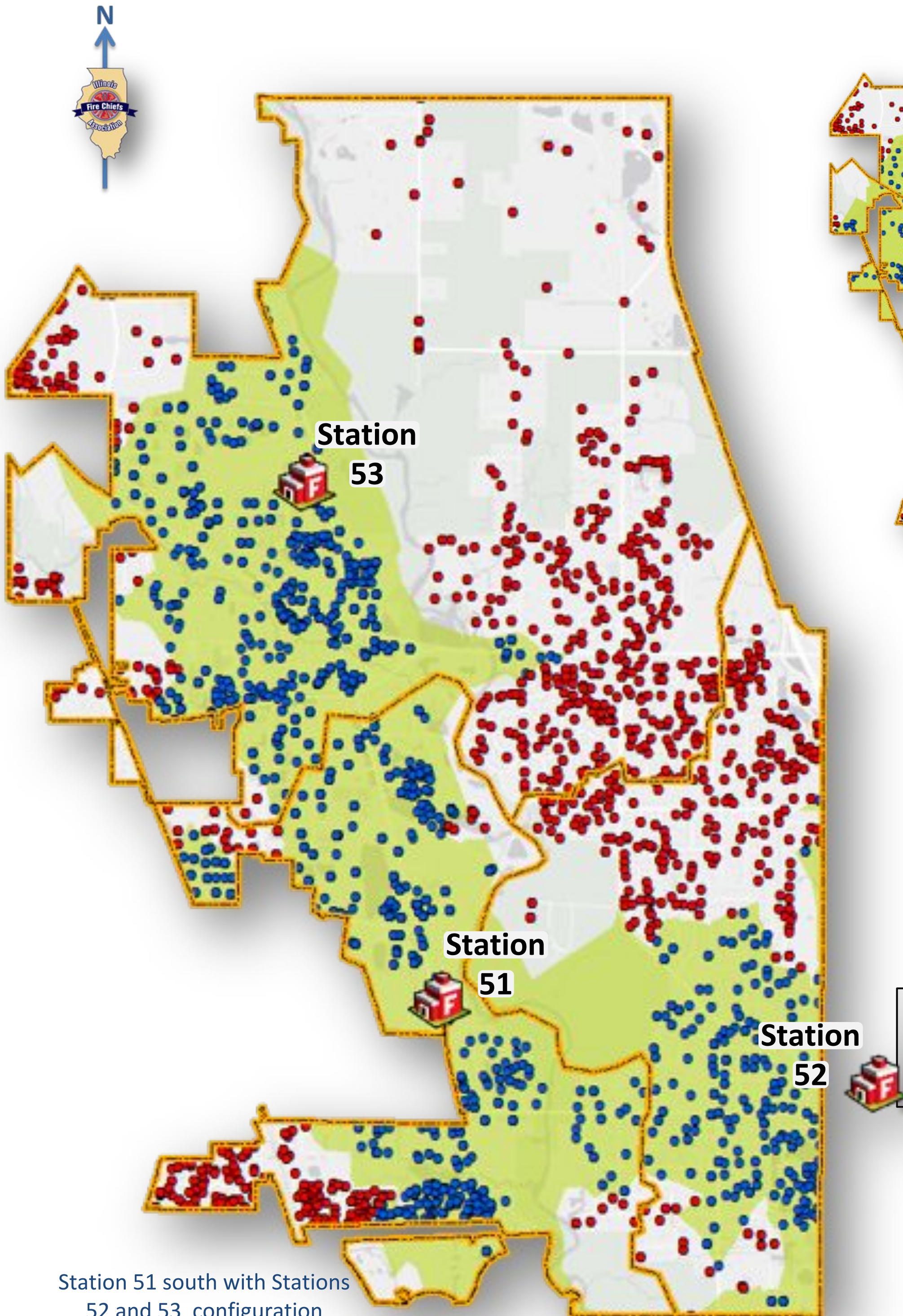
Current 6.1 sq. miles

Proposed 7.0 sq. miles

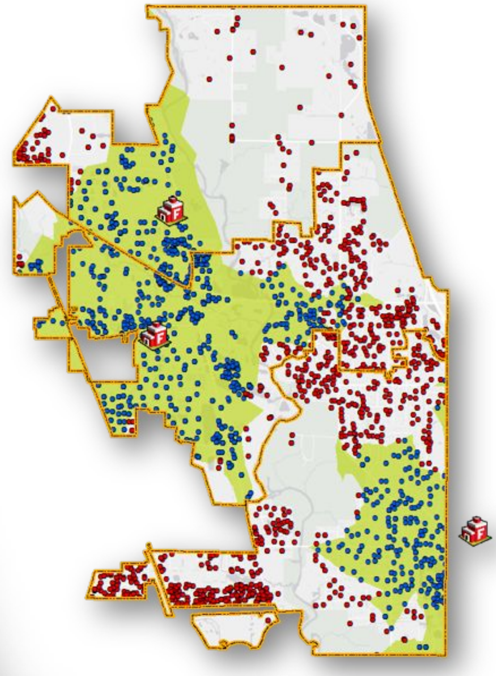
8 minute Coverage

Current 14.7 sq. miles

Proposed 14.4 sq. miles



Station 51 south with Stations 52 and 53 configuration



Current configuration

Incidents Travel Time within 4 minutes:

Current 5,385 incidents, 67% of all incidents

Proposed 6,021 incidents, 75% of all incidents

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:06:49	0:05:38	0:04:40	0:04:10	0:03:34
Current 2 with Ideal	0:06:43	0:05:15	0:04:37	0:03:57	0:03:31
Historic	0:07:17	0:06:12	0:05:27	0:04:55	0:04:28

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:08:15	0:06:35	0:05:46	0:05:46	0:05:38
Current 2 with Ideal	0:07:13	0:05:23	0:04:22	0:04:22	0:04:22
Historic	0:07:28	0:05:49	0:05:07	0:04:20	0:03:49

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:06:36	0:05:13	0:04:30	0:03:47	0:03:31
Current 2 with Ideal	0:06:26	0:04:53	0:04:28	0:03:57	0:03:31
Historic	0:06:38	0:05:40	0:05:04	0:04:38	0:04:14

