

Evaluating Metrics Used in Determining Fire Station Locations

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: 

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Date: August 2, 2015

Abstract

City and fire department leaders are tasked with providing citizens adequate protection through the deployment of scarce resources. Determining when and where to deploy additional resources can be an arduous task. The problem was that the Ankeny Fire Department had not determined if traditional metrics were still effective in determining fire station locations.

The purpose of this Applied Research Project was to evaluate the effectiveness of using traditional metrics in locating fire stations. The research method employed was evaluative and the methodology answered the following research questions: a) How do projected growth trends for the city impact fire department service demands? b) How do traditional metrics fare when determining station locations? and c) What metrics do similar sized communities or organizations use when assessing the need for additional services?

The procedures conducted for this Applied Research Project (ARP) included the following: personal communications with City of Ankeny staff and other organizational leaders, interview with the City of Ankeny Fire Chief, gathering data from City of Ankeny reports, developing statistics from National Fire Incident Reporting System (NFIRS) reports, and the review of local goals and national standards.

The results of this research first indicated that identifying current and future areas of growth in the community was effective. In addition, fractile response time analysis was more effective than using an average response time when evaluating traditional metrics. Lastly, apparatus travel distances and actual drive time are more valid than using Insurance Services Office (ISO) radiuses for engine and ladder companies. The analysis of the results will allow the Ankeny Fire Department to effectively prepare for future fire stations.

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Evaluating metrics used in determining fire station locations

The City of Ankeny (Iowa) is one of the fastest growing communities in the state; in fact, since the year 2000, the City of Ankeny has had a 53.33% increase in population (Sperling, 2015). As a suburb to the largest and capital city, Des Moines, Ankeny is home to many residents that work in Des Moines, or are employed by one of the many major commercial occupants in Ankeny such as Tones®, Mrs. Clark's Food, Toro®, and John Deere® manufacturing.

The exponential growth in both residential, commercial, and industrial development has brought an increase in population and is expanding the fire and emergency medical service (EMS) response districts. The problem is the Ankeny Fire Department has not determined if traditional metrics are still effective in determining fire station locations. The consequences of increased incident call volume, expanding response times, and extended apparatus travel distances affect public safety. These factors affect public safety because increased incident call volume means crews may be assigned to incidents that have led them out of their district, thus expands their response time, and extends their travel distance. Time is an important factor in any emergency which can lead to delayed patient care, and create unsafe structural firefighting conditions such as flashover or collapse.

According to the American Society of Planning Officials (ASPO), strategic location of fire stations and a smooth operating pattern of response to alarms make the difference between life and death, salvage and destruction (American Society of Planning Officials [ASPO], 1957, p. 1). Life and death as a result of increased response times can not only be in a structure fire incidents, but also in an EMS call. Time is important in terms of fire growth because as each minute goes by, flashover conditions persist thus endangering lives and damaging property.

Time is also critical in EMS because time is muscle and as the American Heart Association states, “Early advanced care is essential in the five-part chain of survival” (American Heart Association, 2015).

The purpose of this Applied Research Project is to evaluate the effectiveness of using traditional metrics in locating fire stations. The evaluative method of research will be used for this Applied Research Project (ARP). The following research questions will focus the research efforts: a) How do projected growth trends for the city impact fire department service demands? b) How do traditional metrics fair when determining station locations? and c) What metrics do similar sized communities or organizations use when assessing the need for an additional services? Through the examination of these questions; results from this research assist the Ankeny Fire Department in the evaluation of traditional metrics used in determining fire station locations.

Background and Significance

In 2014, the City of Ankeny was labeled one of the best cities for homeownership and was a top 10 location for best places to live in the state of Iowa (www.ankenyiowa.gov). Ankeny has led cities in the Des Moines metro area for growth and in 2014 the *Des Moines Register* stated, “Ankeny’s certified population count from the 2010 census was 45,582, but newly released estimates show the city has grown to approximately 51,567” (Erzen, 2014). A special census, currently being conducted, estimates that, “Ankeny has added more residents than any other Iowa community since 2011, with 2,468 people being added from 2012 to 2013” (Erzen, 2014). This exponential growth has also been revealed in the educational system as Ankeny residents send more than 9,300 students to school each day in 13 buildings. The city

was the third fastest-growing school district in the state (2012-2013) and is the eighth largest district (City of Ankeny).

City of Ankeny leaders expect the current special census to show a population of over 50,000 people and according to Community Development Director John Peterson, “Hitting that 50,000 mark is a big milestone for a city...because it puts it on the map for big retailers and other companies” (Chandler, March 2015). In the last 15 years Ankeny has increased its population by 90% and currently has 3,074 people per square mile (City-data, 2015). The city has expanded its city limits on the northern sections of the city and both commercial and residential construction has boomed in these areas.

In 2003, the fire department created response zones for the entire city and mutual aid areas which included 110 zones or 110 square miles of coverage. These zones were used to develop methods for the fire department to gather statistical data on incident call volume, response times, and look at city growth as a whole through the use of geographic information system (GIS) data. This data has also allowed the fire department to identify high hazard occupancy locations, population densities and determine projected trends for those locations.

Serving the approximate 51,567 people in the community are the men and women of the Ankeny Fire Department. The department force is a combination of 21 full-time firefighters, 46 part-time firefighters, and seven administrative personnel. For 24 hours a day the department operates out of two fire stations. Each fire station consists of one advanced life support (ALS) engine company and one ALS ambulance. The department added the second fire station in 2008 to meet the needs of the growing community; however, since 2008, the city has continued to grow as demonstrated in the 2010 and 2015 special census. This growth is once again challenging the Ankeny Fire Department (AFD) to maintain a high level of care. An increase in

incident call volume has provided areas of the city where apparatus response times and travel distances do not meet local goals nor national standards.

In 2013, the department responded to 3,156 calls for service of which 78% of the calls were demands for EMS. In 2014, incident call volume increased 14.98% for a total of 3,629 incidents (Ankeny Fire Department, 2015). In 2015, call volume is expected to reach 4,020, as shown in Table 1.

