CITY OF Grand Junction COLORADO

Station Location Study

September 2008

Emergency Services Consulting inc.

Grand Junction Fire Department

Station Location Study

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Table of Contents

Table of Figures

Executive Summary

The executive summary provides an overview of the Grand Junction Fire Department Station Location Study. The purpose of this executive summary is to abridge the document's key points, save the reader time, and serve as an organizer for the reader.

Purpose and Report Conventions

This report by Emergency Services Consulting inc. (ESCi) answers the request of the Grand Junction Fire Department for a station location study. The plan evaluates current station locations and any potential improvement in efficiencies that may be available as well as the development of options for future station locations to maintain acceptable levels services for the future.

ESCi recognizes that information, by its very nature, is often incomplete as it changes from moment to moment. Efforts were made to compile data that was complete, comprehensive, and accurate. The information gathering process included geographical information, station locations and operational needs, and measuring results against acceptable industry standards and best practices.

The Grand Junction Fire Department (GJFD) currently operates out of five facilities. The service coverage area includes most of the City of Grand Junction (City) and the surrounding area, for fire protection and emergency medical services (EMS), including ambulance transports.

There were 3,800 incidents in the fire related database while the medical database contained 14,922 emergency calls over a two year period. The bulk of the workload for GJFD is handling requests for emergency medical aid. This is not unusual for fire department's that participate in either first responder or have transporting capabilities.

NFPA 1710

The National Fire Protection Association (NFPA) has issued a response performance standard for all or mostly career staffed fire departments. This standard, among other things, identifies a target response time performance objective for fire departments and a target staffing standard

for structure fires. Though not a legal mandate, *NFPA 1710*[1] does provide a useful benchmark against which to measure the department's performance.

NFPA 1710 contains time performance standards for structure fire response as well as emergency medical response. ESCi measured each standard separately as outlined below.

NFPA 1710 describes the following performance as meeting the **structure fire response** criteria of the standard:

- *Turnout time within one minute, 90% of the time*
- *Arrival of the first company within five minutes of dispatch, 90% of the time,* ***or***
- *Arrival of the entire initial response assignment (all units assigned to the call) within nine minutes of dispatch, 90% of the time*

There are three time standards within the *NFPA 1710* standard for **emergency medical responses.** They are:

- *Turnout time within one minute, 90% of the time*
- *Arrival of a unit with first responder or higher level of capability (basic life support) within five minutes of dispatch, 90% of the time*
- *Arrival of an advanced life support unit, where this service is provided by the fire department, within nine minutes of dispatch, 90% of the time*

The Grand Junction has a performance goal to meet the *NFPA 1710* standard as it relates to fire incidents. Large portions of the City limits are within travel time limits of four minutes, however there are highly populated areas south of I-70 and west of the airport that are outside the desired four minute travel time between Stations 1 and 5.

For medical calls, GJFD adheres to the requirement set forth for all emergency medical service providers within Mesa County. It stipulates that calls considered high priority[2] are responded to within eight minutes, 90 percent of the time in an urban area. It should be noted that staffed

[1] *NFPA 1710: Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments,* 2004.
[2] Priority is based on criticality of patient complaint as defined by Medical Priority Dispatch System© protocol.

ambulances only respond from Stations 1, 2, and 3, but all stations are staffed with EMS-certified personnel, have EMS equipment on apparatus, and respond to EMS incidents.

Truck Company

GJFD operates a truck company from Station One. A truck company is not required to have an elevating ladder or aerial device unless there are a sufficient number of buildings that would meet the three-story height and square footage limits. ESCi analyzed the buildings within the City that exceed 30,000 square feet and their relation to the recommended the Insurance Services Office (ISO) travel distance of 2.5 miles for truck companies.

Only 45.55 percent of the buildings within GJFD are within the ISO truck company distance of 2.5 miles. The majority of these structures outside of this distance are located near Station 2 and Station 3. While expansive square feet is one consideration for a truck company, another is the building height. Persons trapped on higher floors of buildings may need the elevating ladders that are equipped on truck apparatus.

ESCi's analysis shows that 120 out of the 164 buildings identified are within the 2.5 mile ISO truck company distance, most of the tall buildings beyond this limit are in Station 2's area.

Facility Deployment Strategies

ESCi examined the current facility distribution and capabilities of response time performance with regard to the adopted goals for fire and medical calls within their primary jurisdiction. Workload and subsequent actual response time performance were analyzed along with the extent of a full alarm force assembly.

Certain conclusions are derived from these analyses:

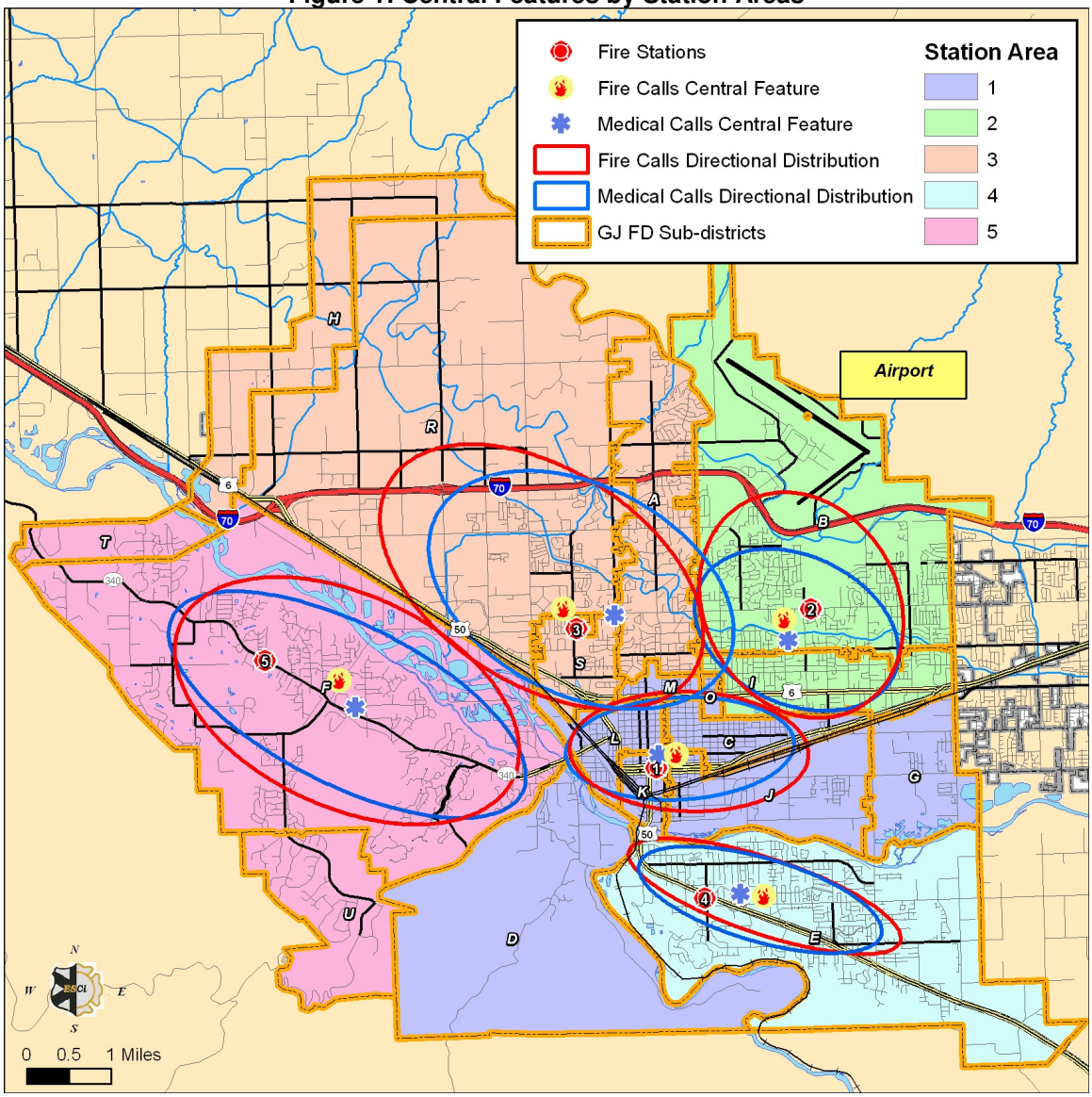
- Current facility deployment is adequate for current demand coverage for medical calls. This is evident, through response time analysis, where the first arrived units have a better performance than mandated by Mesa County.
- Response time performance for fire calls lags behind the departmental goal which indicates the need for additional facilities to meet this goal. This is due to the shorter response time requirement for fire calls and the generalization of response time objectives when compared to the prioritization designation for medical calls.

- Unit workload is not sufficiently high enough to warrant additional apparatus ***based on workload alone***. EMS units ***are approaching*** threshold limits, but still below recommended benchmarks.
- Concurrent calls (more than once call at a time) in high demand areas create a lower reliability for host station units.
- Turnout time is above stated goals, but not unusual for a career department performance.

Given these conclusions, it is important to determine where the center of concentration of calls (central feature) is in each of the station's primary response areas to determine if the current location is optimal for each area. This is not the same as a geographic center where a few outlying calls would influence this location, but where the shortest distance to the most calls within a station area lies.

Along with each central feature, a directional distributional ellipse is drawn for each station area and both types of calls. The direction of the ellipse indicates the orientation of most calls within the station area. The size of the ellipses indicates the compactness, or level of concentration, of calls within each station's area.

Figure 1: Central Features by Station Areas



All fire directional ellipses are larger than the medical calls ellipses. This indicates that more concentrated than Station 5's calls; they follow a similar orientation from northwest-southwest ellipses, along the major arterial roadway in their area. Despite Station 1's primary area, this is the most concentrated area for calls in the downtown area. Station 2's fire directional ellipse differs from the medical ellipses by orienting further north toward the airport. Similarly, Station 3's ellipse stretches further northwest than the more compact medical call ellipses for this station which surrounds the higher residential population.

For all areas, the central feature within a station area is less than one mile from the current location of a fire station. This indicates the current locations are optimal, considering the concentration of calls within the designated station area. ***However, it should be remembered that, based on travel time, the existing stations are not sufficient to provide adequate coverage of service demand at the current response time objective for fire calls.***

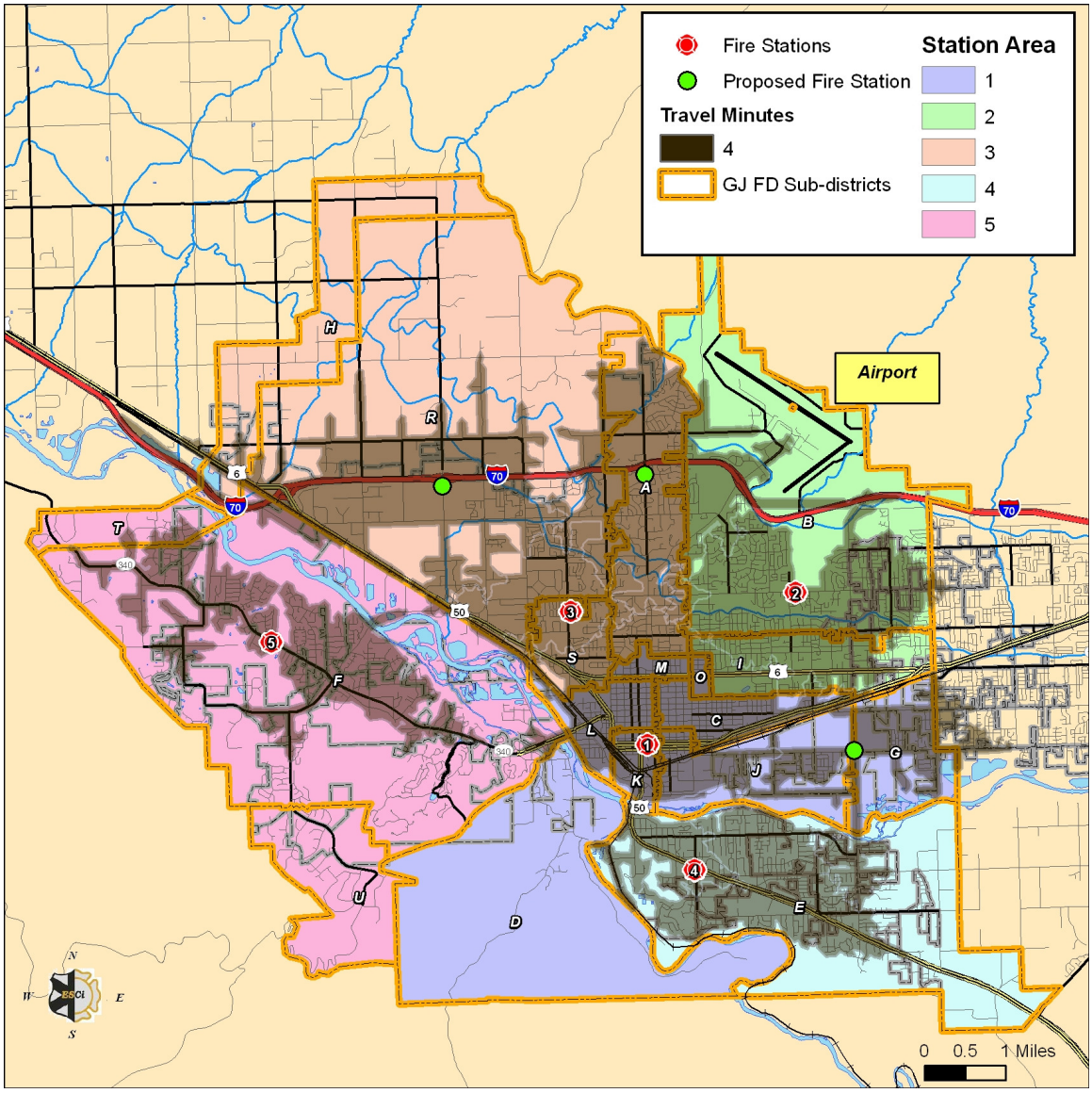
Findings, Recommendations, and Conclusions

Scenario A: Build additional stations to ensure uniform response protection department wide.

ESCi recommends Scenario A as the preferred scenario strategy. Proposed locations for additional facilities are based on the service demand levels that are not within the response time capability of a four minute travel time of the existing stations. For the most part, the location closest to these calls is chosen since it would provide the most additional service demand coverage. ESCi realizes that available property and zoning regulations will ultimately factor into the final location of a proposed station. It can be seen that locations within a half-mile can be considered without significantly altering the study results.

Stations 2 and 3 have the largest amount of uncovered service demand after the measure of four minutes of travel is subtracted from the respective response area service demand. Most of Station 2's underserved demand is at or near the airport; however, locating a station at this location creates a gap between this location and Station 2. Station 3's area of underserved service demand is concentrated in the northern part of response area 'A,' and scattered throughout the response area 'R'. The central feature for Station 3's underserved demand is located near the interchange with I-70 and 24th Road. The combined central feature for the underserved area for Station 2 and Station 3 was located in response area 'A,' just south of the interstate overpass at 26 ½ Rd. and G ½ Rd. A new station at this location along an arterial roadway provided coverage to most of the airport and the northern response area 'A'. Its nearest interstate access is at the Horizon Drive interchange. The following figure illustrates recommendation station locations and the modeled travel time capability.

Figure 2: Proposed Facility Deployment Strategy



The following table is a summary of statistical result for each station addition verses the overall service-demand pattern for GJFD. Additionally, recommended apparatus per station is provided. along with re-assignment of apparatus

Figure 3: Projected Performance Summary

Additional Coverage Considerations

ESCi typically does not recommend additional stations to exceed the goal when the shortfall in coverage is merely a fractional consideration. However, a discussion regarding the service demand patterns in response area 'D', and in the overall Station 5 area merits further attention.

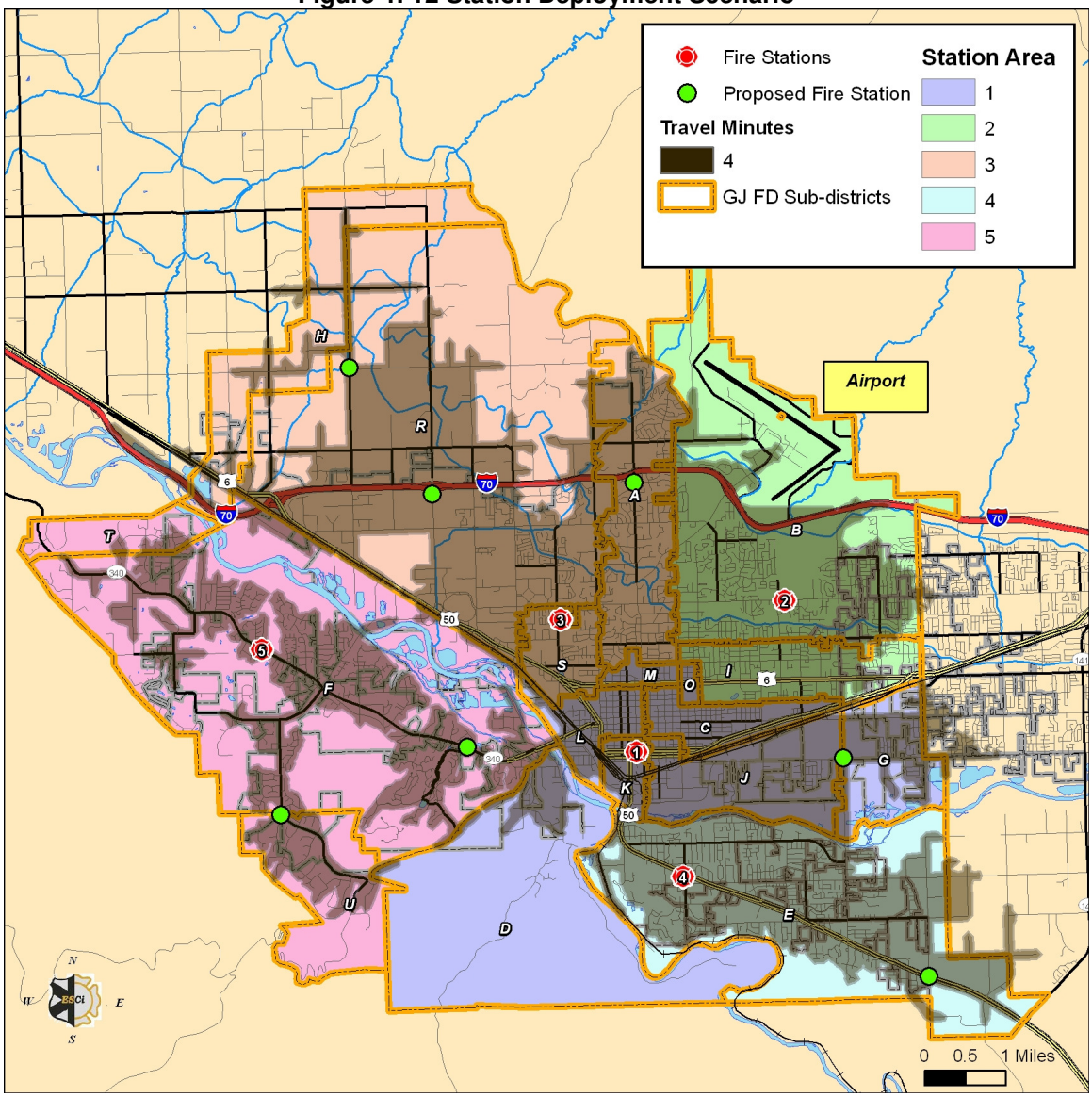
Because Station 1 can reach response area 'D' faster than Station 5, Station 1 responds to calls to this response area even though Station 5 has primary responsibility. However, the response area still cannot be reached within four minutes. Station 5's underserved area is primarily located in two areas on the southeast side of response area 'F' and within response area 'U'. These areas are essentially separated by limited street connectivity due to terrain whereby no single station could cover both areas. The northern neighborhood, just south of Broadway, has more service demand than the southern neighborhood off of S. Camp Rd., when combined with the neighboring response area 'D' service demand. Relocation of Station 5 to its central feature at the intersection of Broadway and Redlands Pkwy. yields little benefit since service demand coverage in the northwest part of response area 'F' and 'T' was lost to the gains further southeast. This station was also the most recently constructed in 2004.

A station at Broadway and Ridges Blvd. provides coverage to the northern neighborhood in response area 'F' and most of the service demand that occurs in the northern portion of response area 'D'. A fractional gain of less than one percent is noted with redundancy area coverage with Station 5 and Station 1. A station on S. Camp Rd. and Buffalo Rd. adds additional coverage to an area that is remote from either existing or proposed Broadway stations.

Similar fractional gains from possible stations in Station 4's area (30 Rd. & Hwy 50), and northwestern response area 'R' (23 Rd. & I Rd.) do make these stations viable economically

based on efficiency of demand coverage. The overall service demand coverage increases about four percent for these four additional stations. With these additional stations, 88.6 percent of road miles are traversable within four minutes. The following figure illustrates these additional locations and their projected travel time capability.

Figure 4: 12 Station Deployment Scenario



This study was based on current conditions and demands on the fire department. Further growth may alter this strategy significantly and make these stations viable for construction. It is advised that forward planning for facilities, apparatus, and staffing be conducted to ensure effective and efficient fire rescue services to the community before development growth surpasses GJFD capability.

Pro: Uniform coverage based on *NFPA 1710* guidelines provides maximum protection against loss of life and property due to fire related incidents.

Con: The need to construct and finance a minimum of three stations, associated apparatus, and staff.

Strategy B: Status quo stations with altered response time objectives for fire calls

One solution, without building additional facilities, would be to raise the response time objective from five minutes, 90th percentile to eight minutes, 90th percentile. A coverage analysis indicates that at this level, over 90 percent of the fire service demand can be reached within seven minute of travel. Alternatively, the response time goal could be increased slightly to seven minutes, but the percentile strength could be reduced to 80th percentile to adequately provide service demand coverage.

Pro: Allows for response time compliance without additional cost of facility construction and operation.

Con: Increased response time can lead to increased property loss and may not be in line with public expectations.

Strategy C: Status quo stations with altered operational protocol for medical calls

To increase the reliability of fire apparatus answering primary district calls and reducing fire response time performance, only assign fire apparatus to medical calls if:

- Any ambulance is unavailable within the station area
- Two EMS calls are occurring concurrently in the station area
- Only to medical calls where additional manpower or other fire apparatus related services are likely to be needed (i.e. spills, CO alarm)

Pro: Fire apparatus availability should increase, thereby reducing response times in higher demand areas.

Con: Ambulances are less likely to be cancelled en route to a call, and resume availability when a fire crew has not assessed the incident.

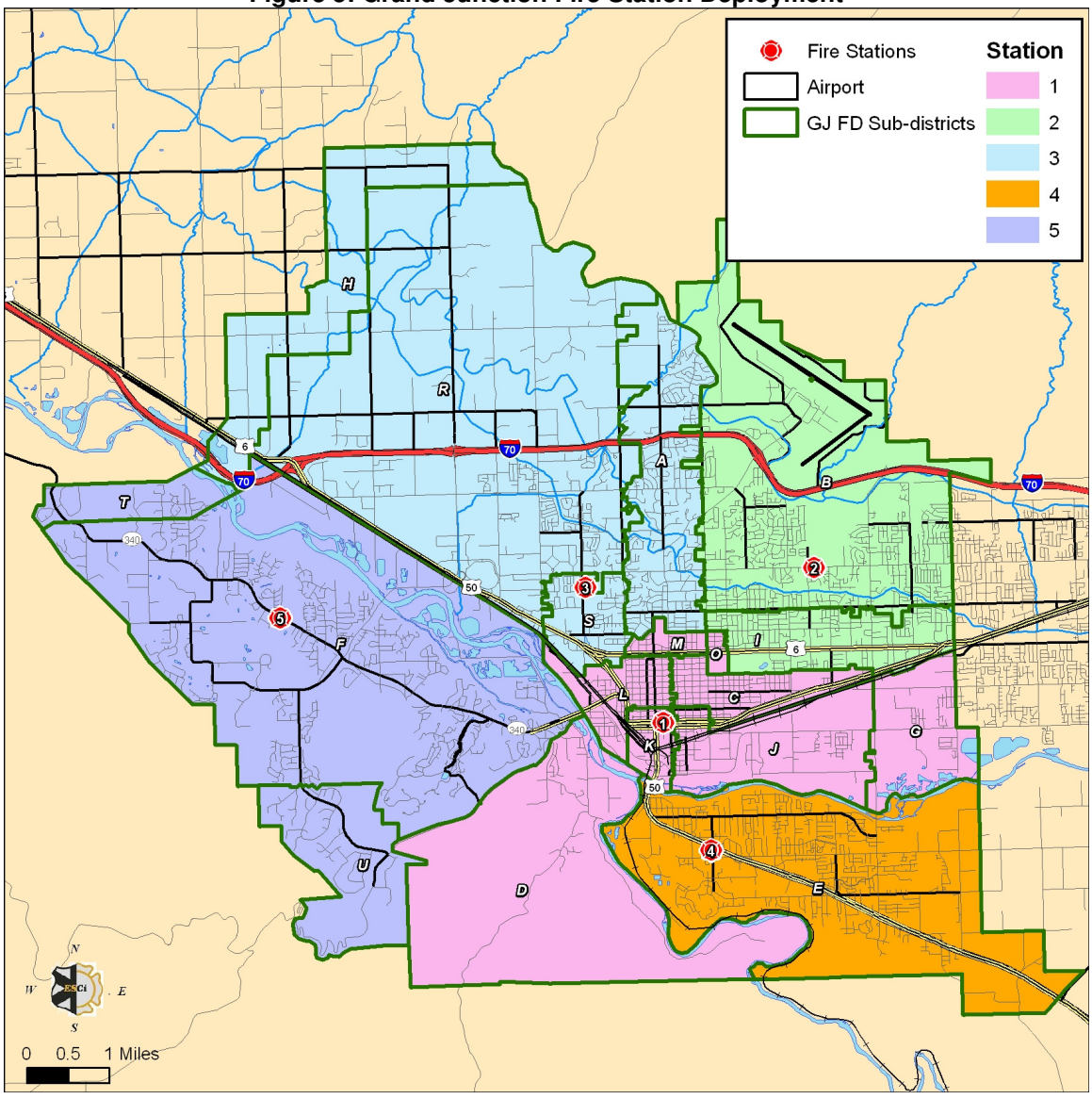
Strategy D: Develop a measure of criticality to fire dispatch procedures

Similar to how medical calls are prioritized, responded to, and measured; the department can have alternate response protocols for fire calls based on caller information. This can be more difficult in many cases than medical calls since the potential extent of the emergency cannot be adequately assessed without a fire crew on the scene. Alternatively, the department can assign differing response time standards based on either City or non-city areas, or by population densities.

Distribution Analysis

The Grand Junction Fire Department (GJFD) currently operates out of five facilities. The service coverage area includes most of the city of Grand Junction (City) and the surrounding area, for fire protection and emergency medical services (EMS), including ambulance transports. The following map depicts fire station locations within the fire response areas. The following sections illustrate the fire district's capability from the currently operated stations.

Figure 5: Grand Junction Fire Station Deployment



The fire department covers approximately 80 square miles and is home to over 84,000 residents, most of whom live within Grand Junction city limits. As the name implies, Grand Junction is located at the confluence of the Gunnison and Colorado Rivers, two major railways, and U.S. Highway 6 and U.S. Highway 50. Along the north side of the City, and well within the department's response area, runs the east-west Interstate 70. On the northeast side is Grand Junction Regional Airport, an aviation facility that serves travelers to and from the Grand Junction area. Mesa State College is located in downtown Grand Junction and has a student population of over 6,000 students, about half of whom are from Mesa County.