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:06:58	0:06:03	0:04:55	0:04:30	0:03:54
Current 2 with Ideal	0:07:09	0:05:42	0:04:50	0:04:06	0:03:30
Historic	0:08:33	0:07:09	0:06:19	0:05:37	0:05:02

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:05:15	0:04:29	0:03:47	0:03:31	0:03:21
Current 2 with Ideal	0:07:04	0:05:48	0:04:54	0:03:37	0:03:27
Historic	0:06:50	0:05:46	0:05:09	0:04:40	0:04:14

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:08:15	0:07:52	0:05:14	0:04:20	0:03:45
Current 2 with Ideal	0:08:19	0:07:07	0:06:38	0:04:37	0:03:32
Historic	0:06:17	0:04:54	0:04:20	0:03:34	0:02:54

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:05:11	0:04:18	0:03:35	0:03:31	0:03:21
Current 2 with Ideal	0:06:54	0:05:39	0:04:34	0:03:37	0:03:25
Historic	0:06:03	0:05:19	0:04:51	0:04:27	0:04:06

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:05:15	0:04:39	0:04:01	0:03:42	0:03:26
Current 2 with Ideal	0:07:25	0:06:09	0:05:20	0:04:07	0:03:31
Historic	0:08:26	0:06:58	0:06:11	0:05:27	0:04:54

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:09	0:06:41	0:06:20	0:05:57	0:05:03
Current 2 with Ideal	0:06:09	0:04:54	0:04:39	0:04:28	0:04:00
Historic	0:07:36	0:06:48	0:06:11	0:05:39	0:05:09

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:09	0:06:44	0:06:35	0:04:19	0:04:14
Current 2 with Ideal	0:07:44	0:07:16	0:05:52	0:05:23	0:04:28
Historic	0:06:39	0:05:57	0:05:40	0:05:17	0:04:47

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:09	0:06:36	0:06:19	0:05:39	0:05:03
Current 2 with Ideal	0:05:35	0:04:43	0:04:39	0:04:27	0:04:05
Historic	0:07:19	0:06:38	0:05:58	0:05:31	0:05:01

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:12	0:06:49	0:06:20	0:06:04	0:05:14
Current 2 with Ideal	0:06:53	0:05:35	0:05:01	0:04:39	0:03:56
Historic	0:08:36	0:07:11	0:06:32	0:05:58	0:05:28

All Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:06	0:06:02	0:04:50	0:04:30	0:03:48
Current 2 with Ideal	0:06:26	0:04:16	0:03:23	0:02:54	0:02:42
Historic	0:08:00	0:06:41	0:05:32	0:04:46	0:04:14

Fire Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:08:30	0:05:46	0:05:46	0:05:46	0:05:46
Current 2 with Ideal	0:04:22	0:04:22	0:04:22	0:04:22	0:04:22
Historic	0:09:07	0:08:22	0:08:16	0:05:23	0:04:47

EMS Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:06:55	0:05:52	0:04:50	0:04:25	0:03:35
Current 2 with Ideal	0:06:26	0:03:55	0:02:57	0:02:42	0:02:42
Historic	0:07:09	0:05:50	0:04:44	0:04:13	0:03:46

Other Incidents Response Time (h:mm:ss)

	90th %	80th %	70th %	60th %	50th %
Station 51 South	0:07:41	0:06:16	0:04:55	0:04:32	0:03:55
Current 2 with Ideal	0:06:49	0:04:38	0:04:00	0:03:23	0:02:54
Historic	0:08:47	0:07:24	0:06:28	0:05:32	0:04:54

Unit Hour Utilization
(UHU)

UHU's at 90th Percentile of Commit Times

	Fire		EMS		Other		Total
	Commit Time	UHU	Commit Time	UHU	Commit Time	UHU	UHU
Station 51	1:29:59	< 0.01	1:33:56	0..20	00:35:03	0.03	**0.23**
Station 52	2:53:14	< 0.01	1:31:23	0.06	00:34:31	0.05	**0.11**
Station 53	2:15:01	< 0.01	1:29:08	0.04	00:34:31	0.03	**0.07**
Total		**0.01**		**0.30**		**0.11**	**0.42**

UHU's at 50th Percentile of Commit Times

	Fire		EMS		Other		Total
	Commit Time	UHU	Commit Time	UHU	Commit Time	UHU	UHU
Station 51	00:25:34	< 0.01	1:00:28	0..13	00:16:41	0.02	**0.14**
Station 52	00:44:38	< 0.01	1:01:56	0.04	00:17:54	0.02	**0.06**
Station 53	00:34:40	< 0.01	12:57:11	0.03	00:15:25	0.01	**0.04**
Total		**<0.01**		**0.20**		**0.05**	**0.25**

Commit Time = Time committed to a single incident.

Analysis of Company Availability (Unit Hour Utilization-UHU)

As defined by the CPSE Manual, response reliability is defined as the probability that the required amount of staff and apparatus will be available when a fire or emergency call is received. If every piece of fire department apparatus were available in its desired location every time a fire/EMS call was received, then the department's response reliability would be 100 percent. If, however, a call is received for a particular company but that company is busy at another call, a replacement company must be assigned from another station. If the substitute station is too far away, that company cannot respond in the maximum prescribed travel time.

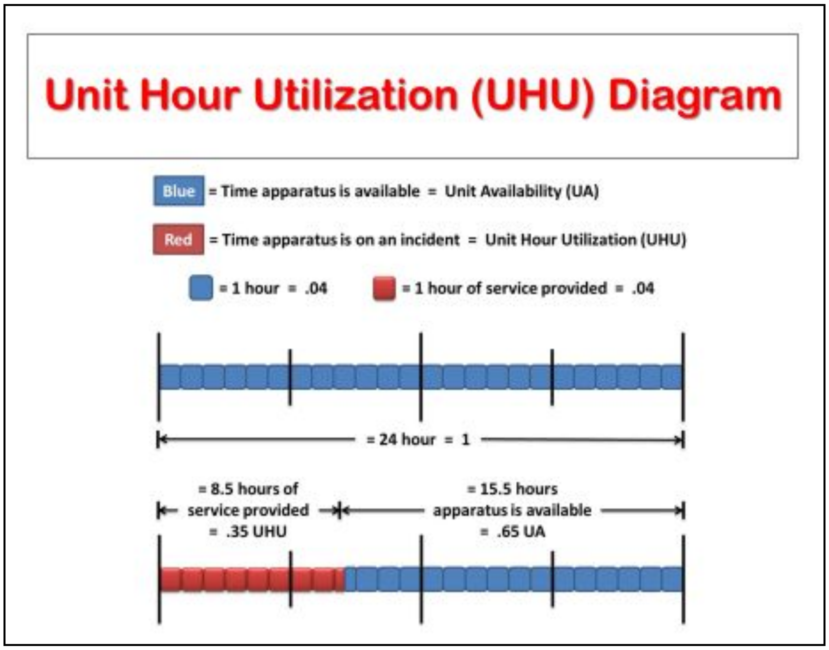
A fire company unavailable for response provides no service to the community. Basically, if a company is not available 80 percent of the time, it is not reasonable to expect the unit to perform at the 80^{th} percentile. Availability refers to the number of hours the company is able to respond to an incident over the number of hours it is in service. In a 24-hour period, if a unit is committed or unavailable for other reasons for seven (7) hours, it has only 75 percent availability remaining.