Table 1

Incident Call Volume and % Increase (2010-2015)

Year	Incidents	% Increase
2010	2,908	N/A
2011	3,022	3.92%
2012	3,304	9.33%
2013	3,156	-4.47%
2014	3,629	14.98%
2015	4,020 ^a	10.8% ^b

Note: ^a Projected Incident Call Volume, ^b Projected Percent Increase

This ARP is significant to the Ankeny Fire Department because the members take pride and ownership for the service they provide. In order to achieve these goals, the Ankeny Fire Department must evaluate current methods to identify successes, as well as failures, and make improvements. Some methods were presented during the author's attendance of the National Fire Academy course: Executive Development (ED). Specifically, this ARP addresses content

learned in chapter five of the student manual. Chapter five states, “Every change effort should start with the identification of a problem or condition requiring modification” (United States Fire Administration [USFA], 2013, p. SM 5-3). Furthermore, this ARP will support the United States Fire Administration’s goal number three, which is, “Enhance the fire and emergency services’ capability for response to and recovery from all hazards, and, enhance data-driven decision-making through information sharing among federal, state, local, tribal, and territorial partners” (United States Fire Administration [USFA], 2014-2018, p. 12). By using these methods and goals, the Ankeny Fire Department can make decisions, based on data that improve services for the community.

Literature Review

The literature review for this ARP allowed the author to gather information about the effectiveness of using traditional metrics in locating fire stations. Researching these metrics will help to understand the overall station location process and how it will benefit the City of Ankeny. The following literature review used books, magazines, and the Internet to accomplish this task and support the research.

A method of locating fire stations in a community is to assess community risk and areas of growth. Identifying key data will allow the fire department to properly allocate assets around the community and meet national standards such as apparatus response times and travel distances. The original examination of community growth and fire protection can be credited to Benjamin Franklin who started the first volunteer fire department in 1736. An advocate for the fire service, Franklin, “Sought to raise public awareness about the city’s dire need to improve fire-fighting techniques” (The Electric Ben Franklin, 2014). In a different message, Franklin

said, “Without continual growth and progress, such words as improvement, achievement, and success have no meaning” (Melendrez, 2009).

Another look at community growth is done by comparing certain factors.

In 2002, Smart Growth America released *Measuring Sprawl and Its Impact*, a landmark study that has been widely used by researchers to examine the costs and benefits of sprawling development. In peer-reviewed research, sprawl has been linked to physical inactivity, obesity, traffic fatalities, poor air quality, residential energy use, emergency response times, teenage drinking, lack of social capital and private-vehicle commute distances and times (Ewing and Hamidi, April 2014).

Researchers Reid Ewing and Shima Hamidi then updated the original publication and developed a new study titled *Measuring Sprawl 2014*. This study analyzed several metropolitan areas and counties within the United States by using four primary factors. These factors included: residential and employment densities, neighborhood mixes of home, jobs and services, strength of activity centers and downtowns, and accessibility of street networks (Ewing and Hamidi, 2014). The first factor, residential and employment densities is also considered development density. Development density is important for a city to consider at when determining the need for more services. Included in development densities are six major factors as described by Ewing and Hamidi (2014). These six major factors include:

- Total density of the urban and suburban census tract
- Percent of the population living in low-density suburban areas
- Percent of the population living in medium to high density areas
- Urban density within total built-upon land

- Relative concentration of density around the center of the metropolitan statistical areas
- Employment density

The next method of locating fire stations in the community is to understand traditionally accepted metrics for fire and EMS responses. These traditional metrics include apparatus response times and apparatus travel distances. For the purpose of this ARP, research will only include a staffed fire department.

The National Fire Protection Association (NFPA) adopted a standard in 2001 that defines levels of service, deployment capabilities, and staffing levels for substantially career fire departments. The standard, NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, was revised in 2004 and then again in 2010 to include terminology for time frames of an incident involving fire department response. Total Response Time, as described in section 3.3.53.6, is “The time interval from the receipt of the alarm at the primary public safety answering point (PSAP) to when the first emergency response unit is initiating action or intervening to control the incident” (NFPA 2010). There are several time factors that make up the total response time. These time factors include: alarm answering time, alarm handling time, alarm processing time, alarm transfer time, initiating action/intervention time, travel time, and turnout time.

NFPA defines turnout time as, “The time interval that begins when the emergency response facility (ERFs) and emergency response units (ERUs) notification process begins by either an audible alarm or visual annunciation or both and ends at the beginning point of travel

time” (NFPA 2010). Section 4.1.2.1 states that fire responses shall have a turnout time of 80 seconds and EMS responses shall be 60 seconds.

In 2005 the *Boston Globe* published a two-part article about response times and that slower arrival at fires are costing lives.

Once a day on average in this country, someone dies when firefighters arrived too late, an investigation of response times by the *Globe* has found. America’s fire departments are giving fires a longer head start, arriving later each year, especially in the suburbs around Boston, Atlanta, and other cities, where growth is brisk but fire staffing has been cut (Dedman, 2005).

The *Boston Globe* article further articulates that every minute counts, and the key is getting enough people (firefighters) on-scene and water on the fire. In fact NFPA states that there are specific fire suppression capabilities needed to conduct operations. These capabilities stated in NFPA 1710 provide sufficient staffing, deployment of resources, and on-scene assignments in order to provide provisions of safe and effective firefighting conditions. One of these conditions that firefighters face is flashover. Flashover as defined by Vincent Dunn is when a room bursts into flames because the furnishings and combustible gases auto-ignite. This event causes major changes in a fire, ceases most firefighting operations such as search, and may cause death for anyone trapped in the room (Dunn, 2000).

Section 4.1.2.1 of NFPA 1710 states that fire departments shall establish objectives for response times to fire and emergency medical service incidents. These objectives include:

- “The first arriving engine company should arrive at the scene of a fire suppression incident within 4 minutes or 240 seconds and the initial full alarm assignment shall arrive within 8 minutes or 480 seconds” (NFPA 2010).

- “Within 4 minutes, a first responder with automatic external defibrillator (AED) or higher level of care should arrive at an emergency medical incident” (NFPA 2010).
- “An advanced life support (ALS) unit shall arrive at an emergency medical incident within 8 minutes” (NFPA, 2010).

