City of Topeka

Kansas

Fire Department Station Location

Update

Table of Contents i
Table of Figures ii
Alternative Fire Station Letter 1
Executive Summary 2
Update of Existing Deployment 5
Service Demand 6
Resource Distribution 12
Reliability Analysis 14
Response Performance 18
Future System Demand Projections 22
Population History 22
Census and Planning Population Projections 22
Community Risk Analysis 23
Service Demand Projections 27
Future Delivery System Models 29
Findings, Recommendations, and Conclusions 43
Primary Findings 43
Recommendations 44
Conclusion 44

Table of Figures

Figure 1: Study Area Base Map 4
Figure 2: Historical Total Service Demand 5
Figure 3: Historical Total Service Demand by Type 6
Figure 4: Historical Total Service Demand by Month 6
Figure 5: Historical Total Service Demand by Day of Week 7
Figure 6: Historical Total Service Demand by Hour of Day 7
Figure 7: Service Demand Density - All Incidents 8
Figure 8: Service Demand Density - Medical Incidents 9
Figure 9: Service Demand Density - Structure Fires 10
Figure 10: Service Demand by Task Force 11
Figure 11: Four-Minute Distribution Capacity 12
Figure 12: Total Utilization by Year 13
Figure 13: Total Utilization by Task Force 14
Figure 14: Total Utilization by Unit 15
Figure 15: Concurrent Incident Analysis 16
Figure 16: Historical Mutual and Automatic Aid Received and Provided 16
Figure 17: Historical Call Processing Performance 18
Figure 18: Historical Turnout Performance 19
Figure 19: Historical Total Response Performance 19
Figure 20: Population History 21
Figure 21: Combined Population Projections 22
Figure 22: Land Use by Risk Category 23
Figure 23: Population Distribution by Age Group 24
Figure 24: Housing Tenure 25
Figure 25: Population Density 26
Figure 26: Service Demand Projections 27
Figure 27: Four-Minute Engine Overlap 29
Figure 28: Future Station Deployment 30
Figure 29: Ladder/Rescue Gap and Redundancy 32
Figure 30: Ladder/Rescue Gap and Redundancy (Eight-Minute Travel) 33
Figure 31: Five Minute Distribution Model 34
Figure 32: Six Minute Distribution Model 35
Figure 33: 5:30 Travel Capability – Minimum Stations 36
Figure 34: 5:30 Travel Capability – Option 1 Redeployment 37
Figure 35: Station Overlap – Reduction Option 1 38
Figure 36: Catchment Area Responses 39
Figure 37: Catchment Area Responses by Station Area 40
Figure 38: Comparable City Response Perormance 42

Jim Colson
City Manager
City of Topeka, Kansas

February 4, 2016

Mr. Colson,

At your request as part of the Station Location Study Update, ESCI evaluated an alternative station location based on property currently owned by the City.

The original recommended station location was at SW 10th Avenue and SW Gage Boulevard. This location (when combined with the other recommended station locations) provides the fire department with 97.5 percent coverage of all parcels within the city at five and a half minutes of travel time. The property owned by the City located at SW 6th Avenue between SW Fairlawn Road and SW Wanamaker Road only reduces the parcel coverage to 97.0 percent; a statistically insignificant reduction.

Based on these two analyses, the property currently owned by the City would be a suitable alternative the originally plotted station location. Please feel free to contact me if you should need further clarification or have questions about the analysis.

Kent Greene, Project Manager

Executive Summary

The City of Topeka, KS engaged Emergency Services Consulting International (ESCI) to review the existing deployment of emergency services resources and to provide recommendations on future needs of additional fire stations. This document serves as the results of the analysis performed by ESCI and begins with a general overview of existing resource deployment.

Generally, service demand for TFD has increased over the last five years at an average rate of 5.02 percent. A slight decreased in overall demand was realized during 2013 after a high volume year during 2012. As would be expected for a department that is involved in emergency medical responses, that category comprises a majority of the department's workload. Actual fires are a very small part of the overall service demand, as is the case across the nation for most fire departments.

Typical human activity plays an integral part in hour service demand is distributed throughout a normal day and TFD's hourly workload is representative of that activity. Service demand typically begins to increase between 6:00 a.m. and 7:00 a.m., peaking during the mid-afternoon hours, and then declining into the nighttime hours. This is important for managers that have the ability to staff dynamic resources during peak demand periods and reduce those resources in lower service demand times.

Reviewing service demand by type geographically also helps managers ensure that appropriate resources are appropriately deployed. The high areas of service demand for all incidents occurs between Stations 3 and 4 with service demand 'ringing' outward from this area. Since a majority of the department's service demand is medical, it stands to reason that geographical representation of medical incidents only would be very similar to that of all incidents as presented previously. However, when evaluating structure fire service demand, the same high density areas appear as with medical incidents indicating that the highest level of service demand correspond to the areas of highest population and structural density.

TFD uses a taskforce approach in the deployment of resources and each station is assigned a taskforce number. TF07 was the busiest taskforce last year but is not in the area of heaviest service demand. This indicates that TF07 is responding to incidents in a larger area than other taskforces and may be supplementing the resources within the higher service demand areas for simultaneous incidents.

Based on resource distribution analysis, TFD can reach approximately 61.7 percent of historic service demand within four minutes of travel; the travel time recommended by *NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.* NFPA 1710 is a national peer standard that provides guidance to policymakers in regards to how to best operate their individual department. However, the standard is not a rule or law. The Authority Having Jurisdiction (AHJ) has the responsibility to evaluate their individual community needs and expectations and to create response performance objectives that satisfy those results. Although NFPA 1710 is commonly quoted in regards to distribution and response performance, it can be, in some cases, extremely aggressive and costly. Although the response performance section found later in this report also uses NFPA 1710 as the base comparison, alternative response performance objectives have been successfully implemented in other agencies across the U.S. Current performance by the fire department will be used to identify potential options for redeployment of resources.

For an under-resourced system multiple simultaneous incidents can lead to resource drawdown and result in longer response time as unit from adjacent areas must be used to cover the multiple incidents. Most incidents within the TFD response area occur singularly. There are, however, a number of incidents that occur simultaneously. Most commonly, two to three incidents are occurring concurrently. Although TFD currently has sufficient resources to handle this level of concurrency, the areas most prone to these simultaneous incidents should be closely monitored so that sufficient resources can be moved into position if necessary.

Turnout time is the first element of the response performance continuum that the fire department actually controls; since they are responsible for receiving the information, making their way to the apparatus and affecting an appropriate response. NFPA 1710 recommends that fire departments respond to emergency incidents within 60 seconds for medical responses and 1:20 for fire responses, both measured at the 90th percentile. TFD's current performance for all incident types is in the range of 2:30, above the recommended standard.

NFPA 1710 also includes a performance objective of 240 seconds or less (4:00) travel time for the arrival of the first arriving engine company in urban areas serviced by career fire departments. This performance objective is for travel only and does not include turnout time performance. When turnout time is added to the overall travel time of emergency responses, the 90th percentile total response performance calculates to just over seven minutes; two minutes longer than the NFPA 1710 standard. It should be understood, however, that ESCI views this performance recommendation as extremely aggressive and few, if any, departments have the resources to actually meet the objective on a regular basis. The authority having jurisdiction (AHJ) has the ability to adopt internal response performance objectives that more realistically match the risks within the community as well as the ability and willingness of the community to pay for enhanced services.

The report continues with a review of local population history and then uses that information combined with a per capita usage rate to project future service demand. Based on historical populations as well as local and census based population projections, TFD should expect to see an increase in overall service demand through the year 2040, at a rate of about six percent.

The report concludes with strategies that are intended to provide policymakers with the necessary information so as to appropriately plan for the future. Several options are provided based on a variety of response performance objectives as detailed below.

1. Turnout time performance is higher than expected and should be monitored to ensure that personnel a getting en route to incidents in a timely manner. This will further reduce overall response time.
2. In order to maintain the current level of service, it is possible to close several stations and relocate others, as noted below:

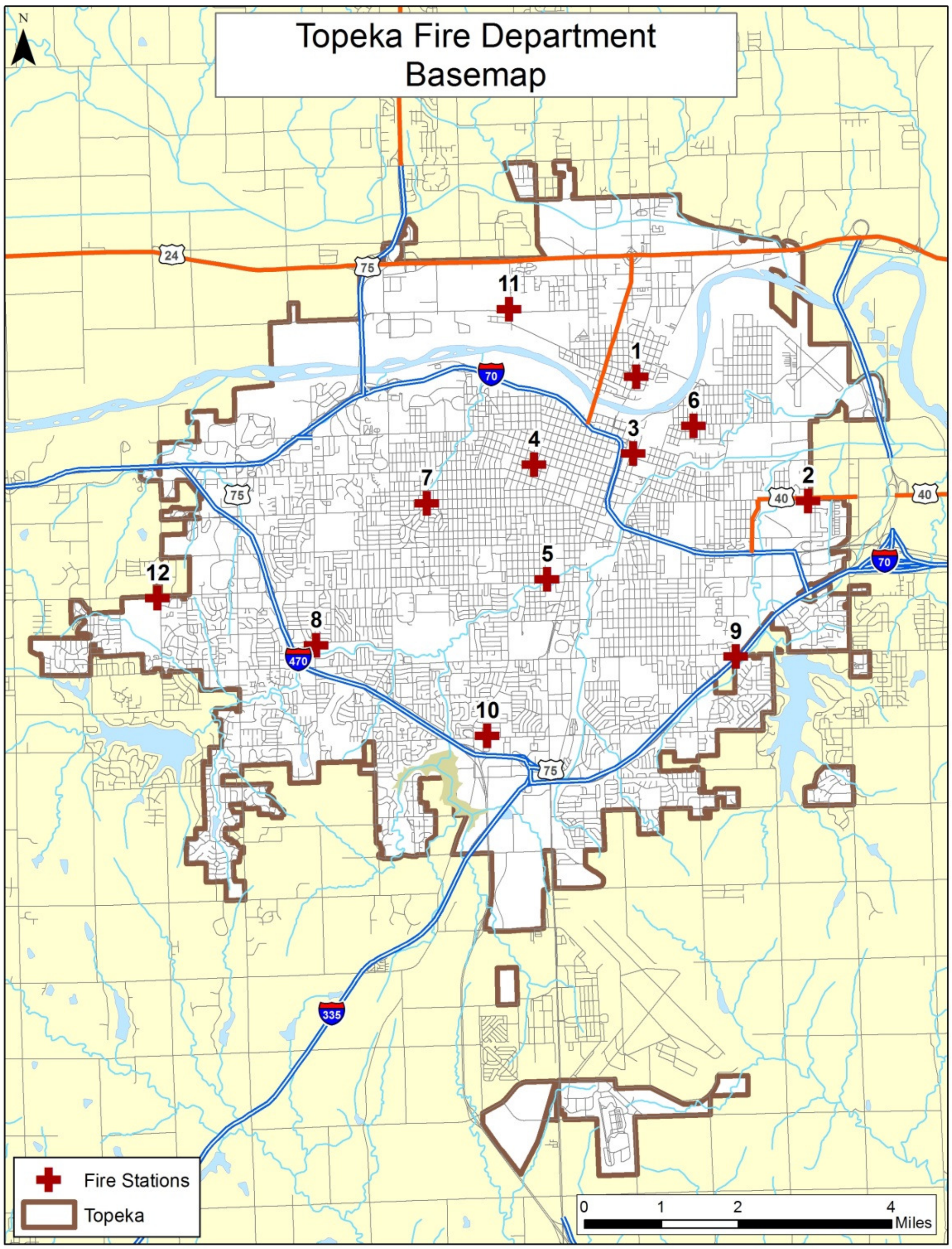
   a. Close Stations 1, 4, 7, and 10
   b. Construct two new stations at:
      i. SW Gage Blvd & SW 10th Ave
      ii. SW Topeka Blvd & S Kansas Ave
3. An additional engine would be necessary at Station 5 to complement the ladder already housed there
4. An additional engine would be necessary at Station 11 to complement the current resources and provide sufficient coverage to the northern areas of the City
5. In order to reduce gaps in ladder/rescue coverage, the City should consider adopting an eight minute travel model for those resources
6. Since a majority of the department's workload is medical in nature, the City should consider alternatives to the current response protocol including implementation of smaller response vehicles for non-structural response.

From a response performance and effectiveness perspective, TFD is not performing unlike many organizations of similar size and operational structure. The NFPA 1710 recommendations noted within this report are for reference only and local policymakers should work with department leaders to adopt a formal set of response objectives that match community risk and expectations. The recommendations provided here that maintain current levels of service would be preferred rather than attempting to meet a standard that may not be in-line with community expectations or fiscal capabilities.

Update of Existing Deployment

The City of Topeka, KS engaged Emergency Services Consulting International (ESCI) to review the existing deployment of emergency services resources and to provide recommendations on future needs of additional fire stations. This document serves as the results of the analysis performed by ESCI and begins with a general overview of existing resource deployment. The following figure illustrates the base service area and existing fire station locations operated by the Topeka Fire Department (TFD).

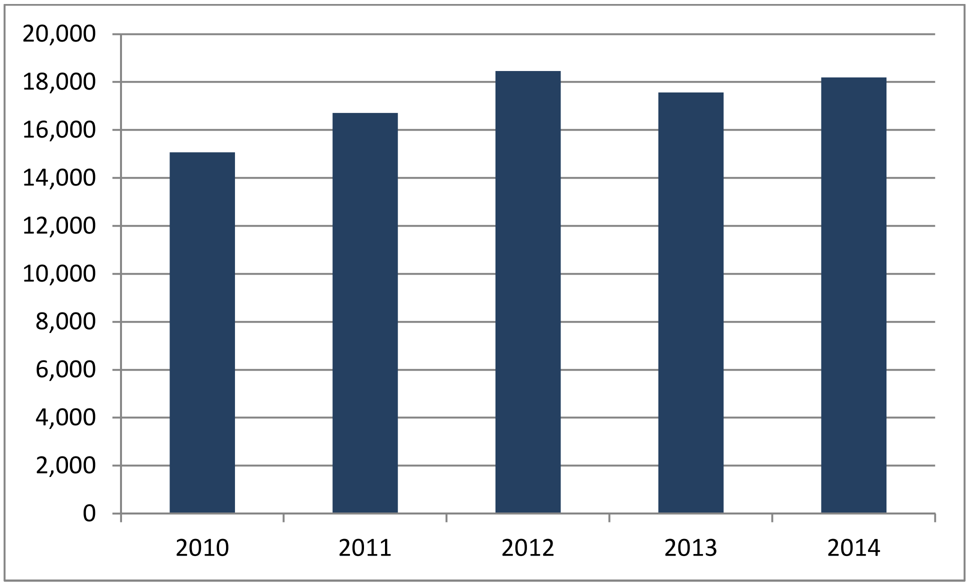
Figure 1: Study Area Base Map



SERVICE DEMAND

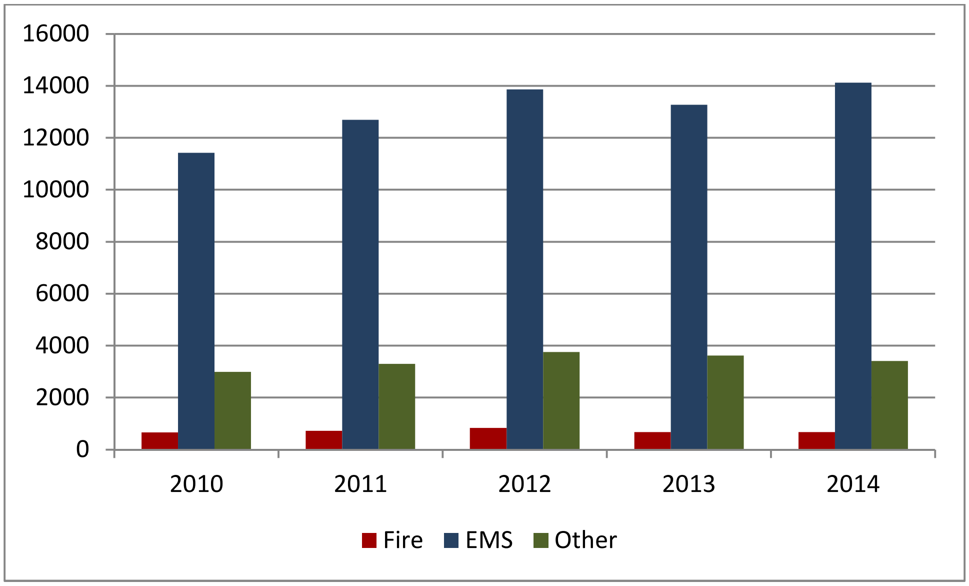
In order to determine the appropriateness of the existing resource deployment, it is first necessary to review service demand experienced by the department. This analysis begins with a general review of total service demand over the past five calendar years as illustrated below.

