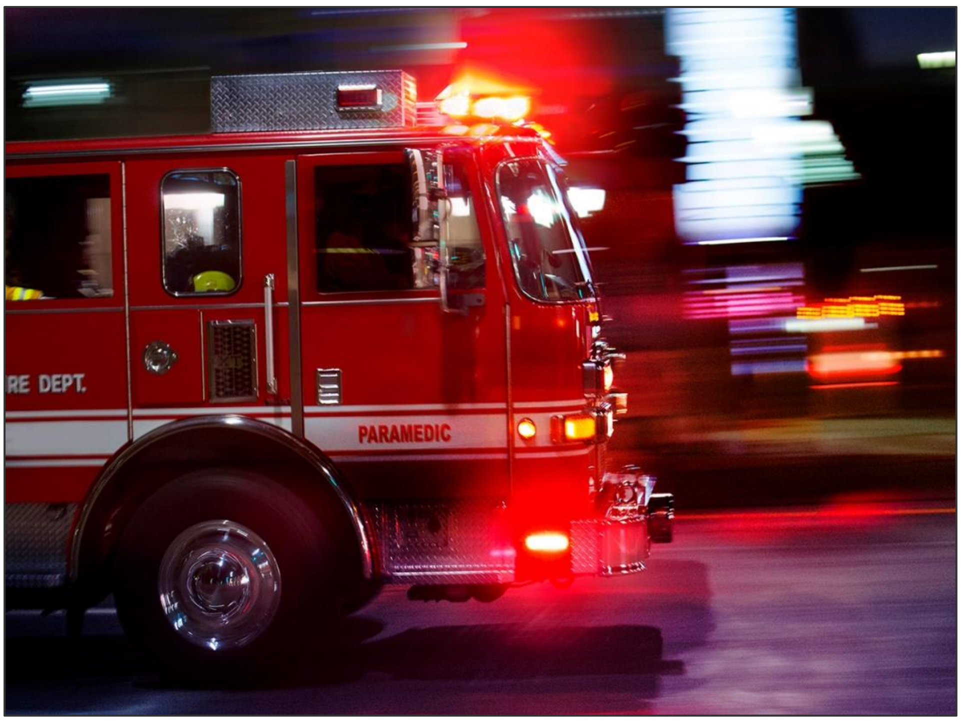
CENTER FOR PUBLIC SAFETY MANAGEMENT, LLC

FIRE MASTER PLAN

Trenton Fire and Emergency Services Department

Trenton, New Jersey

Final Report: April, 2021



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ICMA

Exclusive Provider of Public Safety Technical Services for
International City/County Management Association

THE ASSOCIATION & THE COMPANY

The International City/County Management Association is a 103-year old, nonprofit professional association of local government administrators and managers, with approximately 13,000 members located in 32 countries.

Since its inception in 1914, ICMA has been dedicated to assisting local governments and their managers in providing services to its citizens in an efficient and effective manner.
ICMA advances the knowledge of local government best practices with its website (www.icma.org), publications, research, professional development, and membership. The ICMA Center for Public Safety Management (ICMA/CPSM) was launched by ICMA to provide support to local governments in the areas of police, fire, and emergency medical services.

ICMA also represents local governments at the federal level and has been involved in numerous projects with the Department of Justice and the Department of Homeland Security.

In 2014, as part of a restructuring at ICMA, the Center for Public Safety Management (CPSM) was spun out as a separate company. It is now the exclusive provider of public safety technical assistance for ICMA. CPSM provides training and research for the Association's members and represents ICMA in its dealings with the federal government and other public safety professional associations such as CALEA, PERF, IACP, IFCA, IPMA-HR, DOJ, BJA, COPS, NFPA, and others.

The Center for Public Safety Management, LLC, maintains the same team of individuals performing the same level of service as when it was a component of ICMA. CPSM's local government technical assistance experience includes workload and deployment analysis using our unique methodology and subject matter experts to examine department organizational structure and culture, identify workload and staffing needs, and align department operations with industry best practices. We have conducted 341 such studies in 42 states and provinces and 246 communities ranging in population from 8,000 (Boone, Iowa) to 800,000 (Indianapolis, Ind.).

Thomas Wieczorek is the Director of the Center for Public Safety Management.
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SECTION 1. EXECUTIVE SUMMARY

The Center for Public Safety Management LLC (CPSM) was contracted by the City of Trenton, NJ to complete an analysis of the city's Fire and Emergency Services Department.

The Trenton Fire and Emergency Services Department (TFESD) is responsible for providing services that include fire suppression; first response emergency medical services; fire investigation; technical rescue to include building collapse, confined space rescue, and high-angle rope rescue; response to and mitigation of hazardous materials incidents; and response through the Office of Emergency Management to disasters both natural and man-made. This service is provided out from seven stations located throughout the city. Response is made through seven engine companies, three ladder companies, one rescue company, one hazardous material unit, and various other operational support vehicles.

The service demands of this community are numerous for the department and include EMS first response, fire, technical rescue, hazardous materials, and transportation emergencies to include extensive rail traffic and vehicle, and other non-emergency responses. A significant component of this report is the completion of an All-Hazard Risk Assessment of the Community. The All-Hazard Risk Assessment of the Community contemplates many factors that cause, create, facilitate, extend, and enhance risk in and to a community.

The response time and staffing components discussion of this report are designed to examine the current level of service provided by the TFESD compared to national best practices. As well, these components provide incident data and relevant information to be utilized for future planning and self-review of service levels for continued improvement designed to meet community expectations and mitigate emergencies effectively and efficiently.

Other significant components of this report are an analysis of the current deployment of resources and the performance of these resources in terms of response times and the seven TFESD fire management zones; current staffing levels and patterns; department resiliency (ability to handle more than one incident); critical tasking elements for specific incident responses; and assembling an effective response force. CPSM analyzed these items and is providing recommendations where applicable to improve service delivery and for future planning purposes.

In summation, a comprehensive risk assessment and review of deployable assets are critical aspects of a fire department's operation. First, these reviews will assist the TFESD in quantifying the risks that it faces. Second, the TFESD will be better equipped to determine if the current response resources are sufficiently staffed, equipped, trained, and positioned. The factors that drive the service needs are examined and then link directly to discussions regarding the assembling of an effective response force and when contemplating the response capabilities needed to adequately address the existing risks, which encompasses the component of critical tasking.

This report also contains a series of observations and planning objectives and recommendations provided by CPSM that are intended to help the TFESD deliver services more efficiently and effectively.

Recommendations and considerations for continuous improvement of services are presented here. CPSM recognizes there may be recommendations and considerations offered that first must be budgeted and/or bargained, or for which processes must be developed prior to implementation.

Section 2

2.1 The TFESD does not take full advantage of its records management system (RMS), and continues to use Microsoft Excel spreadsheets for department asset inventory, target hazards, and staffing assignments. These records are decentralized and not maintained on a central records program. The department's current RMS (ESO) is capable of maintaining these records, and more. CPSM recommends the TFESD transition the records now maintained on spreadsheets to the ESO RMS software. CPSM further recommends the following planning objectives be adopted by the TFESD so a seamless transition of data and records is achievable:

- Establish a records management team to conduct an internal needs assessment and review so that current methods on records and data are maintained. This team should include a representative from the city's Information Technology Department.
- Develop and implement a plan for the transition of current records, information, and data to ESO. This plan should include a review of what programs are currently included in the TFESD ESO suite, and what needs to be added. Identify additional costs, if any, and budget accordingly. The fiscal plan should include implementation over a one- to three-year period.
- Establish organizational policies and guidelines for the ESO RMS. These should include who manages the RMS, what information and records will be maintained in the RMS, a records retention program, end-user functions, and who will be responsible for data entry. These polices and guidelines should include necessary training for successful implementation and a sustainable RMS program where continual analytics can be performed.
- Provide necessary training for data input, report building, and analysis of the information and data.

2.2 The TFESD does not have a data analyst or information management specialist position in the department. At present, a firefighter is assigned the duties of information management and provides basic fire incident data extraction and report building, with no real analysis of the mined information. CPSM recommends the TFESD budget for a civilian position to manage the department's records management system. Important aspects of this position include:

- Responsibility for designing and managing the department's information system(s), as well as analyzing and tracking data needed to facilitate department projects and various operations.
- Proficiency in information technologies needed in developing and working in information systems, generating accurate reports and forecasts, analyzing these reports and forecasts, and presenting this information to the TFESD senior management so that planning and decision-making linked to accurate data and information can occur.

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Section 3

3.1 The TFESD operates out of seven operational facilities strategically located throughout the city. Each station houses around-the-clock crews, 365 days a year. Four stations house one crew and one piece of first response apparatus (engine), while three stations house more than one crew and one to three first response apparatus (engine, ladder, rescue, haz-mat). Additionally, most stations house auxiliary response rolling stock such as watercraft, specialty response trailers, reserve fire apparatus, and support vehicles. Two stations also house the on-duty district commander and response vehicle (battalion chief). Each station has significant infrastructure issues to include interior and exterior issues, due primarily to the age of the buildings. Additionally, several of the stations do not have gender-specific bunking and bathroom spaces, and no stations have cleaning equipment for structural turn-out gear (extractor and dryer), or washer/dryer for cleaning and decontamination of station wear. No station has a dedicated decontamination room/area equipped with non-porous sinks for the decontamination of equipment.

- CPSM recommends as a planning objective that, over a three-year period, the department conduct a facility condition assessment of all fire facilities.
  - This assessment should entail a comprehensive inspection of fire facilities and should include all building system components for evidence of movement, deterioration, structural failure, probable useful life, need for repair and maintenance, need for replacement, and associated replacement costs.
  - CPSM further recommends the city and department retain an engineering firm/consultant to conduct a comprehensive review of all TFESD facilities, and develop several options in a Comprehensive Fire Department Facilities Plan that will guide the officials of the City of Trenton and the TFESD in determining the necessity for improvements/station replacements over the next five to ten years. Included in this plan should be a budgetary and funding plan with facility prioritization, as well as what facilities are viable and what facilities should be replaced.

3.2 The TFESD operates with some first-line engine apparatus in excess of 20-plus years and a first-line ladder truck that is 20 years in age. Additionally, the TFESD has reserve engines, a reserve ladder, and a reserve heavy rescue apparatus that are in excess of 25-years of age. The TFESD does not have a structured apparatus replacement plan as outlined in NFPA 1901for first-line fire and rescue apparatus. The current fire administration does have a five-year catch-up plan in place to address those apparatus that have fallen outside of the NFPA recommended replacement schedule.

- CPSM recommends the TFESD develop, over a one-year period, a fire apparatus replacement plan that includes age recommendations in accordance with NFPA 1901 standard, Standard for Automotive Fire Apparatus. With respect to recommended vehicle service life, the following is an excerpt from this standard:

  > *"It is recommended that apparatus greater than 15 years old that have been properly maintained and that are still in serviceable condition be placed in reserve status and upgraded in accordance with NFPA 1912, Standard for Fire Apparatus Refurbishing (2016), to incorporate as many features as possible of the current fire apparatus standard. This will ensure that, while the apparatus might not totally comply with the current edition of the automotive fire apparatus standards, many improvements and upgrades required by the recent versions of the standards are available to the firefighters who use the apparatus."*

- Planning objectives should include:
  - First-line apparatus should not exceed 15 years of service on the front line, and once they reach this age, should be replaced with a new apparatus and then rotated to reserve status. This replacement schedule should be inserted into the TFESD fleet capital replacement plan.
  - Apparatus in reserve status and which have not been properly maintained as evidenced by maintenance records, or that are not operationally or roadworthy as evidenced by maintenance records.
  - Apparatus in reserve status in excess of 20 years old should comply with NFPA 1901 and be upgraded in accordance with NFPA 1912 if the department plans to continue to use this apparatus.
  - Apparatus and major apparatus components such as the motor, fire pump, aerial ladder assembly and hydraulics, chassis and chassis components such as brakes, wheels, and steering equipment should be maintained in accordance with manufacturer and industry specifications and standards.
  - Apparatus components requiring annualized testing either fixed or portable such as fire pumps, aerial ladder and aerial ladder assemblies, ground ladders, self-contained breathing apparatus to include personnel fit-testing, and fire hose should be tested in accordance with manufacturer and industry specifications and standards.
  - Current apparatus/fleet maintenance mechanics should be provided the opportunity to obtain the Emergency Vehicle Technician/Fire Apparatus Track certification.
  - Assess the addition of one additional apparatus/fleet maintenance mechanic.

3.3 The TFESD has a training program in place that includes basic firefighting training, advanced/technical rescue and water emergency response training, hazardous materials training, and company in-service training. Although there is a captain assigned to each shift to oversee training, this position also backfills vacant captain positions due to scheduled and unscheduled leave, thus decreasing the amount of time this position can allot to shift-wide company training. This backfilling occurred 214 times from July 1, 2019 to June 30,2020.

In 2019, the TFESD went through an ISO Fire Suppression Rating Schedule (FSRS), Public Protection Classification (PPC) review. During this review several deficiencies in staff training were noted. These include:

  - No credit for firefighters receiving 18 hours of annualized training.
  - Credit deficiency for officer training (received 8.25 out of 12 available credit score).
  - Significant credit deficiency for annual pre-fire planning inspections, which are considered training as well as inspections in that company personnel familiarize themselves with buildings, fire protection systems, and water supply systems in their respective fire management zones.
  - No annual proficiency evaluations.

- CPSM recommends the following as planning objectives for department training:
  - Develop over a one-year period an internal training plan to address current ISO training deficiencies, which include: an annualized training plan for incumbent employees that is competency-based on National Fire Protection Association (NFPA), International Fire Service Training Association (IFSTA), and New Jersey state fire training standards; utilization of the

assigned shift training captain position to conduct training as intended on a full-time basis, and as well utilize this position to oversee the pre-fire planning/target hazard program to ensure these activities are performed by company personnel on an annualized basis. This plan should have as its goal the training of all department operational members to Firefighter II standards.

- Over a one-year period, develop and budget for an officer training program that is competency-based on National Fire Protection Association (NFPA), International Fire Service Training Association (IFSTA), and New Jersey state fire training standards, and that focuses on contemporary fire service issues including community fire protection and emergency services delivery approaches, fire prevention practices, firefighter safety and risk management and labor/staff relations; reviewing, approving, or preparing technical documents and specifications, departmental policies, standard operating procedures and other formal internal communications; improving organizational performance through process improvement and best practices initiatives; and having a working knowledge of information management and technology systems.
- Develop training programs that ensure the following certifications for the following supervisory levels in the organization:
  - Captain
    - Fire Instructor I.
    - Fire Officer I and II.
    - NJ IMS Level I (already required).
    - NJ Fire Inspector (so companies can perform in-service inspections).
  - Battalion Chief
    - Fire Instructor II.
    - Fire Officer III.
    - NJ IMS Level II.
    - Incident Safety Officer.
  - Deputy Chief
    - Fire Officer IV.
    - NJ IMS Level III.

3.4 The TFESD does not have a Fire Prevention Division, or staff assigned to perform fire prevention building or life-safety inspections. The state performs life-safety inspections in certain buildings in the city through the Inspection Unit of the New Jersey Division of Fire Safety. There is no interaction between the state and the TFESD with regard to fire prevention and life-safety building inspections. Additionally, there are occupancy classifications excluding high-rise and life-hazard use buildings/structures, which are inspected by the state agency that do not receive fire prevention inspections.

The prevention of fire and loss of life, human suffering (injuries to civilians and firefighters), environmental harm, and property damage is the optimum return on investment for fire agencies. Proactive involvement in construction, code enforcement, educating the public to prevent destructive fires, and training the public to survive fires is the best accomplishment of fire prevention. The most effective way to combat fires is to prevent them from occurring in the first place. A strong fire prevention program based on locally identified risk and relevant codes and ordinances reduces loss of property, life, and the personal and community-wide disruption that accompanies a catastrophic fire.

- CPSM recommends as planning objectives for fire prevention:
  - Develop a three- to five-year plan that establishes a Fire Prevention and Inspection Division. This plan should include identifying the number of occupancies in the city that require a fire prevention inspection to ensure the occupancy is compliant with the adopted fire prevention code; the number of supervisors and inspectors required to carry out established and/or recommended frequency of inspections; competencies and training required for each position in the Fire Prevention Division; and budgetary requirements to fund such a division.
  - At a minimum, develop a one- to three-year plan that establishes a position of fire prevention officer and who would interact with the Inspection Unit of the New Jersey Division of Fire Safety on fire prevention inspection issues so that this information is communicated to responding fire companies. This plan should include competencies and training required for this position and budgetary requirements to fund such a position.

3.5 Prior to the April 2019, ISO Public Protection Classification review, the City of Trenton maintained a community rating of 2. The TFESD had an opportunity to develop a work plan to maintain the ISO community rating of 2, but did not.

- As a planning objective, CPSM recommends the TFESD develop a planning objective with specific tasks and personnel assignments to achieve the ISO community rating of 2 once again, as this higher rating has a positive impact on community-wide property insurance premiums. This planning objective should link to other planning objectives identified in this report and which had an adverse effect on the most recent City of Trenton ISO Public Protection Classification review. This objective should have a short-term time planning period of one to three years.

3.6 For the five-year period of 2015 through 2019, the TFESD did not report any loss (in terms of dollars) as a result of fire-related calls for service. Additionally, the TFESD did not report any fire or non-fire related injuries or fatalities during this same five-year period. Typically, fire departments across the nation record community loss in terms of property loss dollars of some type for these types of incidents, specifically for structural, vehicle, and outside fires.

- As a planning objective, CPSM recommends the TFESD begin immediately to record property loss and fire-related injury/fatality information in its records management system so that a community analysis can be completed at the end of each reporting year. The purpose of this objective is to be able to identify trends and issues, and then develop solutions and programs that are aimed at reducing any fire or casualty problem.
- As a planning objective, CPSM recommends the TFESD link this planning objective (Community Loss Information) to operational response and tactical deployment, fire prevention and public education, education and training, and operational resiliency planning objectives as a measure of overall correlation effectiveness.

3.7 An available best practice that involves a comprehensive assessment of a fire department is the fire accreditation program managed by the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation international. This program provides an analytical self-assessment process to evaluate ten categories of the agency's performance.

The CPSE fire accreditation process provides a well-defined, internationally recognized benchmark system to measure the quality of fire and emergency services.[1] As a best practice, the accreditation process assists local governments in justifying their expenditures by demonstrating a direct link to improved services. Particularly for emergency services, local officials need criteria to assess professional performance and efficiency. The TFESD is not an accredited agency through the Center for Public Safety Excellence (CPSE), Commission of Fire Accreditation.

- In terms of a planning objective, CPSM recommends the TFESD develop and implement a five-year plan to become an accredited agency through the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation International. Planning components should include:
  - Identify one TFESD position or a consulting firm to serve as the overarching agency accreditation manager whose focus is to guide the process, liaison with CPSE, and ensure all components of the accreditation process are satisfactorily completed.
  - Assembling personnel from the TFESD and City of Trenton to serve as the core fire accreditation team whose focus is to work with subordinate team members in the completion of the core documents and 240 separate performance indicators.
  - Completing the key building blocks of the accreditation process, which include:
    - The completion of a *Community Risk Assessment* including fire and non-fire risks.
    - Creating *Goals and Objectives* for each of the divisions/programs of the agency utilizing the findings of the risk assessment to develop objectives within the emergency response program.
    - Creating a *Standards of Cover* (SOC) document with benchmarks based upon the community risk assessment (analysis) and the corresponding goals and objectives.
    - Conducting an *Agency Performance* study based upon the benchmarks established within the SOC.
    - Creating the agency's *Strategic Plan*, which will incorporate the components from the previous steps (Community Risk Assessment, Goals and Objectives, Standards of Cover, Agency Performance).
    - Completing the *Self-Assessment Manual* (SAM), answering each of the performance indicators and criteria statements. During this process, the department will examine more than 240 separate performance indicators, 98 of which are considered core or required competencies.
  - Develop a budget for the accreditation process that includes CPSE fees, salary and benefits for an accreditation manager or consulting firm, and supportive materials and supplies.

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1. CPSE, About CPSE (2012), http://www.publicsafetyexcellence.org (accessed on October 31, 2012).

Section 4

4.1 The City of Trenton has diverse environmental risks, building target hazards, and transportation and specials risks to which the TFESD responds.

- CPSM recommends as a planning objective:
  - The TFESD develop and implement, over a one-year period, a training plan that gathers relevant data and educates department members about the community profile (demographics, vulnerable populations, building, environmental, and transportation risks) that exists in each fire management zone, so that each fire company can then develop individual response plans to prepare for and mitigate emergencies more effectively.
  - CPSM further recommends as a planning objective the TFESD develop and implement a plan over a two-year period for individual companies to complete pre-fire planning of all building target hazards in their individual fire management zones, and enter the information and data into the records management system. The plan should include the requirement for companies to visit each target hazard on an annual basis, updating the pre-fire plan and familiarizing themselves with the hazard. Target hazards should be rotated each year to a different shift so that companies walk through each target hazard in their fire management zone once every four years.

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Section 5

5.1 The TFESD currently operates with a minimum on-duty staffing of level of 42 personnel. This includes seven engines each staffed with three personnel, three ladders each staffed with four personnel, one rescue staffed with four personnel, one special services unit staffed with one person, and two battalion chiefs each paired with an adjutant. Considering the high level of risk that the City of Trenton has, engines being staffed with just three personnel can impact efficiency, effectiveness, and safety for both citizens and firefighters. In addition, the shift training officer program has not worked as well as anticipated, particularly from the aspect of them being able to conduct training.

- CPSM recommends as a planning objective that, over a three-year period, the department conduct a minor deployment modification and work to increase staffing levels, particularly on the engines. The overall goal is to increase staffing on each shift to **51** personnel, with a **48-**person minimum. Total operational staffing (not counting administrative and staff positions) would be 204 personnel. When uniformed/sworn staff and administrative personnel are included, overall personnel would be approximately 210 to 212 personnel. This does not include civilian support staff. It also does not include the potential addition of fire prevention staff/inspectors.
  - Under this this recommendation the TFESD would be staffed as follows:
    - Seven engines staffed with four personnel.
    - Three ladders staffed with four personnel.
    - One rescue staffed with four personnel.
    - Two command teams each consisting of one battalion chief and captain/training officer/field incident technician/battalion safety officer.
  - **Year One**:
    - In order to provide for more effective, efficient, and safe overall incident management, and to enhance critical incident scene safety for all personnel, the TFESD should upgrade the battalion chiefs' adjutant positions to the rank of captain to function as a part of an integrated command team with each battalion chief. These personnel will serve not only as a field incident technician, but also as a battalion safety officer and training officer. Advantages of this approach can include
      - Conduct training within their battalion on their shift.
      - Assist the battalion chief with other administrative duties.
      - Incident recon.
      - Assess the risk/benefit of operations.
      - Assess and address safety concerns on the incident scene.
      - Communicate and report safety issues to command.
      - Intervene as necessary to provide for safety.
      - Assist with managing the incident.
      - Define, evaluate, and recommend changes to the incident action plan.
      - Provide direction relating to tactical priorities and specific critical fireground factors.
      - Become the Incident Safety Officer.

- Manage personnel accountability on the incident.
- Evaluate the need for additional resources.
- Assign logistics responsibilities.
- Assist with the tactical worksheet for control and accountability.
- Evaluate the fireground organization and span of control.
- Assist with personnel air management.
- Manage crew work/rest cycles and rehab.
- Other incident scene duties as necessary.

- Reassign training captains to battalion chiefs as recommended above.
- Promote four captains and assign them to battalion chiefs as above.
- Reassign the SS-1 driver to an engine company to bring staffing to four. SS-1 can be assigned to that station and can be brought to the scene, when necessary, either by that engine crew or another company.
- Hire a minimum of 12 personnel to complete staffing the four engines that are in a station by themselves (Engines 6, 7, 8, and 9) to a four-person minimum.

- Year Two:
  - Hire a minimum of 12 personnel to bring staffing on the remaining three engines (Engines 1, 3, and 10) to four personnel.
- Year Three:
  - Hire a minimum of 12 personnel to provide three floater/additional personnel per shift to help fill position vacancies and reduce the need for overtime. This will bring shift staffing to 51 personnel with minimum on-duty staffing of 48.

5.2 One of the keys to being able to maintain increased minimum staffing levels and reduce the amount of overtime being utilized is to monitor and attempt to minimize the amount of unscheduled leave—primarily sick, and injury—that personnel utilize. CPSM is not suggesting that personnel are not entitled to legitimate use of both these types of leave; however, we are also very cognizant of the fact that there are personnel in every department who misuse, and in fact abuse this type of leave and the system. The larger the department, the more of these personnel their likely are. Monitoring these types of leave and personnel who are suspected of misusing it can assist with keeping the need for overtime down and reduce staffing costs.