System analysis requires the use of standard performance measures to calculate success/failure rates within the areas of analysis. An alternate method to calculate the availability threshold is to calculate the Unit Hour Utilization (UHU). The graphic on the next page provides an illustration of how UHU relates to a 24-hour shift. The UHU method considers the number of hours a unit is committed on an emergency or other activity, divided by the number of overall hours a unit is available to respond.

- *A **unit hour** is equal to one hour of service by a fully equipped and staffed fire suppression unit or ambulance available for dispatch or assigned to a call.*
- ***Utilization** is a measure of productivity, which compares the available resources (i.e. unit hours) with the actual amount of time those units are being utilized for emergency calls or productive activity. This measurement is calculated to determine the percentage of unit hours actually consumed in productivity compared with the total staffed unit-hours.*

In most dynamic deployment systems such as the System Status Management program used by private ambulance companies, UHU rates as high as .40 can be achieved. This, however, can lead to paramedic burnout. This is considered to be the point at which a unit is fully committed. For static or fixed deployment systems such as the traditional fire station, the maximum UHU is closer to .25 – .30 depending on factors such as geography or the transportation network and other workload that must be accomplished.

It should be noted that at .30 UHU (or 70% of the time), a 24-hour company does not have time for inspections, training of new personnel, public education activities, or personal time for studying or other self-improvement.



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National Standards

The National Fire Protection Association (NFPA) uses consensus standard rule making. The NFPA was formed in 1896 by a group of insurance firm representatives with the stated purpose of standardizing the new and burgeoning market of fire sprinkler systems. The scope of the NFPA's influence grew from sprinklers to include building electrical systems (another new and fast-growing technology), and then all aspects of building design and construction.

Its original membership consisted of, and was limited to, insurance underwriting firms. NFPA did not allow representation from the industries it sought to regulate. This changed in 1904 to allow other industries and individuals to participate actively in the development of the standards promulgated by the NFPA. The first fire department to be represented in the NFPA was the New York City Fire Department in 1905. Today, the NFPA includes representatives from many fire departments, insurance companies, manufacturing associations, unions, trade organizations, and average people.

NFPA consensus standards establish widely accepted standards of care and requirements for certain practices. Standards are an attempt by an industry or profession to self-regulate by establishing minimal operating, performance, and/or safety standards, which establish a recognized “standard of care.” Committees composed of industry representatives, fire service representatives, and other affected parties, who seek consensus in their final rule, write these standards. The outcome is a “minimum” that everyone can agree on, rather than an “optimum” that is the best case.

The NFPA has many standards that affect fire departments. These standards should be followed by fire departments to protect fire and rescue personnel from unnecessary workplace hazards. The NFPA standards establish the standard of care that may be used to evaluate fire department performance in civil lawsuits against fire and rescue departments (NFPA, 1995). In most cases, compliance with NFPA standards is voluntary. However in some cases, federal or state OSHA agencies have incorporated wording from NFPA standards into regulations. In these cases, compliance with the standards is mandatory.

Regardless of whether compliance with an NFPA standard is voluntary or mandatory, fire and rescue departments must consider the impact of “voluntary” standards on private litigation. In some states, a department may be liable for the negligent performance of its duties. Even in states that protect rescue workers under an immunity statute, most state laws do not protect fire or rescue departments for grossly negligent or willful and wanton acts. Essentially, negligence involves the violation of a standard of care that results in injury or loss to some other individual or organization.

In establishing the standard of care for fire and rescue operations, the courts will frequently look to the "voluntary" standards issued by NFPA and other organizations. Although "voluntary" in name, these standards can be utilized as evidence of the existence of a standard of care that fire or rescue departments may be responsible to comply with. Accordingly, fire and rescue departments should pay close attention to applicable standards.

The mission of the NFPA, established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education.

The world's leading advocate of fire prevention and an authoritative source on public safety, NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

These codes and standards are developed by technical committees staffed by over 6,000 volunteers, and are adopted and enforced throughout the world (NFPA, 2012). Therefore, applicable NFPA standards and codes will be applied within this study.

ISO is mainly concerned with property risk potential. The Insurance Services Office's purpose is to review and categorize a community's ability to fight fires. ISO measures major elements of a community's fire suppression system, such as personnel training; staffing levels of fire apparatus; water supply and distribution systems; receiving and dispatching fire alarms; firefighting equipment; needed fire flow; and fire company locations.

The components of the ISO rating are:

1. Water supply
2. Communications
3. Fire service personnel and training
4. Age and condition of apparatus
5. Automatic and mutual aid agreements
6. Community risk reduction, etc.

By analyzing the data and using criteria outlined in a rating schedule, ISO produces a final classification number for a community. Each of the 43,000 plus communities evaluated by ISO across the U.S. is graded from 1 to 10, with 1 being the best.

The ratings determine insurance rates for property owners. Generally, lower scores yield lower rates.

However, using only the insurance company criteria may produce unrealistic expectations about how effectively the fire department can reduce loss of life. ISO states that their regulations are not intended to design fire departments. Yet, in a practical way they do, for two reasons:

- Fire departments have been intensely influenced by ISO criteria in the past; therefore, the rating process is ingrained into a city's beliefs about fire safety. For instance, ISO stated that a 20 - year old fire truck had to be replaced due to its age regardless of the unit's front line ability.