Figure 2: Historical Total Service Demand



Generally, service demand for TFD has increased over the last five years at an average rate of 5.02 percent. A slight decreased in overall demand was realized during 2013 after a high volume year during 2012. It is also useful to determine what type of service demand is being experienced by the department. The following figure summarizes service demand into three primary categories; actual fires, medical or EMS incidents, and all other incident types.

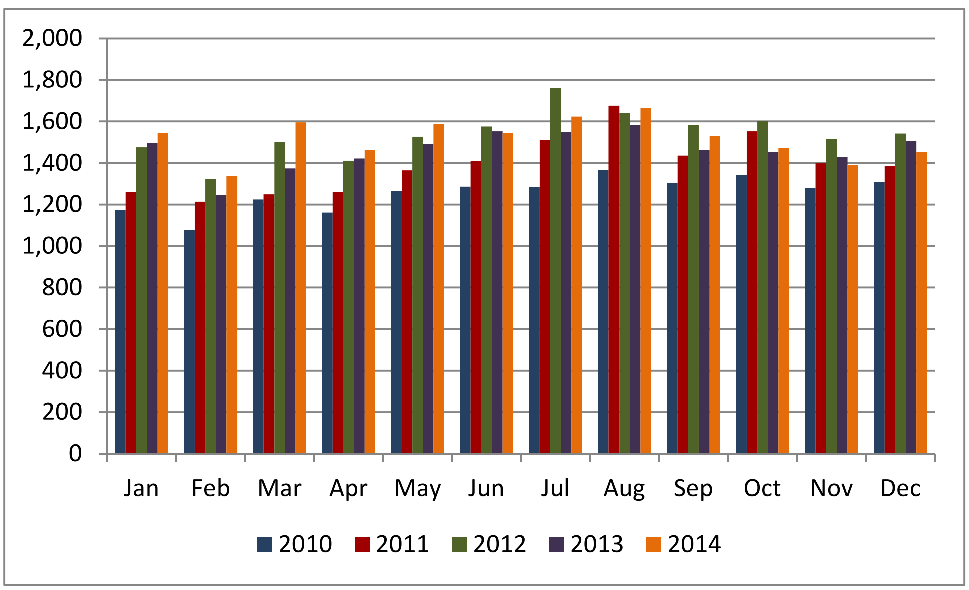
Figure 3: Historical Total Service Demand by Type



As would be expected for a department that is involved in emergency medical responses, that category comprises a majority of the department's workload. Actual fires are a very small part of the overall service demand, as is the case across the nation for most fire departments.

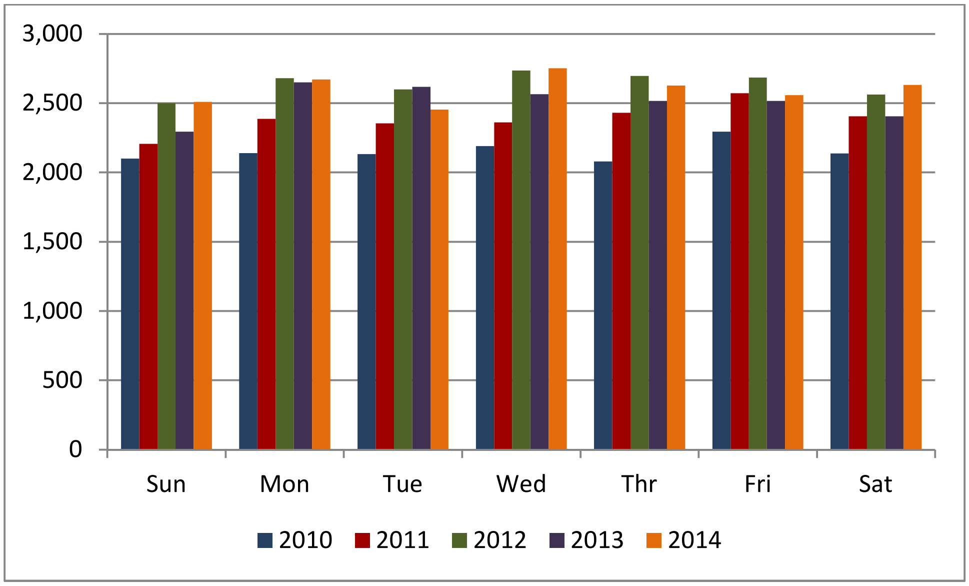
The next analysis reviews service demand temporally beginning with demand by month.

Figure 4: Historical Total Service Demand by Month



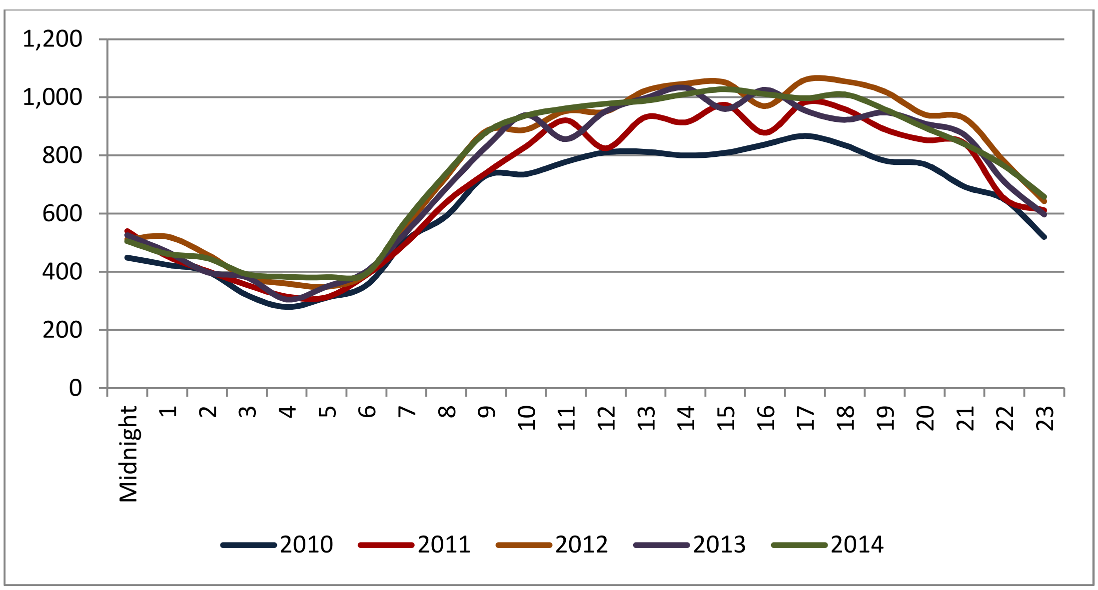
Although no real trend can be seen in the preceding figure, closer analysis indicates that the busiest months for TFD are January, July, and August. Similarly, when service demand is reviewed by day of week, little in the way of a daily trend can be seen.

Figure 5: Historical Total Service Demand by Day of Week



The final temporal analysis is that of hour of day. Typical human activity plays an integral part in hour service demand is distributed throughout a normal day and TFD's hourly workload is representative of that activity.

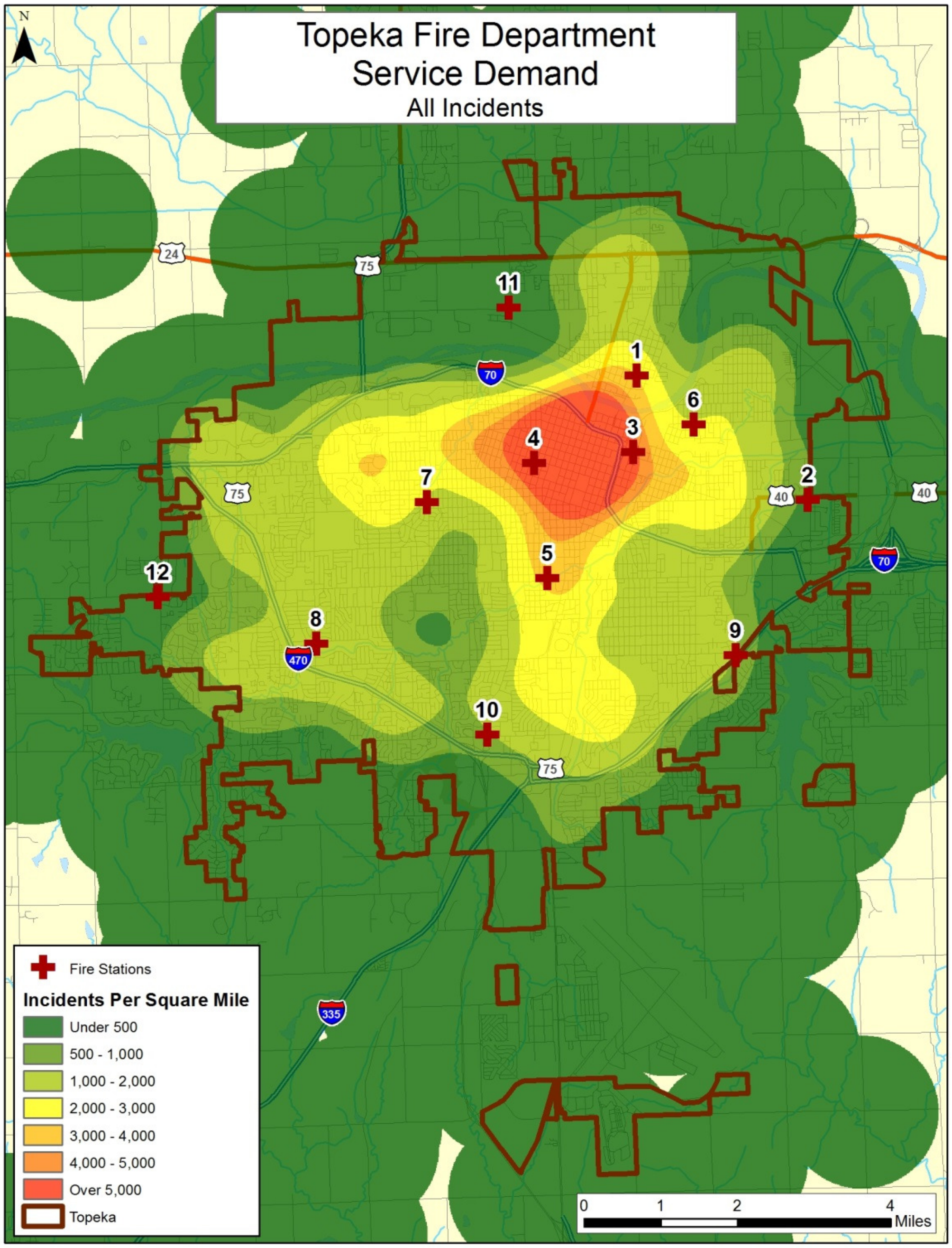
Figure 6: Historical Total Service Demand by Hour of Day



Service demand typically begins to increase between 6:00 a.m. and 7:00 a.m., peaking during the mid-afternoon hours, and then declining into the nighttime hours. This is important for managers that have the ability to staff dynamic resources during peak demand periods and reduce those resources in lower service demand times.

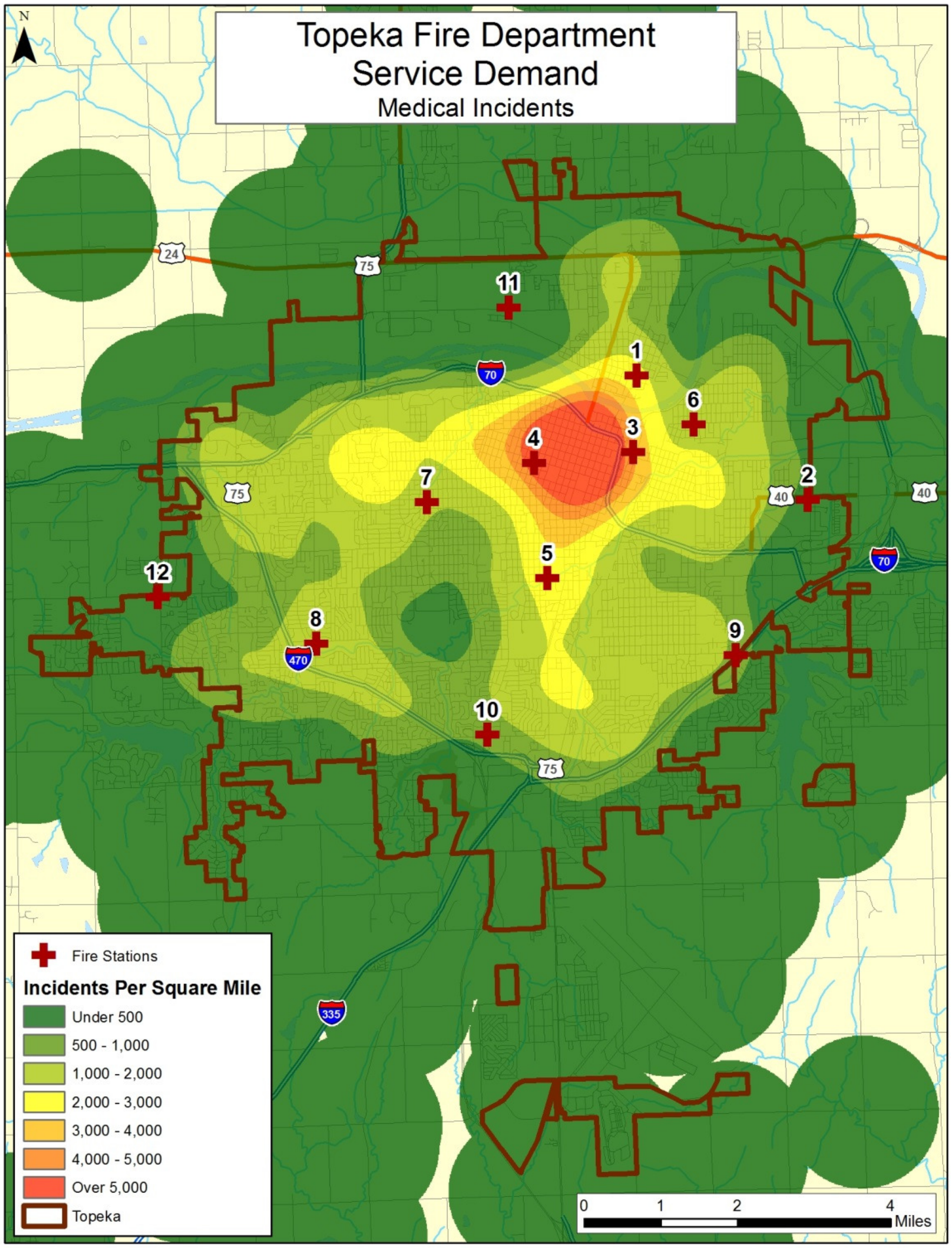
The next review of service demand is geographic. Although the amount of demand is important so that sufficient resources can be in place to handle the workload, knowing where that service demand is occurring is critical to the placement of those resources. The following figure illustrates total service demand for TFD.

