Determining Future Fire Station Needs for the Kalamazoo Department of Public Safety

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CERTIFICATION STATEMENT

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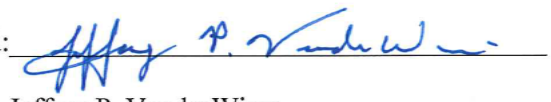
Signed: 

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Abstract

KDPS, like many departments is evaluating its response coverage of fire apparatus. The problem is that KDPS had never analyzed response times or call volume for its current five stations to determine where new fire stations needed to be built. The purpose of the research was to analyze response times, call volumes and anticipated future growth to determine where future stations should be built. Descriptive research was utilized to answer five specific questions: What are the desired response times for Fire and EMS calls? Two, what criteria do other fire departments use when determining where to build new stations? Three, what are the response times and call volumes for each of the current five stations? Four, what is the anticipated growth for the City of Kalamazoo over the next 10 years? Lastly, what areas should be considered for potential locations for new fire stations? The research that was conducted included interviews of KDPS personnel as well as personnel form the Economic Development department with the City. Additionally, a survey was sent out to other fire departments to see what criteria was important to other departments relative to where to build new fire stations. Lastly, GIS mapping was done as a method to identify underserved areas of the City and evaluate/predict potential areas where a new fire stations would best serve the City in the future. The research found that response time was a driving factor in fire station placement and that the City had significant gaps in coverage in the City's northwest and southeast areas. Recommendations were made as to where new fire stations should be built to remedy the coverage gaps identified, along with recommendations on future research that should be conducted to further evaluate the service being provided by KDPS.

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As leaders within our respective organizations it is vital that we plan for the future, even if that future will occur long after we leave the organization. The art of planning requires an examination of current conditions to predict future conditions. "Planning helps an organization chart a course for the achievement of its goals. The process begins with reviewing the current operations of the organization and identifying what needs to be improved operationally…" (Hill, 2013, p. 1). It is inherent that departments are constantly evaluating their current situation and projecting future needs in order to ensure success of the organization. Within the realm of Public Safety, success is measured in at least partial terms as the organizations ability to provide service to its stakeholders which are the residents and visitors within the departments' organizational boundaries.

Over the last decade the ability of Public Safety Departments to effectively grow has been stifled due to a struggling economy and shrinking budgets. Many fire departments have been forced to cut their workforce, close fire stations or "brown out" stations due to lack of funding. This does not negate the need to plan for future growth. As several cities begin to crawl out of the era of shrinking budgets many are looking towards the future to predict public safety needs. The planning process therefore, becomes a vital cog in the wheel towards preparing the department for success and in the future.

The Kalamazoo Department of Public Safety (KDPS) is not unlike other departments in that it too, has experienced stifled growth and a slashed workforce. Planning for the future was unheard of do to the grim five-year budgetary outlook. Instead, KDPS was looking at ways to reduce its costs while at the same time maintaining basic services. During this time, KDPS was

experiencing historic all-time low employment levels. While the future was uncertain in terms of potential growth any talk of such growth was limited and the mere aspect of increasing services virtually unheard of.

Planning for future growth within an organization does not have to be a complicated process, however it is a process that must not be overlooked in importance to an organization. Public Safety Departments that are predicting future growth within their jurisdictions should commit to the planning process today so that they are prepared for the future development when the need arises. Leaders must prepare the organization for the future by ensuring that the planning process starts now. "Our challenge, as today's leaders in the fire service, is to create a vision for the future and to make it happen" (Wallace, 2006, p. xvi).

While it is true that KDPS has faced significant budgetary constraints felt by many departments around the Country, KDPS is emerging from years of shrinking budgets and now faces projected years of growth and increased development even in areas of the City that have not seen significant growth in over a decade. The potential for growth within the Public Safety department is seen as a near certainty and while many leaders within the community can predict where future growth will occur there is little or no data to support KDPS's needs for future demands on the department as that growth occurs.

The problem is that the Kalamazoo Department of Public Safety has not analyzed response times or call volume for its current five (5) stations to determine where additional station(s) will be needed in the future. In failing to analyze our current and projected future needs we are setting the department up to struggle as the City emerges from a period of decline and enters a period of economic growth. In other words, our failure to plan now will cause problems relative to the departments' ability to complete its mission in the future which is to

provide the best Police, Fire and EMS service it can to the community. While the potential for growth is on the horizon the planning for that growth needs to occur now. Additionally, since the City of Kalamazoo combined Police and Fire services in the early 1980's the department has never been in a position to increase the number of fire stations to improve its response times and enhancing its response capabilities and ultimately its' service delivery. This is due in large part to years of shrinking budgets. No one currently employed at KDPS has ever undertaken a study designed to analyze response times, call volume and other variables that effect service delivery, given our current number of fire stations. For this reason, in order to conduct the analysis needed to analyze our current five stations we must first identify the criteria that should be utilized in such analysis.

The purpose of this research is to analyze response times, call volume and anticipated future growth to determine where future station(s) should be built. In conducting this research, KDPS will have the information needed to articulate to city administrators, elected officials, and the community to justify the need for new station(s). In addition, the research provides analysis of its current state of readiness and may bring to light shortcomings within our current processes that could lead to change and improved customer service to the community within the confines of the current operating structure.

The research also hopes to answer the following questions:

a. What is the desired response times for Fire and EMS calls for service within the City of Kalamazoo as identified by current standards and community expectations?
b. What criteria do other Fire Departments use in analyzing where to build new fire stations?

c. What are the response times and call volumes for the five (5) fire stations currently providing coverage to the City of Kalamazoo?
d. What is the anticipated growth for the City of Kalamazoo over the next 10 years?
e. What area should be considered for potential locations for new fire stations in order to improve station coverage within the City of Kalamazoo?

The research methodology to be utilized is descriptive research that will ultimately lead to the identification of preferred response times to every Fire and EMS call within the City of Kalamazoo. Utilizing this information, the research will then look at call volume that exists with the current five stations to identify current gaps within our station coverage currently. Lastly, that information will be cross-referenced with projected future growth in the City over the next 10 years so that future growth can be accounted for when determining which of the 3-5 locations identified as potential sites will be best suited to meet the anticipated needs of the community in the future.

Background and Significance

The Kalamazoo Department of Public Safety (KDPS) is the nations' largest fully integrated Public Safety Department. The department currently employs 213 sworn personnel providing Police/Fire/EMS service to a population of over 75,000 residents and an additional 30,000 college students. The City of Kalamazoo made the decision to combine Police and Fire departments back in the early 1980's and at the time the original plan called for nine (9) stations throughout the City. That station deployment model never came to fruition and over the years the number of stations has actually been cut down to its current five (5) station configuration,

leaving the City with significant gaps in its coverage of certain areas that results in greater response times to those areas.

Since 1996, the economy has played a major factor in the ability to improve service delivery. The emphasis has been on maintaining basic services while at the same time cutting costs. Over the last 10 years, many Cities including Kalamazoo have experienced significant deficits due to the economic downturn. Over the years the City of Kalamazoo has done an outstanding job of maintaining and replacing, as necessary its current five (5) stations, however the ability to work towards building new fire stations in areas where there are longer response times has been hampered by lack of funding and a "keep its head above water" budget. Like many municipalities, the City of Kalamazoo was doing its best to stay afloat, however "by the first quarter of 2011, a projected $4 million dollar deficit had grown to $6 million" (Jessup & Stafford, 2013, p. 11). KDPS being the largest spender of the general fund was required to cut 28 sworn positions resulting in the reduction of sworn personnel from 243 to 215. To address the large number of cuts without laying off personnel, the City leaders adopted the Early Retirement Incentive (ERI) to take advantage of a lucratively funded pension system as a means to humanly cut positions without layoffs.

The effect on the department resulted in the combining of two fire stations into one and the elimination of one (1) Engine as the department used the ERI to reduce its workforce which led to the reduction of minimum staffing. Additionally, two Engines were reduced in manpower from two personnel down to one. Over the last 10 years, the budget has been about survival and not about growth and the ERI had averted what would have amounted to the largest layoff in the City's history. However, the ERI was only a temporary fix for the next couple of years. The

economy while improving slightly did not account for increasing costs and property values were not rebounding nearly as fast as they plummeted during the recession.

In 2015, City leaders were projecting that without some sort of intervention, the City of Kalamazoo was going to be insolvent by the year 2020. The City Manager put together a task force to examine numerous potential ideas to address the budgetary pressures the City was currently facing as well as future budget concerns. The panel met throughout 2015 and at the end of 2015 came up with five (5) non-binding recommendations, none of which would generate the amount of revenue that was necessary to overcome the predicted deficits and keep Kalamazoo out of receivership.

The City Manager determined that while the task force did not recommend a City income tax, such a tax was the only way to generate the income that was needed. As the City Commission mulled the possibility of a putting the income tax out to the voters, a group of businessman came together and vehemently opposed the income tax and vowed to actively lobby against it if the City proceeded. City leaders asked these businessman if not an income tax then what solution was there, with the guiding premise that if nothing was done, Kalamazoo would be taken over by the State of Michigan. The local businessman along with City leaders came up with a plan which raised money in a two-phase project aimed at lowering property taxes, solving the budget deficit and providing for significant amounts of money to be used for aspirational spending over the next three years.

The solution which was termed the *Foundation for Excellence* was solidified in the 4th quarter of 2016 to go into effect with the 2017 budget year. The Foundation is a two-phase plan designed to allow Kalamazoo to prosper and avoid the annual budget cuts that the City had grown accustomed to. The same businessman that opposed the income tax had now “agreed to

provide a $70.3 million donation over the next three years to be used to stabilize the city's finances" (Barrett, 2016, p. 1).

The donated money was designed to lower the City's property tax from over the current 19 mills down to 12 mills, provide money to erase the budget deficit for the next three (3) years and provide $10 million dollars of aspirational funding to the City each year for the next three (3) years. In addition, phase II of the plan called for the establishment of a $500 million dollar fund that would be used to address budget deficits beginning in the year 2020 and to continue for life.

The donors behind the money only had three (3) requests that the City utilize the $10 million dollar aspirational funding for and they were:

> 1) Addressing generational poverty, promoting youth development and removing barriers to employment opportunities, 2) Address capital and human infrastructure improvement and maintenance needs, as identified by the Imagine Kalamazoo 2025 process and city's Capital Improvement Program and 3) Develop and implement neighborhood improvement efforts which reimagine and reinvest in public spaces. (Barrett, 2016, p. 1)

The Foundation for Excellence marked the beginning of economic change in the City of Kalamazoo. All of a sudden, property was being bought up downtown and around the City at an unprecedented rate. At KDPS, the talk had transformed to one of hope and growth with many administrators beginning to talk about increased staffing, better and more facilities and improved technology.

When the City of Kalamazoo passed its 2017 budget any doubt that the *Foundation for Excellence* was going to change the dynamics of City government fell away. "Since 2002,

Kalamazoo has implemented budget reduction measures totaling $25 million. About $12 million of the cuts occurred since 2009" (Barrett, 2016, p. 1). Now the 2017 budget proposed the addition of 64 new positions in which KDPS was slated to receive 28 additional full-time equivalents (FTE's) to put its' staffing back to the level that it was before the ERI in 2009.

The emphasis on the building of infrastructure with the $10 million aspirational money each year all of a sudden created a surge in the possibility of capital improvement projects. The department quickly began to put together a plan to present to City leaders to replace outdated equipment and potentially build new stations. Talk of building new stations had other than the replacement of outdated stations had never been discussed due to past economic conditions. Now, with the *Foundation for Excellence* the talk was more than just firehouse banter it was being discussed seriously amongst department leaders.

The vision of building new station(s) quickly brought about the realization that while the departments' administrators knew that fire station coverage to Fire and EMS incidents was lacking in certain areas of the City, there had never been any study, formal or informal, conducted that would give the departments' Chief the ability to articulate the need to City leaders. It had been well over 20 years since the department had ever considered a new station and no one currently working for the department had ever been involved in a process at the department designed to look at response times and station coverage in large part due to the economic recession and lack of money to expand services. In fact, no one in the department had ever examined what criteria or evaluation measures should be used as the basis for analyzing current station capabilities. Should it be based upon response times, call volume, predicted development of areas within the City or were there other criteria that should be considered.

It became readily apparent that if KDPS was to propose the building of a new station or stations it would have to be able to articulate why the need exists. In addition to articulating the need, additional examination of where to build a new station and what criteria should be used in the evaluating where to build new stations would also be needed to show that the new station(s) would address the identified needs such as the desire for decreased response times or the ability to deal with increased call volumes in developing areas of the City.

The Executive Leadership Course within the Executive Officer Program at the National Fire Academy built upon what was learned in the Executive Development Course to recognize adaptive challenges. "The final-year EFOP course provides an opportunity to extend the learning experienced in prior courses so that the future opportunities to exercise leadership are moved to practice" (FEMA, 2015, p. 9).

The Executive Leadership course has provided me the opportunity to exercise leadership by preparing me to practice adaptive research in examining where future fire stations within the City of Kalamazoo should be built. Identifying those locations is much more involved than examining a map and picking out where a station should be. It is not a technical problem which one can quickly solve. The costs associated with the building of a new fire station is in the millions of dollars and the determination of where to place those new stations is a much more difficult problem that requires adaptive research to gain an understanding of the influential factors that should be considered when determining where to build those fire stations. Such research will provide the articulation that City administrators will require in justifying the high costs of building fire stations.

The United States Fire Administration (USFA) has several goals that sustain its' vision and mission. The research conducted here helps to fulfill some of those goals such as,

"improving local planning and preparedness" and "improving the fire and emergency services professional image" By utilizing adaptive research to develop clear, articulable evidence to show the need for new fire stations it meets the two above goals by increasing the departments' readiness to respond to incidents, improves response times to Fire and EMS incidents and provides for clear and transparent communication to the community about the need for new fire stations and what the community will get in return for such investments. Such research will provide the foundation for the departments' future success in providing excellent Fire and EMS service to the community.

Literature Review

The literature review consisted of library searches at the National Fire Academy Learning Resource Center, Western Michigan University Library, Kalamazoo College Library, internet research as well as internal documents of the Kalamazoo Department of Public Safety. The literature review was conducted to determine what past research and literature exists about the planning for future fire station development. Part of that research focused upon what factors have been found to be successful in the past as driving decision-making related to where new fire stations are to be built. The focus of the literature review is not intended to answer the research questions but to provide a foundation as to what others have found to be relevant factors in determining where to build new fire stations. This literature review will then be compared to the research that will be conducted by this ARP in an effort to draw conclusions and make recommendations as to what criteria should be used in analyzing the current state of fire station response coverage and where the City of Kalamazoo should focus its' attention in the construction of new fire stations in the future based upon the needs of the community.

In order to identify where you need to build a new fire station it is important for a department to be able to articulate why a new station is needed and what the benefits of building a new station are.

> Jim Bloomer, assistant chief for Mesa Fire Department states, "Make data-driven decisions. Nothing sells a fire station like good solid facts. How many calls are you getting in the area to be covered by the new station? Are you having many extended response times? How has the area changed in the last 10 years and where do you expect it to be in the next 10? Is there anything happening that will cause call volume to go up such as new residential developments or commercial facilities? (Wilmoth, 2015, p. 1)

This literature review will focus on many of these factors as they relate to how they drive the decision making process for locating and building a new fire station.

Response Times

The literature review found that "when considering the construction of a new fire station, the terms 'building site' and 'response times' are virtually inseparable" (Mishefske, 2017, p. 2). It became readily apparent that the number one factor that should be considered among all factors is response time and the ability of a new station to effectively lower response times to a particular geographical area. While there are several factors that go into where to build a fire station, one factor that past research was consistent upon was response times and a departments ability to get to a particular area in a designated period of time from the station. "In considering potential sites within the community, acceptable response times within the station's geographic response area, along with other factors, will become one of the most critical factors" (Mishefske, 2017, p. 2).

The ability to respond to emergencies within a prescribed time frame is clearly documented through numerous studies that have been conducted relative to fire growth and the stages of fires. In addition, medical studies have shown that quick intervention in under four minutes significantly increases survival rates in patients suffering a cardiac arrest. Therefore, the importance of response time and well-placed, well-thought out fire station locations has an immediate impact on the ability of the department to deliver timely and efficient service in both the Fire and EMS areas.

The focus of the fire department is to provide Fire, Rescue, and EMS services. When responding to these types of emergency calls, time is of the essence. "Fire growth can expand at a rate of many times its' volume per minute. Time is also a critical factor for the rescue of occupants and the application of extinguishing agents to minimize loss" (ESRI, 2007, p. 4). The nexus between fire department response times and limiting fire growth and damage as well as survivability by trapped victims is discussed in the following paragraphs.

All fires without intervention will go through the same stages of growth. The most significant of these phase if the flashover phase. This phase is important to the fire service for two reasons, fire growth and survivability. "Flashover is considered as the point of transition from a `small fire` involving a small number of objects in the room to a `large fire` involving all objects in the room" (Waters, 1999, p. 1). In addition to fire growth, the point of flashover also reduces the survivability of occupants trapped inside a burning structure. "During flashover, however, the temperature rises very sharply to such a level that survival of persons still in the room at that stage becomes unlikely" (Waters, 1999, p. 1).

There are several factors that play into when flashover will occur, however "flashover can typically occur from less than 4 to beyond 10 minutes after the free burning starts" (ESRI,

2007, p. 5). In a recent UL study, researchers found that flashover occurred in modern constructed homes anywhere from 3 minutes and 20 seconds to 4 minutes and 45 seconds (Kerber, 2014). This further supports that there is a direct nexus between fire department response times and the reduction of property loss and fire casualties.

In addition to fire-related calls, response times to EMS incidents can mean the difference between life and death. "Survival rates for some types of medical emergencies are dependent on rapid intervention by trained emergency medical personnel" (ESRI, 2007, p. 4). For example, for a person suffering a heart attack that subsequently goes into cardiac arrest, the victims' chances of survival are four times greater if cardiopulmonary resuscitation (CPR) is started within four minutes (ESRI, 2007).

> The American Heart Association's scientific position is that brain death and permanent death start to occur in 4–6 minutes after someone experiences cardiac arrest. Cardiac arrest can be reversible if treated within a few minutes with an electric shock and ALS intervention to restore a normal heartbeat. Verifying this standard are studies showing that a victim's chances of survival are reduced by 7%–10% with every minute that passes without defibrillation and advanced life support intervention. Few attempts at resuscitation succeed after 10 minutes. (Ludwig, 2004, p. 1)

The importance of timely fire or EMS response cannot be over-emphasized. Past research has routinely supported that response times play a significant role in decision-making as to where to locate fire stations. "For both fire and medical emergencies, the basis for the placement of fire stations should be the amount of time that it takes to deliver adequate emergency resources to the point of demand from each fire station of a combination of fire stations" (ESRI, 2007, p. 8).

Determining Appropriate Response Times

Currently, there are no laws that mandate specific response times for fire departments. Each community must establish their desired response times based upon a number of factors such as: desired level of service, the financial ability to provide the resources necessary to meet that level of service and the level of risk the community is willing to accept (ESRI, 2007). The community through its elected leaders must maximize its available resources within the financial constraints of the community. Furthermore, if the community determines that the risk is too great it must increase its desired level of service, which in turns requires a greater financial commitment. The three factors are all dependent upon one another and therefore all three (3) must be considered when determining what response times are desired by the community.

In determining response times, many communities rely upon several highly regarded consensus standards set forth by the National Fire Protection Association (NFPA), and supported by agencies such as the International Association of Fire Chiefs (IAFC), and the International Association of Firefighters (IAFF). In addition, the Insurance Services Office (ISO) has established a station distribution model as opposed to a strict time-based response standard. The Commission on Fire Accreditation International (CFAI) promotes response standards by ensuring that agencies are striving to meet one or several of the above outlined standards as a matter of establishing best practices within the fire service. While not mandatory, many fire departments at least try to comply with one of these standards in an effort to reduce risk to the community and limit liability to the department.

With regards to the response times, the main standard that is the highly touted NFPA 1710. NFPA 1710 was first developed in 2001 and remains the primary standard for fire

departments regarding response times to EMS and Fire related incidents. The standard is considered a consensus standard and is not mandatory for fire departments to meet. The standard which was last updated in 2016 has several objectives relating to alarm processing, dispatch time, turnout time, and response time. This ARP is concerned about criteria relative to response time and therefore the focus is towards this part of the NFPA standard only. NFPA 1710 sets forth the following objectives relative to response times:

> For EMS calls a first responder carrying an automatic external defibrillator shall arrive on scene in 240 seconds (4 minutes) or less. For fires (non-hi-rise) the first due Engine Company shall arrive on scene in 240 seconds (4 minutes) or less and that a full first alarm assignment arrive on scene in 480 seconds (8 minutes) or less. Additionally, for fires in hi-rise structures the first Engine Company must arrive on scene within 240 seconds and the full first-alarm assignment arrive on scene in under 610 seconds (10 minutes, 10 seconds) (National Fire Protection Association [NFPA], 2016).

NFPA 1710 recognizes that fire departments are not perfect and that as such cannot be expected to meet these response times 100% of the time. They therefore recommend that fire departments should meet these response times for 90% of the calls they respond to (*FIRE/EMS Response Time Facts*, 2016). The objectives set forth by NFPA 1710 are based upon many of the facts already discussed early as it relates to fire growth and also EMS response to cardiac incidents. The standard points to studies based upon flashover and states,

> …given that the progression of a structure fire to the point of flashover (i.e. the very rapid spreading of the fire due to superheating of room contents and other combustibles) generally occurs in less than 10 minutes, two of the most important elements in limiting

> fire spread are the quick arrival of sufficient personnel and equipment to attack and extinguish the fire as close to the room of origin as possible. (NFPA, 2016, p. 22)

The ability to arrive quickly and with enough resources to contain a fire to the room of origin cannot be over-emphasized.

> The NFPA found that in residential structure fires between the years of 2010 to 2014 there were a total of 358,300 reported fires. Of those, 75% of the fires were confined to the room of origin. Those fires resulted in 480 civilian deaths, and caused $1.1 billion dollars in property damage. Conversely, 25% of the remaining fires spread from the room of origin. In doing so, it resulted in over 2,000 civilian deaths and over $5.6 billion dollars in property damage. (Ahrens, 2016, p. 48)

Clearly the evidence supports that response time plays a role in limiting fires to their room of origin and that quicker response time results in less civilian deaths and significantly less property damage.

Another organization that evaluates fire station locations is the Insurance Services Office (ISO). ISO is an independent organization that evaluates fire department capabilities. One area that they evaluate is fire station distribution. While only a small part of the overall evaluation process, fire station distribution is evaluated in terms of a departments' ability to get to a fire in a prescribed amount of time. "ISO's criteria require that a built-upon area of a community should have a first-due engine company within 1.5 road miles of the protected properties and a ladder-service company within 2.5 road miles" ("Response time," 2007, p. 1). Based upon ISO's response criteria and method of computation, this provides a response time of 3.2 minutes for an engine company and 4.9 minutes for a ladder-service company.

In determining the above distribution guidelines, ISO relied heavily upon the RAND Corporation which developed a formula to determine on average how fast a fire engine can travel taking into account the numerous variables that need to be considered. After conducting extensive studies into these variables, they determined, “that the average speed for fire apparatus responding lights and siren is 35 MPH. That speed considers terrain, average traffic, weather, and slowing down for intersections” ("Response time," 2007, p. 1). ISO conducted a review of the RAND study and verified its accuracy and confirmed that it is valuable tool at predicting average speed and response coverage of a fire apparatus.

In evaluating fire departments, ISO has steered clear of using individual response time statistics of departments. There premise is that many departments lack reliable response-time information and that it would be inappropriate anyways for them to push for fire service personnel to drive faster than what conditions and individual skill level would dictate just for the sake of faster response times ("Response time," 2007).

Comparing the ISO requirements for fire station distribution and NFPA 1710, it is obvious that ISO is more stringent as it relates to the number of fire stations that would be required to meet its standard of having an Engine company for every 1.5 road miles. NFPA 1710 however, allows for a greater distance to be covered due to allowing for greater time. As stated earlier, based upon the RAND Corporations equation, an Engine company should be able to respond within 1.5 miles of its station within 3.2 minutes, thus NFPA allows for 4 minutes of travel response time leading to more generous and much more obtainable standard to achieve. The ISO requirement is much more stringent and would require more fire stations to meet its requirement than what the NFPA standard does.

Another caveat to the ISO requirements is that the ISO evaluation is done to evaluate a fire departments capabilities and assign a score to it from 1 to 10 with 1 being the best. This score is used by insurance agencies to establish insurance rates in the community. Communities must evaluate the cost vs benefit of adding additional stations for the purpose of lowering insurance rates. If the construction of additional stations would result in a significant improvement of the communities ISO score which will correlate into reduced insurance premiums than consideration should be given towards the construction of additional facilities. Therefore, the ISO standard must at least be considered when a community is evaluating locations for a new fire station.

The International City Management Association also weighs in on having a certain amount of firefighters staffing a fire department. In its book, "*Managing Fire and Rescue Services"*, the ICMA states, "if about 16 trained firefighters are not operating at the scene of a working fire within a critical time period, then dollar loss and injuries are significantly increased as is fire spread" (Compton & Granito, 2002, p. 26). Additionally, in 2010 a study conducted by the National Institute of Standards and Technology (NIST) provided for quantifiable data to assist in determining crew size and station location as primary variables in limiting fire damage, and decreasing civilian injury and death. "Fire risks grow exponentially. Each minute of delay is critical to the safety of the occupants and the firefighters and is directly related to property damage" (National Institute of Standards and Technology, 2010, p. 3).

The literature review found that the primary factor associated with building new fire stations is predicated on the new stations ability to affect response times; that is to lower response time. There are other factors however, that come into play relative to where to locate a new fire station. Factors such as call volume and predicted growth in the area to be served

should also be taken into consideration, however the literature available on those two factors paled in comparison to the amount of literature on response times.

Call Volume

While response times was found to be a significant factor on where to build a new fire station, current call volume should also be a determinant in deciding whether or not to build a new fire station and where. Over time, areas of the community change in make-up and demographics. What once was perceived as an area that the fire department rarely went to 10 years ago can know be driving a large percentage of calls and the ability of the fire department to handle those calls can be greatly influenced by its location relative to the geographic area the station serves.

In 2015 in Arlington County, VA, a task force was formed at the request of the community to examine the relocation of Fire Station #8. The demand for the task force was driven in part by the communities' questions such as: how many EMS and Fire Calls had been received yearly in the perceived "underserved" area of North Arlington (Arlingtonva.us, 2015). While these were only a few of the questions asked, the task force was created based upon the call volume increase to the unserved area of North Arlington. The anticipated call volume based upon the predicted increase in that call volume due to increased development led to the decision to build an additional station in that area to meet demand.

In Aurora, Colorado they have established certain thresholds that trigger when they will build a new fire station. For example, anytime the total number of response in the first due area exceeds 100 per year a temporary station must be opened in that area. Additionally, if the number of responses to the first due area exceeds 400 responses this would trigger a new fire station to be built (*AFD Master Plan*, 2017, p. 6-7). While Aurora Fire Department may be the

exception to the rule they are one of the few departments that utilizes call volume thresholds as determinants when to build new stations. These call volume thresholds are not the only criteria that would trigger a temporary or new station being built, but it is one of the qualifying criteria in regards to when to build a new fire station. In addition to call volume, they also have thresholds that are based upon population growth and new construction. This will be examined in the paragraphs that follow.

Future Growth

Future growth is also another factor that was found to drive decisions to build new fire stations. While the current situation is that a particular area is not developed that may not hold true in the future. It is important that departments evaluate predicted future growth so that they can be prepared to serve that area in the future. "Fire Departments must stay proactive by predicting the desired locations of future fire stations based on growth patterns and community growth predictions" (Wallace, 2016, p. 1). Some fire departments such as Aurora FD discussed earlier have thresholds that determine when they are to build new stations.

> AFD requires that whenever the number of single family living units exceeds 100 or the amount of commercial/industrial square footage exceeds two million square feet a temporary station must be established, and when the number of single family living units exceeds 500 or the amount of commercial/industrial square footage exceeds four million square feet a new fire station must be built within that area. (*AFD Master Plan*, 2017, p. 6-7)

In anticipating new and future growth, it is important to look at areas that are currently sparsely developed but are showing signs of future development now. Questions should be asked such as if a new subdivision were to go in, what will the response times be from the

nearest current station and in the case of ISO, is it further than 5 miles from the nearest fire station. If it is, the area will be classified as a Class 10 area and result in higher insurance premiums. This could stifle development in the area. Would the building of a new fire station in that area encourage development due to lower insurance rates? These are all questions that should be considered when determining whether or not to build new stations.

The ability to predict future growth and identify areas within the community that will be developed in the years to come will better prepare you to meet the needs of the community especially in the area of predicted development. "New fire stations don't just pop up overnight. Often it will take several years from the identification of the need to obtaining the funding, acquiring the land, and then completing the design and construction processes" (Wallace, 2016, p. 2). It is important that future growth be part of any evaluation process relative to determining where a new fire station should be built.

Levels of Risk

Fire stations are not cheap and as such the building of fire stations and their associated costs must be weighed on a cost vs. benefit basis. When discussing the benefit, the community must examine what level of risk it is willing to accept in areas where response times are higher and call volume are lower. Questions that should be asked or considered are: 1) is there a high life hazard or high dollar value of property to protect, 2) is there a high incident rate or a lower one and 3) high rate of incidents that require high level of resources versus a low rate (ESRI, 2007).

Communities must be willing to accept some level of risk relative to areas that the fire department serves. Certain areas that are sparsely populated may result in the community determining that higher response times may be acceptable given the lack of development in the

area. Conversely, how many stations so you see surrounding downtown areas with significant development. Communities are not as willing to take such risks in the areas where a majority of the infrastructure is built upon.