- Insurance grading remains a strong political influence because the general-public and/or elected officials do not understand the limitations of fire protection operations. If the public perceives it pays lower insurance rates because of the ISO rating (current fire department design), then they will not pressure the fire protection agency to become more cost effective and efficient, regardless of its limitations.

The Insurance Services Office, Inc. (ISO) publishes and utilizes the Fire Suppression Rating Schedule (FSRS) to “review available public fire suppression facilities and to develop a Public Protection Classification (PPC) for insurance purposes.”

A Class 1 rating is considered superior fire protection, while a Class 10 does not meet the ISO’s minimum criteria. Many insurance companies utilize this rating system to establish premium schedules for fire insurance. Communities with a lower rating can generally expect to have lower fire insurance premiums than those with higher ratings, thus creating an incentive for the communities’ investment in fire protection. However, most insurance rates are often driven by a competitive market between insurance companies, with ISO having little impact. ISO attempts to reevaluate fire departments every 15 years.

In evaluating a community's public fire protection, ISO considers the distribution of fire companies. Generally, ISO’s criteria say that a built-upon area of a community should have a first-due engine company within 1.5 road miles of the protected properties and a ladder-service company within 2.5 road miles.

Those benchmark criteria produce an expected response time of 3.2 minutes for an engine company and 4.9 minutes for a ladder-service company, based on a formula developed by the RAND Corporation.

RAND conducted extensive studies of fire department response times. They concluded that the average speed for a fire apparatus responding with emergency lights and siren is 35 mph. That speed considers average terrain, average traffic, weather, and slowing down for intersections.

Taking into account the average speed and the time required for an apparatus to accelerate from a stop to the travel speed, RAND developed the following equation for calculating the travel time:

Formula: $T = 0.65+1.7D$

- T = time in minutes to the nearest 1/10 of a minute
- 0.65 = a vehicle-acceleration constant for the first 0.5 mile traveled
- 1.7 = a vehicle-speed constant validated for response distances ranging from 0.5 miles to 8.0 miles
- D = distance

ISO, working with several fire departments, recently conducted its own review of the formula and found the earlier RAND work still valid as a predictive tool.

The analysis of company distribution, ISO does not measure or use actual historical response times of individual communities. Many fire departments lack accurate and reliable response-time information, and there is no standardized national record-keeping system that would allow us to determine accurate departmental response times.

Also, it would be inappropriate to incite fire-service personnel to push fire apparatus beyond a safe driving speed for the sake of faster response times, especially since U.S. Fire Administration statistics for 2005 indicate that 17% of firefighter on-duty fatalities resulted from responding to alarms.

ISO is not mandatory , but its requirements and ramifications must be given full consideration when making decisions regarding the nature of projects such as station location or apparatus reponses. The parameters set by ISO are a proven measurement of the fire protection potential of a community and have a direct impact on the ability to attract businesses to the community.

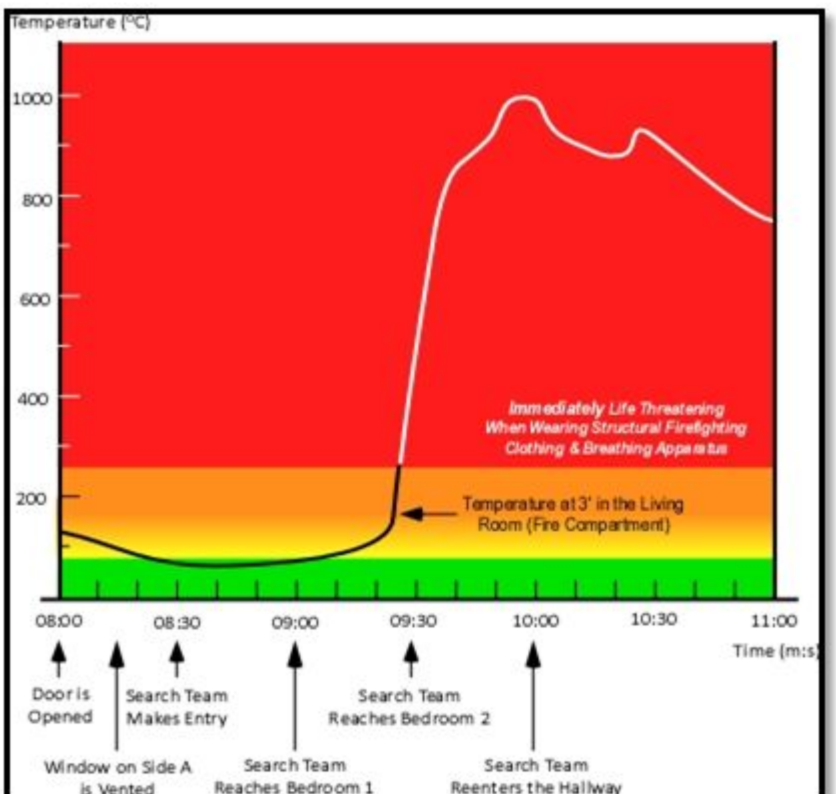
There is limited value in attempting to assess a fire department by solely utilizing the community's ISO rating; rather, the Commission on Fire Accreditation International (CFAI) accreditation process far exceeds any other type of instrument in measuring a service

In 1986, the International Association of Fire Chiefs (IAFC) has developed a program that measures the quality and performance of a particular fire service agency and award national accreditation to those departments that pass the stringent criteria.

The Center for Public Safety Excellence (CPSE) utilizes a process known as the Commission on Fire Accreditation International (CFAI). Accreditation is divided into 45 criteria with 252 performance indicators. Of these performance indicators, 86 are core competencies.

Accreditation is a structured process for documenting the levels of fire safety, fire prevention, fire safety education, and fire suppression services currently provided, and for determining the future level of service the department should provide. Accreditation demonstrates a department's commitment to continuous improvement, serving the community efficiently, and providing a fair and safe work environment for all personnel and document whether its fire protection services are appropriate, adequate, and effective.
Each department must examine every area of its operation and determine the most cost-effective means of providing service. The advantage to the CFAI accreditation program lies in the process itself.