In 2014, Steven Kerber wrote an article for Underwriters Laboratory (UL) titled *Analysis of Changing Residential Fire Dynamics and Its Implications on Firefighter Operational Timeframes*. Kerber, who is the director of the UL Firefighter Safety Research Institute, discusses differences between a modern home versus a legacy home and the relation to ignition to flashover conditions. In the article, Kerber elaborates on six experiments utilizing a candle, a blanket and a sofa in a completely furnished room. Three experiments were completed in a modern furnished room, meaning engineered wood, polyester microfibers, and polyurethane foam cushions. Three other experiments were completed in a legacy furnished room, meaning solid wood furniture, cotton filled sofa cushions, and cotton lined throws. Each fire began with a candle fire extending to a blanket or throw, which then extended into the sofa, and eventually encompassing the remainder of the room furnishings. Kerber states that in Experiment one, “The modern room transitioned to flashover in 3 minutes and 40 s...indicated by ignition of the flooring just inside the opening of the room as a result of the heat flux from the flames coming out of the top of the opening” (Kerber, 2014). Kerber further explains that all three modern room experiments resulted in flashover over conditions under four minutes, while the legacy rooms had flashover times of 29 minutes and 30 seconds, 34 minutes and 15 seconds, and Experiment six did not reach flashover stage at all. The above research that Kerber conducted impacted the research the author completed as part of this ARP. The flashover times in all six

experiments stressed the importance of measuring apparatus travel distances and actual drive time using GIS mapping.

The delivery of responders at the scene of an EMS incident is just as important. In fact the American Heart Association states that, “In 2011, approximately 326,200 people experienced emergency medical services – assessed out-of-hospital cardiac arrests in the United States...Of the 19,300 bystander-witnessed out-of-hospital cardiac arrests 2011, 31.4% of victims survived” (American Heart Association, April 2015, P. e5). Sudden Cardiac Arrest (SCA), is a medical condition that causes a sudden pulseless condition resulting in an abnormal heart rhythm that stops blood flow to the heart, brain, and the body. This unexpected immediate condition contributes to nine out of 10 victims dying each year. According to the Sudden Cardiac Arrest Foundation, “SCA victims can survive if they receive immediate Cardio-Pulmonary Arrest (CPR) and are treated quickly with defibrillators...within 3 to 5 minutes after collapse” (2015).

The Insurance Services Organization (ISO) is an advisory organization that provides information about property and casualty insurances risks (Insurance Services Organization, 2014). ISO helps in the establishment of insurance premiums and this process involves analyzing data collected in communities across the country. The data collected is used in a Fire Suppression Rating Schedule (FSRS) to assign a Public Protection Classification (PPC). The PPC assigns a number from one to 10 which represents a communities’ ability to protect the public from fire. A Class one PPC number would indicate that a community is superior in providing fire-protection services. A Class 10 PPC number would indicate that a department does not meet national standards and is unprotected. One of the data aspects that the FSRS uses in defining effective fire-protection is apparatus travel distances. Section 560 of the PPC program reads, “The built-upon area of the city should have a first-due engine company within 1

½ miles and a ladder-service company within 2 ½ miles” (Insurance Services Office). Meeting these apparatus travel distances will meet the maximum credits for a Class one and strategically place apparatus in fire stations in optimum locations.

Lastly, a method of determining fire station locations is to examine what other communities have done and found to be efficient. The Commission on Fire Accreditation International (CFAI) publishes a manual entitled “Standards of Coverage.” This manual assists fire and emergency service leaders to prepare for and work towards providing a consistent level of service. The CFAI manual provides guidance and direction on the conduct of fire rescue station, apparatus, staffing, and related risk assessment studies. These assessments provide policy makers with a guide for decision making that impact one to 10 years into the future (Public Safety Solutions Inc., Page 8, 2014). Within this guide for decision making, the use of fractile response times can be examined through the use of this manual.

In addition to the CFAI, there are private consultants who aid in the process or evaluation of an entire city, where the growth is, and how well the fire department is providing a standard of coverage. In December of 2014, Public Safety Solutions Inc. prepared a Fire Station Placement Review and Recommendations for Expansion for the Des Moines Fire Department in Des Moines, Iowa. This 169 page report detailed the background of the City of Des Moines and the fire department. The report detailed several metrics such as ISO apparatus travel distances, NFPA 1710 response time considerations, and community risk criteria. The study team consisting of three consultants and two office staff, were able to provide a complete view of the current situation for the entire city. As stated by the study team, an eight-step approach for the report was used and included the following: data collection; interviews with key personnel; on-site observations and fact finding; analysis of data; comparative analysis; alternatives and

recommendations; comprehensive written report; and oral briefing (Adams, Brown, and McNally, 2014).

This report impacted the author's research by examining complete view of a city's current situation and evaluating the metrics the consultants used to determine their recommendations. The consultants used traditional metrics, but also included on-site observations and fact-finding as part of their process. The process, however, did not look at projected statistical data. The Des Moines Fire Department report as well as CFAI Standards of Coverage, along with ISO and NFPA standards provided the framework to use in the evaluation of traditional metrics. This report also allowed a complete view, from a balcony perspective, just as Ronald Heifetz and Marty Linsky wrote about in a book titled *Leadership On the Line*.

Procedures

The purpose of this Applied Research Project is to evaluate the effectiveness of using traditional metrics in locating fire stations and by using procedures such as personal communication, interviews, researching local goals, and identifying national standards, the overall station location process will be evaluated. The procedures and research assisted in answering three research questions.

The procedures used for question number one: How do projected growth trends for the city impact fire department service demands? included interviews, personal communication, examination of response zones, and data analysis. First, an interview of the Ankeny Fire Department fire chief was conducted. The questions related to current and projected city growth as well as how the fire chief sees future growth of the department. Next, the author identified key staff within the City of Ankeny that were able to provide statistical data from records and

GIS mapping. Personal communication through email and phone were conducted with an associate planner from the planning and building department, who was able to provide information on growth trends like building permit applications for both commercial and residential. Data for the last five years was compiled and compared.

Two major sections of the city were the areas of focus: the northeast section, which includes the response zones north of NE 18th street and east of North Ankeny Boulevard, and the northwest section, which includes the response zones north of NE 18th street and west of North Ankeny Boulevard. These two areas were identified based on the interview with the fire chief and the future placement of additional fire stations.

Research question number two: How do traditional metrics fare when determining station locations? was addressed through interviews and data analysis. The interview of the fire chief that took place in research question number one was continued. The chief was interviewed to determine the standard of coverage he wants to establish for the department and that he is directed to establish by the city council and city manager. The level of service includes anticipated number of fire stations and general locations, response time benchmarks, apparatus travel distances, and ISO ratings. Statistical data was gathered from the department's reporting software and charts to include turnout times, response times, and incident call volume were developed and compared.

Average response times and fractile response times were analyzed, charted and compared to department goals and national standards. In addition, assessments of turnout times were also analyzed for a three month period and a chart was made showing differences between shifts of personnel, apparatus, and day vs. night. Lastly, apparatus travel distances were studied by means

of GIS radius and distant mapping from each current fire station and projected fire station locations.