Levels of risk are predicated upon the three factors that have already been discussed, response times, call volume and current and future development of an area all play a role in determining level of risk that a community is willing to accept. In making determinations about which of those factors are important to a community they are determining their level of risk that they are willing to accept.

GIS Mapping

Today's technology allows for future planning decisions to be visually developed with the use of GIS mapping technology. "With the advent of modern software and computer technology, the selection of fire station locations can best be determined with a greater degree of accuracy using GIS" (ESRI, 2007, p. 14). GIS mapping can evaluate response times, call volume, future growth and other factors and produce a colored map that examine all the factors involved that will allow for a more informed decision as it relates to where the need for new fire stations exist.

> Alternative and future station locations can be examined through the use of what-if scenarios, using various fire station locations and travel times. The information from these programs can be integrated with the data from local and regional planning groups to show where new stations and/or roadways may be needed to best serve existing and if about 16 trained firefighters are not operating at the scene of a working fire within a critical time period, then dollar loss and injuries are significantly increased as is fire spread growing communities. (ESRI, 2007, p. 15)

GIS mapping can have multiple layers which can be placed on single map such as response time, call volume and predicted future development to help communities make better informed decisions about the locating of new fire stations. Utilizing GIS mapping will help give departments' articulable data in a visual format that can be used to support the building of new fire stations within the community and to gain community support.

In summary, the literature review has influenced this ARP by establishing a foundation of criteria that has been considered by others when determining where to build new fire stations within any community. While it is clear that there is not a single plan that all departments should follow in determining where to build new fire stations, the literature review has found several potential criteria that should be examined by each community and department individually. Each communities need is different and the decision of where to build new fire stations should be based upon the needs of each community individually. For some communities the need for new fire stations is driven by growth (current or predicted) of a sparsely populated area. For others, the need is based upon a community expectation of service in which response times be cut or improved upon.

Whatever the reason, the literature review has identified that each community identify its priorities based upon what their needs and capabilities are. The review clearly identified the need to evaluate and determine an acceptable level of service as it relates to response times and acceptable levels of risk. Ultimately, the research conducted in this ARP will seek to provide a basic understanding of the current level of risk and predicted future risk to the City of Kalamazoo as it relates to Fire and EMS service. In examining this risk a look at response times and an evaluation into acceptable response times will then a framework from which department

and city leaders can use to determine where they need to build fire stations to meet the community expectations relative to the amount of risk they willing to accept.

The research discussed later in this report was influenced by the literature review by examining what factors typically drive the need and location for new fire stations. These factors then will determine what the City of Kalamazoo desires for its' level of service and determine where future fire stations should be located to meet that desired level of service.

Procedures

The research is being conducted to answer the five (5) research questions outlined at the beginning of this paper and ultimately provide recommendations as to where the department should look to build new fire stations in the future to meet community expectations as well as meet established industry standards. The primary research method will be descriptive research. In the end, the desired outcome of the research is to identify gaps or deficiencies in our current five (5) station coverage based upon the desired level of service the community and city administration expects. To identify those expectations, the research will focus on desired response times, call volume, and predicted future development along with any additional factors found by surveying other fire departments to determine where future fire stations should be built in the future to meet those community expectations.

Research for this paper began in November 2016 while attending the National Fire Academy *Executive* Leadership course. Utilizing the Learning Resource Center (LRC) on campus I began to review what past research has been conducted into fire station development and factors that drive decision-making relative to the locating of new fire stations. While not a

component of the research itself, the Literature Review has set the foundation for the research that was conducted in this paper.

After completing the literature review, the focus turned towards conducting research in order to answer the research questions. The first research question sought to ascertain the desired level of service relative to community needs and expectations. To answer this question, I interviewed the Assistant Chief (A/C) of Fire Operations from KDPS, A/C Ryan Tibbets. Within KDPS, the responsibility of establishing policy and procedure relative to Fire and EMS operations is the responsibility of A/C Tibbets. The interview sought to gain a greater understanding of what the departments goals were relative to providing service to the community and also what the community expects in regards to fire and EMS coverage. The interview included a discussion of current standards as they relate to fire station response times and distribution, community expectations and acceptable levels of risk as well as the future goals of the department.

Research question two, sought to identify criteria that other fire departments have identified as being important when examining their respective capabilities and distribution of fire stations within their community. To examine what other fire departments have done, an external survey was created. The survey attempted to identify criteria that other departments have utilized to base their decision-making upon when studying their own fire station locations. In order to garner as many respondents as possible, the survey was sent out using several different paths. The survey was sent out to the Executive Fire Officer (EFO) section of the International Association of Fire Chiefs (IAFC), the list serve of the Michigan Association of Fire Chiefs (MAFC), a local list serve entitled TEXCOM. TEXCOM is a communication platform that is used by a multitude of fire departments in southwest Michigan. In addition, the survey was sent

out to my respective EFO peers along with a request that they share it with their contacts in the industry in an effort to reach as broad of a population as possible.

The survey was sent out to departments of all sizes and demographics. Due to the methods used to disseminate the survey, is was not possible to determine the exact size of the population sample. The intent was to identify as many departments as possible that have examined their needs relative to fire station locations and what criteria they utilized in determining which criteria to follow. Within the survey itself, questions were asked to delineate which departments serve populations similar to the City of Kalamazoo so that an emphasis could be placed on the data gathered from departments similar to KDPS in composition and population served. A copy of the survey can be found in Appendix A, and a list of the departments that responded to the survey can be found in Appendix B.

While there was not statistical method of testing the surveys' validity, in order to ensure that the survey instrument was testing what I needed it to, I did had five (5) people from local fire departments look over the survey to make a determination that the survey would indeed give me the information that I sought to answer in the second research question. The five individuals were given the survey after I explained what it was that I was looking to answer. Recommendations for improvements were taken and the survey edited to ensure the survey was valid before being sent out to the population sample. In retrospect, the questions in the survey went beyond the scope of what I actually needed to answer the research question. As such any data obtained in the surveys that was not pertinent to answering this research questions was not looked at.

The survey's reliability is really dependent upon the respondents answering truthfully. The reliability of a survey is dependent upon the surveys ability to garner similar results when

taken repeatedly. The questions within the survey were designed so that they examine a departments processes. These questions should be answered in the same manner with similar results no matter who is completing the survey for each department. The five individuals that checked the survey for validity also agreed that the survey was reliable and would produce reliable results.

In examining research question three (3), the researcher examined call volume for KDPS based upon Fire and EMS data. Several methods were utilized to examine call volume. The first was the use of hotspot mapping. These maps compiled data by year. Two years of data were examined 2015 and 2016. Four maps were created, one for each year involving 100 series incident types and one for each year involving 300 series incidents. All incidents that were coded as a 100 (fire-related) or 300 (EMS-related) series within NFIRS were included on their respective maps. Those maps then utilized colored mapping to illustrate where there were increased activity in the City of those specific incident types. The maps utilized color-coding to show frequency. Prior to 2015, NFIRS reporting by the department was spotty and unreliable in terms of data analysis so that limited the quality data to those two years throughout this research.

The next approach that was used was to show a breakdown of calls for service by zone for each year. Again, only 100 series and 300 series calls were included in this analysis. This was largely due to the focus of station coverage being on the ability to get to these types of calls in a timely and efficient manner and to limit the variables associated with the multitude of different calls that the department handles each year.

Lastly, response times were evaluated utilizing the departments' fire incident software, *Firehouse.* Reports were generated by the researcher that specifically targeted response times for Engine companies by zone for specific 100 series calls only. A listing of the specific call types

included along with the data found in the reports can be found in Appendix C. This was done for reasons associated to the Public Safety concept. On any given day, KDPS has approximately 20-30 Public Safety Officers (PSO's) patrolling the City and answer calls for service involving police services. All of these officers are trained to the Medical First Responder (MFR) level in the State of Michigan and each cruiser is equipped with a medical bag and AED.

When an EMS event is dispatched, the closest apparatus will respond but PSO's can and often do respond to assist the Engine Company. The EMS data in *Firehouse* was found to have significantly lower response times to addresses with EMS calls (300 series) than that of fire related calls. The cause of this was determined to be the fact that street PSO's would respond to serious EMS events such as a cardiac arrest and due to already being on the street in patrol cars that are quicker and more agile than fire trucks, they could arrive on scene much quicker and that was reflected in the response times. Therefore, the researcher chose to focus on specific fire incidents in which to analyze response data. The premise being that if the first-due Engine Company could make it to a Fire incident within four (4) minutes than the same would hold true for an EMS call to the same locations.

Research question four (4), sought to answer where the City anticipates growth over the next 10 years. In examining this question, the researcher conducted a joint interview with the City Planner, Rebekah Kik and an Economic Development Analyst for the City, Cal Coplai. The interview was designed to explore future growth within the City over the next 10 years so that future needs of the department could be identified and planned for. Specifically, the interview identified areas of economic growth relative to infrastructure being built or planned for and also predicted population growth over the next 10 years.

Additionally, from that interview, additional data was produced showing future predicted growth trends such as construction permitting history, demolition permitting history, as well as population trends. This information was culled from internal databases as well as census tract data. This data was put in the form of maps that showed the increase or decline of each variable by census tract. In completing the analysis this way, the researcher was able to articulate which census tracts were showing growth and which ones were showing decline so that specific areas of the City could be identified and then correlated with response time mapping utilizing GIS to evaluate where the greatest risk is to the City and identify areas that could potentially benefit from a new fire station being built in their area.

Lastly, the final research question will incorporate information garnered in the previous four questions as well as identifying current response coverage from each of the current five stations. Criteria that is found through this research will be used to define what the standard of coverage should be for the department. Desired response times will be determined based upon the research outlined and then that will be considered along with call volume, population growth, infrastructure growth, to evaluate gaps in the current five station model.

The production of maps utilizing GIS technology was done several ways. Real-time traffic data was utilized which created four minute response areas shown on the maps. The size of these response areas would get larger or smaller based upon the time and day. The issue with this was that it is based upon a vehicle travelling the speed limit and stopping for traffic control devices along the way. This is not a realistic measure of a fire apparatus running lights and siren which can exceed the speed limit and disregard traffic control devices as needed.

The literature review documented a RAND study that is utilized by ISO in determining station distribution needs. That study concluded that a fire apparatus running emergency status

(lights and siren) and taking into account having to slow at intersections but not stop and that normal traffic would yield to the oncoming fire apparatus, averages a speed of 35 MPH. Utilizing this speed, GIS maps were created showing the response area for a vehicle travelling 35 MPH for four minutes.

GIS mapping was utilized to first highlight the response areas from each of the individual stations. This was done to examine each of the stations separately. Then a composite map showing all the stations together and the response area that they hypothetically should be able to cover in four minutes time were created. Areas of the map which showed areas in the City that could not be reached within four minutes by an Engine company were highlighted in red. From there, the maps were cross-referenced with data on call volume, population growth and infrastructure development to obtain areas that potentially could benefit from a new station being built.

Two areas specifically were identified as being underserved. Potential locations were identified for new stations within those areas, three in the northwest portion of the City and two in the southeast portion of the City. These five locations were then placed on a map using GIS mapping and response areas were marked out to ascertain the effect on response times if a new station were to be built in those general areas. From those maps, recommendations were made on where future fire stations should be built in the City of Kalamazoo, ultimately answering the final research question.

Limitations

The procedures outlined above do have some limitations. The first limitation is when examining response time as a method of identifying the amount of area a particular station can cover, it is difficult to take into account all the variable associated with response time, such as

traffic, time of day, number of traffic control devices, etc. The use of the RAND study and average speed of a fire apparatus responding emergency status helps to address those variable but cannot take into account every variable that an apparatus may encounter.

Secondly, this study looks strictly at response time and does not address issue relative to dispatch time and turnout time. Dispatch time is defined as the amount of time it takes for the call to be processed to the time that the dispatcher alerts the station. Turnout time being the amount of time from notification of call to the time that the apparatus leaves the station. In addition, the NFPA allows for 80 seconds of turnout time for fires and 60 seconds for EMS calls. KDPS policy dictates that apparatus turnout time be 120 seconds or less. This policy is old and outdated, and does not account for differing calls of fire vs. EMS. This had to be taken into account when looking at overall response time as recorded by *Firehouse*, the department's data software for Fire/Rescue/EMS incidents.

Third, while the 35 MPH model takes into account variables such as traffic, traffic control devices, the time necessary to get a fire truck up to speed and other variables, it was clear based upon response times that were being recorded in our call history that the 35 MPH model was clearly a "best case scenario". Realistically, the ability to reach the outer fringes of this response area model would be extremely difficult based upon local data. It was determined that a better representation of the response area lies in between the model that shows real-time traffic data at 0300 hours on a Tuesday morning and the 35 MPH mapping.

Lastly, the external survey, while sent out to a large population, did not have a relatively high response rate. Only 75 fire departments returned surveys even though multiple attempts at sending out the survey via the path outlined previously were attempted. While the information obtained from the surveys was useful, a higher response rate would have generated more

suggestions relative to the criteria that other departments deemed important in examine their station distribution.

Results

The research was aimed at answering the following five questions:

1. What is the desired response times for Fire and EMS calls for service within the City of Kalamazoo as identified by the current standards and community expectations?
2. What criteria do other Fire departments use when determining their desired response times for Fire and EMS calls?
3. What are the response times and call volumes for the five (5) fire stations currently providing coverage to the City of Kalamazoo?
4. What is the anticipated growth for the City of Kalamazoo over the next 10 years?
5. What areas should be considered for potential locations for new fire stations in order to improve station coverage within the City of Kalamazoo?

The research was designed to provide articulable data regarding the future development of fire stations in the City to ensure adequate fire station coverage as determined by current standards and community expectations.

Interview Assistant Chief Ryan Tibbets - KDPS

In determining what the desired response times are for Fire and EMS calls should be, the literature review provided a foundation relative to what standards or criteria exist to base such decision-making upon. Standards such as NFPA 1710 exist to provide a voluntary standard for which urban departments should try to meet based upon the type of community that the fire department serves. What this standard does not take into account is the level of risk that a

community chooses to take on when they choose to deviate from the above standard or other benchmark that the community has established. That means that some communities may choose to accept some risk by not meeting the standard due to their inability to being able to afford to provide adequate coverage based on the standard. Such decisions take into account the number of calls to a particular area that may be underserved in terms of coverage or the type of calls.

To ascertain what a desired or acceptable level of service is to the City of Kalamazoo an interview was conducted with KDPS Assistant Chief Ryan Tibbets. A list of the questions that were asked of A/C Tibbets can be found in Appendix D. A/C Tibbets was asked to discuss/rank criteria such as NFPA 1710, ISO, predicted growth and current call volume as factors in determining an appropriate fire station coverage and where future stations might need to be located. A/C Tibbets responded that over the last 13-15 years we have not had the luxury from a financial standpoint to actually consider or evaluate the need for future stations. The mentality was do with what you have and try to maintain services during which we were having year after year of budget cuts.

A/C Tibbets stated that we are now fortunate to be able to have the financial possibility to start looking at things that in years past were not possible. Growth both in population and infrastructure due to the "Foundation of Excellence" has led to the discussion of examining where potential gaps exist in our fire station locations. A/C Tibbets believes that while response times seem to drive the decision-making it is important that we examine predicted growth in population and infrastructure along with current call volume in order to drive decisions on where to locate future stations. He states you can overlay these things on a map or compare them side-by-side to show where our current and future predictable gaps exist in our current coverage with five (5) stations.

A/C Tibbets indicated that while needs can be examined and gaps identified with our current fire station coverage, it is important that there is articulation as to what the intended outcomes are relative to building new fire stations or relocating old ones. "There is a need to articulate capital investment and its' intended outcomes" (R. Tibbets, personal communication, March 2, 2017). He further stated that it is important that the need to spend money of such infrastructure such as new fire stations bust first be articulated through not only the identification of gaps within our current system but what will the money spent get the department. Will it decrease response times in a certain area and if so, how many times are we responding to specific area. Is the demand there to justify a new station, etc?

During the interview A/C Tibbets indicated that he had mixed thoughts relative to the question of whether or not the department meets the NFPA standard of four minutes for a response time to have a unit on scene for any Fire or EMS call 90% of the time. He pointed to the public safety model which we currently operate by. He stated that given that we have several officers out in patrol cars, each of whom carries EMS equipment with AED, it does not surprise him that we would not have a PSO on scene in under four minutes. However, he believes that in some areas of the City, the ability to have an Engine on scene in that same amount of time is extremely difficult. With that said, he indicated that the NFPA standard is a realistic standard that the City should attempt to meet.

A/C Tibbets was asked about the expectations of the City Manager and the City Commission as it relates to Fire and EMS response. He responded that he felt that the current City Manager relies heavily upon the experts within the field. Should gaps exists in our current response times or a need exists to improve our service, it would be up to the Chief's of the department to articulate the need for increasing or relocating current stations. He indicated that a

needs assessment would have to be conducted to identify gaps and be able to articulate those gaps to the City Manager. He further stated that unless there are complaints or a situation exists in which there was an inadequate response to a call, the community at large is generally not going to vocalize their expectations.

When asked about ISO and the need to consider station distribution much like ISO does in determining whether or not the City has adequate station coverage, A/C Tibbets stated that ISO is a good baseline but that it should not be the only baseline. It should be taken into consideration along with the NFPS standard and used as a benchmark as to where the department is at relative to coverage. In addition, he indicated that population growth and call volume should also drive decision making and should be combined with the NFPA standard as well as the ISO station distribution modeling to determine future needs of the department.

The last question that A/C Tibbets was asked was if there was an acceptable level of risk that the community, the City Manager, and the City Commission was willing to accept by not meeting certain standards. He stated that he felt, 'if they knew the data, I think they would be concerned" (R. Tibbets, personal communication, March 2, 2017). He stated there are areas of the City that currently have extended response times. These extended response times are well-known in the department but relatively unknown by those outside the department such as members of the community or City leaders. He stated it is up to department leaders to articulate the gaps that exist and to take steps to reduce that risk.

Call Volume and Response Times

Research question three seeks to evaluate KDPS's current call volume for Fire (100 series) and EMS (300 series) calls for service and to gain a better understanding of where those particular calls are occurring. To do this an analysis was conducted of call data for the years

2015 and 2016 to ascertain where calls are occurring in the City and where they are in relation to the nearest fire station.

In an effort to show areas of the City that show high number of responses for fires and EMS calls, hotspot maps have been created based upon call KDPS call volume for the years 2015 and 2016 respectively. In addition, the call volume data is broken into two separate categories, 100 series calls representing Fire run data as defined by the *National Fire Incident Reporting System* (NFIRS), and 300 series calls representing EMS response.

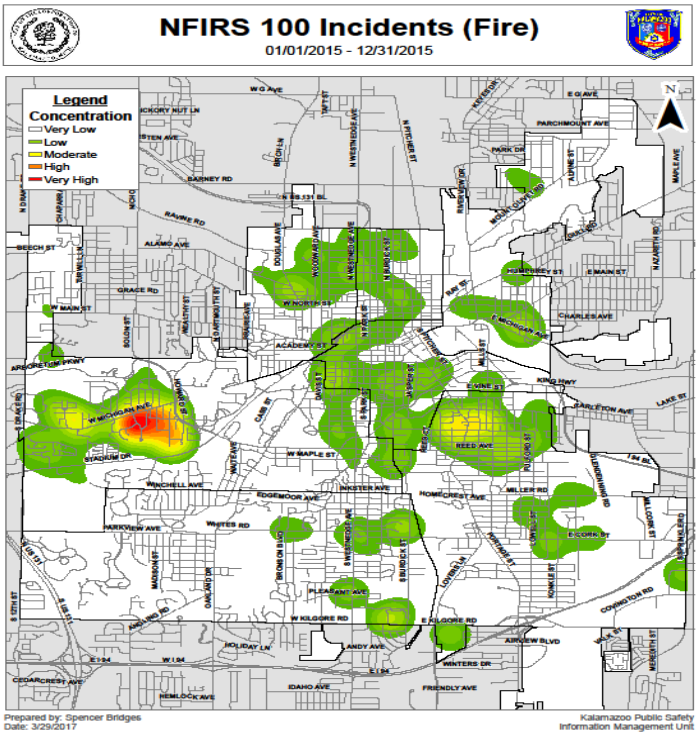


Figure 1a. 2015 NFIRS Fire Incidents (Kalamazoo Department of Public Safety [KDPS], 2017)

In Figures 1a. and 1b, fire run data (100 series) is for year 2015 on the left and 2016 on the right. The maps clearly illustrate a higher call volume for fires in the City's Arcadia and Knollwood districts. This area is in Zone 6 and corresponds to Station 6's first due area. The area is a combination of single and multi-family, residential and represents one of the largest growing areas in the City. In addition to the west

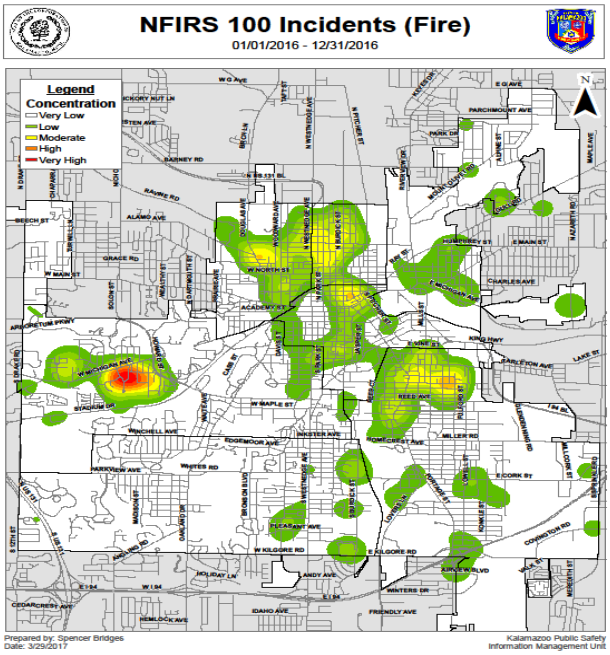


Figure 1b. 2016 NFIRS Fire Incidents (Kalamazoo Department of Public Safety [KDPS], 2017)

side of the City, the figures also show distinct fire call volumes for both years in the City's north side neighborhoods stretching down into the Central portion (downtown) and East side of the City.

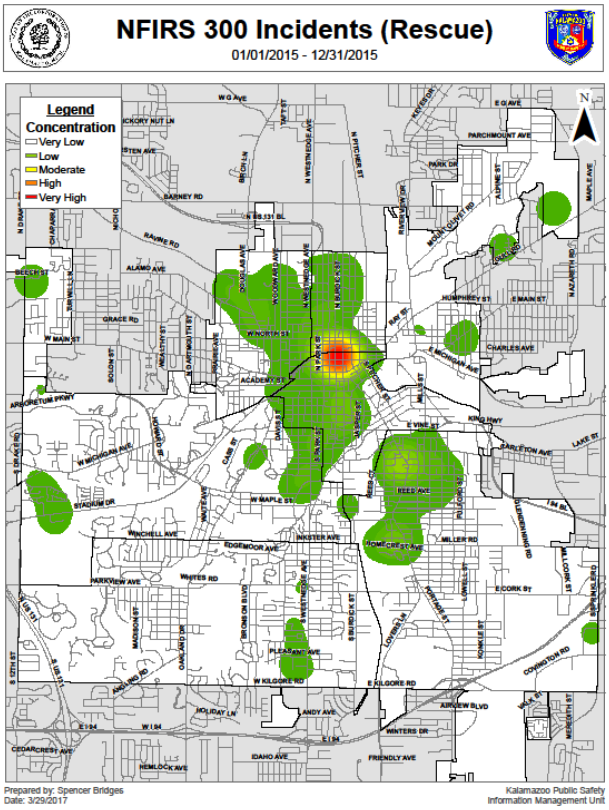


Figure 2a. 2015 NFIRS EMS Incidents (Kalamazoo Department of Public Safety [KDPS], 2017)

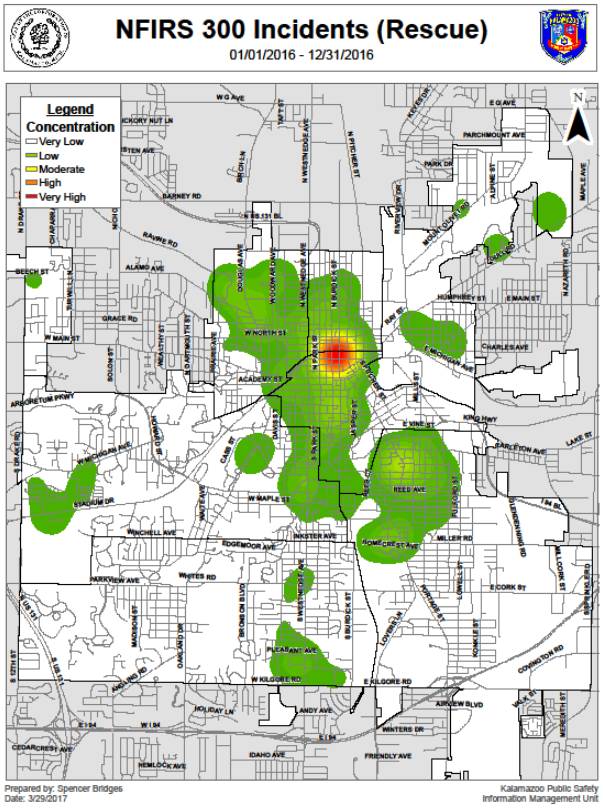


Figure 2b. 2016 NFIRS EMS Incidents (Kalamazoo Department of Public Safety [KDPS], 2017)

The above figures illustrate similar data as the Fire calls on the previous page however they represent 2015 and 2016 EMS calls for service (300 series). As you can see the City's downtown district and Central portion of the City represents the greatest number of EMS runs in both years. The hotspot maps are a good method of illustrating where in the city, KDPS responds to a higher frequency of fire and EMS calls in the City. These maps however do not give exact figures relative to fire and EMS response.

Figure three on the following page shows that data relative to the number of fire and EMS calls that KDPS responded to broken down by zone. The figure only accounts for fire-

related calls (NFIRS 100 series) and EMS calls (NFIRS 300 series) for 2015 and 16 and does not account for other calls for service outside those two call types. The figure above illustrates fire data utilizing a bar graph to show the number of fire calls each year in each zone. As can be seen, Zones 2 and 6 had accounted for a majority of the fire runs in both years. In addition, these two zones also account for the highest number of EMS runs each year also. The only zone that is routinely higher than them for EMS calls is Zone 1, the downtown district.

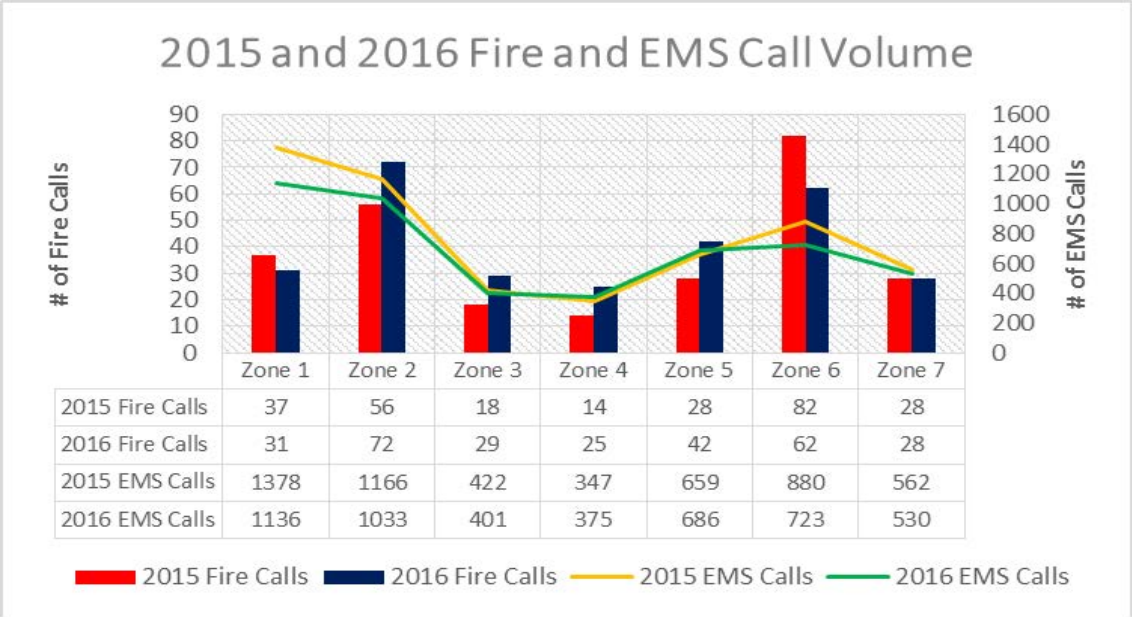
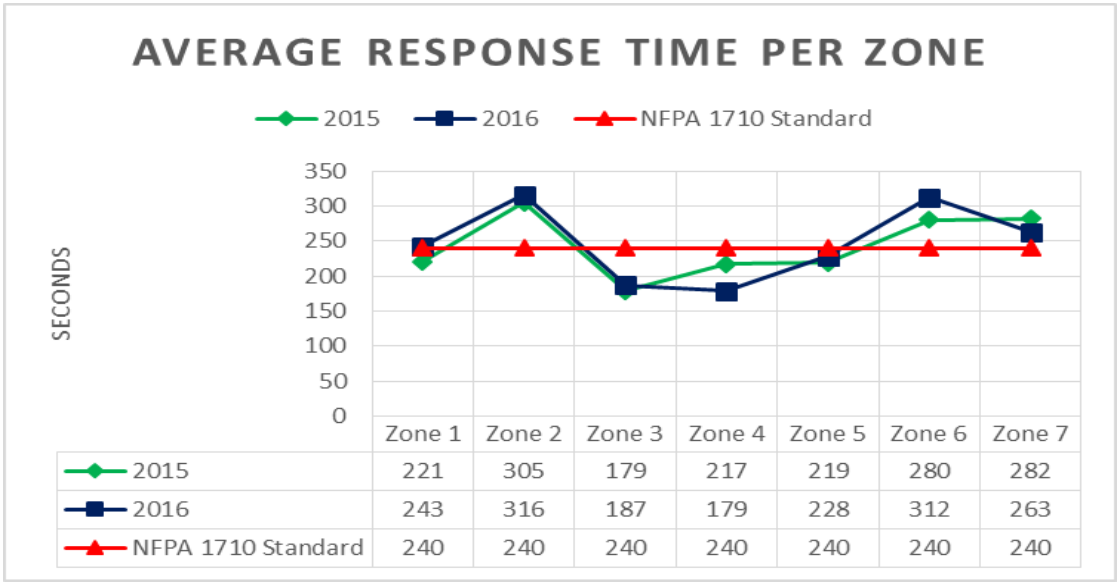


Figure 3. 2015 and 2016 Fire and EMS Call Volume by Zone

In examining response times to fire and EMS calls within the City, it is important to point out that due to the entire department being cross-trained, all of our police patrol cars are outfitted to respond to EMS calls. Therefore, when examining response times the focus was placed on the ability of the department to arrive on scene of fire calls within 240 seconds for the first due apparatus.