Figure 7: Service Demand Density - All Incidents



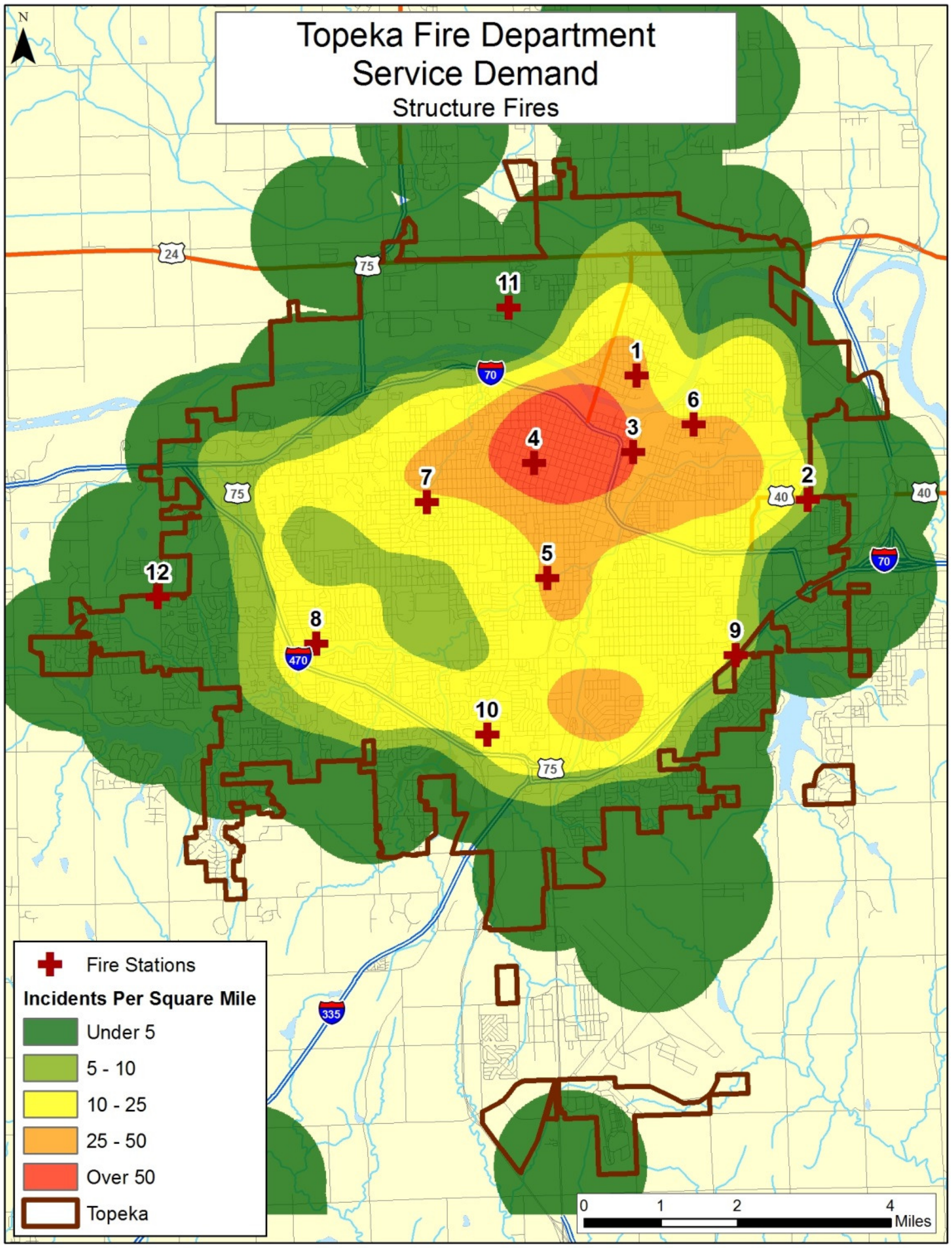
Viewing this map like weather radar, the high areas of service demand for all incidents occurs between Stations 3 and 4 with service demand 'ringing' outward from this area. Reviewing service demand by type geographically also helps managers ensure that appropriate resources are appropriately deployed. The following figure illustrates medical service demand only.

Figure 8: Service Demand Density - Medical Incidents



Since a majority of the department's service demand is medical, it stands to reason that geographical representation of medical incidents only would be very similar to that of all incidents as presented previously. However, when evaluating structure fire service demand, the same high density areas appear as with medical incidents, as illustrated in the following figure.

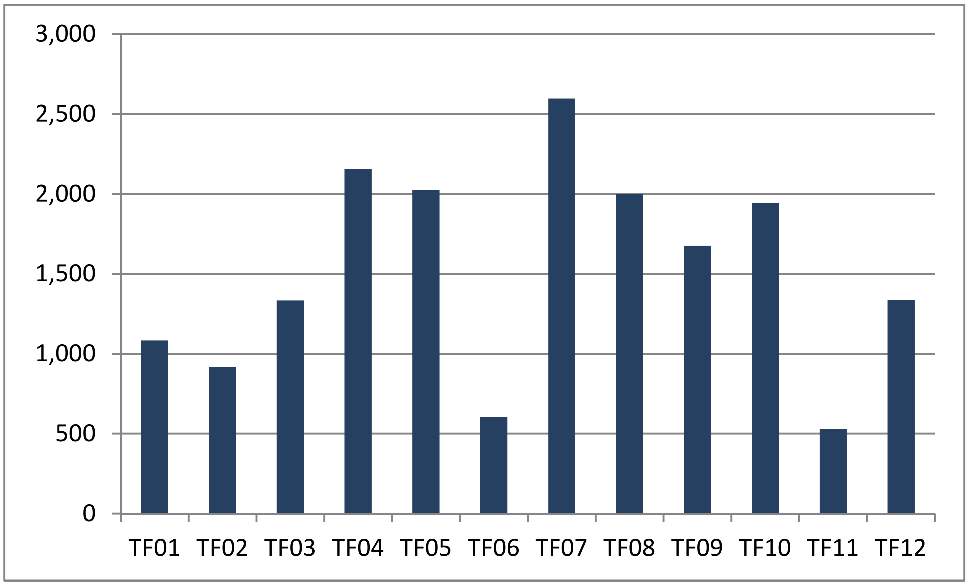
Figure 9: Service Demand Density - Structure Fires



Based on this analysis, it is critical that managers ensure that sufficient resources are in those areas with the highest service demand density and are capable of responding to multiple simultaneous incidents.

Based on the geographic service demand presented previously, it is also important to evaluate service demand by taskforce. TFD uses a taskforce approach in the deployment of resources and each station is assigned a taskforce number. The following figure summarizes how busy each taskforce was during calendar year 2014.

Figure 10: Service Demand by Task Force

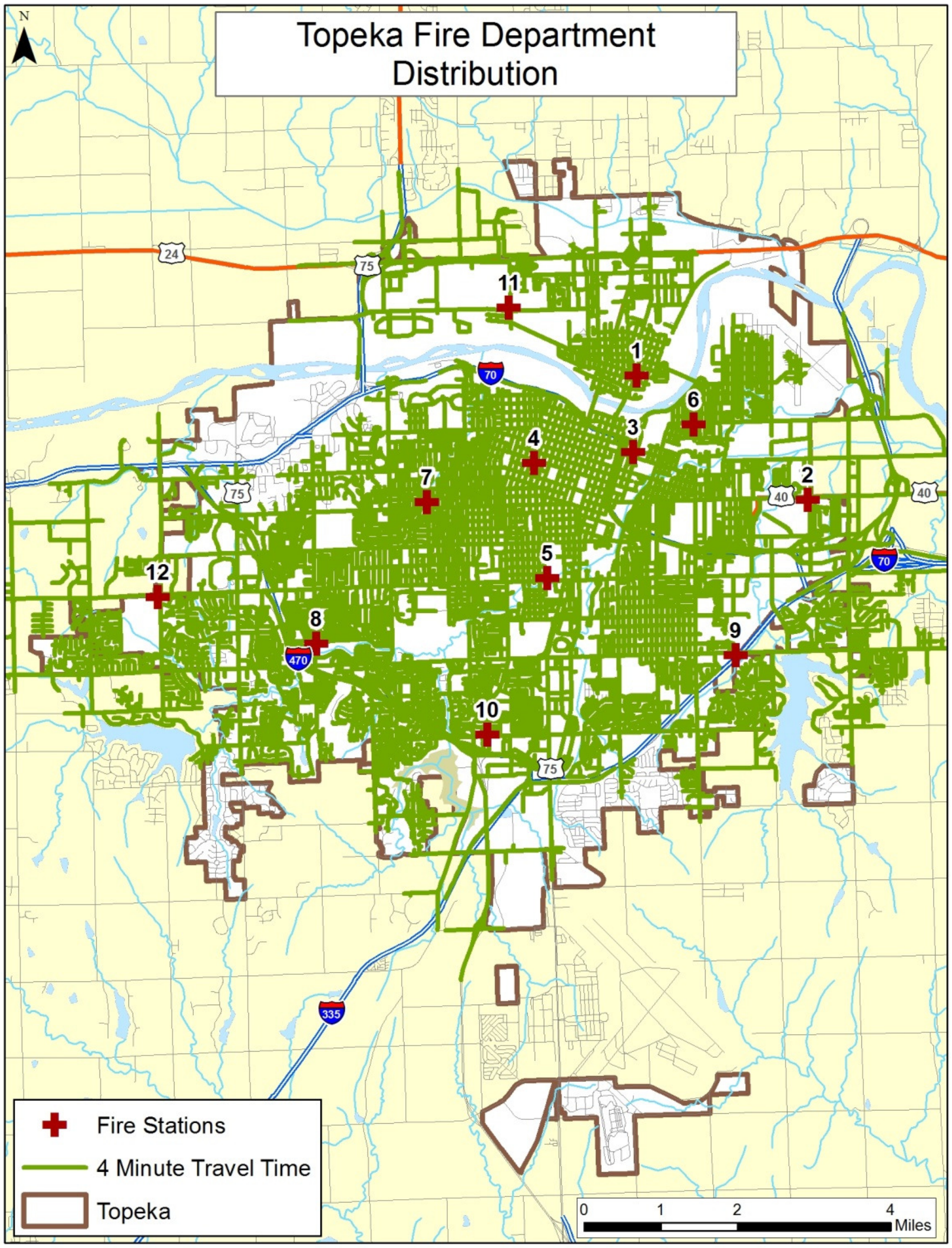


Interestingly, TF07 was the busiest taskforce last year but is not in the area of heaviest service demand. This indicates that TF07 is responding to incidents in a larger area than other taskforces and may be supplementing the resources within the higher service demand areas for simultaneous incidents.

RESOURCE DISTRIBUTION

Resource distribution analysis is a process whereby travel capability of resources is reviewed in comparison to historic service demand. Based on the following figure, TFD can reach approximately 61.7 percent of historic service demand within four minutes of travel; the travel time recommended by *NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.*

Figure 11: Four-Minute Distribution Capacity



Although a majority of the city is adequately covered with the existing deployment of resources, there are some areas that are outside of the four-minute travel model, particularly in the southwest corner of the city as well as around the periphery. Options for reaching these areas will be discussed later in this document.

In addition, it is worth discussing NFPA 1710 in the context of this report. NFPA 1710 is a national peer standard that provides guidance to policymakers in regards to how to best operate their individual department. However, the standard is not a rule or law. The Authority Having Jurisdiction (AHJ) has the responsibility to evaluate their individual community needs and expectations and to create response performance objectives that satisfy those results. Although NFPA 1710 is commonly quoted in regards to distribution and response performance, it can be, in some cases, extremely aggressive and costly. Although the response performance section found later in this report also uses NFPA 1710 as the base comparison, alternative response performance objectives have been successfully implemented in other agencies across the U.S.

RELIABILITY ANALYSIS

Reliability analysis is a process whereby individual units are reviewed for their availability for response. There are various means of evaluating this reliability depending on the type of unit. For transport ambulances, unit hour utilization (UHU) is the common method. Although TFD does not operate transport ambulances, it is sometimes useful to view fire and medical non-transport responses by UHU. The figure below summarizes the departments UHU as a whole over the past five years.

Figure 12: Total Utilization by Year

Year	Total Commit Time	UHU
2010	4621:06:50	0.53
2011	5049:15:38	0.58
2012	5384:15:11	0.61
2013	5003:25:42	0.57
2014	5269:16:00	0.60

Although there is no specific standard for UHU for the fire service in a non-transport environment, common levels for fire-based transport ambulances typically range from 0.02 to 0.03. The following figure summarizes individual taskforce UHUs.

Figure 13: Total Utilization by Task Force

Task Force	Total Commit Time	UHU
TF01	1454:01:00	0.03
TF02	1420:20:55	0.03
TF03	1972:04:58	0.04
TF04	2788:23:44	0.05
TF05	3201:14:33	0.06
TF06	1123:00:42	0.02
TF07	3589:40:15	0.07
TF08	3190:27:22	0.06
TF09	2823:48:57	0.05
TF10	3202:52:38	0.06
TF11	993:23:39	0.02
TF12	1996:05:09	0.04

As expected from the previously presented service demand analysis, TF07 has the highest UHU. This corresponds to that taskforce's high call volume rate. Keeping in mind that this taskforce level analysis encompasses all units within that taskforce, it is also useful to evaluate UHU from the individual unit level as illustrated below.