A Reflex Chart is designed to provide emergency responders with a general rule of time over events and highlights significant benchmarks within the variations of fire growth. These events must be taken into consideration when developing a response strategy and selection of appropriate tactics. As discussed in Underwriter's Laboratory Studies Tactical Implications (2011), fires in the contemporary environment (as opposed to traditionally constructed buildings) progress from ignition and incipient stage to growth, but often become ventilation controlled and begin to decay, rather than continuing to grow into a fully developed fire. This ventilation induced decay continues until the ventilation profile changes (e.g., window failure due to fire effects, opening a door for entry or egress, or intentional creation of ventilation openings by firefighters. When ventilation is increased, heat release rate again rises and temperature climbs with the fire potentially transitioning through flashover to the fully developed stage. The purpose of this study is not to discuss the strategy and tactics involved in firefighting in structure fires. However, it is important to create an awareness of recent data in the correlation of fire growth, building construction and its relationship between response times and firefighter intervention.



Note: Figure 8 illustrates temperature conditions starting <u>eight minutes after ignition</u>. The fire previously progressed through incipient and growth stages before beginning to decay due to lack of ventilation.

National Institute

of

Standards and Technology

(NIST)

Overview

This report is the first of its kind to quantify the effects of crew sizes and arrival times on the fire service's lifesaving and firefighting operations for residential fires as well as EMS operations. While this report focuses on the location of fire stations, the service delivery of each is affected by location and staffing and we felt that an overview of the NIST Field Report was important to review.

It is imperative that decision-makers understand that fire risks grow exponentially. Each minute of delay is critical to the safety of the occupants and firefighters, and is directly related to property damage (NIST Technical Note 1661, Report on Residential Fireground Field Experiments, 2010). These experiments directly addressed 22 fireground activities that routinely occur on a scene of a typical residential fire.

22 Fireground Activities	
Stop @ Hydrant, Wrap Hose	Advance Back Up Line Stairwell
Position Engine 1	Conduct Primary Search
Conduct Size-up	Ground Ladders Placed
Engage Pump	Horizontal Ventilation
Position Attack Line	Horizontal Ventilation (2nd Story)
Establish 2 In/2 Out	Control Utilities (Int.)
Supply Attack Engine	Control Utilities (Ext.)
Establish RIT	Conduct Secondary Search
Gain/Force Entry	Check For Fire Extension (Walls)
Advance Attack Line	Check For Fire Extension (Ceiling)
Advance Back Up Line-Front Door	Mechanical Ventilation

Scope of NIST Fireground Study

The scope of the study was limited to understanding specific variables of response and staffing configuration to "low hazard" residential structure fires as defined by National Fire Protection Association Standard 1710. The experiments utilized a residential structure of 2,000 square feet, two story, single family dwelling with no basement and no exposures.

For the purposes of analysis and evaluation of the study, the data reflected the following apparatus response and staffing distribution: three engines, one truck and a battalion chief with an aide. To create "real time" response, staggering times of arrival companies at one and two minute intervals, close and far, respectively, were incorporated into each segment of the experiments. Some limitations to consider include that the study did not expand to include "medium" and "high" hazard occupancies, commercial or multifamily structures. Additionally, special responses such as hazardous materials, technical rescue, natural disasters or response to emergency medical requests were not addressed. A separate emergency medical experiment/study was conducted and its overview is included following this section.

Scope of NIST Fireground Study

Primary Findings

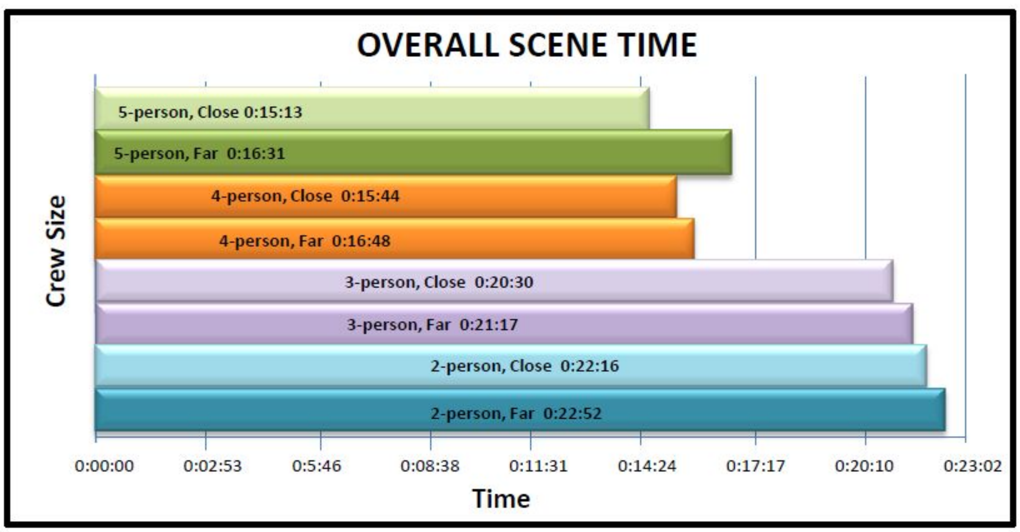
Of the 22 firefighting tasks measured, results indicated that the following phases of all fireground activities had the most impact on overall firefighting operation success.

Overall Scene Time

Four- and five-person crews were able to complete the 22-essential firefighting and rescue tasks in a residential setting 30 percent faster than two-person crews and 25 percent faster than three-person crews. Overall scene time is the time that it takes the firefighters to complete all 22 tasks. The overall scene time measure is critical to the fire crew's ability to complete their work safely and return to the station providing more efficient in-service time. Firefighter crews that complete several of the tasks simultaneously, rather than consecutively, can complete all tasks and are less fatigued.

It is important to note that previous studies have documented significant benefits for five-person crews for medium- and high-hazard structures, particularly in urban settings, unlike the low-hazard residential fire scenario examined in the study.

In addition to varying crew sizes, the NIST experiments assessed the effects of time stagger between the arriving companies. Close stagger was defined as a 1-minute difference in the arrival of each responding company. Far stagger was defined as a 2-minute time difference in the arrival of each responding company. One-minute and two-minute arrival stagger times were determined from analysis of deployment data from more than 300 U.S. fire departments responding to a survey conducted by the International Fire Chiefs Association and the International Association of Firefighters.