The average emergency response times of the first due Engine company to a Fire in each of the zones for the past two years is illustrated in the Figure on the next page. The red line represents the NFPA 1710 standard requiring that the first due Engine company arrive on scene

in 240 seconds or less. The green line represents data from 2015 while the blue line represents data from 2016. As can be seen, the lines from 2015 and 2016 follow each other closely. Response times to the southern and western areas of the city to include zones two, six, and seven all exhibit response times greater than the NFPA standard. These three zones represent the largest response areas and exhibit extended response times to a portion of their respective districts.



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
2015	221	305	179	217	219	280	282
2016	243	316	187	179	228	312	263
NFPA 1710 Standard	240	240	240	240	240	240	240

Figure 4. Average Response Time per Zone

Zone one which represents the central portion of the City which includes the downtown area, is served by four separate Engine companies that all have a portion of that zone as its first due territory. This includes Engine 2, 3, 5, and 6. The response times to zone 1 are in large part influenced by the extended response times of Engines 2 and 6 which have longer runs to get into their first due area. The response times to the north and northeast side of Kalamazoo all show average response times of less than 240 seconds. This area is served by Engine 3 and Engine 5. The biggest area of concern with regards to response time of the first due engine however, lies in

zone six. While Engine 6 is the primary Engine due to this district it arrived first in only 45% of all fires within the zone. Engines 5 and 7 were able to get into certain areas of the zone faster due to the large response area associated with zone six.

Lastly, the data culled from FIREHOUSE, showed that none of the seven zones met the NFPA standard 90% of the time, however certain zones consistently were lower than others in terms of percentage of time that the standard was met. Zone two only met the standard 34% of the time in 2016 down from 2015 when it was at 55% of the time. Additionally, zone six only met the standard 45% and 40% of the time in 2016 and 2015 respectively. All the other zones had percentages in the 70's and 80's in terms of meeting the NFPA standard of 240 seconds. The data utilized to compile these response time statistics can be found in Appendix E and F.

External Survey

An external survey was sent to multiple fire departments in an effort to gain insight into what they felt were the most important factors that should be considered when determining to locate a new fire station. Understanding that the problem for KDPS is that it has not had to evaluate its current model of station locations in over 25 years, there is no one currently employed by the department that has ever examined where new fire stations should be built. The external survey was designed to obtain knowledge from those departments that have conducted such a study and use that information, at least in part, to help determine

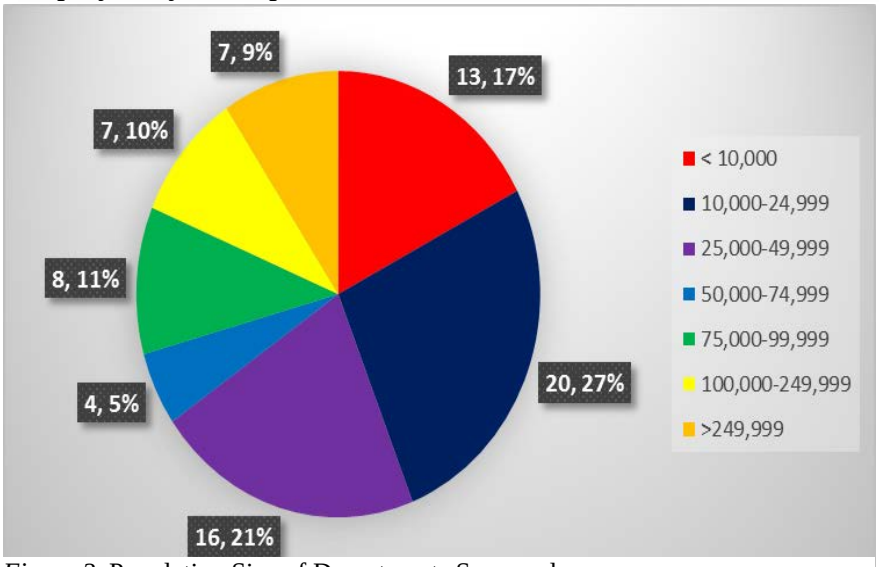


Figure 3. Population Size of Departments Surveyed

what criteria KDPS should use in making decisions about where to build new stations in the future. A copy of the external study can be found in Appendix A.

The first initial questions requested that the respondents answer some basic demographic information about their respective department. The below figure shows the breakdown of the populations that are served by respondents. Of the 75 departments that returned the survey, 50.6% (38) indicated that they were from full-time department. The largest number of departments served a population of 10,000 to 24,999 residents. The least number of surveys were returned by departments serving communities with 50,000 to 74,999 residents.

In addition to the size of the communities that were served, fire departments were were asked how many fire stations that they had in operation. The survey found a majority of those departments surveyed (46 of 75, or 61.3%) had three or more stations in their response area. Of the remaining 29 departments that returned the survey, 16 or 21.6% had only one station.

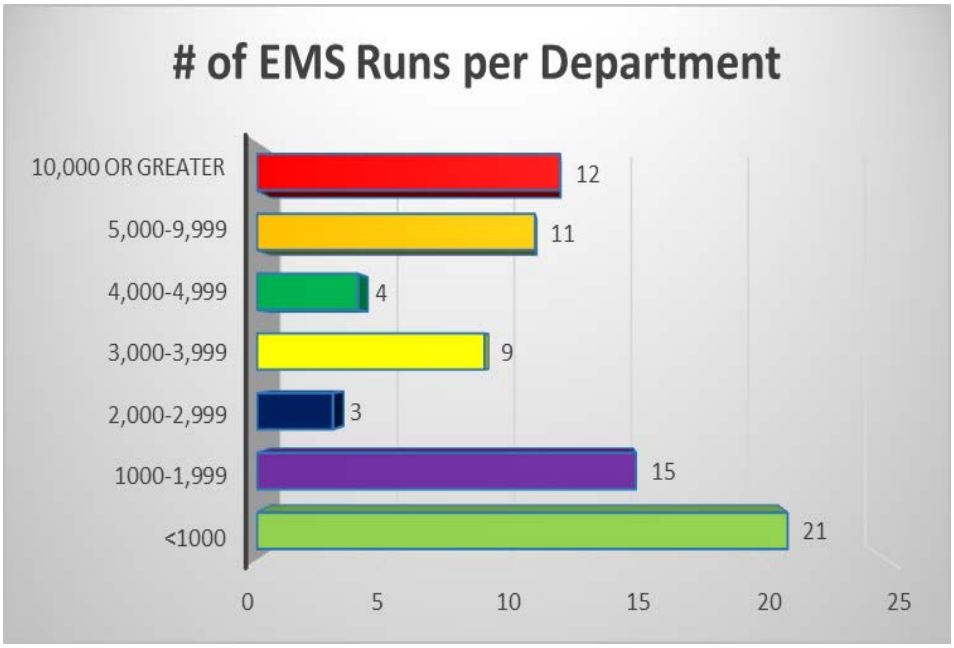


Figure 6. # of EMS Runs – Departments Surveyed

The figure above illustrates the number of EMS runs that departments that completed the survey run annually. The data shows that 23 of the 75 departments surveyed ran more than 5,000 EMS

calls annually. That represents approximately 1/3rd of the departments surveyed. Conversely, 21 of the 75 (28%) of the departments surveyed respond to fewer than 1,000 EMS calls annually.

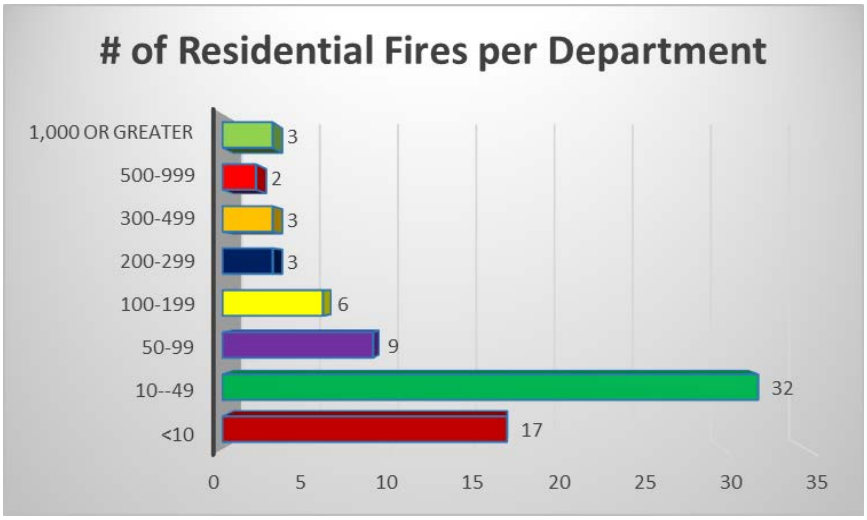


Figure 7. # of Fire Runs – Departments Surveyed

In Figure 7, the same data is shown relative to the number of residential structure fires that the departments surveyed annually respond to. As shown, 32 of the 75 departments surveyed (42.6%) indicated that they respond to less than 50 residential structure fires annually.

After gathering demographic data, departments were asked if they had ever conducted an analysis of their respective fire station locations to evaluate the coverage that each station provides and to identify gaps in their level of service. Of the 75 departments that responded to the survey, 53 indicated that they had conducted such an analysis. This represents 70.6% of all fire departments that responded to the survey. Of the remaining 22 departments, 17 indicated that they had not conducted any type of analysis and another 5 departments responded that they did not know if an analysis had been conducted or not.

The respondents that answered yes that they had conducted an analysis of their fire station location were then asked to identify criteria that they used in their analysis. They were asked to check all of the criteria that applied to them. The criteria listed were: NFPA 1710 or 1720 (response standard), ISO station distribution, current call volumes, predicted future

development, and recommendations based on accreditation. The figure below shows the breakdown of what those departments used as a basis for their analysis of station location coverage.

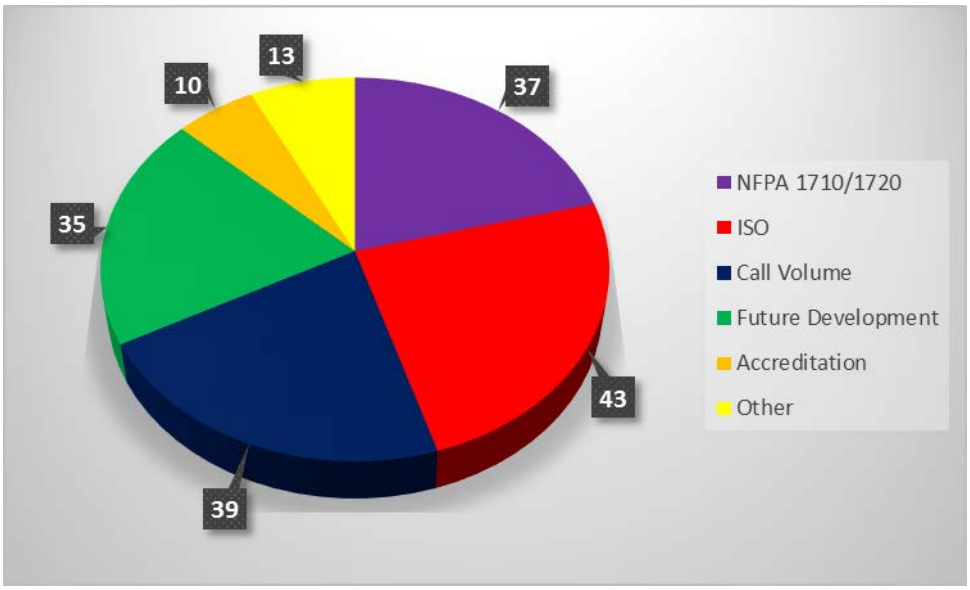


Figure 8. Criteria Used by Departments Surveyed in Fire Station Analysis

As illustrated, of the five criteria that were given as choices relatively few departments indicated that accreditation drove their analysis of their fire station locations. With that said, the other four criteria all appear to have played a significant role in most of the department's analysis. Surprisingly, ISO Station Distribution was identified as being the most utilized criteria, with 43 of 53 departments (81%) indicating they relied on ISO as a criteria in analyzing their fire station locations and determining gaps in coverage. NFPA 1710, current call volume and projected future development were also cited by respondents as being important to the analyzation process and all three scored relatively high. Call volume was cited by 39 departments (73.6%), NFPA 1710 by 37 departments (69.8%), and future development by 35 departments (66%) as criteria that was utilized in analyzing their respective fire station locations.

Thirteen departments indicated that they used something other than the five (5) choices that they were provided. Examining those answers provided under the "Other" category resulted in additional criteria that was used to determine fire station locations for those departments. Some of those criteria were: Management studies, population density and property value data, call mapping, risk assessment, population profiling. These answers provided additional criteria to consider when evaluating which criteria KDPS should utilize to base their decisions upon.

Additionally, departments were asked to rank the five (5) criteria outlined in order of importance based upon how they felt it impacted the decision-making relative to where new fire stations should be built. While 23 of the 53 respondents ranked NFPA 1710 as being the most important decision-maker, it was ISO station distribution that was ranked highest overall. In Figure nine on the next page, the rankings of the five (5) criteria show the number of departments that ranked each of the criteria and how they ranked them. As illustrated, while the NFPA standard received the majority of 1st place votes, it was ISO station distribution that ranked overall the highest by receiving more 1st, 2nd and 3rd, place rankings than the NFPA standard. Overall, the order of ranking as determined by the external study ranked the criteria as follows: 1) ISO station distribution, 2) NFPA 1710, 3) Call volume, 4) Future growth, and 5) Accreditation.

The external survey then looked at the NFPA standard 1710 which indicates that departments should be able have response times of less than 240 seconds (four minutes), to EMS calls and also be able to have the first due apparatus on scene for a residential structure fire, 90% of the time. If response time was viewed as being a vital component of the decision-making process, the survey wanted to ascertain how many departments were able to meet this standard.

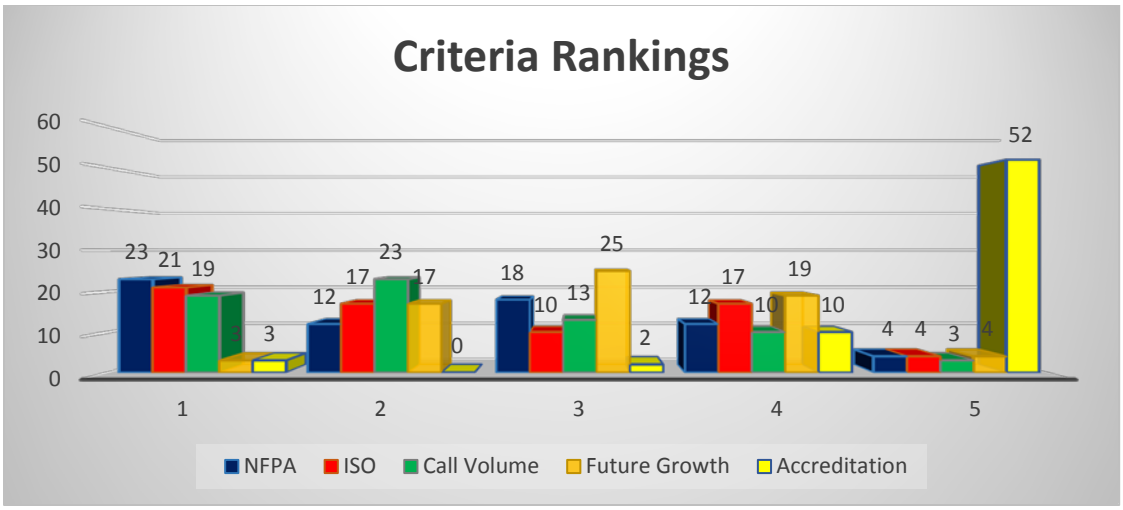


Figure 9. Ranking of Criteria (Importance in Fire Station Planning)

The survey asked only those respondents that had indicated they were full-time departments or those combination departments who have 50% of their personnel being full-time to answer questions related to NFPA 1710. Of the 75 departments that returned the survey, 46 indicated that they met that criteria. Of those 46 departments, 23 (50%) indicated that they were able to meet the NFPA standard of 240 seconds for EMS calls 90% of the time. For fires, 54.4% (25) of the departments indicated that they could meet the response time of 240 seconds 90% of the time.

Of the departments that indicated that they could not meet the NFPA standard, they were asked to provide average response times to those respective calls, 90% of the time. For EMS and Fire runs the answers had significant variation from five to 12 minutes on average for EMS calls and five to 11 minutes to Fire calls. A majority of the responses indicated that they could have an apparatus on scene to either an EMS or Fire call within 5 minutes of checking enroute to a call, 90% of the time.

Lastly, NFPA 1710 indicated that for fires that a full first-alarm assignment arrive on scene no later than eight minutes (480 seconds) to 90% of fire calls. Respondents of the survey

indicated that only 43.5% (20) of the full-time departments could have a full first-alarm assignment on scene within the NFPA standard. This is believed to be due to the large number of variables as to what each department considers a "full first alarm assignment" to be. For example, a department that relies on automatic aid for its full first alarm assignment may not meet the standard due to the automatic aide coming from a neighboring department and further out. Those respondents that answered that they were a completely full-time department were more likely to meet the standard. Of the 20 departments that indicated they could meet the eight minute standard for a full first alarm assignment, 19 of them are classified as being full-time departments.

The external study determined that other fire departments feel that the top four criteria; NFPA 1710/1720, ISO station distribution, call volume, and predicted growth should all be considered when determining where to build new fire stations. It is clear that there is not one criteria that stands out from the rest and that multiple criteria should be considered when determining what is the best fire station coverage for the City of Kalamazoo.

External Interview – Rebekah Kik and Calpoi

In an attempt to gain a better understanding of predicted growth within the City of Kalamazoo over the next five to 10 years, a joint interview was conducted with the City's Director of Community Planning and Development Rebekah Kik and Economic Development Analyst Cal Coplai. Several questions were asked of these two individuals to gain a better grasp of where current development is occurring and where they predict it will continue to occur over the next 10 years. A list of questions that were posed to both of them can be found in Appendix G.

I asked them to evaluate where they believed that the City of Kalamazoo will see increased development by 2022 and 2027 respectively. Kik indicated that she really felt that the City's downtown will see strong development in the next five years. She bases that on her current discussions with developers who are looking to developing the downtown area. She indicated that there is a strong push to develop the area along the Kalamazoo River which has seen some development over the past couple of years, but she indicated that there are several projects along the river that are in various stages of development and she anticipates that a majority of them will move forward. The Kalamazoo River runs north/south on the East side of the downtown district. I asked her what type of development she anticipates based upon her discussions with developers in the community. She stated that it will be a mix of residential and commercial with the residential being more multi-family apartments/condos. In addition, talk is underway for additional hotel space and several five-story residential buildings. Kalamazoo currently has a sky-rise set to begin construction currently and talks are underway to build an additional one in the downtown area.

Kik was asked besides the downtown area and the east side of the downtown core along the river, where else will Kalamazoo see the biggest development. She indicated that the southeast quadrant of the City currently has several develops interested in developing the Davis Creek Business Park which currently only has a couple of businesses in operation. She states that the development here will be primarily commercial and does not anticipate a lot of residential development in this area. When asked about the City's west or north side neighborhoods. She indicated that the north side of Kalamazoo has seen significant development especially in the residential market and will continue to be steady. Kik stated that the west side of Kalamazoo will see significant development in the Arboretum Parkway area. Construction of

Phase 3 of a condo project is already occurring. In addition, there are plans for development of the remaining portions of Arboretum Parkway with a mix of single-family and multi-family residential. She further indicated that there has been a large amount of renovation work done along Stadium Drive, one of the major streets that leads to the west suburbs, as well as Drake Road which represents a boundary line with our mutual aid partners Oshtemo Township, along the west side of Kalamazoo.

Cal Coplai handles the statistical evaluation of the economic development for the City of Kalamazoo. When discussing future development he indicated that it would be wise to look at current permits to gain a better understanding of where we are seeing growth. He provided two maps which provide information regarding a historical perspective of construction permits versus demolition permits that have been pulled within the last couple of years.

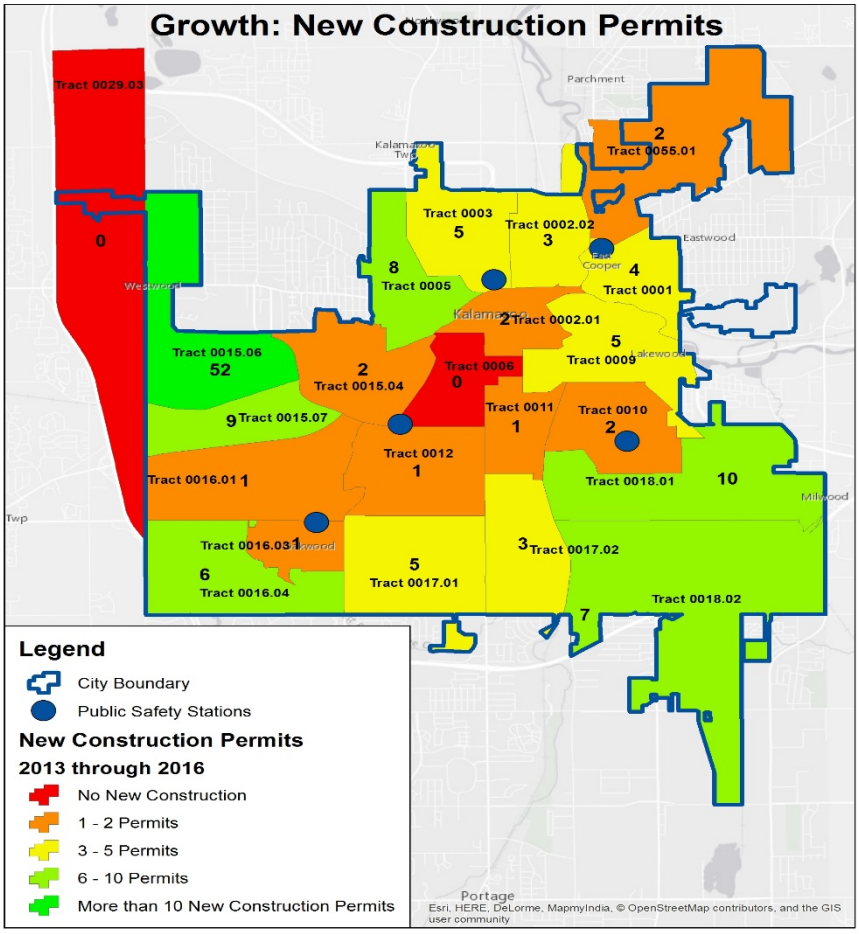


Figure 10. New Construction Permits (2013-2016) (*COK Fire and EMS Analysis*, 2017)

The figure to the left illustrates the number of construction permits that were pulled in the years 2013 thru 2016. The data is separated into census tracts to better grasp where development is occurring in the City of Kalamazoo, and uses colors to show where the majority of permits have been pulled. Dark

green represents the largest number of permits pulled during the time period in question while red represents the least number of permits. In addition, the location of the five (5) KDPS fire stations are indicated on the map with blue dots.

The dark green area shown on the west side of Kalamazoo is the area including Arboretum Parkway that Kik identified as being an area of significant growth in the next five to 10 years. As can be seen, during that time period, census tract 15.06 had 52 construction permits pulled, and the census tract directly south of it had 9 permits pulled during the same time period. Those 61 permits that were pulled from 2013-2016 represent approximately 40% of all the permits pulled during that timeframe. Additionally, the figure shows that the southeast quadrant of the City saw 17 permits pulled during this same time representing approximately 11% of the total permits pulled.

In addition to construction permits that were issued during those years, Coplai also produced a similar graph which highlights the number of demolition permits that were pulled during this same time. Figure 11 utilizes the same color-coding is used which dark green indicating census tracts that saw a large number of demolition permits

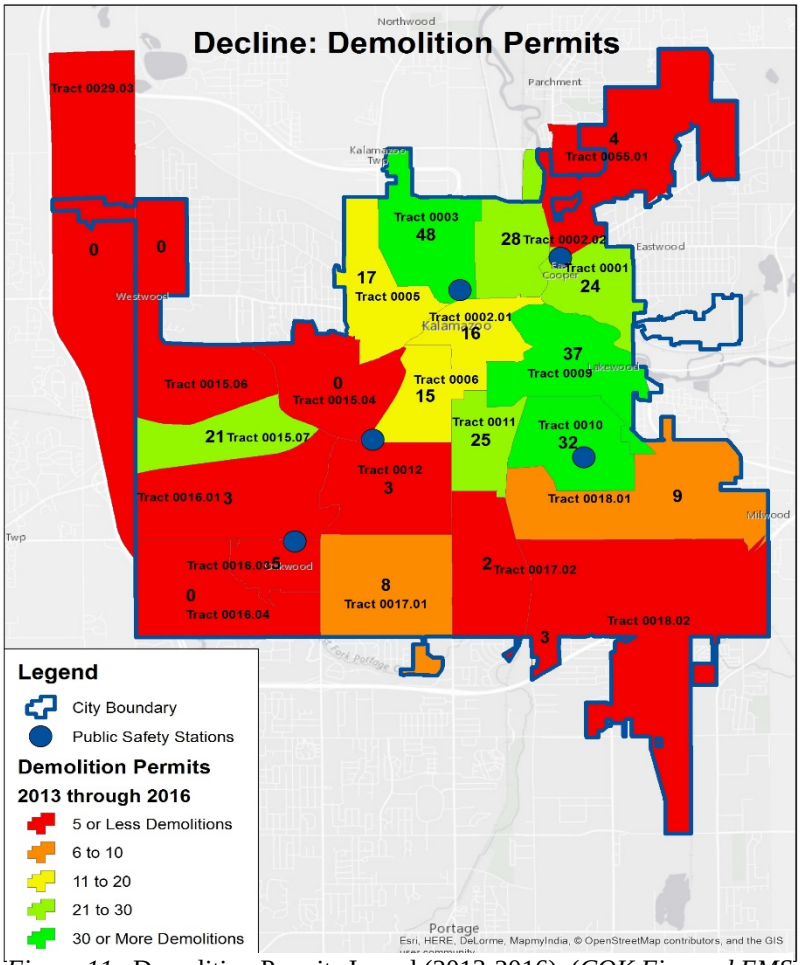


Figure 11. Demolition Permits Issued (2013-2016) (*COK Fire and EMS Analysis*, 2017)

pulled and red indicating that relatively few were pulled. Discussion of the implications these two graphs illustrate will be discussed later however it is important to point out a couple of items that are telling.

There appears to be an inverse relationship between the two graphs, especially in the areas where the graphs show high numbers of construction permits in the City's west and south sides. Secondly, much of the demolition permits are focused in the downtown area. Coplai and Kik stated that this is an indicator that due to the lack of buildable area in the downtown area that developers are demolishing existing structures in preparation for future development that has been discussed earlier. Census tracts 9 and 10 show 37 and 32 demolition permits respectively and these areas fall along the Kalamazoo River, the area that Kik indicated represents high interest with developers currently.