- CPSM recommends as a planning objective that TFESD leadership work with the firefighters and officers' bargaining units to develop a policy for monitoring and verification of personnel who are on sick or injury leave. Examples of things that can be discussed include requiring a location where they will be for in-person verification by a chief officer, providing a doctor's note, being required to see a city-arranged doctor, and not being eligible for overtime until they have worked a regular shift after a sick call out.

5.3 The TFESD will only be marginally able to handle two structure fires simultaneously even if the staffing on all companies is maintained at four personnel.

- CPSM recommends as a planning objective that TFESD should build at least a portion of its training regimens and tactical strategies around the exterior or transitional attack for when the fire scenario and the number of available units/responding personnel warrants this approach.

- CPSM also recommends that as a planning objective—particularly if engine company staffing levels are not increased from three to four personnel—and recognizing the potential for rapid fire spread in a densely developed urban community, the TFESD should equip all of its apparatus, and develop standardized tactical operations that will enable it to quickly develop and place in service, with high-volume fire flows of at least 1200 to 1500 gallons per minute (if the water supply will permit this), utilizing multiple lines/devices. This flow should be able to be developed within four to five minutes after arrival of an engine staffed with three personnel. However, these same capabilities should be an option for an engine staffed with four personnel.

5.4 The call processing (at dispatch) and turnout (in the station) times for the TFESD are much higher than recommended by NFPA 1710 benchmarks. The latter time is the one area where the fire department has the most control over and can serve to reduce overall response times.

- CPSM also recommends that as a planning objective the TFESD should take steps to continue to improve both the dispatch time and incident turnout times for both fire and EMS incidents to reduce overall response times to emergency incidents.

5.5 The current public safety radio system is reported by fire administration to have major problems and should be fully evaluated to determine if it is appropriate for the needs of the city's first responders. All of the TFESD stakeholders expressed significant concern to CPSM regarding the department's, and by extension, the city's overall emergency radio system. CPSM has significant concerns regarding the radio system and the potential negative implications that the system could have on personnel safety particularly if a firefighter or EMT was in trouble and needed emergency assistance. It was widely reported to CPSM that the current radio system is not a public safety radio system and that the system has multiple operational deficiencies and areas throughout the city where coverage is very poor. The life safety of firefighters, EMS personnel, and citizens depends on reliable, functional communication tools that work in the harshest and most hostile of environments. To operate safely in these dynamic environments, it is imperative that firefighters have the ability to immediately communicate information accurately.

Communications and interoperability issues are frequently noted as contributing factors in National Institute for Occupational Safety and Health investigative reports on firefighter line of duty deaths. Effective and reliable communications are mission critical to fire department operations.

- CPSM recommends that as a planning objective that within a one-year period the City of Trenton have an independent, objective consultant evaluate the city's emergency communications radio system and make recommendations for improvement or replacement.
  - Because of their mission critical importance to all firefighters, EMS personnel, and police officers, any recommendations for system upgrades or replacement should be budgeted for as soon as possible.
- CPSM recommends that as a planning objective the TFESD explore the feasibility of transitioning its dispatch operations from the police department to a communications center that is more fire and EMS centric. Options could include the Mercer County Communications Center, which already handles calls for TEMS, or exploring a shared services agreement with the newly formed Hamilton Township Fire Department. Priority should be given to addressing interoperability issues, particularly between TFESD and TEMS.

5.6 Despite the ongoing opioid crises, and despite members of both TFESD and TEMS being trained to administer Naloxone, neither organization carries this life-saving treatment. Only the TPD, which may not even respond to many EMS-related incidents, carries Naloxone.

- CPSM recommends that as a planning objective that ALL TFESD and TEMS units be supplied with Naloxone ASAP to provide an additional potential life-saving option when their personnel respond to drug overdoses.

5.7 The City of Trenton has numerous large buildings where even once emergency responders arrive on the scene they may have to travel an extended distance, which takes valuable minutes, to reach the patient. A number of communities, including Jersey City, have implemented programs that incorporate trained volunteers into the emergency medical response system. Similar to Trenton, the driving factors behind these programs are often the dense population along with numerous high-rises where this type of response force can speed initial life-saving care to those in need, particularly where it may take emergency personnel some time to make their way to the patient even after arriving on location.

The American Heart Association continues to recognize the chain of survival by early recognition, early CPR, early defibrillation, and rapid transport. PulsePoint® is an app on an iPhone that can be downloaded by anyone in the community who is willing to participate in this program, enabling them to be notified when someone is having a cardiac arrest in their vicinity. Fifty-seven percent of adults in the United States say they have had CPR training. Utilizing new technology, bystander performance, and active citizenship involvement enhances the care provided to the community.

- CPSM recommends that as a planning objective the TFESD and TEMS should collaboratively explore the possibility of enhancing their technological capabilities to provide increased service to the community for serious cardiac incidents such as through the iPhone PulsePoint® app or other similar programs or apps.

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SECTION 2. AGENCY REVIEW, CHARACTERISTICS, AND ADMINISTRATIVE PERFORMANCE

DEPARTMENT OVERVIEW AND ORGANIZATIONAL STRUCTURE

The Trenton Fire and Emergency Services Department (TFESD) is responsible for providing services that include fire suppression; first response emergency medical services; fire investigation and education; technical rescue to include building collapse, confined space rescue, and high-angle rope rescue; response to and mitigation of hazardous materials incidents; and response through the Office of Emergency Management to disasters both natural and man-made.

The TFESD is led by a Director of Fire and Emergency Services. This position, equivalent to the position of a fire chief, is a civilian position and serves as a member of the elected Mayor's cabinet. The organizational structure includes senior and middle manager level positions, and first-line supervisors. The largest contingent of personnel in the organization are company-level firefighters. The director does not have fireground authority. The following figure shows the TFESD organizational chart.

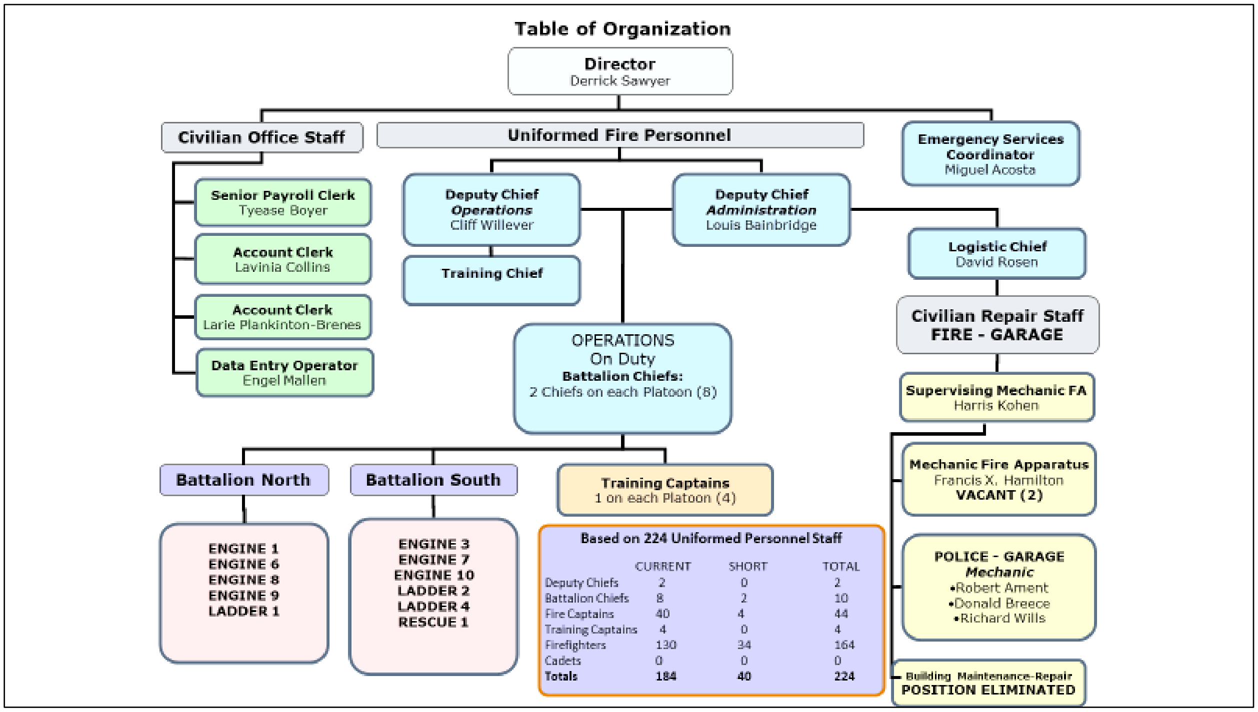
The TFESD provides the aforementioned emergency services from seven stations located throughout the city. Response is made through seven engine companies, three ladder companies, one rescue company, one hazardous material unit, and various other operational support vehicles. In addition to in-city mitigation of fire and emergency service incidents, the TFESD responds outside of the incorporated area of Trenton and into Mercer and Bucks Counties to provide specialized and technical rescue services as Task Force One. The members of Task Force One are comprised of Rescue One, Hazmat One, Engine One and Ladder One.

A Fire Marshal Unit comprised of certified fire investigators and supervisors determines the origin and cause of fires throughout the city. This unit works in conjunction with the Trenton Police Department and the Mercer County Prosecutors Office regarding those investigations the unit has jurisdiction over. Additionally this unit performs fire prevention and inspection activities aimed at ensuring life safety, the maintenance of fire protection systems, and compliance with the fire prevention code.

The TFESD Director also serves as the city's Coordinator of Emergency Management. Through the Office of Emergency Management (OEM), the Director and the OEM staff have the responsibility for ensuring that all-hazards planning concepts can be quickly implemented to respond to natural and man-made disasters as well as providing consequence planning and management of large special events. The OEM works closely with Mercer County Emergency Management as well as the state's Emergency Management office and maintains a current *All-Hazards Mitigation Plan*.

The TFESD Training Division oversees new employee onboarding, training, and progression through the new employee's probationary period. The Training Division also monitors incumbent employee certifications, recertification training, and the development of new programs and training for all personnel. The Training Division is also responsible for the research of contemporary industry practices, particularly in the area of firefighter safety.

FIGURE 2-1: TFESD Organizational Chart



GOVERNANCE AND ADMINSTRATION

The City of Trenton was incorporated in 1792 and serves as the Capital of New Jersey. Trenton utilizes as a form of government the Mayor-Council Plan C of the Optional Charter law of 1950, N.J.S.A 40:69A-55 et seq. (Laws of New Jersey 1950, Chapter 210). The Mayor serves as the elected chief executive and administrator of the city. The Mayor is elected to a four-year term. The City Council consists of seven members each elected to four-year terms. Three council members are elected to at-large council seats, with the remaining four elected to represent their respective wards. Unless otherwise specified by law, City Council serves as the legislative branch of the city.[2]

Article XIII, §2.59(a) of the City Code establishes the Fire Department and the position of Fire Director. Article XIII, §2.60 provides the authority of the Fire Director and §2.61 provides the responsibilities of the fire department; §2.61 also establishes the Office of Emergency Management, fire prevention and fire safety inspection services in the city, and provides for the investigation and cause of fires in the city (today's Fire Marshal Unit). The Director of Fire and Emergency Services reports to and serves as a member of the Mayor's cabinet.[3]

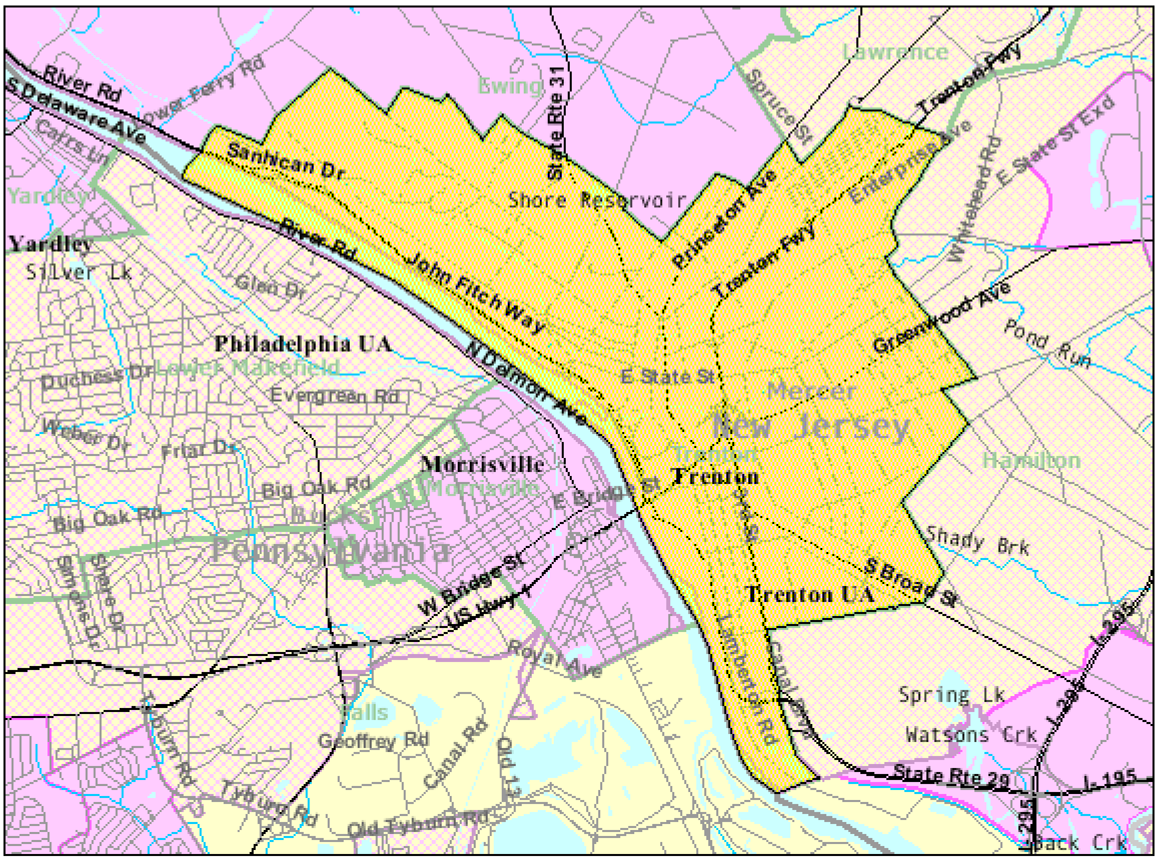
2. City of Trenton Financial Audit, 2019, page 1.
3. https://www.ecode360.com/9129798

SERVICE AREA

The TFESD provides fire and protective services within the municipal boundaries of the city. This includes an area of 8.155 square miles of which 7.648 square miles is land area. Trenton is located in southwestern Mercer County and is considered to be in the geographic center of the state. Trenton serves as the capital of the State of New Jersey.

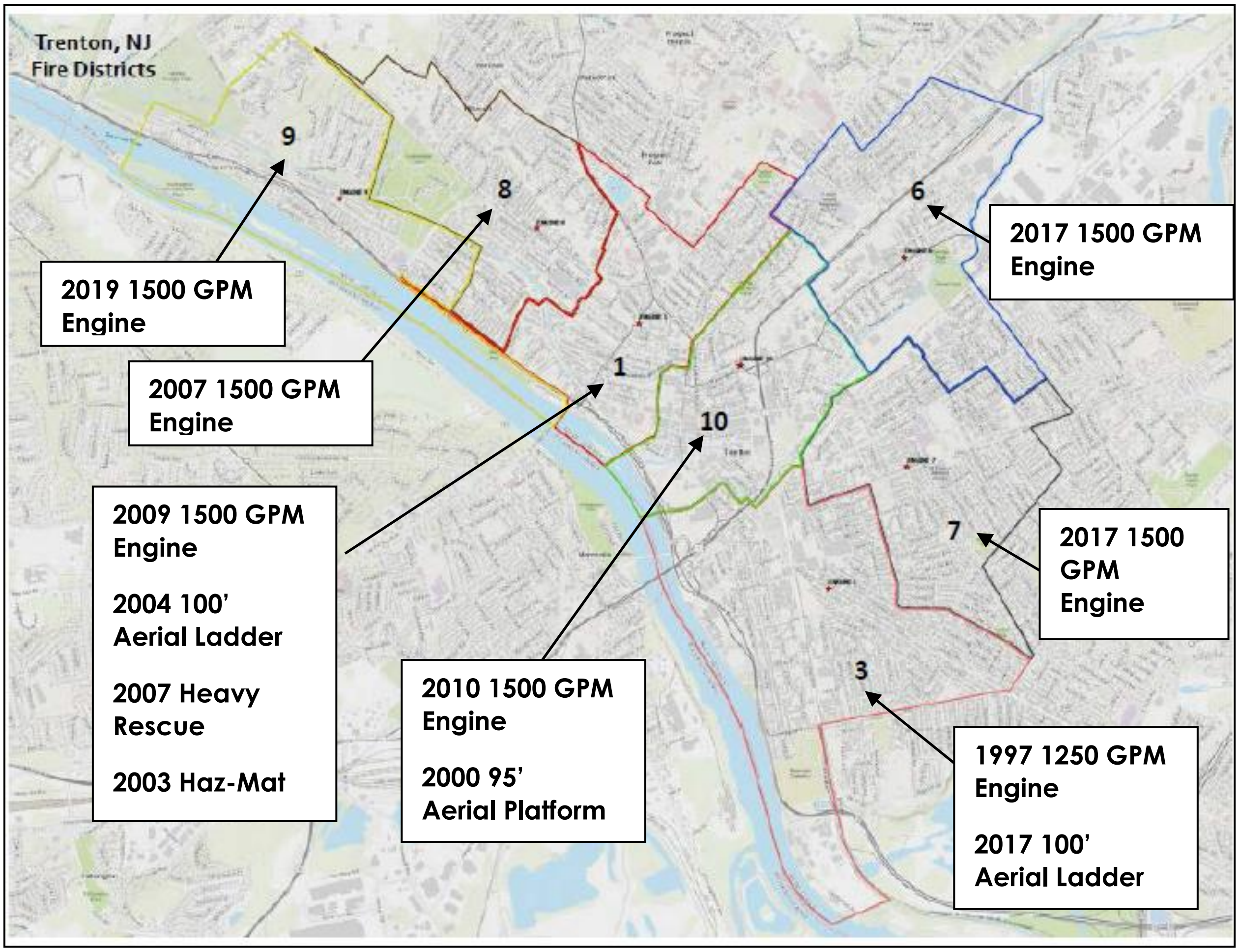
Trenton borders Ewing and Lawrence Townships to the north, Hamilton Township to the east and south, and the Delaware River to the west. Across the river to the west of the city lies the State of Pennsylvania. Several bridges connect Trenton with Morrisville, Penn. The following figure illustrates the location of the city and the department's service area (municipal boundaries).

FIGURE 2-2: TFESD Service Area



The TFESD responds from seven locations within the city. The following figure illustrates TFESD station locations, the response districts each serves, and the primary apparatus assigned to each station.

FIGURE 2-3: TFESD Fire Station Locations, District Served, and Front-line Fire Apparatus



RECORDS AND INFORMATION MANAGEMENT SYSTEMS

Contemporary fire departments must address well-defined programs and objectives, and which will add value, either directly to the bottom line or toward the achievement of the organization's goals and objectives. A fire service records management system is used to manage administrative and operational organizational information through the delivering of timely, accurate, complete, cost-effective, accessible, and useable information. The right information at the right time drives focused and effective decision-making.

Records management programs are not generally a fire service organization's primary business, and even though records management systems do not usually generate income, there are sounds reasons for fire departments to set up a good records management program. These include fire incident reporting; incident data collection; building occupancy/target hazard information; fire prevention inspection information; training records, personnel records, shift scheduling; station log information; and fleet and equipment inventory.

The TFESD utilizes the ESO Records Management System (RMS) software. The primary use of this software is for fire incident reporting. The ESO RMS supports the National Fire Incident Reporting

System (NFIRS) and provides annual fire incident information to the state in the state's required format. Additional features of the ESO RMS include an education module, which can be used to maintain employee training records and certifications as well as assign training topics; and the properties module, which can be used to assist in developing target hazard pre-fire plans for buildings and properties and to track a history of updates to these plans.

For staffing and scheduling, the TFESD utilizes a product called Workforce Telestaff for Public Safety (Telestaff). Telestaff is a scheduling software built specifically for public safety agencies. For the fire service, Telestaff is built to each department's staffing schedule by shift, assignment, and by assigned company. Telestaff also schedules administrative staff both uniform and civilian. Telestaff can be built to department-specific staffing rules and polices, as well collective bargaining agreement staffing protocols. Overtime positions are automatically assigned based on rules a department configures, and employees are notified in entitlement order, with all employee overtime activity tracked for auditing purposes.

Dispatching for the TFESD is handled by the city's public safety dispatch system managed by the Trenton Police Department (TPD). The TPD utilizes a computer-aided dispatch (CAD) system, that is a suite of software packages which receive call inputs primarily from incoming phone calls to initiate public safety calls for service, that automatically load units for dispatch based on the type and location of the call for service, and that maintain the status of responding and non-responding resources in the field. The CAD system serves as a giant incident database wherein raw incident information is stored. This includes call input, call dispatching, call status maintenance, event notes, field unit status and tracking, and call resolution and disposition. In many CAD systems across the country, the system integrates with the incident reporting system and automatically uploads the fire incident report for responding companies. Information automatically uploaded typically includes incident address, initial call type, caller name, and incident notes the dispatcher captured. In Trenton, there is no interface with the TFESD incident reporting system.

For inventory of stations, fleet, and equipment, the TFESD utilizes Microsoft Excel spreadsheets. The department has not transitioned this data to the ESO RSM.

Data Collection and Analysis

The fire service is rich in data. Fire incident reporting captures response times; incident type; actions by fire companies on the scene; injuries and casualties to both fire personnel and civilians; building type or if an outside fire whether the fire was to a vehicle, trash pile, or dumpster; and all common types of non-fire responses to name a few of the incident aspects on which the fire service collects data. In addition, the fire service collects data on training and education, pre-fire planning, community public education, fleet maintenance, building maintenance, daily routines and activities, and performance. For some fire service agencies the analysis of these inputs is minimal.

The forensic data analysis completed by CPSM for this report is an example of comprehensive data analysis of fire incident responses and department incident workload. To deliver a regular analysis such as this, which is critically important in the analysis of department emergency operations for continuous improvement, a data analyst or information management specialist is needed. The TFESD does not have a data analyst or information management specialist position in the department. At present, a firefighter is assigned the duties of information management and provides basic fire incident data extraction and report building, with no real analysis of the mined information.

SECTION 2 RECOMMENDATIONS AND PLANNING OBJECTIVES

2.1 The TFESD does not take full advantage of its records management system (RMS), and continues to use Microsoft Excel spreadsheets for department asset inventory, target hazards, and staffing assignments. These records are decentralized and not maintained on a central records program. The department's current RMS (ESO) is capable of maintaining these records, and more. CPSM recommends the TFESD transition the records now maintained on spreadsheets to the ESO RMS software. CPSM further recommends the following planning objectives be adopted by the TFESD so a seamless transition of data and records is achievable:

- Establish a records management team to conduct an internal needs assessment and review so that current methods on records and data are maintained. This team should include a representative from the city's Information Technology Department.
- Develop and implement a plan for the transition of current records, information, and data to ESO. This plan should include a review of what programs are currently included in the TFESD ESO suite, and what needs to be added. Identify additional costs, if any, and budget accordingly. The fiscal plan should include implementation over a one- to three-year period.
- Establish organizational policies and guidelines for the ESO RMS. These should include who manages the RMS, what information and records will be maintained in the RMS, a records retention program, end-user functions, and who will be responsible for data entry. These polices and guidelines should include necessary training for successful implementation and a sustainable RMS program where continual analytics can be performed.
- Provide necessary training for data input, report building, and analysis of the information and data.

2.2 The TFESD does not have a data analyst or information management specialist position in the department. At present, a firefighter is assigned the duties of information management and provides basic fire incident data extraction and report building, with no real analysis of the mined information. CPSM recommends the TFESD budget for a civilian position to manage the department's records management system. Important aspects of this position include:

- Responsibility for designing and managing the department's information system(s), as well as analyzing and tracking data needed to facilitate department projects and various operations.
- Proficiency in information technologies needed in developing and working in information systems, generating accurate reports and forecasts, analyzing these reports and forecasts, and presenting this information to the TFESD senior management so that planning and decision-making linked to accurate data and information can occur.