Figure 14: Total Utilization by Unit

Unit	Total Commit Time	UHU	Unit	Total Commit Time	UHU
E01A	453:08:00	0.01	E10A	794:39:52	0.02
E01B	433:07:31	0.01	E10B	780:54:14	0.01
E01C	462:47:54	0.01	E10C	820:06:53	0.02
E02A	435:08:03	0.01	E11A	241:32:21	0.00
E02B	450:56:16	0.01	E11B	250:39:18	0.00
E02C	458:04:26	0.01	E11C	245:48:51	0.00
E03A	439:28:18	0.01	E12A	568:08:42	0.01
E03B	439:52:44	0.01	E12B	637:26:23	0.01
E03C	505:46:50	0.01	E12C	606:31:59	0.01
E04A	800:45:24	0.02	T03A	312:37:27	0.01
E04B	957:15:22	0.02	T03B	350:56:51	0.01
E04C	942:59:34	0.02	T03C	321:32:16	0.01
E05A	863:15:52	0.02	T05A	123:26:10	0.00
E05B	797:40:12	0.02	T05B	115:59:14	0.00
E05C	852:10:19	0.02	T05C	136:08:37	0.00
E06A	339:28:16	0.01	T08A	171:38:17	0.00
E06B	366:22:57	0.01	T08B	186:27:49	0.00
E06C	362:12:07	0.01	T08C	144:27:07	0.00
E07A	1004:54:58	0.02	T09A	245:06:44	0.00
E07B	1044:50:03	0.02	T09B	266:15:48	0.01
E07C	1149:34:10	0.02	T09C	283:02:25	0.01
E08A	985:46:07	0.02	T10A	291:43:46	0.01
E08B	874:45:11	0.02	T10B	333:55:33	0.01
E08C	922:44:33	0.02	T10C	337:25:10	0.01
E09A	704:04:58	0.01	T11A	130:18:13	0.00
E09B	650:23:23	0.01	T11B	131:55:23	0.00
E09C	702:10:23	0.01	T11C	133:08:58	0.00

As can be seen in the preceding figure, no TFD unit is above the typical threshold for utilization. Another method to determine unit reliability is to review how often multiple simultaneous incidents are occurring. The following method of reliability analysis shows how often multiple incidents are occurring simultaneously. For an under-resourced system multiple simultaneous incidents can lead to resource drawdown and result in longer response time as unit from adjacent areas must be used to cover the multiple incidents.

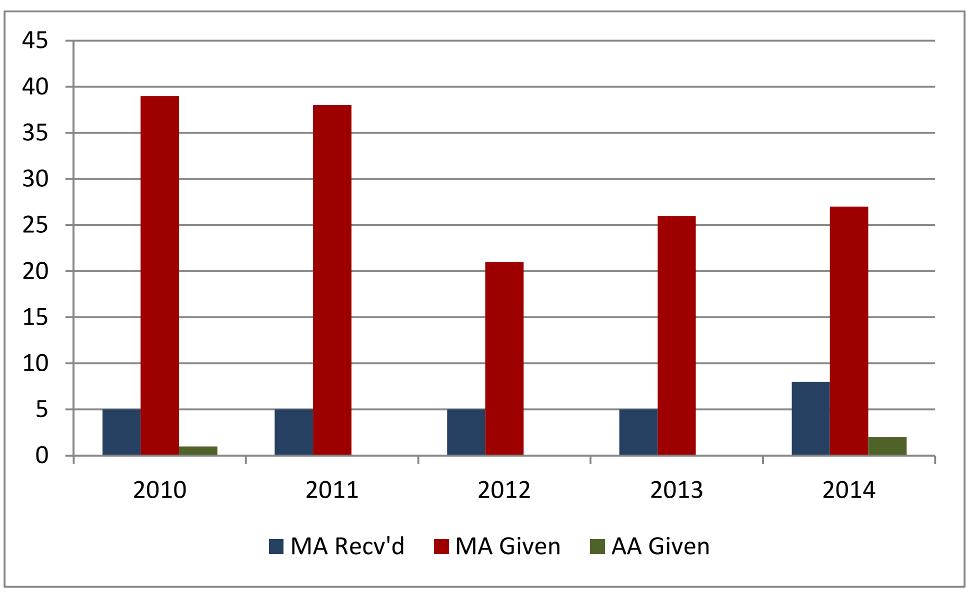
Figure 15: Concurrent Incident Analysis

	1	2	3	4	5	6	7	8	9	10	11	15
2010	55.8%	31.4%	9.7%	2.3%	0.5%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	52.1%	32.0%	11.3%	3.1%	0.9%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
2012	50.9%	33.1%	11.6%	3.2%	0.6%	0.3%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
2013	53.4%	32.4%	10.9%	2.7%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2014	52.1%	32.9%	11.6%	2.6%	0.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

As illustrated above, most incidents within the TFD response area occur singularly. There are, however, a number of incidents that occur simultaneously. Most commonly, two to three incidents are occurring concurrently. Although TFD currently has sufficient resources to handle this level of concurrency, those areas most prone to these simultaneous incidents should be closely monitored so that sufficient resources can be moved into position if necessary.

In most emergency services delivery systems across the nation today, mutual and automatic aid is necessary to supplement intradepartmental resources. This use of resources from outside the primary service area can provide additional personnel and apparatus to major incidents. In the case of automatic aid, no request of a particular agency is necessary as agreements are in place before an incident occurs. For TFD, receipt of mutual and automatic aid is limited but the department does provide a much higher level of aid to adjacent agencies, as illustrated in the following figure.

Figure 16: Historical Mutual and Automatic Aid Received and Provided



Although TFD gives mutual and automatic aid much more than it receives it, the incidents are limited and are not likely to cause a drawdown of resources within the primary response area.

RESPONSE PERFORMANCE

One of the most visible indicators of hour well an organization is performance is measured by response performance. Those in need of emergency services expect a quick response by adequate and well-prepared personnel. The response time continuum, the time between when the caller dials 9-1-1 and when assistance arrives, is comprised of several components:

- Processing Time – The amount of time between when a dispatcher answers the 9-1-1 call and resources are dispatched.
- Turnout Time – The amount of time between when units are notified of the incident and when they are en route.
- Travel Time – The amount of time the responding unit actually spends on the road to the incident.
- Response Time – A combination of turnout time and travel time and generally accepted as the most measurable element.

Other performance measurements are also valuable but not utilized in this analysis of staffing and deployment, such as:

- Patient Contact Time – The actual time personnel arrived at the patient and began treatment.
- Scene Time – The total amount of time resources have spent on the emergency scene prior to transport or clearing the incident.
- Transport Time – The total amount of travel time spent transporting the patient to a definitive care facility.
- Hospital Time – The total amount of time the transporting unit spent at the receiving facility before returning to service.
- Total Commit Time – The total amount of time between dispatch and clearing the incident.

As previously mentioned, a consolidated communications center serves as the Public Safety Answering Point (PSAP) for all emergency calls within the city. Requests for fire or medical resources are then transferred to the appropriate telecommunicator where emergency medical dispatch (EMD) is administered if necessary and the appropriate units dispatched. Before entering this discussion, however, it is important to provide a brief discussion about how the statistical information is presented, particularly in regard to average versus percentile measures.

The "average" measure is a commonly used descriptive statistic also called the mean of a data set. It is a measure to describe the central tendency, or the center of a data set. The average is the sum of all the points of data in a set divided by the total number of data points. In this measurement, each data point is counted and the value of each data point has an impact on the overall performance. Averages should be viewed with a certain amount of caution because the average measure can be skewed if an unusual data point, known as an outlier, is present within the data set. Depending on the sample size of the data set, this skewing can be either very large or very small.

As an example, assume that a particular station with a response time objective of six minutes or less had five calls on a particular day. If four of the calls had a response time of eight minutes while the other call was across the street and only a few seconds away, the average would indicate the station was achieving its performance goal. However, four of the five calls, or 80 percent, were beyond the stated response time performance objective.

The reason for computing the average is because of its common use and ease of understanding. The most important reason for not using averages for performance standards is that it does not accurately reflect the performance for the entire data set.

With the average measure, it is recognized that some data points are below the average and some are above the average. The same is true for a median measure which simply arranges the data set in order and finds the value in which 50 percent of the data points are below the median and the other half are above the median value. This is also called the 50th percentile.

When dealing with percentiles, the actual value of the individual data does not have the same impact as it did in the average. The reason for this is that the percentile is nothing more than the ranking of the data set. The 90th percentile means that 10 percent of the data is greater than the value stated and all other data is at or below this level.

Higher percentile measurements are normally used for performance objectives and performance measurement because they show that the large majority of the data set has achieved a particular level of performance. This can then be compared to the desired performance objective to determine the degree of success in achieving the goal.

For this analysis, ESCI was most interested in the ability to respond with the appropriate resources to the highest percentage of incidents. For this reason, ESCI analyzed National Fire Incident Reporting System (NFIRS) and computer aided dispatch (CAD) data and generated average and 90th percentile response performance for emergency incidents only.

NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems recommends that emergency incidents be dispatched within 60 seconds when measured at the 90th percentile. The following figure summarizes the department's call processing performance over the last five years.

Figure 17: Historical Call Processing Performance

	Average	90th Percentile
2010	00:00:30	00:01:10
2011	00:00:31	00:01:12
2012	00:00:30	00:01:11
2013	00:00:31	00:01:12
2014	00:00:31	00:01:11

Based on the analysis, although missing the NFPA recommendation, the communications center is doing an excellent job at receiving and processing calls for dispatch. The recorded call processing time has remained steady over the last five years but communications supervisors should continue to monitor this element of the overall response performance continuum.

Turnout time is the first element of the response performance continuum that the fire department actually controls; since they are responsible for receiving the information, making their way to the apparatus and affecting an appropriate response. NFPA 1710 recommends that fire departments respond to emergency incidents within 60 seconds for medical responses and 1:20 for fire responses, both measured at the 90th percentile. The following figure summarizes the department turnout time performance over the last five years.

Figure 18: Historical Turnout Performance

	Average	90th Percentile
2010	00:01:41	00:02:27
2011	00:01:43	00:02:30
2012	00:01:42	00:02:30
2013	00:01:44	00:02:33
2014	00:01:47	00:02:37

Based on this analysis, the department is missing the recommended turnout time performance objectives by over a minute. Supervisors should work with department staff to ensure that personnel are making their way to apparatus quickly so that total response performance can be reduced.

NFPA 1710 also includes a performance objective of 240 seconds or less (4:00) travel time for the arrival of the first arriving engine company in urban areas serviced by career fire departments. NFPA 1710 does not differentiate between the various population densities and assumes that all areas served by career or mostly career fire departments will adhere to a single performance objective. This performance objective is for travel only and does not include turnout time performance. When turnout time is added to the overall travel time of emergency responses, the 90th percentile total response performance is calculated as summarized below.

Figure 19: Historical Total Response Performance

	Average	90th Percentile
2010	00:04:45	00:06:53
2011	00:04:50	00:07:02
2012	00:04:38	00:06:54
2013	00:04:46	00:07:04
2014	00:04:51	00:07:08

As can be seen from the preceding figure, the total response performance for emergency incidents is above the recommended performance objective outlined in NFPA 1710. It should be understood, however, that ESCI views this performance recommendation as extremely aggressive and few, if any, departments have the resources to actually meet the objective on a regular basis. The authority having jurisdiction (AHJ) has the ability to adopt internal response performance objectives that more realistically match the risks within the community as well as the ability and willingness of the community to pay for enhanced services.

Future System Demand Projections

In preparing for the development of future service delivery options, it is first necessary to evaluate the population history of the response area and to attempt to predict how populations will change over the next two decades. These changes in populations will directly impact the service demand of the organizations and could stress resources if not properly deployed.

POPULATION HISTORY

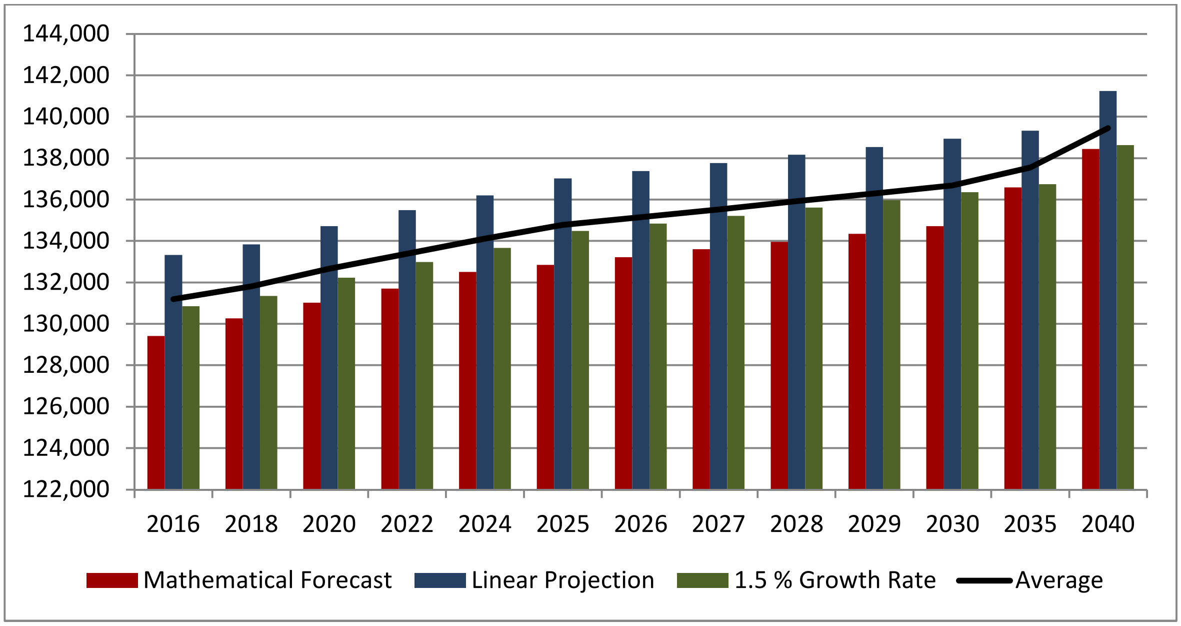
The City of Topeka has enjoyed steady population growth through the first decade of this century but has seen a decline in recent years based on available census data, although this decline has been minimal. The 2014 census estimate indicates that the total population in Topeka is 127,215 as compared to the 2010 census number of 127,473. Policymakers should continue to monitor population levels as this directly impacts service demand.

Figure 20: Population History

CENSUS AND PLANNING POPULATION PROJECTIONS

Based on the population estimates provided by the census bureau, ESCI used a mathematical model based on historical population to generate a population projection through 2040. In addition, a linear projection was generated as was a model that assumed a 1.5 percent average growth rate through 2014, as indicated in local planning documents. From these individual models, ESCI generated an average projection of population as illustrated in the following figure.