Scope of NIST Fireground Study

Primary Findings (continued)

Time to Water Application

In this study the term megawatt (MW) is used to measure the amount of energy that is released by fire. This unit of measurement is a key predictor of the hazard of a fire, directly related to the rate at which heat and toxic gases build up in a compartment or the rate at which they are driven into more remote spaces. Heat release rates on the order of 1 MW to 3 MW that can lead up to a room that has flashed over or from a single large object such as a bed or sofa. Fire risks grow exponentially. Each minute of delay is critical to the safety of occupants and firefighters and is directly related to property damage.

Results show that five-person crews could apply water to the fire 22-percent faster than two person crews. Four-person crews could apply water to the fire 16-percent faster than two-person crews and 6 percent faster than three-person crews. What this means for firefighter safety is that two-person crews arriving later to the scene faced a fire about 2.1 megawatts in size.

On the other end of the spectrum, five-person crews arriving earlier to the scene faced a fire about half as big at 1.1 megawatts. For context, a 1 megawatt fire would be a fully-involved upholstered chair burning at its peak. A 2-megawatt fire, however, would be sufficient to produce near-flashover conditions in the 12 by 16-foot room of fire origin used in our experiments. Facing a fire of twice the intensity greatly increases the danger to both firefighters and civilians and increases the likelihood that the fire will spread beyond the room of origin.

Rescue Effectiveness

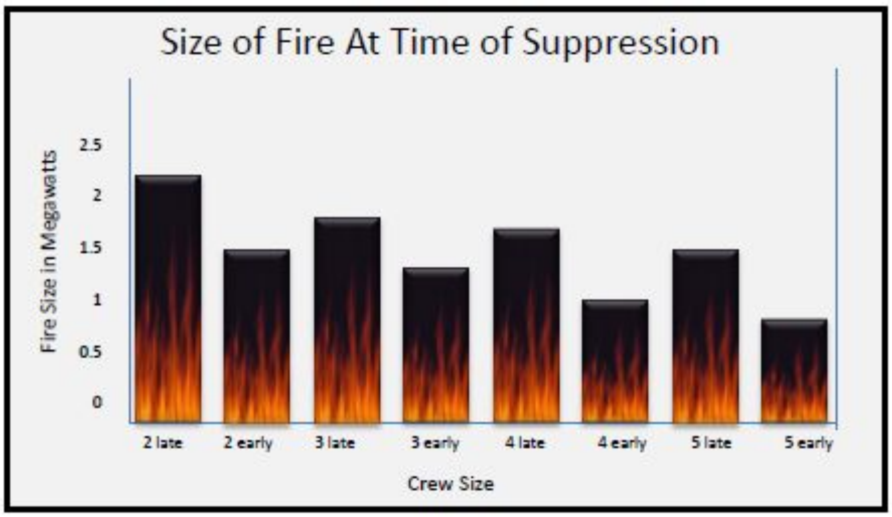
To estimate how various crew sizes would affect the exposure of occupants to toxic gases, slow-, medium-, and fast-growth rate fires were simulated using NISTs' Fire Dynamic Simulator software. The simulation assumed an occupant unable to escape on his own from an upstairs bedroom with the bedroom door open. Occupant exposures were calculated both when firefighters arrive earlier to the scene, representing crews from fire stations nearby the burning structure, and those arriving later, representing crews arriving from more distant locations.

The simulations showed that for a medium-growth fire, two-person crews would not be expected to complete essential tasks in time to rescue occupants from exposures to toxic gases that would incapacitate sensitive populations such as children and the elderly. Two-person crews arriving later would also likely find a significant portion of the public incapacitated by the time of rescue. The simulations for early arriving five, four and three person crews show that they would likely be able to locate and rescue an occupant before sensitive populations would be incapacitated.

Scope of NIST Fireground Study

Summary

The NIST study specifically applied to firefighting crew sizes in a low-hazard residential setting and not to larger, more hazardous structures, outdoor or transportation fires. These studies also held apparatus response to a constant complement of firefighting vehicles. Decisions about crew size and how many apparatus to deploy in a specific community depend on several variables, including population density, the distribution of structures, age and type of construction, the size of the fire station's first due response coverage area and the resources available to that jurisdiction.



Overview

The fire service has become the first line medical responder for all types of medical emergencies in much of the United States. Increased demands for service, including the rising number of emergency medical responses, point to the significance of broadening the focus from suppression activities to include personnel configurations, crew size and apparatus response for emergency medical intervention (Report on EMS Field Experiments, NIST - 2010).

Scope of NIST EMS Field Study

The EMS portion of the Firefighter Safety and Deployment of Resources Study was designed solely to assess the personnel number and configuration aspect of an EMS incident for responder safety, effectiveness, and efficiency. This study does not address the efficacy of any patient care intervention. This study does however quantify first responder crew size, i.e., the number and placement of ALS trained personnel resources on the time-to-task measures for EMS interventions. Upon recommendation of technical experts, the investigators selected trauma and cardiac scenarios to be used in the experiments as these events are resource intensive and will likely reveal relevant differences regarding the research questions. The applicability of the conclusions from this report to a large-scale hazardous or multiple-casualty event has not been assessed and should not be extrapolated from this report.

Primary Findings

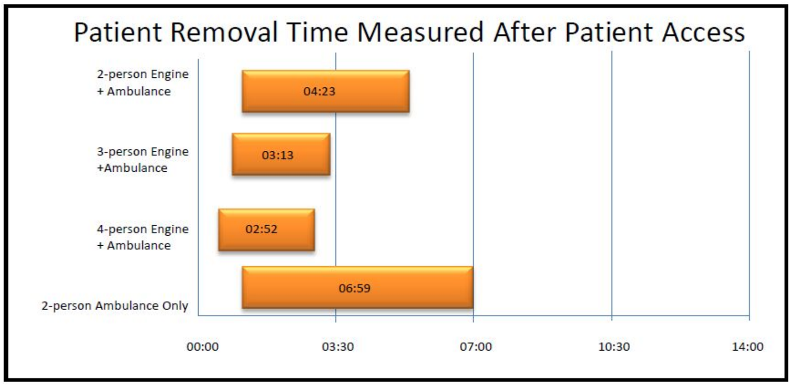
The objective of the experiments was to determine how first responder crew size, ALS provider placement, and the number of ALS providers is associated with the effectiveness of EMS providers. EMS crew effectiveness was measured by task intervention times in three scenarios including patient access and removal, trauma, and cardiac arrest.