SECTION 3. FIRE DEPARTMENT PROGRAMS AND SERVICES

CAPITAL ASSETS AND PLANNING OBJECTIVES

Facilities

Fire facilities must be designed and constructed to accommodate both current and forecast trends in fire service vehicle type and manufactured dimensions. A facility must have sufficiently-sized bay doors, circulation space between garaged vehicles, departure and return aprons of adequate length and turn geometry to ensure safe response, and floor drains and oil separators to satisfy environmental concerns. Station vehicle bay areas should also consider future tactical vehicles that may need to be added to the fleet to address forecast response challenges, even if this consideration merely incorporates civil design that ensures adequate parcel space for additional bays to be constructed in the future.

Personnel-oriented needs in fire facilities must enable performance of daily duties in support of response operations. For personnel, fire facilities must have provisions for vehicle maintenance and repair; storage areas for essential equipment and supplies; space and amenities for administrative work, training, physical fitness, laundering, meal preparation, and personal hygiene/comfort; and—where a fire department is committed to minimize "turnout time"—bunking facilities.

A fire department facility may serve as a de facto "safe haven" during local community emergencies, and also serve as likely command center for large-scale, protracted, campaign emergency incidents. Therefore, design details and construction materials and methods should embrace a goal of having a facility that can perform in an uninterrupted manner despite prevailing climatic conditions and/or disruption of utilities. Programmatic details, such as the provision of an emergency generator connected to automatic transfer switching—even going so far as to provide tertiary redundancy of power supply via a "piggyback" roll-up generator with manual transfer (should the primary generator fail)—provide effective safeguards that permit the fire department to function fully during local emergencies when response activity predictably peaks.

Personnel/occupant safety is a key element of effective station design. This begins with small details such as the quality of finish on bay floors and nonslip treads on stairwell steps to decrease tripping/fall hazards, or use of hands-free plumbing fixtures and easily disinfected surfaces/countertops to promote infection control. It continues with installation of specialized equipment such as an exhaust recovery system to capture and remove cancer-causing by-products of diesel fuel exhaust emissions. A design should thoughtfully incorporate best practices for achieving a safe and hygienic work environment.

An ergonomic layout and corresponding space adjacencies in a fire station should seek to limit the travel distances between occupied crew areas to the apparatus bays. Likewise, facility design should carefully consider complementary adjacencies, such as lavatories/showers in proximity of bunk rooms, desired segregations, and break rooms or fitness areas that are remote from sleeping quarters. Furnishings, fixtures, and equipment selections should provide thoughtful consideration of the around-the-clock occupancy inherit to fire facilities. Durability is essential, given the accelerated wear and life cycle of systems and goods in facilities that are constantly occupied and operational.

Sound community fire-rescue protection requires the strategic distribution of fire station facilities to ensure that effective service area coverage is achieved, that predicted response travel times satisfy prevailing community goals and national best practices, and that the facilities are capable of supporting mission-critical personnel and vehicle-oriented requirements and needs. Additionally, depending on a fire-rescue department's scope of services, size, and complexity, other facilities may be necessary to support emergency communications, personnel training, fleet and essential equipment maintenance and repair, and supply storage and distribution.

National standards such as NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, outlines standards that transfer to facilities such as infection control, personnel and equipment decontamination, cancer prevention, storage of protective clothing, and employee fitness. NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Firefighting and Proximity Fire Fighting*, further delineates laundering standards for protective clothing and station wear. Laundry areas in fire facilities continue to evolve and are being separated from living areas to reduce contamination. Factors such as wastewater removal and air flow need to be considered in a facility design.

The TFESD operates out of seven operational facilities strategically located throughout the city. Each station houses around-the-clock crews, 365 days a year. Four stations house one crew and one piece of first response apparatus (an engine), while three stations house more than one crew and one to three first response apparatus (engine, ladder, rescue, haz-mat unit). Additionally, most Trenton stations house auxiliary response rolling stock such as watercraft, specialty response trailers, reserve fire apparatus, and support vehicles. Two stations also house the on-duty district commander and response vehicle (battalion chief). The TFESD makes efficient use of apparatus bay space.

Specific information about each fire facility follows.

Station 1

Station 1 was built in 1976, is one story in height, and encompasses approximately 6,497 square feet.

Maintenance, infrastructure, and repair issues and concerns include:

- Has its original roof, which needs to be replaced as it leaks.
- Windows rusted to the point they are separating from building.
- Brick mortar washed out throughout structure.
- Needs new overhead doors (three).
- HVAC system needs maintenance and thorough cleaning.
- Original bathrooms.
- Original kitchen.
- Original electric.
- Original plumbing.
- Original flooring/tile.

Space needs assessment is as follows:

- Adequate living space.
- No gender-specific bathrooms/dorms.
- Adequate storage and apparatus space.
- No room for growth in any category, living/storage/apparatus.

Station 3

Station 3 was built in the early 1900s, had additional square footage added in the 1970s, is three stories in height, and has a basement; it encompasses approximately 8,654 square feet (includes basement; 6,958 w/o basement).

Maintenance, infrastructure, and repair issues and concerns include:

- Areas of roof leaking.
- Bathrooms have not been updated since addition in the 1970s.
- Kitchen has not been updated since addition in the 1970s.
- Flooring/tile/carpet have not been updated since completion of the addition in the 1970s.
- Electric and plumbing have not been updated since the completion of the addition in the 1970s.
- HVAC system needs maintenance and a thorough cleaning.

Space needs assessment is as follows:

- Adequate living/storage/apparatus space.
- No gender-specific bathrooms/dorms.
- Room for growth with apparatus; depending on type of apparatus the apparatus bay may need expansion and shoring of two bays.

Station 6

Station 6 was built in 1889, is three stories in height, has a basement, and encompasses approximately 4,060 square feet (includes basement; 2,960 w/o basement).

Maintenance, infrastructure, and repair issues and concerns include:

- Areas of roof leaking.
- Brick walls leak/paint peeled off/plaster falling.
- Mold/mildew issues.
- Kitchen, bathrooms, flooring, and carpeting have not been replaced/professionally maintained since 2002.
- Electric and plumbing infrastructure is antiquated.
- Wood rotted throughout structure.
- Interior/exterior has not been prepped and painted in 20 years.

Space needs assessment is as follows:

- Adequate living space.

- No gender-specific bathrooms/dorms.
- No room for expansion for living/storage/apparatus.
- Inadequate storage space.

Station 7

Station 7 was built in 1907, is three stories in height, has a basement, and encompasses approximately 3,810 square feet (includes basement; 2,760 w/o basement).

Maintenance, infrastructure, and repair issues and concerns include:

- Electric and plumbing infrastructure antiquated.
- Bathroom, flooring and tile all 50-plus years old.
- Windows are 50-plus years old.
- Interior/exterior requires prepping and painting.

Space needs assessment is as follows:

- Adequate living/storage/apparatus space.
- No gender-specific bathrooms/dorms.
- Room for growth with apparatus, depending on size.

Station 8

Station 8 was built in 1914, is three stories in height, has a basement, and encompasses approximately 2,450 square feet (includes basement; 1,900 w/o basement).

Maintenance, infrastructure, and repair issues and concerns include:

- Needs new bay floor to support modern fire apparatus.
- Kitchen, bathrooms need updating.
- Windows at least 50 years old.
- Electric and plumbing infrastructure antiquated.
- Apparatus floor supported by metal plates due to structural issues.

Space needs assessment is as follows:

- Inadequate space for living/storage/apparatus.
- No room for growth in any category, living/storage/apparatus.

Station 9

Station 9 was built in 2003 is one story in height with a partially elevated second floor (mechanical room) and encompasses approximately 8,928 square feet.

Maintenance, infrastructure, and repair issues and concerns include:

- Concrete issues in rear of structure surrounding drainage trough that requires repair.
- This facility has a more contemporary HVAC system that requires a larger budget to maintain and repair. Current budget does not fully support this system.

- HVAC system needs maintenance and a thorough cleaning.
- Alarm system does not function.

Space needs assessment is as follows:

- Room for growth.
- Has gender-specific bathroom.
- No gender-specific dorm.
- Adequate room for storage of equipment and apparatus.
- No room for growth for any additional apparatus.

Station 10

Station 10, which includes fire headquarters, the repair shop, and administration, was built/refurbished in 2001 and encompasses approximately 64,731 square feet. The original administration building was built in 1927. The repair shop is one story; fire operations is three stories in height and includes a basement, and headquarters/fire administration is four stories in height and includes a basement.

Maintenance, infrastructure, and repair issues and concerns include:

- Mold issues.
- Water damage.
- Plumbing and sewer line issues throughout; multiple bathrooms are not in service.
- This facility has a more contemporary HVAC system that requires a larger budget to maintain and repair. Current budget does not fully support this system.
- HVAC system needs maintenance and a thorough cleaning.
- Carpeting throughout is 20 years old.
- Paint throughout is 20 years old.
- Alarm system does not function.

Space needs assessment is as follows:

- Adequate space or living/storage/apparatus.
- No gender-specific bathrooms/dorms.
- No room for growth in any category, living/storage/apparatus.

Overall:

- No stations have vehicle exhaust systems to remove carbon monoxide and other carcinogens emitted from vehicle exhaust.
- No stations have cleaning equipment for structural turn-out gear (extractor and dryer), or washer/dryer for cleaning and decontamination of station wear.
- No station has a dedicated decontamination room/area equipped with non-porous sinks for the decontamination of equipment.
- Only Station 10 has an emergency generator (Station 9 is programmed to have one installed).

- Not all stations have more than one means of egress from the second-floor living areas.

Fleet

The provision of an operationally ready and strategically located fleet of mission-essential fire-rescue vehicles is fundamental to the ability of a fire-rescue department to deliver reliable and efficient public safety within a community.

The TFESD currently operates a fleet of front-line fire and rescue apparatus that includes:

- Seven engine apparatus.
  - 1997, 1250 GPM pump.
  - 2007, 1500 GPM pump.
  - 2010, 1500 GPM pump.
  - 2017, 1500 GPM pump.
  - 2017, 1500 GPM pump.
  - 2019, 1500 GPM pump.
- Three ladder apparatus.
  - 2000, 95-foot Aerial Platform.
  - 2005, 100-foot Aerial Ladder.
  - 2017, 100-foot Aerial Ladder.
- One rescue apparatus.
  - 2007, Heavy Rescue (specialty rescue, vehicle extrication, high angle rope rescue, confined space rescue, trench rescue equipment).
- Haz-Mat apparatus.
  - 2003, Haz-Mat (hazardous materials response and entry level equipment [Levels I, II, III], Chemical, Biological, Radiological, Nuclear, Explosives [CBRNE] equipped).

The TFESD also has an assortment of command and light response vehicles to include watercraft and special equipment trailers.

The procurement, maintenance, and eventual replacement of response vehicles is one of the largest expenses incurred in sustaining a community's fire-rescue department. While it is the personnel of the TFESD who provide emergency services within the community, the department's fleet of response vehicles is essential to operational success. Reliable vehicles are needed to deliver responders and the equipment/materials they employ to the scene of dispatched emergencies within the city. Maintenance is performed by department fleet mechanics.

Replacement of fire-rescue response vehicles is a necessary, albeit expensive, element of fire department budgeting that should reflect careful planning. A well-planned and documented emergency vehicle replacement plan ensures ongoing preservation of a safe, reliable, and operationally capable response fleet. A plan must also include a schedule future capital outlay in a manner that is affordable to the community.

NFPA 1901, *Standard for Automotive Fire Apparatus*, serves as a guide to the manufacturers that build fire apparatus and the fire departments that purchase them. The document is updated every five years using input from the public/stakeholders through a formal review process. The committee membership is made up of representatives from the fire service, manufacturers, consultants, and special interest groups. The committee monitors various issues and problems that occur with fire apparatus and attempts to develop standards that address those issues. A primary interest of the committee over the past years has been improving firefighter safety and reducing fire apparatus crashes.

The Annex Material in NFPA 1901 (2016) contains recommendations and work sheets to assist in decision-making in vehicle purchasing. With respect to recommended vehicle service life, the following excerpt is noteworthy:

> *"It is recommended that apparatus greater than 15 years old that have been properly maintained and that are still in serviceable condition be placed in reserve status and upgraded in accordance with NFPA 1912, Standard for Fire Apparatus Refurbishing (2016), to incorporate as many features as possible of the current fire apparatus standard. This will ensure that, while the apparatus might not totally comply with the current edition of the automotive fire apparatus standards, many improvements and upgrades required by the recent versions of the standards are available to the firefighters who use the apparatus."*

The impetus for these recommended service life thresholds is continual advances in occupant safety. Despite good stewardship and maintenance of emergency vehicles in sound operating condition, there are many advances in occupant safety, such as fully enclosed cabs, enhanced rollover protection and air bags, three-point restraints, antilock brakes, higher visibility, cab noise abatement/hearing protection, and a host of other improvements as reflected in each revision of NFPA 1901. These improvements provide safer response vehicles for those providing emergency services within the community, as well those "sharing the road" with these responders.

The TFESD currently has in service first-line engine apparatus that are in excess of 20-plus years of age and a first-line ladder truck that has 20 years of service. The engine is targeted for replacement in 2021, and the ladder truck is targeted for replacement in 2022. Additionally, the TFESD has reserve engines, a reserve ladder, and a reserve heavy rescue apparatus that are in excess of 25 years of age. These reserve units will eventually be placed out of service when replaced front-line units are cascaded down to reserve status. In addition to the replacement of one engine and one ladder as noted above, needed future heavy fire apparatus replacements include one engine in 2023, one ladder in 2024, the heavy rescue unit in 2024, and one engine in 2025.

The TFESD does not have a structured replacement plan as outlined in NFPA 1901 for first-line fire and rescue apparatus. The current fire administration does have a five-year catch-up plan in place to address those apparatus that have fallen outside of the NFPA recommended replacement schedule.

The TFESD has two mechanics/fleet maintenance personnel to maintain the fleet. Fleet staff is consistently prioritizing only the highest priority mechanical work. Additionally, these mechanics are not Emergency Vehicle Technician (EVT)-certified. The EVT track for fire apparatus is specific to the components, maintenance, and service of these emergency vehicles.

COMMUNITY AND DEPARTMENT PROGRAMS AND SERVICES

Training Programs and Performance Improvement

Education and training are vital at all levels of fir service operation to ensure that are completed safely and effectively. The level of training or education required given a set of tasks varies with the jobs to be performed. Because so much depends upon the ability of the emergency responder to effectively deal with an emergency situation, education and training must have a prominent position within an emergency responder's schedule of activities when on duty.

The TFESD has a training program for fire, EMS, and technical responses that includes:

- Sixteen-week new-hire academy that includes certification in Firefighter Level 1 and Medical First Responder.
- Haz-mat Awareness and Operations.
- Vehicle Extrication, Technical Rescue (rope rescue, water response, trench collapse, confined space, building collapse).
- Hands-on back-to-basics training at the TFESD Fire Academy.

Recently, the department added a captain to each shift to lead company training. However, this training effort suffers as the captain assigned to training also backfills on-shift vacancies created by scheduled and un-scheduled leave. This program is not effective for training purposes, as during a one-year period (7/1/2019-6/30/2020), this position filled in at the company level 214 times.

Operational performance is monitored by company supervisors. This monitoring covers fire and EMS operations, driver operations, and fireground decision-making. Individuals identified as being under-performing are placed on a Performance Improvement Plan. This plan is a written document that outlines the performance issue(s), and the additional training and tasks required for improvement. The immediate supervisor along with command staff are involved in the design of the plan, as well as the evaluation of the improvement elements and the individual.

In 2019, the TFESD went through an ISO Fire Suppression Rating Schedule (FSRS), Public Protection Classification (PPC) review. During this review several deficiencies in staff training were noted.

These include:

- No credit for firefighters receiving 18 hours of annualized training.
- Credit deficiency for officer training (received 8.25 out of 12 available credit score).
- Significant credit deficiency for annual pre-fire planning inspections, which are considered training as well as inspections, in that company personnel familiarize themselves with buildings, fire protection systems, and water supply systems in their respective fire management zones.

Fire Prevention Programs

Fire prevention is one of the most important missions in a modern-day fire department. A comprehensive fire prevention program should include, at a minimum, the key functions of fire prevention, code enforcement, inspections, and public education. Preventing fires before they occur, and limiting the impact of those that do occur, should be a priority of every fire department. Fire investigation is a mission-important function of fire departments, as this function serves to determine how a fire started and why the fire behaved the way it did, information that plays a significant role in fire prevention efforts. Educating members of the public about fire safety and teaching them appropriate behaviors on how to react should they be confronted with a fire is also an important life-safety responsibility of the fire department.

Fire suppression and response, although necessary to protect property, have little impact on preventing fire deaths. Rather, it is public fire education, fire prevention, and built-in fire protection systems that are essential elements in protecting citizens from death and injury due to fire, smoke inhalation, and carbon monoxide poisoning. The fire prevention mission is of utmost importance, as it is the only area of service delivery that dedicates 100 percent of its effort to the reduction of the incidence of fire.

Currently, the TFESD does not have a Fire Prevention Division, or staff assigned to perform fire prevention building or life safety inspections. The state performs life safety inspections in certain buildings in the city. The Inspection Unit of the New Jersey Division of Fire Safety enforces the Uniform Fire Code in municipalities that do not elect to establish local enforcement agencies. This is the case in Trenton. The Bureau is responsible for the inspection of high-rise and life hazard-use buildings/structures when the Department has retained direct enforcement authority.[4] There is no interaction between the state and the TFESD with regard to fire prevention and life safety building inspections.

The TFESD has a Fire Marshal unit that is responsible to determine origin and cause of fires within the City of Trenton. This unit works closely with the TPD, Mercer County, and the New Jersey Division of Fire Safety when arson is determined to be the cause of the fire, or the fire resulted in serious injury or a fatality.

The TFESD does have a public fire education program. As of the 2019 ISO review, the department listed 45 certified public educators who annually reach 70 percent of the city's population. These personnel receive 16 hours of annual recertification training. The public education program also includes a juvenile fire-setter program, wherein 100 percent of known juveniles who set fires are referred.

ISO RATING

The ISO is a national, not- for-profit organization that collects and evaluates information from communities across the United States regarding their capabilities to combat building fires. The data collected from a community is analyzed and applied to ISO's Fire Suppression Rating Schedule (FSRS) from which a Public Protection Classification (PPC™) grade is assigned to a community (1 to 10). A Class 1 represents an exemplary fire suppression program that includes all of the components outlined below. A Class 10 indicates that the community's fire suppression program does not meet ISO's minimum criteria. It is important to understand the PPC is not just a fire department classification, but rather a compilation of community services that include the fire department, the emergency communications center, and the community's potable water supply system operator.[5]

A community's PPC grade depends on:

- **Needed Fire Flows** (building locations used to determine the theoretical amount of water necessary for fire suppression purposes).

4. https://www.nj.gov/dca/divisions/dfs/offices/
5. TFESD ISO PPC report; November 2019.

- **Emergency Communications** (10 percent of the evaluation).
- **Fire Department** (50 percent of the evaluation).
- **Water Supply** (40 percent of the evaluation).

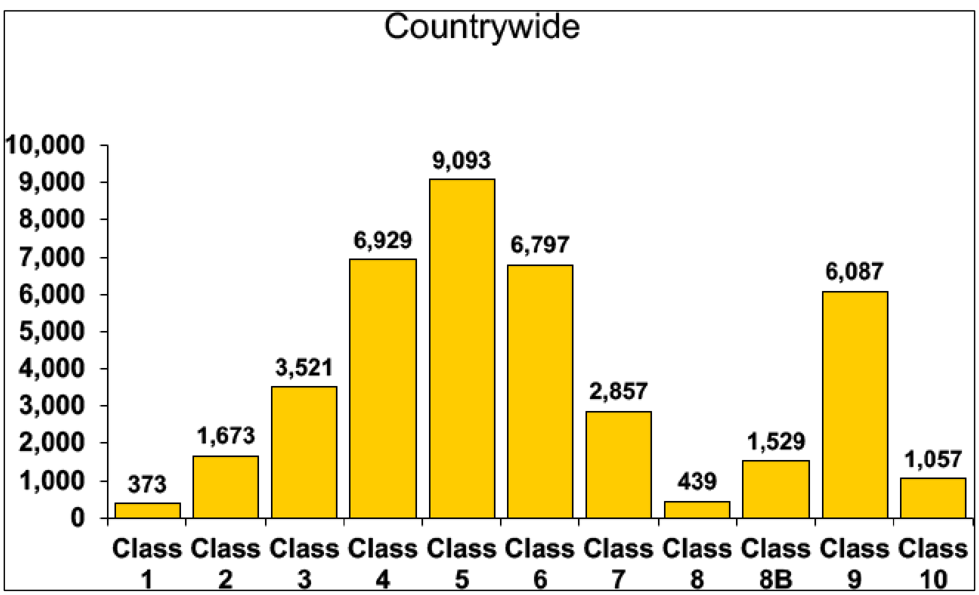
The City of Trenton has an ISO rating of ***Class 3***. This rating was achieved in April 2019. Previously, the city had a rating of Class 2. Significant deficiencies that contributed to this regression in rating were:

- Telecommunicator point deficiency (staffing deficiency).
- Fire training point deficiency.
- Credit deficiency for company personnel (staffing deficiency).
- Credit for deployment analysis (deficiency in the number of engine and ladder companies responding to the built-upon-area).
- Credit deficiency for training (no record of each firefighter receiving 18 hours of training per year; officer training deficiency; pre-fire planning/target hazard building familiarization training deficiency).
- Credit deficiency for inspection and flowing of fire hydrants (public works responsibility).
- No credit for Community Risk Reduction (no TFESD fire prevention inspection program, no record of public education activities; no record of fire investigation activities).

The TFESD was given the opportunity to provide a plan to the ISO rating office to make improvements to maintain the Class 2 rating. The TFESD Director has developed and submitted a plan. As of the completion of this report there has been no adjustment in the April 2019 rating of Class 3.

The following figure illustrates the dispersion of PPC ratings across the United States.

FIGURE 3-1: PPC Ratings in the United States[6]



6. https://www.isomitigation.com/ppc/program-works/facts-and-figures-about-ppc-codes-around-the-country/

COMMUNITY LOSS AND SAVE INFORMATION

Fire loss is an estimation of the total loss from a fire to the structure and contents in terms of replacement. Fire loss includes contents damaged by fire, smoke, water, and overhaul. Fire loss does not include indirect loss, such as business interruption.

In a 2019 report published by the National Fire Protection Association on trends and patterns of U.S. fire losses, it was determined that home fires still cause the majority of all civilian fire deaths, civilian injuries, and property loss due to fire. Key findings from this report include:[7]

- Public fire departments responded to 1,318,500 fires in 2018, virtually the same as the previous year.
- Every 24 seconds, a fire department in the United States responds to a fire somewhere in the nation. A fire occurs in a structure at the rate of one every 63 seconds, and a home fire occurs every 87 seconds.
- Seventy-four percent of all fire deaths occurred in the home.
- Home fires were responsible for 11,200 civilian injuries, or 74 percent of all civilian injuries, in 2018.
- An estimated $25.6 billion in property damage occurred as a result of fire in 2018, a large increase, as this number includes a $12 billion loss in wildfires in Northern California.
- An estimated 25,500 structure fires were intentionally set in 2018, an increase of 13 percent over the year before.

For the five-year period of 2015 to 2019, the TFESD did not report any loss (in terms of dollars) as a result of fire-related calls for service. Additionally, the TFESD did not report any fire or non-fire related injuries or fatalities during this same five-year period. Typically, fire departments across the nation record community loss in terms of property loss dollars of some type for these types of incidents, specifically for structural, vehicle, and outside fires. Additionally, over a five-year period there typically would be some level of property/community save information as well.

FIRE ACCREDIDATION AND THE COMMISSION ON FIRE ACCREDITATION INTERNATIONAL

An available best practice that involves a comprehensive assessment of a fire department is the fire accreditation program managed by the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation International. This program provides an analytical self-assessment process to evaluate ten categories of the agency's performance.

The key building blocks of the accreditation process include:

- The completion of a *Community Risk Assessment*, including fire and non-fire risks.
- Creating *Goals and Objectives* for each of the divisions/programs of the agency utilizing the findings of the risk assessment to develop objectives within the emergency response program.
- Creating a *Standards of Cover* (SOC) document with benchmarks, based upon the community risk assessment (analysis) and the corresponding goals and objectives.

7. https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fire-loss-in-the-United-States

- Conducting an *Agency Performance* study, based upon the benchmarks established within the SOC.
- Creating the agency's *Strategic Plan*, which incorporates the components from the previous steps (Community Risk Assessment, Goals and Objectives, Standards of Cover, Agency Performance).
- Completing the *Self-Assessment Manual* (SAM), answering each of the performance indicators and criteria statements. During this process, the department would examine more than 240 separate performance indicators, 98 of which are considered core or required competencies.