Figure 21: Combined Population Projections



COMMUNITY RISK ANALYSIS

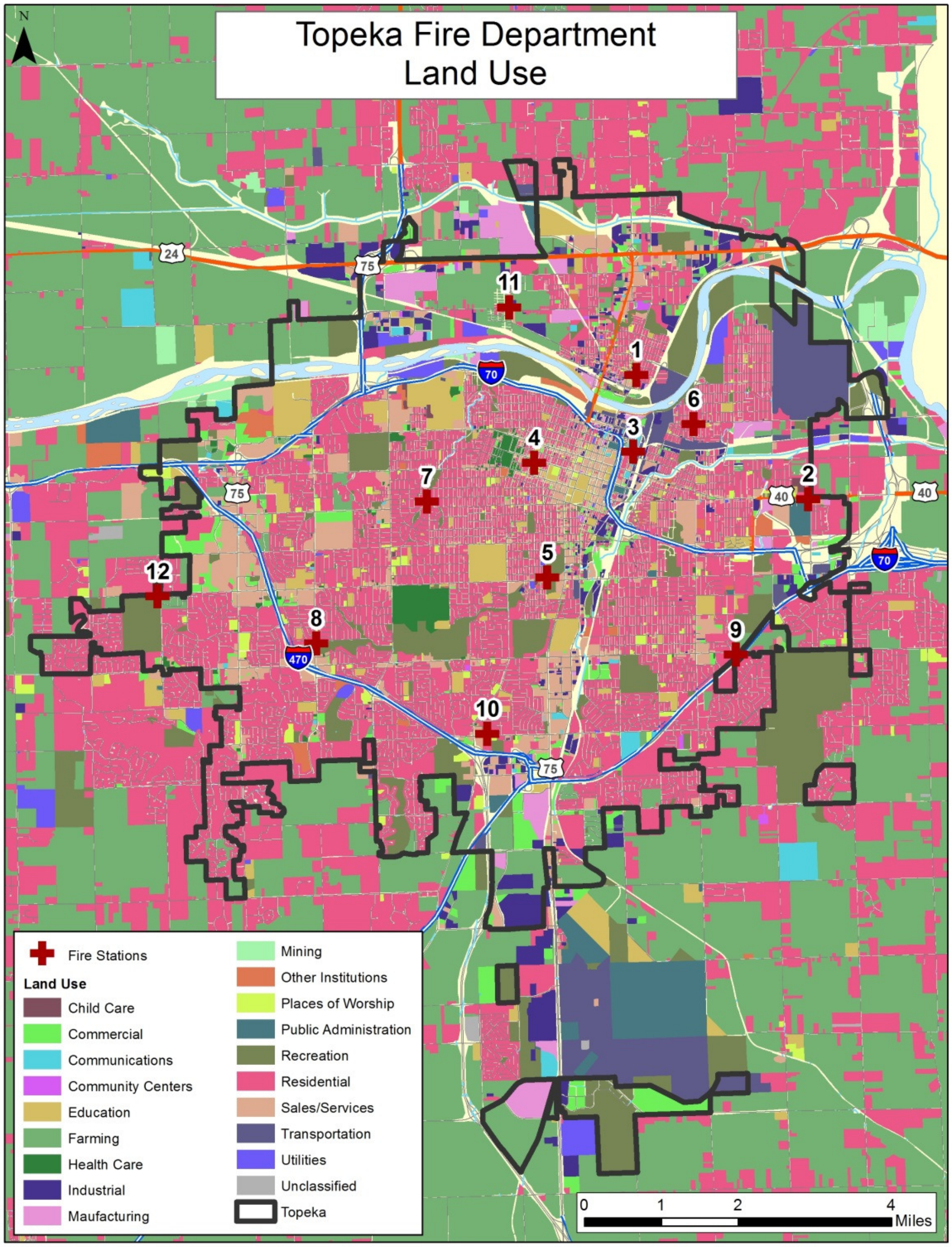
The fire service assesses the relative risk of properties based on a number of factors. Properties with high fire and life risk often require greater numbers of personnel and apparatus to effectively mitigate a fire emergency. Staffing and deployment decisions should be made with consideration of the level of risk within geographic sub-areas of a community. Unlike medical responses that focus on human life, fire incidents are intended to protect property in addition to life. Property values translate into tax revenue for municipalities and the protection of that valuation is often imperative to the success of a fire department.

The following translates land use (potential scale and type of development within geographic sub-areas) to categories of relative fire and life risk.

- Low risk – Areas zoned and used for agricultural purposes, open space, low-density residential, and other low intensity uses.
- Moderate risk – Areas zoned for medium-density single family properties, small commercial and office uses, low-intensity retail sales, and equivalently sized business activities.
- High risk – Higher-intensity business districts, mixed use areas, high-density residential, industrial, warehousing, and large mercantile centers.

The city has a diverse mix of risk across the jurisdiction. Proper code enforcement and fire prevention efforts will assist the fire department in ensuring that all properties, particularly those of higher risk, are operating safely. The figure below illustrates the distribution of the various risks across the city.

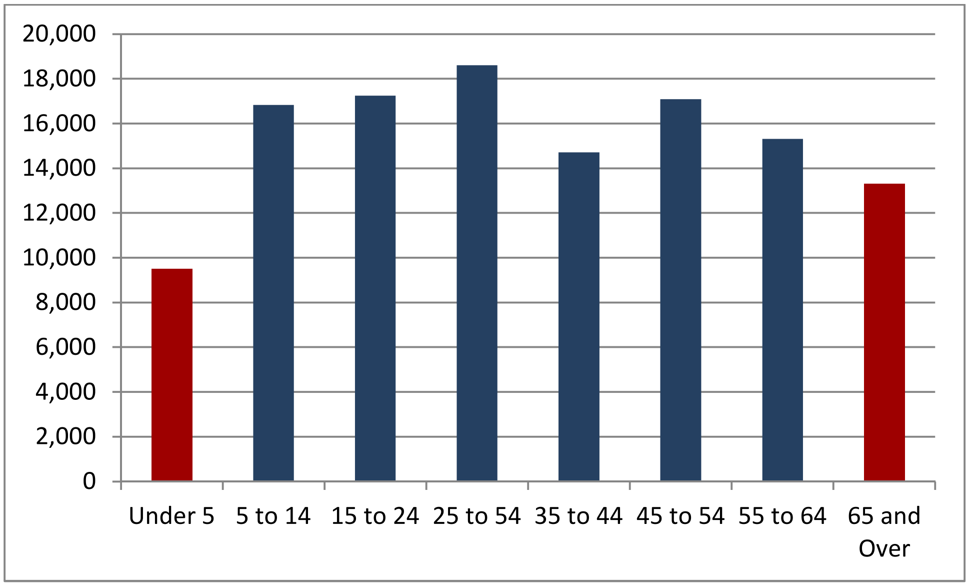
Figure 22: Land Use by Risk Category



The city is largely residential in nature with a scattering of commercial and industrial occupancies. Many of the higher risk occupancies are located around the edges of the city. Being mostly residential in the core of the city, stations appear to be adequately located to accommodate those risks.

In addition to occupancy risk, the relative age of a population can impact service demand and service delivery. Studies have shown that departments that participate in emergency medical services generally see utilization rates higher in certain age groups; typically those under the age of five and those over the age of 65. The following figure illustrates how the population in the city is distributed across the various age groups.

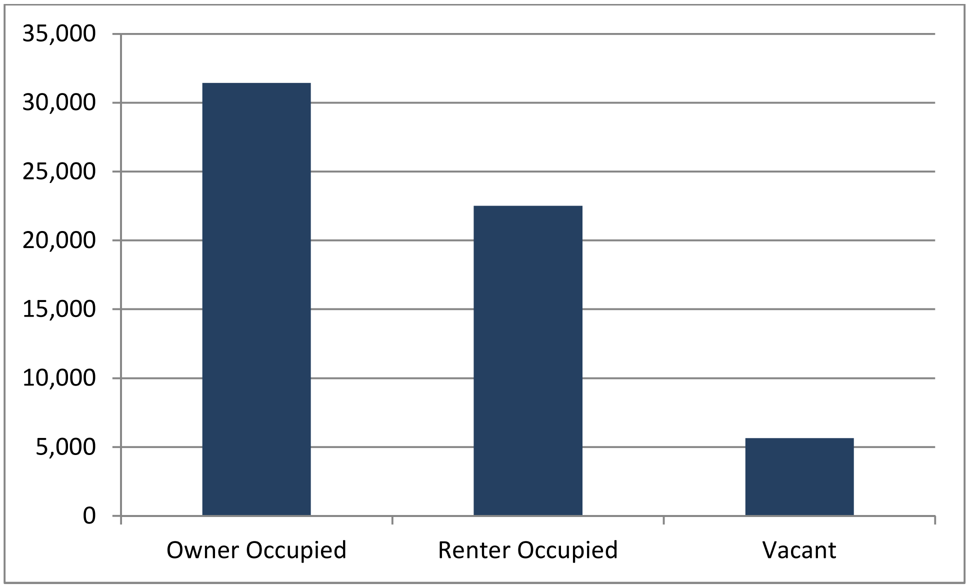
Figure 23: Population Distribution by Age Group



Approximately 18.6 percent of the population falls into the higher risk categories. Public education efforts are one the best ways to ensure that residents are aware of home dangers and emphasis should be placed on those populations.

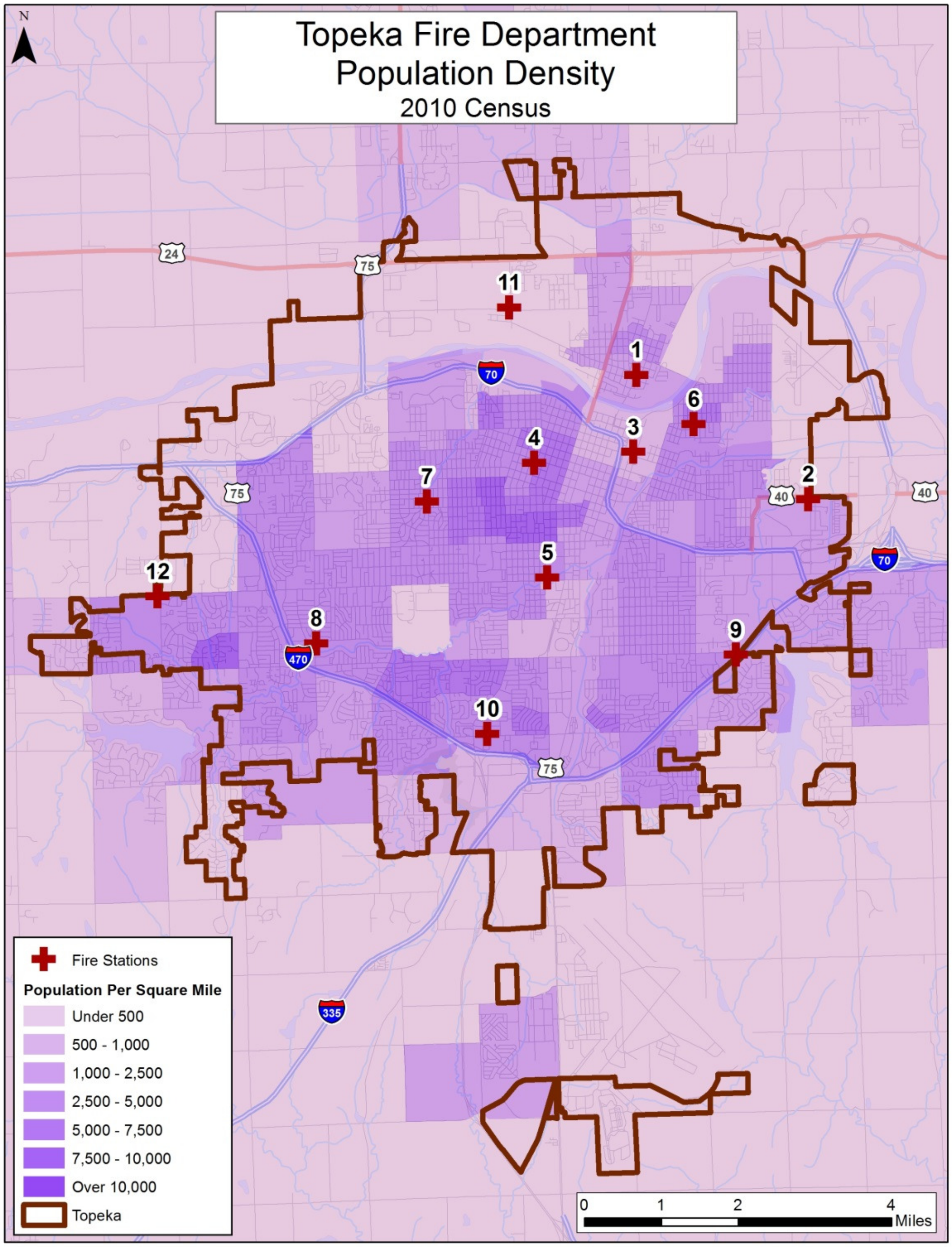
In some areas of the country, economic conditions have increased service demand whether it be due to medically related issues or vacant properties that are damaged by vandalism. In some cases, high vacancy rates or high renter-occupancy rates can translate into higher service demand. Fortunately for the township, renter occupancy and vacancy rates are low in comparison to owner-occupied properties as illustrated in the following figure.

Figure 24: Housing Tenure



As previously discussed, population density can also impact service demand and delivery. Although the city is considered an urban area as a whole (over 1,000 population per square mile) there are a number of 'pockets' within the city that have lower levels of population density. The following figure illustrates how population density is distributed throughout the township.

Figure 25: Population Density

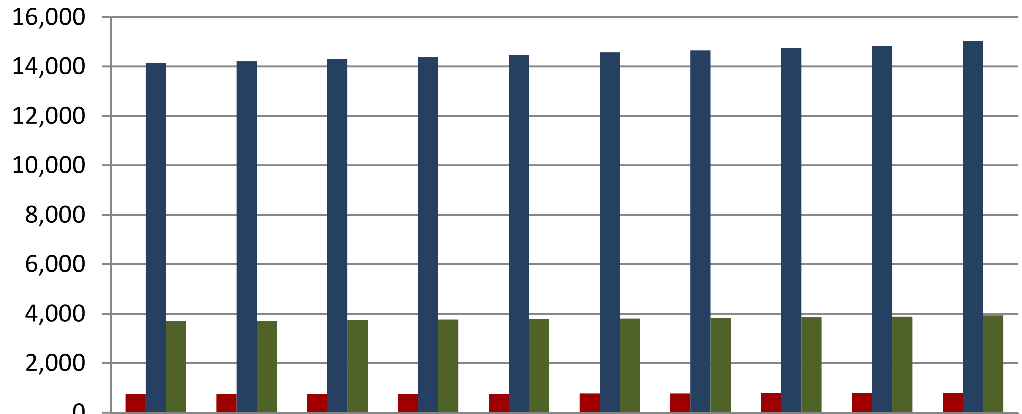


SERVICE DEMAND PROJECTIONS

In evaluating the deployment of facilities, resources, and staffing, it is imperative that consideration be given to potential changes in workload that could directly affect such deployment. Any changes in service demand can require changes and adjustments in the deployment of staff and resources in order to maintain acceptable levels of performance.

For purposes of this study, ESCI utilized population projections obtained through the previously presented methods and multiplied the average model by a forecast incident rate derived from a five-year history of incident per capita rates to identify workload potential through the year 2040. The results of the analysis are shown in the following figure.