The results were evaluated from the perspective of firefighter and paramedic safety and scene efficiency rather than as a series of distinct tasks. More than 100 full-scale EMS experiments were conducted for this study.

Patient Access and Removal

Patient access is an important component of the time sequence. It is defined as the time segment between apparatus/vehicle arrival on the scene and the responder's first contact with the patient. Regarding accessing the patient, crews with three or four first responders reached the patient around half a minute faster than smaller crews with two first responders. Regarding completing patient removal, larger first responder crews in conjunction with a two-person ambulance were more time efficient. The removal tasks require heavy lifting and are labor intensive.

The tasks also involve descending stairs while carrying a patient, carrying all equipment down stairs, and getting patient and equipment out multiple doors, onto a stretcher and into an ambulance. The patient removal results show substantial differences associated with crew size. **Crews with three - or four-person first responders' complete removal between 1.2 – 1.5 minutes faster than smaller crews with two first responders.** All crews with first responders' complete removal substantially faster (by 2.6 - 4.1 minutes) than the ambulance-only crew.



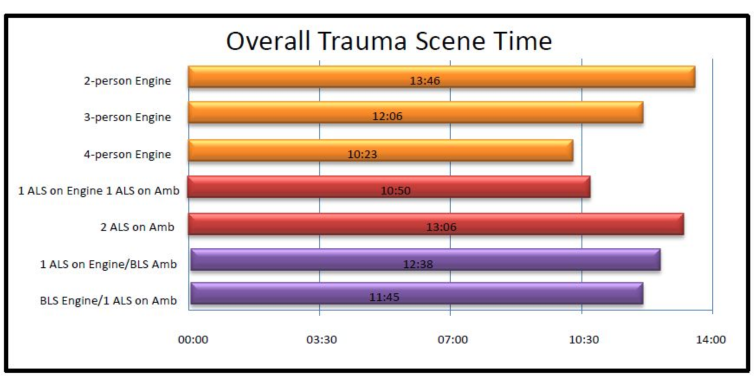
These results suggest that time efficiency in access and removal can be achieved by deploying three- or four-person crews on the first responding apparatus (relative to a first responder crew of two). To the extent that each second counts in an EMS response, these staffing features deserve consideration.

Though these results establish a technical basis for the effectiveness of first responder crews and specific ALS crew configurations, other factors contributing to policy decisions are not addressed.

Trauma

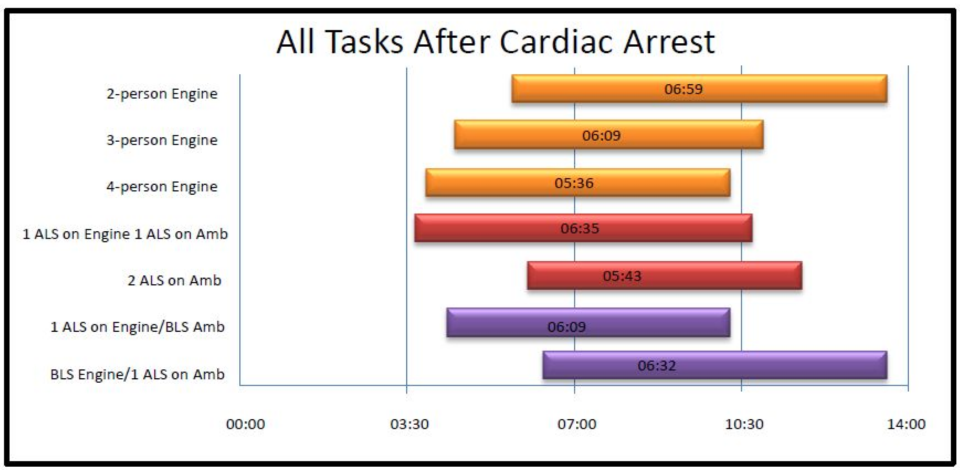
Overall, field experiments reveal that four-person first responder crews completed a trauma response faster than smaller crews. Towards the latter part of the task response sequence, four-person crews start tasks significantly sooner than smaller crews of two or three persons. Additionally, crews with one ALS provider on the apparatus and one on the ambulance completed all tasks faster and started later tasks sooner than crews with two ALS providers on the ambulance. This suggests that getting ALS personnel to the emergency incident in a shorter time frame is important. A review of the patterns of significant results for task start times reinforced these findings and suggests that (in general) small non-significant reductions in task timings accrue through the task sequence to produce significantly shorter start times for the last third of the trauma tasks.

Finally, when assessing crews for their ability to increase on-scene operational efficiency by completing tasks simultaneously, crews with an ALS provider on the apparatus and one ALS provider on the ambulance completed all required tasks 2.3 minutes (2 minutes 15 seconds) faster than crews with a BLS apparatus and two ALS providers on the ambulance. Additionally, first responders with four-person first responder crews completed all required tasks 1.7 minutes (1 minute 45 seconds) faster than three-person crews and 3.4 minutes (3 minutes and 25 seconds) faster than two-person crews.



Cardiac

The overall results for cardiac echo those of trauma. Regardless of ALS configuration, crews responding with four first responders completed all cardiac tasks (from at-patient to packaging) more quickly than smaller first responder crew sizes. In the critical period following cardiac arrest, crews responding with four first responders also completed all tasks more quickly than smaller crew sizes. As noted in the trauma scenario, crew size matters in the cardiac response. Considering ALS placement, crews responding with one ALS provider on both the apparatus and ambulance completed all scene tasks (from at-patient to packaging) more quickly than a crew with a BLS apparatus and two ALS providers on the ambulance. This suggests that ALS placement can make a difference in response efficiency. One curious finding was that crews responding with a BLS apparatus and an ambulance with two ALS providers completed the tasks that follow cardiac arrest 50 seconds sooner than crews with an ALS provider on both the apparatus and ambulance. As noted, this counter-intuitive difference in the results may be attributable to the delay of the patient arrest time based on the arrival of the 12-Lead ECG monitor with the two-person ALS Ambulance crew.