The accreditation process offers a department the benefit of a critical self-analysis of its performance at varying levels to ensure continuous self-improvement. It is an extremely comprehensive review that is conducted over a certain time period and requires reaccreditation, which helps to ensure that the standards are being maintained.

Included within the ten accreditation categories is an expectation for the fire department to analyze itself by planning zones, to identify the hazards posed within each planning zone, to rank hazards by potential severity, and to ensure that the appropriate resources are available to manage the hazards.[8] There is a current trend to focus an agency's planning and resources on becoming accredited and/or maintaining the accreditation. The accreditation program is a continuous process that requires an agency to constantly strive for excellence, even after accreditation is achieved. This is achieved through the reaccreditation process every five years.

The CPSE fire accreditation process provides a well-defined, internationally recognized benchmark system to measure the quality of fire and emergency services.[9] As a best practice, the accreditation process assists local governments to justify their expenditures by demonstrating a direct link to improved services. Particularly for emergency services, local officials need criteria to assess professional performance and efficiency.

The TFESD is not an accredited agency through the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation International.

SECTION 3 RECOMMENDATIONS AND PLANNING OBJECTIVES

3.1 The TFESD operates out of seven operational facilities strategically located throughout the city. Each station houses around-the-clock crews, 365 days a year. Four stations house one crew and one piece of first response apparatus (engine), while three stations house more than one crew and one to three first response apparatus (engine, ladder, rescue, haz-mat). Additionally, most stations house auxiliary response rolling stock such as watercraft, specialty response trailers, reserve fire apparatus, and support vehicles. Two stations also house the on-duty district commander and response vehicle (battalion chief). Each station has significant infrastructure issues to include interior and exterior issues, due primarily to the age of the buildings. Additionally, several of the stations do not have gender-specific bunking and bathroom spaces, and no stations have cleaning equipment for structural turn-out gear (extractor and dryer), or washer/dryer for cleaning and decontamination of station wear. No station has a dedicated decontamination room/area equipped with non-porous sinks for the decontamination of equipment.

8. CPSE, CFAI Accreditation Process (2012) http://www.publicsafetyexcellence.org/agency-accreditation/the-process.aspx (accessed on October 31, 2012).
9. CPSE, About CPSE (2012), http://www.publicsafetyexcellence.org (accessed on October 31, 2012).

- CPSM recommends as a planning objective that, over a three-year period, the department conduct a facility condition assessment of all fire facilities.
  - This assessment should entail a comprehensive inspection of fire facilities and should include all building system components for evidence of movement, deterioration, structural failure, probable useful life, need for repair and maintenance, need for replacement, and associated replacement costs.
  - CPSM further recommends the city and department retain an engineering firm/consultant to conduct a comprehensive review of all TFESD facilities, and develop several options in a Comprehensive Fire Department Facilities Plan that will guide the officials of the City of Trenton and the TFESD in determining the necessity for improvements/station replacements over the next five to ten years. Included in this plan should be a budgetary and funding plan with facility prioritization, as well as what facilities are viable and what facilities should be replaced.

3.2 The TFESD operates with some first-line engine apparatus in excess of 20-plus years and a first-line ladder truck that is 20 years in age. Additionally, the TFESD has reserve engines, a reserve ladder, and a reserve heavy rescue apparatus that are in excess of 25-years of age. The TFESD does not have a structured apparatus replacement plan as outlined in NFPA 1901for first-line fire and rescue apparatus. The current fire administration does have a five-year catch-up plan in place to address those apparatus that have fallen outside of the NFPA recommended replacement schedule.

- CPSM recommends the TFESD develop, over a one-year period, a fire apparatus replacement plan that includes age recommendations in accordance with NFPA 1901 standard, Standard for Automotive Fire Apparatus. With respect to recommended vehicle service life, the following is an excerpt from this standard:

  > *"It is recommended that apparatus greater than 15 years old that have been properly maintained and that are still in serviceable condition be placed in reserve status and upgraded in accordance with NFPA 1912, Standard for Fire Apparatus Refurbishing (2016), to incorporate as many features as possible of the current fire apparatus standard. This will ensure that, while the apparatus might not totally comply with the current edition of the automotive fire apparatus standards, many improvements and upgrades required by the recent versions of the standards are available to the firefighters who use the apparatus."*

- Planning objectives should include:
  - First-line apparatus should not exceed 15 years of service on the front line, and once they reach this age, should be replaced with a new apparatus and then rotated to reserve status. This replacement schedule should be inserted into the TFESD fleet capital replacement plan.
  - Apparatus in reserve status and which have not been properly maintained as evidenced by maintenance records, or that are not operationally or roadworthy as evidenced by maintenance records.
  - Apparatus in reserve status in excess of 20 years old should comply with NFPA 1901 and be upgraded in accordance with NFPA 1912 if the department plans to continue to use this apparatus.
  - Apparatus and major apparatus components such as the motor, fire pump, aerial ladder assembly and hydraulics, chassis and chassis components such as brakes, wheels, and

steering equipment should be maintained in accordance with manufacturer and industry specifications and standards.

- Apparatus components requiring annualized testing either fixed or portable such as fire pumps, aerial ladder and aerial ladder assemblies, ground ladders, self-contained breathing apparatus to include personnel fit-testing, and fire hose should be tested in accordance with manufacturer and industry specifications and standards.
- Current apparatus/fleet maintenance mechanics should be provided the opportunity to obtain the Emergency Vehicle Technician/Fire Apparatus Track certification.
- Assess the addition of one additional apparatus/fleet maintenance mechanic.

3.3 The TFESD has a training program in place that includes basic firefighting training, advanced/technical rescue and water emergency response training, hazardous materials training, and company in-service training. Although there is a captain assigned to each shift to oversee training, this position also backfills vacant captain positions due to scheduled and unscheduled leave, thus decreasing the amount of time this position can allot to shift-wide company training. This backfilling occurred 214 times from July 1, 2019 to June 30,2020.

In 2019, the TFESD went through an ISO Fire Suppression Rating Schedule (FSRS), Public Protection Classification (PPC) review. During this review several deficiencies in staff training were noted. These include:

- No credit for firefighters receiving 18 hours of annualized training.
- Credit deficiency for officer training (received 8.25 out of 12 available credit score).
- Significant credit deficiency for annual pre-fire planning inspections, which are considered training as well as inspections in that company personnel familiarize themselves with buildings, fire protection systems, and water supply systems in their respective fire management zones.
- No annual proficiency evaluations.

- CPSM recommends the following as planning objectives for department training:
  - Develop over a one-year period an internal training plan to address current ISO training deficiencies, which include: an annualized training plan for incumbent employees that is competency-based on National Fire Protection Association (NFPA), International Fire Service Training Association (IFSTA), and New Jersey state fire training standards; utilization of the assigned shift training captain position to conduct training as intended on a full-time basis, and as well utilize this position to oversee the pre-fire planning/target hazard program to ensure these activities are performed by company personnel on an annualized basis. This plan should have as its goal the training of all department operational members to Firefighter II standards.
  - Over a one-year period, develop and budget for an officer training program that is competency-based on National Fire Protection Association (NFPA), International Fire Service Training Association (IFSTA), and New Jersey state fire training standards, and that focuses on contemporary fire service issues including community fire protection and emergency services delivery approaches, fire prevention practices, firefighter safety and risk management and labor/staff relations; reviewing, approving, or preparing technical documents and specifications, departmental policies, standard operating procedures and other formal internal communications; improving organizational performance through process improvement and best practices initiatives; and having a working knowledge of information management and technology systems.

- Develop training programs that ensure the following certifications for the following supervisory levels in the organization:
  - Captain
    - Fire Instructor I.
    - Fire Officer I and II.
    - NJ IMS Level I (already required).
    - NJ Fire Inspector (so companies can perform in-service inspections).
  - Battalion Chief
    - Fire Instructor II.
    - Fire Officer III.
    - NJ IMS Level II.
    - Incident Safety Officer.
  - Deputy Chief
    - Fire Officer IV.
    - NJ IMS Level III.

3.4 The TFESD does not have a Fire Prevention Division, or staff assigned to perform fire prevention building or life-safety inspections. The state performs life-safety inspections in certain buildings in the city through the Inspection Unit of the New Jersey Division of Fire Safety. There is no interaction between the state and the TFESD with regard to fire prevention and life-safety building inspections. Additionally, there are occupancy classifications excluding high-rise and life-hazard use buildings/structures, which are inspected by the state agency that do not receive fire prevention inspections.

The prevention of fire and loss of life, human suffering (injuries to civilians and firefighters), environmental harm, and property damage is the optimum return on investment for fire agencies. Proactive involvement in construction, code enforcement, educating the public to prevent destructive fires, and training the public to survive fires is the best accomplishment of fire prevention. The most effective way to combat fires is to prevent them from occurring in the first place. A strong fire prevention program based on locally identified risk and relevant codes and ordinances reduces loss of property, life, and the personal and community-wide disruption that accompanies a catastrophic fire.

- CPSM recommends as planning objectives for fire prevention:
  - Develop a three- to five-year plan that establishes a Fire Prevention and Inspection Division. This plan should include identifying the number of occupancies in the city that require a fire prevention inspection to ensure the occupancy is compliant with the adopted fire prevention code; the number of supervisors and inspectors required to carry out established and/or recommended frequency of inspections; competencies and training required for each position in the Fire Prevention Division; and budgetary requirements to fund such a division.
  - At a minimum, develop a one- to three-year plan that establishes a position of fire prevention officer and who would interact with the Inspection Unit of the New Jersey Division of Fire Safety on fire prevention inspection issues so that this information is

communicated to responding fire companies. This plan should include competencies and training required for this position and budgetary requirements to fund such a position.

3.5 Prior to the April 2019, ISO Public Protection Classification review, the City of Trenton maintained a community rating of 2. The TFESD had an opportunity to develop a work plan to maintain the ISO community rating of 2, but did not.

- As a planning objective, CPSM recommends the TFESD develop a planning objective with specific tasks and personnel assignments to achieve the ISO community rating of 2 once again, as this higher rating has a positive impact on community-wide property insurance premiums. This planning objective should link to other planning objectives identified in this report and which had an adverse effect on the most recent City of Trenton ISO Public Protection Classification review. This objective should have a short-term time planning period of one to three years.

3.6 For the five-year period of 2015 through 2019, the TFESD did not report any loss (in terms of dollars) as a result of fire-related calls for service. Additionally, the TFESD did not report any fire or non-fire related injuries or fatalities during this same five-year period. Typically, fire departments across the nation record community loss in terms of property loss dollars of some type for these types of incidents, specifically for structural, vehicle, and outside fires.

- As a planning objective, CPSM recommends the TFESD begin immediately to record property loss and fire-related injury/fatality information in its records management system so that a community analysis can be completed at the end of each reporting year. The purpose of this objective is to be able to identify trends and issues, and then develop solutions and programs that are aimed at reducing any fire or casualty problem.
- As a planning objective, CPSM recommends the TFESD link this planning objective (Community Loss Information) to operational response and tactical deployment, fire prevention and public education, education and training, and operational resiliency planning objectives as a measure of overall correlation effectiveness.

3.7 An available best practice that involves a comprehensive assessment of a fire department is the fire accreditation program managed by the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation international. This program provides an analytical self-assessment process to evaluate ten categories of the agency's performance.

The CPSE fire accreditation process provides a well-defined, internationally recognized benchmark system to measure the quality of fire and emergency services.[10] As a best practice, the accreditation process assists local governments in justifying their expenditures by demonstrating a direct link to improved services. Particularly for emergency services, local officials need criteria to assess professional performance and efficiency. The TFESD is not an accredited agency through the Center for Public Safety Excellence (CPSE), Commission of Fire Accreditation.

- In terms of a planning objective, CPSM recommends the TFESD develop and implement a five-year plan to become an accredited agency through the Center for Public Safety Excellence (CPSE), Commission on Fire Accreditation International. Planning components should include:
  - Identify one TFESD position or a consulting firm to serve as the overarching agency accreditation manager whose focus is to guide the process, liaison with CPSE, and ensure all components of the accreditation process are satisfactorily completed.

10. CPSE, About CPSE (2012), http://www.publicsafetyexcellence.org (accessed on October 31, 2012).

- Assembling personnel from the TFESD and City of Trenton to serve as the core fire accreditation team whose focus is to work with subordinate team members in the completion of the core documents and 240 separate performance indicators.
- Completing the key building blocks of the accreditation process, which include:
  - The completion of a *Community Risk Assessment* including fire and non-fire risks.
  - Creating *Goals and Objectives* for each of the divisions/programs of the agency utilizing the findings of the risk assessment to develop objectives within the emergency response program.
  - Creating a *Standards of Cover* (SOC) document with benchmarks based upon the community risk assessment (analysis) and the corresponding goals and objectives.
  - Conducting an *Agency Performance* study based upon the benchmarks established within the SOC.
  - Creating the agency's *Strategic Plan*, which will incorporate the components from the previous steps (Community Risk Assessment, Goals and Objectives, Standards of Cover, Agency Performance).
  - Completing the *Self-Assessment Manual* (SAM), answering each of the performance indicators and criteria statements. During this process, the department will examine more than 240 separate performance indicators, 98 of which are considered core or required competencies.
- Develop a budget for the accreditation process that includes CPSE fees, salary and benefits for an accreditation manager or consulting firm, and supportive materials and supplies.

§ § §

SECTION 4. ALL-HAZARD RISK ASSESSMENT OF THE COMMUNITY

POPULATION AND COMMUNITY GROWTH

The U.S. Census Bureau estimated the 2019 City of Trenton population to be 83,203. This is a 2.1 percent decrease from the 2010 decennial population of 84,913. As the city is about 7.7 square miles in land area, the population density based on the Census Bureau population data is 11,102/square mile. Thus, Trenton has significant urban density.

The age and socio-economic profiles of the population can also have an impact on the number of requests for fire and EMS service. Evaluation of the number of seniors and children by fire management zones can provide insight into trends in service delivery and quantitate the probability of future service requests. In a 2018 National Fire Protection Association (NFPA) report on residential fires, the following key findings were identified for the period 2011–2015:[11]

- Males were more likely to be killed or injured in home fires than females, and accounted for a larger percentages of the victims (57 percent of the deaths and 54 percent of the injuries).
- The largest number of deaths (19 percent) in a single age group was among people ages 55 to 64.
- Half (50 percent) of the victims of fatal home fires were between the ages of 25 and 64, as were three of every five (62 percent) of the non-fatally injured.
- One-third (33 percent) of the fatalities were age 65 or older; only 15 percent of the non-fatally injured were in that age group.
- Children under the age of 15 accounted for 12 percent of the home fire fatalities and 10 percent of the injuries. Children under the age of 5 accounted for 6 percent of the deaths and 4 percent of the injuries.
- Adults of all ages had higher rates of non-fatal fire injuries than children.
- While smoking materials were the leading cause of home fire deaths overall, this was true only for people in the 45 to 84 age group.
- For adults 85 and older, fire from cooking was the leading cause of fire death.

In Trenton the following age and socioeconomic factors should be considered when assessing and determining risk for fire and EMS preparedness and response:

- Children under the age of five represent 7.5 percent of the population.
- Persons under the age of 18 represent 26.0 percent of the population.
- Persons over the age of 65 represent 9.8 percent of the population.
- Female persons represent 49.8 percent of the population.
- There are 2.92 persons per household in Trenton.
- The median household income in 2018 dollars is $35,387.

11. M. Ahrens, "Home Fire Victims by Age and Gender", Quincy, MA: NFPA, 2018.

- Persons living in poverty make up 28.4 percent of the population.
- Black or African American alone represents the highest percentage of race in Trenton at 50.7 percent. The remaining percentage of population by race includes White alone at 41.1 percent, American Indian or Alaska Native alone at 0.3 percent, Asian alone at 1.2 percent, two or more races at 1.5 percent, and Hispanic or Latino at 36.4 percent.

ENVIRONMENTAL FACTORS

Due to its location in the northeast corridor of the country, and because it is contiguous with the Delaware River on its western boundary, the city is prone to predictable environmental risks. Other bodies of water found in the city include the Delaware & Raritan Canal, Assunpink Creek, and Crosswicks Creek. Environmental risks include:

- Severe rain/thunderstorms that produce high winds, urban flooding, and water rise in the Delaware River and inland creeks above the banks, as well as power outages.
- Severe winter storms that produce high winds, snow, ice, extreme low temperatures, as well as power outages and carbon monoxide emergencies.
- Hurricanes/tropical storms that produce high winds, heavy rain/thunder storms that lead to urban flooding and water rise in the Delaware River and inland creeks above the banks, as well as power outages and infrastructure damge.
- Remnants of tropical systems that produce high winds, heavy rain/thunderstorms that lead to urban flooding and water rise in the Delaware River and inland creeks above the banks, as well as power outages.
- Dam failure that could cause flooding from Whitehead Pond Dam (2.29 miles from Trenton), Colonial Lake Dam (2.84 miles from Trenton), and Sylva Lake Dam (4.05 miles from Trenton).
- Drought and extreme high temperatures causing dry brush, grass, and other vegetation which leads to outside brush fires.
- Earthquakes, which could cause building, road, and infrastructure damage.
- Nor'Easters, which could cause high winds and flooding.

BUILDING AND TARGET HAZARD FACTORS

A community risk and vulnerability exercise evaluates the community as a whole, and with regard to buildings, measures all buildings and the risks associated with each property and then segregates the property as either a high-, medium-, or low-hazard depending on factors such as the life and building content hazard, and the potential fire flow and staffing required to mitigate an emergency in the specific property. According to the NFPA *Fire Protection Handbook*, these hazards are defined as:

High-hazard occupancies: Schools, hospitals, nursing homes, explosives plants, refineries, high-rise buildings, and other high life-hazard (vulnerable population) or large fire-potential occupancies.

Medium-hazard occupancies: Apartments, offices, and mercantile and industrial occupancies not normally requiring extensive rescue by firefighting forces.

Low-hazard occupancies: One-, two-, or three-family dwellings and scattered small business and industrial occupancies.[12]

The construction type for residential structures in Trenton is a mix of wood frame with wood or composite siding, and wood frame with brick veneer. Basements are typical in residential structures. Townhomes, condos, and lofts are also common in Trenton. Typical construction includes wood frame with wood or composite siding, wood frame with brick veneer, and ordinary (block/brick) construction. Other construction types for residential structures are present in Trenton as well and may include masonry non-combustible and fire resistive. The commercial/industrial structure building inventory is ordinary (block/brick) construction, wood frame with composite siding, and masonry non-combustible.

Trenton has the following building types:

- Single-family homes.
- Condos, lofts, townhomes.
- Apartment buildings.
- Apartments above commercial.
- Commercial/industrial structures.
- Professional business/educational structures.
- Strip malls.
- Hotel structures.
- Rooming/lodging structures.
- Assisted living/long-term care structures.
- Housing/commercial/professional business structures over 75 feet in height (high rise).
- Public education structures.
- Correctional institution.
- Hospitals/medical centers.

In terms of identifying target hazards, consideration must be given to the activities that take place (public assembly, life safety vulnerability, manufacturing, processing, etc.), the number and types of occupants (elderly, youth, handicapped, imprisoned, etc.), and other specific aspects related to the construction of the structure.

Trenton has a variety of target hazards that include:

- Hospital/medical center target hazards.
- Hotel target hazards (life safety).
- Correctional instituion target hazard (life safety/access).
- Educational/school/public assembly target hazard (life safety).
- Mercantile/Business/Industrial (Life Safety, Hazardous Storage and or Processes).

12. Cote, Grant, Hall & Solomon, eds., *Fire Protection Handbook* (Quincy, MA: National Fire Protection Association, 2008), 12.

- Long-term care target hazard (life safety, vulnerable population).
- Government infrastructure target hazard (hazardous storage/processes and continuity of operations).
- Government business target hazards (life safety, continuity of operations).
- Private business target hazards (life safety).
- High-rise traget hazards (life safety).

The city has a mix of low- and medium-risk structures that make up the majority of the target hazard risk. High-hazard building risks are noted in this section as well. These include correctional institutions, assisted/long-term care facilities, residential structures housing a vulnerable population, hospital/medical centers, residential high-rise structures, public assembly structures when occupied, and those that have hazardous materials used in processes or that are stored in large quantities.

TRANSPORTATION FACTORS

The road network in Trenton is typical of cities across the country and includes arterial streets, which carry high volumes of traffic; collector streets, which provide connection to arterial roads and local street networks as well as residential and commercial land uses; and local streets, which provide a direct road network to property and move traffic through neighborhoods and business communities.

Trenton is served by four highways. These are: US Route 1 (north-south), US Route 206 (north-south), NJ Route 29 (north-south), and NJ Route 129 (north-south). NJ Transit operates a commuter bus system in Trenton, with multiple routes and stops throughout the city. Commuter bus systems present risks associated with traffic accidents that may result in multiple patients requiring care and transport.

The road network described herein poses risks for a vehicular accident, some at medium to high speeds, as well as vehicular-versus-pedestrian risks, to Trenton. There are additional transportation risks since tractor-trailer and other commercial vehicles traverse the roadways of Trenton to deliver mixed commodities to businesses and residential locations. Fires involving these products can produce smoke and other products of combustion risks that may be hazardous to health.

There are active railroad lines that pass through the city as well. These include the Amtrak Northeast Corridor commuter rail, which has a stop in Trenton; NJ Transit commuter train service from the Trenton Transit Station; Southeast Pennsylvania Transit Authority (SEPTA) commuter rail, which has a stop in Trenton (Northeast Corridor rail line); a light rail line utilizing Conrail Shared Assets Operations (CSAO) rail line (River Line); Conrail local freight service between Philadelphia and Trenton utilizing Amtrak's Northeast Corridor rail line; and Conrail local freight service on the CSAO rail lines during the overnight hours. There are some at-grade crossings on connector and local roads, and these create transportation risks. Otherwise, arterial streets and highways do not intersect directly with rail traffic, which helps neutralize rail/vehicular traffic accidents. Primary commodities handled by Conrail include containerized consumer goods, intermodal, semifinished steel, chemicals, lumber, and sand and gravel. While all of these commodities may not be considered hazardous materials, fires involving these commodities can produce smoke and other products of combustion risks that may be hazardous to health. Hazardous materials themselves present hazards to health risks.

The following figure illustrates the major road system that travels through Trenton. The two subsequent figures illustrate the commuter bus routes and stops in Trenton, as well as the River Line commuter rail line in Trenton; and the rail lines and service in Trenton.