Figure 26: Service Demand Projections



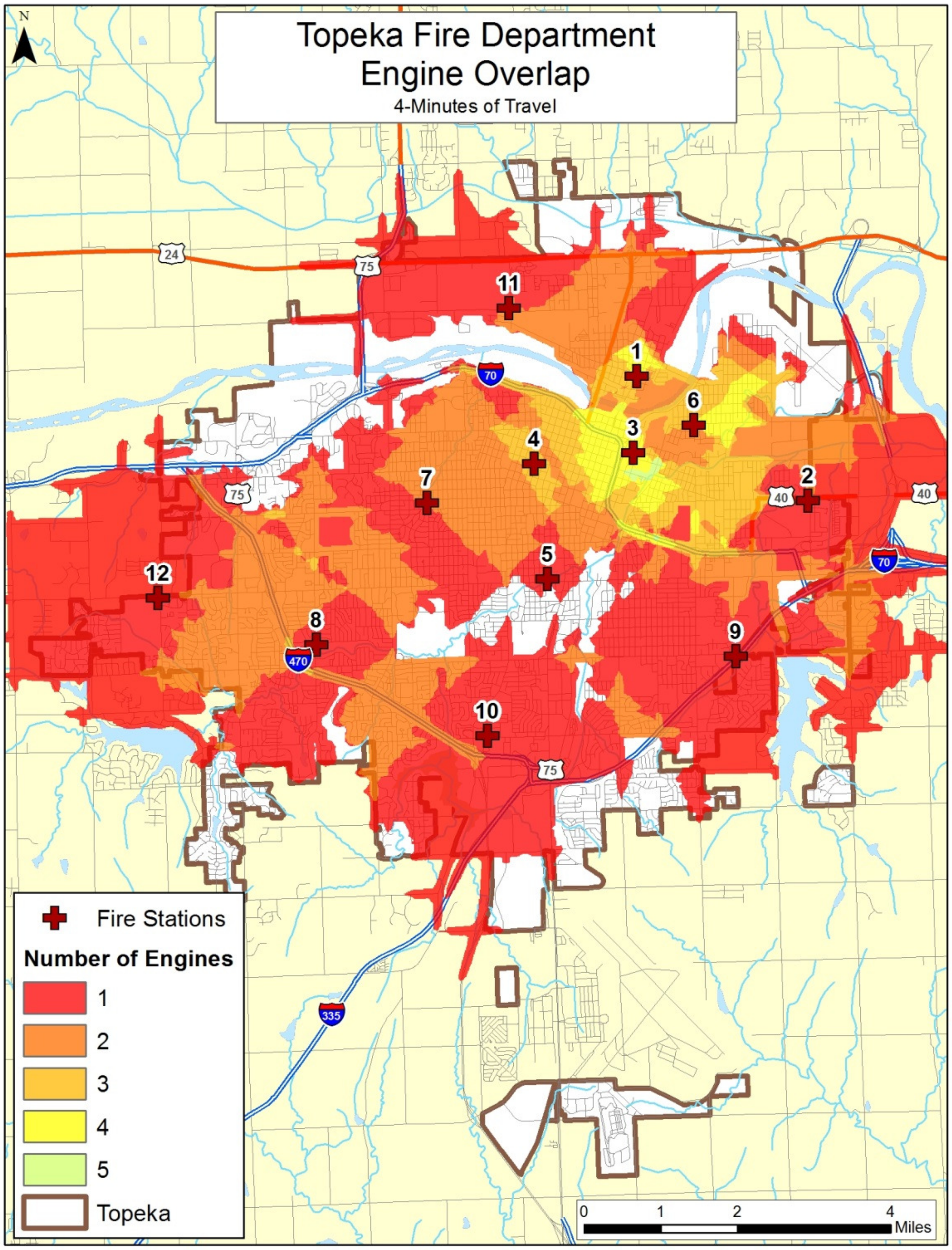
	2016	2018	2020	2022	2024	2026	2028	2030	2035	2040
Fire Calls	748	751	756	760	764	770	775	779	784	795
EMS Calls	14,142	14,209	14,299	14,379	14,457	14,568	14,651	14,732	14,827	15,031
Other Calls	3,694	3,712	3,735	3,756	3,777	3,805	3,827	3,848	3,873	3,926

Future Delivery System Models

Although the foregoing sections of this report focused primarily on the conditions that currently exist within the City of Topeka, the intent of this study is to combine that evaluation with a look into the future and provide policy makers with information necessary to carry the system forward over the next 10 to 20 years or further. This portion of the report provides recommendations related to the deployment of facilities with a focus on future service delivery and an improvement in overall efficiency within the system.

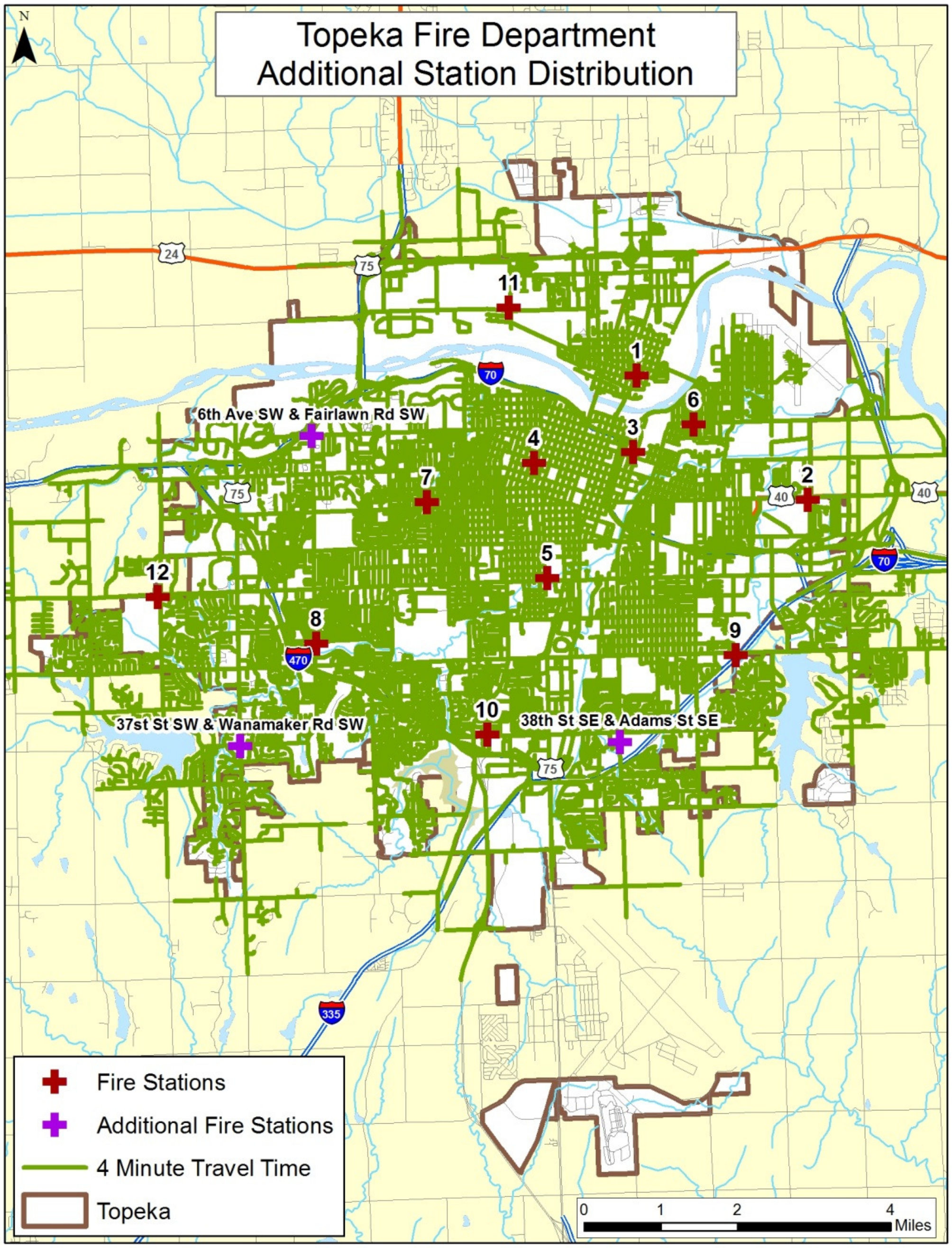
From a gap analysis perspective, there are several areas around the fringes of the city that are currently outside the four-minute travel model. There are also a number of redundancies throughout the city. Both of these situations are illustrated in the following figure.

Figure 27: Four-Minute Engine Overlap



Based on previous analysis regarding distribution of resources, three additional stations would be necessary to cover existing gaps in coverage at the four-minute travel model. These three locations would be in proximity of 6th Avenue SW and Fairlawn Road SW, 37th Street SW and Wanamaker Road SW, and 38th Street SE and Adams Street SE as illustrated in the following figure.

Figure 28: Future Station Deployment

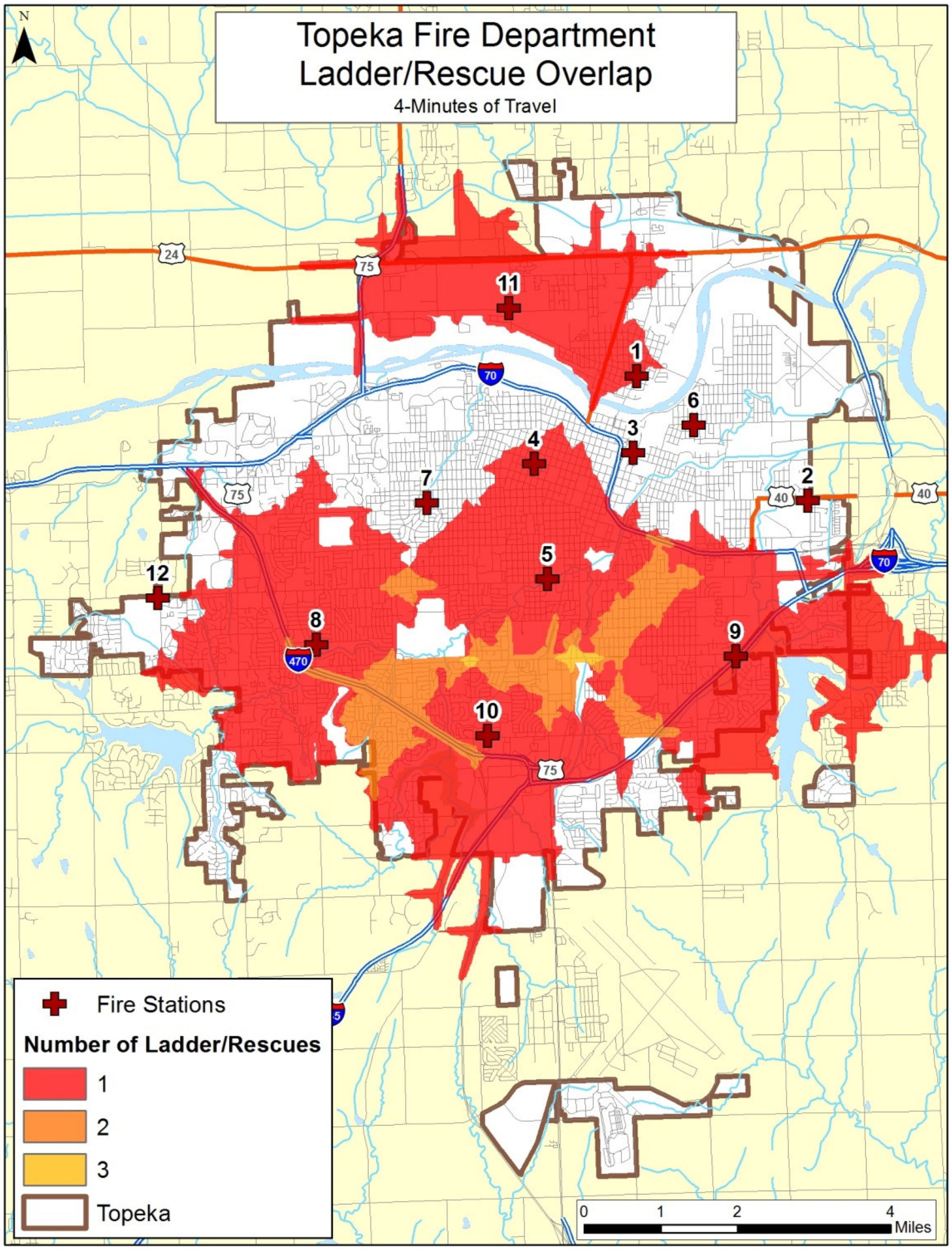


Each of the three additional stations would require an engine and appropriate staff. Also, in order to improve performance across the entire system, an additional engine would be required at Station 5 to complement the ladder already housed there. The placement of these stations and resources would increase TFD's coverage to 85.3 percent at the four-minute model.

As mentioned, in addition to the gaps that exist in certain areas, there are also several areas of redundancy, particularly in the core of the city. This is not uncommon and supports the needed effective response force for major incidents. Although most incidents occur singularly, as indicated during the reliability analysis previously, a number of incidents are occurring simultaneously. These types of incidents will require additional apparatus to respond; as will more involved incidents such as structure fires and multiple-casualty incidents. Therefore, although redundancy does exist, it is not believed to be a matter of over-resourcing but rather, a proper placement of apparatus and personnel within the higher risk areas of the city.

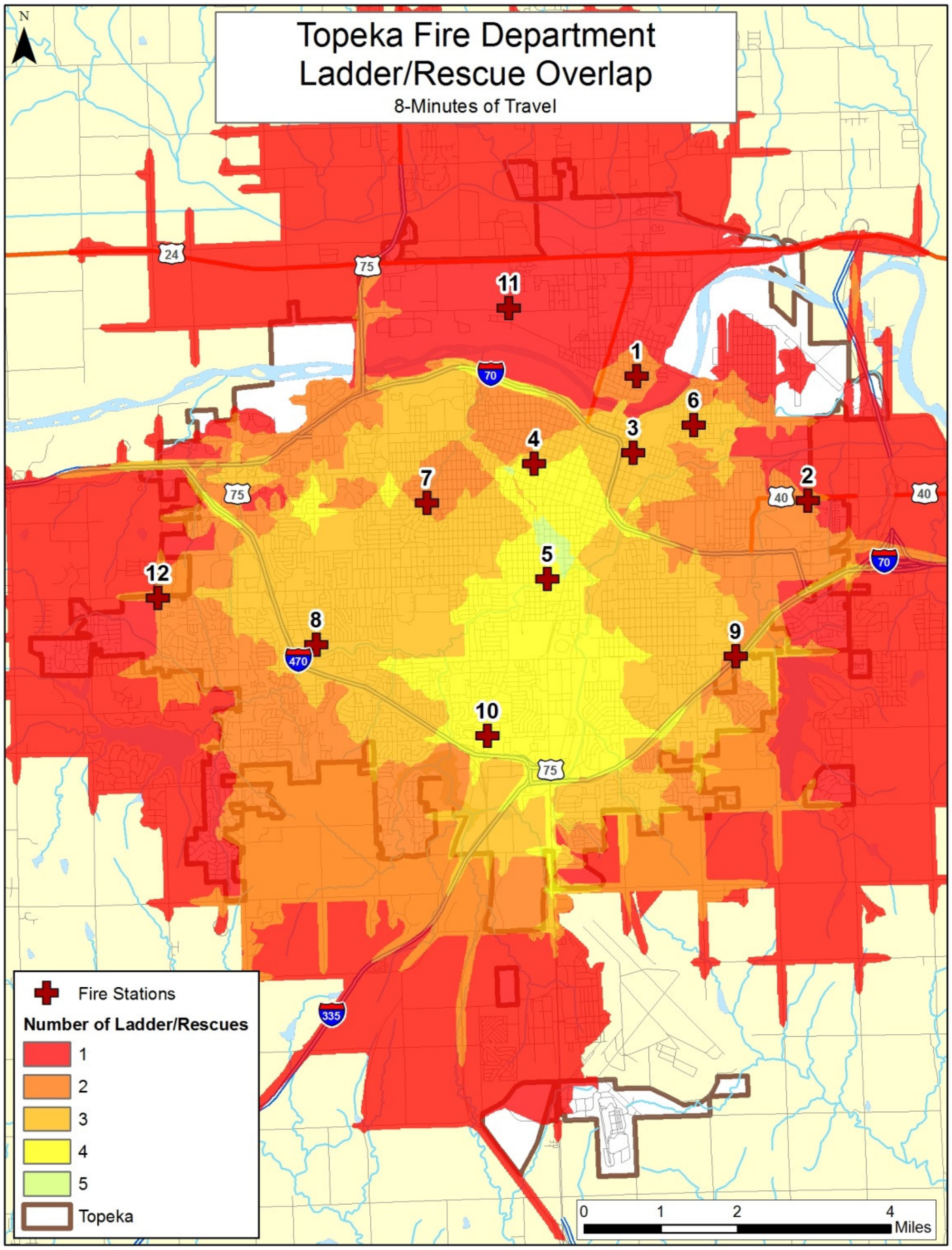
Although the addition of engines to the system would improve overall performance for first arriving apparatus, there may still be some delay in response by aerial and rescue apparatus. Based on the four-minute travel model, there are still some significant gaps in coverage of these apparatus, as illustrated below.