Response Time Performance Objectives

The ultimate goal of any emergency service delivery system is to provide sufficient resources (personnel, apparatus, and equipment) to the scene of an emergency in time to take effective action to minimize the impacts of the emergency. This goal applies to fires, medical emergencies, and any other emergency situation to which the fire department responds.

Before discussing the department's current performance, it is important to gain an understanding of the dynamics of fire and medical emergencies.

Dynamics of Fire in Buildings

Most fires within buildings develop in a predictable fashion unless influenced by highly flammable material. Ignition, or the beginning of a fire, starts the sequence of events. It may take some minutes or even hours from the time of ignition until flame is visible. This smoldering stage is very dangerous, especially during times when people are sleeping, since large amounts of highly toxic smoke may be generated during the early phases of a fire.

Once flames do appear, the sequence continues rapidly. Combustible material adjacent to the flame heats and ignites which, in turn, heats and ignites other adjacent materials if sufficient oxygen is present. As the objects burn, heated gases accumulate at the ceiling of the room. Some of the gases are flammable and highly toxic.

The spread of the fire continues quickly. Soon flammable gases at the ceiling reach ignition temperature. At that point, *flashover* takes place; the gases ignite, which then ignites everything in the room. Once flashover occurs, damage caused by the fire is significant and the environment within the room can no longer support human life.

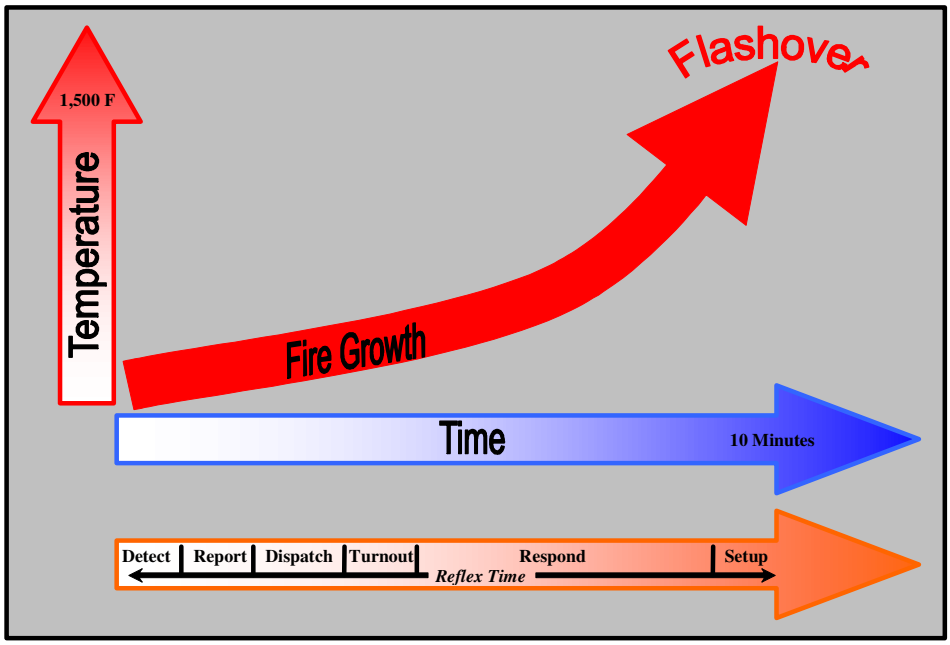
Flashover usually happens five to eight minutes from the appearance of flame in typically furnished and ventilated buildings. Since flashover has such a dramatic influence on the outcome of a fire event, the goal of any fire agency is to begin firefighting efforts before flashover takes place.

Perhaps as important as preventing flashover is the need to control a fire before it does damage to the structural framing of a building. Materials used to construct buildings today are often less fire resistive than the heavy structural skeletons of older frame buildings. Roof trusses and floor joists are commonly made with lighter materials more easily weakened by the effects of fire. *Light weight* roof trusses fail after five to seven minutes of direct flame impingement. Plywood I-beam joists can fail after as little as three minutes of flame contact. This creates a very dangerous environment for firefighters.

In addition, the contents of buildings today have a much greater potential for heat production than in the past. The widespread use of plastics in furnishings and other building contents rapidly accelerate fire spread and increase the amount of water needed to effectively control a fire. All of these factors make the need for early application of water essential to a successful fire outcome.

A number of things must happen quickly to make it possible to achieve fire suppression prior to flashover. Figure 6 illustrates the sequence of events.

Figure 6: Fire Growth vs. Reflex Time



The reflex time continuum consists of six steps, beginning with ignition and concluding with the application of (usually) water. The time required for each of the six components varies. The policies and practices of the department directly influence four of the steps, but two are only indirectly manageable. The six parts of the continuum are:

1. **Detection**: The detection of a fire may occur immediately if someone happens to be present or if an automatic system is functioning. Otherwise, detection may be delayed, sometimes for a considerable period.
2. **Report**: Today most fires are reported by telephone to the 9-1-1 center. Call takers must quickly elicit accurate information about the nature and location of the fire from persons who are apt to be excited. A citizen well trained in how to report emergencies can reduce the time required for this phase.
3. **Dispatch**: The dispatcher must identify the correct fire units, subsequently dispatch them to the emergency, and continue to update information about the emergency while the units respond. This step offers a number of technological opportunities to speed the process including computer aided dispatch and global positioning systems.

4. **Turnout**: Firefighters must don firefighting equipment, assemble on the response vehicle, and begin travel to the fire. Good training and proper fire station design can minimize the time required for this step.
5. **Response**: This is potentially the longest phase of the continuum. The distance between the fire station and the location of the emergency influences reflex time the most. The quality and connectivity of streets, traffic, driver training, geography, and environmental conditions are also a factor.
6. **Set up**: Last, once firefighters arrive on the scene of a fire emergency, fire apparatus are positioned, hose lines stretched out, additional equipment assembled, and certain preliminary tasks performed (such as rescue) before entry is made to the structure and water is applied to the fire.

As apparent by this description of the sequence of events, application of water in time to prevent flashover is a serious challenge for any fire department. It is critical, though, as studies of historical fire loss data can demonstrate.

The National Fire Protection Association studied data from residential structures occurring between 1994 and 1998 in order to analytically quantify the relationship between the growth of a fire beyond the room of origin and losses in life and property. As Figure 3 clearly indicates, fires contained to the room of origin (typically extinguished prior to or immediately following flashover) had significantly lower rates of death, injury, and property loss when compared to fires that had an opportunity to spread beyond the room of origin (typically extinguished post-flashover). Incidents in which a fire spreads beyond the room where it originates are likely to experience six times the amount of property loss and have almost nine times greater chance of resulting in a fatality.

Figure 7: National Data- Fire Growth to Life and Property Loss

Fire Extension in Residential Structure Fires 1994 - 1998			
Extension	***Rates per 1,000 Fires***		
	Civilian Deaths	***Civilian Injuries***	***Dollar Loss Per Fire***
Confined to room of origin	2.32	35.19	$3,385
Beyond room of origin; confined to floor of origin	19.68	96.86	$22,720
Beyond floor of origin	26.54	63.48	$31,912

Emergency Medical Event Sequence

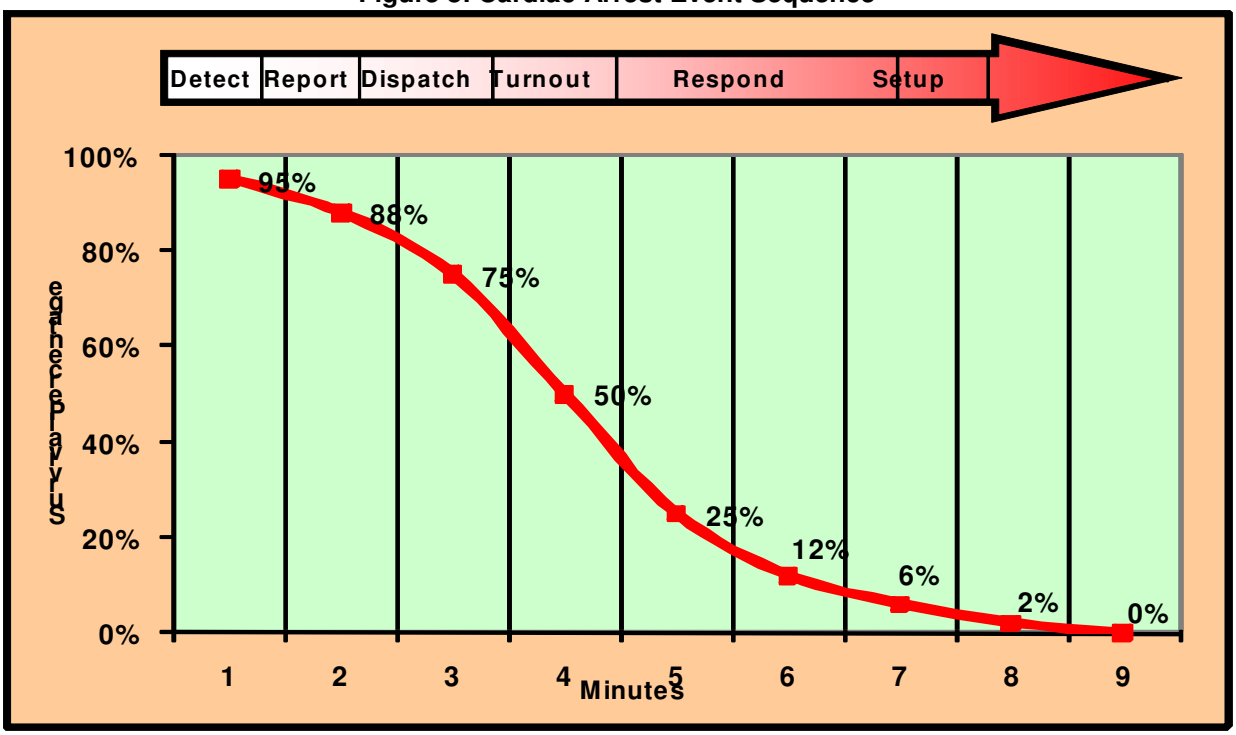
Cardiac arrest is the most significant life threatening medical event. A victim of cardiac arrest has mere minutes in which to receive definitive lifesaving care if there is to be any hope for resuscitation.

The American Heart Association (AHA) issued a set of cardiopulmonary resuscitation guidelines designed to streamline emergency procedures for heart attack victims, and to increase the likelihood of survival. The AHA guidelines include goals for the application of cardiac defibrillation to cardiac arrest victims.

Heart attack survival chances fall by seven to ten percent for every minute between collapse and defibrillation. Consequently, the AHA recommends cardiac defibrillation within five minutes of cardiac arrest.

As with fires, the sequence of events that lead to emergency cardiac care can be visually shown, as in the following figure.

Figure 8: Cardiac Arrest Event Sequence



The percentage of opportunity for recovery from cardiac arrest drops quickly as time progresses. The stages of medical response are very similar to the components described for a fire response. Research stresses the importance of rapid cardiac defibrillation and administration of certain drugs as a means of improving the opportunity for successful resuscitation and survival. An Oregon[3] fire department studied the effect of time on cardiac arrest resuscitation and found that nearly all of their *saves* were within one and one-half miles of a fire station, underscoring the importance of quick response.

People, Tools, and Time

Time matters a great deal in the achievement of an effective outcome to an emergency event. Time, however, isn't the only factor. Delivering sufficient numbers of properly trained, appropriately equipped, personnel within the critical time period completes the equation.

For medical emergencies, this can vary based on the nature of the emergency. Many medical emergencies are not time critical. However, for serious trauma, cardiac arrest, or conditions that may lead to cardiac arrest, response time is very critical.

Equally critical is delivering enough personnel to the scene to perform all of the concurrent tasks required to deliver quality emergency care. For a cardiac arrest, this can be up to six personnel; two to perform CPR, two to set up and operate advanced medical equipment, one to record the actions taken by emergency care workers, and one to direct patient care.

Thus, for a medical emergency the real test of performance is the time it takes to provide the personnel and equipment needed to deal effectively with the patient's condition, not necessarily the time it takes for the first person to arrive.

Fire emergencies are even more resource critical. Again, the true test of performance is the time it takes to deliver sufficient personnel to initiate application of water on the fire. This is the only practical method to reverse the continuing internal temperature increases and ultimately prevent flashover. The arrival of one person with a portable radio does not provide fire intervention capability and should not be counted as *arrival* by the fire department.

[3] Grazer RE, Jui J, Farjah F, & Zechnich A. *Survival for Out of Hospital Cardiac Arrest in Multnomah County, Oregon for 1995- 1997*: Reporting using Utstein Criteria; presented at Western SAEM Regional Meeting, Portland, Oregon, April 29-30, 2000.

National standards dictate at least four (4) fire personnel on scene before interior firefighting operations are initiated. The initial arrival of effective resources should be measured at the point in time when at least four personnel, properly trained and equipped, have assembled at the fire.

Emergency service agencies should have clearly defined response performance objectives established to allow evaluation of capability and service delivery. An organization's performance objectives should clearly state both the current and desired emergency service capabilities in very measurable terms. For emergency response, performance objectives should define response performance using both time and resource criteria.

For example:

- *Provide for the arrival of adequate resources to initiate basic emergency medical services at the scene of any medical emergency within "X" minutes following dispatch, 90% of the time.*
- *Provide for the arrival of adequate resources to initiate interior fire suppression operations at the scene of any fire within "X" minutes following dispatch, 90% of the time.*

With specific performance criteria a fire district can develop deployment methodologies to achieve desired levels of performance, and can quickly identify when conditions in the environment degrade performance.

NFPA 1710

The National Fire Protection Association (NFPA) has issued a response performance standard for all or mostly career staffed fire departments. This standard, among other things, identifies a target response time performance objective for fire departments and a target staffing standard for structure fires. Though not a legal mandate, *NFPA 1710* does provide a useful benchmark against which to measure the department's performance.

NFPA 1710 contains time performance standards for structure fire response as well as emergency medical response. Each will be discussed individually.

NFPA 1710 recommends that the first company arrive at the scene of a structure fire within five minutes of dispatch, 90 percent of the time. NFPA uses the 90th percentile rather than average. This allows an evaluation of a department's performance on the vast majority of its incidents.

There is another reason the arrival of four personnel is critical for structure fires. As mentioned earlier, current OSHA safety regulations require that before personnel can enter a building to extinguish a fire at least two personnel must be on scene and assigned to conduct search and rescue in case the fire attack crew becomes trapped. This is referred to as the *two-in, two out* rule.[4] The only exception to this regulation is if it is known that trapped victims are inside the building.

Finally, the NFPA standard calls for the arrival of the entire initial assignment (sufficient apparatus and personnel to effectively combat a fire based on its level of risk) within nine minutes of dispatch, 90 percent of the time. This is to ensure that enough people and equipment arrive soon enough to be effective in controlling a fire before substantial damage occurs.[5]

NFPA 1710 describes the following performance as meeting the structure fire response criteria of the standard:

- *Turnout time within one minute, 90% of the time*
- *Arrival of the first company within five minutes of dispatch, 90% of the time,* ***or***
- *Arrival of the entire initial response assignment (all units assigned to the call) within nine minutes of dispatch, 90% of the time*

There are three time standards within the *NFPA 1710* standard for emergency medical responses. They are:

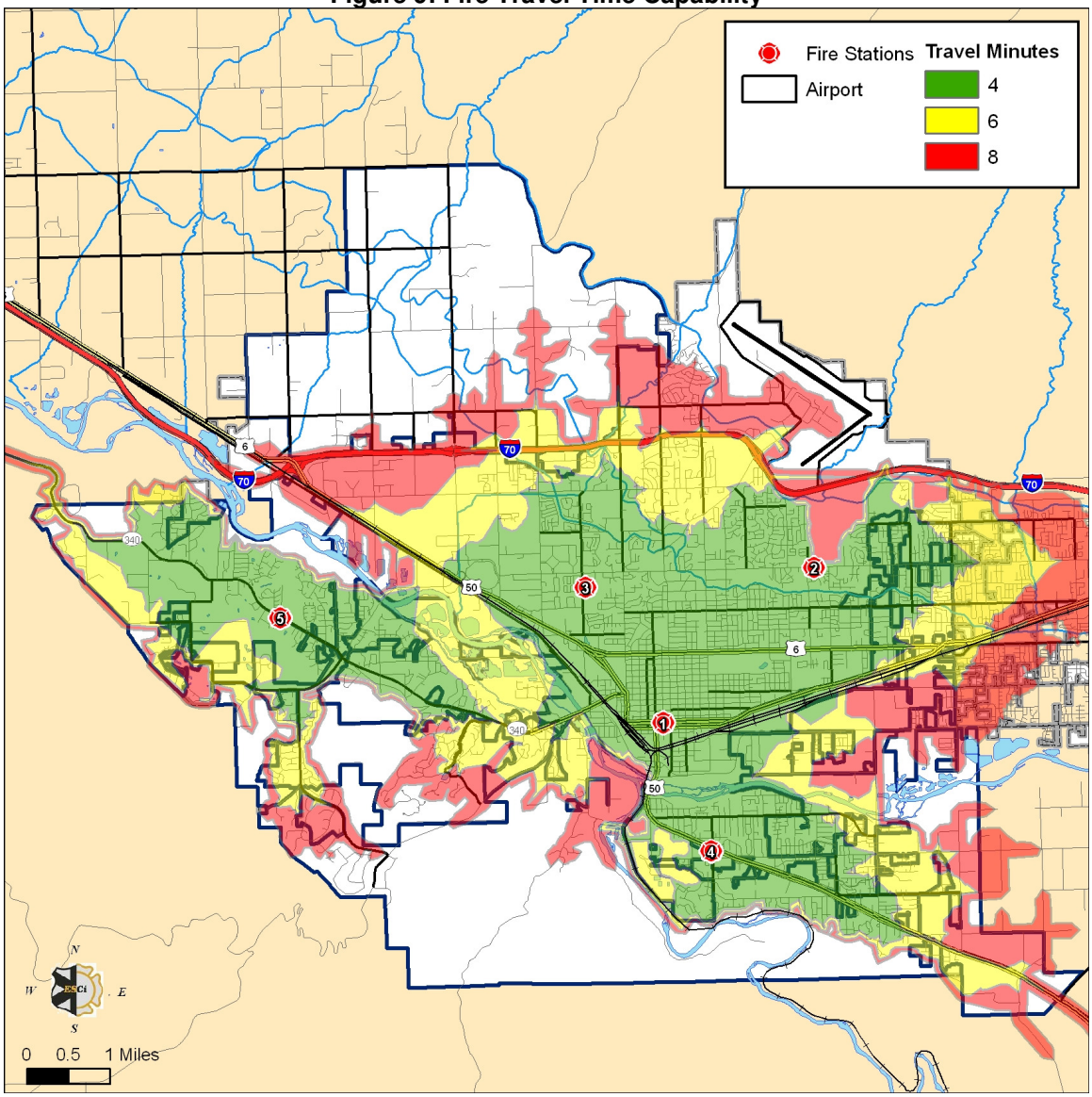
- *Turnout time within one minute, 90% of the time*
- *Arrival of a unit with first responder or higher level of capability (basic life support) within five minutes of dispatch, 90% of the time*
- *Arrival of an advanced life support unit, where this service is provided by the fire department, within nine minutes of dispatch, 90% of the time*

[4] 29 CFR 1910.134 respiratory protection.
[5] See previous discussion about the *time/temperature curve* and the effects of flashover.

Departmental Response Performance Objectives

The Grand Junction Fire Department has a goal to meet the *NFPA 1710* requirement department-wide as it pertains to fire-related incidents. The following map demonstrates those areas within a four to eight minute travel time from stations within the department. The time is calculated by modeling travel time on the actual roadway network. Speed reduction has been utilized to account for apparatus negotiating turns and intersections. This travel time does not include the one minute turnout time allotted by the *NFPA 1710* guideline, hence the four minute travel time shown below.

Figure 9: Fire Travel Time Capability

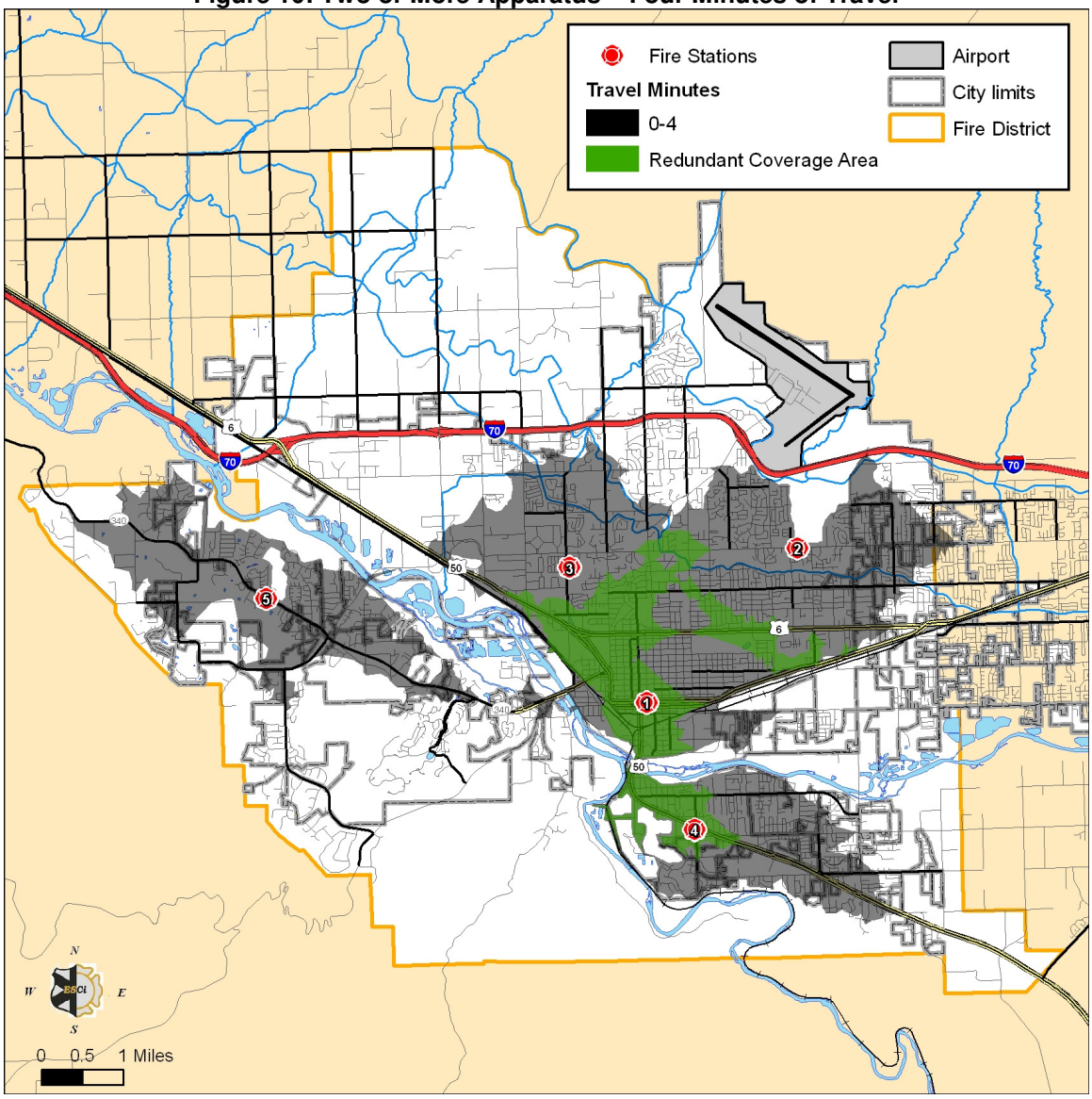


It can be seen that while a large portion of the City limits are within travel time limits, there are highly populated areas south of I-70 and west of the airport that are outside of the desired four minute travel time model. The only gap in coverage is noted at the four minute travel time between Station 1 & Station 5. Depending on the structural risk and population level in this area, this gap in coverage may be of concern.

Another aspect of facility deployment is to identify areas where two or more apparatus can reach in the same time frame. These overlapping or redundant coverage areas are not necessarily inefficiencies that require elimination, unless they are of significant size. Rather, these areas could be considered areas of best coverage when incidents (such as structure fires) require multiple apparatus from multiple stations to respond.

Figure 10 illustrates the areas that two or more apparatus can reach within four minutes of travel.

Figure 10: Two or More Apparatus – Four Minutes of Travel



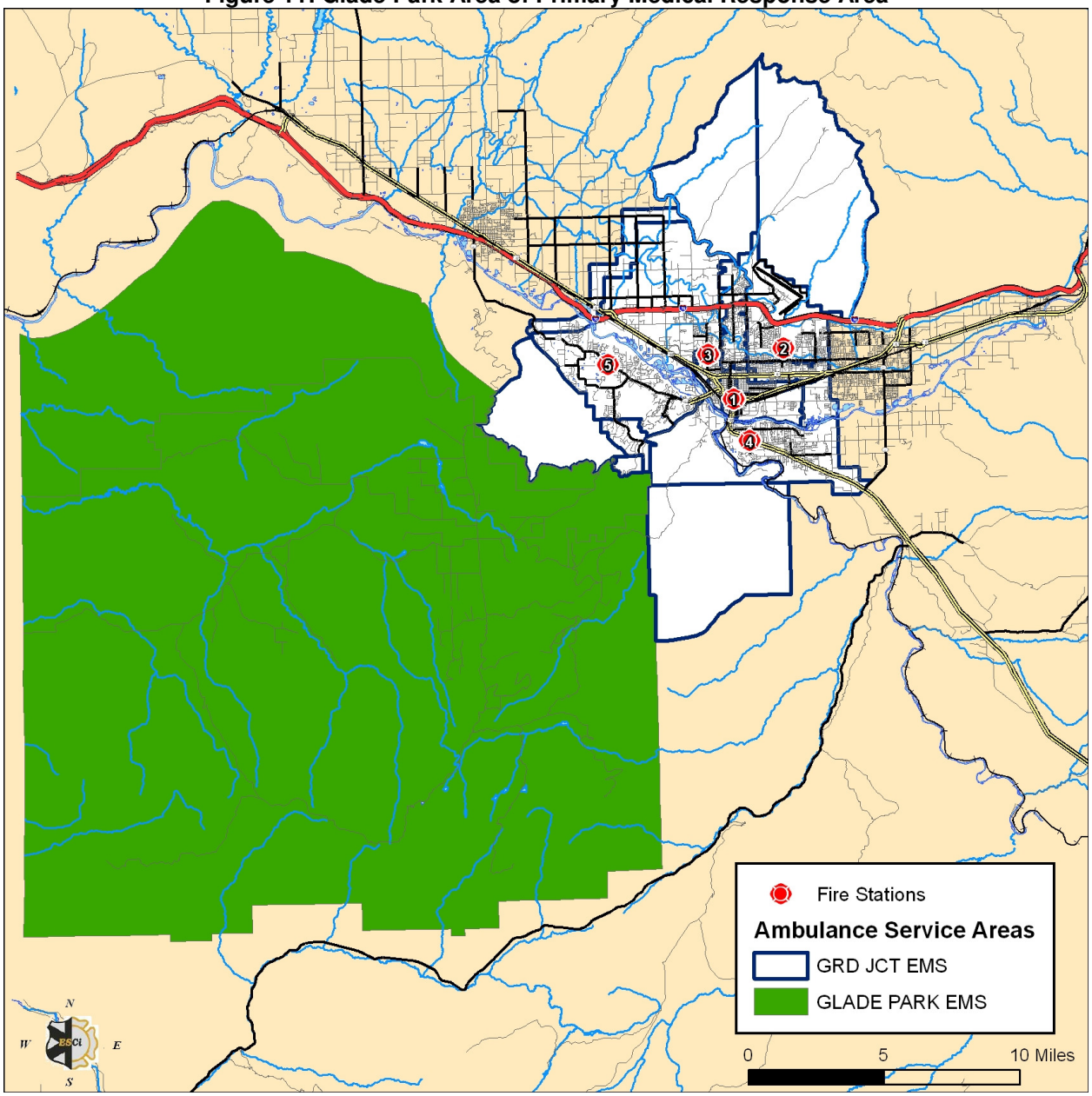
It can be seen that much of the downtown area is provided with redundant coverage. The map represents the minimum redundancy area that would increase proportionally with increases in travel time. The four minute travel time most closely aligns with the first-due apparatus arrival. The first alarm assignment, to establish an effective concentration of apparatus and firefighters, is recommended by *NFPA 1710* to be within nine minutes of dispatch, 90 percent of the time. Therefore, the redundant area would be larger at an eight minute travel (one minute turnout), and may offer opportunities to relocate stations further apart, if the first due coverage of service demand at four minutes does not suffer by these relocations.