FIGURE 4-1: Trenton Major Roads and Highways

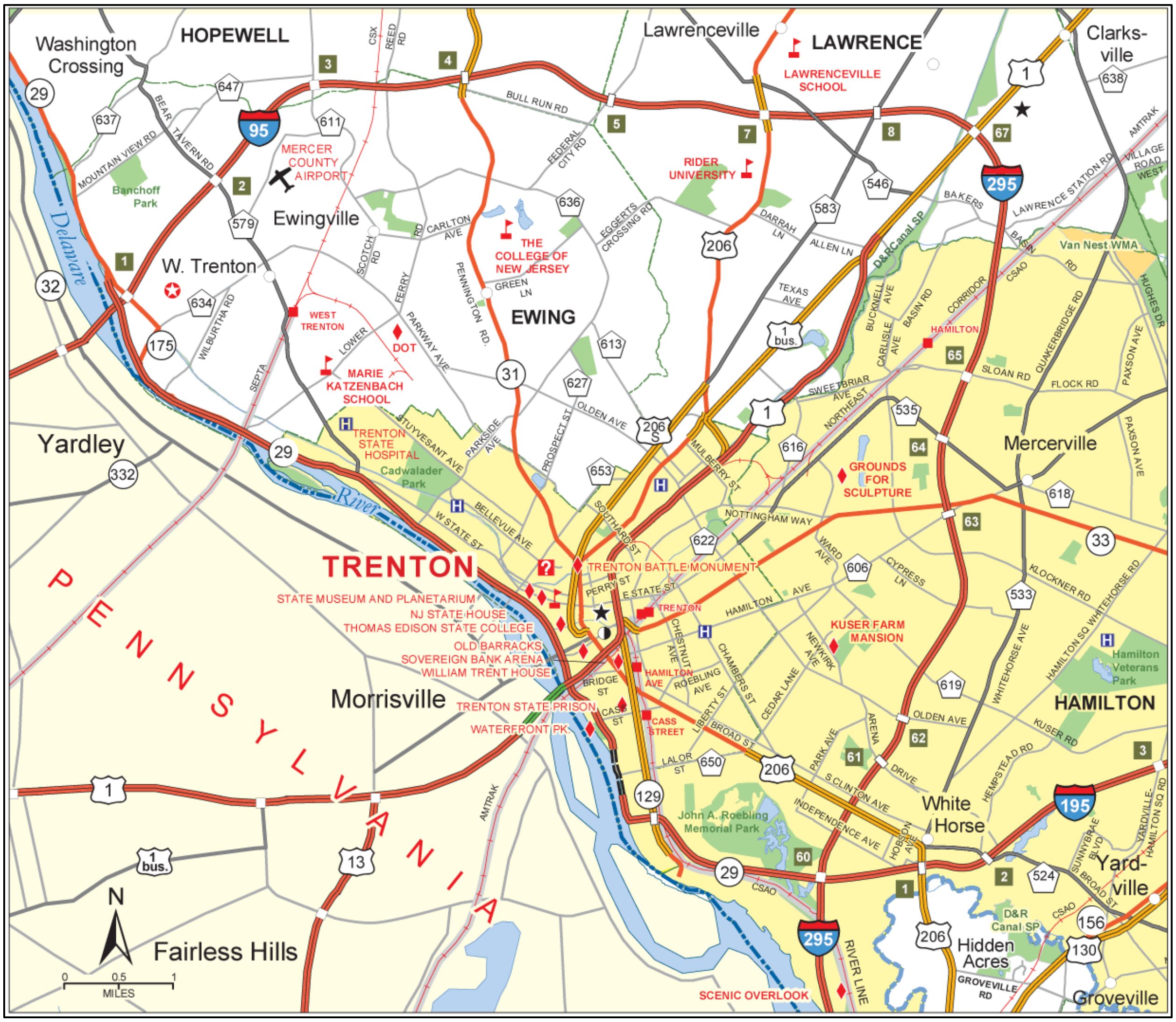


FIGURE 4-2: Trenton Commuter Bus Routes and Stops

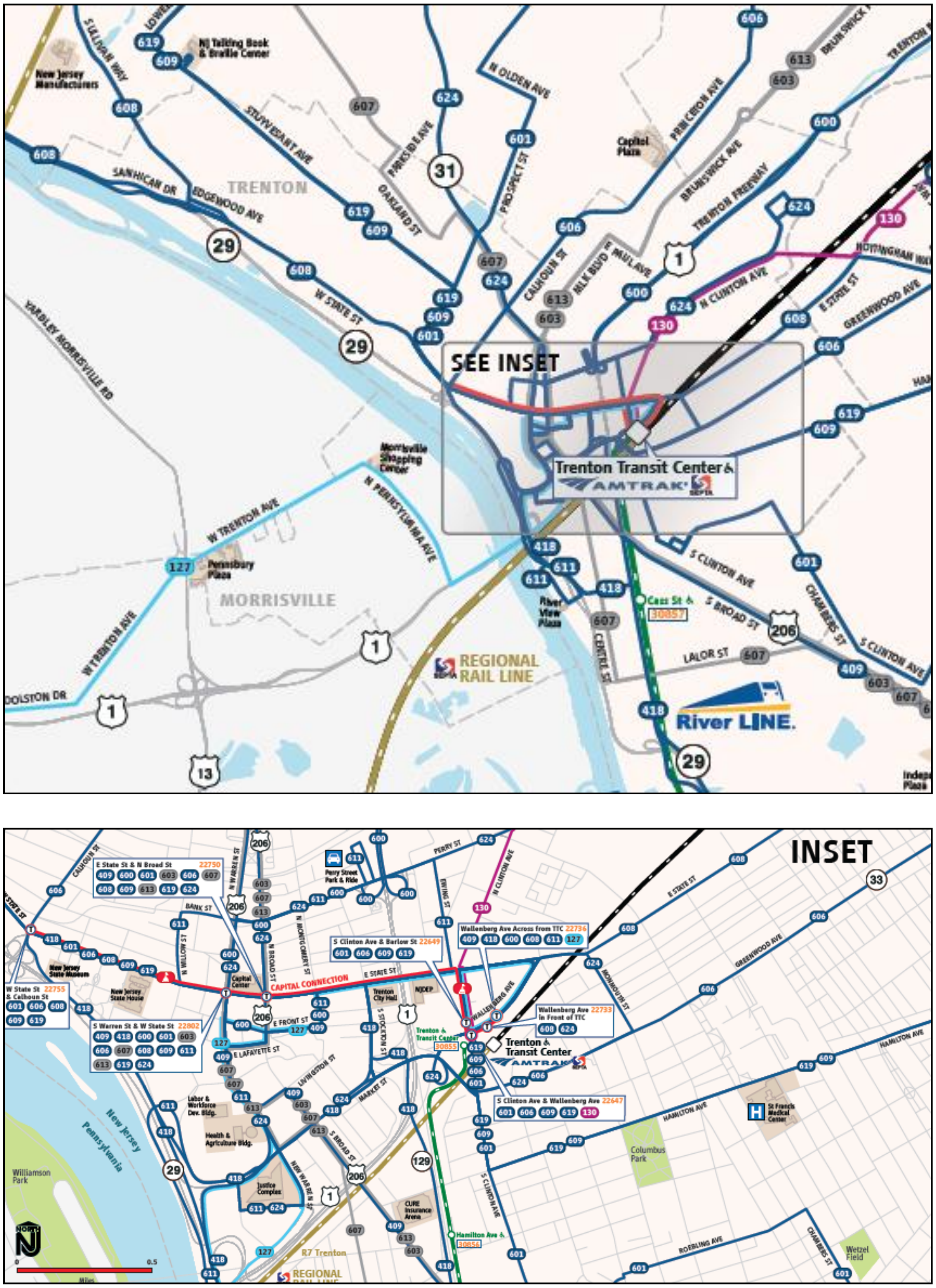
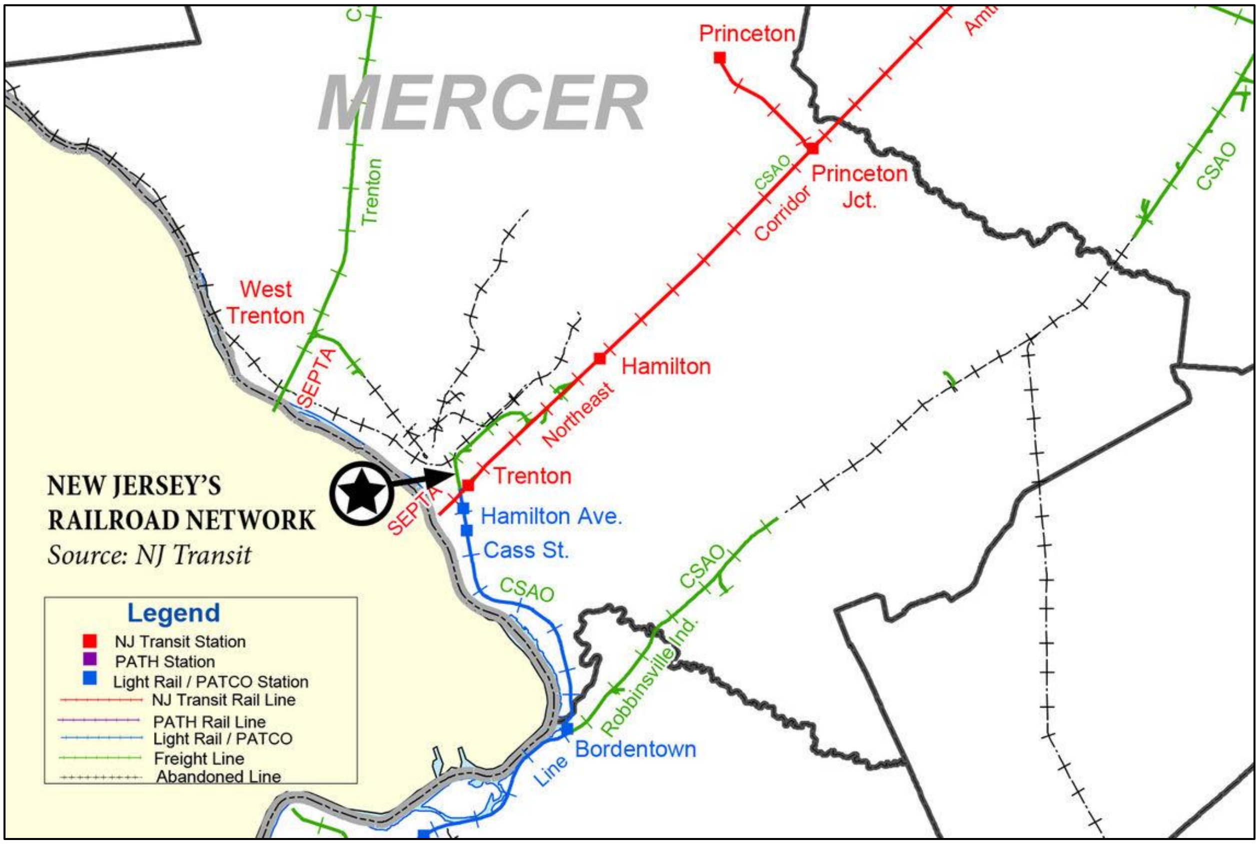


FIGURE 4-3: Trenton Rail Service: Commuter and Freight



FIRE AND FIRE-RELATED INCIDENT RISK

An indication of the community's fire risk is the type and number of fire-related incidents the fire department responds to. During the CPSM data analysis study period of January 1, 2019 to December 31, 2019, the TFESD responded to 3,581 fire-related calls for service. The following table details the call types and call type totals for these types of fire-related risks.

TABLE 4-1: Fire Call Types

Call Type	Number of Calls	Calls per Day	Call Percentage
False alarm	1,292	3.5	16.7
Good intent	314	0.9	4.1
Hazard	753	2.1	9.7
Outside fire	170	0.5	2.2
Public service	540	1.5	7.0
Structure fire	512	1.4	6.6
Fire Total	**3,581**	**9.8**	**46.3**

Key takeaways from the data in this table are:

- Fire calls for the study period totaled 3,581 (46.3 percent of all calls), an average of 9.8 fire calls per day.
- False alarm calls were the highest category of fire calls and made up 16.7 percent of all calls, and averaged 3.5 calls per day. False alarms typically include fire alarms activated with no fire or smoke present (largest percent) and fire alarm/sprinkler system malfunction.
- Hazardous conditions calls were the second highest category of fire type calls at 9.7 percent of all calls, and averaged 2.1 calls per day. Hazardous conditions calls are those responses by the TFESD to incidents such as combustible/flammable spills, electrical wiring/equipment problem, and hazardous release to name a few.
- Structure and outside fire calls combined made up 19 percent of fire calls and 8.8 percent of all calls, with an average of 1.9 calls per day. Outside fires include vegetation, brush, wild land, vehicle, dumpster, trash pile, and other actual fires not in or exposing a structure where the structure is also involved in fire.

In Trenton, fire-related calls represent 46.3 perent of all calls, which also includes EMS, mutual aid, and those calls for which units were canceled en route.

EMS RISK

As with fire risks, an indication of the community's pre-hospital emergency medical risk is the type and number of EMS calls to which the fire department responds. During the CPSM data analysis study period of January 1, 2019 to December 31, 2019, the TFESD responded to 4,025 EMS-related calls for service. The following table outlines the call types and call type totals for these types of EMS risks.

TABLE 4-2: EMS Call Types

Call Type	Number of Calls	Calls per Day	Call Percentage
Breathing difficulty	989	2.7	12.8
Cardiac and stroke	707	1.9	9.2
Fall and injury	244	0.7	3.2
Illness and other	563	1.5	7.3
MVA	257	0.7	3.3
Overdose and psychiatric	284	0.8	3.7
Seizure and unconsciousness	981	2.7	12.7
EMS Total	**4,025**	**11.0**	**52.1**

Key takeaways from the data in this table are:

- Breathing difficulty made up the largest category of EMS calls at 12.8 percent of all calls, with an average of 2.7 calls per day.
- Seizure and unconscious calls made up the second largest EMS call category at 12.7 percent of all calls, with an average of 2.7 calls per day.
- Cardiac and stroke calls made up 9.2 percent of all calls, with an average of 1.9 calls per day.

In Trenton, EMS-related calls represent the largest number of overall calls responded to by the TFESD at 52.1 percent; all calls also includes fire,mutual aid, and those calls for which units were canceled en route.

FIRE INCIDENT DEMAND AND EMS INCIDENT DEMAND

The fire and EMS risk in terms of numbers and types of incidents is important when analyzing a community's risk, as outlined above. Analyzing where the fire and EMS incidents occur, and the demand density of fire and EMS incidents, determines adequate fire management zone resource assignment and deployment. The following figures illustrate fire and EMS demand in the TFESD fire management zones. Figure 4-4 illustrates fire incidents (structural and outside fires, alarm activations etc.); Figure 4-5 illustrates other types of fire-related incidents such as good intent and public service calls, which are calls for service such as smoke scares (no fire), wires down, lock outs, water leaks, etc.; Figure 4-6 illustrates the call density of false alarms; and Figure 4-7 illustrates EMS incident demand.

The following four demand maps (with current fire station locations shown) tell us that: structure/outside fire-related and EMS incident demand is highest in the central and southeast portions of the city; fire/false alarm demand is highest in the central portion of the city; and other types of fire incidents (hazardous conditions, service calls) are spread out in all areas of the city with high demand in all fire management zones.

FIGURE 4-4: Fire Incident Demand Density (Structure and Outside Fires)

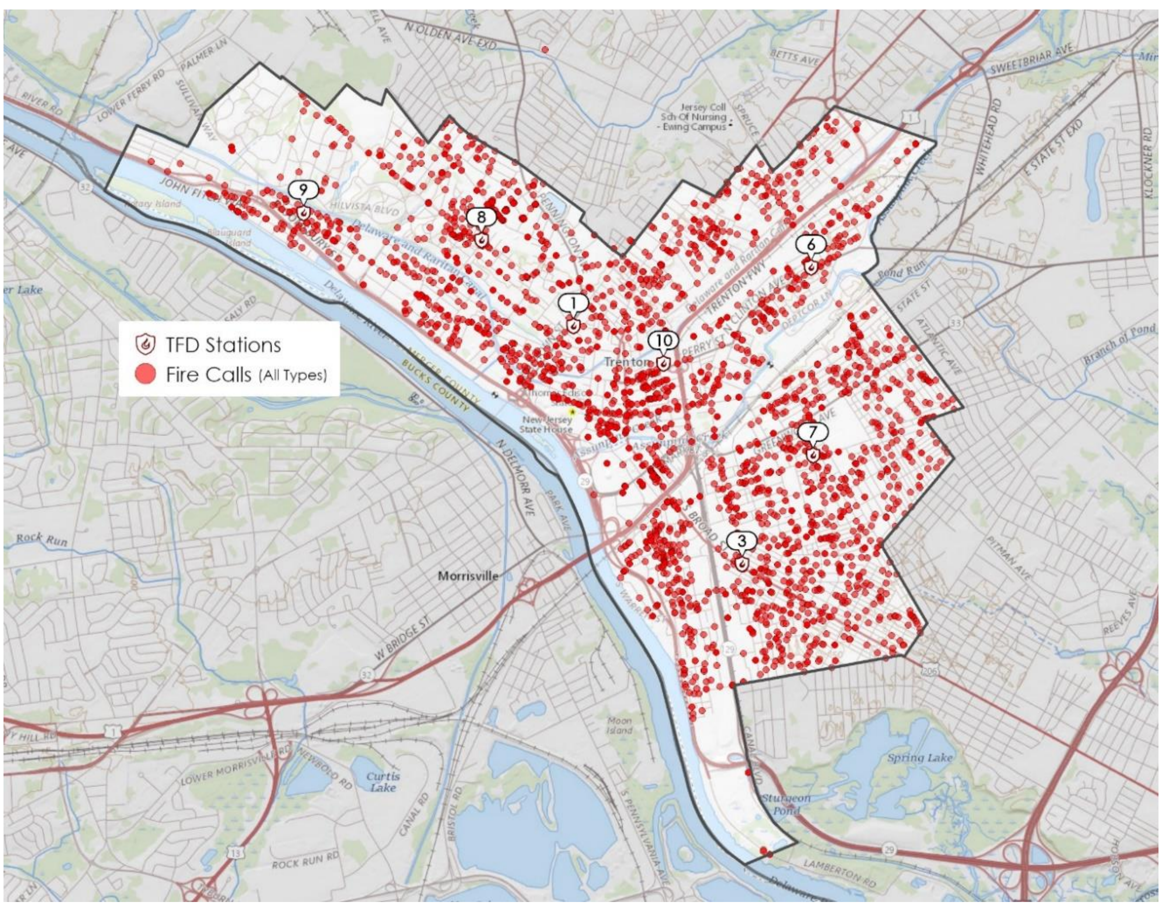


FIGURE 4-5: Other Fire-related Incident Demand Density

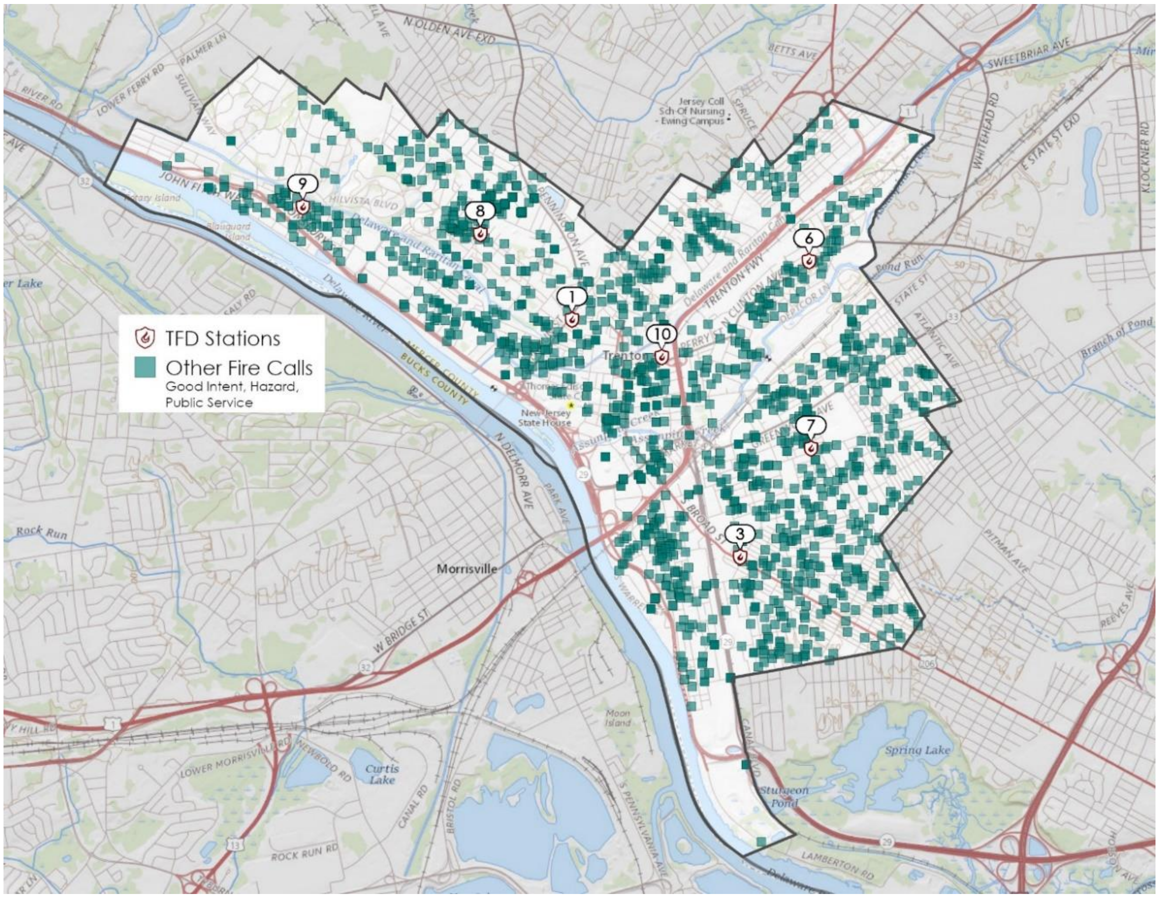


FIGURE 4-6: False Alarm Incident Demand Density

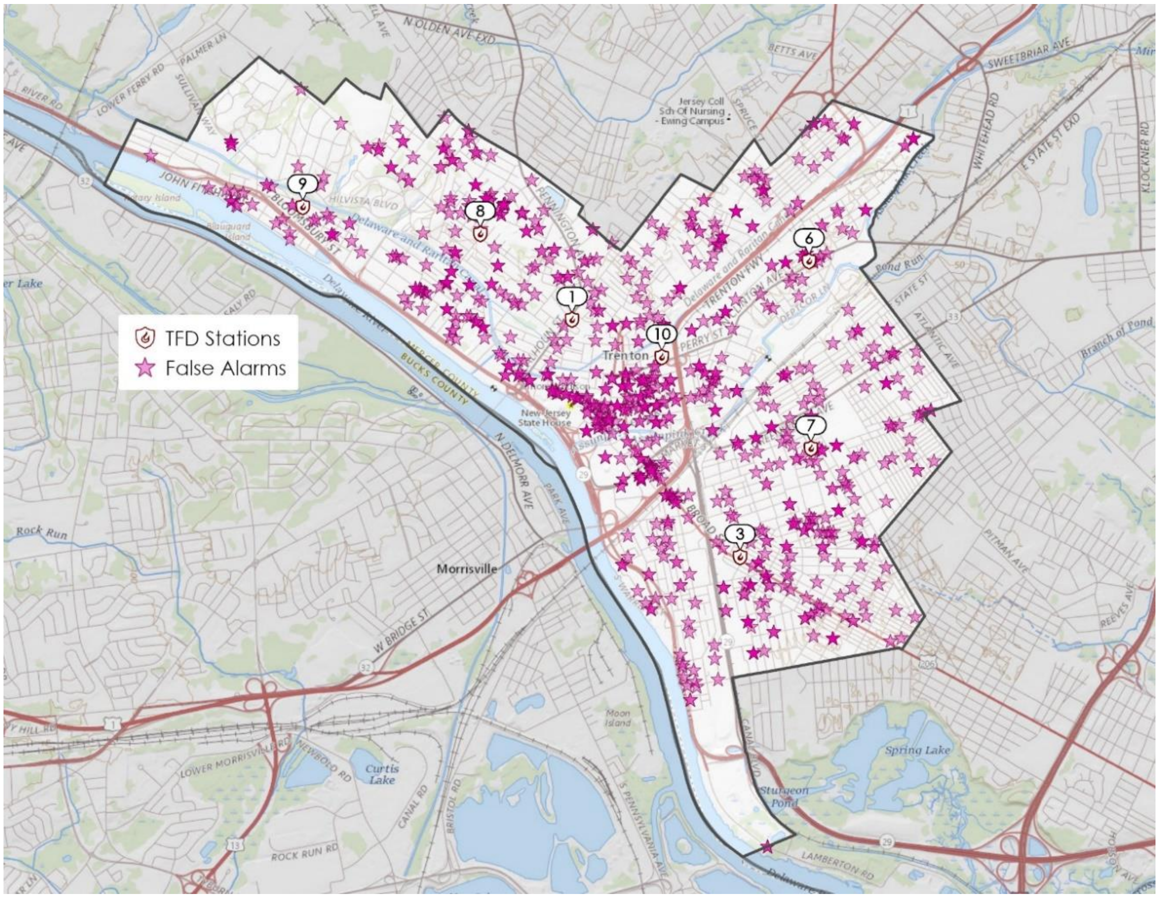
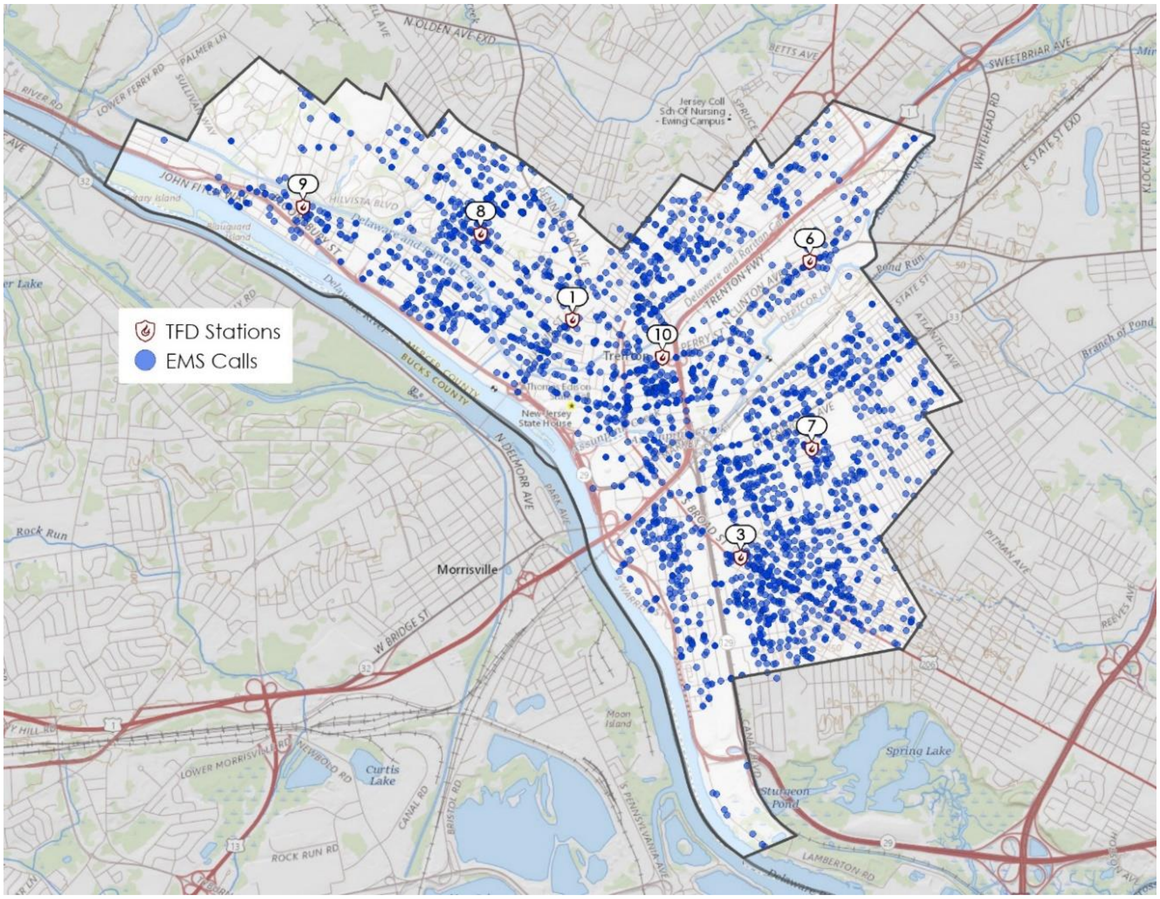


FIGURE 4-7: EMS Incident Demand Density



Resiliency

Resiliency as defined by the Center for Public Safety Excellence (CPSE) in the FESSAM 9th edition is: "an organization's ability to quickly recover from an incident or events, or to adjust easily to changing needs or requirements." Greater resiliency can be achieved by constant review and analysis of the response system and focuses on three key components:

- Resistance: The ability to deploy only resources necessary to safely and effectively control an incident and bring it to termination, which is achieved through the development and implementation of critical tasking and its application to the establishment of an effective response force for all types of incidents.
- Absorption: The ability of the agency to quickly add or duplicate resources necessary to maintain service levels during heavy call volume or incidents of high resource demand.
- Restoration: The agency's ability to quickly return to a state of normalcy.