Figure 29: Ladder/Rescue Gap and Redundancy



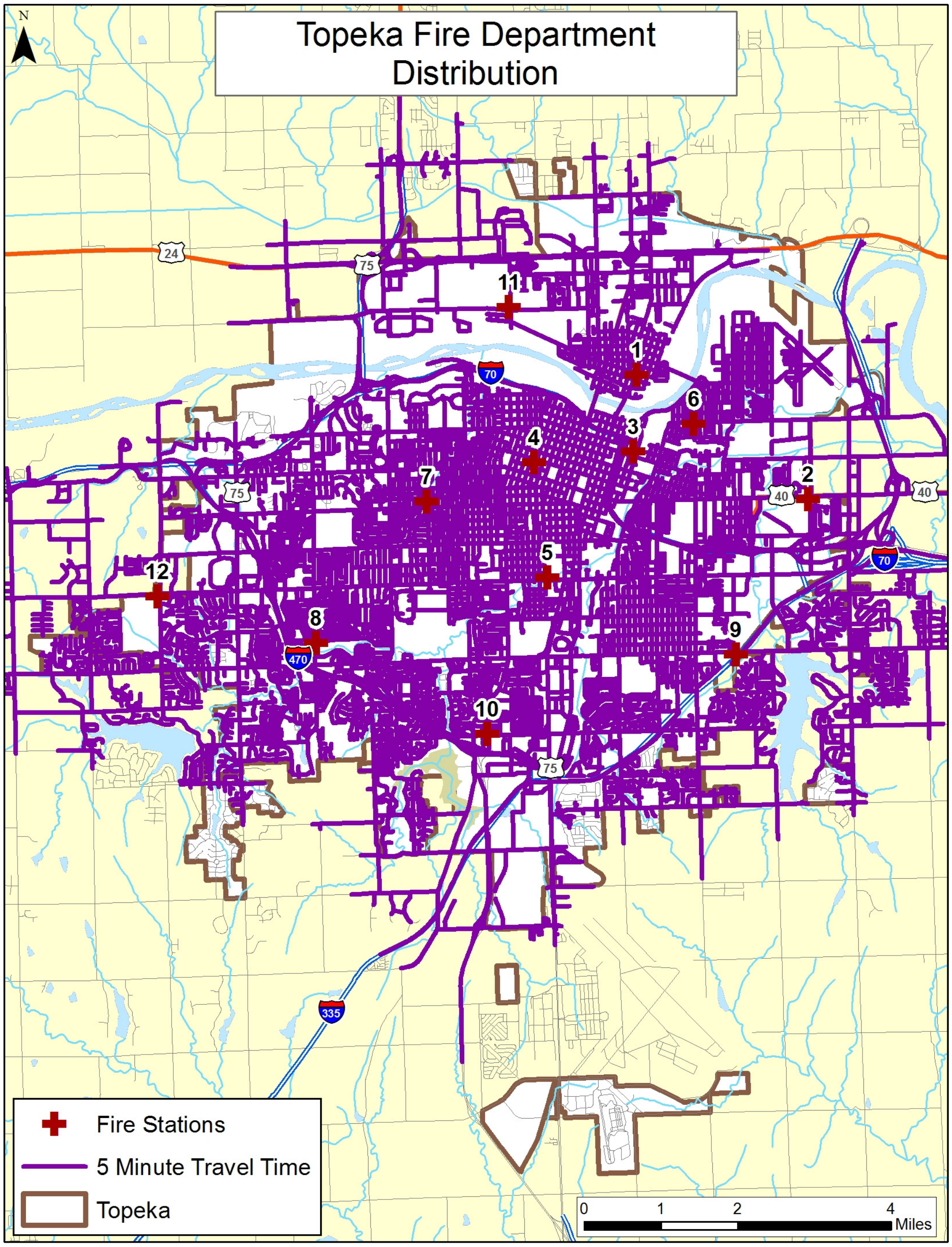
However, if engines are to be the primary responding unit to most incidents, and can provide initial strategies for the mitigation of the incident, it is conceivable that a longer response time may be acceptable. Based on an eight-minute travel model for ladders and rescues, the gap areas are significantly reduced as illustrated below.

Figure 30: Ladder/Rescue Gap and Redundancy (Eight-Minute Travel)



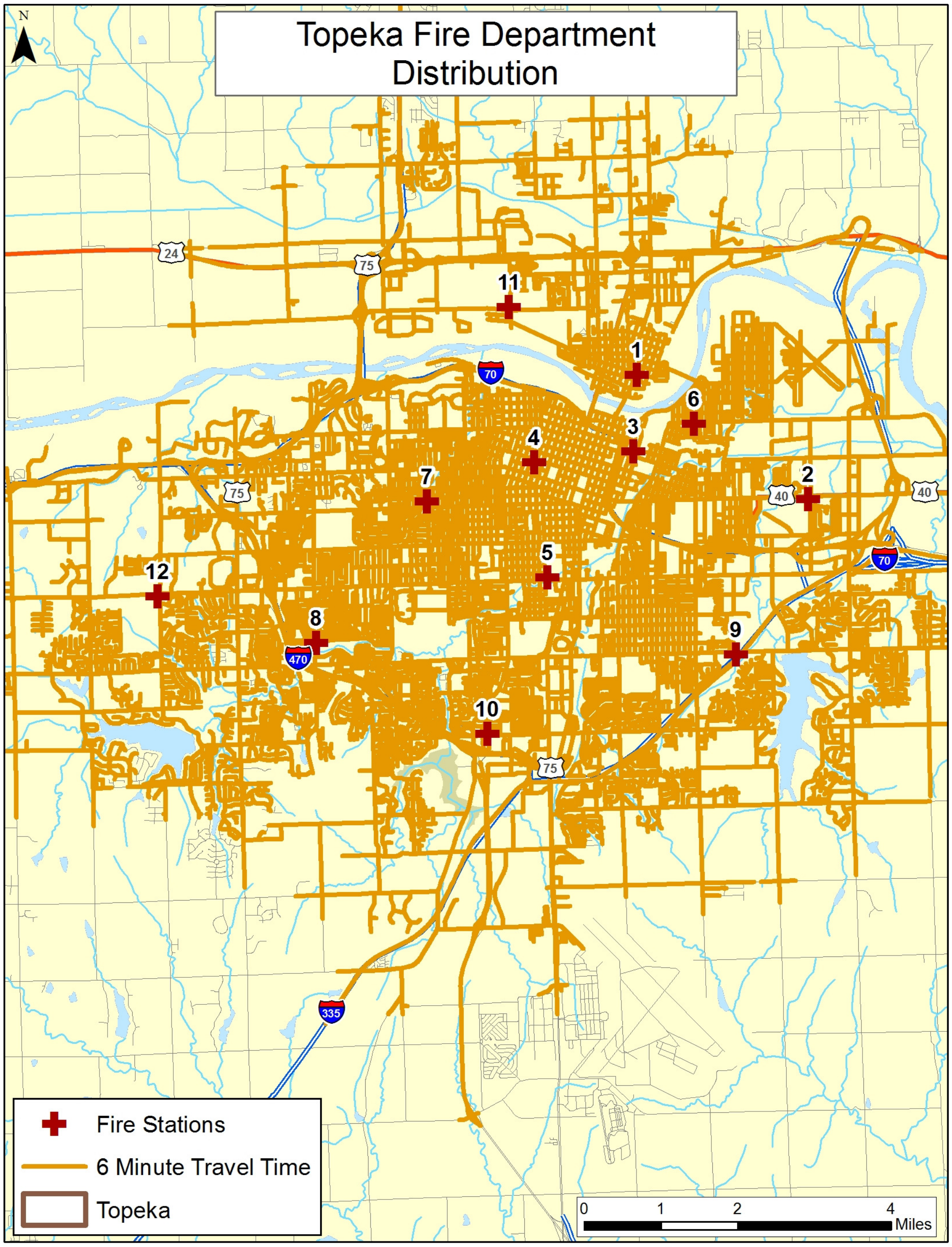
Although the preceding discussion uses common response performance objectives, it is possible to modify the formally adopted performance objectives and lengthen the overall response of primary apparatus to five or six minutes of travel. The following figure illustrates the potential coverage with five minutes of travel as opposed to four from the previous analysis.

Figure 31: Five Minute Distribution Model



As can be seen in the figure, extending the primary response performance to five minutes of travel significantly improves the travel capability of primary resources as compared to Figure 11, particularly in the northwestern area of the city. If the model is extended even further to six minutes, the travel capability improves even further, as illustrated below.

Figure 32: Six Minute Distribution Model

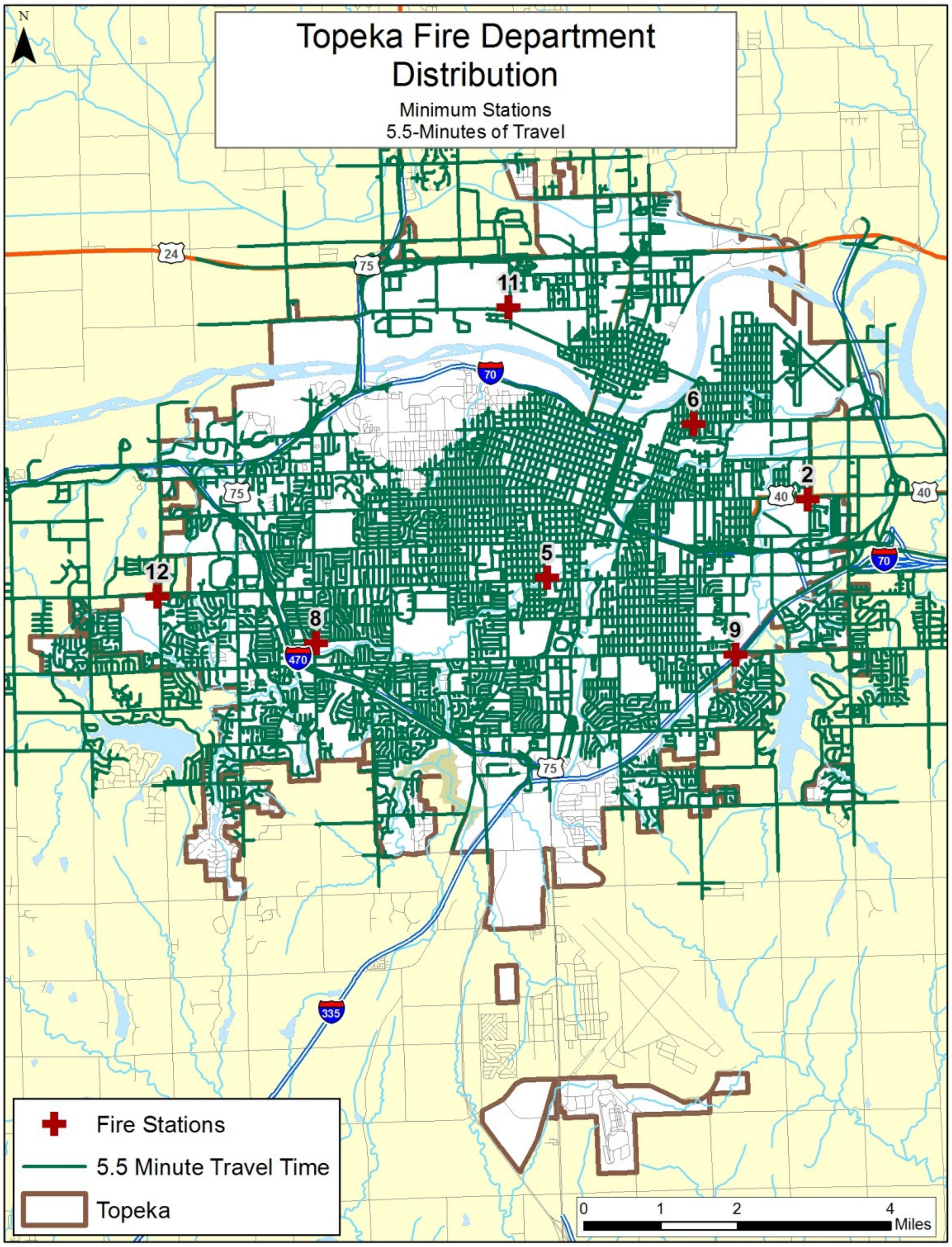


At six minutes of travel, 100 percent of the primary response area can be reached by existing apparatus.

As presented in the previous models, achieving a response time in line with NFPA standards (5:20 at the 90th percentile) would require additional resources within the current system. However, communities must decide what level of protection is desired and what level of service the community is expecting. This is a difficult question because, in time of emergency, the community will have a higher expectation.