For medical calls, GJFD adheres to the requirement set forth for all emergency medical service providers within Mesa County. It stipulates that calls considered high priority[6] are responded to within eight minutes, 90 percent of the time in an urban area. The entire district of GJFD is considered urban for this benchmark. Lower priority call types are allowed a longer response time goal which is twelve minutes within an urban area. Priority 1 calls are responded to emergently by using lights & sirens, while Priority 2 calls are generally not.

The primary medical response area includes all of the district and areas north, south, and south west of the City in area that are managed by the Bureau of Land Management and the Colorado National Monument. These areas effectively more than double the size of the response area and is considered frontier for response time reporting requirements. They have a recommended response time of either one or two hours depending on the priority designation. The following figure displays the entire primary medical response area including the Glade Park section in green. This expansive area is omitted from subsequent EMS related maps due to its size obscures detailed analysis in these other maps.

[6] Priority is based on criticality of patient complaint as defined by Medical Priority Dispatch System© protocol.

Figure 11: Glade Park Area of Primary Medical Response Area



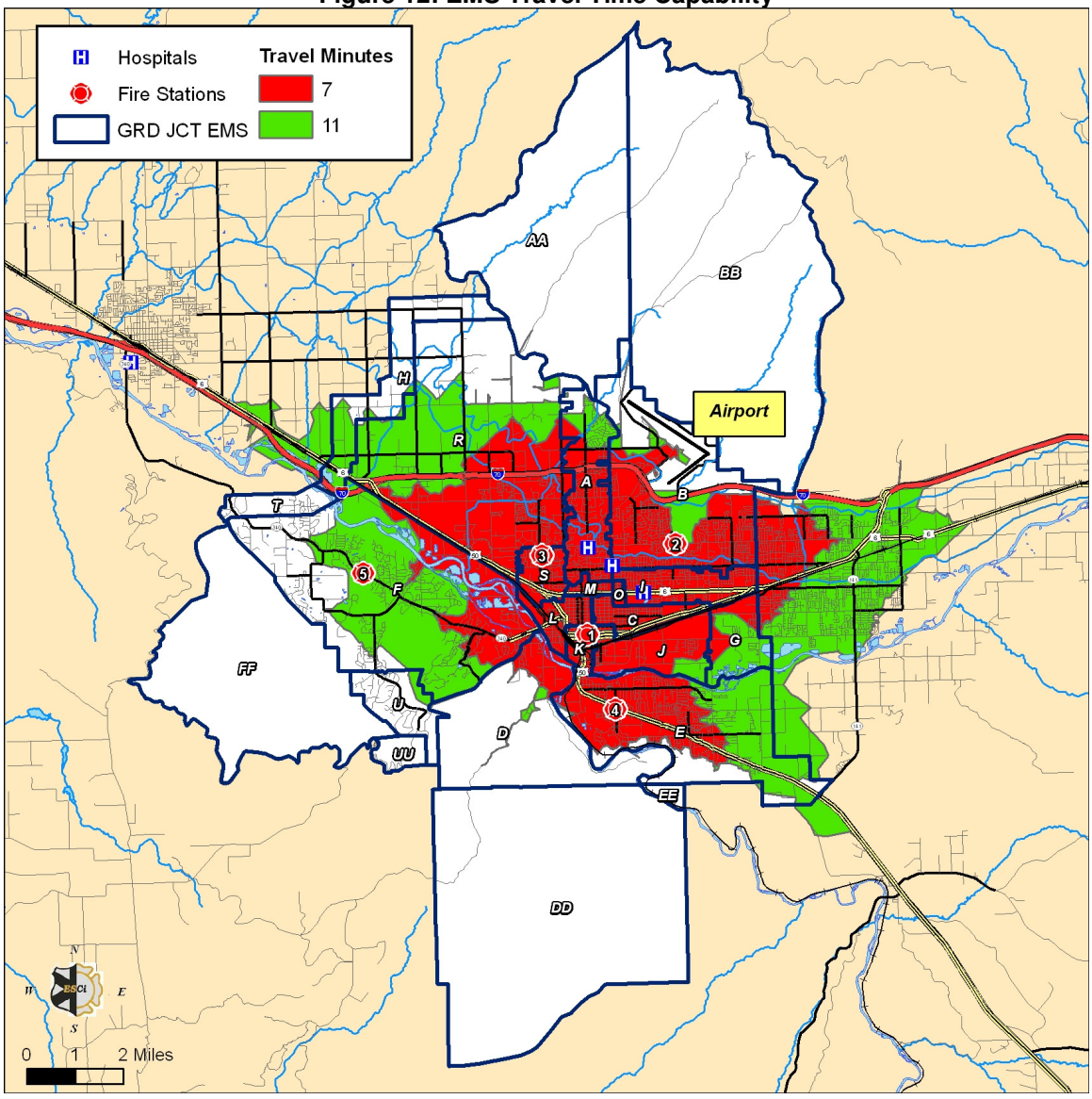
Because GJFD is an advanced life support first responder, which means paramedic-level care is available from the staff on all fire apparatus, the travel time capability illustrated in the previous figure can be utilized for medical call coverage as well. Nonetheless, it should be noted that certain high priority medical calls require rapid transportation to a hospital. Certain types of heart attacks, strokes, and traumatic incidents benefit from the tools and expertise currently only found in a hospital environment. Limitations of field surgical techniques and latest medication

availability require the rapid transportation that only a properly equipped ambulance can provide.

It should be noted that staffed ambulances only respond from Stations 1, 2, and 3, but all stations are staffed with EMS-certified personnel, have EMS equipment on apparatus, and respond to EMS incidents.

The following figure illustrates the extent of the EMS service area and the travel time capability of the ambulance–equipped stations. This travel time does not include turnout time by the paramedics, hence the seven minute travel time in Figure 12.

Figure 12: EMS Travel Time Capability



The remainder of the area is easily reached within an hour of travel time for those calls which may occur in the frontier areas. At times, ambulances may respond from a hospital rather than a station, fortunately the three hospitals are located within the core downtown area.

The next map examines coverage based on credentialing criteria for the Insurance Services Office (ISO). The ISO evaluates fire protection in communities nationwide and is influential in the rate determination that insurers charge business and residential customers. While it is not to suggest that facility deployment be dependent on any such rated distance, it is an important

factor to be considered by the community, economically, as lower insurance rates can attract growth.

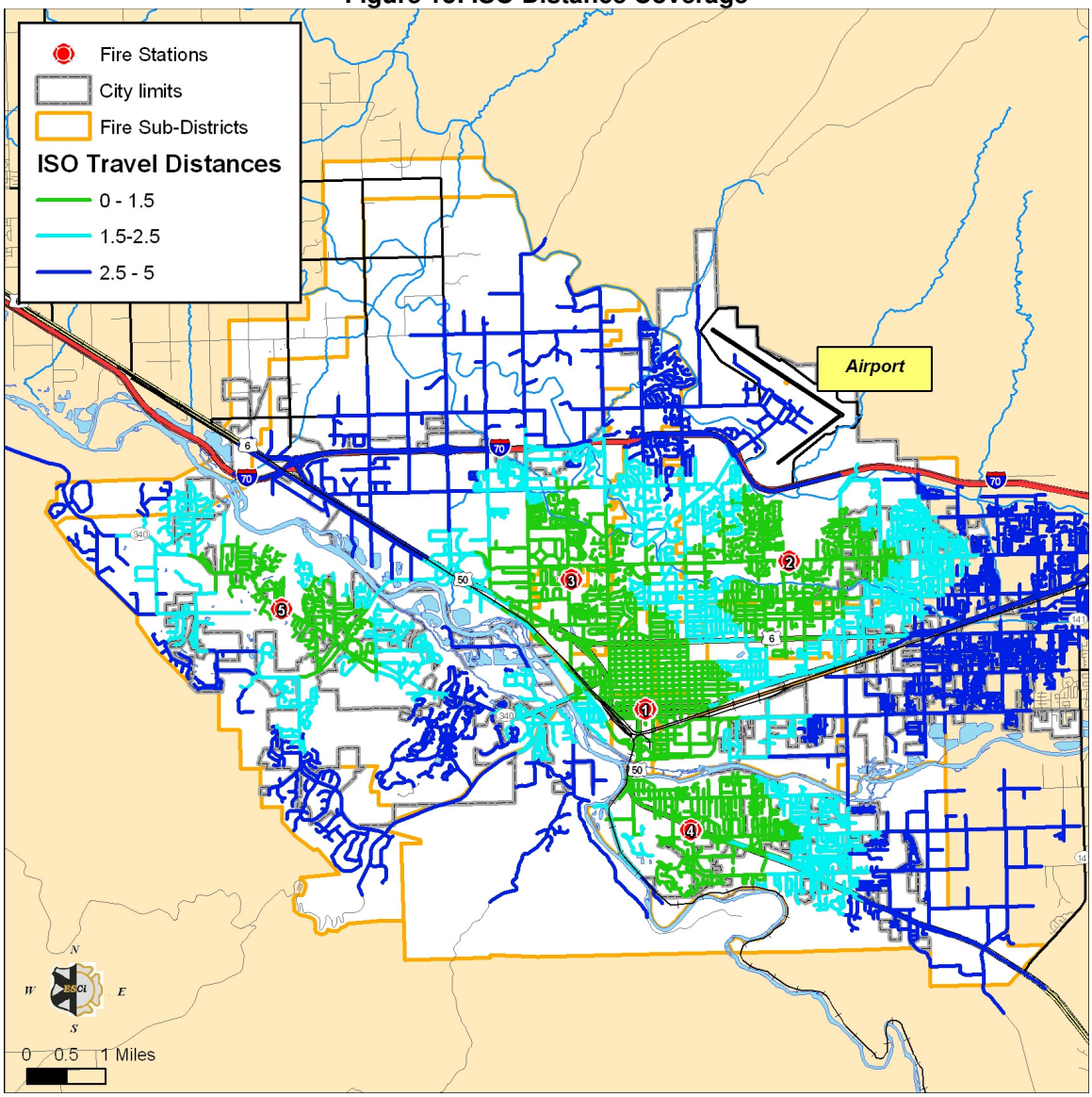
To receive the maximum credit of four points in this section, all *built-upon* portions of a community would need to be within 1.5 road miles of an engine company and 2.5 road miles of a ladder or service company. In order to determine the distribution of engine companies across built-upon areas, ISO reviews the response area of each existing engine and identifies the number of fire hydrants within those response areas. ISO analyzes whether there are additional geographic areas of the district outside of the existing engine company response where at least 50 percent of the number of hydrants served by the largest existing response area could be served by a new engine. For ISO purposes, the response area is measured at 1.5 miles of travel distance from each engine company on existing roadways.

Since hydrant location data was provided, an analysis to indicate areas which may fall within the ISO parameter for an additional engine company was conducted. Forty-four percent of the over 4,000 hydrants in the area are within the ISO recommended distance.

In similar fashion, to achieve optimum credit for the number of truck companies, ISO reviews the response area of each existing truck and identifies the number of fire hydrants within those response areas. ISO analyzes whether there are additional geographic areas outside of the existing truck response areas where at least 50 percent of the number of hydrants served by the largest existing response area could be served by a new truck were one to be added. For ISO purposes, the response area is measured at 2.5 miles of travel distance from each engine company on existing roadways. Grand Junction Fire Department houses its truck apparatus in Station 1; within 2.5 miles of 25.5 percent of the hydrants in the district.

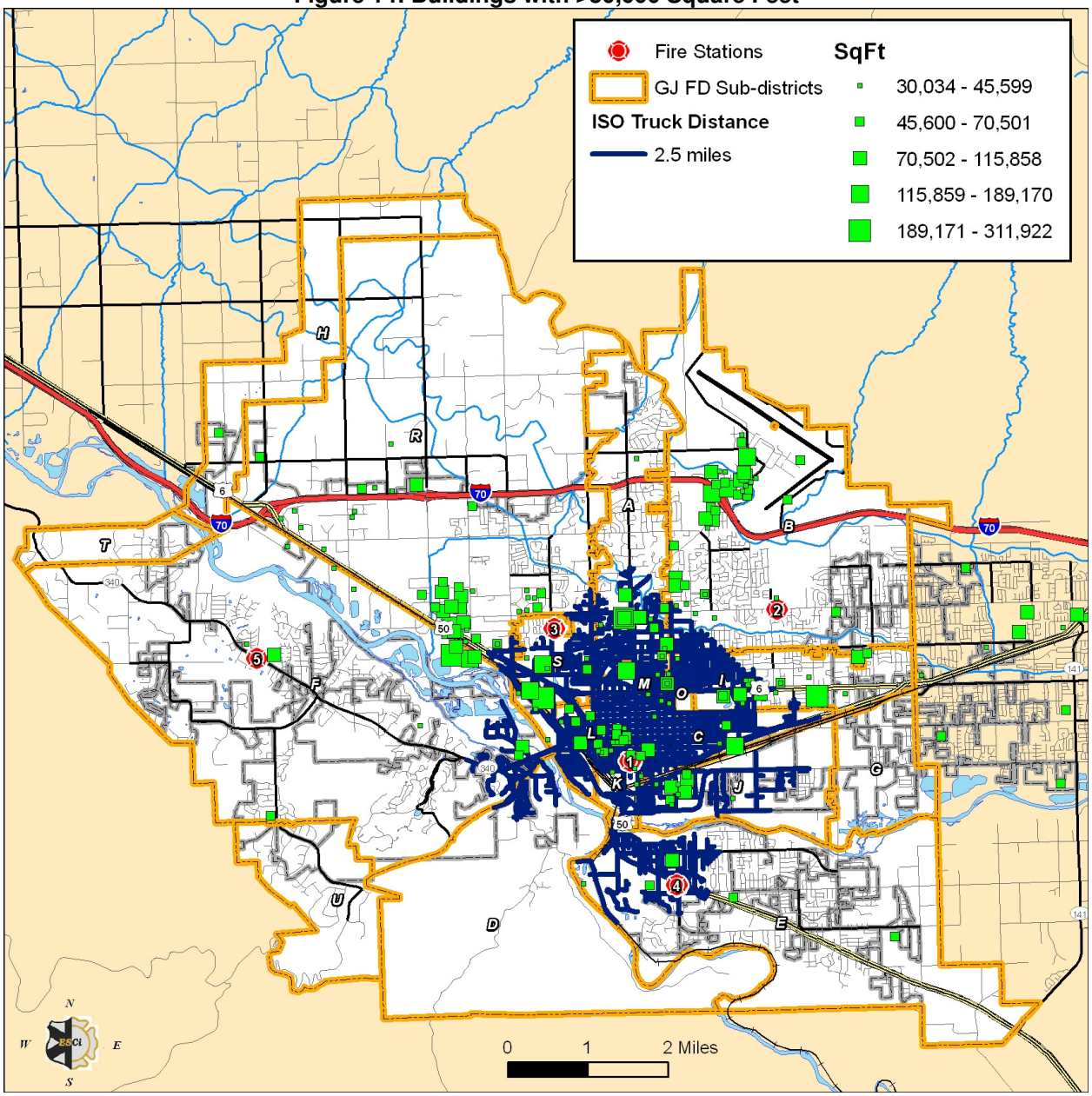
Additionally, ISO considers property outside of five miles from a fire station to be considered as *unprotected* for insurance rating purposes. The following map illustrates the ISO travel distances for engine companies, the truck company at Station 1, and the extent of the five mile limit.

Figure 13: ISO Distance Coverage



A truck company is not required to have an elevating ladder or aerial device unless there are a sufficient number of buildings that would meet the three-story height and square footage limits. The following figure illustrates the buildings within the region that exceed 30,000 square feet and their relation to the recommended ISO travel distance for truck companies.

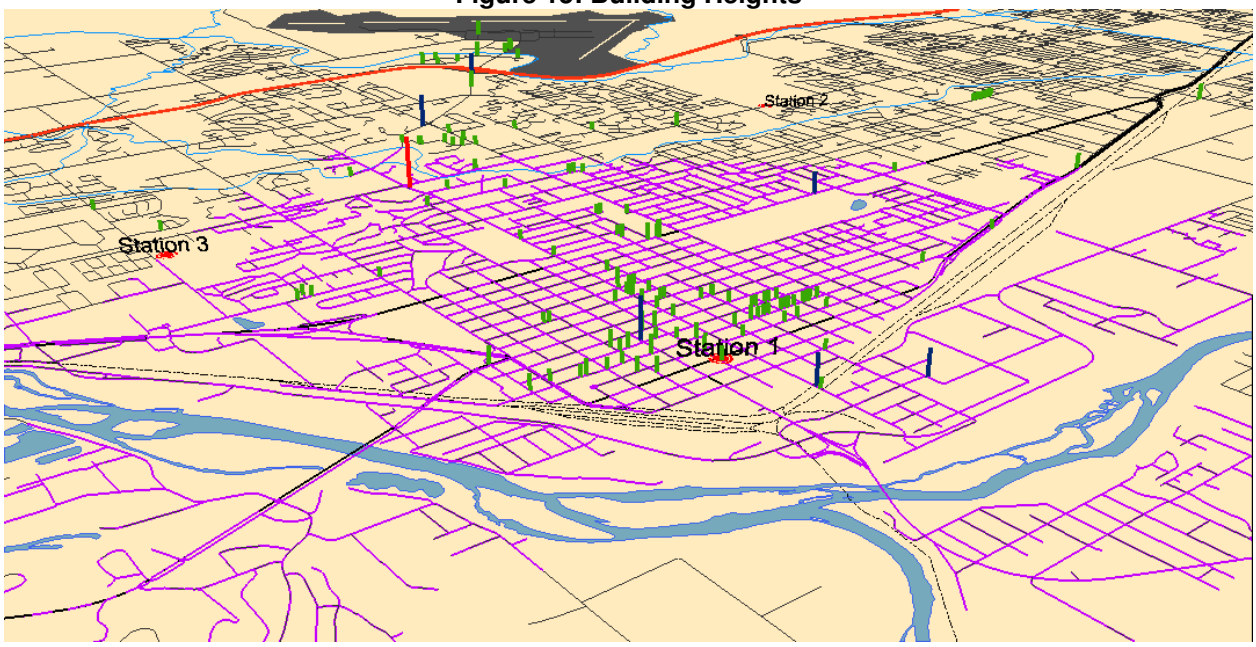
Figure 14: Buildings with >30,000 Square Feet



Of the buildings within the GJFD fire district, 45.55 percent are within the ISO truck company distance of 2.5 miles. The majority of the structures outside of this distance are located near Station 2 and Station 3. While expansive square feet is one consideration for a truck company, another is the building height. Persons trapped on higher floors of buildings may need the elevating ladders that are equipped on truck apparatus. The following figure illustrates the relative heights of buildings within the downtown area of Grand Junction. The green stalks are buildings between three and six stories, the blue stalks represent buildings higher to 12 stories,

while the red stalks represent taller structures. Once again the truck company ISO distance is displayed, this time as purple street lines.

Figure 15: Building Heights



While 120 out of the 164 buildings identified are within the 2.5-mile ISO truck company distance, most of the tall buildings beyond this limit are in Station 2's area. Other areas can receive credit for a truck company without the requirement of an elevated device and can even receive partial credit for a truck company if other apparatus, such as an engine, carries a complement of truck company equipment.

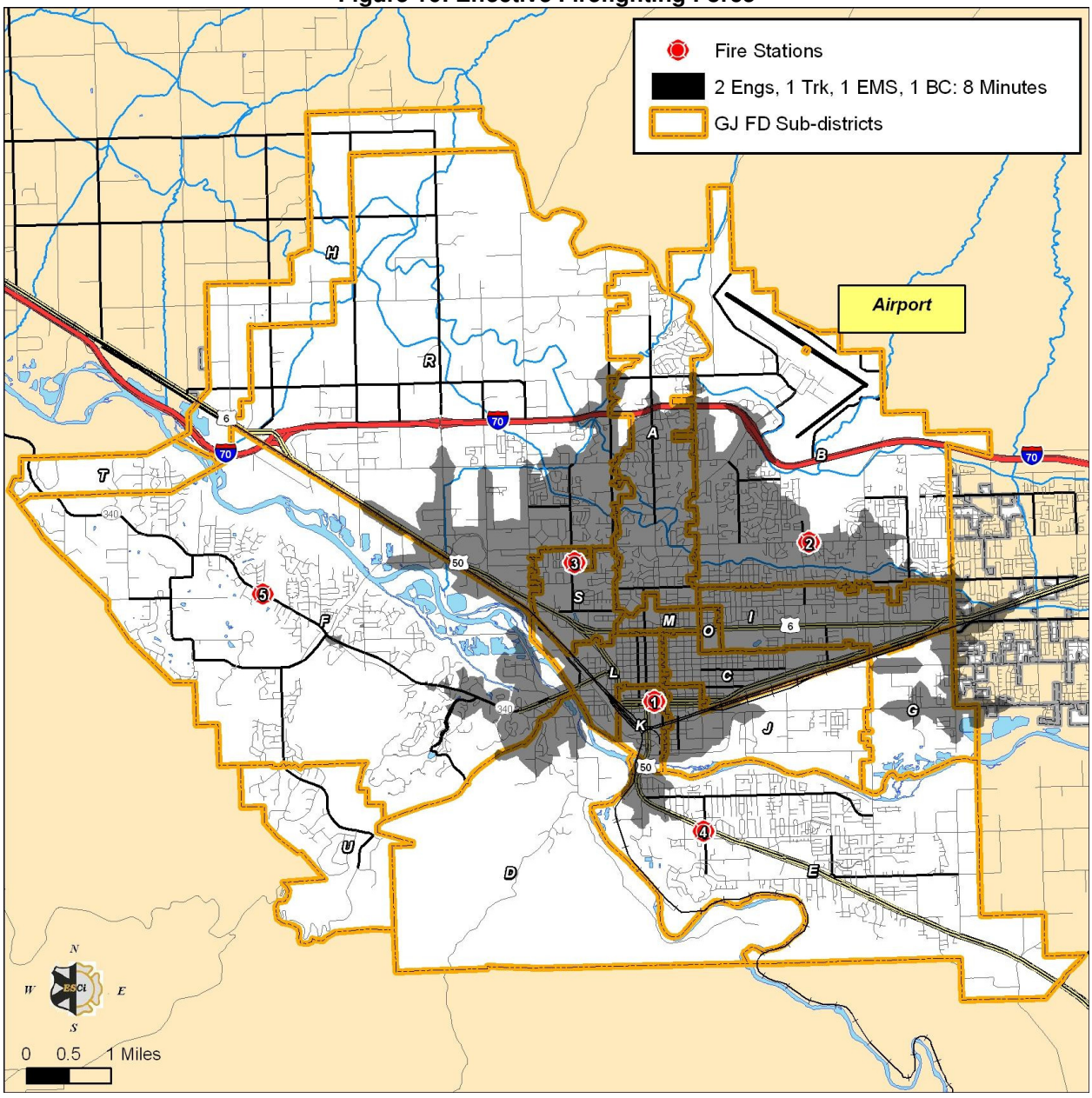
It is possible that additional apparatus in reserve status may provide some increase in credit for reserve companies, but it is not likely to affect the overall community insurance rating. This may not be the case in all areas and, therefore, truck company coverage will be further evaluated by ESCi, in light of fire and life risk factors within the GJFD district, in a subsequent section. However, in light of the building data available, additional truck apparatus should be considered in the department.

Concentration Analysis

Standard firefighting procedures call for the arrival of the entire initial assignment (sufficient apparatus and personnel to effectively combat a fire based on its level of risk) within a certain amount of time. This is to ensure that enough people and equipment arrive soon enough to be

effective in controlling a fire before substantial damage occurs.[7] Based on reported minimum staffing of apparatus, a collective response of two engine companies, one truck company, one ambulance, and a chief officer would likely respond to a structure fire. The area shaded in black in the following figure would be the extent of an effective firefighting force in GJFD's district.

Figure 16: Effective Firefighting Force

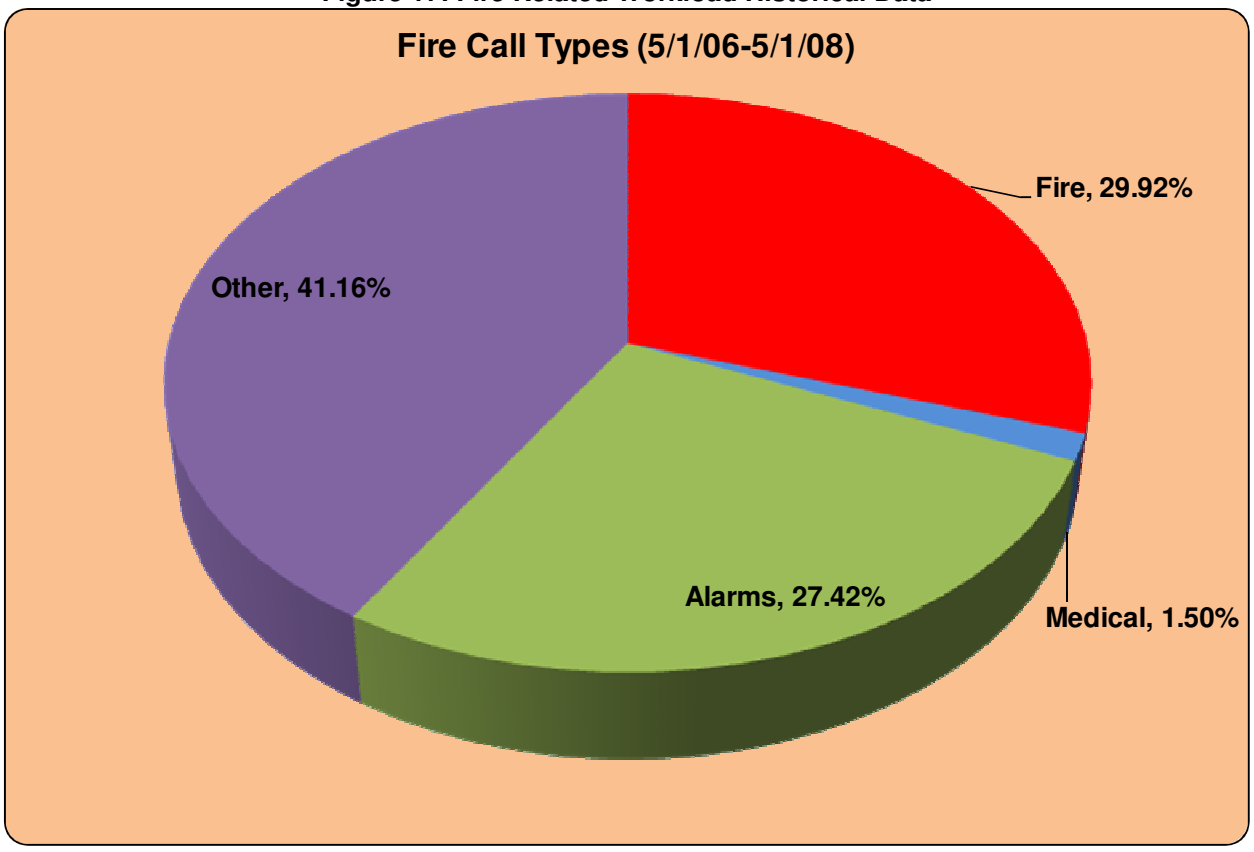


[7] See supplemental discussion about time/temperature curve and the effects of flashover.