Resistance is controlled by the TFESD through staffing and response protocol, and with TFESD resources dependent on the level of staffing and units available at the time of the alarm.

Absorption is accomplished through initial responding units available to respond by the TFESD.

Restoration is managed by TFESD unit availability as simultaneous calls occur, recall of staff to staff fire units during campaign events when warranted, and efficient work on incidents for a quick return to service.

Regarding restoration, the following three tables analyze the station availability to respond to calls, and the frequency by number of hours that units are dedicated to a single or multiple incidents.

TABLE 4-3: Station Availability to Respond to Calls

Station	Calls in Area	First Due Responded	First Due Arrived	First Due First	Percent Responded	Percent Arrived	Percent First
1	998	857	854	755	85.9	85.6	75.7
3	1,773	1,584	1,581	1,394	89.3	89.2	78.6
6	765	648	642	568	84.7	83.9	74.2
7	1,213	1,008	1,001	905	83.1	82.5	74.6
8	1,172	1,017	1,013	913	86.8	86.4	77.9
9	403	360	357	323	89.3	88.6	80.1
10	1,234	1,154	1,154	1,082	93.5	93.5	87.7
Total	**7,558**	**6,628**	**6,602**	**5,940**	**87.7**	**87.4**	**78.6**

TABLE 4-4: Frequency Distribution of the Number of Calls

Calls in an Hour	Frequency	Percentage
0	3,783	43.2
1	3,016	34.4
2	1,373	15.7
3	442	5.0
4	120	1.4
5+	26	0.3
Total	**8,760**	**100.0**

TABLE 4-5: Top 10 Hours with the Most Calls Received

Hour	Number of Calls	Number of Runs	Total Deployed Hours
5/29/2019, 6:00 p.m. to 7:00 p.m.	14	40	8.2
7/22/2019, 6:00 p.m. to 7:00 p.m.	14	31	12.1
11/1/2019, 6:00 a.m. to 7:00 a.m.	7	16	4.2
2/3/2019, 5:00 p.m. to 6:00 p.m.	6	16	3.9
10/21/2019, 5:00 p.m. to 6:00 p.m.	6	13	5.6
7/22/2019, 7:00 p.m. to 8:00 p.m.	6	10	4.9
5/25/2019, 10:00 p.m. to 11:00 p.m.	6	9	1.8
9/15/2019, 10:00 p.m. to 11:00 p.m.	6	7	1.2
12/13/2019, 10:00 p.m. to 11:00 p.m.	6	6	1.7
8/7/2019, 3:00 a.m. to 4:00 a.m.	6	6	1.3

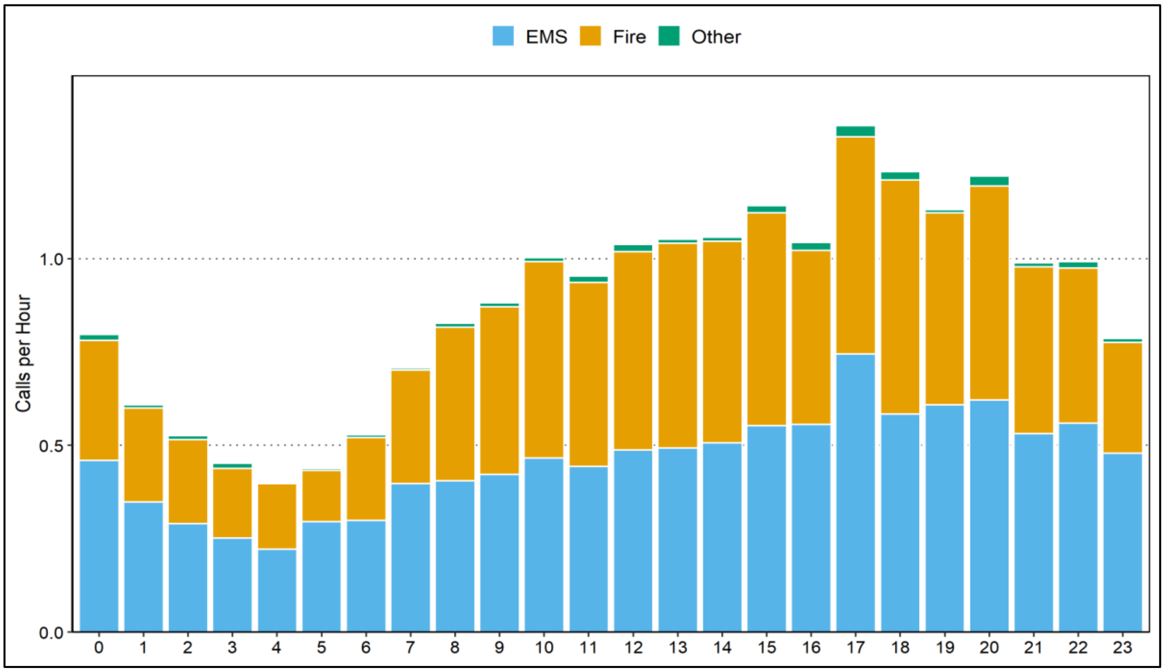
The next table analyzes the workload for TFESD units by station and unit.

TABLE 4-6: Call Workload by Station and Unit

Station	Unit ID	Unit Type	Deployed Minutes per Run	Total Annual Hours	Deployed Minutes per Day	Annual Runs	Runs per Day
1	ENG1	Engine	19.2	551.1	90.6	1,726	4.7
	LAD1	Ladder	23.9	434.5	71.4	1,089	3.0
	MAR1	Marine	44.4	23.7	3.9	32	0.1
	Total		**21.3**	**1,009.3**	**165.9**	**2,847**	**7.8**
3	ENG3	Engine	20.1	654.6	107.6	1,952	5.3
	LAD2	Ladder	25.0	391.4	64.3	938	2.6
	Total		**21.7**	**1,046.0**	**171.9**	**2,890**	**7.9**
6	ENG6	Engine	21.4	375.5	61.7	1,054	2.9
	Total		**21.4**	**375.5**	**61.7**	**1,054**	**2.9**
7	ENG7	Engine	20.3	571.6	94.0	1,690	4.6
	RE7	Reserve engine	0.1	0.0	0.0	1	0.0
	Total		**20.3**	**571.6**	**94.0**	**1,691**	**4.6**
8	ENG8	Engine	19.7	494.6	81.3	1,509	4.1
	Total		**19.7**	**494.6**	**81.3**	**1,509**	**4.1**
9	ENG9	Engine	22.5	294.8	48.5	785	2.2
	RE9	Reserve engine	92.7	1.5	0.3	1	0.0
	SS2	Utility	68.1	7.9	1.3	7	0.0
	Total		**23.0**	**304.3**	**50.0**	**793**	**2.2**
10	ENG10	Engine	18.0	677.0	111.3	2,255	6.2
	HM1	Hazmat	19.7	117.4	19.3	358	1.0
	LAD4	Ladder	22.2	488.7	80.3	1,319	3.6
	RES1	Rescue	18.3	580.4	95.4	1,904	5.2
	RL2	Reserve ladder	105.0	5.2	0.9	3	0.0
	RL4	Reserve ladder	37.6	3.1	0.5	5	0.0
	RR1	Reserve rescue	80.3	10.7	1.8	8	0.0
	SS1	Air and light truck	80.9	121.4	20.0	90	0.2
	U12	Utility	224.4	15.0	2.5	4	0.0
	Total		**20.4**	**2,018.9**	**331.9**	**5,946**	**16.3**

The following figure illustrates the calls by hour of day, and shows the peak times of the day a call is likely to occur.

FIGURE 4-8: Calls by Hour of Day



Regarding the TFESD's resiliency to respond to calls, analysis of these tables and figure tell us:

- On average the TEFESD averaged 16.3 calls per day.
- On average, all calls averaged 20 minutes per run.
- On a station level, station 10 made the most runs (5,946, or an average of 16.3 runs per day) and had the highest total annual deployed time (2,018.9 hours, or an average of 5.5 hours per day).
- On a unit level, ENG10 made the most runs (2,255, or an average of 6.2 runs per day), and had the highest total annual deployed time (677.0 hours, or an average of 111.3 minutes per day).
- 34.4 percent of the time there was a single call (no call overlap).
- 22.4 percent of the time a call was overlapped with another call.
- 6.7 percent of the time there were three or more calls in an hour.
- 87.7 percent of the time the first due unit responded to calls in its first due area.
- 78.6 percent of the time the first due unit arrived first in its first due area.
- Hourly deployed time was highest during the day from 10:00 a.m. to 10:00 p.m.
- The deployed time peaked between 5:00 p.m. and 8:00 p.m.
- The deployed time was lowest between 3:00 a.m. and 6:00 a.m.

On average, about 78 percent of the time, the TFESD does not have a resiliency issue.
A resiliency issue occurs about 22 percent of the time.

RISK CATEGORIZATION

A comprehensive risk assessment is a critical aspect of creating standards of cover and can assist the TFESD in quantifying the risks that it faces in the city. Once those risks are known, the department is better equipped to determine if the current response resources are sufficiently staffed, equipped, trained, and positioned. In this component, the factors that drive the service needs are examined and then link directly to discussions regarding the assembling of an effective response force (EFR) and when contemplating the response capabilities needed to adequately address the existing risks, which encompasses the component of critical tasking.

The risks that the department faces can be natural or man-made and may be affected by the changing demographics of the community served. With the information available from the CPSM data analysis, the TFESD, the city, and public research, CPSM and the TFESD can begin an analysis of the city's risks, and can begin working towards recommendations and strategies to mitigate and minimize their effects. This section contains an analysis of the various risks considered within the TFESD's service area.

Risk is often categorized in three ways, which are consequence of the event on the community, the probability the event will occur in the community, and the impact on the fire department. The following three tables look at the probability of the event occurring (Table 4-7) which ranges from unlikely to frequent; consequence to the community (Table 4-8), which is categorized ranging from insignificant to catastrophic; and the impact to the organization (Table 4-9), which ranges from insignificant to catastrophic.

TABLE 4-7: Event Probability

Probability	Chance of Occurrence	Description	Risk Score
Unlikely	2%-25%	Event may occur only in exceptional circumstances.	**2**
Possible	26%-50%	Event could occur at some time and/or no recorded incidents. Little opportunity, reason, or means to occur.	**4**
Probable	51%-75%	Event should occur at some time and/or few, infrequent, random recorded incidents or little anecdotal evidence. Some opportunity, reason, or means to occur; may occur.	**6**
Highly Probable	76%-90%	Event will probably occur and/or regular recorded incidents and strong anecdotal evidence. Considerable opportunity, means, reason to occur.	**8**
Frequent	90%-100%	Event is expected to occur. High level of recorded incidents and/or very strong anecdotal evidence.	**10**

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TABLE 4-8: Consequence to Community Matrix

Impact	Impact Categories	Description	Risk Score
Insignificant	Life Safety	■ 1 or 2 people affected, minor injuries, minor property damage, and no environmental impact.	**2**
Minor	Life Safety Economic and Infrastructure Environmental	■ Small number of people affected, no fatalities, and small number of minor injuries with first aid treatment. Minor displacement of people for <6 hours and minor personal support required. ■ Minor localized disruption to community services or infrastructure for <6 hours. Minor impact on environment with no lasting effects.	**4**
Moderate	Life Safety Economic and Infrastructure Environmental	■ Limited number of people affected (11 to 25), no fatalities, but some hospitalization and medical treatment required. Localized displacement of small number of people for 6 to 24 hours. Personal support satisfied through local arrangements. Localized damage is rectified by routine arrangements. ■ Normal community functioning with some inconvenience. ■ Some impact on environment with short-term effects or small impact on environment with long-term effects.	**6**
Significant	Life Safety Economic and Infrastructure Environmental	■ Significant number of people (>25) in affected area impacted with multiple fatalities, multiple serious or extensive injuries, and significant hospitalization. ■ Large number of people displaced for 6 to 24 hours or possibly beyond. External resources required for personal support. Significant damage that requires external resources. Community only partially functioning, some services unavailable. ■ Significant impact on environment with medium- to long-term effects.	**8**
Catastrophic	Life Safety Economic and Infrastructure Environmental	■ Very large number of people in affected area(s) impacted with significant numbers of fatalities, large number of people requiring hospitalization; serious injuries with long-term effects. General and wide-spread displacement for prolonged duration; extensive personal support required. Extensive damage to properties in affected area requiring major demolition. ■ Serious damage to infrastructure. Significant disruption to, or loss of, key services for prolonged period. ■ Community unable to function without significant support. ■ Significant long-term impact on environment and/or permanent damage.	**10**

TABLE 4-9: Impact on TFESD

Impact	Impact Categories	Description	Risk Score
Insignificant	Personnel and Resources	One apparatus out of service for period not to exceed one hour.	**2**
Minor	Personnel and Resources	More than one but not more than two apparatus out of service for a period not to exceed one hour.	**4**
Moderate	Personnel and Resources	More than 50 percent of available resources committed to incident for over 30 minutes.	**6**
Significant	Personnel and Resources	More than 75 percent of available resources committed to an incident for over 30 minutes.	**8**
Catastrophic	Personnel, Resources, and Facilities	More than 90 percent of available resources committed to incident for more than two hours or event which limits the ability of resources to respond.	**10**

This section also contains an analysis of the various risks considered in the city. In this analysis, information presented and reviewed in this section (All-Hazards Risk Assessment of the Community) have been considered. Risk is categorized as Low, Moderate, High, or Special.

Prior risk analysis has only attempted to evaluate two factors of risk: probability and consequence. Contemporary risk analysis considers the impact of each risk to the organization, thus creating a three-axis approach to evaluating risk as depicted in the following figure.
A contemporary risk analysis now includes probability, consequences to the community, and impact on the organization, in this case the TFESD.

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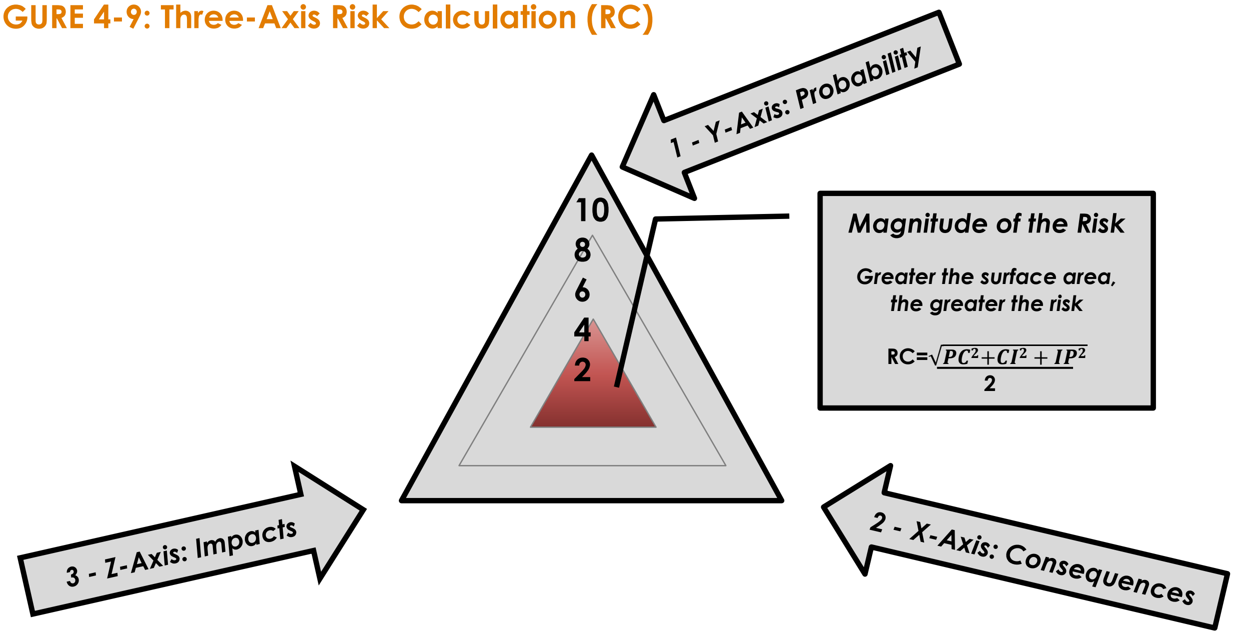
FIGURE 4-9: Three-Axis Risk Calculation (RC)



The following factors/hazards were identified and considered:

- **Demographic factors** such as age, socio-economic, vulnerability.
- **Natural hazards** such as flooding, snow and ice events, wind events, wild land fires.
- **Man-made hazards** such as rail lines, roads and intersections, target hazards.
- **Structural/building risks**.
- **Fire and EMS incident numbers and density**.

The assessment of each factor and hazard as listed below took into consideration the likelihood of the event, the impact on the city itself, and the impact on TFESD's ability to deliver emergency services, which includes automatic aid capabilities as well. The list is not all inclusive but includes categories most common or that may present to the city and the TFESD.

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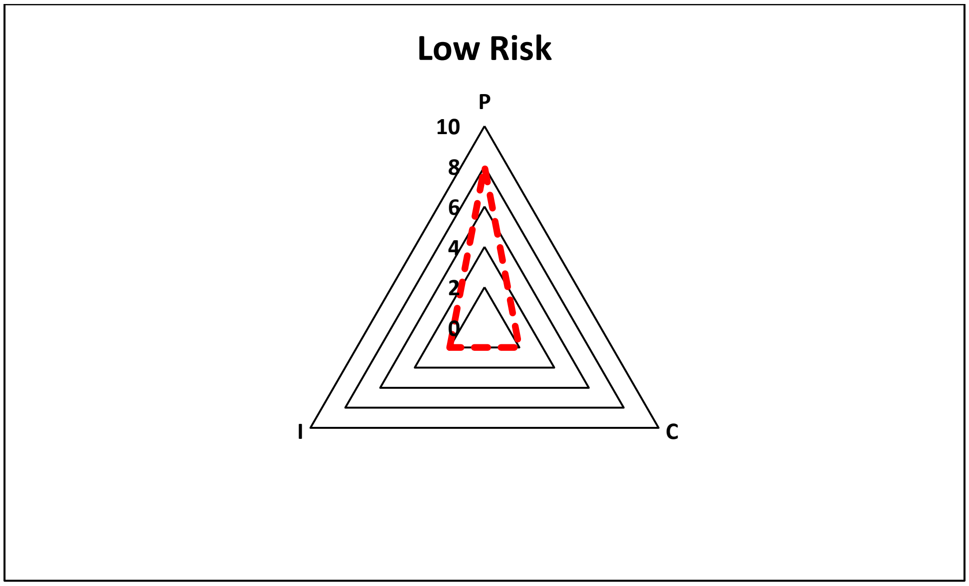
Low Risk

- Automatic fire/false alarms.
- BLS EMS Incidents.
- Low-risk environmental event.
- Motor vehicle accident (MVA).
- Good intent/hazard/public service fire incidents with no life-safety exposure.
- Outside fires such as grass, rubbish, dumpster, vehicle with no structural/life-safety exposure.

FIGURE 4-10: Low Risk



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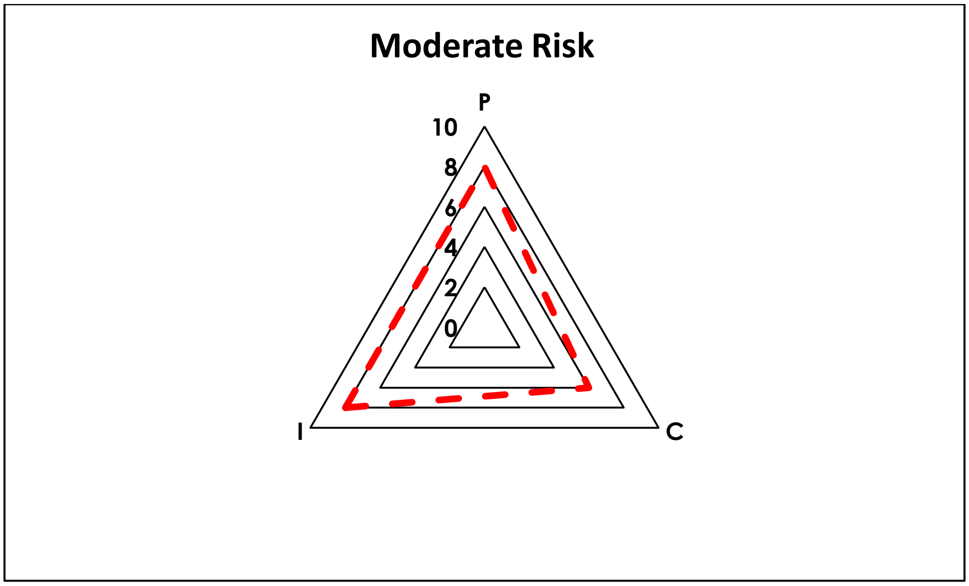
Moderate Risk

- Fire incident in a single-family dwelling where fire and smoke or smoke is visible, indicating a working fire.
- Suspicious substance investigation involving multiple fire companies and law enforcement agencies.
- ALS EMS incident.
- MVA with entrapment of passengers.
- Grass/brush fire with structural endangerment/exposure.
- Low angle rescue involving ropes and rope rescue equipment and resources.
- Surface water rescue.
- Good intent/hazard/public service fire incidents with life-safety exposure.