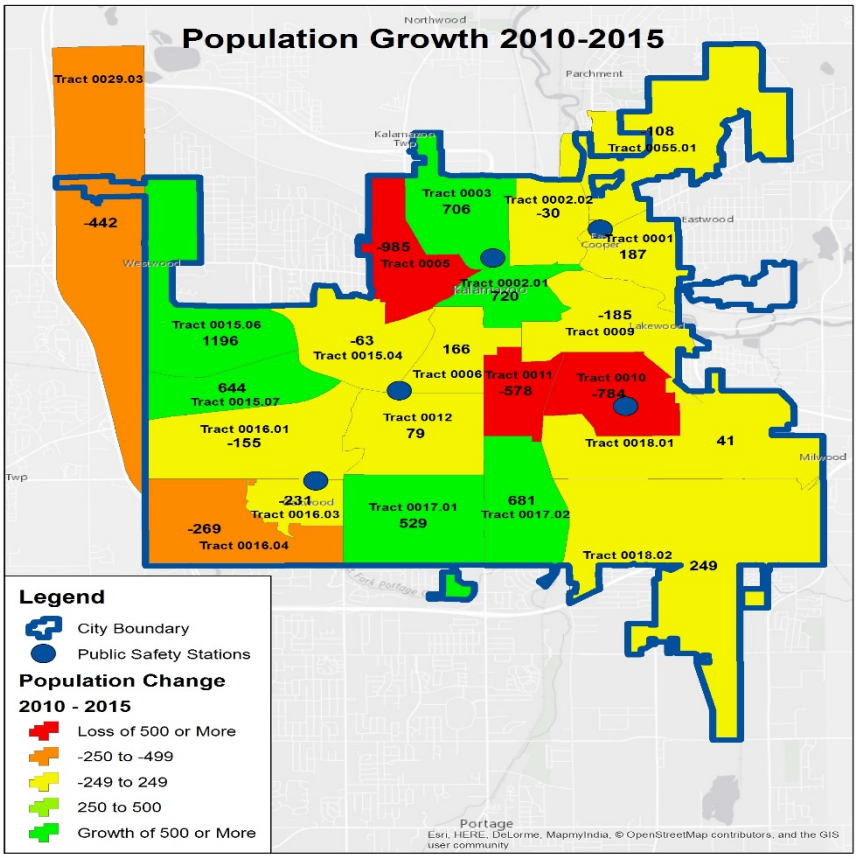


Figure 12. Population Growth/Decline (2010-2015) (*COK Fire and EMS Analysis*, 2017)

In addition to economic and infrastructure development, I also asked about projected population growth within the City of Kalamazoo. Kik indicated that the recent rollback of

property taxes from over 19 mills down to 12 mills will help to encourage more families to move into the City. In addition, she anticipates steady growth as their projections show that more and more people are being drawn back to the urban core to reside. Coplai again indicated that past growth of the City is a good indicator about where population growth will occur and to what extent.

Figure 12 on the previous page illustrates the population growth by census tract between the years 2010 and 2015. As can be seen on the map, darker shades of green illustrate areas of the City that exhibited the greatest growth with the areas in red seeing the largest loss of population during that same time period. Again, the areas that saw the most significant growth are census tracts 15.06 and 15.07 which also represent the area in which the greatest number of construction permits Have been issued in the last three years as well. Additionally, the south side along the Westnedge Ave. corridor saw an increase in population as well as the north side of Kalamazoo indicative of the steady growth that Kik eluded to earlier.

As the interview has shown, certain areas of Kalamazoo have seen an increase in population and development over the past 5 years even though the fiscal outlook of the City was in question. Kik and Coplai both stated that with the advent of the *Foundation of Excellence* that was discussed in the Background section of this paper, they believe that the development of certain areas in the City as well as increased population growth is set to explode.

Potential Future Fire Station Locations

To answer the fifth research question as to where future fire stations should be built, the researcher utilized GIS mapping to evaluate the coverage that is provided in the current five (5) station deployment model utilized by KDPS. Previously we discussed the NFPA 1710 standard which requires the first due apparatus to a structure fire be on scene within 240 seconds once

they leave the station. In addition the author discussed how ISO utilized the 35 MPH as developed by RAND Corporation as its basis for identifying the amount of area an apparatus can cover. To evaluate both of these items, GIS maps were created to show both of these response guidelines to gain a better understanding of their effect on station coverage.

Appendix H contains all of the maps that were created for this portion of the research, however an example of one of the station maps can be found in Figure 13 below. The map shows three separate travel distances for from Station 6, home of Engine 6 and Truck 6. The first line (green) represents the distance that can be travelled in four (4) minutes by Engine 6, based on real-time traffic conditions for a Tuesday at 11 am. The brown line corresponds to

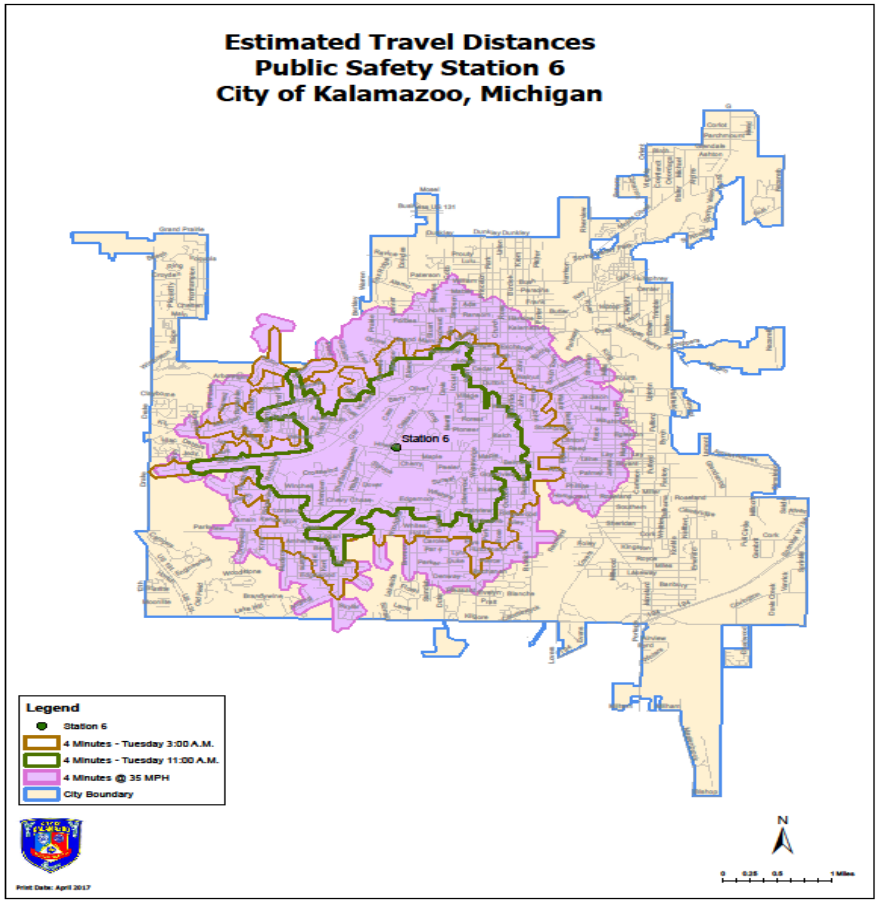


Figure 13. Estimated Travel Distances - Station 6 (Hoch, 2017)

the area that can be travelled in the same four minute time frame but at 3 am on a Tuesday. This is significant because as expected, the amount of traffic can play a significant role on response times within a specific area. The only problem with utilizing these response areas as a basis for

comparison is that they cannot account for a fire apparatus running emergency status (lights and siren) and they cannot account for a fire apparatus that can exceed posted speed limits, disregard traffic control devices and get other motorists to yield and pull over when running emergency status.

In an effort to project an area that an apparatus can respond within four minutes that takes into account lights and siren, traffic, and traffic control devices, the RAND Corporation came up with an equation which found that on average an apparatus can travel 35 MPH to a call running emergency status. Figure 14 to the right illustrates an example of the coverage that each station can provide using the 35 MPH average as a basis to travel four minutes. The area highlighted in red in Figure 14 represents the area that is currently underserved. These areas have response times that can average between five to eight minutes depending on how far out of the response coverage areas they are. The 35 MPH average that the RAND Corporation developed is based upon a perfect world and tries to account for as many variables as possible. Unfortunately, the equation cannot factor

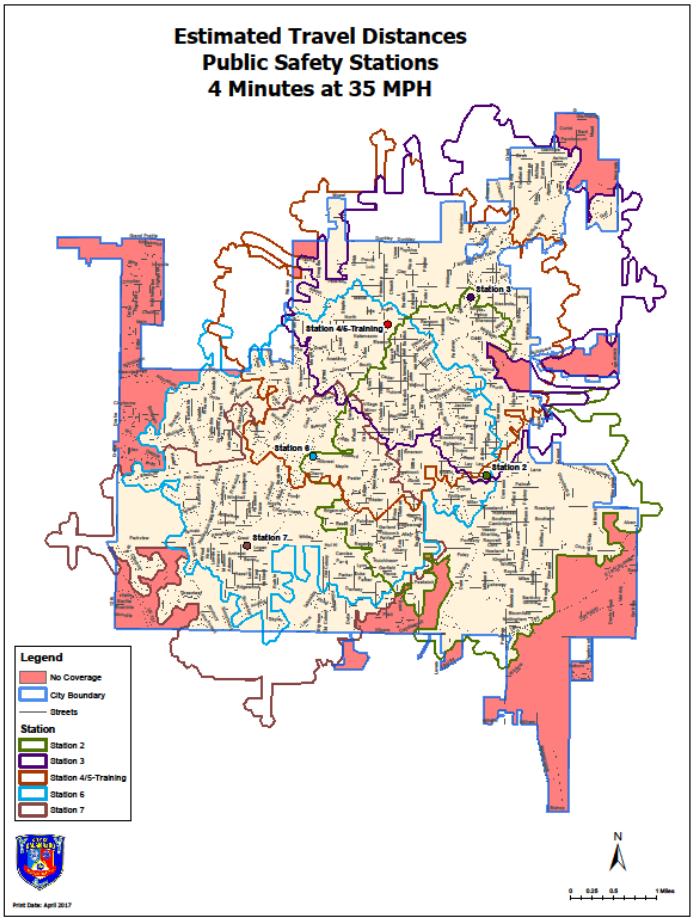


Figure 14. Composite City Fire Station Coverage – 35 MPH (Hoch, 2017)

all variables for all departments across the country and must be taken for what it actually represents. It represents an estimated average that apparatus can travel and in reality does not represent a certainty. In all actuality, the distance that any one station can cover is probably found somewhere between the 35 MPH average and the maps illustrating the coverage area for 3 am in the morning on a Tuesday. These maps were repeated for each stations to illustrate the actual area that each station can cover based upon a desired four (4) minute response time.

Figure 15 below illustrates what the 3 am and 11 am Tuesday morning response coverage would look like. This map shows the four minute response standard at 3 am on a Tuesday in gold and also a four minute response area at 11 am on Tuesday shown in green. The remaining area shown in red illustrates the underserved area of the City of Kalamazoo. As can be seen in the map, the amount of area that is underserved by the current station deployment is much larger than the map that utilizes an average 35 MPH speed to illustrate response coverage. While Figure 15 to the left illustrates the same areas as being underserved, this map shows a significantly larger amount of

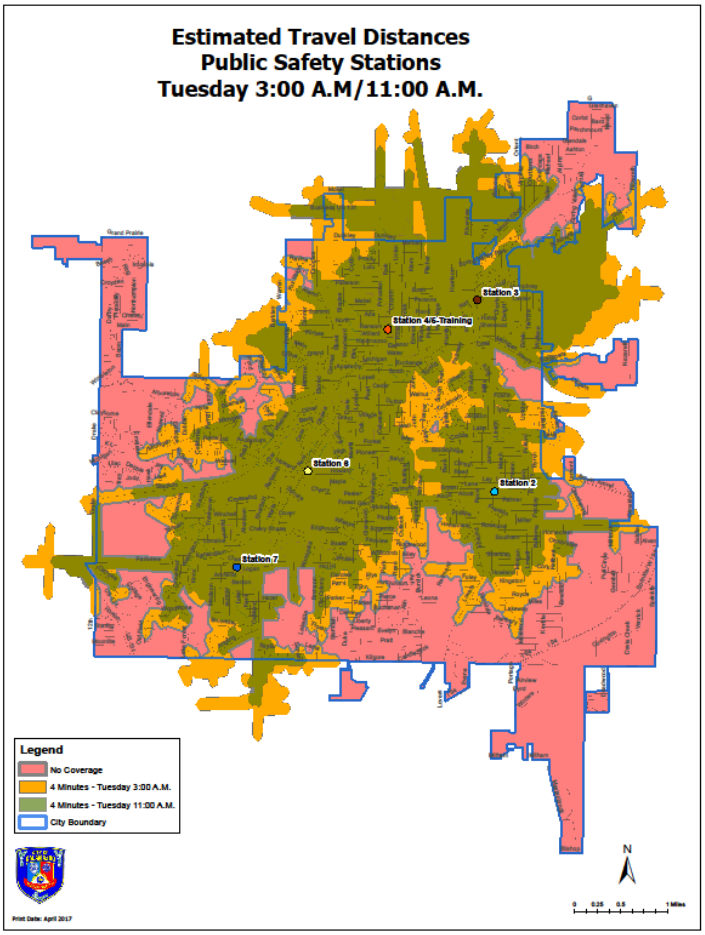


Figure 15. Composite City Fire Station Coverage 3am/11am (Hoch, 2017)

area that is underserved comparatively to Figure 14, specifically in the northwest and southeast portions of the City.

Figures 14 and 15 along with the individual station maps as shown in Figure 13, all provide a basis from which we can examine where new fire stations should be built. In addition to the figures, looking at additional variables as discussed previously such as call volume, future predicted growth and predicted population growth all provide a basis for identifying potential locations for future station development to better serve the community.

In evaluating station coverage that KDPS has with its' five (5) station current deployment model, locations within the City were identified as possible areas that could be potential sites for future station construction. The areas that were identified as possible areas to build future fire stations were based upon the response maps discussed previously while taking into account the maps that illustrated where growth was currently occurring as well as where the prediction of future growth was identified. Additionally, population growth that has occurred over the last five years and illustrated previously was utilized. Together two specific areas were identified as areas within the City that should be evaluated further for constructing a future fire station to serve the needs of those underserved areas which are growing and will need better fire and EMS coverage in the near future.

The two areas of the City that met these criteria were the City's northwest side and the south and southeast area of the City. The research conducted showed that fire station response times were greatest on the City's northwest and southeast sides. The focus of future fire station development was focused on those areas since those areas were also seeing a significant increase in construction growth and in case of the northwest portion of the City, significant population growth.

Three potential sites were examined on the City's northwest side and two sites on the southeast. Those areas that were identified as potential sites were:

1. 2900 Howard Street
2. 800 S. Drake Street
3. 3700 W. Michigan
4. 3300 Lovers Lane
5. 200 E. Cork Street

These five locations were plotted on GIS mapping and the same analysis was conducted based upon what was done for the current five stations. Maps showing the five above areas and their respective projected response coverage areas utilizing the same analysis that was used for the departments current stations can be found in Appendix I.

Of the three (3) locations on the City's northwest side, 3700 W. Michigan appears to be centrally located and provides a significantly better coverage area than the other two potential locations (2900 Howard and 800 S. Drake). The most significant reason that 3700 W. Michigan is the best fit for what is needed is due in large part to its ability to provide evenly distributed coverage to areas that are currently underserved. The other two locations are closer to the City's boundaries and therefore have a large portion of the response area outside the jurisdictional area of the City. 3700 W. Michigan provides the greatest amount of coverage to the areas that are underserved currently without wasting coverage area in surrounding communities.

2900 Howard appears to be a little too far to the north and therefore extends a majority of its coverage area into Kalamazoo Township. What is gained in the underserved areas to the north and west is then lost in coverage along Stadium Drive, a major commercial thoroughfare and artery leading into and out of the City. 800 S. Drake represents a boundary street with

Oshtemo Township. As such, half of the response coverage area for this location is in Oshtemo Township.

When evaluating 200 E. Cork and 3324 Lovers Lane, both locations provide additional coverage to those areas currently underserved. Additional consideration should be given to whether or not this station will be an additional station added to the existing infrastructure or if this station will replace a current station in operation. If the determination is made that this location would replace an existing location then the best placement based response time coverage and overlap with other existing stations would be 200 E. Cork Street. If however the determination is made that an additional station shall be built in addition to existing stations then the best location would be in the area of 3300 Lovers Lane. This location provides greater coverage into the extreme southeast corner of the City.

Four additional maps were created and can be found in Appendix J. These four maps represent the following hypothetical situations from which additional analysis can be done. These four maps illustrated two possible choices for the City to consider. The first two maps are composite maps of the City fire stations that show adding two stations bringing the total number of stations at KDPS to seven. No existing stations would be closed down. The difference between the two maps is the method of computation used to compute the response coverage shown. One map utilizes real-time traffic for a Tuesday at 3 am and 11 am, while the other shows the 35 MPH response coverage area. Both maps clearly show the areas that would still be underserved by those stations.

The other two maps included in Appendix J illustrate the construction of a new station in the northwest portion of the City, but calls for the re-locating of Station 6 to the area of 200 E. Cork Street. While this still represents building two additional stations the net gain in number of

stations is only one thus keeping future maintenance and personnel costs lower. The same format was utilized to illustrate the response times. In the next section, additional discussion will occur regarding the benefits of each plan.

The above research was conducted in order to answer the five specific research questions set forth by this ARP. In the paragraphs that follow, this ARP will discuss the implications of the research and how that research has directly answered the research questions and led to a foundation from which recommendations on where to locate new KDPS fire stations in the future.

Discussion

The purpose of this research was to analyze response times, call volumes, and anticipated future growth to determine where future fire stations should be built. This section will discuss how the research conducted relates to the literature review to answer five basic research questions. The authors' interpretation of the study results will be presented and the implication of those results will be discussed.

The problem that faced the author was the fact that in attempting to determine where future fire stations should be built in the future, there was no previous research into what criteria should be utilized when analyzing where to build stations. In addition, there had not been any studies conducted in the past 20+ years that would serve to guide or facilitate current research into our current station coverage and predicting future fire station development.

Evaluating Criteria

Prior to conducting a study into how effective our current station coverage was, the author needed to identify criteria that should be used in the evaluation. Identifying the determining factors or at least those factors that should be emphasized in the evaluation was

crucial to establish a foundation in examining where coverage gaps exist and why. During the literature review several criteria were identified that influence where fire stations should be located. These criteria were then evaluated by the research questions a, b, and d, to ascertain how impactful each of the criteria were in real-life application and which of the criteria should be utilized by KDPS when making decisions relative to future fire station location.

While there are many factors that are considered, the literature review along with the research conducted clearly identified one specific criteria as being a major factor in determining where to build a new fire station. "In considering potential sites within a community, acceptable response times within the station's geographic response area, along with other factors, will become the most critical factors" (Mishefske, 2017, p. 2).

When discussing response time, NFPA 1710 identifies staffing levels and response times for full-time fire departments. The research was not concerned with staffing but sought to identify what response standard should be utilized for KDPS. Meaning what should the response time be of the responding apparatus and why. NFPA 1710 requires a fire department to establish the following objective, "240 seconds or less of travel time for the arrival of the first arriving engine company at a fire suppression incident and 480 seconds or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident" (NFPA, 2016, p. 7).

The literature review found that the NFPA 1710, 240 second response time standard is based upon numerous studies into fire growth and cardiac arrest incidents that support the quicker that units can arrive on scene the better the capability of the fire department in limiting property damage and civilian injuries in fires and increasing the number of lives saved in serious EMS calls such as a cardiac arrest.

> There are a number of critical time frames that the fire department can manage as well as some it cannot, that impact success….Response time is one of the most manageable segments of time in the entire sequence. This is the amount of time that it takes for a piece of apparatus or an ambulance to travel from a fire station to an incident scene (wheel start to wheel stop). Travel time can be managed by selecting strategic fire station locations based on the amount of time that it takes to travel from the fire station along the most efficient travel route to the incident scene (ESRI, 2007, p. 5-6).

In addition to NFPA 1710, the literature review also discussed ISO and its station distribution requirement. "ISO's criteria say that a built-upon area of a community should have a first-due engine company within 1.5 road miles of the protected properties" ("Response time," 2007, p. 1). This requires that a engine company have a response time of 3.2 minutes to each protected property in its' protection area. While ISO is much more stringent than NFPA 1710, it uses similar principles of statin distribution relative to the ability to be on scene in matter of a certain amount of time. All of which is predicated on the ability to stop a fire before it gets too big or save a person's life who is in cardiac arrest in the most optimum time as determined by numerous studies.

The literature review clearly outlines the importance of response time as a criteria that should be considered when evaluating fire station coverage. The research also found that response time is important. The external study that asked fire departments to rank the criteria that they felt were most important showed that three-quarters of the departments indicated that they used the NFPA 1710 and/or the ISO station distribution guideline when analyzing their fire station locations. Overall, ISO was ranked second and NFPA 1710 third when fire departments were asked to rank their importance in determining where to build a new fire station.

In researching what the desired response times are for fire and EMS calls in the City of Kalamazoo, Assistant Chief Ryan Tibbets indicated that he did not feel that as a department we meet the NFPA standard in all circumstances. He indicated that he felt that our PSO's who are in patrol cars are able to help us meet the standard on the EMS side of calls however, he did not feel that we could make the standard in all circumstances. A/Chief Tibbets indicated that response time, while important should also be considered with other factors such as call volume and predicted growth. He stated that decision-making on new stations should be more than about response times. It is about evaluating how you will improve service to the community (R. Tibbets, personal communication, March 2, 2017). Ultimately, you want to reduce response times and meet the NFPA standard, but there are other factors which could also drive decision-making that do not necessary reduce response time to a particular area.

Lastly, A/Chief Tibbets indicated that he suspects that the data would lead the community, City Commission, and the City Manager's office to be concerned about the areas that are currently underserved in our present fire station location model. He stated that a lack of awareness about the standards leads to the necessity that research such as this be done so that City leaders can make an educated decision regarding future fire stations (R. Tibbets, personal communication, March 2, 2017).

Call volume is another leading indicator when examining where to build a new fire station. In the external study, call volume was ranked the number one criteria in order of importance in determining where to build future fire stations. The master plan for Aurora (CO) Fire Department calls for a new station to be built whenever "the total number of responses in the first due area exceeds the annual rate of 400 per year" (*AFD Master Plan*, 2017, p. 6). While

the City of Kalamazoo does not have a similar threshold, the importance of this threshold cannot be overlooked.

The research discovered that call volume for fires and EMS runs are highest in Zones 2 and 6. These zones also represent areas in the City that were found to represent the majority of the areas which are underserved relative to response times for fire and EMS incidents. In addition, the hot spot maps that were included in the research found that in 2015 and 2016, fires were more prevalent in the zone six area on the western edge of the City. This area is very close to the outer fringe of the four-minute response time regardless of which model was used to predict those times. The call volume is predicted to increase as the areas in questions continue develop in both the commercial and residential markets.

The future predicted development of the City was ranked fourth by the external study in order of importance in analyzing where to build new stations. In addition, Assistant Chief Tibbets indicated that call volume and predicted future development is as important a determining factor as is response times when it comes to determining the needs for new station for the City of Kalamazoo. The research showed several significant items relative to growth in the City of Kalamazoo. As noted in Figure 12, the highest population growth from 2010 to 2015 was found in census tracts 15.06 and 15.07. These tracts saw steady to brisk growth in the population. These tracts are found on the western edge of the City of Kalamazoo and are part of an area that has been identified as being underserved by the current fire department station deployment. In addition, census tracts 17.01 and 17.02 also saw steady growth and they two are in areas that have been identified as underserved.

Additionally, the research found that new construction permits issued between 2013 and 2016 were found to be the highest in census tracts 15.06 and 15.07 in the northwest portion of

the City and 18.02 which is in the far southeast portion of the City and also identified as an underserved area with regards to response times.

Current Level of Service

To answer research question c., the evaluation of response times, call volume and predicted growth was utilized to research and evaluate the current level of service that our five fire stations provide presently. GIS mapping was then utilized to create a visualization of the areas that the current fire station locations can respond to in four minutes. The GIS mapping utilized in this research identified three distinct response areas based upon conditions. Those conditions were: 1) real-time traffic conditions at 0300 hours on a Tuesday, 2) real-time traffic conditions at 1100 hours on a Tuesday and 3) a four minute response area based on an average speed of 35 MPH. The reasoning for the differing models was to provide a clearer representation of how much area each Engine could cover. The first two are dependent upon traffic conditions, speed limits, and the fact that the vehicle is not running emergency status. The third area is based upon the RAND Corporation study that took into account those things and created an overall average speed that a fire apparatus can travel based upon those variables.

No equation however is perfect and while a fire engine running lights and siren will be able to respond to an area greater than that of the 1100 hour response area on a Tuesday, the 35 MPH area represents the best case scenario of the amount of area that an Engine company can cover under ideal conditions. Realistically, the amount of area that can be covered in a four minute response time is probably a combination of the three models. Furthermore, as indicated in Figure 4, the response times for emergency responses to the various zones were examined. In zones two, six, and seven response times on average were greater than the four-minute standard

as outlined on the maps. This is significant in that it points out the zones which on face-value of the response data cannot meet the four minute response standard to much of their response area.

The response time maps were completed for each fire station and a composite was completed of all stations. In the composite it was determined that there exists areas that could not be reached within the four minute standard and those areas represented areas that have had a high frequency of fire calls over the past two years (please see the hot spot data maps). It is clear from the GIS mapping that there are areas within the City that clearly lack adequate service per the standards. Couple that with the research that found these areas that are on the fringe of the station response coverage are also some of the areas that are growing both in population and infrastructure development and the need to consider building a fire station in the near future is more of a certainty.

Future Level of Service

To answer research question e., which asks what areas should be considered for potential locations for new fire stations in order to improve station coverage within the City of Kalamazoo, the evaluation of current coverage coupled with an extensive review of population growth, infrastructure growth and current call volume was completed to evaluate which areas of the City had the highest need for additional fire stations. Therefore to answer the research question the author had to first analyze the above criteria and determine where the greatest needs existed.

Based upon the current level of coverage it is clear that the area lacking fire station coverage (having a response time greater than four minutes), was the City's northwest areas and the also the southeast portion of the City. The northwest district is served by Station 6 and the southeast by Station 2. Evaluating these areas further, the northwest area also is the area of the

City that has seen the greatest growth in population and infrastructure development over the past few years and also represents the zone with the second highest calls for service in the City. "The area of largest population growth (Arcadia and Knollwood) is also the area of the most new construction permits. Of the 129 new construction permits issued from 2013 to 2016, 61 (47%) were in these areas" (*COK Fire and EMS Analysis*, 2017, p. 4).

In addition to the northwest portion, the City's southeast area also exhibits higher response times. While growth and development has not been as significant in this area as with the northwest, the area does represent the second largest area in terms of construction permits. As the interview with Rebekah Kik indicated, the development in this area is largely commercial and is the main factor in the increase in construction permits for the area even though population growth has been stagnant. Additionally, call volume for this zone represents the highest in the City. This could be due to it being the largest of all seven zones but this fact lends the zone to having more area that is underserved relative to fire station coverage.

Based upon the above information, points were plotted and examined for potential sites for new fire stations. Taking into account the areas that are underserved but also exhibit the largest area of growth and population increase, additional mapping occurred to illustrate what type of coverage would be gained by adding a station at these particular locations. Points were picked based upon location relative to the above underserved areas that were identified and the actual availability of property in these areas was not addressed. The GIS mapping allowed for recommendations to be made relative to future fire stations that would be best suited to meet the changing needs of the City of Kalamazoo.

Again, with the assistance of GIS mapping, the selected points were plotted and maps were created showing four minute response coverage areas based on real-time traffic conditions

at 3 am and 11 am on Tuesday as well as the 35 MPH average. These are the same type of maps that were produced for each of KDPS's existing stations. The mapping was able to show which of the plotted areas provided the best coverage of the currently underserved portions of the City.

Of the three locations that were plotted for the City's northwest side, 3700 W. Michigan provided the greatest benefit in terms of covering underserved areas. 2900 Howard provided great coverage to the currently underserved areas of the City but left a majority of the central part of the district uncovered which meant greater response times to the downtown area which would not work due to the high call demand in that area. 800 S. Drake was determined to not be feasible due to the fact that it is on the City's boundary with Oshtemo Township. Half of the response coverage area would not be within the City. The only reason to consider this location would be if the City and Oshtemo looked at a joint venture in which they built a shared station along this roadway.

Of the two locations evaluated in the City's southeast portion of the City, both 200 E. Cork and 3300 Lovers Lane provided excellent additional coverage to the currently underserved area in that portion of the City. Either would provide adequate coverage, however the determination on which site would have to be made based upon whether or not the City envisions increasing the number of stations in the near future by more than one station. Obviously, the closing of a station and relocating that station to a different portion of the City for better coverage carries with it the need to examine what effects the relocation would have on current level of service and coverage.

Author's Interpretation

The research conducted with interviews and external study clearly does not promote one single criteria over another when determining where to build new fire stations. Even being

ranked as the number one criteria, call volume is decidedly one of several items that the research indicated should be utilized when determining where to build fire stations.

Conversely, the literature review was extremely weighted towards response time and the ability to cover an area within a prescribed amount of time. The biggest reasoning for this is in large part that a NFPA consensus standard on response time or an ISO station distribution standard is measurable. It provides a standard that is backed in part by the progression of fire time line and the need to quickly respond in order to limit damage. As A/Chief Tibbets indicated in his interview, "the need to build fire stations requires a capital expenditure that needs to have articulation as to what the intended outcomes are" (R. Tibbets, personal communication, March 2, 2017). In other words, standards are easy to articulate and can be used to establish arguments that justify capital expenditures such as building a new fire station.

In addition, the value of being able to respond in four minutes or less to both fire and EMS incidents has been proven in multiple studies to reduce fire loss, decrease civilian and firefighter injuries and death, and to lead to better outcomes in instances of cardiac arrest.

Studies have also shown that the quicker that life-saving defibrillation can be administered to cardiac arrest patients the higher the odds for survival. The CPR timeline for heart attack victims indicates that the longer it takes for life-saving measures to be initiated the increased likelihood that brain death will occur. Zero to four minutes – brain damage is unlikely, four to 10 minutes brain damage is possible and over 10 minutes means probable brain death (ESRI, 2007).

In fire response, time is our enemy. The faster we can complete fire ground tasks, the faster we can provide a safer environment for ourselves and the community we've sworn

> to protect. The faster the fire goes out, the faster the danger to occupants goes away (Kirby, 2012, p. 5).

The author would agree with the literature review that response times should be a decisive factor in where to build new fire stations, however based upon the research conducted, to limit the analysis to just response times is foolish and the ability to better assess and better articulate the need for new stations is done by utilizing all available data to include population growth, new construction and a thorough examination of current call volume to determine the best areas to build new stations in to improve the level of service provided by the fire department.