Demand Analysis

The GJFD provided two years of incident data from May 1, 2006 through the first four months of 2008 from its communications provider's database. This data was divided into fire–related and emergency medical calls. The following chart illustrates the categories of fire- related incidents by call type.

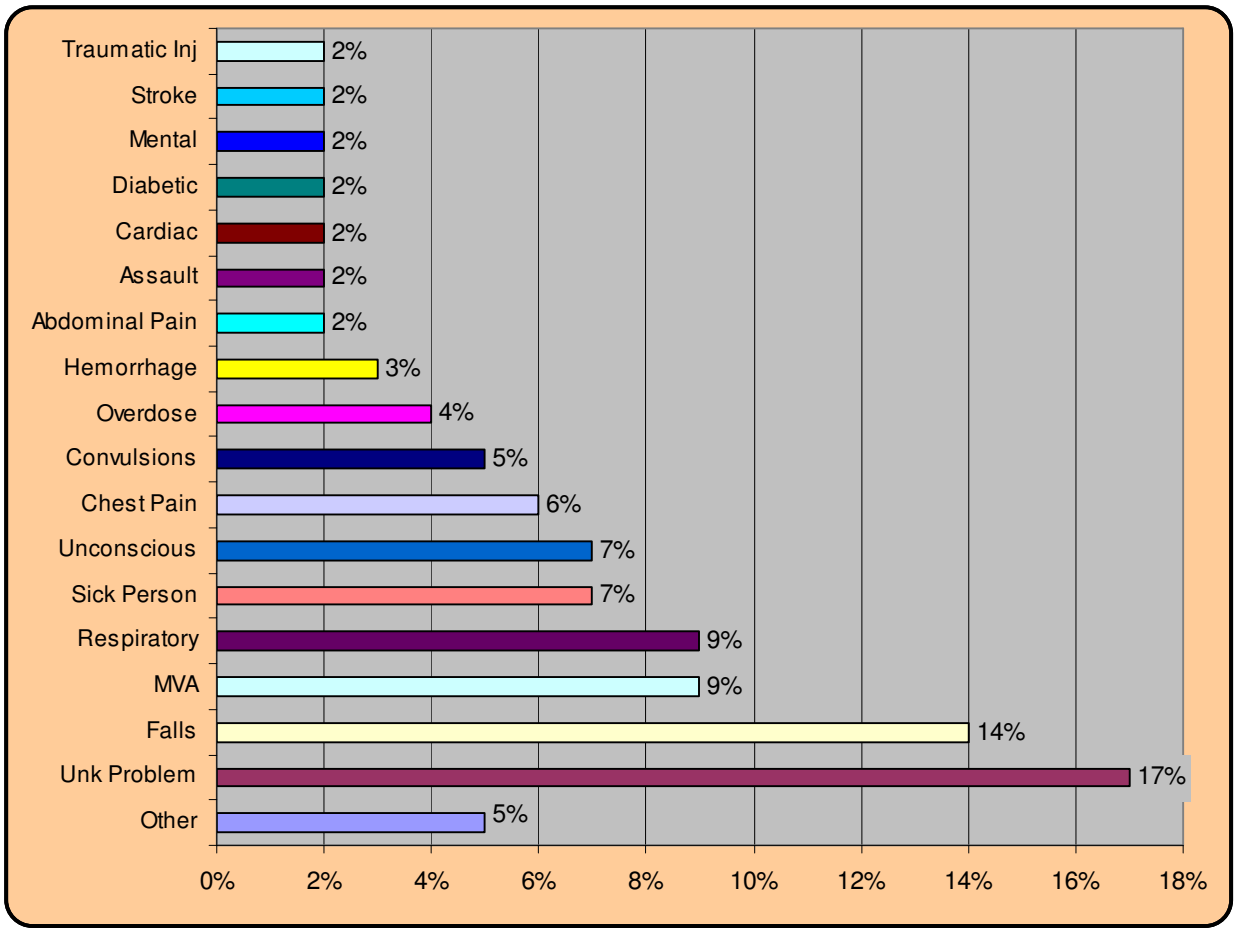
Figure 17: Fire Related Workload Historical Data



Most of the calls in the fire incident database were for fire alarms followed by calls that were designated as O*ther* by the communications center. Presumably, they did not fit one of the other categories listed. There were 3,800 incidents in the fire related database while the medical database contained 14,922 emergency calls over the two year period. The bulk of the workload for GJFD is handling requests for emergency medical aid. This is not unusual for fire department's that participate in either first responder or have transporting capabilities.

The following chart details the call type breakdown for the medical database of calls from the communications center.

Figure 18: Medical Workload Historical Data

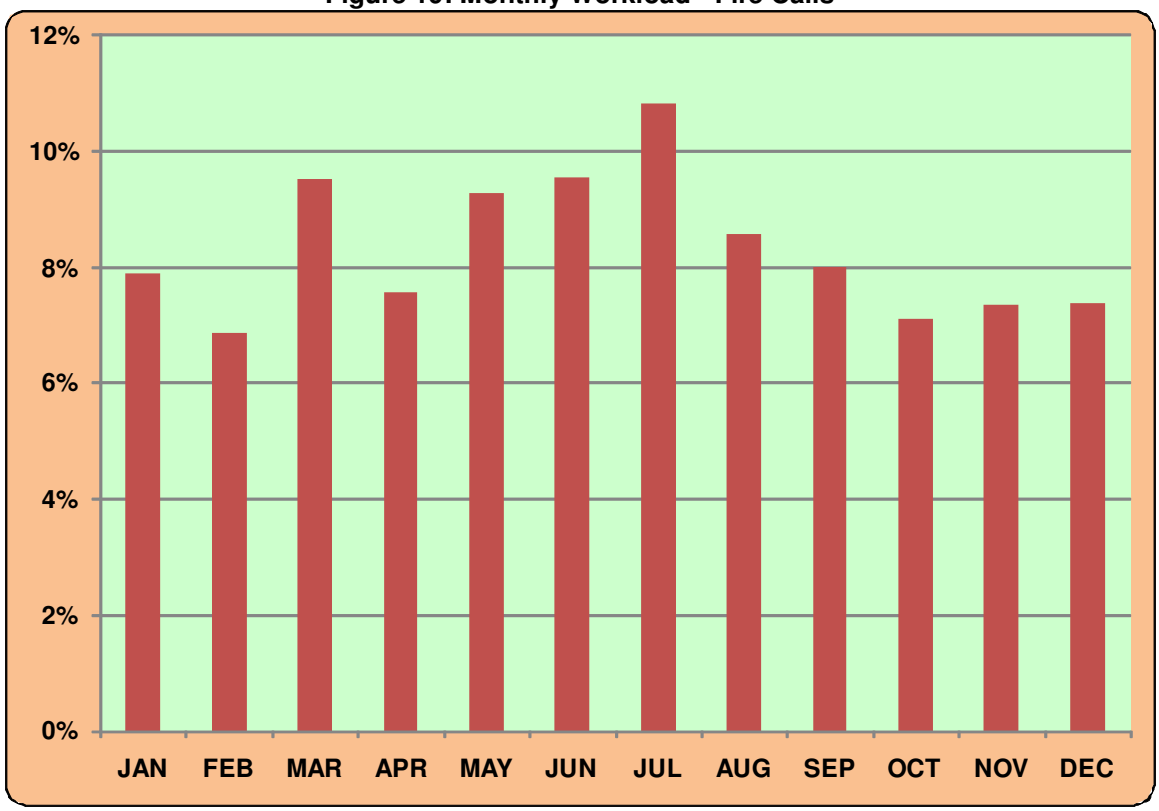


A large portion of medical calls are for falls; however, a larger number are designated as *unknown,* which conflicts with the purpose of a prioritization dispatch protocol. Priority 1 calls accounted for 44 percent of the emergency medical calls recorded.

A review of incidents by time of occurrence reveals when the greatest response demand is occurring. The following charts show how activity and demand changes for GJFD based on various measures of time displayed as percentages of the total dataset of calls. ESCi began by breaking down yearly workload into monthly increments.

The following figure depicts the changes in monthly call volume for fire calls by the month of the year.

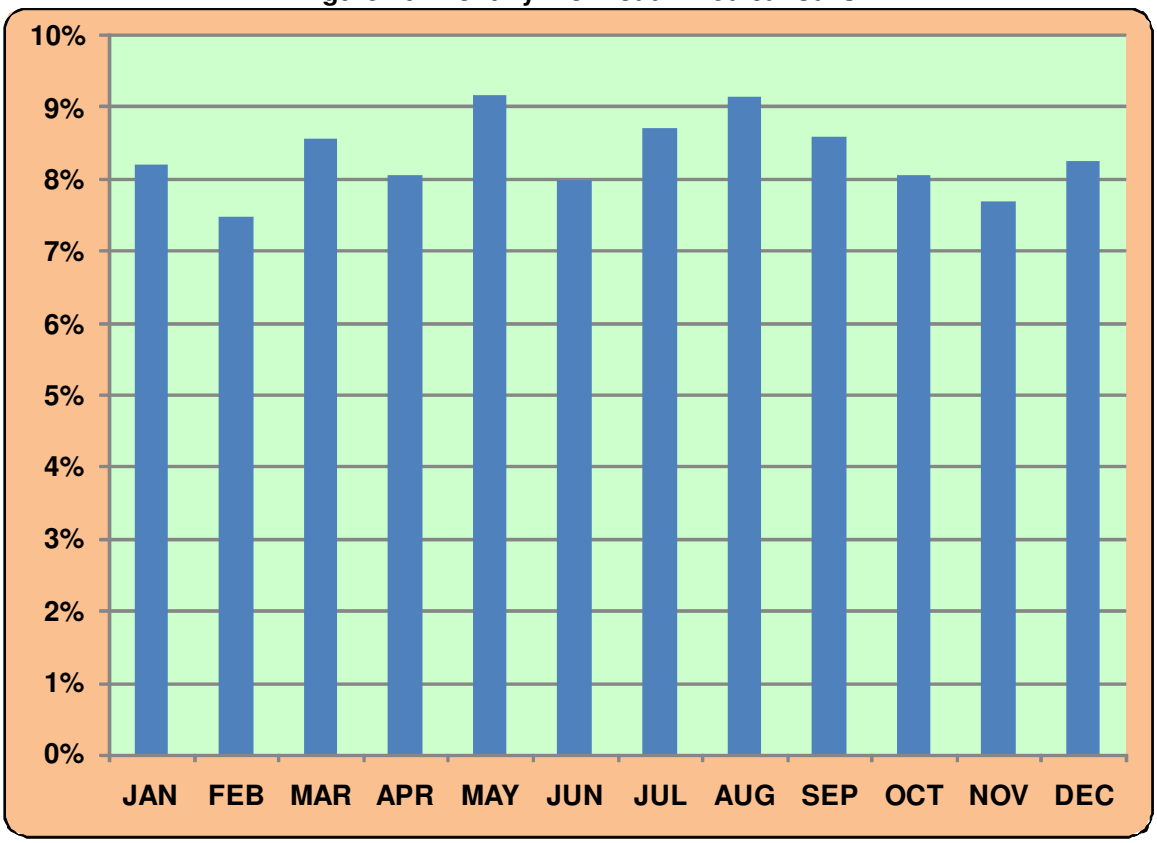
Figure 19: Monthly Workload - Fire Calls



The monthly trend for fire calls is a generally higher call volume during the late spring and summer months. The exception to this trend is a higher volume experienced in the month of March.

Medical calls should coincide less with weather and more with population trends for the area. The following figure depicts the changes in monthly call volume for medical calls by the month of the year. Monthly workload for medical calls has been more consistent in nature.

Figure 20: Monthly Workload - Medical Calls



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In further analysis, workload is examined by day of the week. It appears that service demand generally rises throughout the week for both types of calls, with a slight respite on Sundays.

Figure 21: Workload by Day of Week - Fire Calls

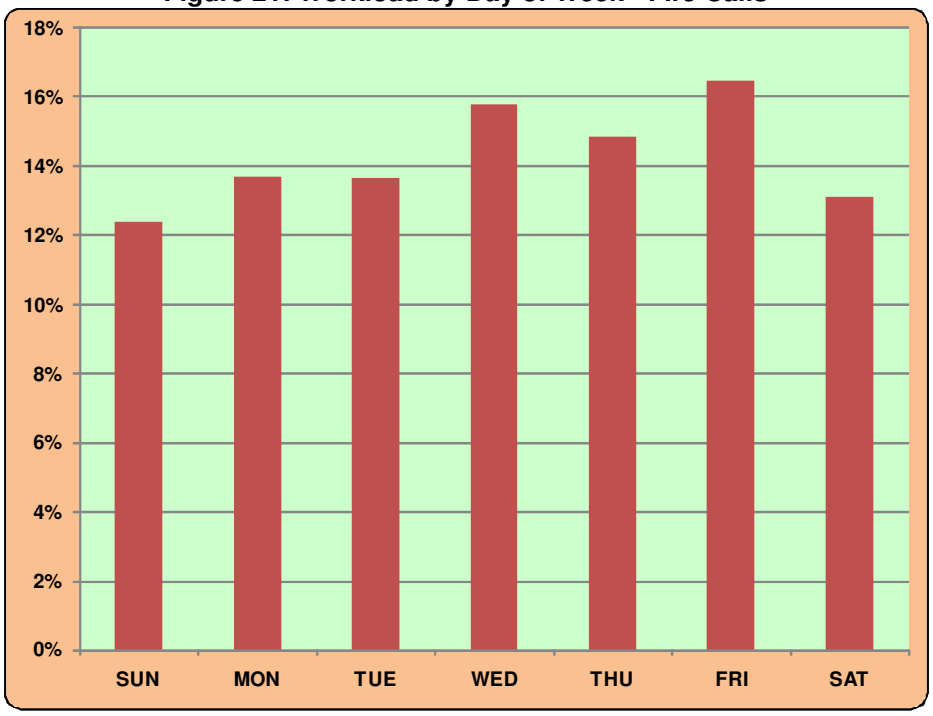
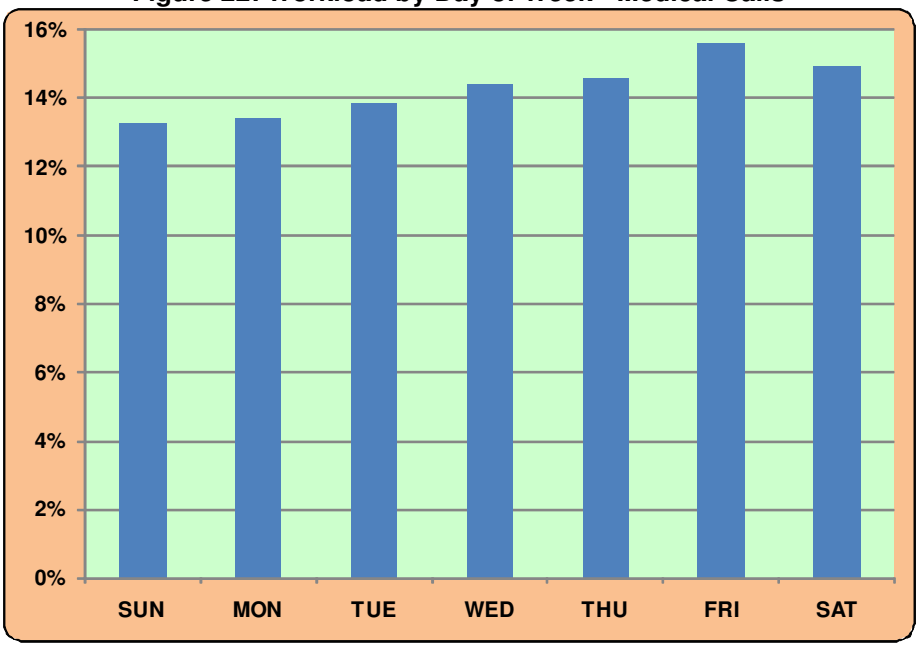
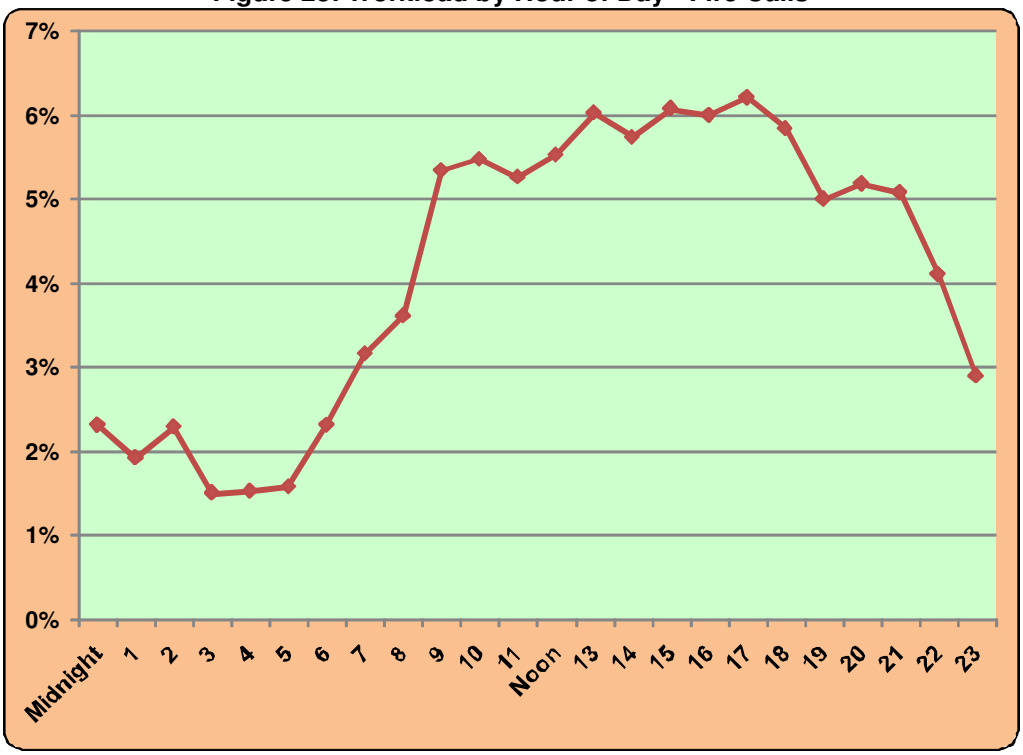


Figure 22: Workload by Day of Week - Medical Calls



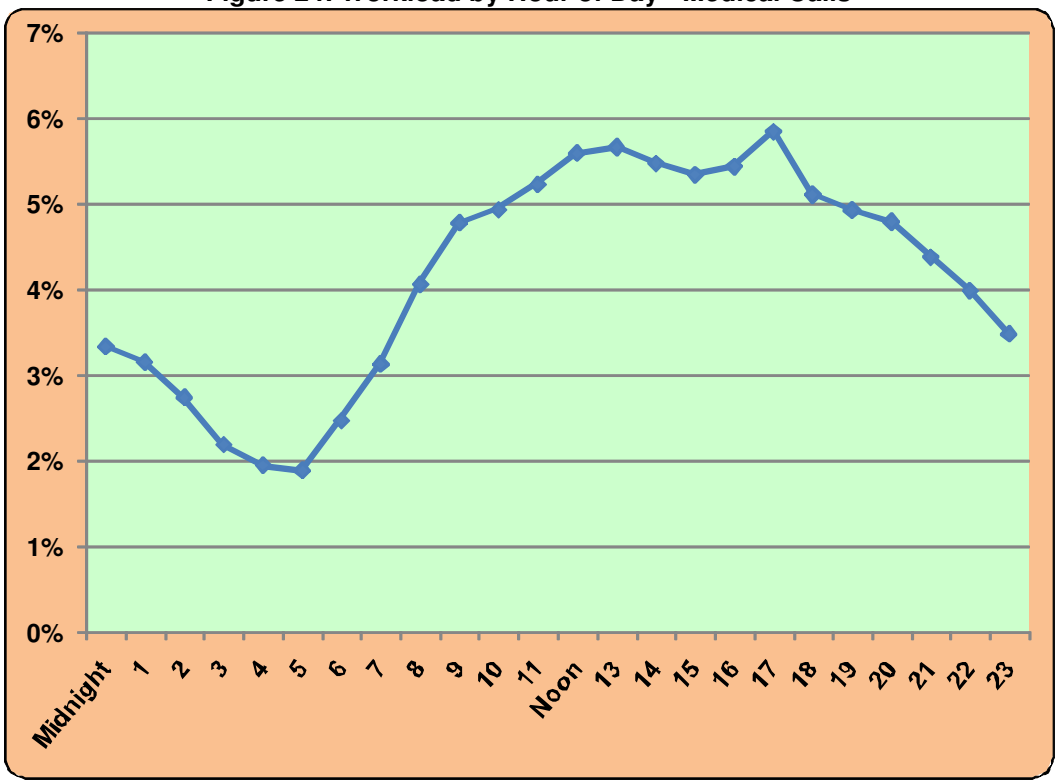
The final analysis of historical workload concludes with examination of call types by hour of day. The hours of peak activity can strain an under-equipped or under-staffed fire department. Understanding when peak activity occurs begins the process of developing deployment strategies and needs assessment. The next two figures illustrate how peak demand varies by the hour of day.

Figure 23: Workload by Hour of Day - Fire Calls



Activity for fire calls begins to increase dramatically at 6:00 a.m., reaching peak volume during the 9:00 a.m. hour, rising at a slower pace until the 5:00 p.m. hour before declining into the evening.

Figure 24: Workload by Hour of Day - Medical Calls

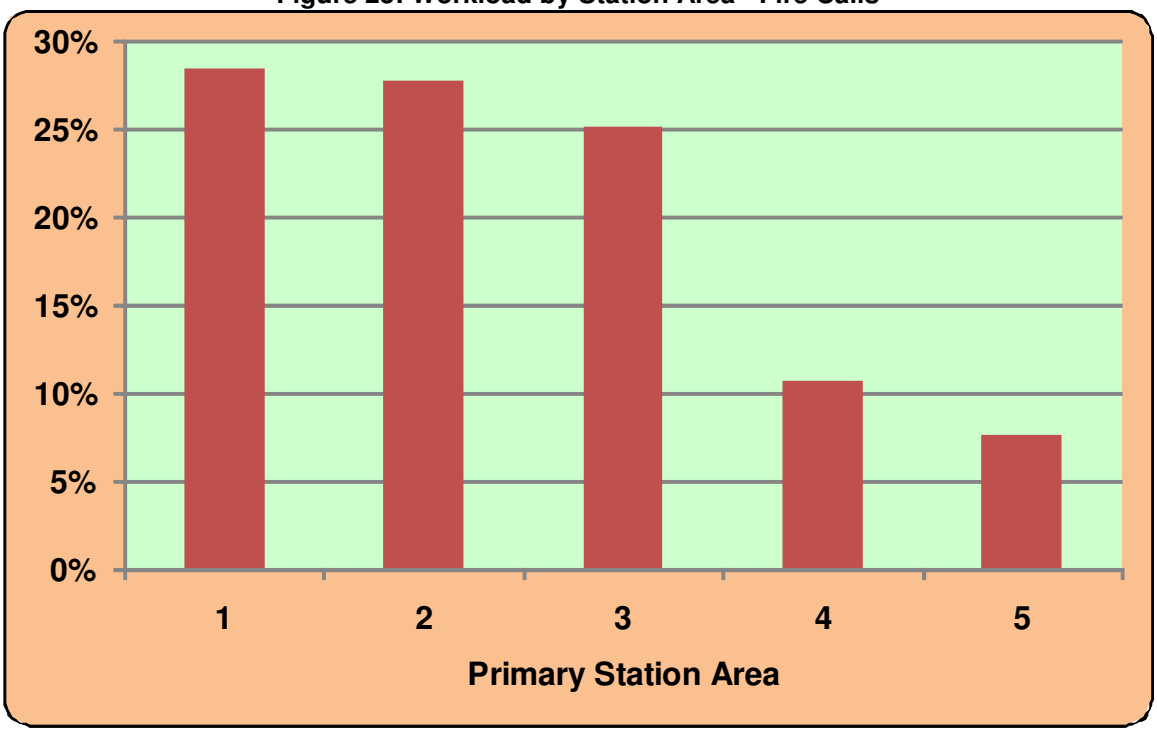


Activity for medical calls begins to increase earlier at 5:00 a.m., reaching peak volume during the 1:00 p.m. hour, and remaining stable before gradually declining into the evening. A notable spike in activity is recorded at 5:00 p.m.

Peak activity times can be reflected in response time performance in certain cases. The impact of response time on the outcome of emergency incidents has been exhaustively studied, both in the laboratory and in historical data, with predictable correlation between the two. Though seemingly intuitive, it is still useful to review how longer response times can have a negative effect on the ability to suppress fires, particularly in structures, or to successfully intervene in a life-threatening medical emergency. Response time performance is examined in a separate section.

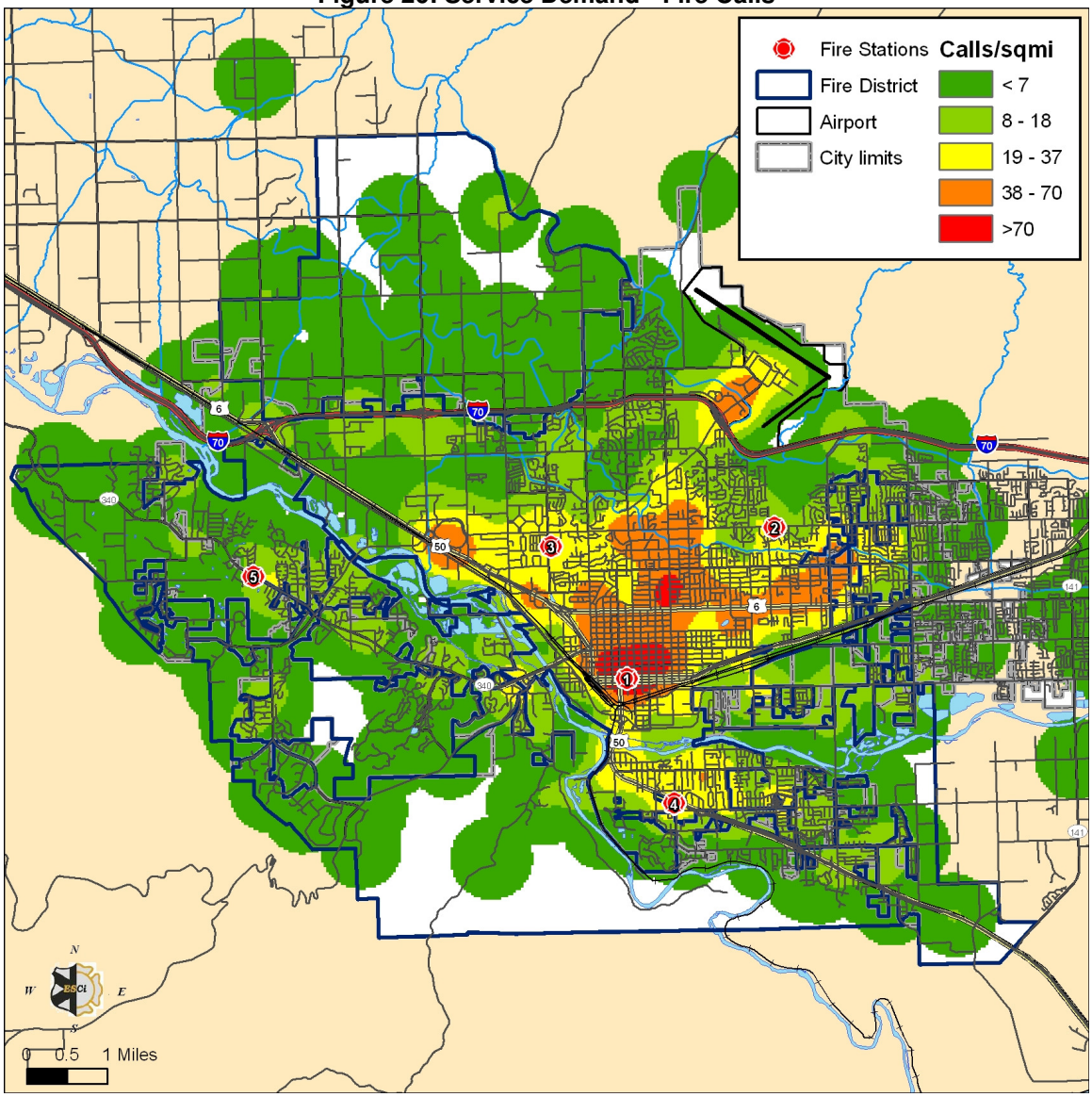
In addition to the temporal analysis of the current service demand, it is useful to examine geographic distribution of service demand. Later in this study, this will allow for assessing station locations in comparison to the actual service demand within the area. The following chart details the level of workload for each station's area. It can be seen that the area near Stations 1, 2, and 3 account for most of the workload for fire calls.