FIGURE 4-11: Moderate Risk



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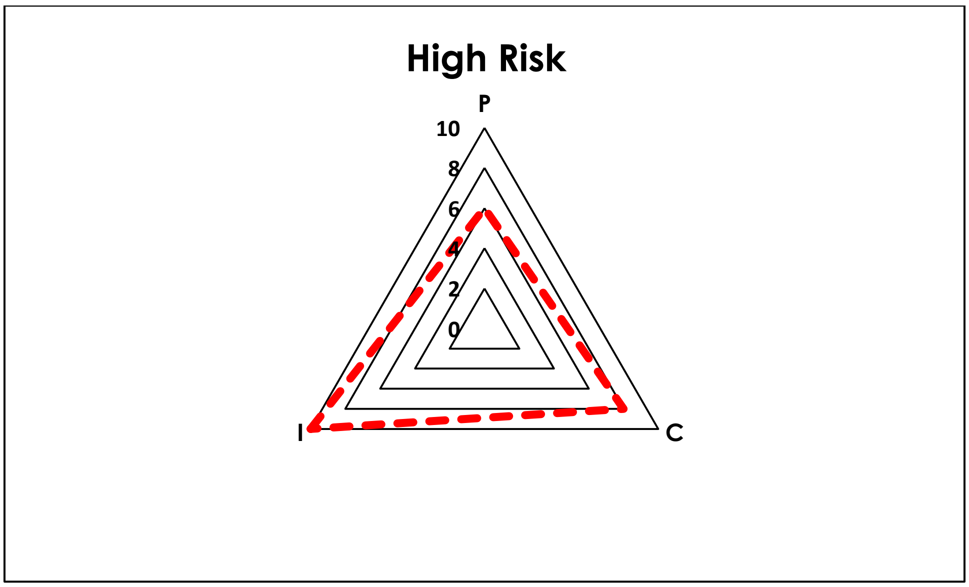
High Risk

- Working fire in a target hazard.
- Cardiac arrest.
- Mass casualty incident of more than 10 patients but fewer than 25 patients.
- Confined space rescue.
- Structural collapse involving life-safety exposure.
- High-angle rescue involving ropes and rope rescue equipment.
- Trench rescue.
- Suspicious substance incident with multiple injuries.
- Industrial leak of hazardous materials that causes exposure to persons or threatens life safety.
- Weather event that creates widespread flooding, heavy snow, heavy winds, building damage, and/or life-safety exposure.

FIGURE 4-12: High Risk



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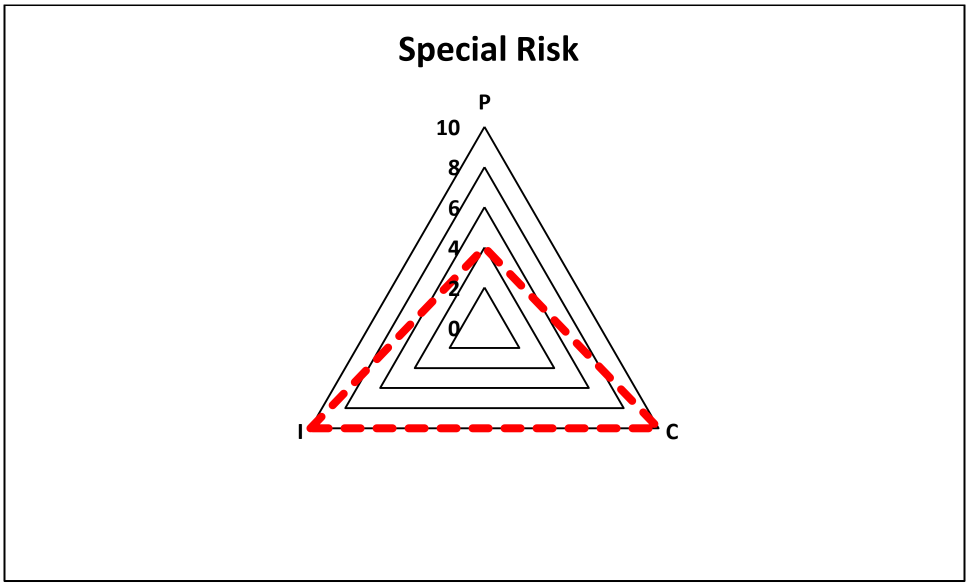
Special Risk

- Working fire in a structure of more than three floors.
- Fire at an industrial building or complex with hazardous materials.
- Fire in an occupied targeted hazard with special life-safety risks such as age, medical condition, or other identified vulnerabilities.
- Mass casualty incident of more than 25 patients.
- Rail or transportation incident that causes life-safety exposure or threatens life safety through the release of hazardous smoke or materials and evacuation of residential and business occupancies.
- Explosion in a building that causes exposure to persons or threatens life safety or outside of a building that creates exposure to occupied buildings or threatens life safety.
- Massive river/estuary flooding, fire in a correctional or medical institution, high-impact environmental event; pandemic.

FIGURE 4-13: Special Risk



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SECTION 4 RECOMMENDATIONS AND PLANNING OBJECTIVES

4.1 The City of Trenton has diverse environmental risks, building target hazards, and transportation and specials risks to which the TFESD responds.

- CPSM recommends as a planning objective:
  - The TFESD develop and implement, over a one-year period, a training plan that gathers relevant data and educates department members about the community profile (demographics, vulnerable populations, building, environmental, and transportation risks) that exists in each fire management zone, so that each fire company can then develop individual response plans to prepare for and mitigate emergencies more effectively.
  - CPSM further recommends as a planning objective the TFESD develop and implement a plan over a two-year period for individual companies to complete pre-fire planning of all building target hazards in their individual fire management zones, and enter the information and data into the records management system. The plan should include the requirement for companies to visit each target hazard on an annual basis, updating the pre-fire plan and familiarizing themselves with the hazard. Target hazards should be rotated each year to a different shift so that companies walk through each target hazard in their fire management zone once every four years.

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SECTION 5. EMERGENCY RESPONSE DEPLOYMENT AND PERFROMANCE

EVALUATION OF CURRENT DEPLOYMENT AND PERFORMANCE

Response times are typically the primary measurement for evaluating fire and EMS services. Response times can be used as a benchmark to determine how well a fire department is currently performing, to help identify response trends, and to predict future operational needs. Achieving the quickest and safest response times possible should be a fundamental goal of every fire department.

However, the actual impact of a speedy response time is limited to very few incidents. For example, in a full cardiac arrest, analysis shows that successful outcomes are rarely achieved if basic life support (CPR) is not initiated within four to six minutes of the onset. However, cardiac arrests occur very infrequently; on average they are 1 percent to 1.5 percent of all EMS incidents.[13] There are also other EMS incidents that are truly life-threatening and the time of response can clearly impact the outcome. These involve cardiac and respiratory emergencies, full drownings, obstetrical emergencies, allergic reactions, electrocutions, and severe trauma (often caused by gunshot wounds, stabbings, and severe motor vehicle accidents, etc.). Again, the frequencies of these types of calls are limited.

An important factor in the whole response time question is what we term "**detection time**." This is the time it takes to detect a fire or a medical situation and notify 911 to initiate the response. In many instances, particularly at night or when automatic detection systems (fire sprinklers and smoke detectors) are not present or inoperable, the detection process can be extended. Fires that go undetected and are allowed to expand in size become more destructive and are difficult to extinguish.

For the purpose of this analysis, ***response time*** is a product of three components: ***dispatch time***, ***turnout time***, and ***travel time***.

Dispatch time (alarm processing time) is the difference between the time a call is received and the time a unit is dispatched. Dispatch time includes call processing time, which is the time required to determine the nature of the emergency and types of resources to dispatch. ***Turnout time*** is when the emergency response units are notified of the incident and ends when travel time begins. ***Travel Time*** is the difference between the time the unit is en route and arrival on scene. ***Response time*** is the total time elapsed between receiving a call to arriving on scene.

For this study, and unless otherwise indicated, response times and travel times measure the first arriving unit only. The primary focus of this section is the dispatch and response time of the first arriving units for calls responded to with lights and sirens (Code 3).

According to NFPA 1710, the alarm processing time or dispatch time should be less than or equal to 60 seconds 90 percent of the time. NFPA 1710 also states that turnout time should be less than or equal to 80 seconds (1.33 minutes) for fire and special operations 90 percent of the time and 60 seconds (1.0 minute) for EMS. As noted above, turnout time is the segment of total response time that the fire department has the most ability to control. Travel time shall be less than or

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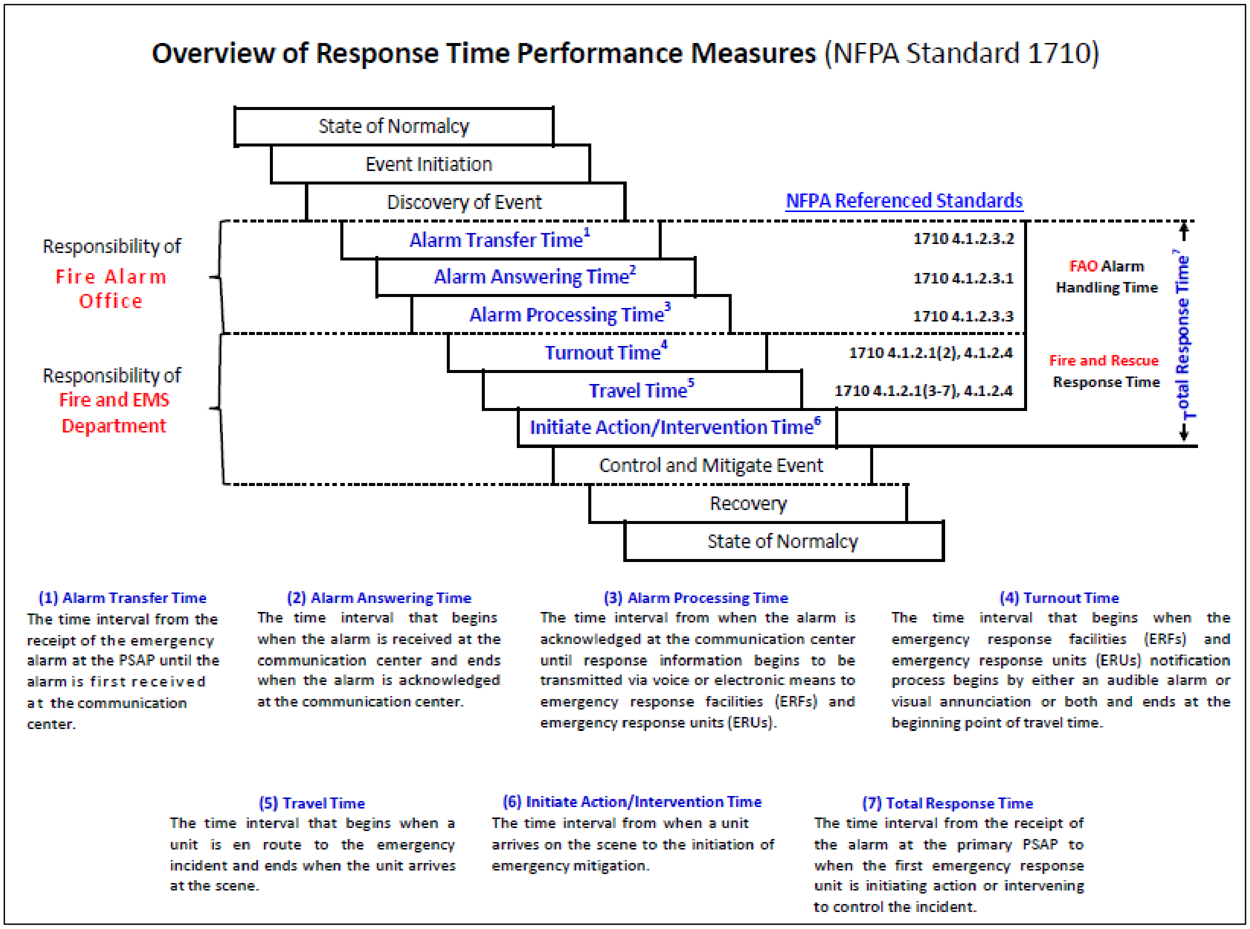
13. Myers, Slovis, Eckstein, Goodloe et al. (2007). "Evidence-based Performance Measures for Emergency Medical Services System: A Model for Expanded EMS Benchmarking." *Pre-hospital Emergency Care*.

equal to 240 seconds for the first arriving engine company 90 percent of the time and for the second due engine 360 seconds 90 percent of the time. The standard further states the initial first alarm assignment should be assembled on scene in 480 seconds, 90 percent of the time for low/medium hazards, and 610 seconds for high-rise or high hazards. Note that NFPA 1710 response time criterion is a benchmark for service delivery and not a CPSM recommendation.

The following figure provides an overview of response time performance and identifies responsibility of the key components of the emergency communications center and the fire and rescue department.

FIGURE 5-1: Response Time Performance Measures



Regarding response times for fire incidents, the criterion is linked to the concept of "flashover." This is the state at which super-heated gasses from a fire are released rapidly, causing the fire to burn freely and become so volatile that the fire reaches an explosive state (simultaneous ignition of all the combustible materials in a room). In this situation, usually after an extended period (often eight to twelve minutes after ignition but times as quickly as five to seven minutes), and a combination of the right conditions (fuel and oxygen), the fire expands rapidly and is much more difficult to contain. When the fire does reach this extremely hazardous state, initial firefighting forces are often overwhelmed, larger and more destructive fire occurs, the fire escapes the room and possibly even the building of origin, and significantly more resources are required to affect fire control and extinguishment.

Flashover occurs more quickly and more frequently today and is caused at least in part by the introduction of significant quantities of plastic- and foam-based products into homes and businesses (e.g., furnishings, mattresses, bedding, plumbing and electrical components, home and business electronics, decorative materials, insulation, and structural components). These materials ignite and burn quickly and produce extreme heat and toxic smoke.

National Fire Protection Association (NFPA) Standard 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments,* 2020 edition (National Fire Protection Association, Quincy, Mass.) outlines recommended organization and deployment of operations by career, and primarily career fire and rescue organizations.[14] It is the benchmark standard that the United States Department of Homeland Security utilizes when evaluating applications for staffing grants under the Staffing for Adequate Fire and Emergency Response (SAFER) grant program.

As a benchmark, paragraph 4.1.2.1(3) of NFPA 1710 recommends the first arriving engine at a fire suppression incident have **a travel time of 240 seconds or less**. Paragraph 4.1.2.1(4) recommends that other than for a high-rise incident, **the entire initial response of personnel be on scene within eight minutes (480 seconds) travel time.** It is also important to keep in mind that once units arrive on scene, they will need to get set up to commence operations. NFPA 1710 recommends that units be able to commence an initial attack within two minutes of arrival, 90 percent of the time.

Although trying to reach the NFPA benchmark for travel time may be laudable, the question is, at what cost. What is the evidence that supports such recommendations? NFPA 1710's travel times are established for two primary reasons: (1) the fire propagation curve (Figure 5-2); and (2) sudden cardiac arrest, where brain damage and permanent brain death occurs in four to six minutes.

The following figure shows the fire propagation curve relative to fire being confined to the room of origin or spreading beyond it and the percentage of destruction of property by the fire.

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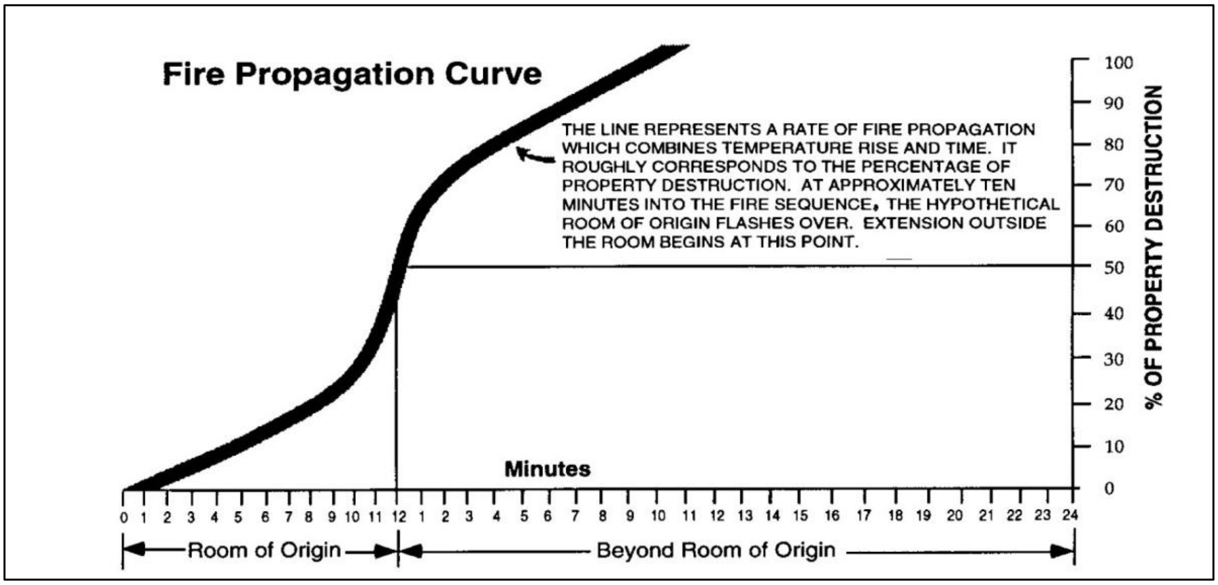
14. NFPA 1710 is a nationally recognized standard, but it has not been adopted as a mandatory regulation by the federal government or the State of New Jersey. It is a valuable resource for establishing and measuring performance objectives for the City of Trenton but should not be the only determining factor when making local decisions about the city's fire and EMS services.

FIGURE 5-2: Fire Propagation Curve



Source: John C. Gerard and A. Terry Jacobsen, "Reduced Staffing: At What Cost?" Fire Service Today (September 1981), 15–21.

According to fire service educator Clinton Smoke, the fire propagation curve establishes that temperature rise and time within in a room on fire corresponds with property destruction and potential loss of life if present.[15] At approximately the ten-minute mark of fire progression, the fire flashes over (due to superheating of room contents and other combustibles) and extends beyond the room of origin, thus increasing proportionately the destruction to property and potential endangerment of life. The ability to quickly deploy adequate fire staff prior to flashover thus limits the fire's extension beyond the room or area of origin.

Regarding the risk of flashover, the authors of an IAFF report conclude:

> *Clearly, an early aggressive and offensive initial interior attack on a working structural fire results in greatly reduced loss of life and property damage. Consequently, given that the progression of a structural fire to the point of "flashover" (the very rapid spreading of the fire due to super-heating 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 numbers of personnel and equipment to attack and extinguish the fire as close to the point of its origin as possible.*[16]

The following figure illustrates the time progression of a fire from inception through flashover. The time versus products of combustion curve shows activation times and effectiveness of residential sprinklers (approximately one minute), commercial sprinklers (four minutes), flashover (eight to ten minutes), and firefighters applying first water to the fire after notification, dispatch, response, and set up (ten minutes). It also illustrates that the fire department's response time to the fire is one of the only aspects of the timeline that the fire department can exert direct control over.

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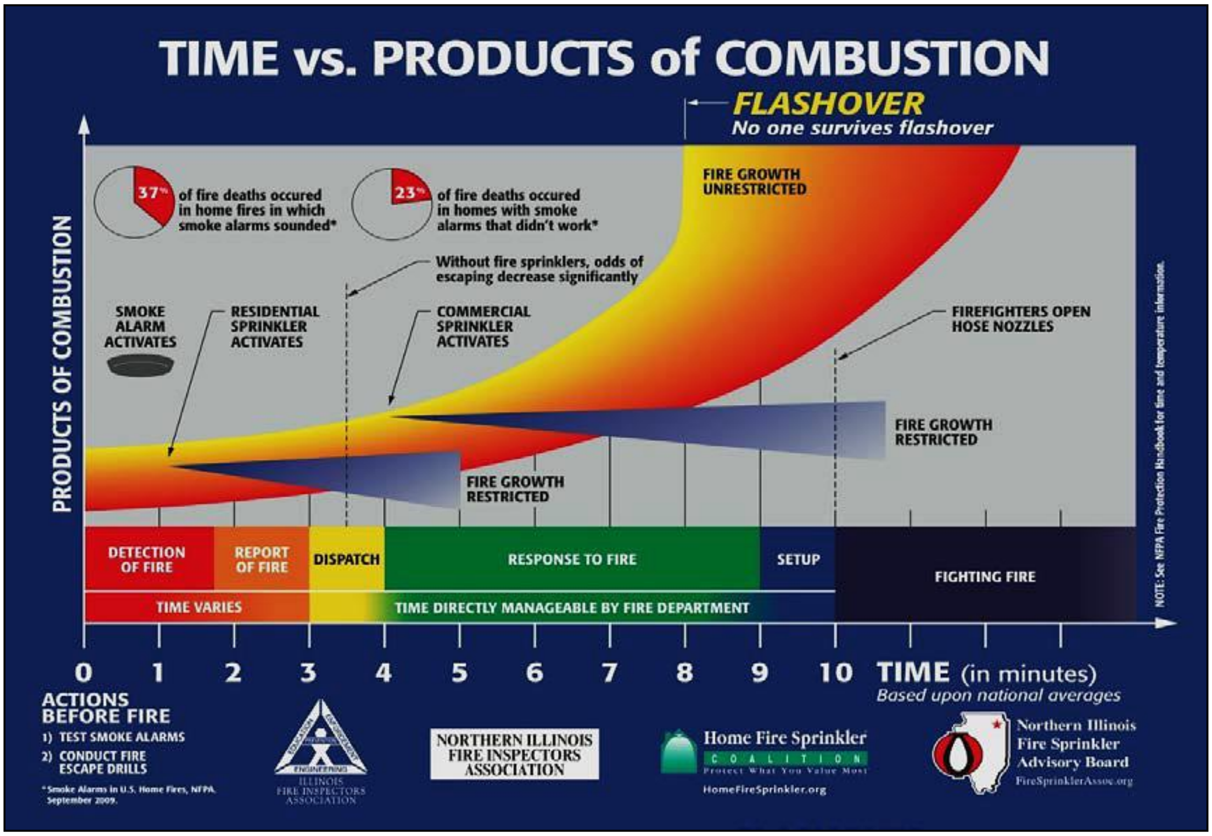
15. Clinton Smoke, *Company Officer*, 2nd ed. (Clifton Park, NY: Delmar, 2005).
16. *Safe Fire Fighter Staffing: Critical Considerations*, 2nd ed. (Washington, DC: International Association of Fire Fighters), 5.

FIGURE 5-3: Fire Growth from Inception to Flashover[17]

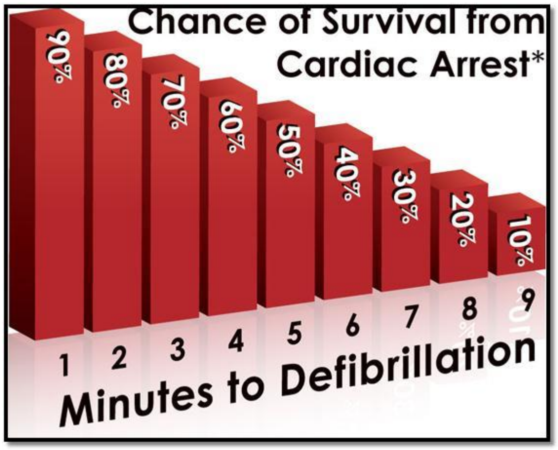


EMS response times are measured differently than fire service response times. Where the fire service uses NFPA 1710 and 1720 as response time benchmarking documents, EMS' focus is and should be directed to the evidence-based research relationship between clinical outcomes and response times. Much of the current research suggests response times have little impact on clinical outcomes outside of a small segment of call types. These include cerebrovascular accidents (stroke), injury or illness compromising the respiratory system, injury or illness compromising the cardiovascular system to include S-T segment elevation emergencies, and certain obstetrical emergencies. Each require rapid response times, rapid on-scene treatment and packaging for transport, and rapid transport to the hospital.

Paragraph 4.1.2.1(7) of NFPA 1710 recommends that for EMS incidents a fire unit with first responder or higher-level trained personnel and equipped with an AED should arrive on scene within four minutes of travel time (time after call is processed, dispatched, and the unit turns out). An advanced life support (ALS) unit should arrive on scene within eight minutes travel time, provided the fire department responded first with a first responder or higher-level trained personnel and equipped with an AED. According the NFPA 1710, "This requirement is based on experience, expert consensus, and science. Many studies note the role of time and the delivery of early defibrillation in patient survival due to heart attacks and cardiac arrest, which are the most time-critical, resource-intensive medical emergency events to which fire departments respond." The next figure illustrates the chance of survival for a victim in cardiac arrest who does not have access to critical emergency defibrillation.