To answer the third and final question: What metrics do similar sized communities or organizations use when assessing the need for an additional services? was asked through personal communications with a similar sized fire department organizations and non-fire industrial business. The personal communication examined each department's past metrics used for fire station locations and what future metrics each department anticipates. Each department communicated with is comparable in operations as well as community size and are used in the mutual-aid system. Lastly, the author examined local organizations outside of the fire service that offer services and continue to develop their organization within the City of Ankeny as well as the Midwest. The organization is a well-known convenience store and the personal communication conducted with a director answered questions related to how they determine their levels of service and what the metrics are that they use for determining the location of additional stores/services.

There were several limitations associated with the research. First, although traditional metrics such as apparatus response times and travel distances are important, outside factors have just as much influence in the process. For example, city and community politics often determine where and how services are provided. Similarly, city owned land often plays a big role in where services are located because it ultimately decreases the overall price of the project. This limitation is un-measurable and was not able to be researched. The next limitation was that response times indicated only first arriving vehicles and does not include a structural engine company for a fire nor an advanced life support ambulance for an emergency medical service call. Furthermore, the response time does not indicate a full alarm assignment response time or

arrival time. In addition, when looking at research question number three, comparing similar sized communities or organizations is difficult as they are all unique and cannot be accurately compared to the Ankeny Fire Department.

Results

The ARP used an evaluative method of research and the results were derived through personal communication, interviews, publications, and the internet. The results from the research questions are summarized in the following paragraphs of this ARP.

Results for research question number one: How do projected growth trends for the city impact fire department service demands? were obtained through interviews and personal communication. The interview of Fire Chief James Clack indicated, in his opinion, the importance of locating additional fire stations is to provide the best coverage for the citizens with consideration given and protecting the needs of the future. Clack also stated that future planning of two to three and even four additional fire stations aids in providing the best overall coverage for the entire response district. Clack also stated that the city continues to grow to the north and that much of the growth is west of Interstate 35. Clack explained, using a map that by strategically placing the third fire station ultimately places the fourth fire station in a specific location. Clack's interpretation of the city growth affects the growth of the fire department to maintain a standard of coverage. Clack stated that the department and city leaders need to monitor the city growth and be proactive on locating services to meet demands (J. Clack, personal communication, June 23, 2015). Chief Clack's interview led to personal communication with the planning and building department and the questions used in the interview can be found in Appendix A.

The City of Ankeny has grown and continues to grow on the western side of Interstate 35 and is slowing growing north towards the City of Alleman (Iowa). Ankeny has two major thoroughfares that split the city into east/west and north/south and for the purpose of this ARP, area one will be considered the northeast section of the city from NE 18th north and Ankeny Boulevard east. Area two will be considered from NW 18th north and Ankeny Boulevard west.

The City of Ankeny Planning and Building Department was contacted and personal communication with Debra Gervais, Associate Planner, was conducted. Gervais reported through reports, that the northern section of the city has the most growth in commercial and residential permit applications. From 2010-2014, area one had shown a yearly average of 167 residential permits and an average of 44 commercial permits when combined with multi-family dwellings. Area two experienced growth with a yearly average of 80 residential permits and an average of 100 commercial permits. Looking closer at the data and results, area two had the highest increase in occupancy types that include multifamily dwellings such as apartments, condos, and townhomes (D. Gervias, personal communication, June 22, 2015). The data provided in the reports are summarized in Appendix B and led to additional research on city growth a population increases.

Since 2000 the City of Ankeny has grown exponentially. In fact, the population in 2000 was 27,584 and the estimated 2014 population was 53,801, which represents a 95% increase in overall population for the city (United States Census Bureau). The results of the special census that took place in early 2015 shows that Ankeny's current population estimate is 54,000. Table 2 shows the population for the City of Ankeny over the past 5 years. The increase in population is represented by the surge in building permits and areas of growth within the city.

Table 2

Population and % increase (2000-2014)

Year	Population	% Increase
2000	27,584	N/A
2005	36,039	30.7
2010	45,898	27.4
2011	47,177	2.8
2012	49,099	4.1
2013	51,567	5.1
2014	53,801	4.3

Note: The statistical information was obtained from United States Census Bureau

Results for research question number two: How do traditional metrics fare when determining station locations? were generated through the previous interview with Fire Chief James Clack who also provided answers relating to metrics and data analysis. Chief Clack's opinion was that there are many other types of metrics used in locating fire stations and in addition to these metrics are political influences such as city owned property and considerations from city leadership. Clack stated it is his responsibility to explain, to provide data, and to stress the importance of local goals and national standards to city leadership. The local goals include having a first arriving apparatus on scene within eight minutes, 80% of the time, but Clack states that he would like that changed to 90% of the time to raise the standard of coverage. Chief Clack also explain that the department's ISO rating is currently a four and that he would like the department to meet the requirement of a three which was missed by a few points (J. Clack, personal communication, June 23, 2015).

The Ankeny Fire Department concentrates specifically on turnout time and travel time to evaluate effective response to incidents in the community. Although total response time includes alarm answering, handling, processing, transferring, and intervention, the Ankeny Fire Department only has the ability to monitor these times and recommend changes through a dispatch liaison at the Polk County Sheriff's Office. An evaluation of turnout times is completed by the Ankeny Fire Department each month through an audit process and a standard turnout time of 80 seconds, 90% of the time shall be met. This audit for a three month period from March – May 2015 can be viewed in Appendix C.

Traditionally calls for emergency service are measured by the person who is calling. When someone has an emergency, whether EMS or fire, it is the worst day of their life. The amount of time it takes from taking the call at the dispatch center to the arrival of the emergency vehicle is measured by how quickly the emergency responders get there and where they came from. These measurements are apparatus response times and apparatus travel distances. Total Response Time, as described in section 3.3.53.6 of NFPA 1710, is “The time interval from the receipt of the alarm at the primary public safety answering point (PSAP) to when the first emergency response unit is initiating action or intervening to control the incident” (NFPA 2010).

Research of apparatus response times for the City of Ankeny was completed using FIREHOUSE software, which is the department's NIFRS reporting software. The author was able to identify average response times to area one and area two for the past five years and determine percent of increase each year following 2010. The researched illustrated that the average response time was near the eight minute maximum response time set forth by the department and NFPA 1710.

Fractile measuring of response times allowed the author to understand how many times the department met the requirements of the first arriving apparatus. Averaging does not fully explain how many incidents that the fire department failed to meet the requirement of less than eight minutes, 80% of the time. In fact through research it was found that although the average response times meet the requirements in 2014, the fractile measurements showed there were several times where the department did not meet the requirement. The data showing average and fractile response times can be found in Appendix D.