Figure 25: Workload by Station Area - Fire Calls



This is evident when analyzing the concentration of fire call incidents on a map. The following map indicates the distribution of fire related incidents responded to by GJFD during the last full year of data provided.

Figure 26: Service Demand - Fire Calls



It can be seen that most areas of highest service demand are located in areas of high residential population density in the City. A pocket of higher demand for fire services is located at the mall and near the airport. Analysis of the current service demand indicates that 72.87 percent of this demand can be reached within four minutes of travel from a fire station. This

indicates additional stations are necessary in order to meet the department's goal of compliance with *NFPA 1710*.

The following map illustrates the concentration of medical calls within that were handled by the GJFD over the same time period. Measured on the same density scale, it illustrates that many more medical calls occur near the populated areas and within proximity of the fire stations.

Figure 27: Service Demand - Medical Calls

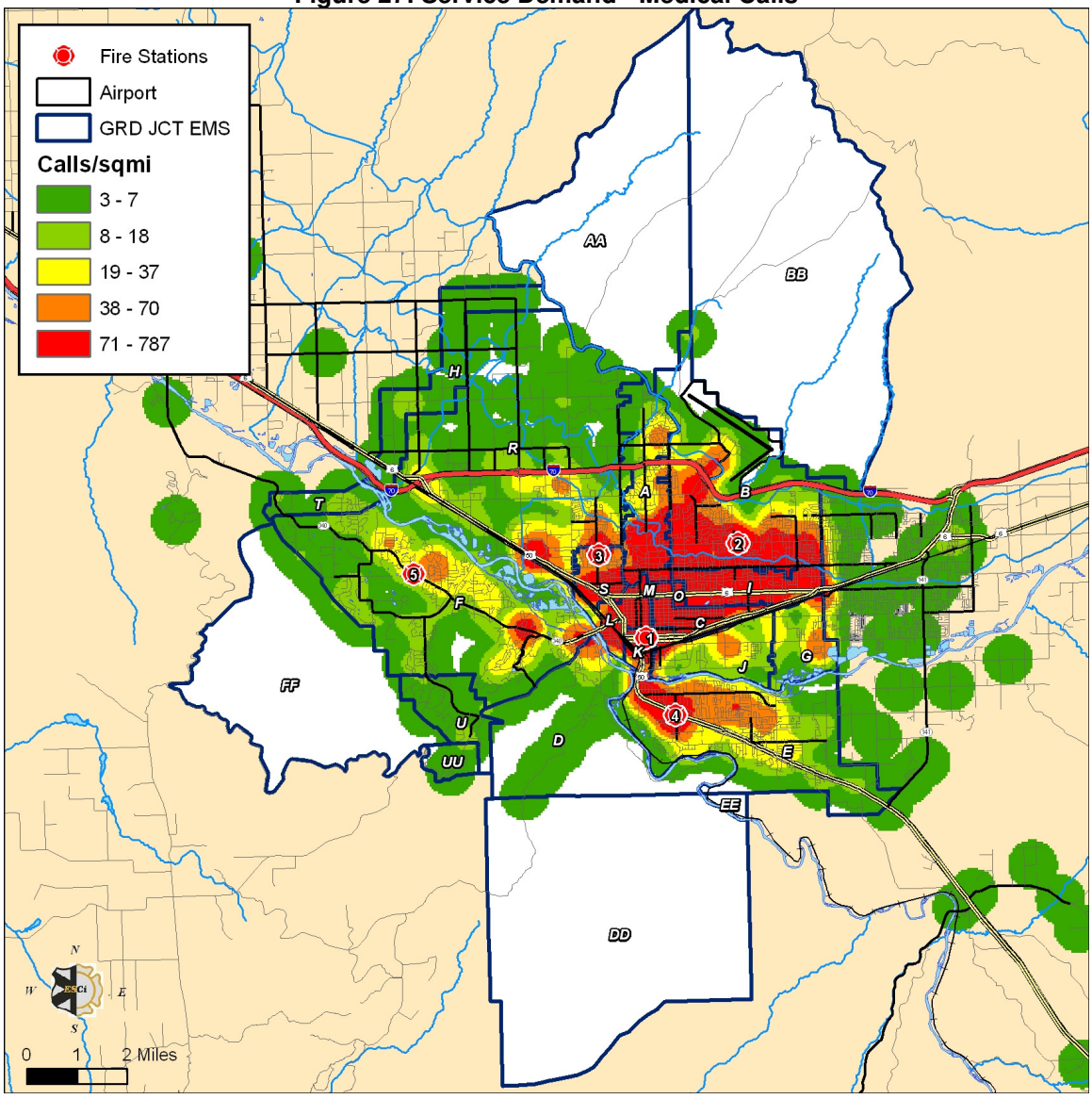
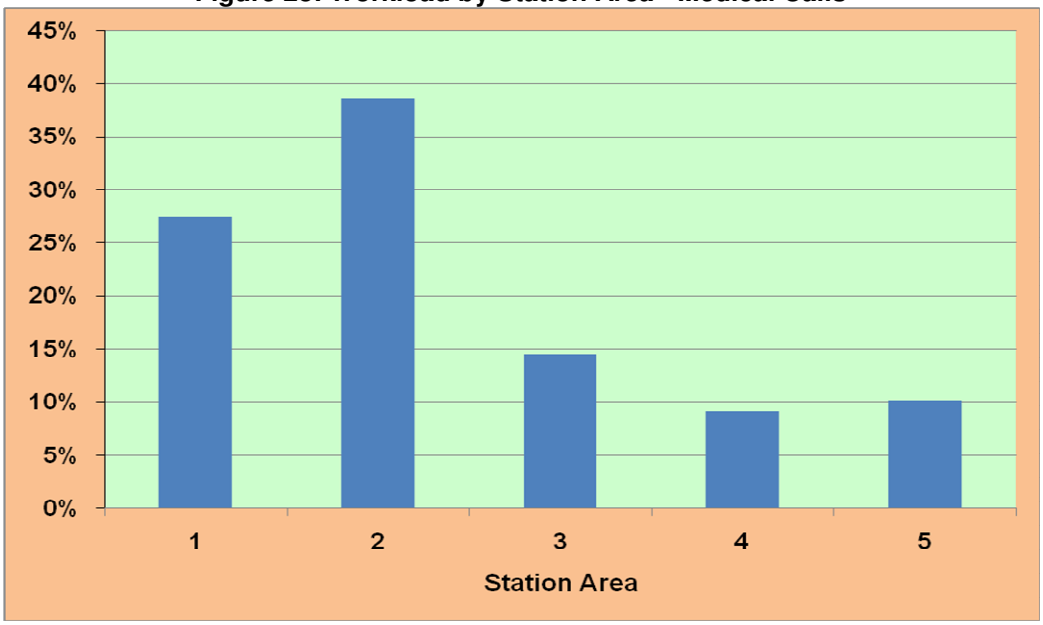


Figure 28: Workload by Station Area - Medical Calls



An analysis of service demand coverage compared against the travel time model indicates that adequate response time is obtainable by all station apparatus from current locations. This is detailed in the table that follows.

Figure 29: EMS Service Demand Coverage

[redacted]

This indicates that a redeployment of stations or additional stations for demand coverage *based on EMS travel time* requirement is not necessary.

Reliability Analysis

Workload and Failure Rates

The workload of emergency response units can be a factor in response time performance. The busier a given unit, the less available it is for the next emergency. If a response unit is unavailable, a unit from a more distant station must respond, increasing overall response time. A cushion of surplus response capacity above average values must be maintained due to less

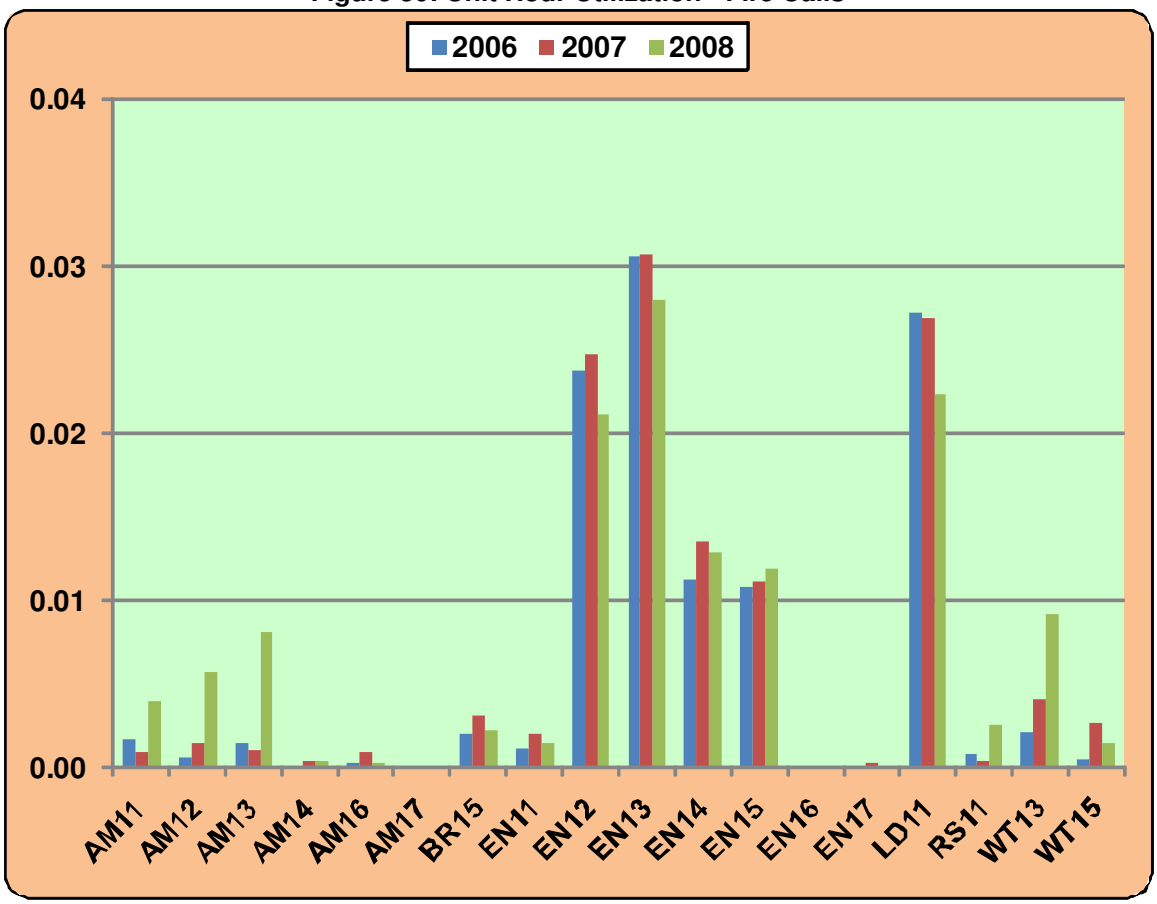
frequent, but very critical times, when atypical demand patterns appear in the system. Multiple medical calls, simultaneous fires, multi-casualty events, or multiple alarm fires are all examples.

Unit hour utilization, an important workload indicator, describes the amount of time a unit is not available for response since it's already committed to an incident. It is derived by dividing the total time on an incident from dispatch to clearing the scene divided by the total time available for the study period. The larger the number, the greater its utilization and the less available it is for assignment to an incident.

The highest unit hour utilization (UHU) figures for fire suppression units are typically around 0.20 with some studies indicating that unit failure rates[8] at this workload will begin to hit 10 percent. Studies of fire-based medical units indicate that significant employee burnout can occur with 0.30 unit hour utilization. In this case, the overall utilization is currently well below recommended targets for fire-related incidents. To maintain geographic coverage and economic efficiency, a department should determine its optimum UHU figure considering the cost of operations.

[8] The unit failure rate is the percentage of calls for which a unit is unavailable due to handling an existing call where it otherwise would have been dispatched as the primary unit.

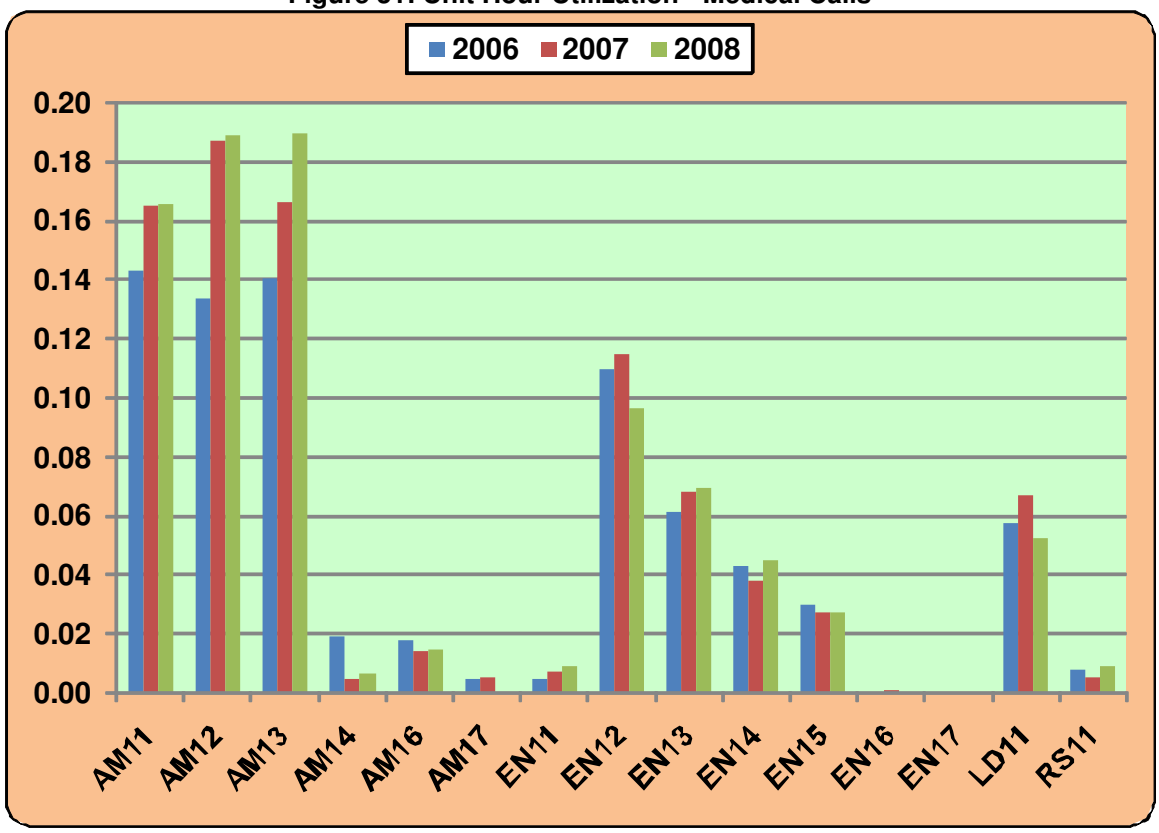
Figure 30: Unit Hour Utilization - Fire Calls



[redacted]

It would be expected that Station 1 apparatus would have higher UHU figures than Station 3 apparatus, however Station 3 spent longer time per call on the average and had the second highest call volume per apparatus. This may be due to responding to other districts when they are out of service or on second due assignment to busy downtown response areas.

Figure 31: Unit Hour Utilization - Medical Calls



[redacted]

Because of the time for transporting patients to the hospital, providing a report to the staff, and finishing paperwork, it is expected the ambulance units would have a higher UHU on medical calls. It should be noted that UHU ratios do not measure total work activity for the units, just the amount of times it is committed to a call. The time for returning from assignments, report compilation, station duties, training, and other non-call related activity is not included. At times, a unit may even *clear* an assignment because they are essentially available for a call within their district, and endeavor to reduce cross-district responses even though some work is left to do on the assignment at hand.

Another aspect of workload for the department is responding to non-emergent medical transportation and related requests. The department staffs one ambulance daily to handle these requests. However, when it is busy, other units may be deployed to handle the call, even in some cases which do not necessarily require an ambulance such as helicopter landing, stand-bys, and lifting assistance for fallen patients. The following table measures the UHU for each unit that was recorded in the non-emergency dataset provided by Pridemark, the agency which dispatches GJFD on non-emergent calls.

Figure 32: Non-Emergent Medical Transportation Workload (UHU)

Transports	2006			2007			2008		
Veh/Unit	Calls	Time	UHU	Calls	Time	UHU	Calls	Time	UHU
101			0.00	1	0:22:32	0.00			0.00
Amb-11	134	174:14:34	0.02	244	227:10:24	0.03	43	37:57:44	0.01
Amb-12	153	143:51:33	0.02	337	216:11:00	0.02	71	25:17:55	0.01
Amb-13	143	202:50:31	0.02	290	219:16:14	0.03	42	38:09:12	0.01
Amb-14	312	421:05:27	0.05	12	59:33:23	0.01	3	6:14:43	0.00
Amb-15			0.00	10	50:18:19	0.01	11	39:26:45	0.01
Amb-16	327	403:51:55	0.05	1618	1740:33:39	0.20	872	895:44:28	0.31
Amb-17	30	48:24:42	0.01	501	846:01:17	0.10	31	115:17:41	0.04
Amb-18			0.00	2	9:55:35	0.00	1	4:51:07	0.00
ENG-15			0.00	4	19:53:03	0.00			0.00
Squ-12	1	6:15:08	0.00	4	11:16:02	0.00			0.00
Squ-14	5	25:23:41	0.00	3	11:12:54	0.00			0.00
Grand Total	**1105**	**1425:57:31**	**0.16**	**3026**	**3411:44:22**	**0.39**	**1074**	**1162:59:35**	**0.40**

While the designated non-emergency transport unit (Amb-16) has the highest UHU naturally in this dataset, it can be seen that other units also supply services to these types of calls. The following table is the UHU table by unit for non-emergent calls that were cancelled prior to transportation.

Figure 33: Cancelled Non-Emergent Medical Requests Workload (UHU)

Cancelled	2006			2007			2008		
Veh/Unit	Calls	Time	UHU	Calls	Time	UHU	Calls	Time	UHU
Amb 18			0.00	1	0:00:02	0.00			0.00
Amb-11	34	49:15:13	0.01	27	16:10:35	0.00	4	0:46:02	0.00
Amb-12	34	49:27:50	0.01	62	20:04:43	0.00	9	2:44:22	0.00
Amb-13	12	3:25:24	0.00	37	18:44:06	0.00	7	2:28:59	0.00
Amb-14	35	25:32:35	0.00	6	30:49:24	0.00			0.00
Amb-15			0.00	2	6:45:54	0.00			0.00
Amb-16	38	56:52:59	0.01	289	315:27:14	0.04	119	103:59:55	0.04
Amb-17	6	6:56:23	0.00	70	49:43:58	0.01	3	10:23:59	0.00
ENG-13			0.00	11	12:39:56	0.00			0.00
ENG-15			0.00	8	0:01:09	0.00			0.00
L-11			0.00	1	0:00:07	0.00			0.00
Squ-12	2	3:00:00	0.00	4	0:00:47	0.00			0.00
Squ-14			0.00	2	3:17:40	0.00			0.00
Grand Total	**161**	**194:30:24**	**0.02**	**520**	**473:45:35**	**0.05**	**142**	**120:23:17**	**0.04**

These cancellations can occur for a variety of reasons presented in the table below, the most often reason for cancelled call is assisting the medical helicopter flight team to transport a patient either from a scene or in some cases, the hospital helipad.

Figure 34: Reasons for Non-Emergent Cancellation & Workload (UHU)

	2006			2007			2008		
Canceled Reason	Calls	Time	UHU	Calls	Time	UHU	Calls	Time	UHU
Appointment Changed			0.00	1	0:00:00	0.00			0.00
Community Donation (Billing)	28	87:13:57	0.01	17	46:23:54	0.01	5	4:18:32	0.00
Dispatch error	7	3:00:50	0.00	8	4:00:26	0.00	3	0:00:48	0.00
DOA			0.00	3	0:21:46	0.00			0.00
Facility Canceled	14	0:44:05	0.00	61	98:32:33	0.01	17	15:32:59	0.01
Fire Refusal	1	2:11:03	0.00			0.00			0.00
Flight Team Transport	28	55:17:26	0.01	205	210:09:35	0.02	88	89:44:10	0.03
Lift Asst/Pub. Asst.	33	13:04:25	0.00	109	54:03:59	0.01	13	4:37:56	0.00
Missing Trip	1	0:00:43	0.00			0.00			0.00
Not Needed- No contact / UTL	32	23:28:33	0.00	35	32:56:38	0.00	2	0:58:39	0.00
Not Needed- with pt contact	8	4:17:27	0.00	10	6:24:37	0.00	4	1:43:26	0.00
Other Agency Tx	2	0:40:10	0.00	8	1:22:13	0.00	2	0:00:33	0.00
Pt Doesn't Go Anymore			0.00	2	0:46:03	0.00			0.00
Pt in hospital			0.00	1	0:18:40	0.00			0.00
Pt Refusal	5	2:13:07	0.00	38	15:11:22	0.00	8	3:26:14	0.00
Pt refused transport @ p/u			0.00	4	2:07:53	0.00			0.00
Rescheduled			0.00	1	0:00:02	0.00			0.00
Transported by other means	2	2:18:38	0.00	11	1:05:49	0.00			0.00
Unable to Handle			0.00	5	0:00:00	0.00			0.00
Wrong service type order			0.00	1	0:00:05	0.00			0.00
Grand Total	**161**	**194:30:24**	**0.02**	**520**	**473:45:35**	**0.05**	**142**	**120:23:17**	**0.04**

For Amb-16, the total UHU for all call types (fire, emergency medical, non-emergent transports, and cancelled calls) is over .35. The total workload for the downtown emergency ambulances is near .20. This will impact the reliability that an ambulance will be available to answer a call within their response areas. Reliability of units will be evaluated later in this section. The following table details the total workload for ambulances in the first four months of 2008.

Figure 35: Total Ambulance Workload (UHU)

Call Concurrency and Resource Drawdown

Another way to look at resource workload is to examine the amount of time multiple calls happen within the same time frame, on the same day. ESCi examined the calls to find the frequency that GJFD apparatus is handling multiple calls within any time frame. This is important because the more calls occurring at one time can stretch available resources and extend response times from distant responding available apparatus.'

Figure 36: Call Concurrency Table - Fire Calls

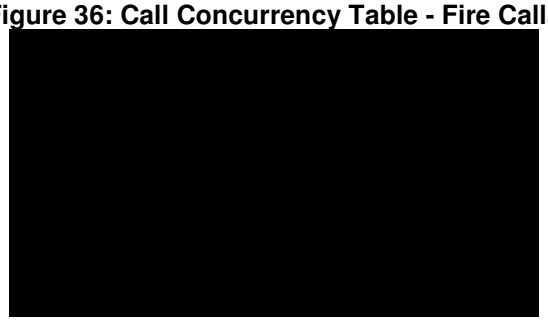


Figure 37: Call Concurrency Table - Medical Calls

As in most communities, the majority of calls happen singularly. However, as communities grow the propensity for concurrent calls increase. When the concurrency reaches a level to which it stretches resources to near capacity, response times begin to extend. Although multiple medical calls will cause drawdown especially as concurrency increases, they usually occupy one unit at a time.

Concurrent fire calls however, are of more concern as they may require multiple unit responses for each call depending upon the dispatch criteria. Typically, *other* calls, that are not actual fires nor medical calls, do have higher rates of concurrency than fires, and depending on the dispatch criteria, may create period of extensive resource drawdown.

It is important to note that the area with the highest workload, and especially medical calls, typically has the highest rate of concurrent calls. This requires response units from other stations, to respond into the area. The impact on station area reliability can be affected by several factors such as:

- Out of service for mechanical reasons
- Out of service for training exercises
- Out of area on move-up deployment
- Lack of staffing
- Concurrent calls
- Non-emergency transports/calls

When these factors impact the reliability of a station to respond within its prescribed territory, response time performance measures for the back-up station/apparatus can be negatively affected. The following charts illustrate the reliability of *first response* on activity within the fire response areas, color-coded by the primary station.