Summary

While resource deployment is addressed in the context of three basic scenarios, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many factors including geography, resource availability, community expectations as well as population demographics that drive EMS call volume. While this report contributes significant knowledge to community and fire service leaders regarding effective resource deployment for local EMS systems, other factors contributing to policy decisions are not addressed. The results, however, do establish a technical basis for the effectiveness of first responder crews and ALS configuration with at least one ALS level provider on first responder crews. The results also provide valid measures of total crew size efficiency in completing on-scene tasks some of which involve heavy lifting and tasks that require multiple responders to complete. (Report on EMS Field Experiments, 2010).

Term	Definition
Alarm Processing Time	The time interval from the point at which a request or alarm is received and transmitted to emergency responders. The benchmark is 60 seconds.
All Incidents	All incidents regardless of NFIRS group codes.
American Heart Association (AHA)	The American Heart Association is a national voluntary health agency whose mission is to reduce disability and death from cardiovascular diseases and stroke.
AOR	Area of Responsibility
Automatic Aid	Planned first alarm response of engine and/or ladder-service companies between two or more jurisdictions by prior agreement, so that each department operates substantially as one department.
AW	Area workload is the percentage of a given time frame in which there is a demand for service within a station's AoR.
Built-Up Area	A built-up area shall include city blocks on which 25% of the building lots are built-up, and street front sections 200' back from the road on which a minimum of 25% of the building lots are built-on. However, when hydrants are available, and where lot sizes are large or irregular, a reasonable method of determining built-up area for the purpose of determining fire department response district size, is to count the hydrants and use that count as a representative "size" in other areas having hydrants.
Catchment	A geographical area based on travel time.
Center for Public Safety Excellence (CPSE)	The CPSE is a non-profit organization dedicated to the improvement of fire and emergency service agencies through self-assessment and accreditation.
Concentration	The spacing of multiple resources arranged so that an initial "effective response force" can arrive on scene within sufficient time frames to mobilize and likely stop the escalation of an emergency in a specific risk category.
Construction Class	Six categories of building construction determined by exterior walls, floors, roof or the structural frame.
Creditable Water Supply	A water system capable of delivering 250 gpm or more for a period of 2 hours or more, plus domestic consumption at the maximum daily rate.
Demand Zone	An area used to define or limit the management of a risk situation.

Distribution	The station and resource locations needed to assure rapid response deployment to minimize and terminate emergencies.
Drive Time	The time measured from fire company en-route to fire company on scene.
EMS Incidents	Incidents in the NFIRS group codes 300's.
Engine Company	A fire engine (pumper) with equipment and personnel, which may be paid or volunteer.
Fire Incidents	Incidents in the NFIRS group codes 100's.
Fire Flow	The amount of water required to control the emergency, which is based on contents and combustible materials.
First Due Response	That distance prescribed: for an engine company, 1½ distance miles; for a ladder company, 2½ miles.
Flash Over	A critical stage of fire growth where the likelihood of survival and the chance of saving lives drops dramatically. In this stage, greater amounts of water are needed to reduce burning material below its ignition temperature.
Full Consolidation	A model under which two or more (fire) organizations merge into one large organization with its own governance structure, budget, personnel, equipment and operational framework.
Get Out or Turnout Time	The time point at which responding units acknowledge receipt of the call from the dispatch center. Total get out time begins at this point and ends at the beginning of travel time. For staffed fire stations the benchmark is 60 seconds.
Historical	Incidents that have happened in the past. Data that has been collected in the past.
Hotspots	A representation of an area with a statistical higher density than its surrounding area.
Initiation of Action	The point at which operations to mitigate the event begins.
Insurance Services Office(ISO)	ISO is a leading source of information about risk. The organization supplies data, analytics, and decision-support services for professionals in many fields, including insurance, finance, real estate, health services, government, and human resources. Their products help customers measure, manage, and reduce risk.
Ladder Company	A ladder truck with equipment and personnel assigned.

Ladder Truck	Fire apparatus with numerous ladders of varying lengths and types, forcible entry tools and salvage equipment. It may have a hydraulic aerial ladder or elevating platform, generally following NFPA 1901 specifications.
National Fire Protection Association (NFPA)	Established in 1896, NFPA serves as the world's leading advocate of fire prevention and is an authoritative source on public safety. The mission of the NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training, and education.
Occupancy Risk	An assessment of the relative risk to life and property resulting from a fire inherent in a specific occupancy or in generic occupancy class.
On-Scene Time	The point at which the responding units arrive on the scene.
Operational Consolidation	A model which embraces a unified operations framework under which the “closet unit responds” regardless of municipal or district boundaries, but which retains the each organization as separate entities with independent personnel, vehicles and governance.
Other Incidents	Incidents in the NFIRS group codes 200’s, and 400’s through 900’s.
Projected	The results that may happen in the future based on analysis
Pumper (Engine)	Fire apparatus used to deliver water to a fire at pressures necessary for good fire streams; having a pump, equipment and hose; and usually conforming to NFPA 1901 specifications.
Quint	Quint apparatus are equipped with the following five (5) components: water tank, hose, multiple ground ladders, a fire pump and an aerial device such as a ladder or platform.
Response Time	The time measured from fire company notification to fire company on scene.
Required Fire Flow	The estimated flow of water in gallons per minute that may be considered a reasonable rate necessary to fight a major fire in an unsprinklered building under most conditions.
Service Area	A geographical area where service is provided or demanded.
Service / Squad Truck	Fire apparatus carrying ground ladders, tools, and equipment required for a service / squad truck.
Standard Response District	A Standard Response District is a built-upon area which is within satisfactory response travel distance. (See first due response distance).

Standards of Cover	Those adopted written policies and procedures that determine the distribution, concentration, and reliability of fixed and mobile response forces for fire, emergency medical services, hazardous materials, and other forces of technical response.
Total Response Time	CPSE definition: *Alarm Processing Time* + *Turnout time* + *Travel Time* = **Total Response Time**. NFPA definition: *Get Out Time* + *Travel Time* = **Total Response Time**.
TRA	The complete geographical area in which a fire agency is responsible to provide service.
Travel Time	The point at which units are in route to the call through when units arrive on the scene. Travel time is based on 38 mph or 55.7 feet per second.
Turnout Time	The time point at which responding units acknowledge receipt of the call from the dispatch center through the point that the apparatus goes in service. The benchmark is 60 seconds.
Unit Hour Utilization (UHU)	The UHU method considers the number of hours a unit is committed on an emergency or other activity, divided by the number of overall hours a unit is available to respond.