In addition to average response times and fractile response times, Section 4.1.2.1 of NFPA 1710 (2010) states that fire departments shall establish objectives for response times to fire and emergency medical service incidents. These objectives include the first arriving engine company should arrive at the scene of a fire suppression incident within four minutes and within four minutes a first responder with automatic external defibrillator (AED) or higher level of care should arrive at an emergency medical incident. The four minute response time is determined using roadways in a response district and the posted speed limit. Through GIS mapping Appendix E was created illustrating a four minute travel distance from Ankeny Fire Station-One, 120 NW Ash Drive. Similarly, Appendix F illustrates a four minute travel distance from Ankeny Fire Station-Two, 665 SE Oralabor. Lastly, Appendices G and H represent four minute travel distances from two potential locations for Ankeny Fire Station-Three. In comparison, the four minute travel distance mapping was more efficient than the use of ISO coverage's for Engine and Ladder companies. As seen on Appendix I, the ISO radiuses provide a coverage of one and a half mile and two and a half mile coverage as the crow flies. But upon comparing the four minute GIS mapping to the ISO radius mapping, there are several parts of the city that are not covered in four minutes when examining actual drive times.

Results for research question number three: What metrics do similar sized communities or organizations use when assessing the need for additional services? were derived from personal communication. Personal communication began with Urbandale (Iowa) Fire Chief Jerry Holt. Chief Holt leads a combination force of 50 personnel operating out of two fire stations. The Urbandale Fire Department is another suburb to the City of Des Moines and in 2013 provided coverage to an estimated 41,776 people. In 1997 the department expanded its fire and EMS coverage by adding a second fire station in the western part of the city. This station staffs five personnel 24 hours a day and operates a quint and an ambulance. Chief Holt discussed that the city has continued to grow to the west and that the standard of coverage in that area indicates the need for an additional fire station. He stated that several metrics will be used in the determination of this location to include response times and travel distances. Chief Holt further explained that the metrics used for their second station were limited to where the city owned land and the fact that the westward growth divided the city along the Interstate 35/80 corridor (J. Holt, personal communication, July 2, 2015). In a May 2015 article in the *Des Moines Register*, Urbandale Fire Department's Public Information Officer stated, "While the average for fire response is four to five minutes...circumstances can drag on the response time, such when a call comes in from the east while crews are in the west" (Ta, May 2015.) The metrics used in Urbandale were then compared to the City of Johnston (Iowa).

The Johnston Fire Department is an adjacent department that often works with the Ankeny Fire Department under mutual-aid agreements and is comparable in size. The Johnston Fire Department operates out of one fire station and has 35 members in a combination department. In 2013, the Johnston Fire Department added an additional fire station on the western edge of the city, which is shared between the Johnston Fire Department and the Grimes

Fire Department. Deputy Chief Mike Gentosi stated, “The location of this station was chosen in a location approximately half way between the two cities” (M. Gentosi, personal Communication, June 27, 2015). Chief Gentosi further explained that not only did the Johnston Fire Department look at metrics such as response times and growth, but also ISO travel distances. Gentosi stated that the city averaged the ISO travel distances for engine and ladder companies and created a map indicating a radius of two miles from each fire station. The location of the new fire station was placed in an area where the two radiuses met in the middle, indicating a half-way point. Lastly, Gentosi stated that the city has also experimented with FireCARES, which would allow the Johnston Fire Department to assess their community through the use of data collection on GIS mapping.

To enhance the view of determining the effectiveness of metrics, the author researched a large local company that provides services all over Iowa and many surrounding states. Casey’s General Store is a convenience store that offers gasoline and diesel services, as well as common grocery products and was founded in 1959 by Don Lamberti. In July of 1968 the first Casey’s General Store was opened in Boone, Iowa and included a converted three-bay garage as the first convenience store. At the time, the population of Boone was around 12,468 (Casey’s General Store). Casey’s had continued to meet the service demands of the population and have increased their service by adding what is known to the company as “famous homemade pizza”. In 1985, Casey’s General Store introduced the famous homemade pizza and is now the 6th largest pizza chain in the United States. In order to meet the continued demands for its customers, Casey’s General Store often adds additional general stores throughout communities. Similar to the fire service, there are metrics used to achieve efficiency and effectiveness.

In the City of Ankeny, there are nine Casey's General Stores, all of which offer an array of services. The locations of these stores were strategically placed throughout the city to meet the demands of the public and the services they need. Director of Real Estate and Store Development, Kirk Haworth, stated that the metrics used to determine convenience store locations is very similar to locating fire stations. Casey's General Store uses metrics that include: traffic counts; population; number of fast food competitors; locations near schools, major intersections, and hospitals (K. Haworth, personal communication, June 22, 2015).

Although these metrics are unique to Casey's General Store, traffic counts and population can be compared to the amount of people living in a certain area and the percent of those people needing services, or incident call volume. Similarly, the number of competitors is comparing the location of fire stations to include mutual-aid departments. Lastly, the location of services near major intersections or hospitals is identifying occupancies that have higher incident call volume.

Discussion

The City of Ankeny continues to have a high growth rate in population and residential/commercial construction. It is essential for city leaders to stay proactive in fire and EMS data collection of fractile response times and apparatus travel distances, as well as community growth trends so that deficiencies to local goals and national standards can be addressed. Addressing these deficiencies may include adding fire stations, apparatus, and personnel. In addition, identifying areas of growth that include multi-family dwellings such as apartments, townhomes, and condominiums that contain vulnerable populations like elderly and pediatric. The identification of community growth trends are a key component when determining the need for additional services. By using data specific to a community, city leaders

can project current and future needs specific to population, construction permits, and areas of vulnerable residents.

The Commission on Fire Accreditation International (CFAI) publishes a manual entitled “Standards of Coverage.” This manual assists fire and emergency service leaders to prepare for and work towards providing a consistent level of service. The CFAI manual provides guidance and direction on the conduct of fire rescue station, apparatus, staffing, and related risk assessment studies. These assessments provide policy makers with a guide for decision making that impact one to 10 years into the future (Public Safety Solutions Inc., 2014, p. 8). The Ankeny Fire Department uses this manual, as well as other national standards, as a framework for decision making.