Figure 38: Reliability - Fire Calls

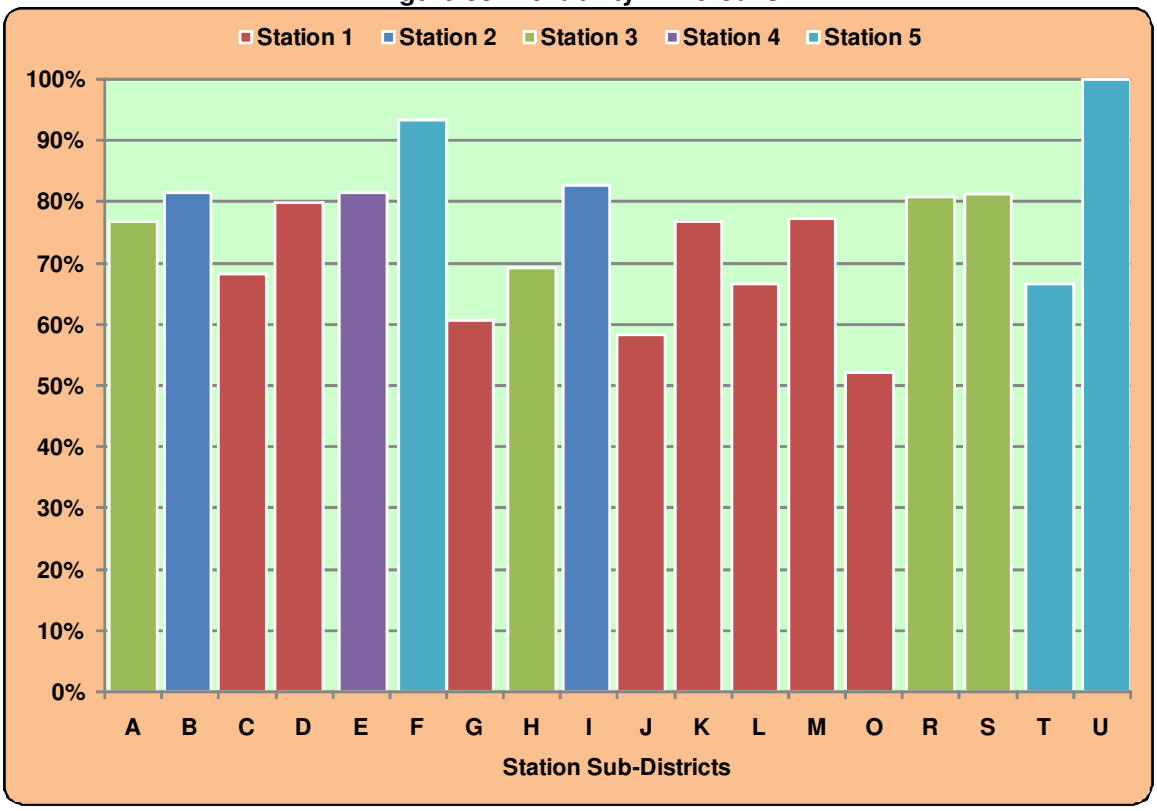
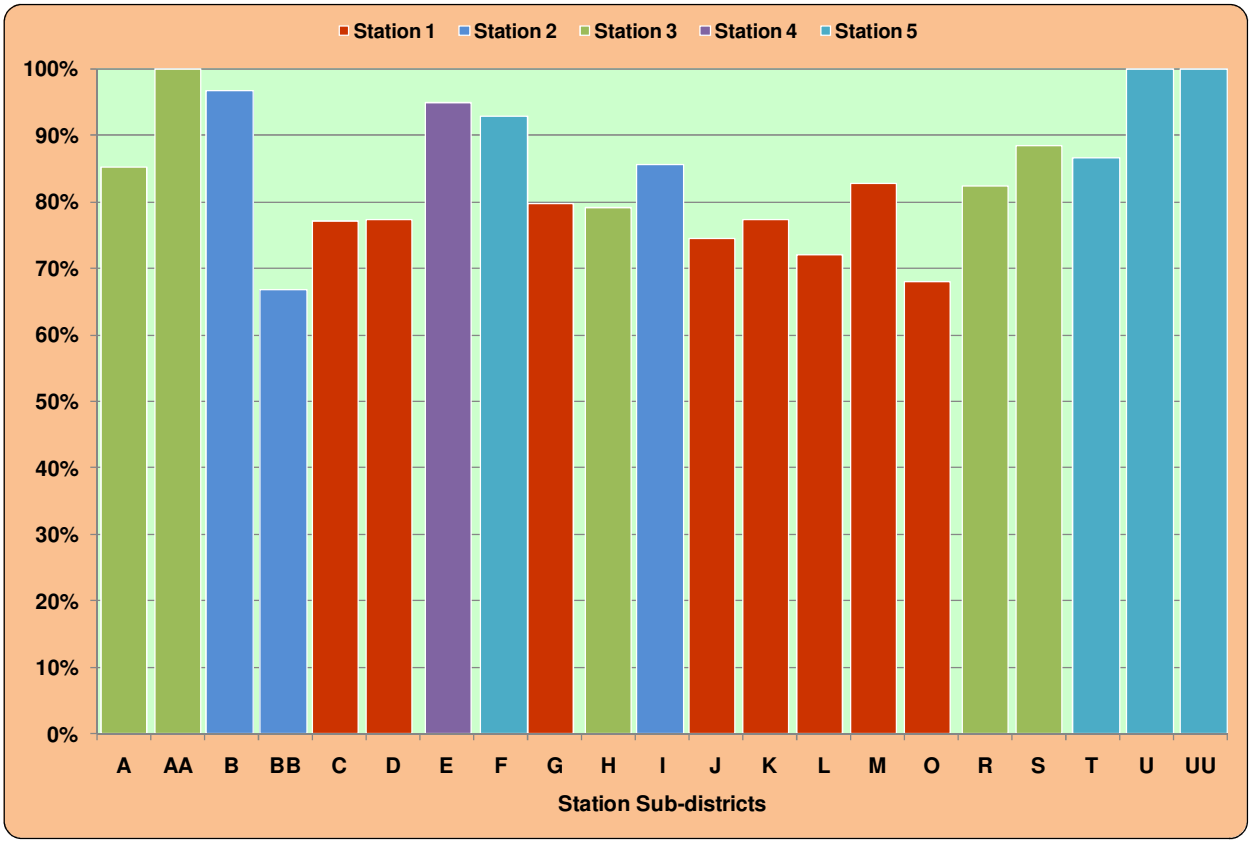


Figure 39: Reliability - Medical Calls



For both call types, it appears that Station 1 has less reliable response than the other stations in the department.

Recorded System Response Performance

Throughout this document, certain descriptive statistical measures are utilized which may not be familiar to all readers. In an effort to reduce confusion or the drawing of inaccurate conclusions, this section seeks to provide a brief explanation of these measures. The measures most often used which require clarification are the use of *average* and *percentile* measures.

Average

The *average* measure is a commonly used descriptive statistic also called the mean of a data set. It is a measure which is a way 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, the skewness can be either very large or very small.

For example, assume that a particular fire 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 opposite can be true where one call with an unusually long response time can make otherwise satisfactory performance appear unacceptable. These calls with unusually short or long response time have a direct impact on the total performance measurements, and the farther they are from the desired performance, the greater the impact.

The reason to compute average is because of its common use and ease of understanding that is associated with it. 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. As illustrated above, one extremely good or bad call skewed the entire average. While it does reflect all values, it does not really speak to the level of accomplishment in a strong manner.

Percentile

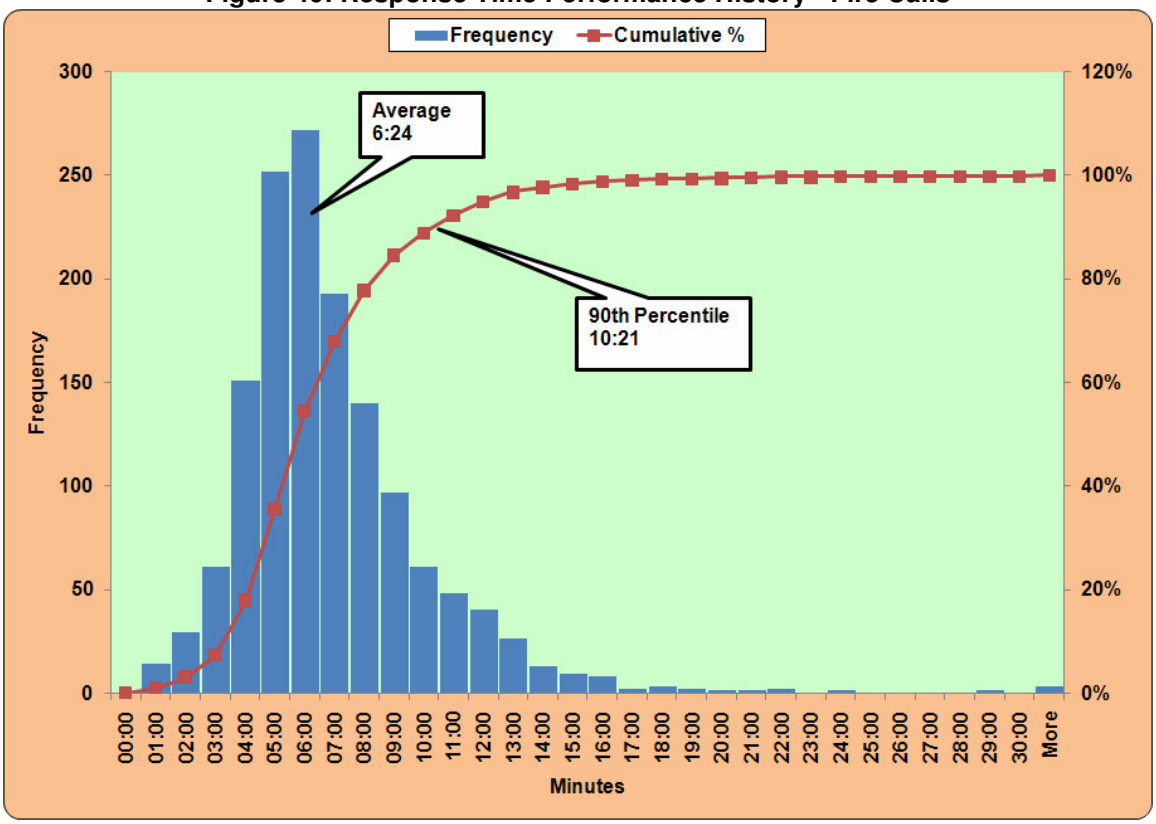
With average measure, it is recognized that some data points are below the average and some are above the average. The same is true for a median measure which simply arranges the data set in order and finds the value in which 50 percent of the data points are below the median and the other half are above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

When dealing with fractiles or percentages, 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 fractile 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 fractile 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 be compared to the desired performance objective to determine the degree of success in achieving the goal.

Total response time is the amount of time a resident or business waited until an apparatus arrived at the scene of emergency beginning when they first called the designated emergency number, often 9-1-1. It is made up of several elements which were discussed earlier (See *Response Time Performance Objectives*). Since the fire department has no influence on call processing time, fire departments are measured on response time from the time of dispatch to the arrival on scene. The following chart illustrates the overall response time frequency for the GJFD over the last full year of data provided.[9]

Figure 40: Response Time Performance History - Fire Calls

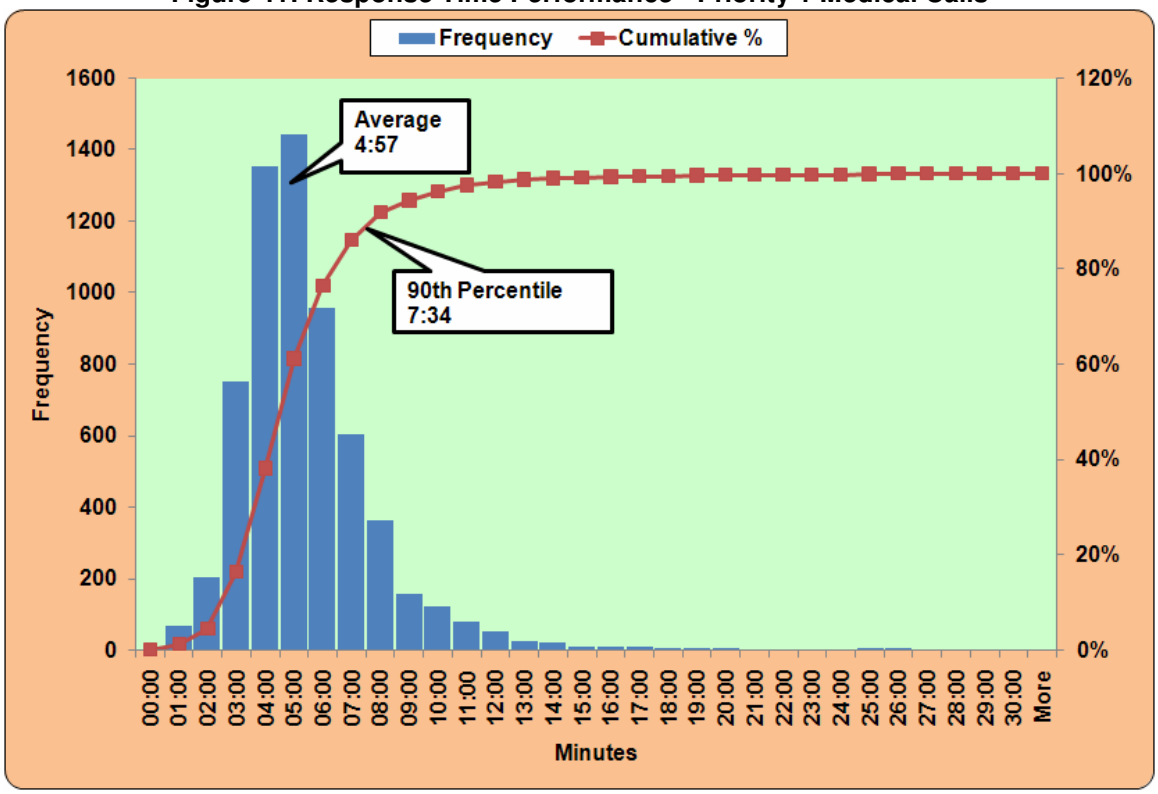


[9] Mutual aid calls and non-emergent calls were removed from response time analyses as they were found.

The most frequently recorded response time for fire calls was in the six minute range. The average of all fire calls is calculated to be 6 minutes 24 seconds. Ninety percent of all fire calls are answered within a 10-minute 21-second response time department-wide.

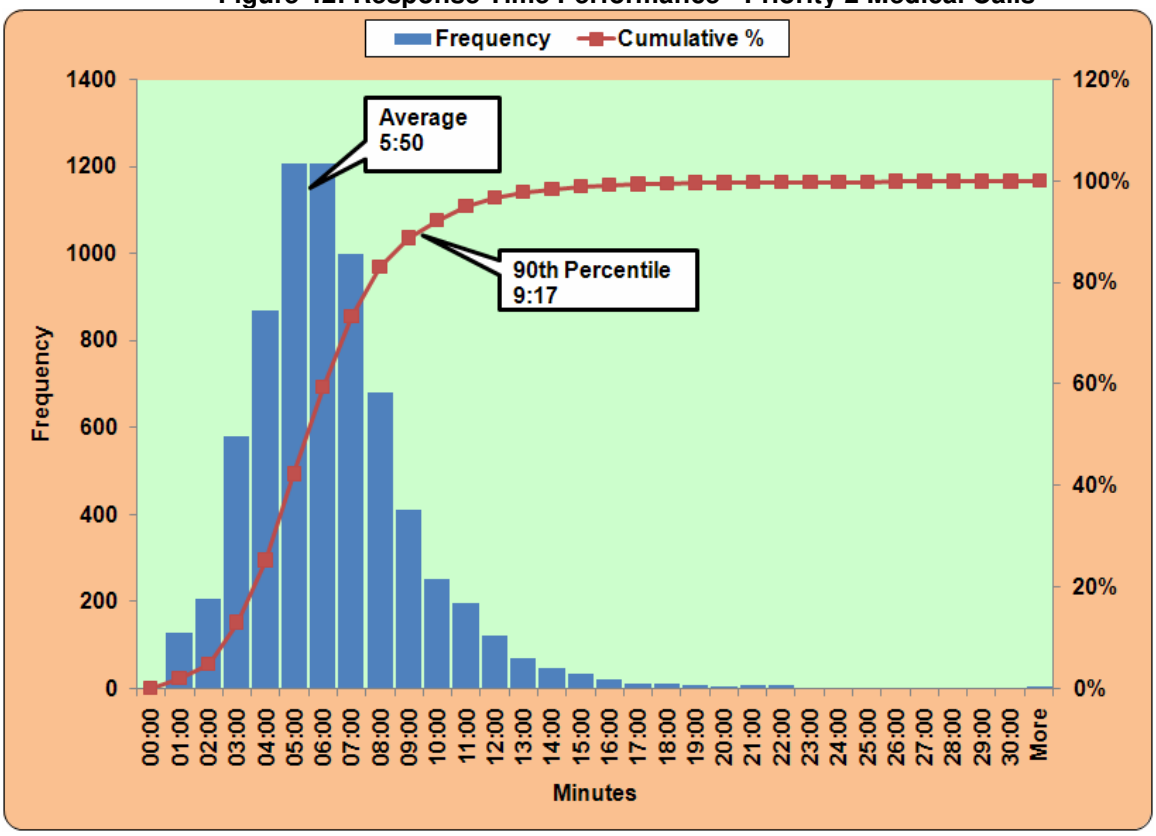
Priority 1 medical calls within the urban designated area beat the response time goal of eight minutes to 90 percent of the Priority 1 dispatched classifications as illustrated below.

Figure 41: Response Time Performance - Priority 1 Medical Calls



The most frequently recorded response time for Priority 1 medical calls was in the five-minute range. The average of all Priority 1 medical calls is calculated to be 4 minutes 57 seconds. Ninety percent of these calls are answered within a 7-minute 34-second response time in the urban designated area. This is less than the eight-minute response time required by Mesa County for these types of calls.

Figure 42: Response Time Performance - Priority 2 Medical Calls



The most frequently recorded response time for Priority 2 medical calls was in the five to seven-minute range. The average of all Priority 2 medical calls is calculated to be 5 minutes 50 seconds. Ninety percent of these calls are answered within a 9-minute 17-second response time in the urban designated area. This is less than the 12-minute response time required by Mesa County for these types of calls.

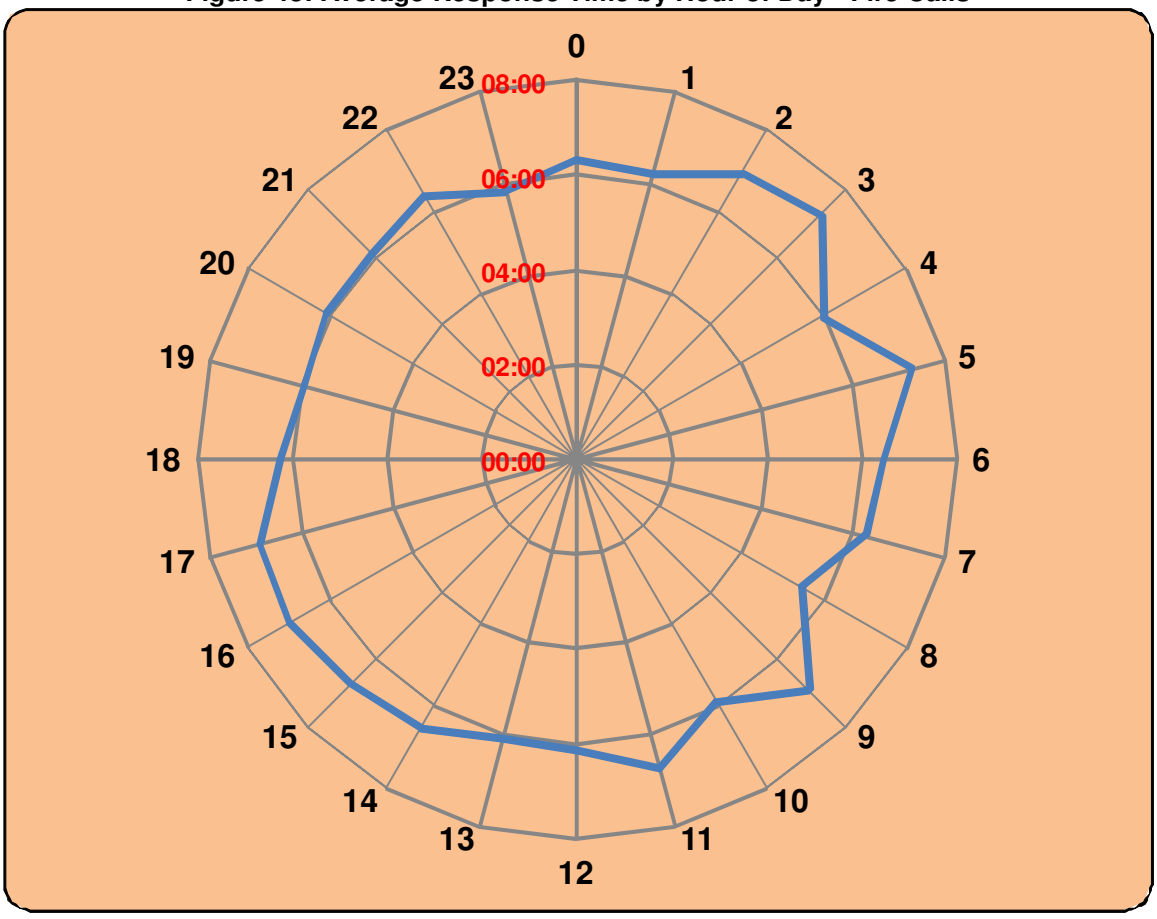
Medical calls outside of the fire response areas are considered *frontier* for response time reporting purposes. As seen in the service demand density map for medical calls, this is a relatively small sample of calls. Priority 1 calls within the frontier zones were answered within fifteen minutes, twelve seconds, 90 percent of the time. Priority 2 frontier calls had a 12-minute 25-second, 90th percentile response time. No calls took over one hour to reach in either case.

These response times reflect the first arriving apparatus which include engine companies since they operate at a paramedic-capable level. Examining ambulances only reveals a response time of six minutes and thirteen seconds on the *average* for Priority 1 calls, and seven minutes and

twenty one seconds for Priority 2 calls. It should be remembered that these ambulance units are only staffed in three of the five stations, have higher concurrent call volume, and may be responding from the hospital or other areas if cancelled or the patient refused travel services.

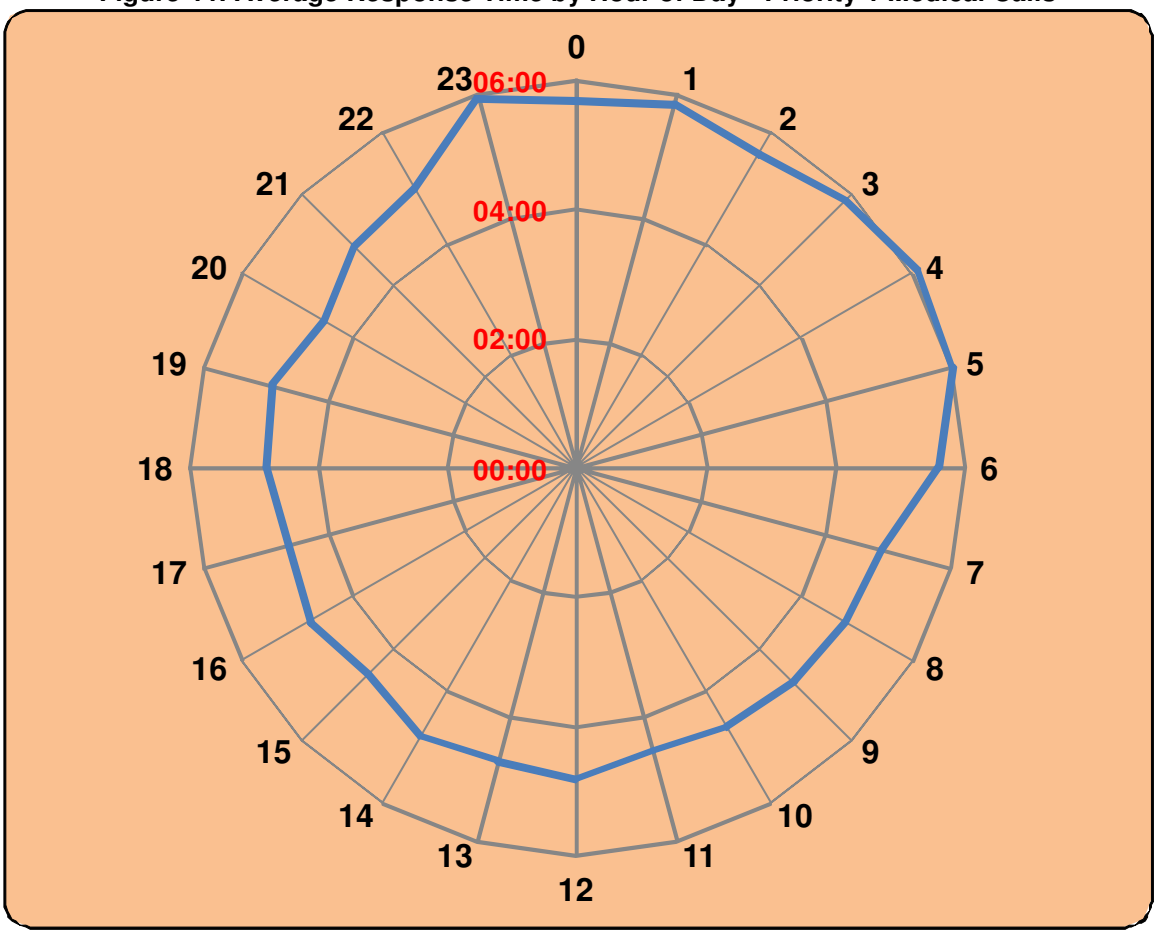
Response times can vary by time of day in reflection of service demand workload, traffic congestion, weather, and distance to the call from the station, to name but a few. The next figures illustrate how the response time can differ by time of day. The 24-hour clock-like graph has lower response time as the blue line becomes closer to the center of the graph.

Figure 43: Average Response Time by Hour of Day - Fire Calls



Average response times for fire calls is best during the early afternoon and early evening hours.

Figure 44: Average Response Time by Hour of Day - Priority 1 Medical Calls

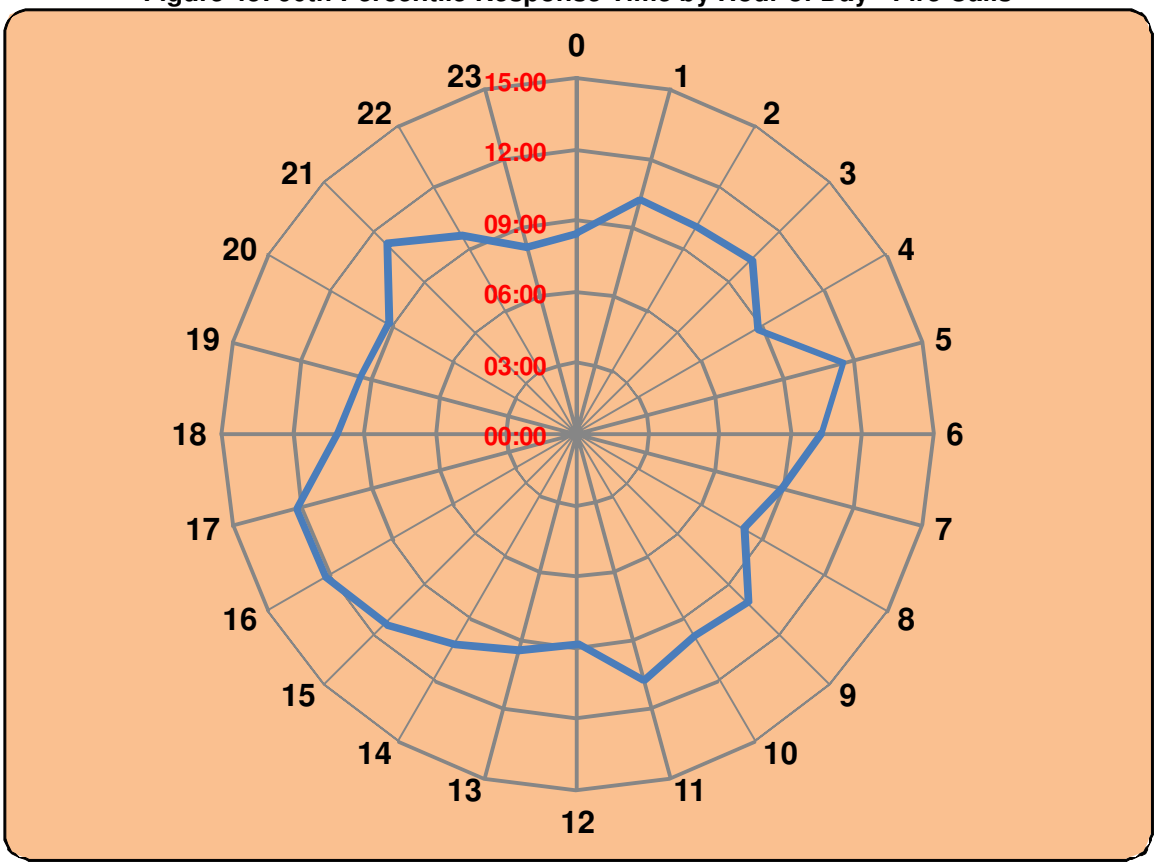


Response time averages for Priority 1 medical calls are consistently better from 7 a.m. through the 9 p.m. hour.

Average response time is one useful measure to determine how well geographic-based coverage is achieved. As discussed, more significant is how well the majority of emergency response demand is being serviced. One useful way to determine how well demand-based coverage is achieved is by determining maximum response time to a larger percentage of the incidents, in most cases 90 percent.