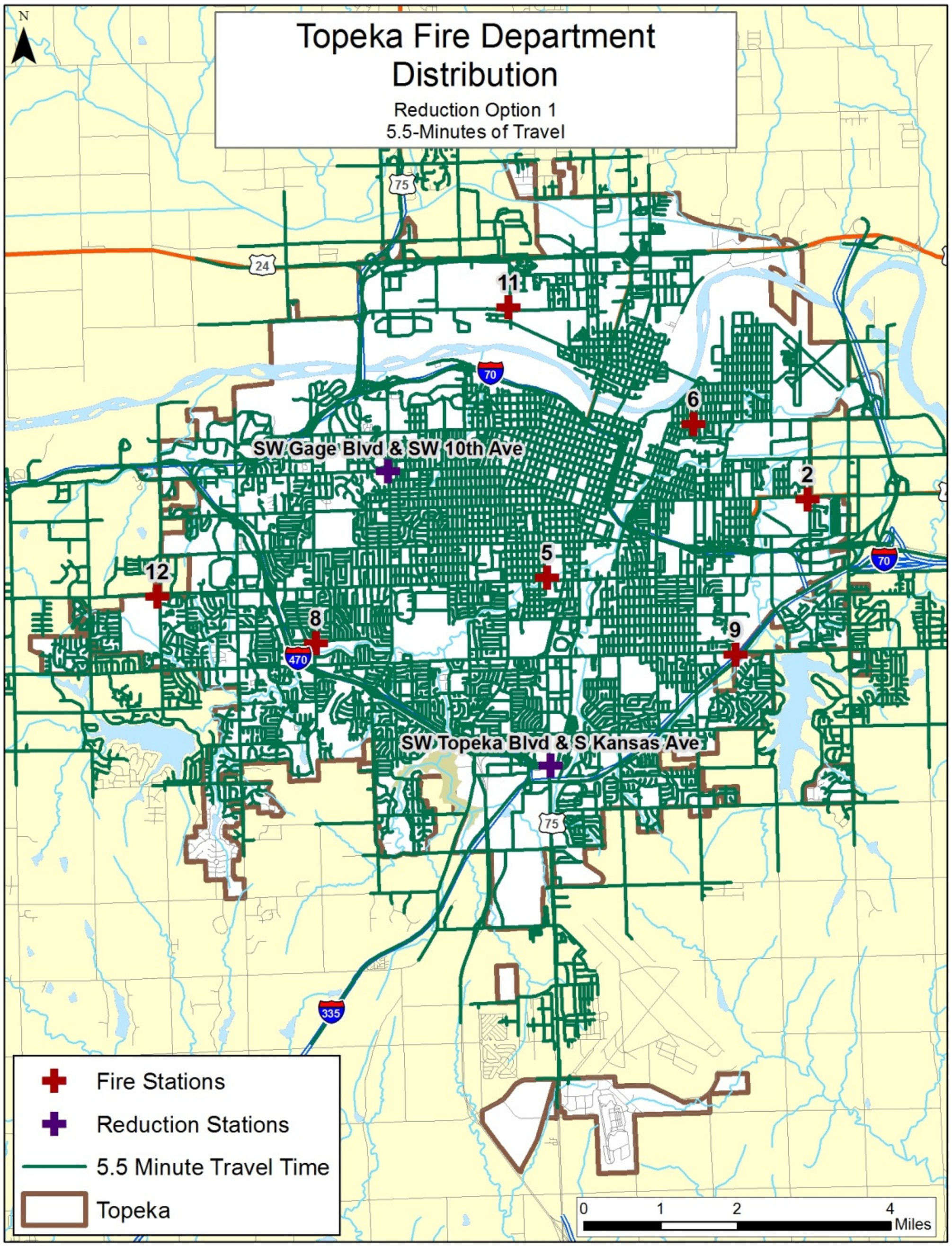
There are, however, other methods to provide the current level of service to the City of Topeka by consolidating some resources. ESCI used the historical travel time performance for TFD (5:30) to generate what could provide the current level of service without additional resources. The following figure illustrates the model distribution with a minimum number of stations.

Figure 33: 5:30 Travel Capability – Minimum Stations



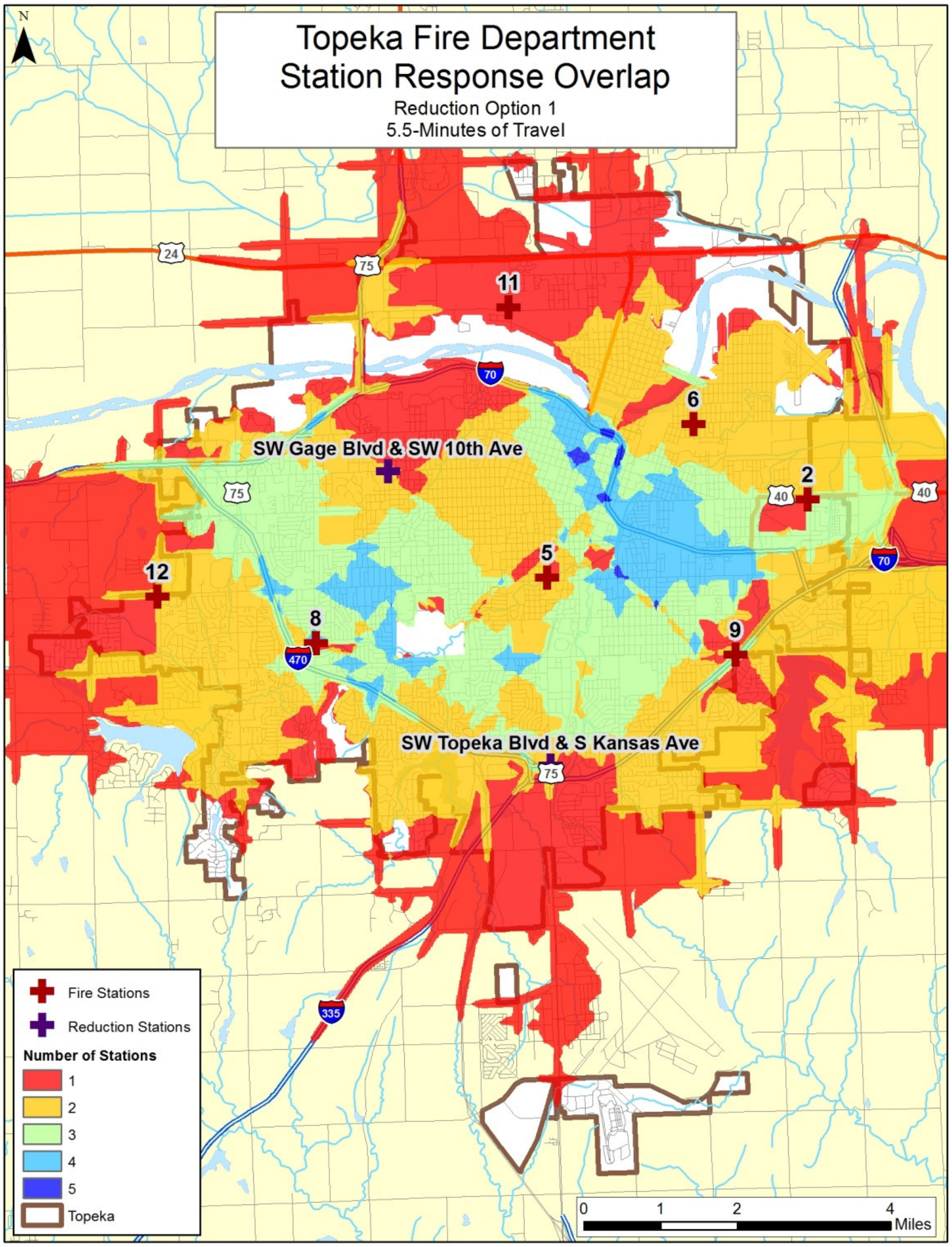
As can be seen in the figure above, this model would eliminate five stations but still be able to provide coverage to 92 percent of existing parcels within the City but leaves a significant portion of the northwest and south outside the travel model. Thus, if the City wishes to retain some of those resources and relocate them to a better suited area, three stations could be closed and two additional stations relocated as illustrated in the following figure.

Figure 34: 5:30 Travel Capability – Option 1 Redeployment



This model would maintain the current 5:30 travel capability and provide coverage to 98.5 percent of current parcels within the City. Effectively, this model would close Stations 1, 3, 4, 7, and 10 while placing new stations at SW Gage Blvd & SW 10th Ave as well as at SW Topeka Blvd & S Kansas Ave. This model substantially reduces the overlap as previously presented to a maximum of five engines in the core of the city as illustrated below.

Figure 35: Station Overlap – Reduction Option 1



Since this model reduces the number of stations from the current level of 12 to nine, ESCI wanted to ensure that services would not be substantially impacted due to increased workload for the remaining stations. In order to analyze this, ESCI developed 'catchment areas' based on each existing station's current primary response area to determine how many incidents were occurring in each area and which units were responding to those incidents. In other words, how often was an incident being responded to by a unit from another primary response area?

From this analysis, it was determined that Station 6 responded to the highest percentage of incidents within its primary response area (82.2 percent) while Station 5 only responded to 34.7 percent; with 55.8 percent of its responses into other areas. This is illustrated in the following figure.

Figure 36: Catchment Area Responses

Station	Primary Response Area	Outside Primary Response Area
1	76.64%	21.56%
2	68.12%	28.16%
3	73.61%	24.53%
4	70.37%	27.33%
5	34.65%	55.81%
6	82.17%	11.37%
7	59.65%	37.59%
8	47.39%	41.59%
9	59.28%	30.86%
10	61.68%	29.46%
11	53.14%	35.72%
12	58.96%	29.50%

If individual station responses are reviewed in relation to every other response area, much more detail can be realized in regards to how units are responding into other areas. The following figure illustrates the amount of responses that are occurring within primary and other station response areas.

Figure 37: Catchment Area Responses by Station Area

	Station Territory											
Station	1	2	3	4	5	6	7	8	9	10	11	12
1	76.64%	0.08%	13.49%	2.25%	0.25%	1.60%	0.25%	0.00%	0.02%	0.06%	3.50%	0.06%
2	0.12%	68.12%	19.34%	2.35%	2.83%	1.03%	0.07%	0.05%	1.80%	0.50%	0.07%	0.00%
3	1.68%	2.67%	73.61%	7.25%	2.61%	3.15%	3.30%	0.09%	0.61%	0.66%	0.49%	2.03%
4	0.07%	0.18%	6.23%	70.37%	8.82%	0.04%	9.05%	0.10%	0.02%	0.50%	0.07%	2.25%
5	0.65%	0.22%	10.28%	30.65%	34.64%	0.31%	3.96%	1.91%	2.43%	3.69%	0.02%	1.70%
6	2.83%	3.32%	4.29%	0.28%	0.12%	82.17%	0.09%	0.03%	0.09%	0.06%	0.22%	0.03%
7	0.02%	0.34%	2.39%	17.60%	12.10%	0.21%	59.65%	1.59%	0.01%	1.33%	0.13%	1.88%
8	0.17%	0.03%	0.20%	0.46%	15.08%	0.01%	12.14%	47.39%	1.44%	5.30%	0.23%	6.53%
9	0.03%	2.27%	5.54%	0.16%	13.30%	1.98%	0.18%	0.17%	59.28%	7.17%	0.07%	0.01%
10	0.12%	0.04%	2.02%	5.56%	4.17%	0.02%	7.37%	5.50%	3.51%	61.68%	0.20%	0.96%
11	19.60%	0.00%	0.96%	8.49%	1.16%	0.33%	2.64%	0.17%	0.33%	0.00%	53.14%	1.06%
12	0.00%	0.00%	0.51%	1.72%	9.01%	0.00%	2.60%	9.85%	0.53%	5.14%	0.13%	58.96%

In the figure above, the cells shaded in blue are those responses inside each station's primary response area. Those cells shaded in orange are responses into other areas at a rate above 10 percent. This information is important in any decision to relocate stations and must be considered in addition to simple deployment and travel models. Although from a distribution and travel capability model Station 3 could be removed from the current deployment model, the fact that other stations are responding to incidents within that catchment area at a rather high rate indicates that the station should remain, perhaps with additional resources.

In addition, Station 1 could be removed from the current deployment and additional resources placed within Station 11 to provide coverage to the area between Station 11 and Station 6. Also, with the distribution and catchment area information combined, Station 4 could be closed and additional resources located within Station 5 to absorb some of the additional workload.

Findings, Recommendations, and Conclusions

PRIMARY FINDINGS

Based on the analysis detailed in the body of this report, the existing 12 TFD fire stations can provide coverage to 61.7 percent of historic service demand within four minutes of travel but 100 percent within 5:30 of travel. Service demand, however, is expected to increase over the next 25 years and additional resources will be necessary to maintain the current level of service if NFPA 1720 standards are the goal. The current level of service being provided by TFD (just over 7:00 of total response time) is above the level recommended by NFPA 1710 but, as discussed in the report, local policymakers must decide what is best for their communities in regard to what level of service is expected, what level of service is the community *able* to pay for; and what level of service is the community *willing* to pay for.

If the goal of the City and the fire department is to continue to provide the current level of service while improving efficiency within the overall system, a slightly higher response time should be considered. As previously stated, in ESCI's nearly 40 years of experience working on deployment studies, no department has been able to consistently meet the NFPA 1710 response performance objective.

In support of this, ESCI collected comparable data from Midwestern cities that serve approximately the same population as TFD. Within that comparable data, ESCI wanted to identify the average response time of each agency. As can be seen in the figure below, TFD's average response time is better than the other four comparable cities.

Figure 38: Comparable City Response Perormance

	Population	Area	Responses	Average RT
Topeka	127,473	61.47	18,198	4:51
Sterling Hgts, MI	129,699	36.80	10,352	5:22
Warren, MI	134,056	34.46	11,226	6:30
Cedar Rapids, IA	126,326	72.07	10,589	5:00
Olathe, KS	125,872	60.42	10,167	5:17

As such, it would be the recommendation of ESCI that TFD adopt a response performance objective similar to their current performance of 7:00 minutes total response time when measured at the 90th percentile.

Many times, studies such as these are conducted because there is a concern about current service delivery. That is not necessarily the case for Topeka. The fire department, in concert with the City, desires to begin a planning process for the future of emergency services delivery within the primary response area. This will allow policymakers and department managers to adequately plan for future necessary funding and capital needs.

RECOMMENDATIONS

1. Turnout time performance is higher than expected and should be monitored to ensure that personnel a getting en route to incidents in a timely manner. This will further reduce overall response time.
2. In order to maintain the current level of service, it is possible to close several stations and relocate others, as noted below:
    a. Close Stations 1, 4, 7, and 10
    b. Construct two new stations at:
        i. SW Gage Blvd & SW 10th Ave
        ii. SW Topeka Blvd & S Kansas Ave
3. An additional engine would be necessary at Station 5 to complement the ladder already housed there
4. An additional engine would be necessary at Station 11 to complement the current resources and provide sufficient coverage to the northern areas of the City
5. In order to reduce gaps in ladder/rescue coverage, the City should consider adopting an eight minute travel model for those resources
6. Since a majority of the department's workload is medical in nature, the City should consider alternatives to the current response protocol including implementation of smaller response vehicles for non-structural response.
7. Adopt a response performance objective of 7:00 minutes when measure at the 90th percentile.

CONCLUSION

From a response performance and effectiveness perspective, TFD is not performing unlike many organizations of similar size and operational structure. The NFPA 1710 recommendations noted within this report are for reference only and local policymakers should work with department leaders to adopt a formal set of response objectives that match community risk and expectations. The recommendations provided here that maintain current levels of service would be preferred rather than attempting to meet a standard that may not be in-line with community expectations or fiscal capabilities.