In addition to the CFAI Standards of Coverage is NFPA 1710, which also provides a structure to use in many areas to include apparatus response times. Response times are important when providing emergency medical care or extinguishing structure fires. Section 4.1.2.1 of NFPA 1710 (2010) states that fire departments shall establish objectives for response times to fire and emergency medical service incidents. These objectives include that first arriving engine companies should arrive at the scene of a fire suppression incident within four minutes and first responders with automatic external defibrillators (AED) shall also arrive in four minutes.

The results of the research on response times indicated the importance of looking at fractile response times rather than average. According to Routley (n.d.),

A fractile measure refers to how often a particular objective or benchmark is achieved. This is very appropriate in situations where there is a definitive “pass-fail” point, or in the case of emergency response, a time that is considered “fast enough” versus “not fast enough”. A fractile measure can be used to compare the

number of responses that pass (fast enough) with the number of responses that fail (not fast enough).

Average response times do not look at how many times the expectation is met, but rather an average of the highest time and the lowest time. Using an average will not demonstrate an accurate account of meeting a standard in a certain area, rather, fractile response times will show the accuracy and the difference can be reviewed in Appendix D.

When looking at apparatus travel distances, it is important to look at drive time rather than a circumference around a specific location such as ISO criteria. Research shows that the one and a half mile distance for an engine company and the two and a half mile distance for a truck company is a guideline to use, but actual drive time shown in GIS mapping of four minute travels are more accurate. The Ankeny Fire Department was able to identify certain areas of the city that were covered in a four minute drive time map, but not covered in a circumference map of ISO distances.

Lastly, a method of determining fire station locations is to examine what others have done and found to be efficient. This is known as getting a “balcony view” and Ronald Heifetz and Marty Linsky wrote a book titled *Leadership On the Line* in 2002 about this view. In this book, the authors speak of getting on the balcony and seeing a different perspective. According to Heifetz and Linsky (2002),

Seeing the whole picture requires standing back and watching even as you take part in the action being observed. But taking a balcony perspective is tough to do when you’re engaged on the dance floor, being pushed and pulled by the flow of events and also engaged in some of the pushing and pulling yourself (p. 52).

Getting a balcony view and reviewing what metrics other communities and organizations are using is important because being set on one metric or set of metrics can give tunnel vision to what is best for the community. The Ankeny Fire Department was impacted by the research with a non-fire industry organization and the methods they use to determine levels of service. The personal communication with Kirk Haworth of Casey's General Store showed that organizations such as a convenience store also uses metrics to determine their own standard of coverage. The similarities of identifying areas of population growth and locating of services in high occupancy areas is essential to provide a quality service and this balcony view will change the way the Ankeny Fire Department will examine challenges in the future.

Recommendations

It is clear that traditional metrics yield mixed results in examining their relevance and effectiveness in determining fire station locations. Communities and fire departments are ever changing and most traditional ways of showing effective coverage are not effective today. City leaders need to be in consistent communication with fire service personnel on future growth trends and fire departments must be aware of incident call volume increasing in areas of growth and be able to adjust services to meet the needs of the growing community. In addition, blending traditional methods with modern methods will provide real-time results, thus creating data-driven decision making on growth trends and services efficient.

Utilizing response times to analyze effectiveness is appropriate when used correctly. NFPA standards provide a framework to use and objectives to meet, but the measurement of that data is essential. Fire service leaders must understand fractile response times, how the data is compiled and how it is figured, rather than average response times. Average response times are

not an effective use of data and it is important when looking at response times that the parameters such as emergent or non-emergent responses are identified and used appropriately. It is also important to make sure that the data being entered is correct and is monitored through an audit process, because inaccuracies in data reporting will produce unreliable results.

When mapping apparatus travel distances, ISO provides a basis for engine and ladder companies by using a radius around a specific location and that radius is set for one and a half miles for engine companies and two and a half miles for ladder companies. This radius, however, does not take into consideration using road driving on actual streets rather than as the crow flies. Using GIS mapping of actual driving distances with roads is a more accurate way of determining resource allocation. The coverage difference between ISO radiuses and GIS mapping can be significant and thus representing false data.

When comparing similar sized fire departments or organizations, it is important to remember that the comparison will be similar but not exact. Therefore these metrics used in other organizations may be slightly different, but may still be effective. It is important, however, to still have personal communications with these organizations to ensure efficiency in using certain metrics. This concept of obtaining a view from the balcony is important so that a department does not get tunnel vision in determining their own metrics. NFPA, ISO, CFAI and other fire departments are great resources to ensure that a community is protected effectively and efficiently. The use of these resources along with data collection and analysis can help a fire department be the best that they can be for the citizens of their community and the surrounding jurisdictions.

In order to properly locate fire stations within a community and provide a quality standard of coverage, it is the author's recommendation to be detailed when looking at data. To

ensure accuracy in data collection and proper presentation of that data, fire departments must be able to collect the data needed through the use of city leaders and department records. City leaders have current and accurate data when looking explicitly at community growth such as population densities and construction permit issuance. It is also important to be specific about the data needed to be collected; for example, when referring to response times, the response times should be narrowed to emergent responses or non-emergent responses rather than all response types. That response time data shall then be looked at in a fractile measurement rather than an average, as fractile statistics are a more accurate account of the data that shows results needed for justification of a service. It is also the author's recommendation to use GIS mapping for apparatus drive time and travel distances. GIS mapping is an accurate measurement of data rather than an estimate such as ISO radius mapping of engine and ladder company coverage. One of the most important recommendations is to have a balcony view of the entire project. Stepping back and viewing how others collect data or present the data, can provide an advantage in the process to ensure accuracy. It is imperative to be open to the metrics other organizations use to complete their processes and data collection.

Lastly, it is the author's recommendation to further the research on evaluating metrics used in locating additional fire stations, specifically in the use of computer modeling such as FireCARES. FireCARES, which can be accessed through the International Association of Fire Fighters, is a community assessment tool that allows the collection of data and an evaluation of responses using GIS mapping. Using this type of technology, can accurately illustrate current data, such as plotting incident call volumes for certain areas of a community. Through the use of most traditional metrics and computer modeling, a fire department can effectively locate additional fire stations within their communities.

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Appendix A: Interview Fire Chief James Clack

The following questions were used in the interview with Ankeny Fire Department Fire Chief James Clack.