Organizational Implications

The organizational implications of this research and its results are significant. First and foremost, the implication of the study is the establishment of a desired level of coverage throughout the City. While it is impossible to ensure 100% coverage that provides fire and EMS response in under four minutes to the entire City, the organizational implications of the results clearly have shown that the City of Kalamazoo has significant deficits at it relates to the its current fire station coverage. Gaps in coverage exist in areas of the City that are seeing increased growth and increased call volume. The mere establishment of a consensus agreement on a desired response time standard would have wide-sweeping ramifications to the way the department does things, since there is currently not an established desired response time standard.

Secondly, all the research that was conducted for this study in addition to the literature review suggests that a one-size-fits all evaluation of fire station coverage is not feasible. The literature review seemed to focus on response times while the research conducted indicated a

more broad approach be taken that evaluates other items such as call volume, and population increase increases. Even with the additional items identified through the research, it is important to understand that each department must evaluate its desired fire station coverage based upon the factors that are important to the department, the community, and the City leaders. Common sense would indicate that all departments and communities differ in their respective make ups and what works for one community may not work for the other when it comes to deployment of fire stations.

After establishing the criteria to be used to evaluate the current fire station locations within the City of Kalamazoo, the results found utilizing GIS mapping provided a foundation for identifying potential sites for new fire stations to better meet the needs of the community based upon the criteria that were identified earlier. Lastly, utilizing the results of the potential future sites the research will lead to recommendations that can be utilized to provide the basis for future fire station development.

The literature review and research conducted led to results that have allowed us to make recommendations about the current and future fire station coverage within the City of Kalamazoo. The next step is recommending options that the City leaders may consider that would improve service delivery to the community as they look to build fire stations in the future.

Recommendations

The problem that this research was intended to address was the fact that KDPS has not analyzed response times or call volume for its current five (5) stations to make a determination on where to locate new fire stations in the future. Additionally, not having conducted an analysis of where to build new fire stations in well over 20 years, there did not exist a set of criteria from

which an evaluation could occur. For example, examining response times is ineffective without first identifying what the desired response time is that KDPS should establish as a benchmark for call response. In addition to response time benchmarks, how much should call volume and population growth play a part in the decision-making if at all.

The purpose of this ARP was to analyze response times, call volumes, and anticipated future growth to ascertain where future fire stations should be built. That analyzation required that the research include what standards exist relative to response times and other criteria, so that an examination of current statin coverage could be conducted and recommendations made on where future stations should be located throughout the City. This research has led to the following recommendations:

Recommendations #1:

The first recommendation is that the City of Kalamazoo begin immediate plans to build an additional fire station in the northwest quadrant of the City. This recommendation stems from the evaluation of current response times from Station 6 to the area in question. Current response times are not effective enough to meet the NFPA 1710 response time standard or the ISO Station Distribution Standard. This was clearly demonstrated in the response time maps included in Appendix H.

In conducting the research for this ARP, examination was conducted of three (3) potential sites for future fire station development. These sites were identified based upon their ability to meet response time standards to the first-due response area. This was coupled with the fact that the area that is on the border of the underserved portion of the City currently is exhibiting the

highest incidence of fires over the last two years and is the second highest zone in terms of calls for service. This is currently stretching the first-due resource of Engine 6 to its limits.

Additionally, the areas in question is also exhibiting the largest amount of growth in the City over the last three (3) years. Census tracts 15.06 and 15.07 have seen the largest population growth in the entire City. This has been driven by the largest number of construction permits pulled in the City since 2013. Together these two criteria provide the supporting data as to why the need for an additional station exists in the northwest portion of the City.

Three potential sites were examined for their various capabilities in terms of response time and their ability to provide overlap with existing stations to provide redundant coverage. The best location for an additional station would be in the area of 3700 E. Michigan. This site provides the greatest response coverage for the area that is underserved while decreasing response times into the area that has seen the most incidents of fire over the last two years in the City. Additionally, the location allows for overlap with Engines 5 and 7 allowing for the most redundant coverage that is available. In addition, if recommendation # 2 is implemented, by locating the new station in the 3700 block of W. Michigan, it will allow for the existing Station 6 to be relocated further south and east which will improve coverage to that underserved area while having little to no impact of station response to the Zone 6 area.

Recommendation #2

The second recommendation of this research is that a determination be made as to whether or not it is feasible from a budgetary standpoint to build and maintain a seventh station. If it is determined that a seventh station was economically acceptable then this station would be built in addition to the one in recommendation # 1 resulting in an overall increase of two stations above the current staffing. If building a seventh station, then the existing Station 6 located at

Oakland and Howard would remain in service allowing that station to serve the central portion of the City still. This would allow the new station in the southeast to be pushed further to the south and east allowing for greater coverage of the underserved areas that were identified in the research.

If building a seventh station was the option chosen then the recommendation is that it be located in the area of 3300 Lovers Lane. By locating the station here, response coverage to virtually the entire area of the underserved in the southeast corner of the City would be possible. Consideration should be given to moving the station even further to the east if a suitable location could be found that still addresses the underserved area of S. Westnedge Avenue.

If however, the decision was made to not add a seventh station to the existing fire stations then the recommendation would be that the City of Kalamazoo close down current station 6 located at Howard and Oakland and locate it further to the south and east to address the south and southeast portion of Zone 2 and Zone 7 that are currently in areas that cannot get an Engine company to it within four minutes of response time. The location of this replacement station should be in the area of 200 E. Cork Street. This was determined to be the optimal location to build a station that could still cover the soon to be shuttered Station 6's area in the southern portion of the downtown district that is currently covered by Station 6.

Combined with the new station to be built in recommendation # 1, a new station in this area will provide overlap with that new station as well as Station 2, Station 4/5 and Station 7 to ensure adequate coverage to the downtown area while still reducing response times to those underserve areas of S. Westnedge Avenue as well as the areas in the southeast corner of the City. This option results in improved service delivery while maintaining fiscal responsibility by

keeping the number of stations at six as opposed to seven. Appendix J contains GIS mapping that shows the response coverage for each of the recommendations that have been outlined.

Recommendation # 3:

The third recommendation is that additional analysis be conducted that goes beyond the scope of the research of this ARP. The focus of this project sought to examine response coverage as it relates specifically to the first due apparatus to EMS and Fire calls for service, however NFPA 1710 addresses much more than just this aspect of response time. In actuality, this research just scratches the surface of NFPA 1710. Further research to include an examination of KDPS's ability to put a full-alarm assignment on scene at a fire within 480 seconds should be examined, along with staffing of such a full-alarm assignment.

Additionally, examination into the departments call processing times, dispatch times, and turnout times should be evaluated to ensure that the department is operating as efficiently as possible and meeting the expectations of these various stages as intended by the NFPA 1710 standard.

Lastly, additional analysis should be conducted of community risk factors that could increase or decrease the need for additional fire stations within a certain area as well as examine the need for specific types of apparatus to be housed at certain stations (i.e. Aerial platform in an areas serving the downtown hi-rise buildings). Other risk factors such as the age of homes, the age of the population within a certain area of the City as well as particular buildings that are subject to a greater risk of fire.

The recommendations above identify recommendations for future research to be conducted by the City of Kalamazoo but more importantly provide recommendations for future fire station locations that will improve service delivery by decreasing response times underserved

areas of the City as well as improve response to a majority of the community who fall within the four minute response time window currently.

The ability to provide timely and efficient response to Fire and EMS emergencies is critical in the outcome of such events. The research has shown that decreased response times lead to better outcomes for EMS incidents especially those involving cardiac arrest. In addition, it has shown to reduce the extent of fires thereby reducing property damage and limiting civilian injuries in fires. Analyzing call volume, population growth, infrastructure growth and response times throughout the City will allow for a better understanding of where future fire stations in the City of Kalamazoo should be located.

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Appendix A

Fire Station Location Study

Good day..

My name is Jeff VanderWiere and I am a Captain with the Kalamazoo Department of Public Safety. I am currently enrolled in the Executive Fire Officer (EFO) at the National Fire Academy. Could you please complete the below survey regarding how fire stations and criteria used in determining where to locate new stations.

Thank you,

Jeff

1. Contact Information

Rank/Name

Department

City/Town

State/Province

Email Address

Phone Number

2. What is the population of the community your department serves?

- ◯ less than 10,000
- ◯ 10,000 - 24,999
- ◯ 25,000 - 49,999
- ◯ 50,000 - 74,999
- ◯ 75,000 - 99,999
- ◯ 100,000 - 249,999
- ◯ 250,000 or greater

3. How many fire stations do you have?

4. How many EMS calls does your department run per year on average?

- <1000
- 1000-1999
- 2000-2999
- 3000 - 3999
- 4000 - 4999
- 5,000-9,999
- 10,000 or greater

5. How many Residential structure fires do you run per year on average?

- <10
- 10-49
- 50-99
- 100-199
- 200-299
- 300 - 499
- 500 - 999
- 1,000 or greater

6. Has your department ever conducted an analysis of its fire station locations to evaluate the coverage each station provides and to identify gaps within that coverage?

- Yes (Please answer Question #7)
- No (Please skip to Question # 8)
- Unknown

7. When conducting an analysis of your fire station locations what criteria did your department consider in its analysis?(Please check all that apply)

- [ ] NFPA 1710 or 1720 - Response Times
- [ ] ISO - Station Distribution and Distances
- [ ] Call Volume within a geographical part of the community that was/is currently underserved
- [ ] Predicted Future Development
- [ ] Accreditation Recommendation (i.e. CPSE)
- [ ] No research was conducted
- [ ] Other (please specify)

8. Assuming that your department was preparing to build a new fire station. Please rank the following items in order of importance relative to determining where that new station should be built:

- [ ] NFPA 1710 or 1720 - Response Times
- [ ] ISO - Station Distribution and Distances
- [ ] Call volume within a geographical part of the community that was/is underserved
- [ ] Predicted Future Development
- [ ] Accreditation Recommendation (i.e. CPSE)

9. Please select your type of department

- ◯ Full-Time (Career)
- ◯ Combination - OVER 50% of personnel are considered full-time
- ◯ Combination - LESS THAN 50% of personnel are considered full-time
- ◯ Paid on-call
- ◯ Volunteer

FOR QUESTION #9 ABOVE:

IF YOU INDICATED THAT YOUR DEPARTMENT IS FULL-TIME OR A COMBINATION DEPARTMENT IN WHICH OVER 50% OF THE DEPARTMENT IS CONSIDERED FULL-TIME, PLEASE ANSWER QUESTIONS 10-15.

IF YOU INDICATED YOU WERE A VOLUNTEER, PAID-ON-CALL, OR COMBINATION DEPARTMENT WITH LESS THAN 50% OF THE DEPARTMENT BEING FULL-TIME THEN PLEASE SKIP TO QUESTION #16.

10. Per NFPA 1710, response times for EMS calls should be 4 minutes or less, 90% of the time. Does your department currently meet this standard?

- ◯ Yes (skip to Question #12)
- ◯ No
- ◯ Unknown, we do not track response times (skip to Question #12)

11. If you answered NO to Question # 7, what is your departments average response time to EMS incidents 90% of the time.

Minutes _____

Seconds _____

12. Per NFPA 1710, response times for the first due Engine Company to a residential structure fire should be 4 minutes or less, 90% of the time. Does your department currently meet this standard?

- ◯ Yes (skip to Question 14)
- ◯ No
- ◯ Unknown, we don't track response time (skip to Question #14

13. If your answered NO to Question # 9, what is your departments average response time of the first due Engine to a structure fire, 90% of the time?

Minutes _____

Seconds _____

14. Per NFPA 1710, response times for the first alarm assignment to a residential structure fire should be 8 minutes or less, 90% of the time. Does your department currently meet this standard?

- ◯ Yes, please skip to Question #16
- ◯ No
- ◯ Unknown, we don't track response time (please skip to Question #16)

15. If you answered NO to Question #11, what is your departments preferred or acceptable response time of the entire first-alarm assignment to a structure fire?

Minutes _____

Seconds _____

FULL-TIME OR A COMBINATION DEPARTMENTS IN WHICH OVER 50% OF THE DEPARTMENT IS CONSIDERED FULL-TIME, PLEASE STOP HERE. THANK YOU FOR COMPLETING THE SURVEY.

ALL OTHER TYPES OF DEPARTMENTS PLEASE CONTINUE TO QUESTION # 16

16. Based on the parameters defined below regarding population densities and understanding that many departments serve more than one population density, which one of the below choices best describes the community you serve? . (Please check all that apply)

- ☐ Urban (greater than 1000 people per square mile)
- ☐ Suburban (500-1000 people per square mile)
- ☐ Rural (<500 people per square mile)

17. In Question 16, did you check the box indicating that at least part of the community you serve is considered Urban, having a population density of over 1000 people per mile squared?

- ◯ **YES.....Please continue to Question #18**
- ◯ **NO: PLEASE STOP HERE. Thank you for your answers and your time**

18. NFPA 1720 stipulates that volunteer and combination departments serving an "urban" population (more than 1000 people per square mile) have 15 personnel on scene within 9 minutes of dispatch notification, 90% of the time. Does your department currently meet this standard? NOTE: Automatic aid can be factored in to this

- ◯ YES (Thank you for completing the Survey)
- ◯ NO (Please answer question #19)
- ◯ Unknown, we do not track response time

19. If you answered NO to question #18, what is your departments average response time and number of personnel to a residential structure fire 90% of all incidents?

# of personnel	
Minutes	
Seconds	

Thank you for completing this study. I appreciate your time and effort.

Appendix B

DEPARTMENT	CITY	STATE
Visalia Fire Dept	Visalia	CA
Shepherd Tri-Twp FD	Shepherd	MI
Grand Junction Fire Department	Grand Junction	CO
Durham Fire Department	Durham	NC
Sugar Land Fire-EMS	Sugar Land	TX
Smithfield Fire Department	Smithfield	RI
Copley Fire Department	Copley	OH
New Bern Fire-Rescue	New Bern	NC
Huntley Fire District	Huntley	IL
Round Rock Fire Dept	Round Rock	TX
San Marcos Fire Department	San Marcos	TX
Gwinnett County Fire & Emergency Services	Lawrenceville	GA
Clifton Fire Department	Clifton	NJ
Keller Fire Department	Keller	Texas
Maynard Fire Department	Maynard	MA
Fruitport Fire Department	Muskegon	MI
Solon Township	Cedar Springs	MI
Greensboro Fire Department	Greensboro	NC
Hampton Twp.	Essexville	MI
Muskegon Charter Township	Muskegon	MI
Thornapple Twp Emergency Services	Middleville	MI
Texas Township	kalamazoo	MI
Des Moines Fire Dept	Des Moines	IA
Graafschap Fire Department	Holland	MI
City of Walker Fire Department	Walker	MI
Delta Township Fire Department	Lansing	MI
Richland Township Fire Department	Kalamazoo	MI
Covert Township	Covert	MI
Watervliet Fire Department	Watervliet	MI
Ada Township Fire Department	Ada Township	MI
Oshtemo Twp.	Kalamazoo	MI
Portage	Portage	MI
Charter Township of Comstock	Comstock	MI
Evesham fire rescue	Evesham	NJ
City of Ann Arbor Fire Department	Ann Arbor	MI
Comstock Township	Kalamazoo	MI
Aurora Fire Rescue	Aurora	CO

Pigeon Forge Fire Dept	Pigeon Forge	TN
Marysville dept. of public safety	Marysville	MI
Shelby-Benona	Shelby	MI
KDPS	Kalamazoo	MI
Avondale Fire Medical	Avondale	AZ
Muskegon Heights Fire	Muskegon Heights	MI
Holland DPS	Holland	MI
Wyandotte	Wyandotte	MI
South Haven Area Emergency Services	South Haven	MI
St. Louis Area Fire Department	St. Louis	MI
Tulsa Fire	Tulsa	OK
Bolingbrook Fire Department	Bolingbrook	IL
Las Vegas Fire & Rescue	Las Vegas	NV
Westminster Fire Department	Westminster	CO
Dexter Area Fire Department	Dexter	MI
Resort Bear Creek Fd	Petoskey	MI
Bellbrook Fire Department	Bellbrook	OH
Baroda Fire Department	Baroda	MI
Bourne Fire/Rescue	Bourne	MA
North county fire	Fallbrook	CA
Okeechobee County Fire Rescue	Okeechobee	FL
Lodi Fire	Lodi	CA
Monitor Twp. FD	Bay City	MI
City of Oshkosh FD	Oshkosh	WI
Chesterfield County Fire and EMS	Chesterfield	VA
Norfolk Fire-Rescue	Norfolk	VA
City of Athens FD	Athens	OH
Bernalillo County Fire Department	Albuquerque	NM
Narragansett Fire Department	Narragansett	RI
Goshen Fire and EMS	Goshen	OH
Brentwood Fire Rescue	Brentwood	TN
Algoma	Rockford	MI
Cutlerville/Byron Twp.	Grand Rapids	MI
Lyon Township Fire	New Hudson	MI
Grand Rapids Fire Department	Grand Rapids	MI
South Bend Fire Department	South Bend	IN
Canton Fire Department	Canton	OH
Naperville Fire Department	Naperville	IL

Appendix C

NFIRS "100 Series" Calls Included in Data Analysis

100	Fire, Other
110	Structure Fire, Other
111	Building Fire
112	Fire in structure other than Building
113	Cooking Fire, contained to container
114	Chimney or flue fire, confined to chimney or flue
117	Commercial Compactor fire, confined to rubbish
120	Fire in mobile property used as fixed structure, other
121	Fire in mobile home used as fixed residence
122	Fire in motor home, camper, recreational vehicle
130	Mobile property (vehicle) fire, Other
131	Passenger Vehicle fire
132	Road freight or transport vehicle fire

Appendix D

Interview Questions

Assistant Chief Ryan Tibbets

March 2nd, 2017

1. Please discuss (rank) the following criteria relative in terms of their importance in determining where to build new fire stations:
    a. NFPA 1710
    b. ISO – Station Distribution
    c. Predicted future growth
    d. Current Call Volume
2. With regards to response times…Do you feel we meet the 4 minute standard as outlined by NFPA 1710 90% of the time?
    a. What about a full first alarm assignment within 8 minutes?
    b. Is the Standard of 4 minutes a realistic expectation for the City of Kalamazoo
    c. If not, realistic, what do you feel is a realistic response time that could be met?
3. What do you feel the expectations of the City Manager are with regards to response time and fire station coverage?
    a. City Commission?
    b. Community?
4. Should ISO and Station Distribution drive decision making?
    a. Population growth?
    b. Call Volume?
5. Is there a level of risk that the following entities are willing to accept by not meeting certain standards in terms of station coverage?
    a. Community
    b. City Manager
    c. City Commission
6. Where does the line exist relative to what risk is acceptable?

Appendix E

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2015} And {12/31/2015}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121","122 ","130 ","131 ","132 ","800
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "1 " and Response Code = "1 "

Incident#	Unit	Date/Time	Arv Time	Response Code	Response
15-0001942	E4 Engine 4	01/09/2015 07:47:30	07:59:13	Emergency	00:10:43
15-0020631	E6 Engine 6	03/18/2015 20:54:15	20:05:39	Emergency	00:04:24
15-0026783	E4 Engine 4	04/09/2015 17:41:12	17:46:20	Emergency	00:04:38
15-0029603	E2 Engine 2	04/18/2015 18:48:49	18:54:20	Emergency	00:05:31
15-0036257	E7 Engine 7	05/11/2015 08:13:18	08:20:19	Emergency	00:07:01
15-0036597	E5 Engine 5	05/11/2015 11:01:06	11:05:02	Emergency	00:03:56
15-0044893	E5 Engine 5	06/08/2015 13:56:35	14:00:36	Emergency	00:04:01
15-0046402	E5 Engine 5	06/14/2015 10:49:02	10:55:33	Emergency	00:06:31
15-0051322	E7 Engine 7	06/27/2015 17:34:40	17:34:59	Emergency	00:05:19
15-0054048	E2 Engine 2	07/06/2015 01:34:24	01:44:47	Emergency	00:10:23
15-0059362	E5 Engine 5	07/19/2015 02:08:44	02:08:56	Emergency	00:04:12
15-0064535	E3 Engine 3	08/09/2015 10:06:45	10:12:38	Emergency	00:05:53
15-0066547	E6 Engine 6	08/15/2015 23:29:27	23:34:58	Emergency	00:05:31
15-0069603	E6 Engine 6	08/29/2015 10:12:46	10:2x:52	Emergency	00:13:07
15-0073887	E3 Engine 3	09/07/2015 17:18:23	17:23:31	Emergency	00:05:48
15-0083231	E3 Engine 3	10/10/2015 13:13:11	13:41:13	Emergency	00:29:02
15-0086820	E3 Engine 3	10/23/2015 19:22:09	19:27:47	Emergency	00:05:38
15-0099120	E2 Engine 2	12/08/2015 06:32:17	14:38:20	Emergency	00:07:47
15-0099632	E7 Engine 7	12/10/2015 15:10:46	15:15:52	Emergency	00:04:46
15-0100383	E3 Engine 3	12/13/2015 01:55:58	02:00:02	Emergency	00:04:04
15-0104224	E3 Engine 3	12/26/2015 23:03:59	23:09:04	Emergency	00:05:07

Overall Average Response Time: 00:06:30

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Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2015} And {12/31/2015}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","136
Type = 11 for Eng or 12 for Ladder ="11 " and
District In "2 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0001244	E2 Engine 2	01/06/2015	09:23:15	09:28:54	Emergency	00:04:39
15-0005576	E2 Engine 2	01/22/2015	17:35:37	17:39:03	Emergency	00:03:54
15-0014670	E3 Engine 3	02/21/2015	15:11:28	15:17:48	Emergency	00:06:00
15-0015540	E3 Engine 3	02/24/2015	17:13:43	17:17:47	Emergency	00:04:04
15-0017409	E7 Engine 7	03/07/2015	12:17:38	12:23:30	Emergency	00:05:52
15-0020171	E3 Engine 3	03/19/2015	15:21:02	15:25:13	Emergency	00:04:11
15-0020708	E2 Engine 2	03/19/2015	17:54:35	17:57:00	Emergency	00:02:25
15-0022769	E2 Engine 2	03/25/2015	14:04:31	14:13:26	Emergency	00:08:55
15-0024845	E6 Engine 6	04/02/2015	11:57:17	12:01:45	Emergency	00:04:28
15-0025861	E6 Engine 6	04/04/2015	07:43:21	07:45:03	Emergency	00:01:42
15-0026553	E2 Engine 2	04/06/2015	19:40:39	19:47:09	Emergency	00:06:30
15-0029870	E7 Engine 7	04/15/2015	12:11:07	12:21:50	Emergency	00:06:43
15-0030652	E2 Engine 2	04/17/2015	11:11:35	11:16:52	Emergency	00:05:17
15-0030803	E7 Eng ne 7	04/17/2015	23:25:28	23:30:36	Emergency	00:05:08
15-0032707	E2 Eng ne 2	04/23/2015	00:40:13	00:46:13	Emergency	00:06:00
15-0038989	E7 Engine 7	05/12/2015	09:13:27	09:20:17	Emergency	00:06:50
15-0039729	E2 Engine 2	05/14/2015	6:28:33	6:33:38	Emergency	00:05:05
15-0040328	E7 Engine 7	05/16/2015	17:46:24	17:50:13	Emergency	00:03:49
15-0042845	E2 Engine 2	05/27/2015	01:09:10	01:47:10	Emergency	00:01:00
15-0049816	E2 Engine 2	06/22/2015	19:45:05	19:50:20	Emergency	00:05:15
15-0052146	E2 Engine 2	06/30/2015	08:07:25	08:07:26	Emergency	00:01:01
15-0053974	E2 Engine 2	07/01/2015	20:36:27	20:48:01	Emergency	00:11:34
15-0056138	E2 Engine 2	07/23/2015	00:07:48	00:01:54	Emergency	00:04:02
15-0060487	E2 Engine 2	07/26/2015	09:56:38	09:01:41	Emergency	00:04:03
15-0063378	E2 Engine 2	08/01/2015	21:10:56	21:15:00	Emergency	00:04:04
15-0064198	E3 Engine 3	08/07/2015	15:11:21	15:21:58	Emergency	00:06:37
15-0065231	E2 Engine 2	08/10/2015	20:28:50	20:37:26	Emergency	00:09:19
15-0066110	E2 Eng ne 2	08/13/2015	18:10:18	18:16:50	Emergency	00:06:47
15-0071175	E7 Engine 7	08/30/2015	10:13:14	10:21:16	Emergency	00:08:02

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Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between (01/01/2015) And (12/31/2015)
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","138 "
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "2 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0074421	E2 Engine 2	03/08/2015	18:09:38	18:12:34	Emergency	00:02:56
15-0075199	E2 Engine 2	03/17/2015	02:29:33	02:32:06	Emergency	00:02:33
15-0081197	E2 Engine 2	10/22/2015	00:01:[illegible]	00:03:09	Emergency	00:02:12
15-0082766	E2 Engine 2	10/28/2015	21:24:32	21:27:44	Emergency	00:02:12
15-0085230	E2 Engine 2	10/17/2015	19:44:37	19:48:35	Emergency	00:03:32
15-0090771	E2 Engine 2	11/06/2015	13:34:[illegible]	13:38:30	Emergency	00:04:48
15-0091374	E2 Engine 2	11/09/2015	21:09:01	21:14:18	Emergency	00:04:57
15-0097004	E2 Engine 2	11/29/2015	23:10:[illegible]	23:15:34	Emergency	00:04:34
15-0103422	E2 Engine 2	12/25/2015	02:51:[illegible]	02:58:48	Emergency	00:07:47

Overall Average Response Time: 00:09:05

01/05/2017 17:12 Page: 2

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2015} And {12/31/2015}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","123 ","130 ","131 ","138 ","356
Type = 11 for Eng or 12 for Ladder ""11 " and
District In "3 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0008679	E5 Engine 5	02/01/2015	04:04:59	04:11:32	Emergency	00:06:33
15-0013192	E3 Engine 3	02/27/2015	09:57:28	10:05:46	Emergency	00:08:17
15-0021460	E3 Engine 3	03/21/2015	02:22:01	02:46:35	Emergency	00:24:34
15-0021950	E3 Engine 3	03/22/2015	20:13:21	20:18:00	Emergency	00:04:39
15-0030219	E3 Engine 3	04/20/2015	20:28:39	20:32:56	Emergency	00:04:17
15-0031588	E3 Engine 3	04/23/2015	11:43:01	11:50:35	Emergency	00:07:34
15-0031618	E3 Engine 3	04/23/2015	17:07:37	17:12:49	Emergency	00:05:12
15-0031976	E3 Engine 3	04/24/2015	9:00:38	19:12:12	Emergency	00:03:36
15-0035357	E3 Engine 3	05/07/2015	18:35:52	18:40:06	Emergency	00:04:14
15-0035944	E3 Engine 3	05/09/2015	10:07:22	10:12:29	Emergency	00:05:07
15-0060703	E5 Engine 5	07/27/2015	09:46:31	09:47:19	Emergency	00:00:51
15-0062734	E3 Engine 3	08/01/2015	17:56:20	18:01:04	Emergency	00:04:44
15-0072158	E6 Engine 6	09/02/2015	15:04:38	15:09:51	Emergency	00:05:13
15-0076997	E5 Engine 5	09/15/2015	12:25:47	12:31:03	Emergency	00:05:56
15-0086151	E3 Engine 3	10/01/2015	09:51:27	09:56:21	Emergency	00:04:54
15-0092555	E3 Engine 3	11/13/2015	08:06:57	08:11:10	Emergency	00:04:13

Overall Average Response Time: 00:07:44

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between (01/01/2015) And (12/31/2015)
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","140
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "4 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0001319	E5 Engine 5	01/06/2015	18:29:08	18:32:05	Emergency	00:04:06
15-0013865	E5 Engine 5	02/22/2015	19:46:17	19:51:25	Emergency	00:07:08
15-0015955	E5 Engine 5	03/01/2015	02:22:58	02:32:45	Emergency	00:09:50
15-0035910	E3 Engine 3	05/09/2015	05:03:06	05:12:29	Emergency	00:09:23
15-0040794	E5 Engine 5	05/24/2015	2 :22:02	2 :27:36	Emergency	00:04:36
15-0053800	E5 Engine 5	07/05/2015	04:10:10	04:10:06	Emergency	00:00:41
15-0066563	E7 Engine 7	08/13/2015	00:14:53	00:17:21	Emergency	00:02:36
15-0075593	E3 Engine 3	09/13/2015	13:19:22	13:22:10	Emergency	00:02:49
15-0096975	E5 Engine 5	11/23/2015	21:05:24	21:11:07	Emergency	00:06:02
15-0098762	E7 Engine 7	12/07/2015	02:13:38	02:17:11	Emergency	00:03:33
15-0099846	E3 Engine 3	12/11/2015	09:56:33	10:00:09	Emergency	00:03:16