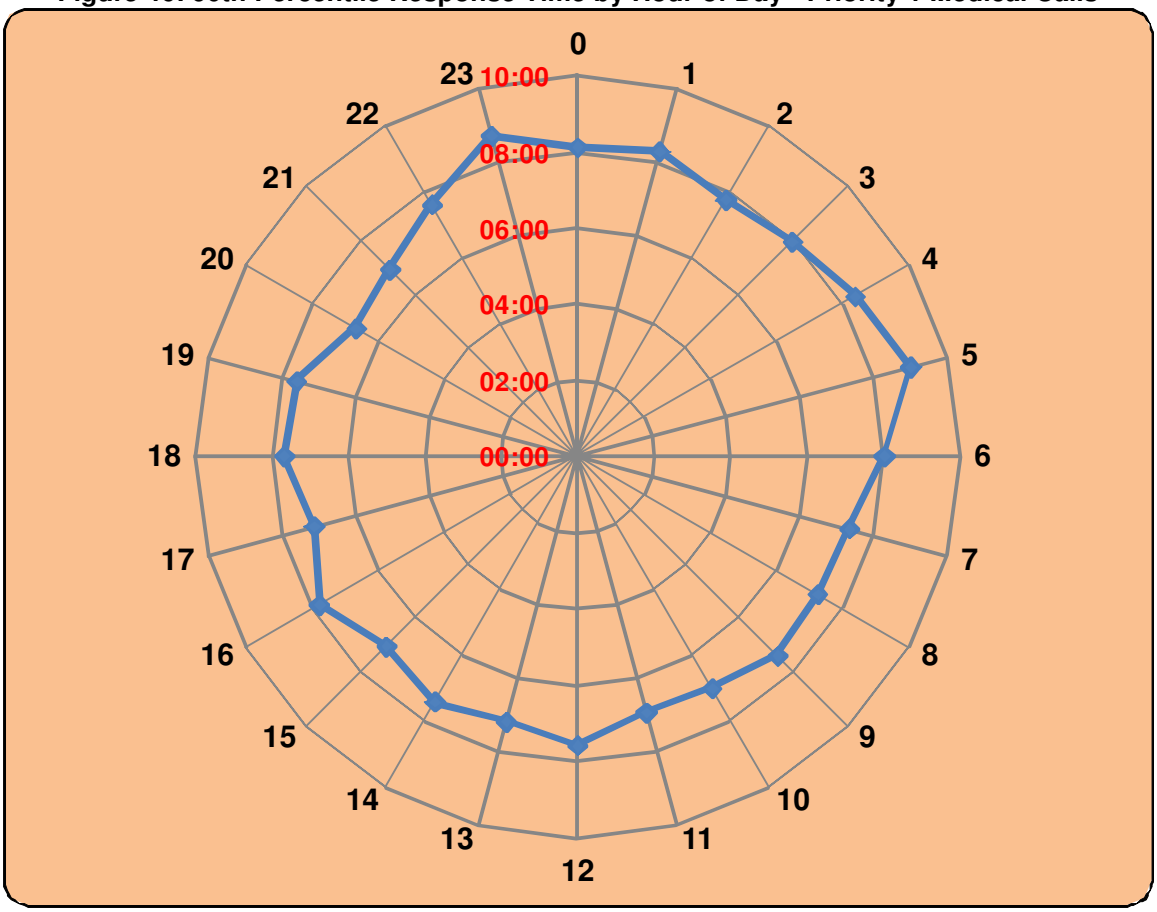
The following figure displays the 90th percentile response time performance by hour of day for fire and Priority 1 medical calls within the fire department.

Figure 45: 90th Percentile Response Time by Hour of Day - Fire Calls



Fire call response times are best in the midmorning, early afternoon, and early evening hours.

Figure 46: 90th Percentile Response Time by Hour of Day - Priority 1 Medical Calls

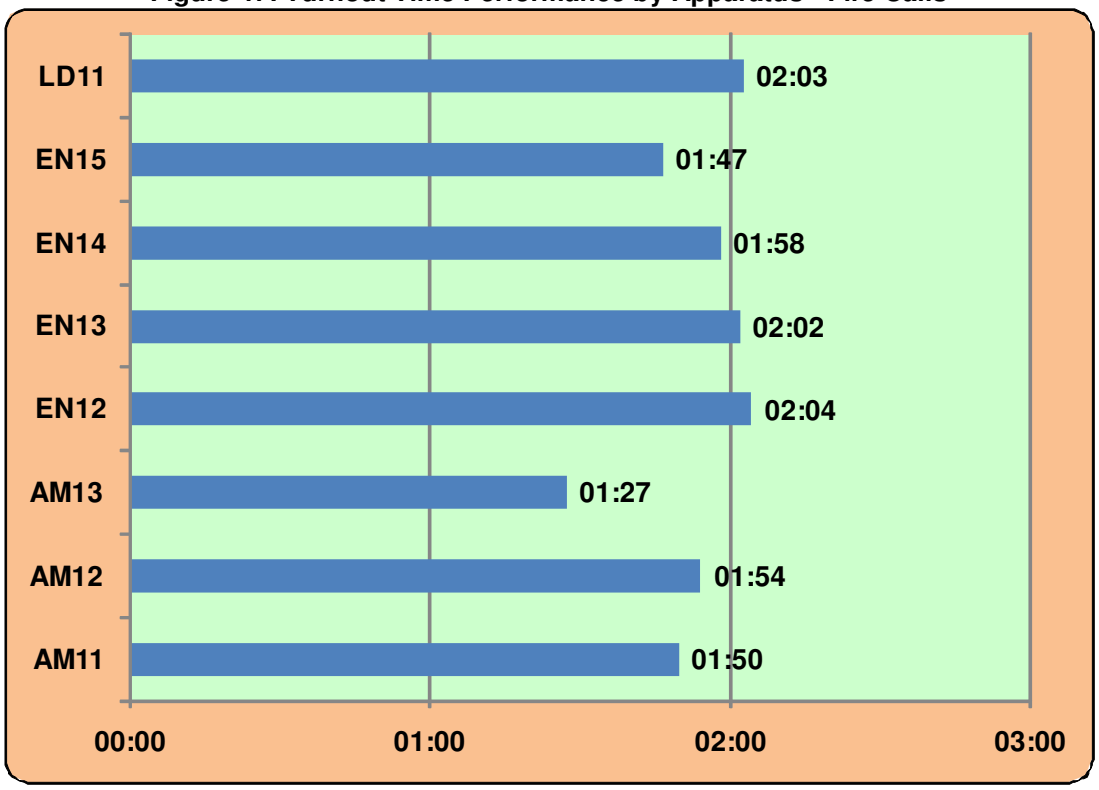


Medical Priority 1 calls have a consistently better response time performance from 6 a.m. through the 9 p.m. hour.

Some response time inhibitors are not necessarily controllable by firefighters; however, the reaction or turnout time when they are notified of a call to when they leave the station is controllable to a great extent. GJFD has a departmental objective of less than one-minute duration for turnout time.

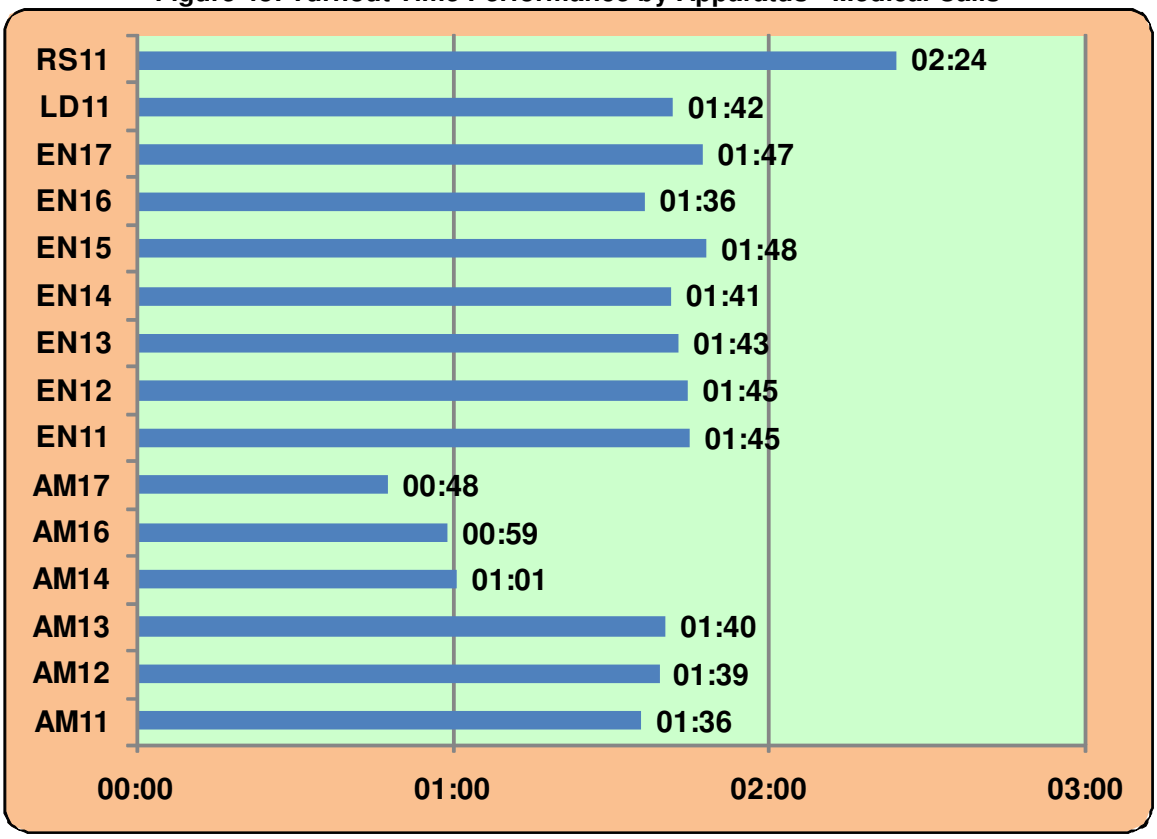
The following figures illustrate the average turnout time based on apparatus for fire and medical calls.

Figure 47: Turnout Time Performance by Apparatus - Fire Calls



The overall average turnout time for fire calls is a full two minutes. Effort should be taken to reduce this figure as much as possible including station design, incentive policies, automated mapping systems, and traffic signals in front of the stations.

Figure 48: Turnout Time Performance by Apparatus - Medical Calls



Overall, the turnout time average for Priority 1 calls is 1 minute 39 seconds, Priority 2 calls have an average turnout time of 1 minute 44 seconds collectively.

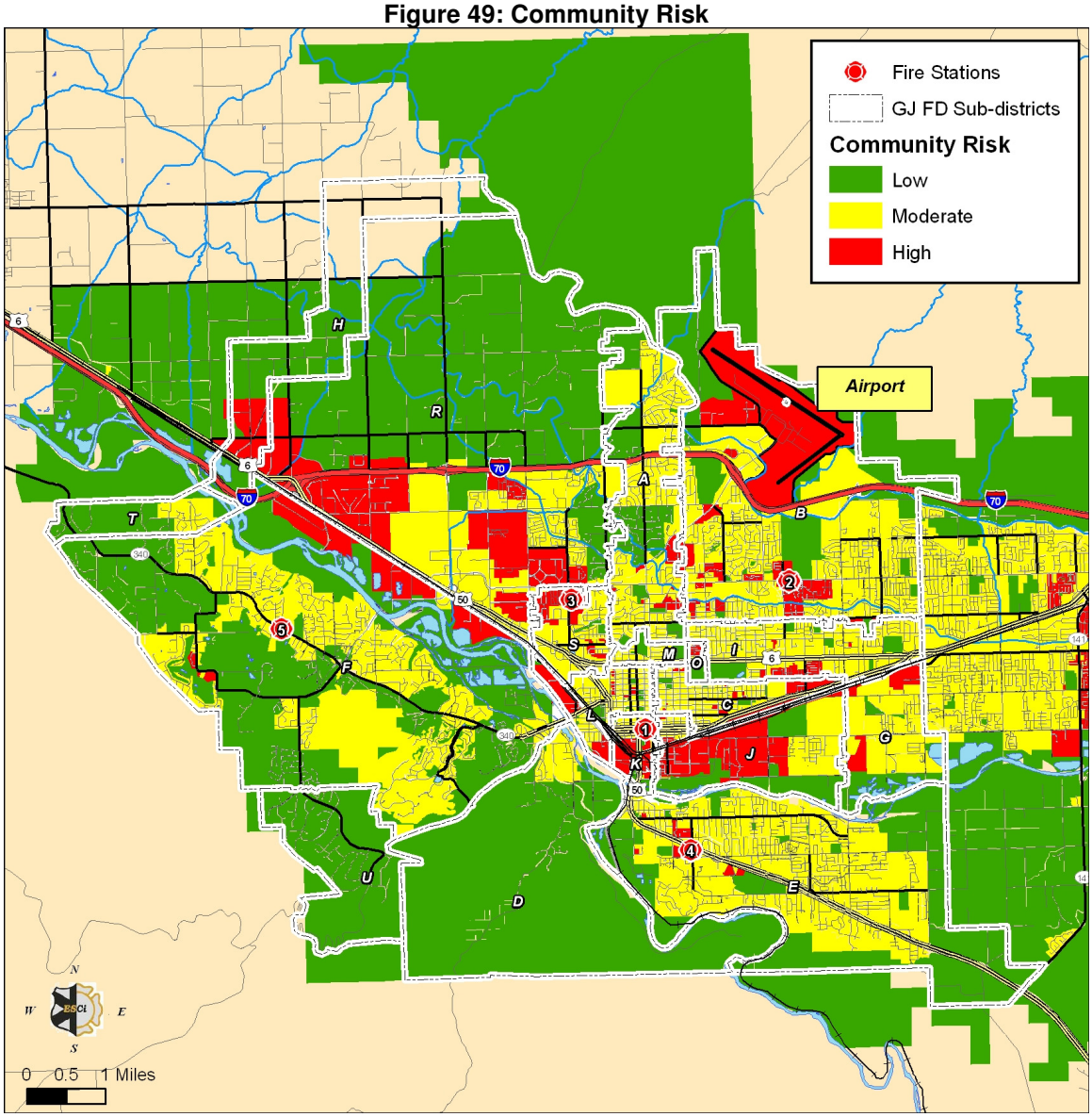
Community Risk Analysis

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.

The community's risk assessment has been developed based on potential land use within its anticipated future boundaries. These potential uses are found in the City's and Mesa County's development plans and zoning designations. The following map translates land use (potential scale and type of development within geographic sub-areas) to categories of relative fire and life risk.

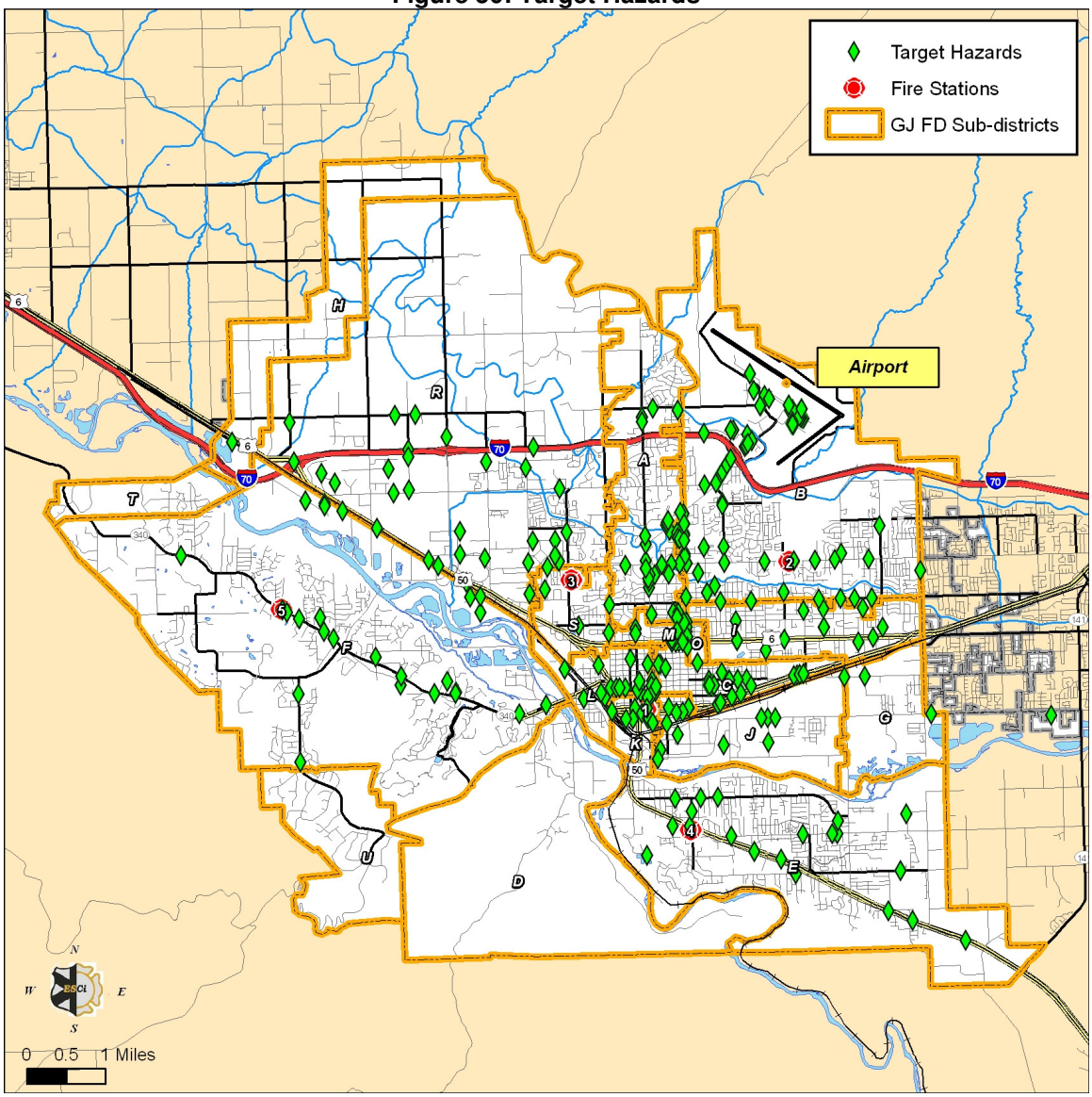
- Low risk – Areas zoned and used for agricultural purposes, open space, low-density residential, and other low intensity uses.
- Moderate risk – Areas zoned for medium-density single family properties, small commercial and office uses, low-intensity retail sales, and equivalently sized business activities.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

Figure 49: Community Risk



From the previous figure, it can be seen that the fire stations are located in areas of higher risk. They are also located near structures identified by the fire department as specific hazards to significant loss of life, property, or community at-large. These *target hazards* are located within the following figure.

Figure 50: Target Hazards



Facility Deployment Strategies

ESCi examined the current facility distribution and capabilities of response time performance with regard to the adopted goals for fire and medical calls within their primary jurisdiction. Workload and subsequent actual response time performance were analyzed along with the extent of a full alarm force assembly.

Certain conclusions are derived from these analyses:

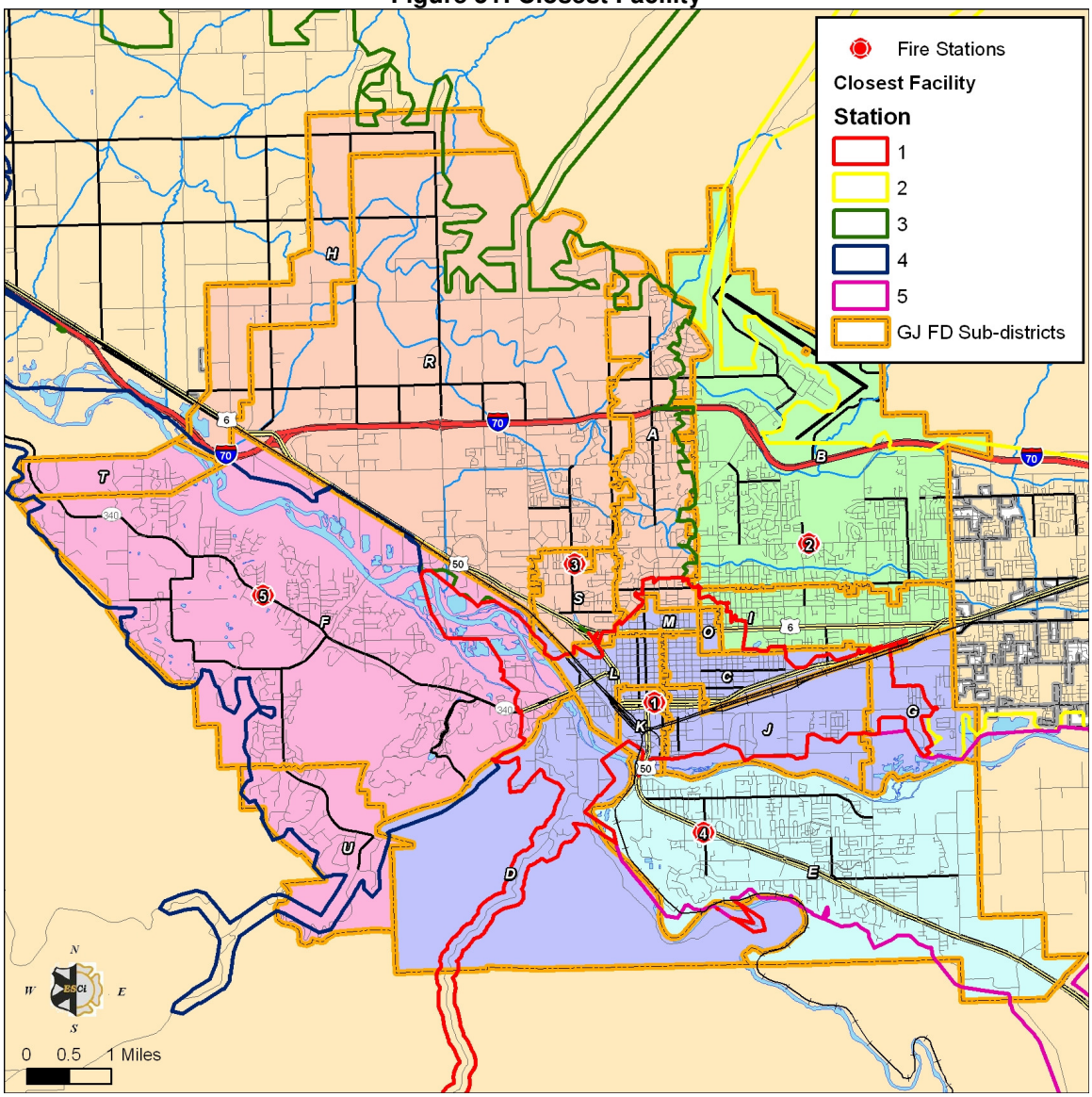
- Current facility deployment is adequate for current demand coverage for medical calls. This is evident through the response time analysis where the first arrived units have a better performance than mandated by Mesa County.
- Response time performance for fire calls lags behind the departmental goal which indicates the need for additional facilities to meet this goal.
    - This is due to the shorter response time requirement for fire calls and the generalization of response time objectives when compared to the prioritization designation for medical calls.
- Unit workload is not sufficiently high enough to warrant additional apparatus ***based on workload alone***. EMS units are approaching threshold limits, but currently still below recommended benchmarks.
- Concurrent calls in high demand areas create (in part) a lower reliability for host station units.
- Turnout time is above stated goals, but not unusual for a career department performance.

Given these conclusions, it is important to determine where the center of concentration of calls (central feature) is in each of the station's primary response areas to determine if the current location is optimal for each area. This is not the same as a geographic center where a few outlying calls would influence this location, but where the shortest distance to the most calls within a station area lies.

First, it is appropriate to convey that these central features are influenced by the number of calls and to a certain degree, the geographic extent of the station areas. These station areas were determined by the fire department to (presumably) provide closest unit response to the area it serves. In Grand Junction, there are natural and man-made barriers that affect the street network that factor into this determination. Rivers, railroads, terrain, and limited access

highways all act as physical barriers to apparatus response capabilities. It appears that these physical barriers and the road network capability were taken into account when determining the primary station for each fire response area. The following figure illustrates the station areas compared to the closest unit travel time according to the model.

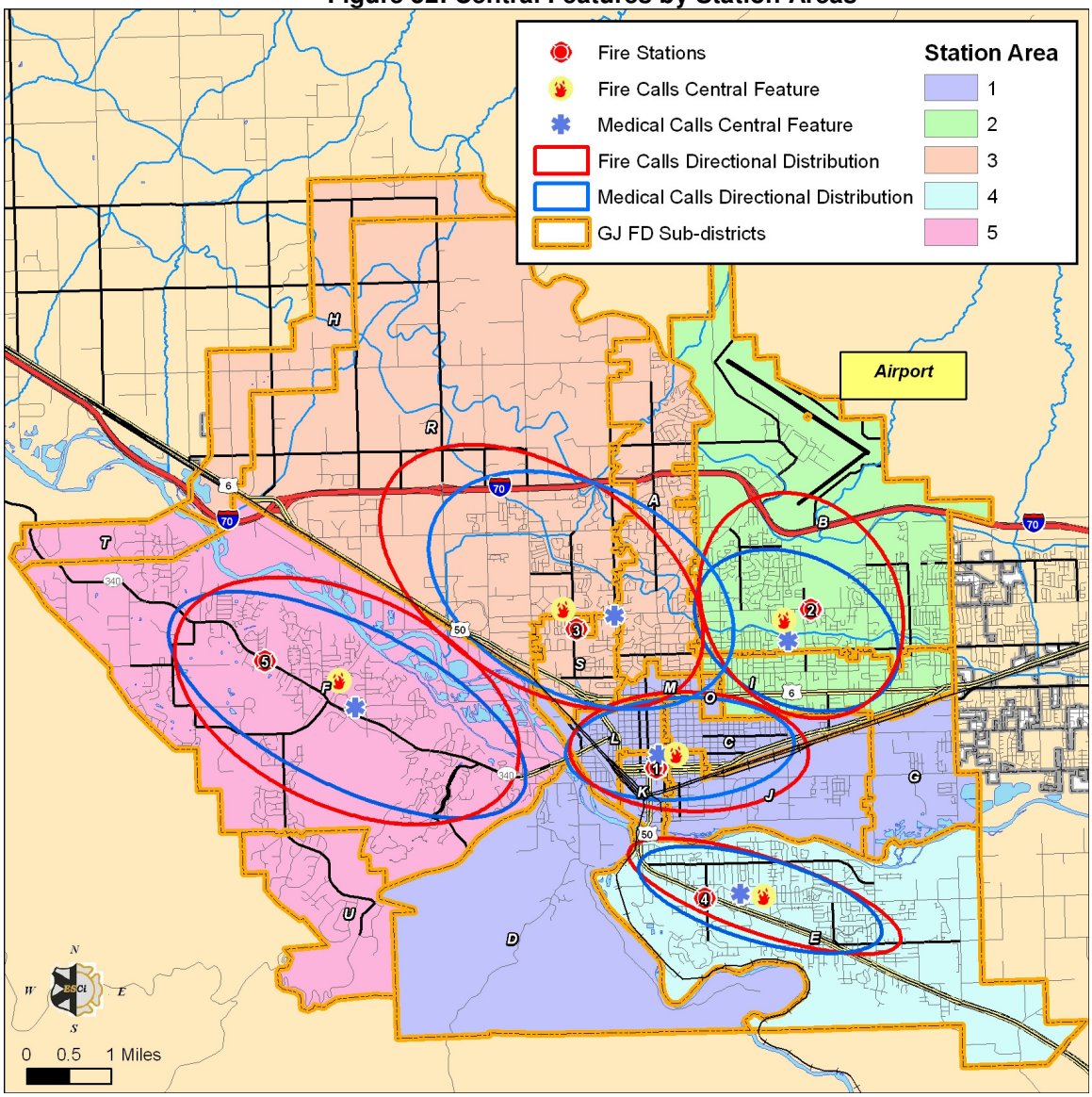
Figure 51: Closest Facility



Although there appears to be some discrepancies, generally the fire response areas are allocated properly. Nonetheless, each station area's central feature for fire and medical calls is presented in the following figure. Along with each central feature, a directional distributional ellipse is drawn for each station area and both types of calls. The direction of the ellipse

indicates the orientation of most calls within the station area. The size of the ellipses indicates the compactness, or level of concentration, of calls within each station's area.