- 1.) Where has been the City of Ankeny's growth in the last five years and where do you expect the growth to take place in the next five to 10 years?
- 2.) What impact does this growth have on the Ankeny Fire Department?
- 3.) Knowing that future growth trends include expanding districts to the northern sections of the city, what are your expectations for future standards of coverage to include anticipated number of fire stations and their general locations?
- 4.) How do these locations fare in apparatus response times and travel distances?
- 5.) What metrics has the Ankeny Fire Department used in locating current fire stations and what metrics do you see the Ankeny Fire Department using in locating future fire stations?
- 6.) What other metrics are used in considering a location for a fire station, for example, political or city owned property?
- 7.) What is your role in the decision making process with city leaders?

Appendix B: City of Ankeny Residential and Commercial Permits Issued

Year	Area 1	Area 2
Multi-Family Permits		
Jan-July 1, 2015	0	209
2014	0	140
2013	67	68
2012	129	192
2011	12	93
2010	7	0
Single-Family Attached Permits		
Jan-July 1, 2015	38	4
2014	19	6
2013	3	0
2012	0	0
2011	0	0
2010	0	0
Single-Family Detached Permits		
Jan-July 1, 2015	37	51
2014	216	163
2013	174	116
2012	157	61
2011	113	27
2010	147	28
Commercial Permits		
Jan-July 1, 2015	0	0
2014	2	1
2013	0	4
2012	4	1
2011	0	2
2010	0	0

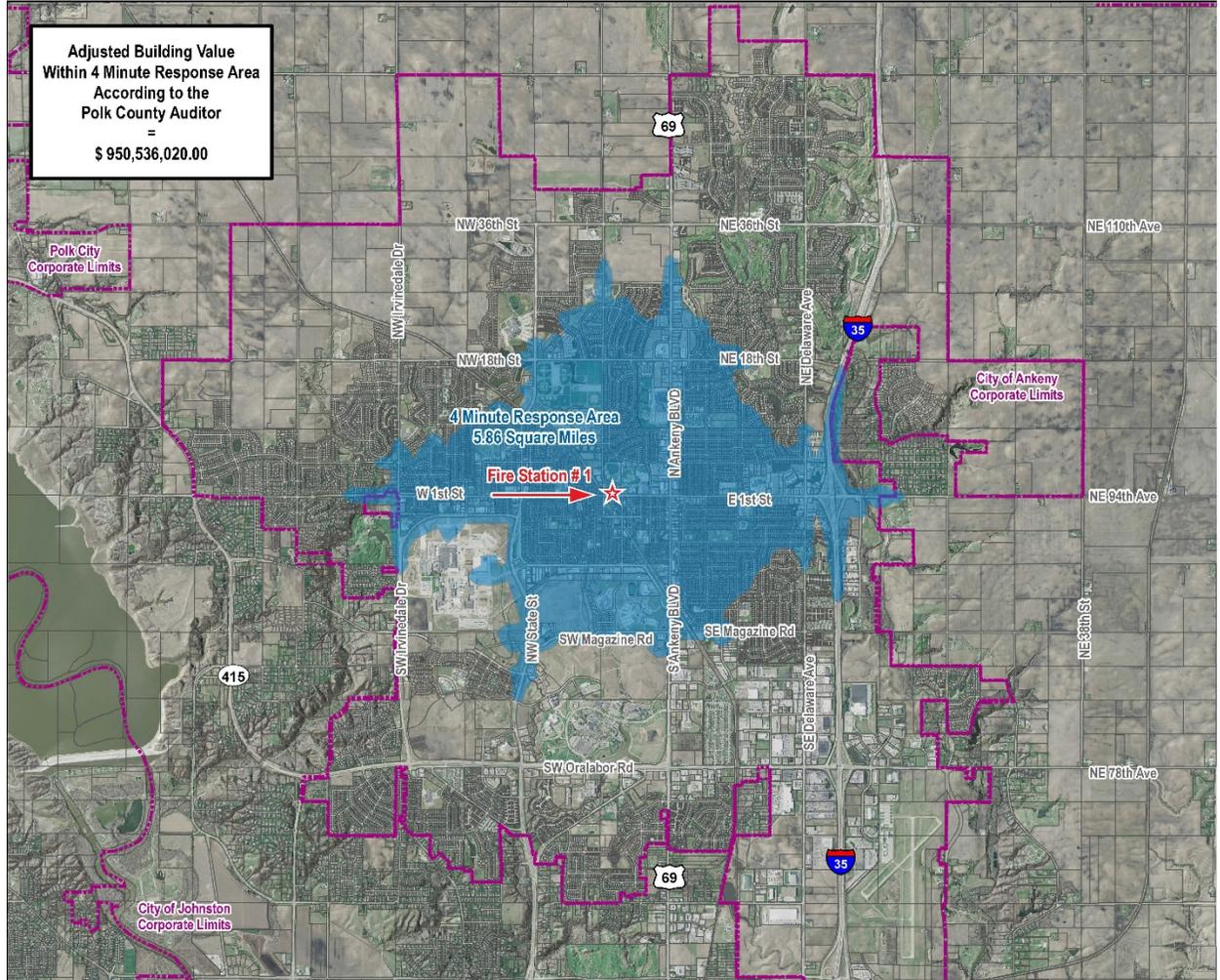
Appendix C: Ankeny Fire Department Turnout Time Matrix