Overall Average Response Time: 00:05:37

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2015} And {12/31/2015}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","138 ","140 "
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "5 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0005218	E5 Engine 5	01/21/2015	11:35:10	11:36:22	Emergency	00:05:31
15-0006616	E5 Engine 5	01/31/2015	06:36:06	06:41:00	Emergency	00:04:52
15-0012322	E5 Engine 5	02/21/2015	01:35:49	01:40:54	Emergency	00:05:05
15-0016328	E5 Engine 5	03/05/2015	19:0x:00	19:11:07	Emergency	00:05:42
15-0021009	E5 Engine 5	03/25/2015	20:52:06	20:56:38	Emergency	00:04:35
15-0025173	E5 Engine 5	04/03/2015	17:32:00	17:37:47	Emergency	00:05:46
15-0027315	E6 Engine 6	04/11/2015	12:06:24	12:11:06	Emergency	00:04:42
15-0029780	E5 Engine 5	04/18/2015	02:18:17	02:22:15	Emergency	00:03:58
15-0032006	E5 Engine 5	04/26/2015	21:16:47	21:22:17	Emergency	00:05:30
15-0040870	E5 Engine 5	05/05/2015	00:56:00	01:07:11	Emergency	00:11:11
15-0047268	E6 Engine 6	06/14/2015	10:32:17	10:42:22	Emergency	00:10:05
15-0051183	E5 Engine 5	06/27/2015	02:18:30	02:22:35	Emergency	00:04:05
15-0057802	E7 Engine 7	07/15/2015	01:21:52	01:30:00	Emergency	00:11:08
15-0058546	E7 Engine 5	07/20/2015	14:44:20	14:49:24	Emergency	00:05:04
15-0067583	E3 Engine 6	08/15/2015	12:52:12	12:57:20	Emergency	00:04:08
15-0069870	E5 Engine 5	08/26/2015	12:06:21	12:11:13	Emergency	00:06:49
15-0080408	E5 Engine 5	09/30/2015	06:16:17	06:20:03	Emergency	00:04:46
15-0097982	E5 Engine 5	12/07/2015	03:42:0x	23:48:52	Emergency	00:06:49

Overall Average Response Time: 00:07:02

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between (01/01/2015) And (12/31/2015)
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121","122 ","123","130","131","132","133","140
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "6 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
15-0001224	46 Engine 6	01/06/2015	08:15:38	08:20:30	Emergency	00:04:52
15-0003388	46 Engine 6	01/20/2015	11:38:04	11:43:00	Emergency	00:04:56
15-0005778	42 Engine 2	01/25/2015	15:41:44	15:51:19	Emergency	00:09:35
15-0008033	47 Engine 7	02/01/2015	13:11:42	13:20:40	Emergency	00:08:58
15-0016462	47 Engine 7	02/04/2015	20:27:55	20:30:46	Emergency	00:02:51
15-0031390	47 Engine 7	02/14/2015	20:34:44	20:39:47	Emergency	00:05:03
15-0047282	66 Engine 6	02/24/2015	11:34:54	11:42:21	Emergency	00:07:27
15-0053817	46 Engine 6	02/28/2015	05:55:21	06:04:55	Emergency	00:09:34
15-0060921	47 Engine 7	03/03/2015	21:52:16	21:57:51	Emergency	00:05:35
15-0065539	47 Engine 7	03/11/2015	20:44:48	20:48:00	Emergency	00:03:12
15-0065875	47 Engine 7	03/12/2015	22:12:18	22:18:18	Emergency	00:06:00
15-0067189	66 Engine 6	03/17/2015	02:27:55	02:37:22	Emergency	00:09:27
15-0067798	46 Engine 6	03/19/2015	04:27:01	04:37:27	Emergency	00:10:26
15-0070946	46 Engine 6	03/29/2015	10:42:32	10:48:37	Emergency	00:06:04
15-0072731	43 Engine 3	03/24/2015	08:18:53	08:24:28	Emergency	00:05:35
15-0078410	47 Engine 7	04/03/2015	12:39:48	12:45:51	Emergency	00:06:03
15-0086294	47 Engine 7	04/21/2015	20:29:33	20:35:27	Emergency	00:05:54
15-0089401	47 Engine 7	04/27/2015	18:43:32	18:49:18	Emergency	00:05:46
15-0091541	66 Engine 6	04/29/2015	13:35:26	13:41:30	Emergency	00:06:04
15-0100369	66 Engine 6	05/13/2015	01:05:01	01:11:38	Emergency	00:06:37

Overall Average Response Time: 00:06:43

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2015} And {12/31/2015}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","138 " and
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "7 " and Response Code = "1 "

Incident#	Unit	Date	Arr Time	Alt Time	Response Code	Response
15-0005177	E2 Engine 2	01/21/2015	07:27:30	07:32:00	Emergency	00:04:10
15-0005766	E6 Engine 6	01/23/2015	18:57:58	19:07:15	Emergency	00:09:17
15-0010431	E6 Engine 6	02/09/2015	22:08:10	22:13:20	Emergency	00:05:10
15-0011676	E7 Engine 7	02/11/2015	01:55:30	02:00:30	Emergency	00:05:00
15-0012739	E2 Engine 2	02/13/2015	16:41:31	16:50:35	Emergency	00:09:39
15-0034199	E2 Engine 2	05/21/2015	20:58:45	21:02:16	Emergency	00:03:31
15-0039769	E7 Engine 7	05/31/2015	20:01:29	20:06:03	Emergency	00:04:34
15-0041511	E7 Engine 7	06/11/2015	00:08:41	00:14:19	Emergency	00:05:38
15-0050280	E3 Engine 3	06/24/2015	07:18:58	07:25:41	Emergency	00:06:43
15-0059655	E7 Engine 7	07/23/2015	23:05:11	23:10:36	Emergency	00:05:25
15-0060751	E7 Engine 7	07/27/2015	13:31:50	13:34:27	Emergency	00:02:37
15-0063279	E7 Engine 7	08/04/2015	16:06:32	16:12:50	Emergency	00:06:18
15-0063649	E7 Engine 7	08/05/2015	20:17:31	20:22:18	Emergency	00:04:47
15-0070704	E7 Engine 7	08/29/2015	00:28:14	00:33:05	Emergency	00:04:51
15-0078732	E7 Engine 7	09/21/2015	18:52:41	18:56:19	Emergency	00:03:38
15-0085160	E7 Engine 7	10/11/2015	13:19:10	13:24:57	Emergency	00:05:47
15-0087569	E7 Engine 7	10/26/2015	09:31:36	09:38:13	Emergency	00:06:37
15-0092445	E7 Engine 7	11/13/2015	20:05:09	20:11:01	Emergency	00:05:52
15-0093930	E7 Engine 7	11/15/2015	02:47:29	02:52:55	Emergency	00:05:26
15-0096138	E7 Engine 7	11/25/2015	11:12:25	11:17:03	Emergency	00:04:38
15-0103210	E7 Engine 7	12/23/2015	23:33:44	23:41:13	Emergency	00:05:29

Overall Average Response Time: 00:06:42

Appendix F

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 " and
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "1 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16-0001398	E5 Engine 5	01/06/2016	22:02:17	22:06:41	Emergency	00:04:24
16-0014693	E5 Engine 5	02/27/2016	03:23:16	03:30:20	Emergency	00:06:04
16-0023207	E5 Engine 5	04/21/2016	09:24:32	09:28:13	Emergency	00:03:41
16-0031702	E5 Engine 5	05/27/2016	18:25:07	18:31:00	Emergency	00:05:53
16-0035406	E2 Engine 2	06/19/2016	02:33:12	02:39:05	Emergency	00:05:53
16-0049479	E3 Engine 3	06/23/2016	16:43:15	16:50:33	Emergency	00:07:18
16-0049739	E30 Engine 301	06/30/2016	11:40:32	11:44:32	Emergency	00:03:50
16-0051768	E7 Engine 7	07/06/2016	15:38:24	15:43:28	Emergency	00:05:19
16-0071332	E5 Engine 5	09/06/2016	15:30:27	15:36:22	Emergency	00:05:57
16-0072878	E5 Engine 5	09/ 5/2016	12:06:15	12:11:12	Emergency	00:04:57
16-0074398	E6 Engine 6	09/15/2016	00:54:11	00:58:40	Emergency	00:04:29
16-0083119	E5 Engine 5	10/11/2016	00:17:40	00:24:37	Emergency	00:06:57
16-0085905	E3 Engine 3	10/16/2016	10:38:36	10:44:26	Emergency	00:05:50
16-0087158	E7 Engine 7	10/20/2016	17:16:33	17:21:26	Emergency	00:04:53
16-0099409	E5 Engine 5	12/12/2016	16:08:13	16:13:43	Emergency	00:05:30

Overall Average Response Time: 00:06:03

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Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between (01/01/2016) And (12/31/2016)
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","133 ","138 "
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "2 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16-0007351	E2 Engine 2	01/02/2016	03:10:20	03:22:10	Emergency	00:05:50
16-0011241	E2 Engine 2	01/15/2016	11:43:04	11:47:48	Emergency	00:04:44
16-0012061	E3 Engine 3	02/18/2016	20:50:37	20:56:59	Emergency	00:06:22
16-0013906	E7 Engine 7	02/28/2016	09:47:53	09:50:16	Emergency	00:02:23
16-0013929	E2 Engine 2	02/28/2016	12:17:01	12:23:00	Emergency	00:05:59
16-0014554	E2 Engine 2	02/29/2016	18:30:47	18:41:17	Emergency	00:10:30
16-0014822	E2 Engine 2	02/29/2016	20:15:12	20:20:02	Emergency	00:04:50
16-0017617	E7 Engine 7	03/11/2016	06:21:38	06:31:58	Emergency	00:10:20
16-0017609	E8 Engine 8	03/11/2016	20:20:44	20:44:26	Emergency	00:23:42
16-0022338	E3 Engine 3	04/28/2016	15:27:12	15:36:42	Emergency	00:09:30
16-0023394	E7 Engine 7	04/11/2016	17:45:16	17:59:10	Emergency	00:13:54
16-0023615	E2 Engine 2	04/12/2016	13:14:36	13:28:42	Emergency	00:14:06
16-0025780	E2 Engine 2	04/17/2016	09:54:12	10:11:49	Emergency	00:17:37
16-0028415	E2 Engine 2	04/26/2016	11:20:05	11:26:34	Emergency	00:06:29
16-0033210	E6 Engine 6	05/06/2016	02:08:39	02:16:59	Emergency	00:08:20
16-0033214	E7 Engine 7	05/06/2016	02:25:27	02:29:15	Emergency	00:03:48
16-0033999	E601 Engine 601	05/09/2016	17:45:35	18:00:00	Emergency	00:14:25
16-0036943	E2 Engine 2	05/20/2016	19:37:25	19:42:10	Emergency	00:04:45
16-0037246	E7 Engine 7	05/21/2016	18:37:35	18:43:02	Emergency	00:05:27
16-0038781	E2 Engine 2	05/26/2016	18:01:59	18:09:00	Emergency	00:07:01
16-0039705	E2 Engine 2	05/29/2016	13:21:09	13:26:00	Emergency	00:04:51
16-0041236	E2 Engine 2	06/03/2016	16:56:22	16:58:10	Emergency	00:01:48
16-0049633	E2 Engine 2	06/20/2016	23:51:15	23:58:47	Emergency	00:07:32
16-0049643	E2 Engine 2	06/20/2016	07:08:32	07:14:00	Emergency	00:05:28
16-0051067	E2 Engine 2	07/04/2016	13:58:48	14:05:50	Emergency	00:07:02
16-0052566	E2 Engine 2	07/09/2016	00:57:53	01:01:25	Emergency	00:03:32
16-0055469	E7 Engine 7	07/18/2016	14:58:01	15:06:59	Emergency	00:08:58
16-0055627	E2 Engine 2	07/19/2016	08:28:41	08:38:03	Emergency	00:06:12
16-0057966	E2 Engine 2	07/27/2016	20:57:48	21:01:00	Emergency	00:03:12

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Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","123 ","130 ","131 ","132 ","133 ","140
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "2 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16-0060024	E1 Engine 2	09/02/2016	20:13:06	20:20:16	Emergency	00:07:46
16-0063847	E2 Engine 2	08/15/2016	19:24:39	19:35:50	Emergency	00:11:11
16-0064954	E2 Engine 2	08/18/2016	15:46:54	15:47:13	Emergency	00:00:25
16-0066780	e6 Engine 6	08/25/2016	04:34:54	04:37:00	Emergency	00:02:06
16-0068182	e2 Engine 2	08/29/2016	21:37:03	21:41:57	Emergency	00:04:54
16-0069479	e6 Engine 6	09/02/2016	17:09:43	17:15:14	Emergency	00:06:26
16-0075204	e2 Engine 2	09/20/2016	22:02:07	22:07:15	Emergency	00:05:09
16-0076233	E2 Engine 2	09/21/2016	06:00:38	06:06:23	Emergency	00:05:45
16-0077341	E2 Engine 2	09/27/2016	19:26:03	19:36:03	Emergency	00:09:59
16-0084226	E6 Engine 6	9/20/20 6	2:25:3	21:34:12	Emergency	00:08:59
16-0084727	E2 Eng ne 2	9/22/20 6	14:4 :17	14:51:11	Emergency	00:05:54
16-0084743	E2 Engine 2	10/22/2016	18:01:44	18:06:00	Emergency	00:04:16
16-0089980	E2 Engine 2	11/05/2016	23:15:48	23:20:00	Emergency	00:04:12
16-0093020	E2 Engine 2	11/19/2016	00:17:01	00:19:01	Emergency	00:02:00
16-0095110	e2 Engine 2	11/26/2016	16:51:35	16:56:46	Emergency	00:05:11
16-0095165	e2 Engine 2	11/26/2016	20:1 :36	20:17:23	Emergency	00:02:12
16-0096416	e7 Engine 7	12/01/2016	11:5 :51	12:02:12	Emergency	00:07:19
16-0097685	e7 Engine 7	12/1 /2016	19:17:31	19:22:29	Emergency	00:05:38
16-0099686	e6 Engine 6	12/1 /2016	18:1 :21	18:1 :22	Emergency	00:01:1
16-0102438	e6 Engine 6	12/14/2016	19:2 :22	19:29:28	Emergency	00:03:06
16-0103594	E6 Engine 6	12/19/20 6	22:07:1	22:16:3	Emergency	00:04:02

Overall Average Response Time: 00:07:16

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","and
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "3 " and Response Code = "1 "

Incident#	Unit	Date And Time Arr	Time	Response Code	Response
16-0000445	E6 Engine 6	01/02/2016	21:13:43	21:19:36	Emergency	00:05:53
16-0001570	E3 Engine 3	01/07/2016	19:07:48	19:13:17	Emergency	00:05:29
16-0002890	E5 Engine 5	01/12/2016	17:12:47	17:20:00	Emergency	00:07:13
16-0014356	E3 Engine 3	02/27/2016	20:09:42	20:13:56	Emergency	00:04:14
16-0014360	E6 Engine 6	02/27/2016	20:28:11	20:33:26	Emergency	00:05:15
16-0021300	E3 Engine 3	03/24/2016	19:00:37	19:05:40	Emergency	00:05:03
16-0022054	E3 Engine 3	03/27/2016	13:38:18	13:42:29	Emergency	00:04:11
16-0045172	E3 Engine 3	06/16/2016	13:06:30	13:13:26	Emergency	00:06:28
16-0066236	E3 Engine 3	08/23/2016	08:18:22	08:24:58	Emergency	00:06:36
16-0071148	E2 Engine 2	09/07/2016	18:15:31	18:19:35	Emergency	00:04:04
16-0086044	E3 Engine 3	10/27/2016	10:13:43	10:17:47	Emergency	00:04:04
16-0089182	E3 Engine 3	11/06/2016	16:01:42	16:07:27	Emergency	00:05:45
16-0093172	E3 Engine 3	11/19/2016	13:26:01	13:31:51	Emergency	00:05:50
16-0094129	E3 Engine 3	11/22/2016	12:56:26	13:01:17	Emergency	00:04:51
16-0096715	E3 Engine 3	12/02/2016	12:43:36	12:47:58	Emergency	00:04:22

Overall Average Response Time: 00:05:07

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","132 ","133 ","134 " and
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "4 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16-0007417	E7 Engine 7	01/31/2016	00:07:1	00:11:03	Emergency	00:04:02
16-0018950	E5 Engine 5	03/15/2016	22:47:20	22:47:50	Emergency	00:03:30
16-0045601	E5 Engine 5	06/21/2016	23:00:31	23:04:07	Emergency	00:03:36
16-0054101	E5 Engine 5	07/12/2016	05:02:34	05:07:37	Emergency	00:04:37
16-0057607	E6 Engine 6	07/25/2016	23:39:31	23:40:71	Emergency	00:01:00
16-0059325	E3 Engine 3	07/31/2016	16:15:27	16:18:10	Emergency	00:02:06
16-0072268	E3 Engine 3	09/11/2016	19:32:32	19:38:30	Emergency	00:05:58
16-0075177	E3 Engine 3	09/20/2016	20:21:02	20:23:00	Emergency	00:02:58
16-0080255	E5 Engine 5	10/07/2016	15:12:16	15:15:43	Emergency	00:03:27
16-0097752	E5 Engine 5	12/06/2016	00:17:55	00:20:03	Emergency	00:02:08
16-0098179	E7 Engine 7	12/07/2016	16:11:02	16:13:38	Emergency	00:02:36
16-0100179	E3 Engine 3	12/15/2016	18:17:57	18:22:56	Emergency	00:05:05
16-0100189	E5 Engine 5	12/15/2016	19:18:00	19:21:53	Emergency	00:03:30
16-0101202	E6 Engine 6	12/17/2016	23:55:1	23:59:41	Emergency	00:04:40

Overall Average Response Time: 00:04:03

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}

and Incident Type In "110 ","111 ","1111","1112","1113","112 ","113 ","114 ","117 ","120 ","121 ","122 ","130 ","131 ","132 ","138 ","140 " and Type = 11 for Eng or 12 for Ladder = "11 " and District In "5 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16 0006391	05 Engine 5	01/27/2016	13:05:39	13:13:41	Emergency	00:08:02
16-0007014	07 Engine 7	01/29/2016	20:50:10	20:59:11	Emergency	00:09:01
16-0013588	07 Engine 5	02/24/2016	17:38:01	17:48:00	Emergency	00:09:59
16-0015008	07 Engine 5	03/01/2016	15:44:58	15:50:27	Emergency	00:05:30
16-0015220	07 Engine 3	03/02/2016	11:22:58	11:28:45	Emergency	00:05:47
16-0022674	07 Engine 6	03/29/2016	20:24:01	20:29:42	Emergency	00:05:41
16-0024875	05 Engine 5	04/07/2016	15:06:57	15:21:09	Emergency	00:14:12
16-0027334	05 Engine 5	04/18/2016	10:31:11	10:36:44	Emergency	00:05:33
16-0034907	05 Engine 5	05/13/2016	06:00:47	06:06:27	Emergency	00:05:40
16-0037375	05 Engine 5	05/22/2016	01:15:39	01:20:42	Emergency	00:05:03
16-0038651	06 Engine 6	05/24/2016	07:25:39	07:29:39	Emergency	00:04:00
16-0040554	03 Engine 3	06/01/2016	15:30:27	15:35:03	Emergency	00:04:36
16-0059989	05 Engine 5	08/02/2016	18:11:15	18:16:15	Emergency	00:05:00
16-0063576	03 Engine 3	08/14/2016	12:31:27	12:40:56	Emergency	00:09:29
16-0071898	06 Engine 6	09/10/2016	08:33:26	08:37:15	Emergency	00:03:49
16-0075709	05 Engine 5	09/22/2016	17:06:30	17:16:19	Emergency	00:09:49
16-0085621	05 Engine 5	10/25/2016	16:02:03	16:15:12	Emergency	00:09:43
16-0088026	05 Engine 5	11/01/2016	15:45:08	15:50:00	Emergency	00:04:52
16-0091234	05 Engine 5	11/13/2016	00:15:44	00:24:05	Emergency	00:08:21
16-0095568	05 Engine 5	11/18/2016	02:11:43	02:15:47	Emergency	00:04:04
16-0097322	05 Engine 5	12/04/2016	13:30:44	13:35:10	Emergency	00:04:26

Overall Average Response Time: 00:05:48

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121","122 ","130 ","131","132","136"
Type = 11 for Eng or 12 for Ladder = "11 " and
District In "6 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	At Time	Response Code	Response
16-0002792	E6 Engine 6	01/13/2016	06:37:07	06:42:17	Emergency	00:05:10
16-0004378	E7 Engine 7	01/18/2016	18:24:52	18:31:59	Emergency	00:07:18
16-0007188	E6 Engine 6	01/30/2016	07:48:58	07:53:02	Emergency	00:04:04
16-0009332	E7 Engine 7	02/07/2016	03:20:23	03:27:03	Emergency	00:06:04
16-0011854	E6 Engine 6	02/17/2016	21:41:22	21:52:10	Emergency	00:07:14
16-0017345	E7 Engine 7	03/10/2016	06:09:20	06:14:03	Emergency	00:05:43
16-0017508	E6 Engine 6	03/10/2016	21:06:36	21:12:12	Emergency	00:05:04
16-0022101	E6 Engine 6	03/27/2016	18:11:11	18:18:05	Emergency	00:07:54
16-0024528	E6 Engine 6	04/06/2016	03:13:10	03:20:06	Emergency	00:07:56
16-0026068	E7 Engine 7	04/12/2016	11:26:09	11:33:05	Emergency	00:06:56
16-0041717	E7 Engine 7	05/05/2016	02:35:59	02:43:11	Emergency	00:07:12
16-0043340	E6 Engine 6	05/11/2016	21:33:17	21:57:49	Emergency	00:24:32
16-0045827	E7 Engine 7	05/18/2016	15:01:40	15:08:35	Emergency	00:07:55
16-0056471	E7 Engine 7	06/22/2016	02:19:38	02:26:38	Emergency	00:07:00
16-0059557	E7 Engine 7	06/30/2016	23:21:52	23:27:58	Emergency	00:06:06
16-0077314	E7 Engine 7	08/27/2016	13:41:16	13:51:21	Emergency	00:09:05
16-0082803	E6 Engine 6	09/13/2016	22:32:38	22:38:11	Emergency	00:05:33
16-0089247	E6 Engine 6	10/06/2016	14:32:10	14:38:00	Emergency	00:05:50
16-0098422	E6 Engine 6	10/28/2016	17:29:07	17:34:17	Emergency	00:05:10
16-0104137	E7 Engine 7	11/17/2016	20:00:35	20:02:50	Emergency	00:02:15

Overall Average Response Time: 00:07:12

Kalamazoo Department of Public Safety

Avg Resp Time of the First Arriving Unit

Alarm Date Between {01/01/2016} And {12/31/2016}
and Incident Type In "110 ","111
","1111","1112","1113","112 ","113 ","114 ","117
","120 ","121 ","122 ","130 ","131 ","138 "
Type = 11 for Eng or 12 for Ladder = "11" and
District In "7 " and Response Code = "1 "

Incident#	Unit	Date	Alm Time	Arr Time	Response Code	Response
16-0008479	2801 Engine 801	02/04/2016	11:41:26	11:45:00	Emergency	00:03:34
16-0010122	87 Engine 7	02/11/2016	17:02:38	17:07:43	Emergency	00:05:45
16-0010137	86 Engine 6	02/11/2016	19:09:10	19:16:04	Emergency	00:10:46
16-0014504	87 Engine 7	02/25/2016	09:30:14	09:46:03	Emergency	00:06:49
16-0037150	87 Engine 7	05/21/2016	10:32:36	10:38:06	Emergency	00:05:30
16-0042166	87 Engine 7	06/06/2016	18:13:41	18:21:07	Emergency	00:07:26
16-0042700	87 Engine 7	06/08/2016	15:22:03	15:29:03	Emergency	00:04:59
16-0047392	87 Engine 7	06/23/2016	12:17:54	12:28:12	Emergency	00:10:18
16-0048178	87 Engine 7	06/27/2016	16:20:11	16:27:54	Emergency	00:07:43
16-0059057	87 Engine 7	07/30/2016	19:37:32	19:50:47	Emergency	00:05:15
16-0065616	87 Engine 7	08/27/2016	07:35:10	07:40:35	Emergency	00:06:17
16-0071851	87 Engine 7	09/10/2016	00:36:20	00:43:52	Emergency	00:07:32
16-0084512	85 Engine 5	10/21/2016	20:14:14	20:20:19	Emergency	00:06:05
16-0102031	87 Engine 7	12/13/2016	08:55:25	09:02:28	Emergency	00:07:03
16-0102752	87 Engine 7	12/06/2016	18:42:48	18:46:00	Emergency	00:03:12
16-0103176	87 Engine 7	12/08/2016	04:26:26	04:30:17	Emergency	00:03:52

Overall Average Response Time: 00:06:23

Appendix G

Interview Questions

Rebekah Kik and Cal Coplai

Interview Date: March 2nd, 2017

1. What areas of the City do you project will see increased development…
    a. Within the next year?
    b. Within next 5 years? (2022)
    c. Within next 10 years? (2027)

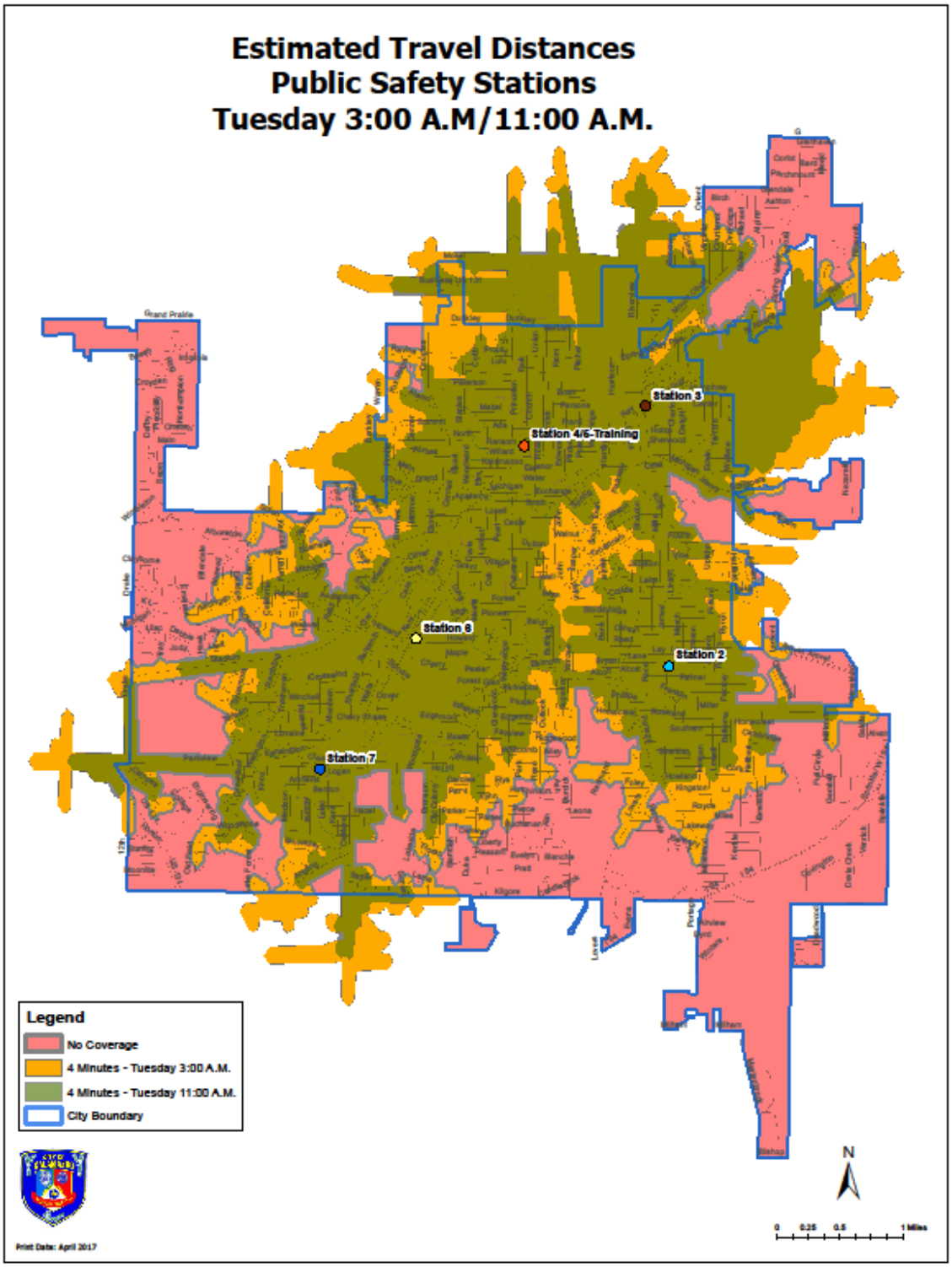
2. Given the projected development, what percentage will be:
    a. Residential?
    b. Commercial?
    c. Other?