Figure 52: Central Features by Station Areas



All fire directional ellipses are larger than the medical calls ellipses. This indicates that fire calls are less concentrated in station areas than medical calls. Station 4 calls are more concentrated than Station 5's calls; they follow a similar orientation from northwest-southwest ellipses, along the major arterial roadway in their area. Despite Station 1's primary area, this is the most concentrated area for calls in the downtown area. Station 2's fire directional ellipse differs from the medical ellipses by orienting further north toward the airport. Similarly, Station 3's ellipse

stretches further northwest than the more compact medical call ellipses for this station which surrounds the higher residential population.

For all areas, the central feature within a station area is less than one mile from the current location of a fire station. This indicates the current locations are optimal, considering the concentration of calls within the designated station area. However, it should be remembered that, based on travel time, the existing stations are not sufficient to provide adequate coverage of service demand at the current response time objective for fire calls.

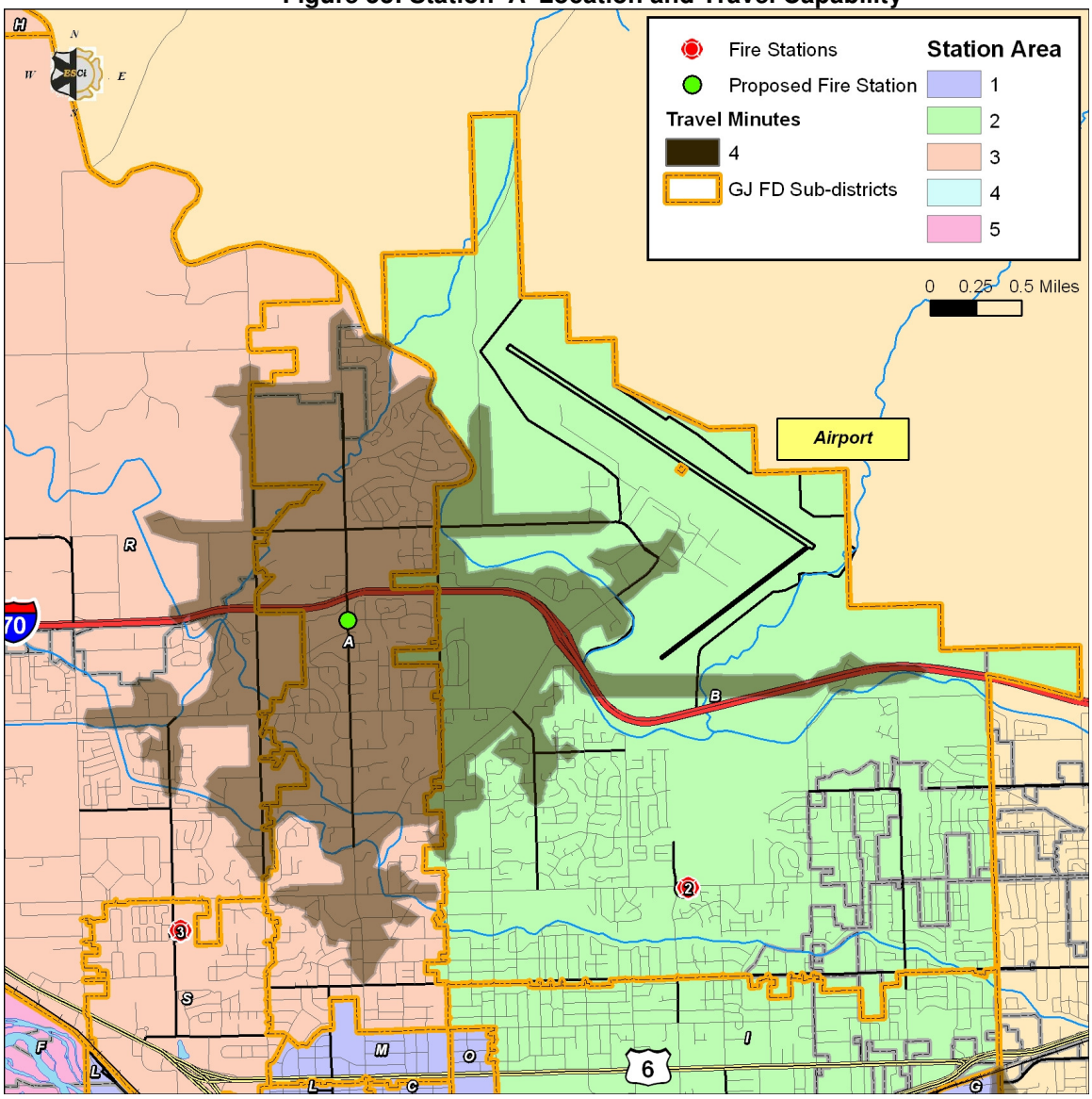
Findings and Recommendations

It is ESCi's preferred recommended that GJFD proceed with Scenario A: Build additional stations to ensure uniform response protection department wide.

In the section that follows, proposed locations for additional facilities are based on the service demand levels that are not within the response time capability of a four minute travel time of the existing stations. For the most part, the location closest to these calls is chosen since it would provide the most additional service demand coverage. ESCi realizes that available property and zoning regulations will ultimately factor into the final location of a proposed station. It can be seen that locations within a half-mile can be considered without significantly altering the study results.

Stations 2 and 3 have the largest amount of uncovered service demand after the measure of four minutes of travel is subtracted from the respective response area service demand. Most of Station 2's underserved demand is at or near the airport; however, locating a station at this location creates a gap between this location and Station 2. Station 3's area of underserved service demand is concentrated in the northern part of response area 'A,' and scattered throughout the response area 'R'. The central feature for Station 3's underserved demand is located near the interchange with I-70 and 24th Road. The combined central feature for the underserved area for Station 2 and Station 3 was located in response area 'A,' just south of the interstate overpass at 26 ½ Rd. and G ½ Rd. A new station at this location along an arterial roadway provided coverage to most of the airport and the northern response area 'A'. Its nearest interstate access is at the Horizon Drive interchange. The following figure illustrates this location (Station 'A') and the modeled travel time capability.

Figure 53: Station 'A' Location and Travel Capability

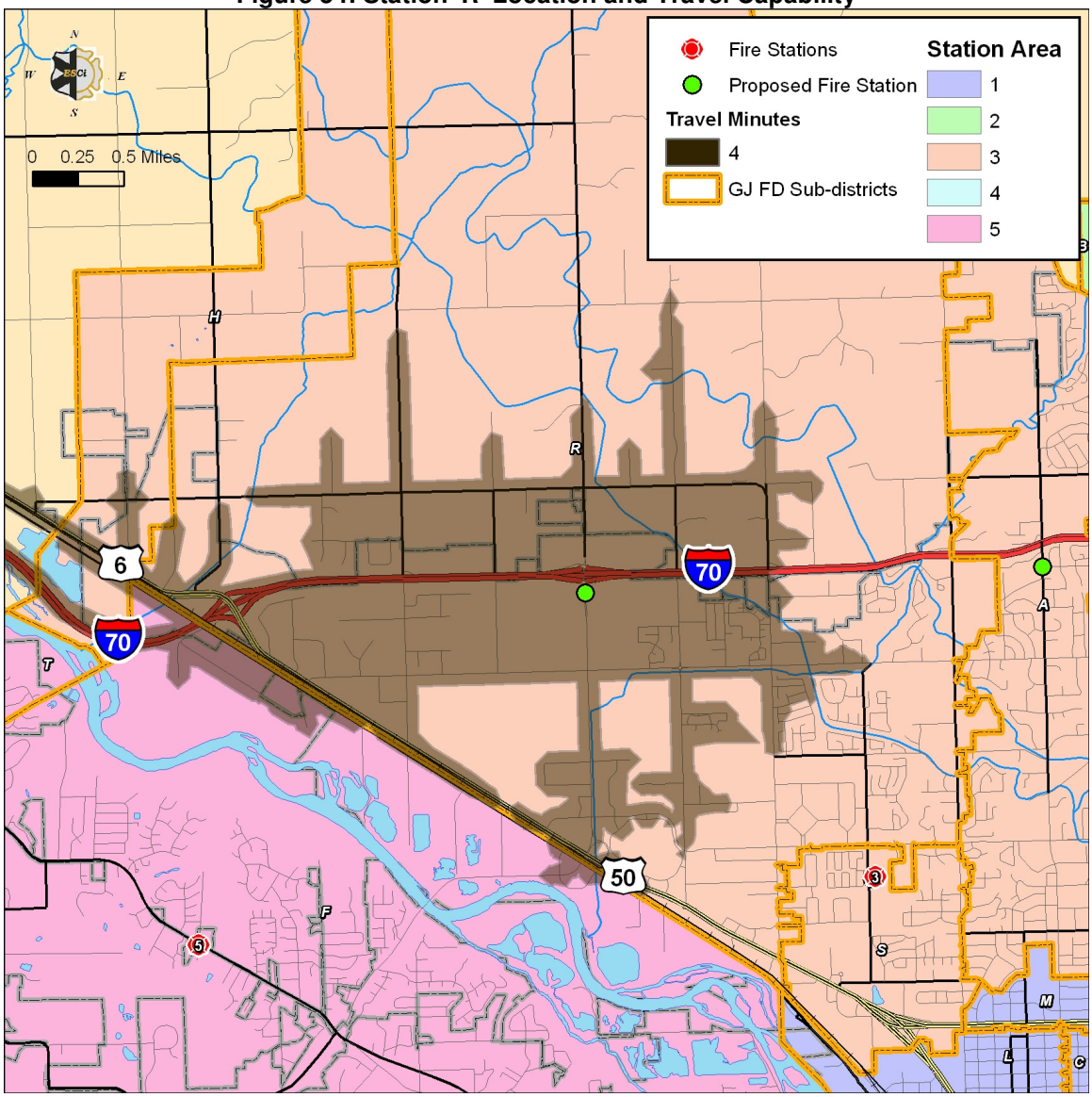


Service demand coverage of fire calls increased from 72.87 percent to 81.33 percent with this additional station having provided coverage to over 100 more calls. However, this is still short of the objective for 90 percent coverage of service demand at four minutes of travel. The remaining underserved calls in Station 3 response area's 'R' and 'H,' place the central feature a mile west of the former location for Station 3's central feature.

Despite this, it is recommended to utilize the previous central feature location of 24 Rd & I-70 due to the ability to access the interchange at that location. Placing the station just south of this

interchange yielded more calls than just north. The following figure illustrates this location (Station 'R') and the expectant travel time capability.

Figure 54: Station 'R' Location and Travel Capability



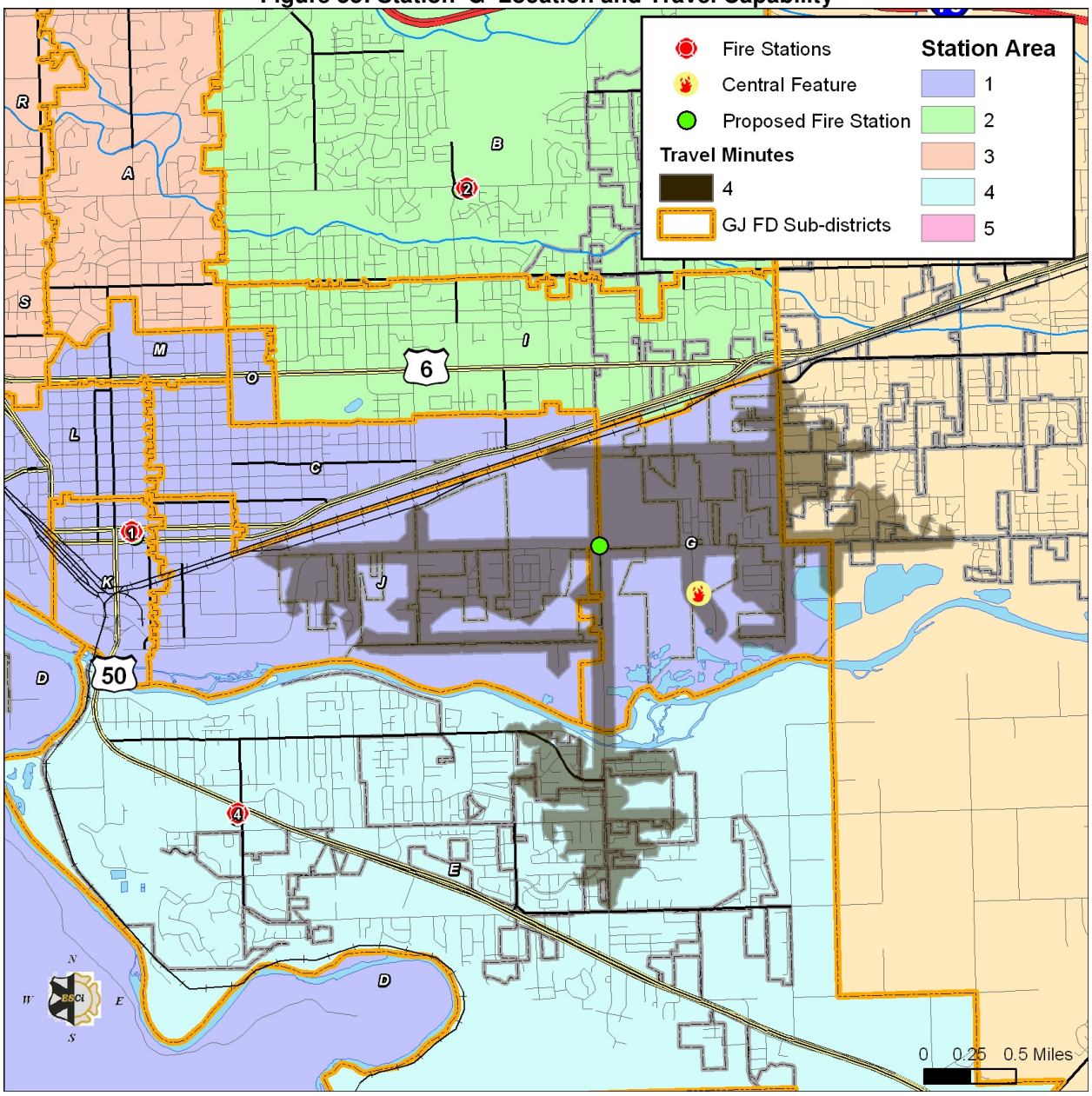
The addition of this station increases overall service demand coverage to 86.53 percent, still below the service demand coverage goal of 90 percent.

While these two stations provided coverage to the majority of the underserved service demand, the residual calls outside of the travel time capability of these stations amounted to fewer than

the amounts still underserved in other response areas, thereby redirecting attention to these areas.

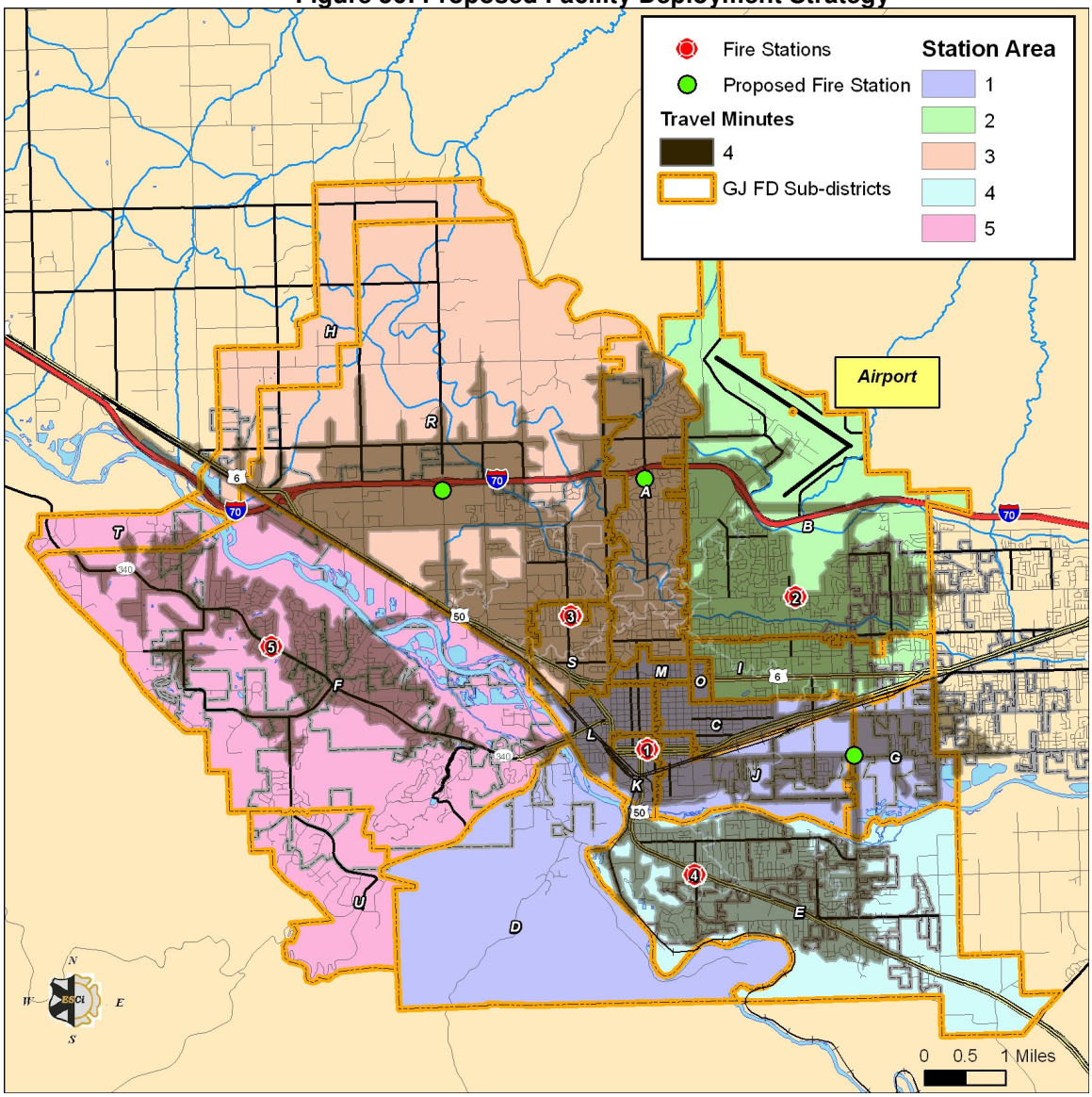
On the southeast part of the fire district, there are underserved areas of service demand east of Station 1 and Station 4. To avoid placing two stations in this area by measuring the central feature separately, it was calculated by the location of shortest distance to all underserved calls within the two station areas. The central feature was located on 29 ½ Rd., but a location at the intersection of 29 Rd. and D Rd. was selected due to its accessibility in all primary directions and along one of the few river crossings into Station 4's area. The following figure illustrates this location (Station 'G') and its projected travel time capability.

Figure 55: Station 'G' Location and Travel Capability



With the addition of this station, service demand coverage overall increased to 89.53 percent, which is just short of the service demand goal coverage for the fire department. The overall station distribution and travel time capability is illustrated in the following figure.

Figure 56: Proposed Facility Deployment Strategy



Within the response area, 76.46 percent of the road miles is traversable within four minutes for this proposed facility deployment. More important is the service demand coverage because roads may or may not have structures or population nearby in rural areas.

Below is a summary statistical result for each station addition verses the overall service-demand pattern for GJFD. Additionally, recommended apparatus per station, whether acquired or relocated is given.

Figure 57: Projected Performance Summary

Additional Coverage Considerations

ESCi typically does not recommend additional stations to exceed the goal when the shortfall in coverage is merely a fractional consideration. However, a discussion regarding the service demand patterns in response area 'D' and in the overall Station 5 area merits attention.

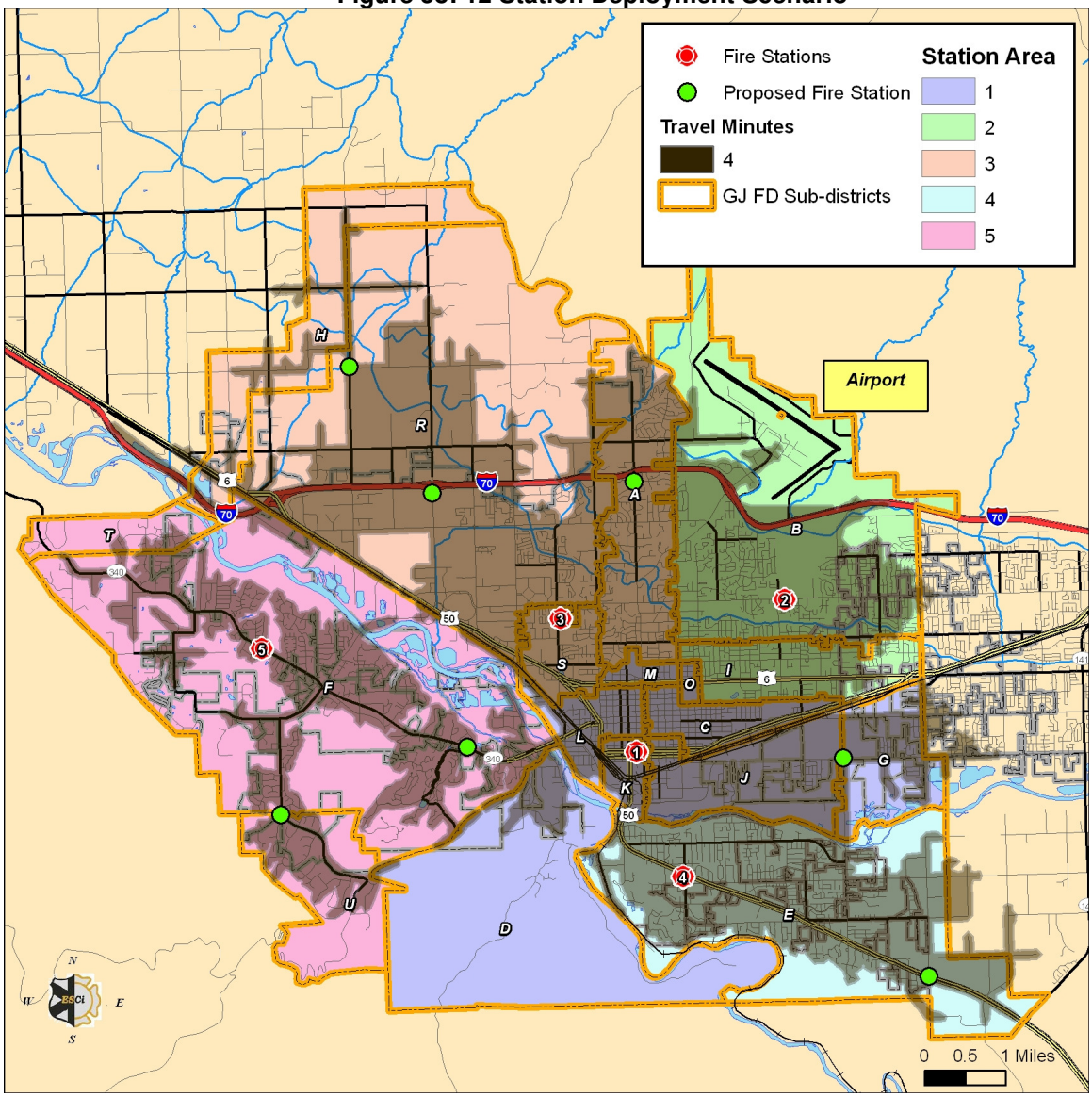
Because Station 1 can reach response area 'D' faster than Station 5, Station 1 responds to calls to this response area even though Station 5 has primary responsibility. However, the response area still cannot be reached within four minutes. Station 5's underserved area is primarily located in two areas on the southeast side of response area 'F' and within response area 'U'. These areas are essentially separated by limited street connectivity due to terrain whereby no single station could cover both areas. The northern neighborhood, just south of Broadway, has more service demand than the southern neighborhood off of S. Camp Rd., when combined with the neighboring response area 'D' service demand. Relocation of Station 5 to its central feature at the intersection of Broadway and Redlands Pkwy. yielded little benefit since service demand coverage in the northwest part of response area 'F' and 'T' was lost to the gains further southeast. This station was also the most recently constructed in 2004.

A station at Broadway and Ridges Blvd. provides coverage to the northern neighborhood in response area 'F' and most of the service demand that occurs in the northern portion of response area 'D'. A fractional gain of less than one percent is noted with redundancy area coverage with Station 5 and Station 1. A Station on S. Camp Rd. and Buffalo Rd. adds additional coverage to an area that is remote from either existing or proposed Broadway stations.

Similar fractional gains from possible stations in Station 4's area (30 Rd. & Hwy 50), and northwestern response area 'R' (23 Rd. & I Rd.) do make these stations viable economically based upon efficiency of demand coverage. The overall service demand coverage increases-

about 4 percent for these four additional stations. With these additional stations, 88.6 percent of road miles are traversable within four minutes. The following figure illustrates these additional locations and their projected travel time capability.

Figure 58: 12 Station Deployment Scenario



This study was based on current conditions and demands on the fire department. Further growth may alter this strategy significantly and make these stations viable for construction. It is advised that forward planning for facilities, apparatus, and staffing be conducted to ensure effective and efficient fire rescue services to the community before development growth surpasses GJFD capability.

Pro: Uniform coverage based on *NFPA 1710* guidelines provides maximum protection against loss of life and property due to fire related incidents.

Con: The need to construct and finance a minimum of three stations, associated apparatus, and staff.

Strategy B: Status quo stations with altered response time objectives for fire calls

One solution, without building additional facilities, would be to raise the response time objective from five minutes, 90th percentile to eight minutes, 90th percentile. A coverage analysis indicates that at this level, over 90 percent of the fire service demand can be reached within seven minute of travel. Alternatively, the response time goal could be increased slightly to seven minutes, but the percentile strength could be reduced to 80th percentile to adequately provide service demand coverage.

Pro: Allows for response time compliance without additional cost of facility construction and operation.

Con: Increased response time can lead to increased property loss and may not be in line with public expectations.

Strategy C: Status quo stations with altered operational protocol for medical calls

To increase the reliability of fire apparatus answering primary district calls and reducing fire response time performance, only assign fire apparatus to medical calls if:

- Any ambulance is unavailable within the station area
- Two EMS calls are occurring concurrently in the station area
- Only to medical calls where additional manpower or other fire apparatus related services are likely to be needed (i.e. spills, CO alarm)

Pro: Fire apparatus availability should increase, thereby reducing response times in higher demand areas.

Con: Ambulances are less likely to be cancelled en route to a call, and resume availability when a fire crew has not assessed the incident.

Strategy D: Develop a measure of criticality to fire dispatch procedures

Similar to how medical calls are prioritized, responded to, and measured; the department can have alternate response protocols for fire calls based on caller information. This can be more difficult in many cases than medical calls since the potential extent of the emergency cannot be adequately assessed without a fire crew on the scene. Alternatively, the department can assign differing response time standards based on either City or non-city areas, or by population densities.