1181 & 1281 Ambulances 1131 & 1231 Engines	Total Runs	Day Runs	Night Runs	Turnout	Turnout	Turnout	Turnout	Turnout
				Average All (min)	Average Day (min)	Average Night (min)	< 1.5 min Day	< 2.0 min Night
May, 2015								
1181, A Shift	50	34	16	1.28	1.05	2.01	88%	44%
1181, B Shift	59	46	13	1.18	1.06	1.98	91%	46%
1181, C Shift	52	40	12	1.57	1.29	2.75	83%	17%
1131, A Shift	60	40	20	1.58	1.21	2.39	68%	25%
1131, B Shift	69	54	15	1.31	1.28	2.01	70%	33%
1131, C Shift	58	43	15	1.57	1.46	2.30	53%	33%
1281, A Shift	35	29	6	1.18	1.19	1.87	69%	50%
1281, B Shift	45	34	11	1.05	1.14	1.37	76%	82%
1281, C Shift	45	37	8	1.19	1.13	1.77	81%	75%
1231, A Shift	36	30	6	1.47	1.31	2.55	57%	17%
1231, B Shift	48	35	13	1.29	1.38	1.85	57%	62%
1231, C Shift	46	39	7	1.27	1.19	2.25	82%	71%
April, 2015								
1181, A Shift	48	39	9	1.03	0.88	1.80	90%	44%
1181, B Shift	51	37	14	1.18	0.90	2.00	97%	50%
1181, C Shift	64	51	13	1.35	1.11	2.60	90%	31%
1131, A Shift	50	41	9	1.48	1.32	2.21	71%	33%
1131, B Shift	57	43	14	1.23	0.96	2.40	88%	21%
1131, C Shift	72	57	15	1.49	1.51	1.97	58%	53%
1281, A Shift	42	34	8	1.11	0.93	1.88	85%	63%
1281, B Shift	38	34	4	0.83	0.69	2.23	94%	75%
1281, C Shift	37	29	8	1.04	1.00	1.33	90%	100%
1231, A Shift	49	42	7	1.15	1.11	1.78	88%	57%
1231, B Shift	38	32	6	1.11	1.11	1.51	75%	83%
1231, C Shift	42	33	9	0.99	1.02	1.53	88%	78%
March, 2015								
1181, A Shift	46	35	11	1.09	0.93	1.70	83%	45%
1181, B Shift	38	25	13	1.24	0.91	2.04	84%	54%
1181, C Shift	37	31	6	1.33	1.24	2.45	68%	17%
1131, A Shift	51	39	12	1.41	1.39	2.40	74%	25%
1131, B Shift	41	29	12	1.49	1.43	2.15	52%	33%
1131, C Shift	36	27	9	1.19	1.38	2.22	67%	44%
1281, A Shift	29	25	4	1.23	1.19	1.77	76%	50%
1281, B Shift	28	24	4	0.84	0.74	1.65	96%	75%
1281, C Shift	28	22	6	1.03	1.13	1.55	77%	67%
1231, A Shift	37	30	7	1.12	1.08	1.45	63%	71%
1231, B Shift	32	26	6	1.13	1.03	1.97	77%	67%
1231, C Shift	33	27	6	1.17	1.13	1.97	78%	67%

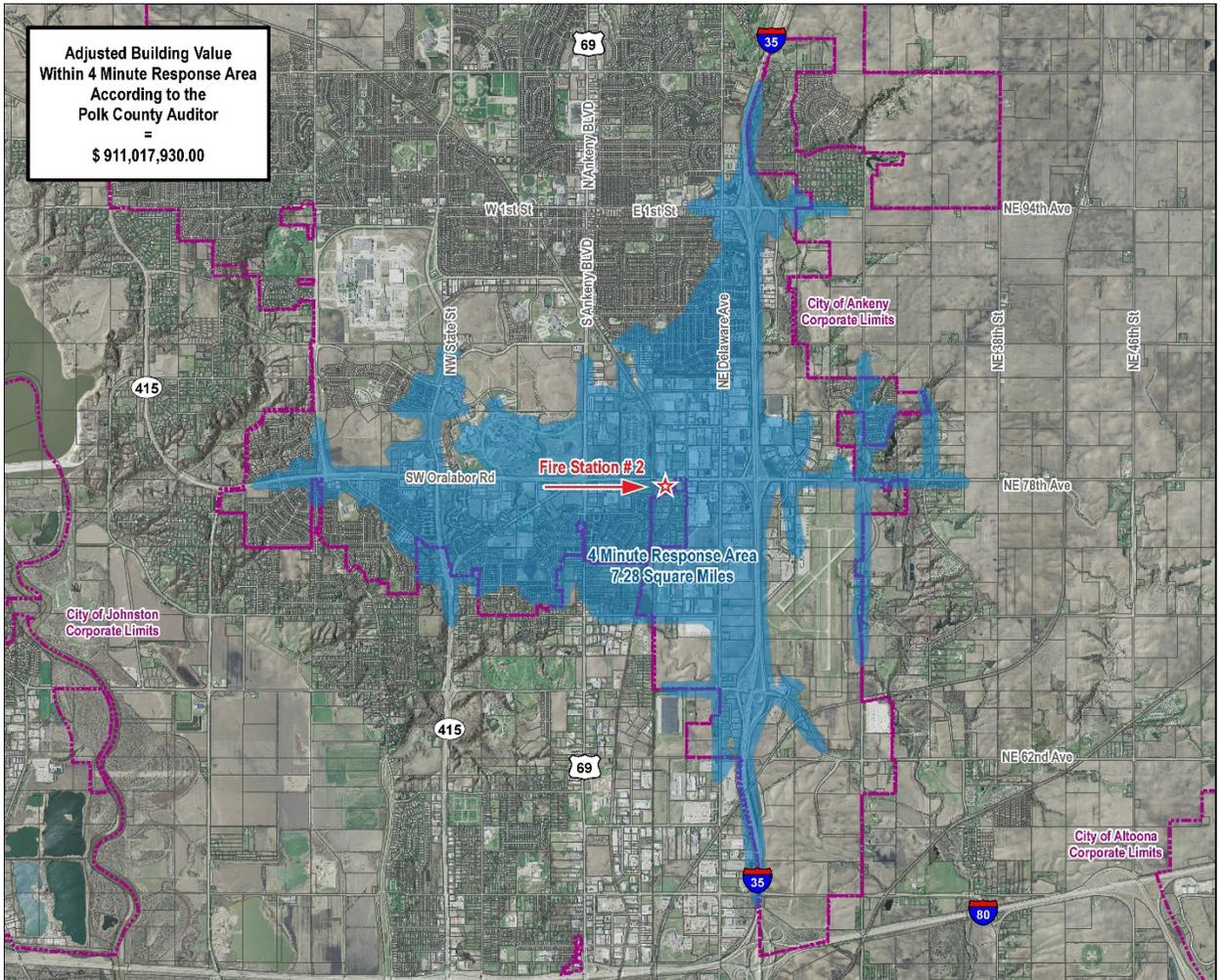
Appendix D: Ankeny Fire Department Average vs. Fractile Response Times (2010-2014)

Zone	Year	Calls for service	Average Response Time	Fractile: (Eight Min or less)	Maximum Time
Area One	2010	139	7:34	63%	17:32
	2011	144	7:42	61%	14:09
	2012	166	8:01	57%	18:42
	2013	188	8:00	54%	14:56
	2014	248	7:42	60%	14:17
Area Two	2010	74	6:28	86%	17:13
	2011	68	6:23	89%	14:15
	2012	81	6:36	84%	15:03
	2013	89	6:29	80%	10:43
	2014	106	6:48	78%	10:49

Appendix E: Four Minute Response Time from Ankeny Fire Department Station-One



Appendix F: Four Minute Response Time from Ankeny Fire Department Station-Two



Appendix G: Four Minute Response Time from all Ankeny Fire Department Stations including Station Three site Choice-One