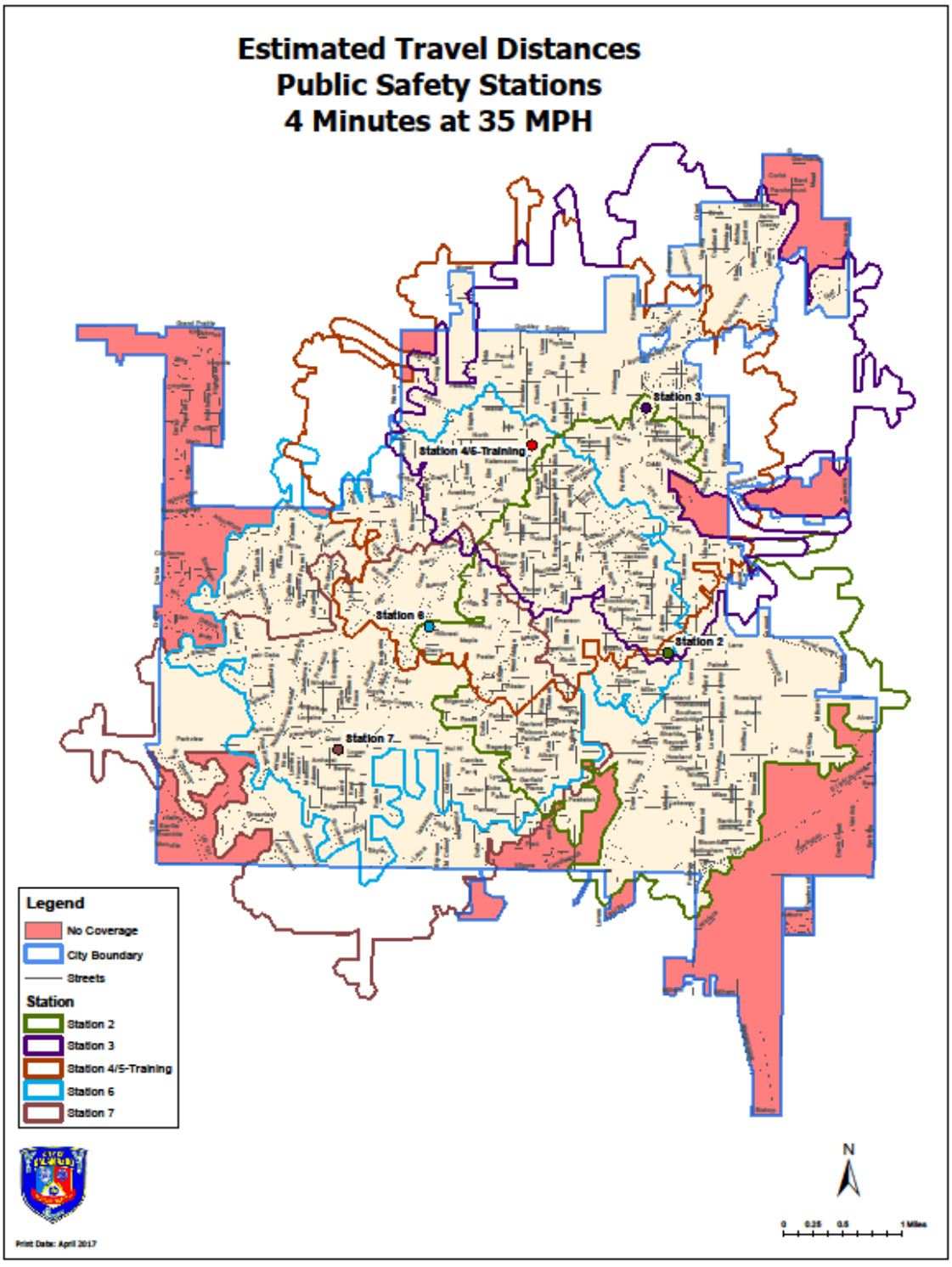
3. Will residential development predominantly be single-family or multi-family development? Or Will is vary based upon geography?

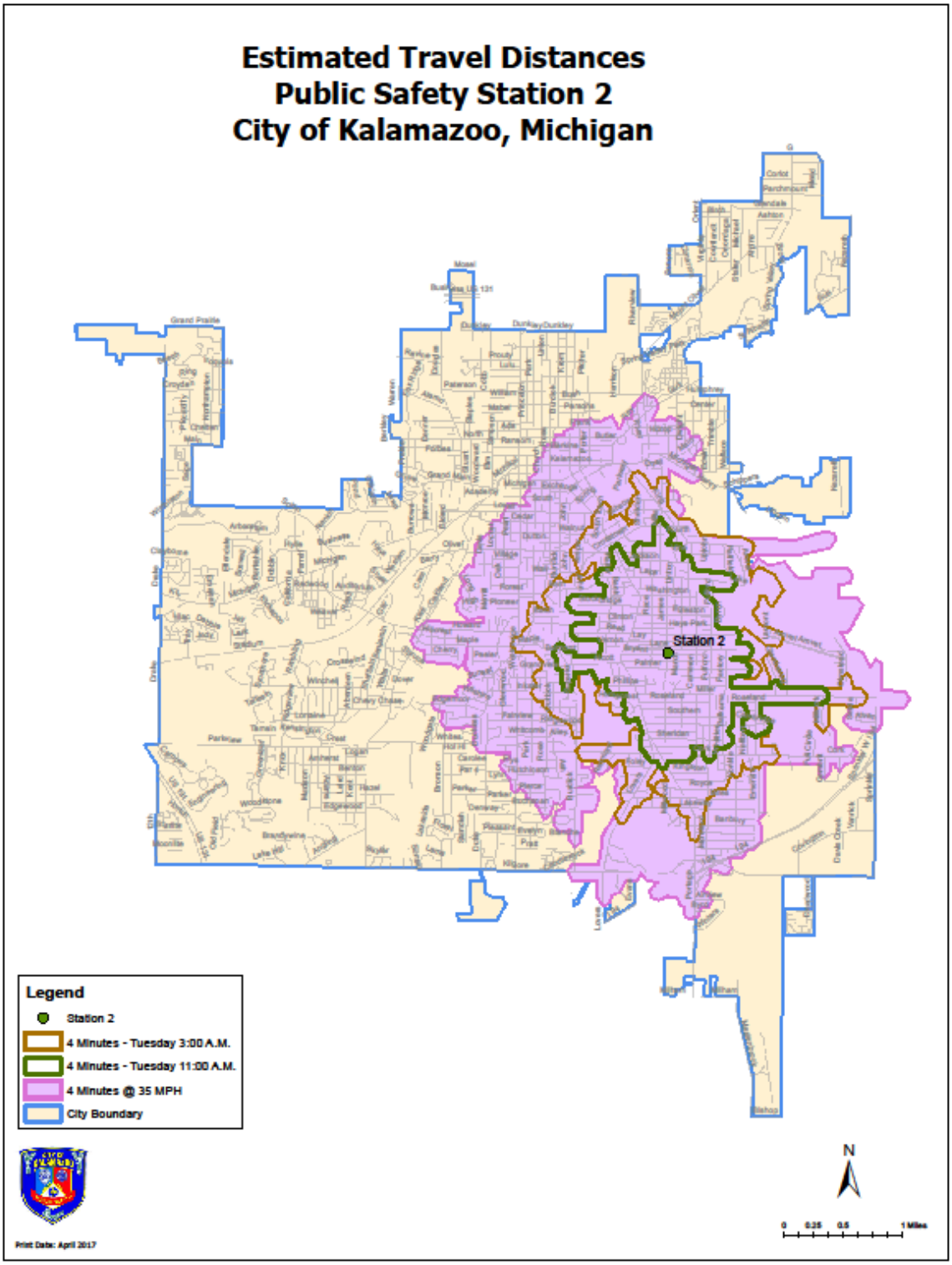
4. What population growth do you anticipate in the City:
    a. Next year?
    b. Next 5 years?
    c. Next 10 years?

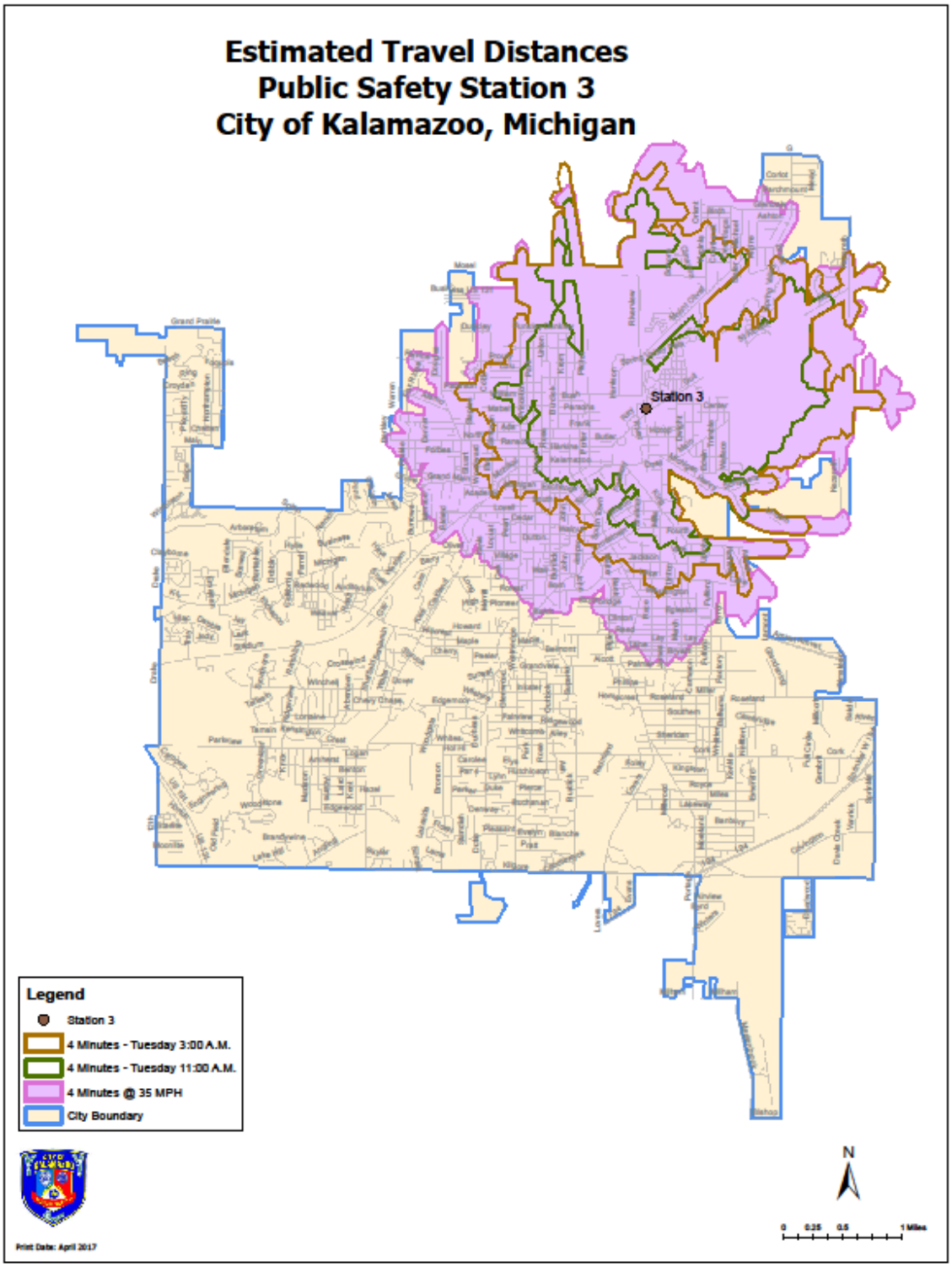
5. What areas of the City do you predict will see the greatest growth?

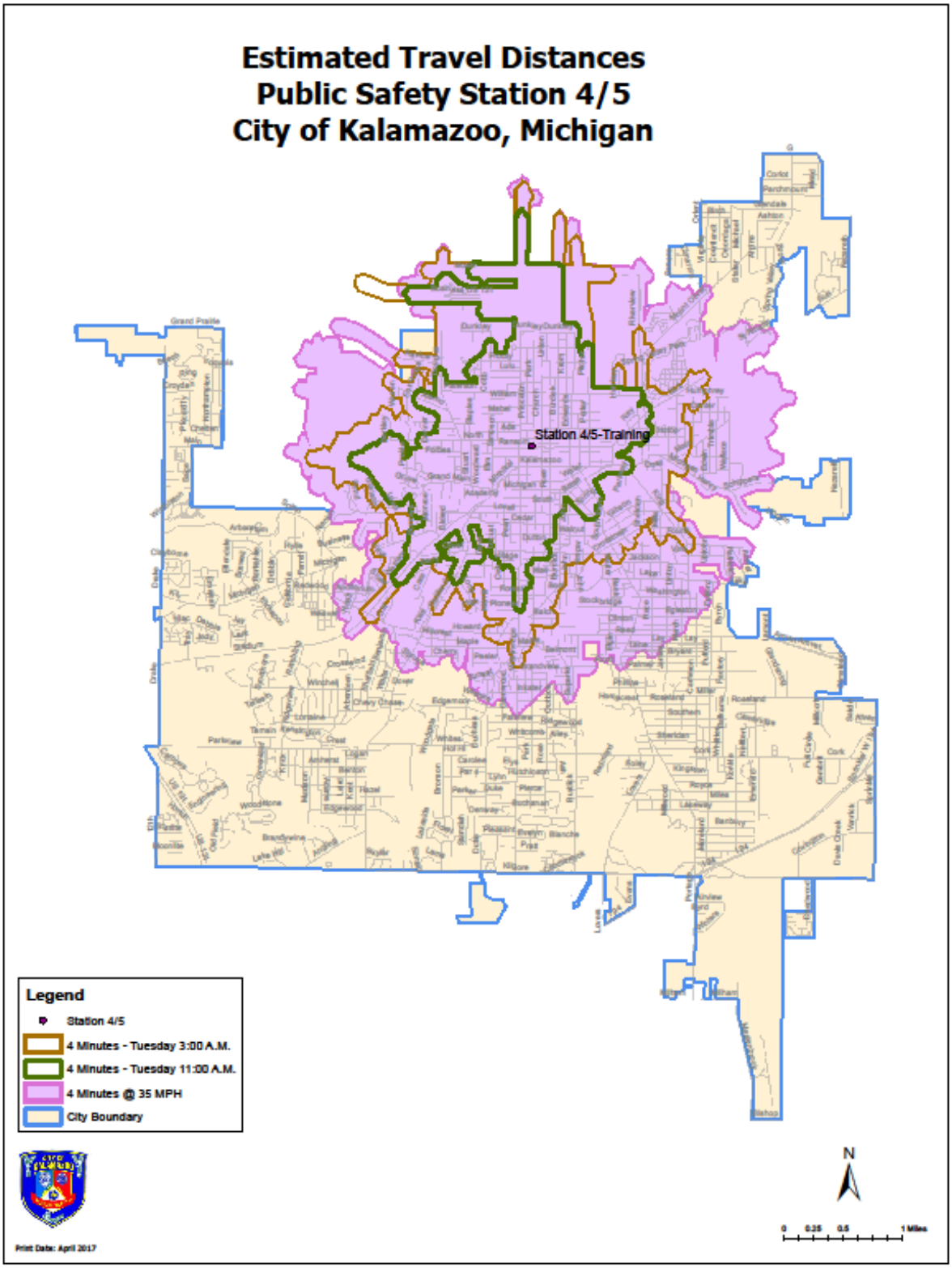
Appendix H

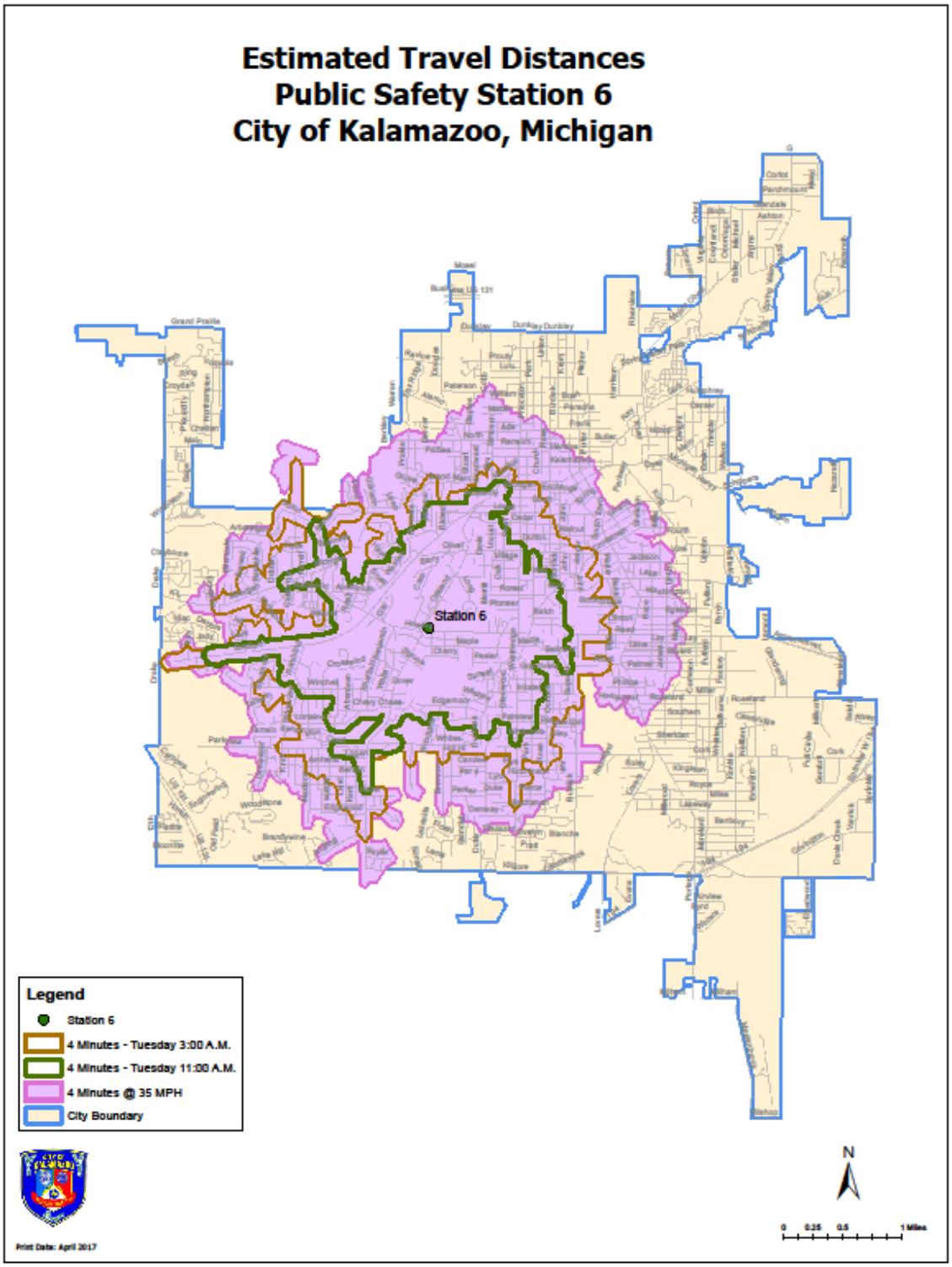

Estimated Travel Distances
Public Safety Stations
Tuesday 3:00 A.M/11:00 A.M.
Station 3
Station 4/6-Training
Station 8
Station 2
Station 7
Legend
No Coverage
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
City Boundary
N
Print Date: April 2017

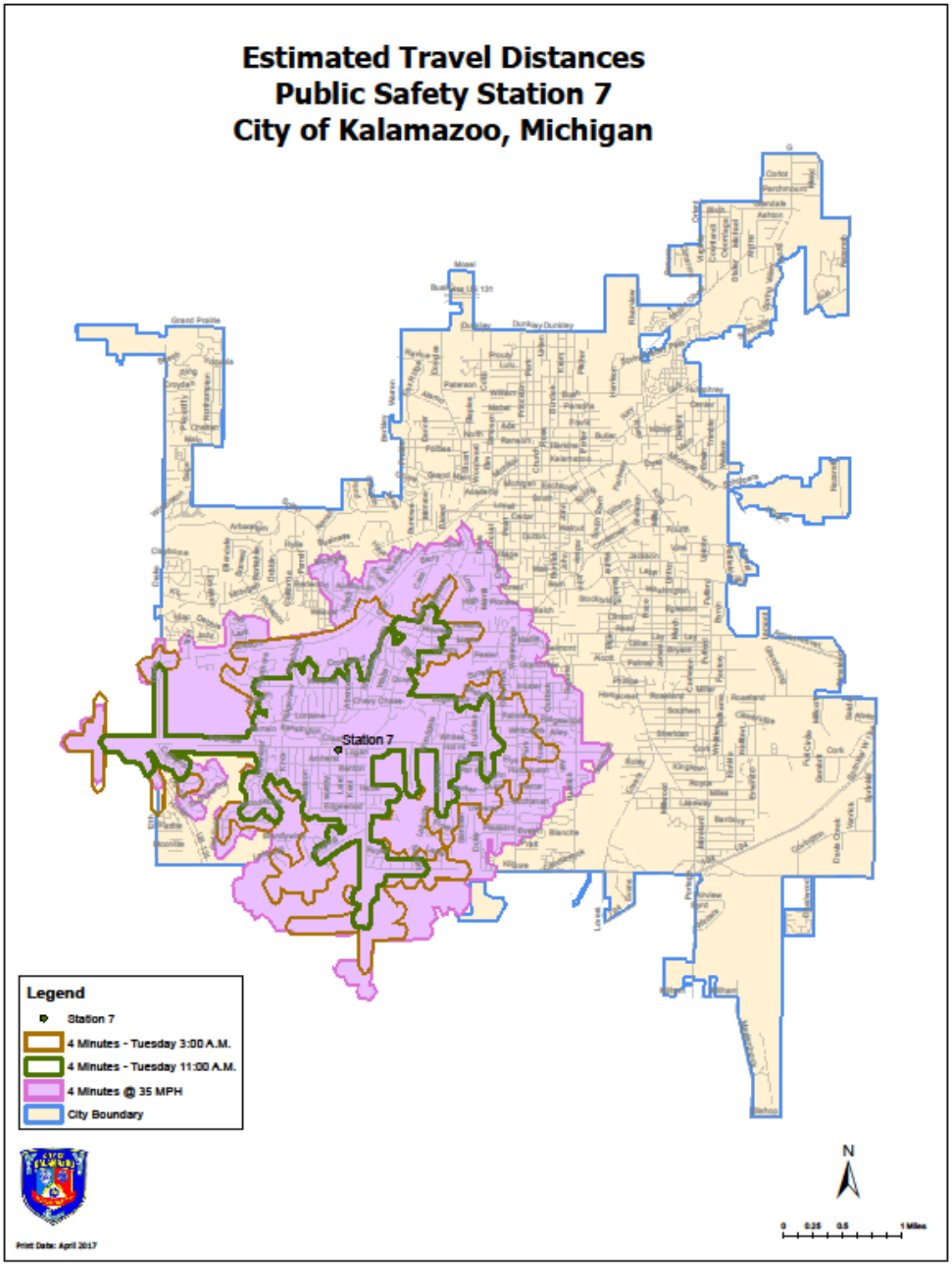

Estimated Travel Distances
Public Safety Stations
4 Minutes at 35 MPH
Station 3
Station 4/5-Training
Station 6
Station 2
Station 7...
Legend
No Coverage
City Boundary
Streets
Station
Station 2
Station 3
Station 4/5-Training
Station 6
Station 7
N
0 0.25 0.5 1 Miles
Print Date: April 2017


Estimated Travel Distances
Public Safety Station 2
City of Kalamazoo, Michigan
Station 2
Legend
Station 2
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

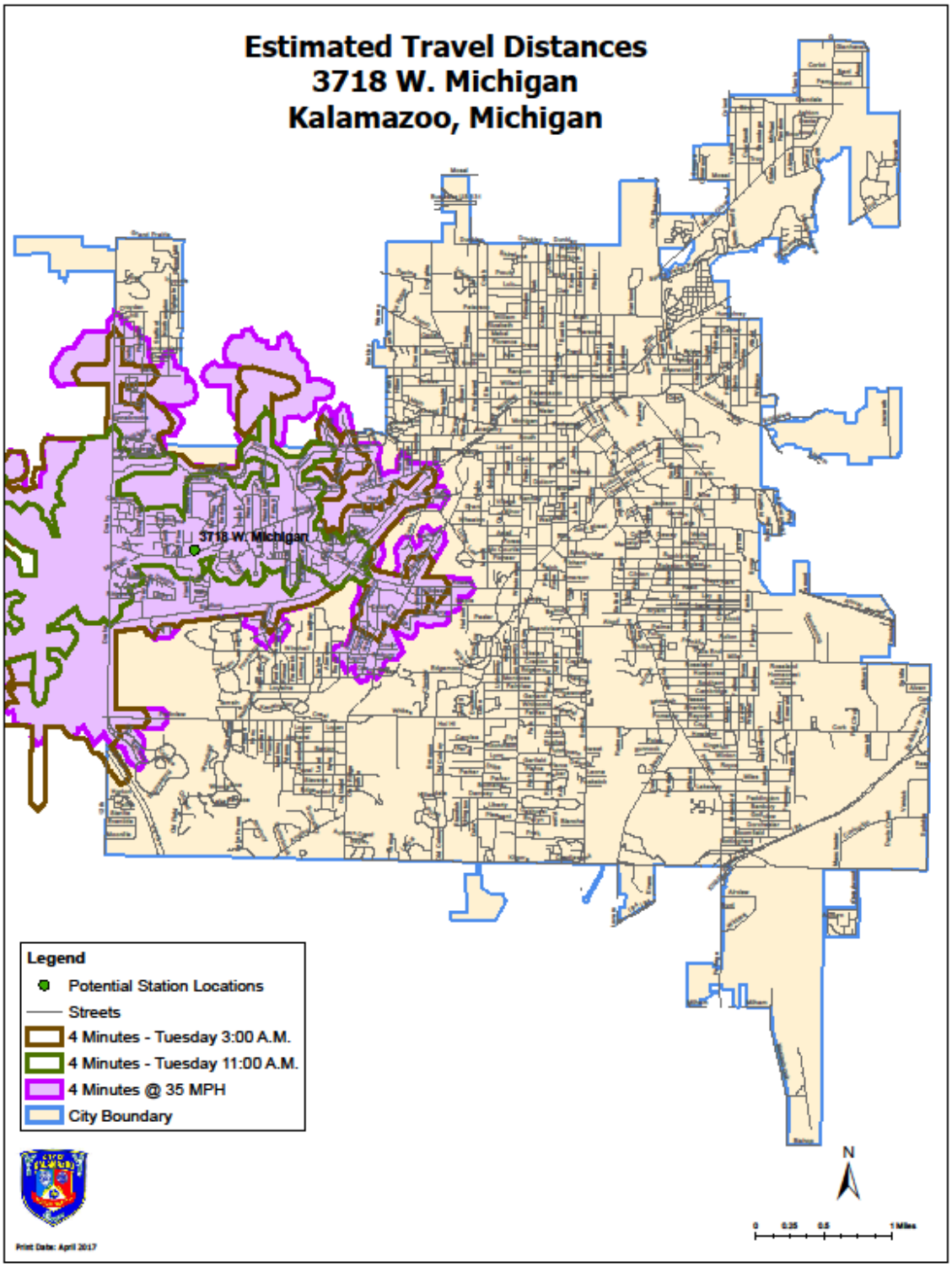

Estimated Travel Distances
Public Safety Station 3
City of Kalamazoo, Michigan
Station 3
Legend
Station 3
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

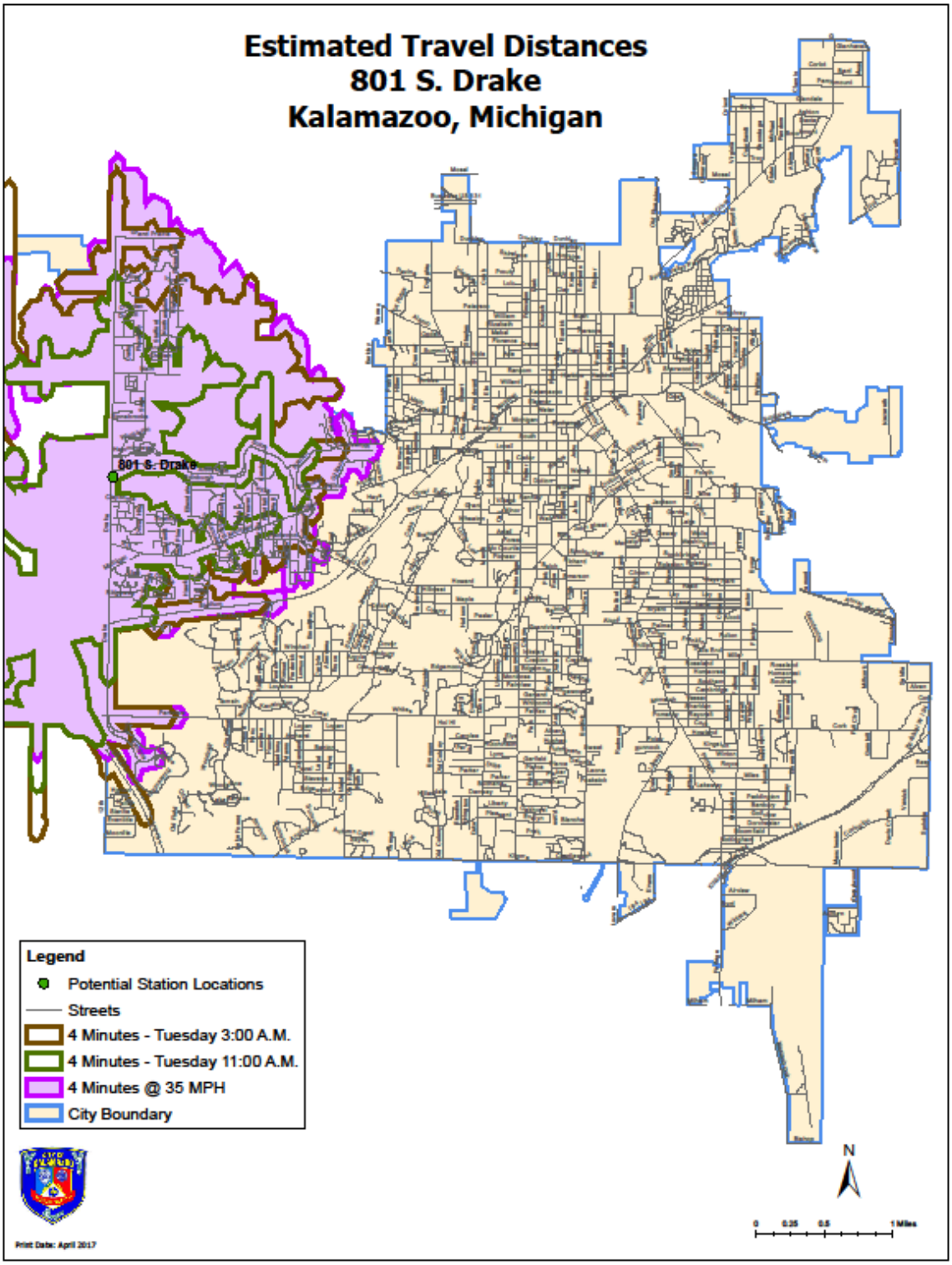

Estimated Travel Distances
Public Safety Station 4/5
City of Kalamazoo, Michigan
Station 4/5-Training
Legend
Station 4/5
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

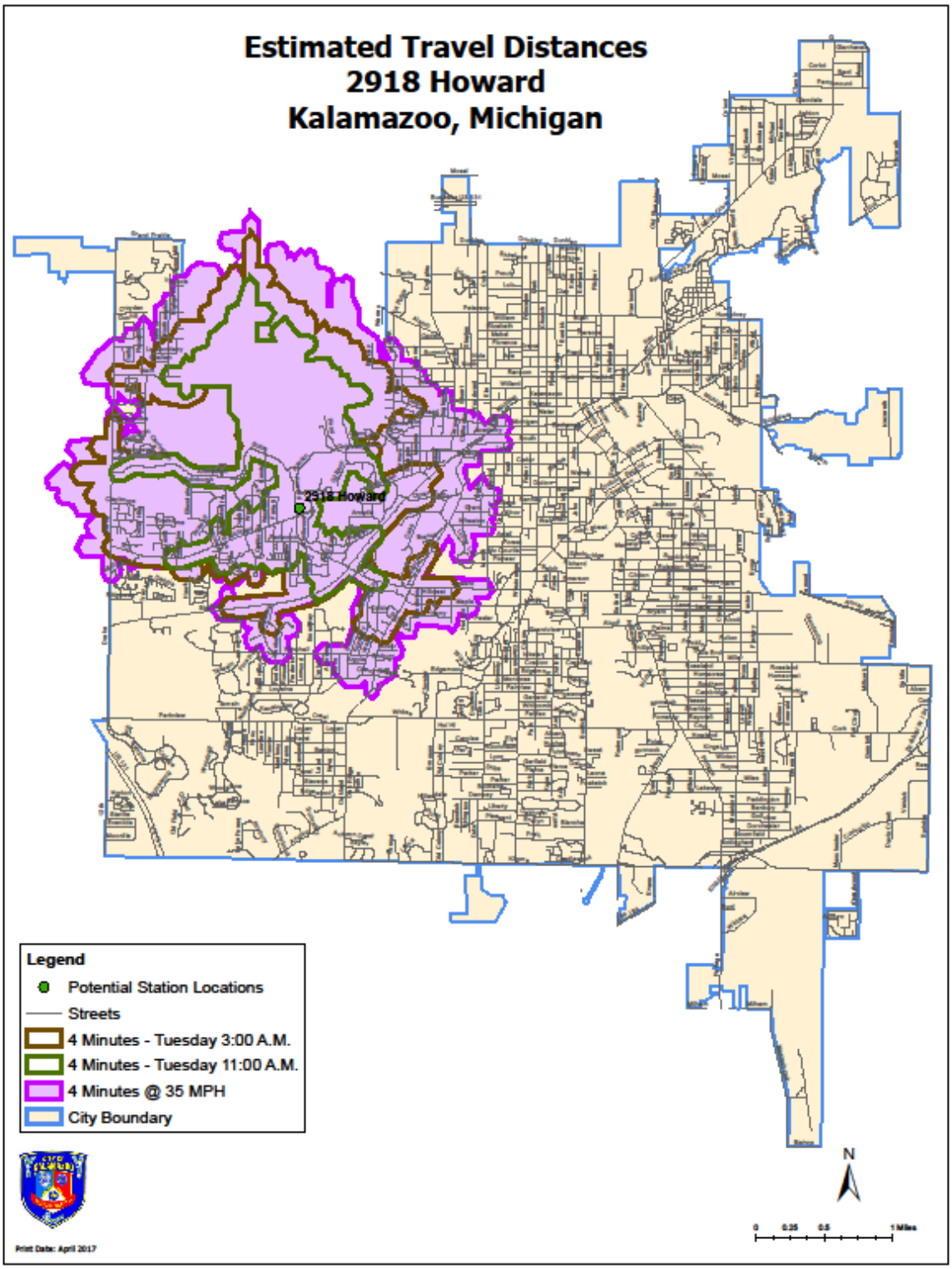

Estimated Travel Distances
Public Safety Station 6
City of Kalamazoo, Michigan
Station 6
Legend
Station 6
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

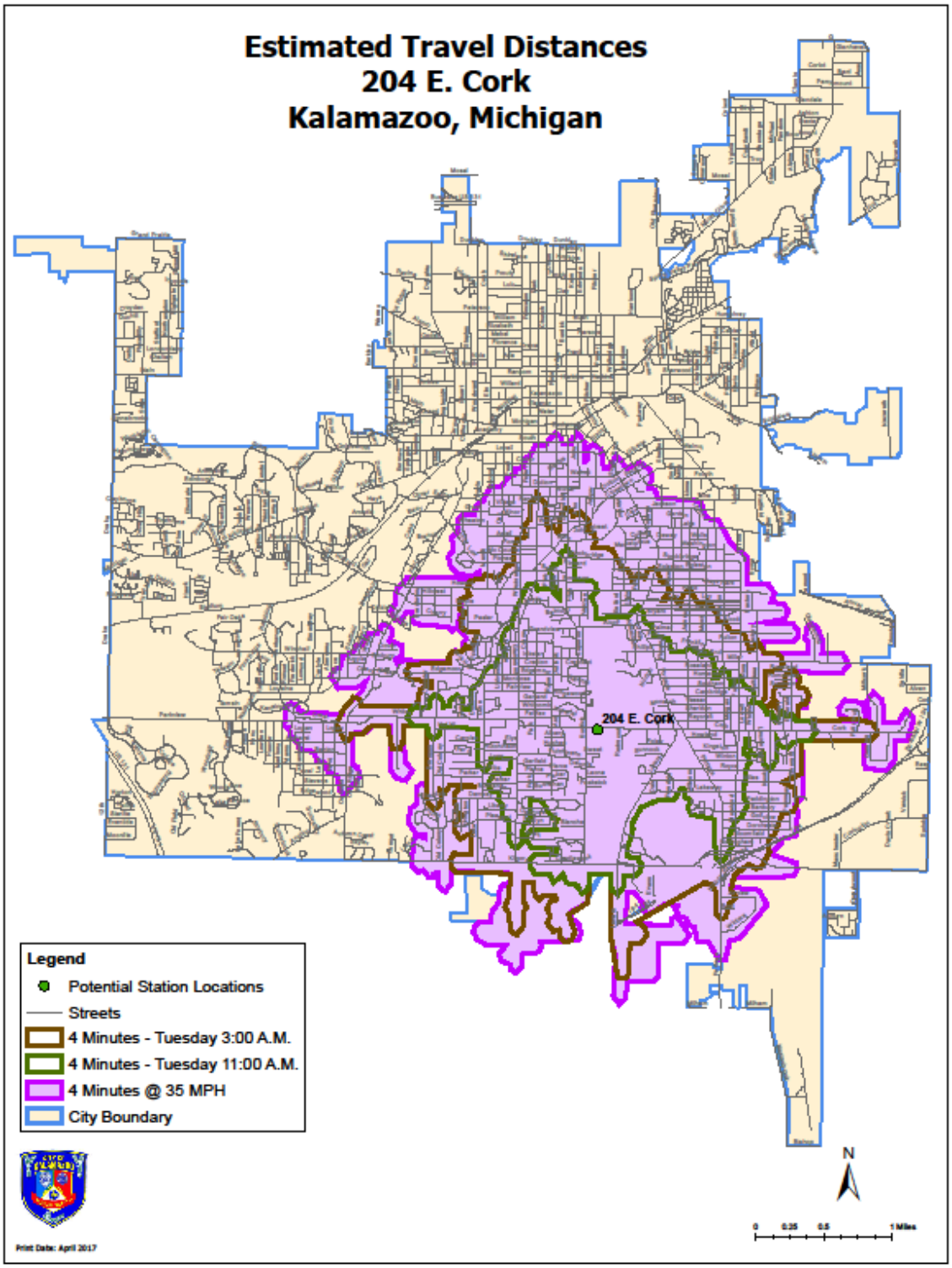

Estimated Travel Distances
Public Safety Station 7
City of Kalamazoo, Michigan
Station 7
Legend
Station 7
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

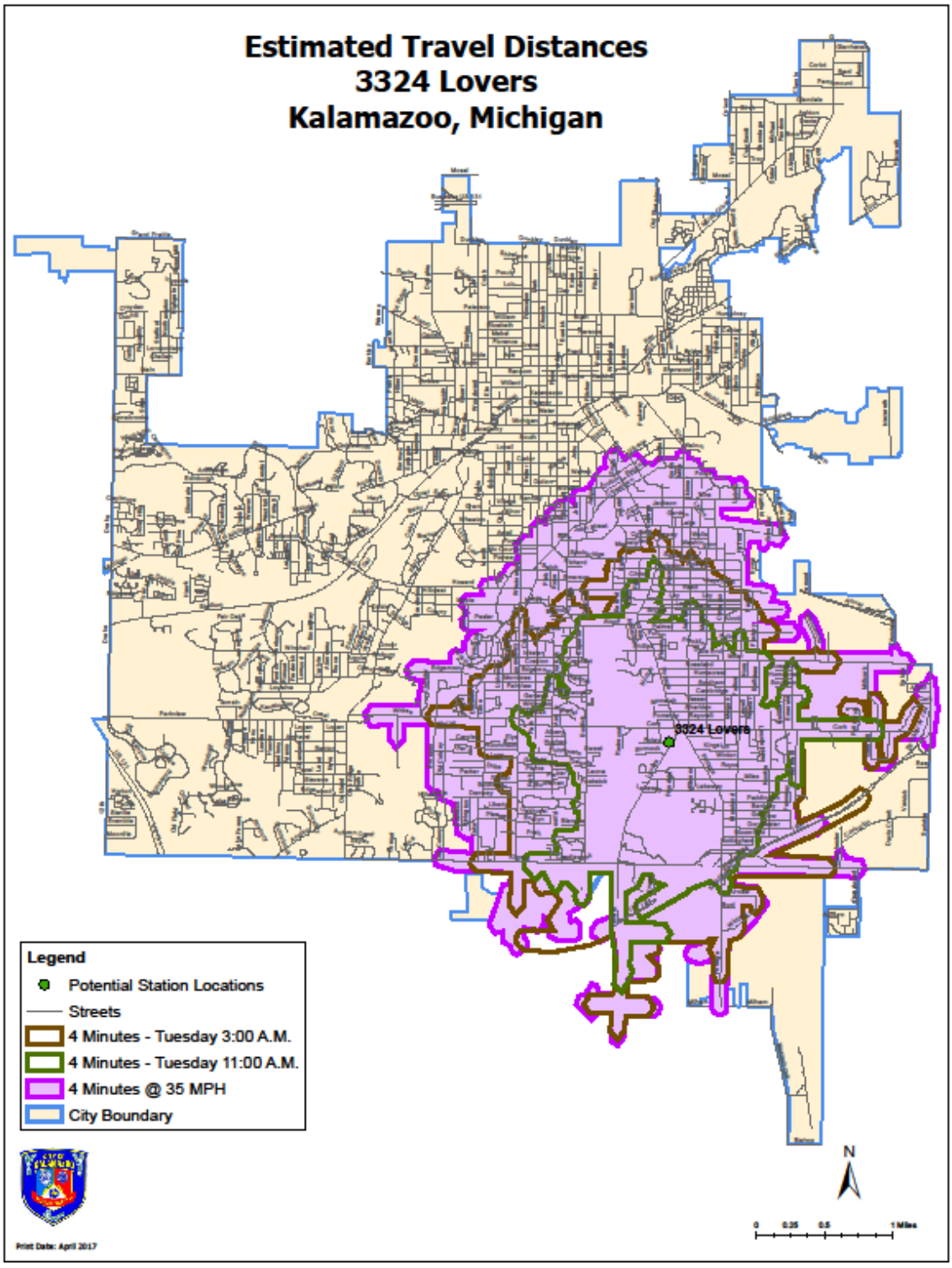
Appendix I


Estimated Travel Distances
3718 W. Michigan
Kalamazoo, Michigan
3718 W. Michigan
Legend
Potential Station Locations
Streets
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

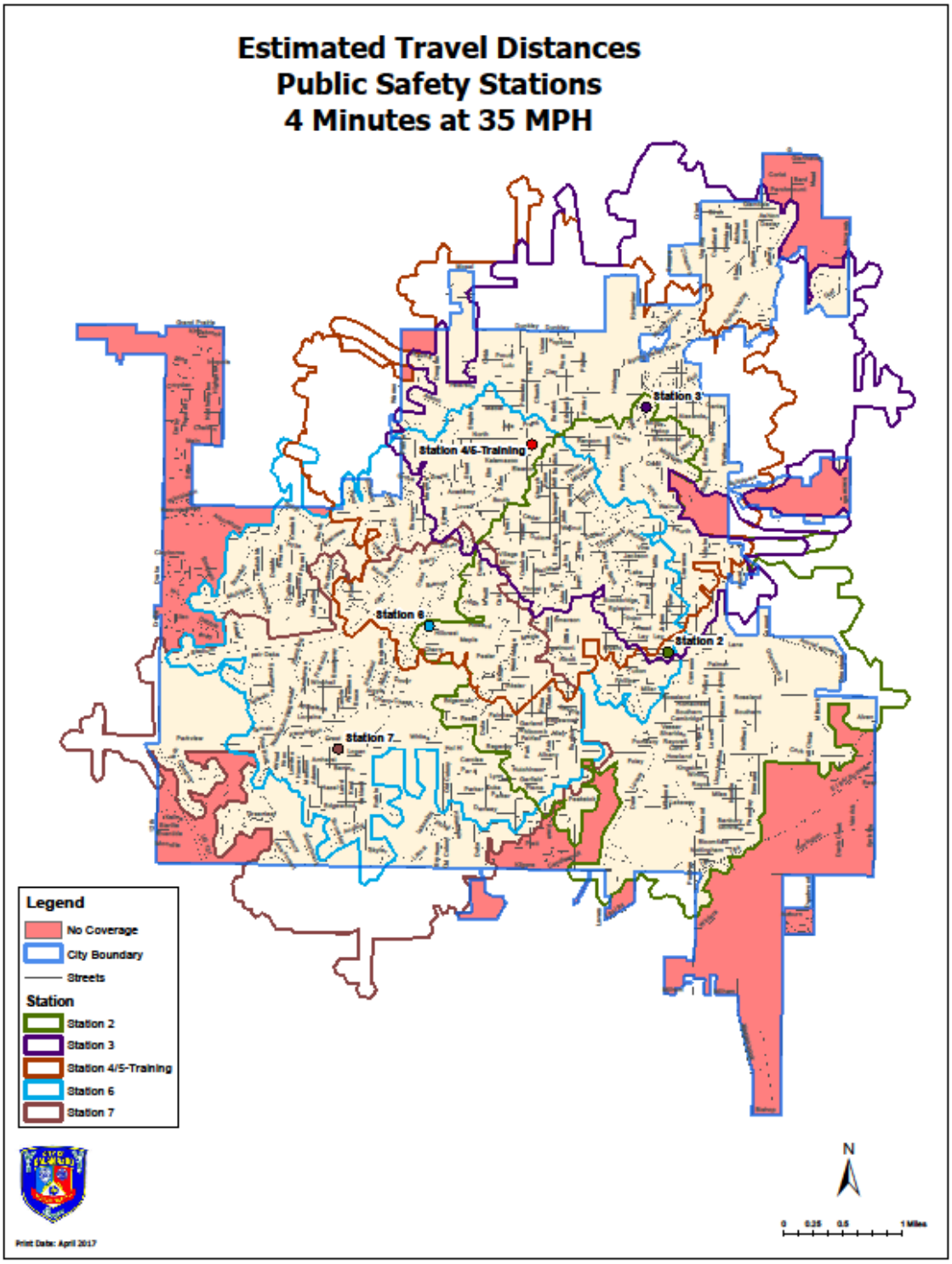

Estimated Travel Distances
801 S. Drake
Kalamazoo, Michigan
801 S. Drake
Legend
Potential Station Locations
Streets
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

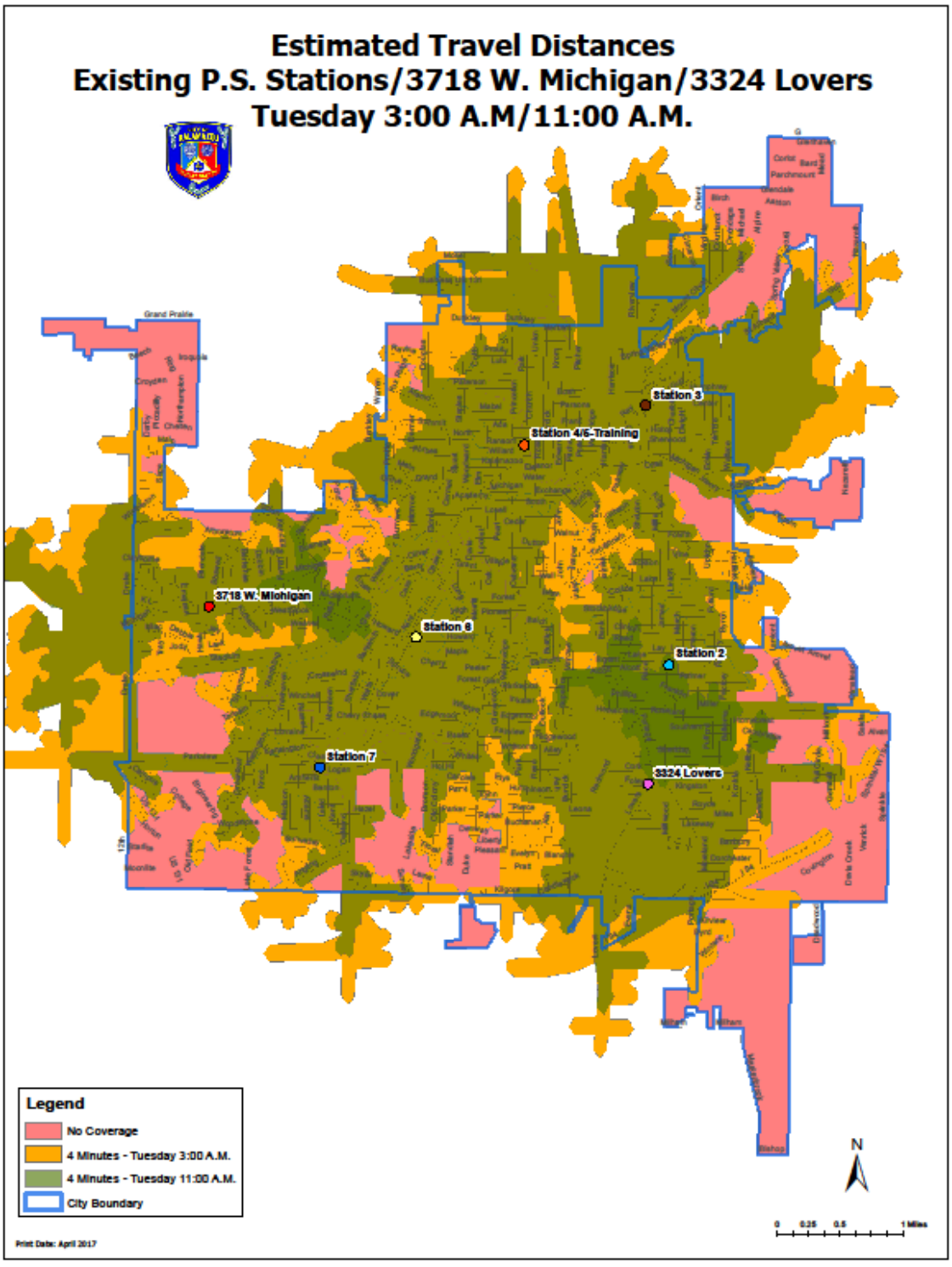

Estimated Travel Distances
2918 Howard
Kalamazoo, Michigan
2918 Howard
Legend
Potential Station Locations
Streets
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

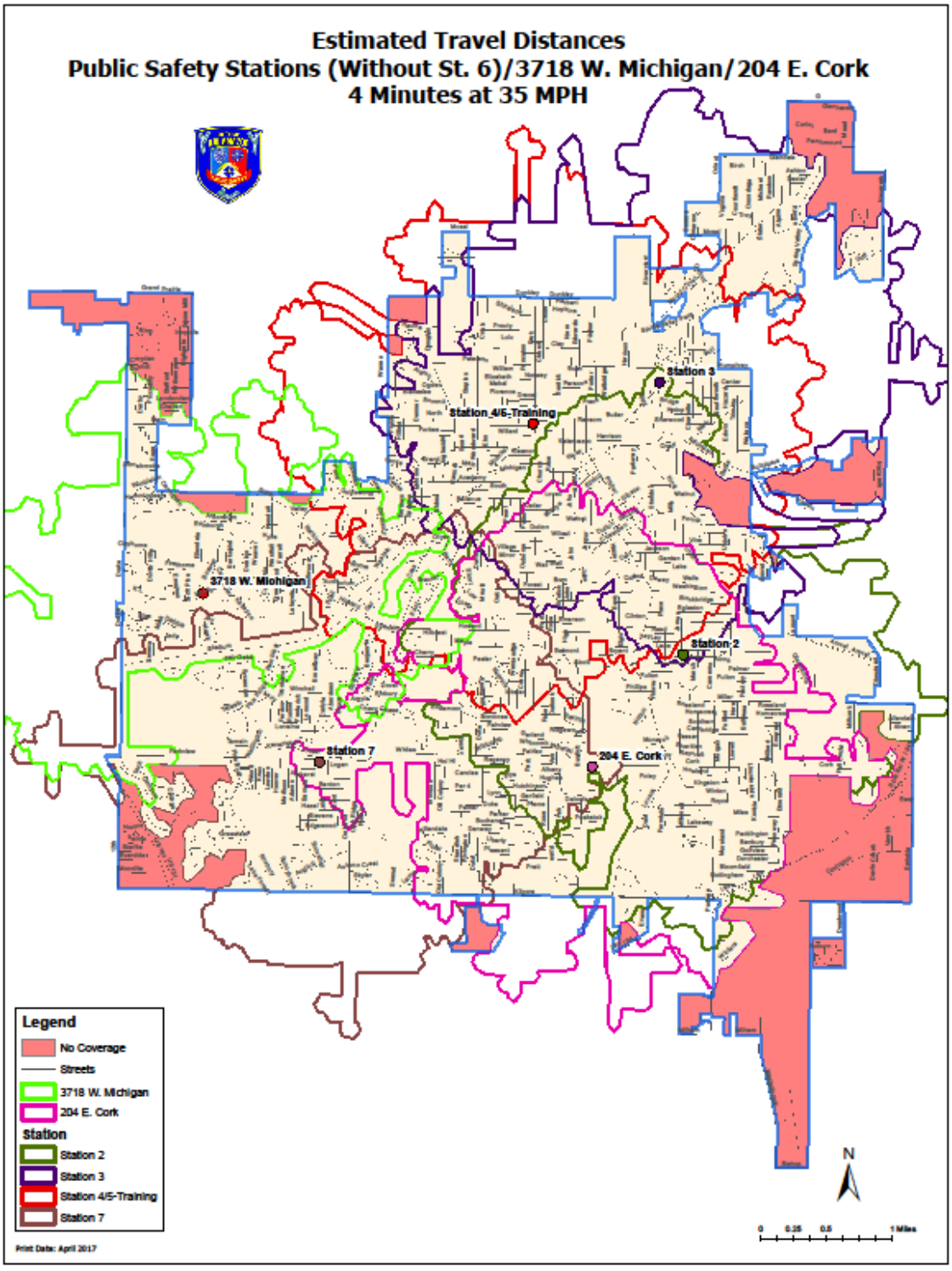

Estimated Travel Distances
204 E. Cork
Kalamazoo, Michigan
204 E. Cork
Legend
Potential Station Locations
Streets
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

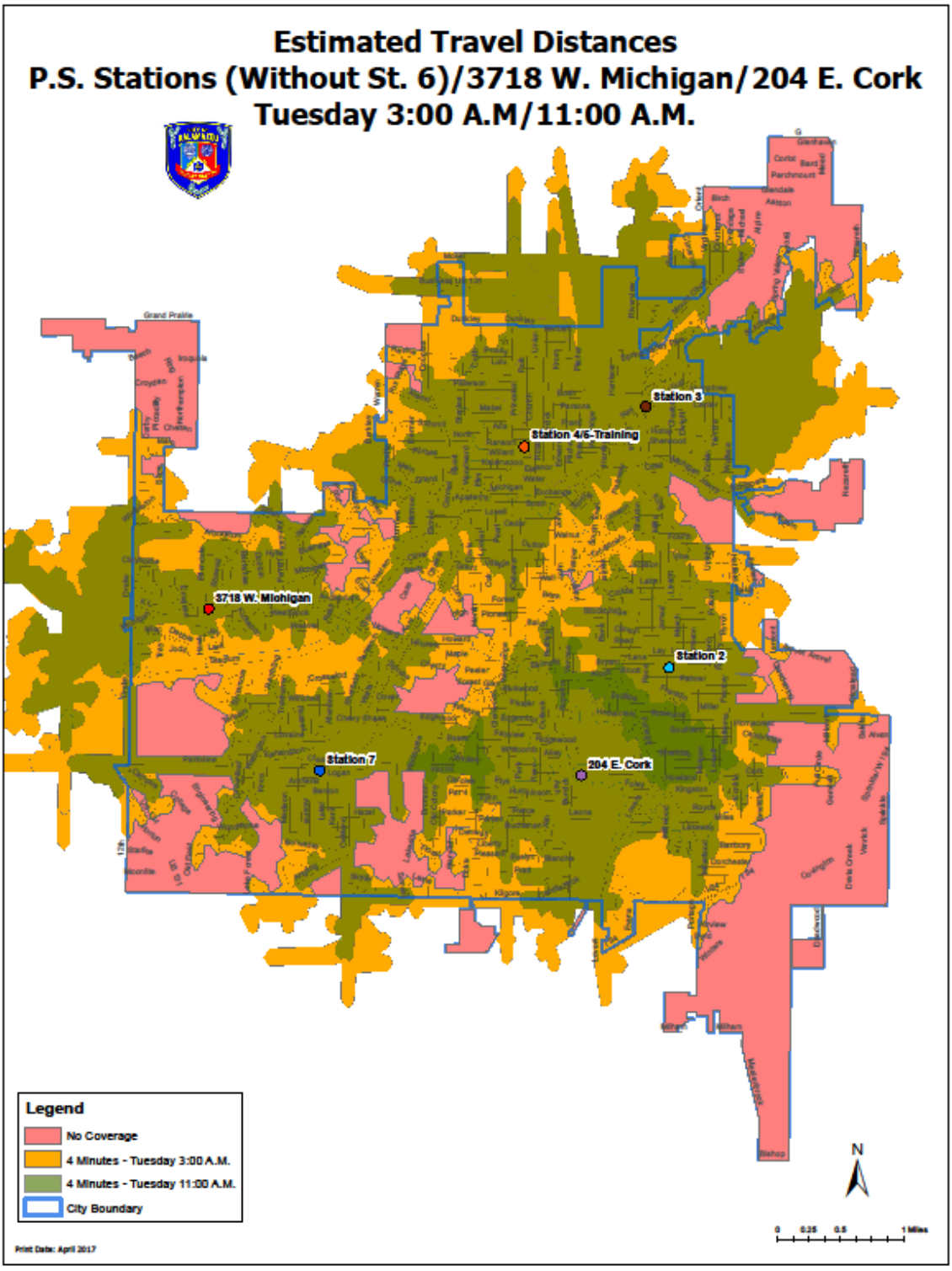

Estimated Travel Distances
3324 Lovers
Kalamazoo, Michigan
3324 Lovers
Legend
Potential Station Locations
Streets
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
4 Minutes @ 35 MPH
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017

Appendix J


Estimated Travel Distances
Public Safety Stations
4 Minutes at 35 MPH
Station 3
Station 4/5-Training
Station 6
Station 2
Station 7
Legend
No Coverage
City Boundary
Streets
Station
Station 2
Station 3
Station 4/5-Training
Station 6
Station 7
N
0 0.25 0.5 1 Miles
Print Date: April 2017


Estimated Travel Distances
Existing P.S. Stations/3718 W. Michigan/3324 Lovers
Tuesday 3:00 A.M/11:00 A.M.
Station 3
Station 4/6-Training
3718 W. Michigan
Station 8
Station 2
Station 7
3324 Lovers
Legend
No Coverage
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017


Estimated Travel Distances
Public Safety Stations (Without St. 6)/3718 W. Michigan/204 E. Cork
4 Minutes at 35 MPH
Station 3
Station 4/5-Training
3718 W. Michigan
Station 2
Station 7
204 E. Cork
Legend
No Coverage
Streets
3718 W. Michigan
204 E. Cork
Station
Station 2
Station 3
Station 4/5-Training
Station 7
Print Date: April 2017
N
0 0.25 0.5 1 Miles


Estimated Travel Distances
P.S. Stations (Without St. 6)/3718 W. Michigan/204 E. Cork
Tuesday 3:00 A.M/11:00 A.M.
Station 3
Station 4/6-Training
3718 W. Michigan
Station 2
Station 7
204 E. Cork
Legend
No Coverage
4 Minutes - Tuesday 3:00 A.M.
4 Minutes - Tuesday 11:00 A.M.
City Boundary
N
0 0.25 0.5 1 Miles
Print Date: April 2017