17. Source: Northern Illinois Fire Sprinkler Advisory Board.

FIGURE 5-4: Cardiac Arrest Survival Probability by Minute



Typically, a low percentage of 9-1-1 patients have time-sensitive and advanced life support (ALS) needs. But, for those patients that do, time can be a critical issue of morbidity and mortality. For the remainder of those calling 9-1-1 for a medical emergency, though they may not have a medical necessity, they still expect rapid customer service. Response times for patients and their families are often the most important measurement of the EMS department. Regardless of the service delivery model, appropriate response times are more than a clinical issue; they are also a customer service issue and should not be ignored.

In addition, a true emergency is when an illness or injury places a person's health or life in serious jeopardy and treatment cannot be delayed. Examples include severe trauma with cardiovascular system compromise, difficulty breathing, chest pain with S-T segment elevation (STEMI), a head injury, or ingestion of a toxic substance.[18]

If a person is experiencing severe pain, that is also an indicator of an emergency. Again, the frequencies of these types of calls are infrequent as compared to the routine, low-priority EMS incident responses. In some cases, these emergencies often make up no more than 5 percent of all EMS calls.[19]

Cardiac arrest is one emergency for which EMS response times were initially built around. The science tells us that the brain begins to die without oxygenated blood flow at the four- to six-minute mark. Without immediate cardiopulmonary resuscitation (CPR) and rapid defibrillation, the chances of survival diminish rapidly at the cessation of breathing and heart pumping activity. For every minute without CPR and/or defibrillation, chances of survival decrease 7 to 10 percent. Further, only 10 percent of victims who suffer cardiac arrest outside of the hospital survive.[20].

The following figure illustrates the out of hospital chain of survival, which is a series of actions that, when put in motion, reduce the mortality of sudden cardiac arrest. Adequate EMS response times coupled with community and public access defibrillator programs potentially can impact the survival rate of sudden cardiac arrest victims by deploying early CPR, early defibrillation, and early advanced life support care provided in the prehospital setting.

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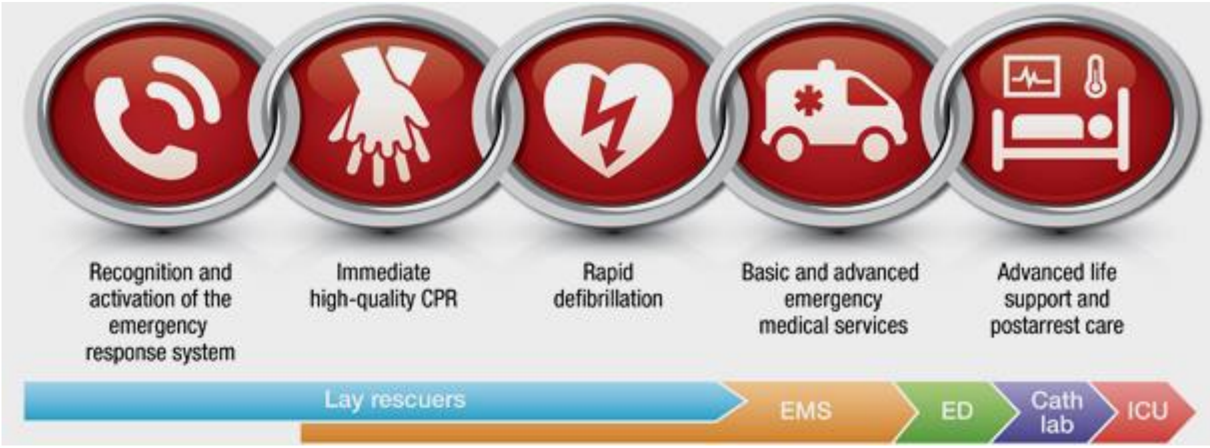
18. Mills-Peninsula Health Blog, Bruce Wapen, MD.
19. www.firehouse.com/apparatus/article/10545016/operations-back-to-basics-true-emergency-and-due-regard
20. American Heart Association. *A Race Against the Clock, Out of Hospital Cardiac Arrest*. 2014

FIGURE 5-5: Sudden Cardiac Arrest Chain of Survival



From: "Out of Hospital Chain of Survival," http://cpr.heart.org/AHAECC/CPRAndECC/AboutCPRFirstAid/CPRFactsAndStats/UCM_475731_Out-of-hospital-Chain-of-Survival.jsp

TFESD Response Times

There is no "right" amount of fire protection and EMS delivery. It is a constantly changing level based on such things as the expressed needs of the community, community risk, and population growth. So, in looking at response times it is prudent to design a deployment strategy around the actual circumstances that exist in the community and the fire problem that is identified to exist. The strategic and tactical challenges presented by the widely varied hazards that the department protects against need to be identified and planned for through a community risk analysis planning and management process as identified in this report. It is ultimately the responsibility of elected officials to determine the level of risk that is acceptable to their respective community. Once the acceptable level of risk has been determined, then operational service objectives can be established. Whether looking at acceptable risk, or level of service objectives, it would be imprudent, and probably very costly, to build a deployment strategy that is based solely upon response times.

For this study, and unless otherwise indicated, response times and travel times measure the first arriving unit only. The primary focus of this section is the dispatch and response time of the first arriving units for calls responded to with lights and sirens (Code 3).

According to NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Departments*, 2016 Edition:

- Alarm processing time or dispatch time should be less than or equal to 60 seconds 90 percent of the time.
- Turnout time should be less than or equal to 60 seconds for EMS incidents, and 80 seconds (1.33 minutes) for fire and special operations 90 percent of the time. As noted above, turnout time is the segment of total response time that the fire department has the most ability to control.

- Travel time shall be less than or equal to 240 seconds for the first arriving fire suppression or EMS unit, 90 percent of the time. The standard further states the initial full first alarm assignment for structure fires should be assembled on scene in 480 seconds, 90 percent of the time.

It should be noted that NFPA 1710 response time criterion is a nationally accepted benchmark for service delivery but not necessarily a CPSM recommendation. However, **CPSM was informed that the City of Trenton desires to meet the NFPA 1710 recommended benchmarks as much as possible and that maintaining acceptable response times are an important priority for the Mayor and citizens of the city.**

Our analysis of TFESD response times included all calls to which at least one non-administrative unit responded with lights and sirens; we excluded canceled and mutual aid calls, and those calls with an extended response time (more than 30 minutes). Also, only units that had complete time stamps are included so that each segment of response time could be calculated. Based upon this criterion, a total of 5,634 calls are included in this part of the analysis. It is important to note there were 248 calls for which no units recorded a valid on-scene time, and 1,709 calls where one or more segments of the first arriving unit's response time could not be calculated due to either missing or faulty data. This equates to 25.3 percent of all calls, a significant percentage that could result in the analysis being skewed. This is an area that the TFESD should address moving forward.

The following table provides the average dispatch, turnout, travel, and total response time for the first arriving unit to each call in the city.

TABLE 5-1: Average Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.1	2.3	2.8	6.2	772
Cardiac and stroke	1.1	2.2	2.8	6.1	552
Fall and injury	1.0	2.1	2.6	5.7	167
Illness and other	1.3	2.3	3.0	6.7	402
MVA	0.7	2.1	2.4	5.2	164
Overdose and psychiatric	0.9	2.2	2.6	5.7	209
Seizure and unconsciousness	1.1	2.1	2.7	5.9	753
EMS Total	**1.1**	**2.2**	**2.8**	**6.1**	**3,019**
False alarm	1.8	2.2	2.2	6.3	944
Good intent	1.7	2.2	2.6	6.5	237
Hazard	1.7	2.3	2.6	6.6	570
Outside fire	1.6	2.2	2.4	6.3	112
Public service	1.6	2.6	3.8	7.9	377
Structure fire	1.5	2.0	2.1	5.7	375
Fire Total	**1.7**	**2.2**	**2.6**	**6.5**	**2,615**
Total	**1.4**	**2.2**	**2.7**	**6.3**	**5,634**

Analysis of the data in this table tells us:

- The average dispatch time for all calls was 1.4 minutes.

- The average turnout time for all calls was 2.2 minutes.
- The average travel time for all calls was 2.7 minutes.
- The average total response time for all calls was 6.3 minutes.
  - The average response time was 6.1 minutes for EMS calls and 6.5 minutes for fire calls.
  - The average response time was 6.3 minutes for outside fires and 5.7 minutes for structure fires.

A more conservative and stricter measure of total response time is the 90th percentile measurement. Simply explained, for 90 percent of calls, the first unit arrived within a specified time, and if measured, the second and third unit. The following table includes the 90th percentile times for dispatch, turnout, travel, and total response time to each call in Trenton, broken down by call type. The table shows a 90th percentile response time of 8.5 minutes, which means that 90 percent of the time a call had a response time of no more than 8.5 minutes.

TABLE 5-2: 90th Percentile Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.9	3.8	4.8	8.5	772
Cardiac and stroke	1.8	3.5	4.6	7.9	552
Fall and injury	2.1	3.6	4.4	7.8	167
Illness and other	2.2	3.8	5.0	8.9	402
MVA	1.4	3.4	4.3	7.1	164
Overdose and psychiatric	1.6	3.6	4.4	7.9	209
Seizure and unconsciousness	1.8	3.7	4.7	7.7	753
EMS Total	**1.9**	**3.7**	**4.7**	**8.2**	**3,019**
False alarm	2.9	3.7	3.8	8.2	944
Good intent	3.1	3.5	4.7	8.7	237
Hazard	3.0	3.8	4.6	9.1	570
Outside fire	2.7	3.5	4.0	8.0	112
Public service	2.8	4.2	7.3	11.7	377
Structure fire	2.7	3.4	3.4	7.2	375
Fire Total	**2.9**	**3.8**	**4.5**	**8.8**	**2,615**
Total	**2.5**	**3.7**	**4.6**	**8.5**	**5,634**

Observations that can be derived from data in the table tell us:

- 90th percentile dispatch time was 2.5 minutes. **Both fire and EMS dispatching times are well above the recommended NFPA benchmark. At just under three minutes for fire, this is totally inadequate and needs to be addressed.**
- **90th percentile turnout time was 3.7 minutes and well above the NFPA 1710 benchmark of 1.0 minutes for EMS and 1.33 minutes for fire.** This is equally inadequate and the one aspect of total response time the fire department has the most direct control over.
- Aggregate fire and EMS 90th percentile travel time was 4.6 minutes (slightly above the NFPA 1710 benchmark).

- 90th percentile total response time for all calls was 8.5 minutes, significantly exceeding the NFPA 1710 benchmarks of 6.0 and 6.33 minutes, respectively. **The extended total response times negate the advantages that Trenton enjoys of having the entire city well within a 240-second response time of the first due unit.**

Response Times by Station Locations

The fire station is a critical link in service delivery and where these facilities are located is the single most important factor in determining overall response times. The TFESD operates from a total of seven facilities. The following are the locations of the city's fire stations and the staffed resources deployed from each.

TABLE 5-3: Trenton Fire and Emergency Services Department Station Locations

Station	Address	Staffed Operations Units	Specialty Units/Functions
Station 1	460 Calhoun St.	Engine 1 Ladder 1	Marine Unit 1 Dive Team
Station 3	720 S. Broad St.	Engine 3 Ladder 2	
Station 6	561 N. Clinton Ave.	Engine 6	
Station 7	502 Hamilton Ave.	Engine 7	Reserve Engine 7
Station 8	698 Stuyvesant Ave.	Engine 8	
Station 9	1464 W. State St.	Engine 9 TEMS BLS Unit	Reserve Engine 9 SS2 – Utility Truck
Station 10 Fire Headquarters	244 Perry St.	Engine 10 Ladder 4 Rescue 1 SS1 Air and Light Unit North Battalion Chief South Battalion Chief 3 – TEMS BLS Units (2 - 24 hour; 1 – 12 hour)	Haz. Mat. 1 Reserve Ladder 2 Reserve Ladder 4 Reserve Rescue 1 U12 – Utility Truck TEMS Shift Chief

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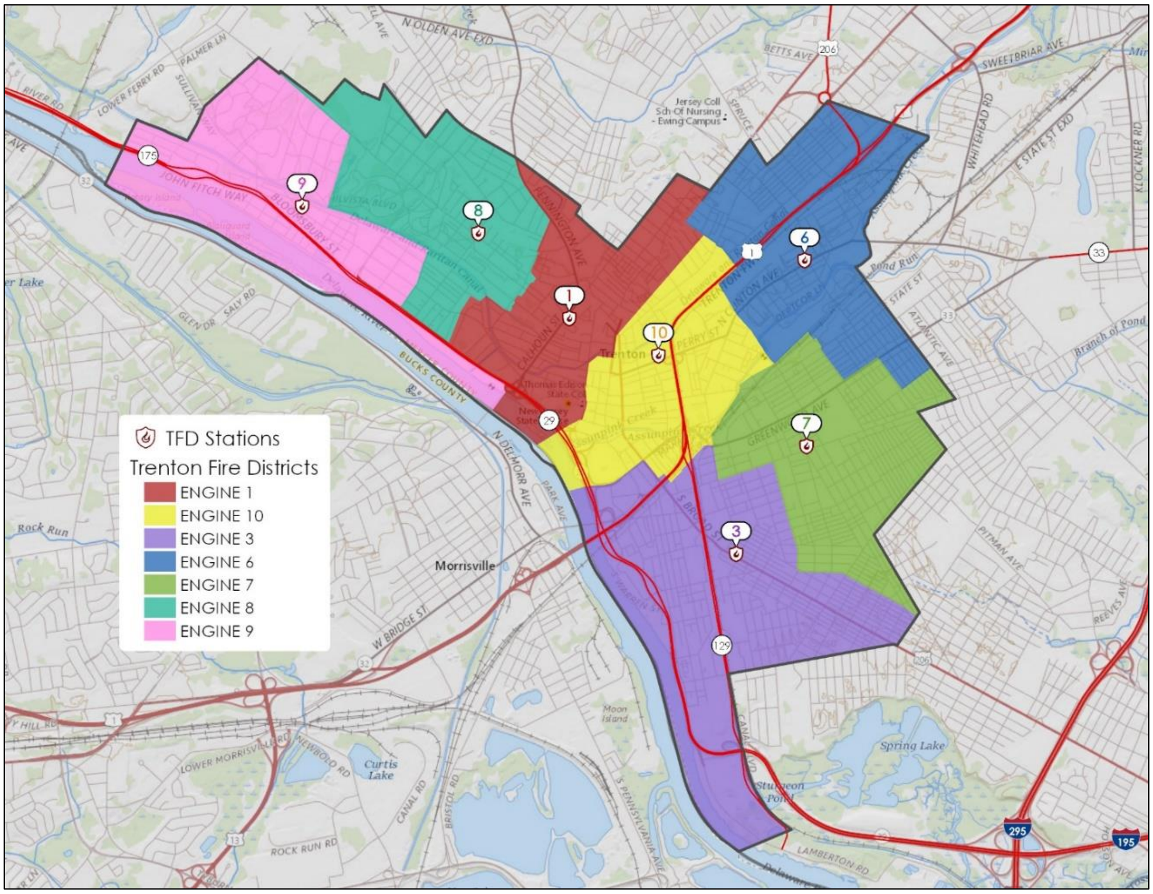
FIGURE 5-6: Trenton Fire and Emergency Services Department Station Locations and Response Districts



In a 2011 *Performance Measurement Data Report* on fire and EMS, ICMA tabulated survey information from 76 municipalities with populations ranging from 25,000 to 100,000 people. In this grouping the average fire station service area was 11 square miles.[21] The median service area for this grouping of communities was 6.67 square miles per fire station.[22] The TFESD protects a densely developed and populated community of 8.15 square miles. Based upon the city's area, this equates to a service area of 1.16 square miles for each of the seven current city stations from which fire suppression units are deployed.

NFPA and ISO have established different indices in determining fire station distribution. The ISO Fire Suppression Rating Schedule, section 560, indicates that first-due engine companies should serve areas that are within a 1.5-mile travel distance. The placement of fire stations that achieves this type of separation creates service areas that are approximately 4.5 square miles in size, depending on the road network and other geographical barriers (rivers, lakes, railroads, limited access highways, etc.). NFPA references the placement of fire stations in an indirect way. It recommends that fire stations be placed in a distribution that achieves the desired minimum response times. NFPA Standard 1710, section 4.1.2.1(3) and (6), suggests an engine placement that achieves a 240-second (four-minute) travel time for the first arriving unit. Using an empirical model called the "piece-wise linear travel time function" the Rand Institute has estimated that

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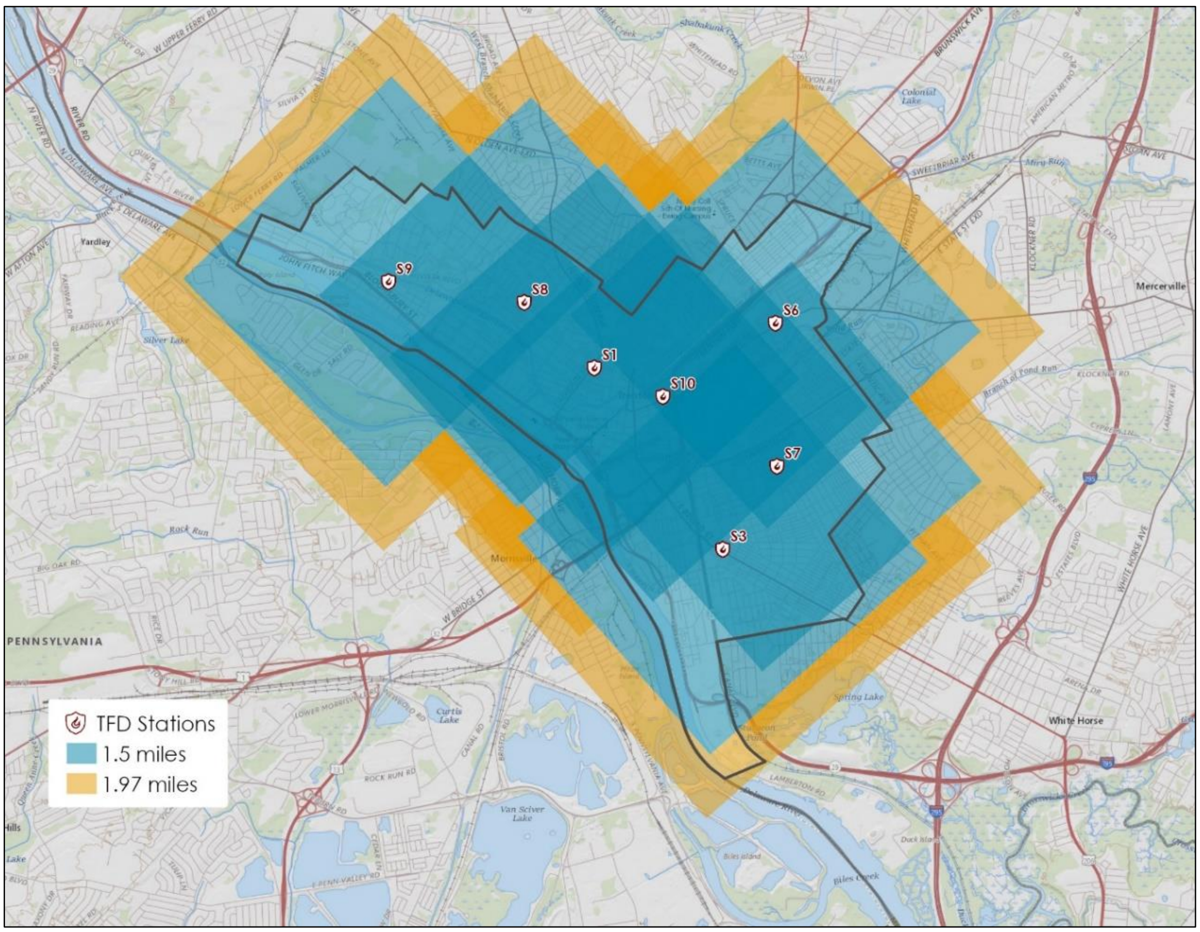
21. Comparative Performance Measurement, FY 2011 Data Report - Fire and EMS, ICMA Center for Performance Measurement, August 2012.
22. Ibid.

the average emergency response speed for fire apparatus is 35 mph. At this speed, the distance a fire engine can travel in four minutes is approximately 1.97 miles.[23] A polygon based on a 1.97-mile travel distance results in a service area that, on average, is 7.3 square miles.[24]

It is important to make several notes regarding the polygon models and the associated travel distances and times. First, the model often assumes that resources are distributed equally throughout the service area, which is generally not the case. In addition, the road network, and geographical barriers such as a railroad or limited access highways, can impact the distance units can cover over the same amount of time. That said, the formulas do provide a useful reference when attempting to benchmark travel distances and response times.

The following figure illustrates 1.5- and 1.97-square mile polygons around each TFESD station. Although there is significant overlap in the station coverage areas, this situation is not uncommon in densely developed urban areas where fire can spread rapidly, and being able to rapidly assemble an effective response force to handle all of the crucial tasks necessary for fire suppression is mission critical.

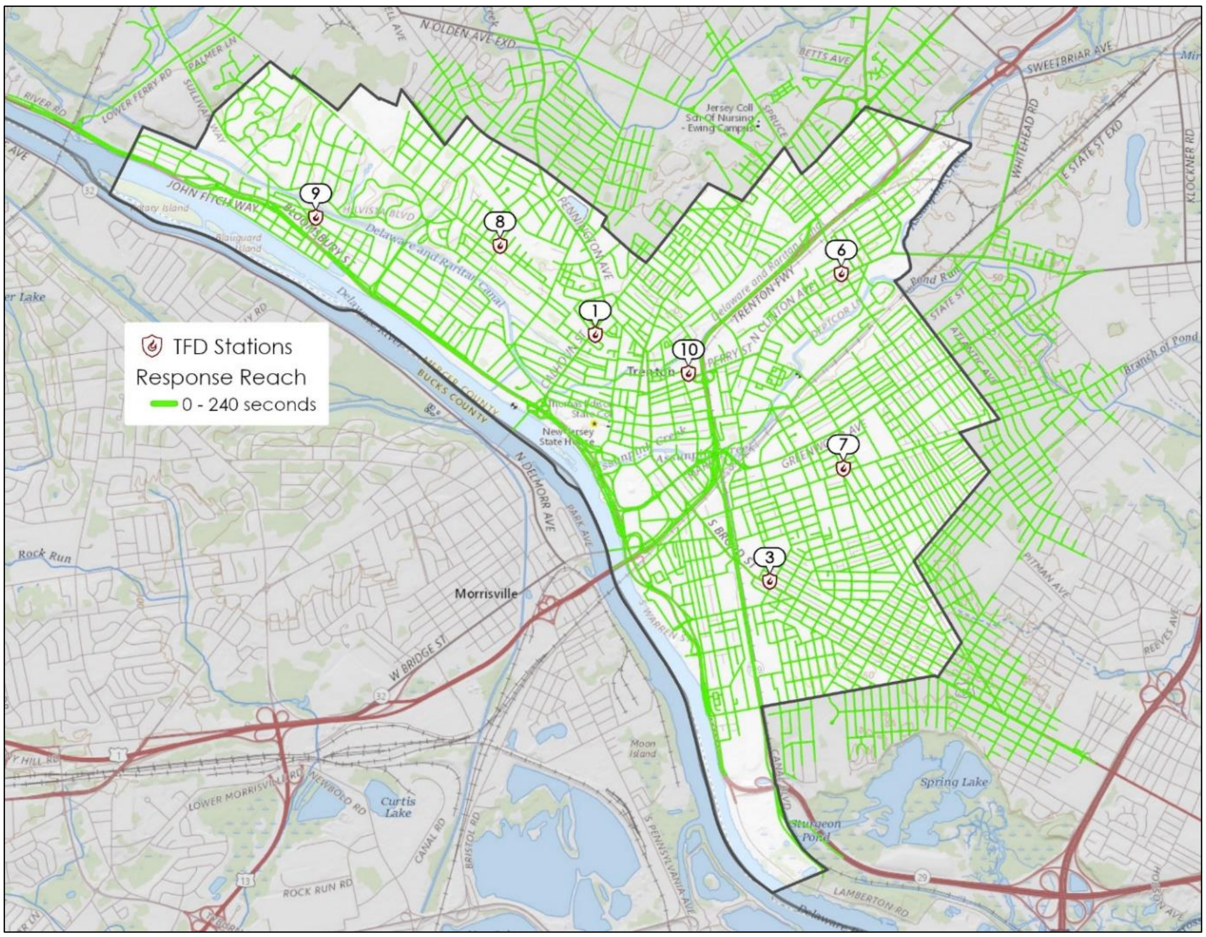
FIGURE 5-7: TFESD Station Locations, Showing 1.5- and 1.97-Square Mile Response Area Polygons



23. University of Tennessee Municipal Technical Advisory Service, *Clinton Fire Location Station Study*, Knoxville, TN, November 2012. p. 8.
24. Ibid., p.9

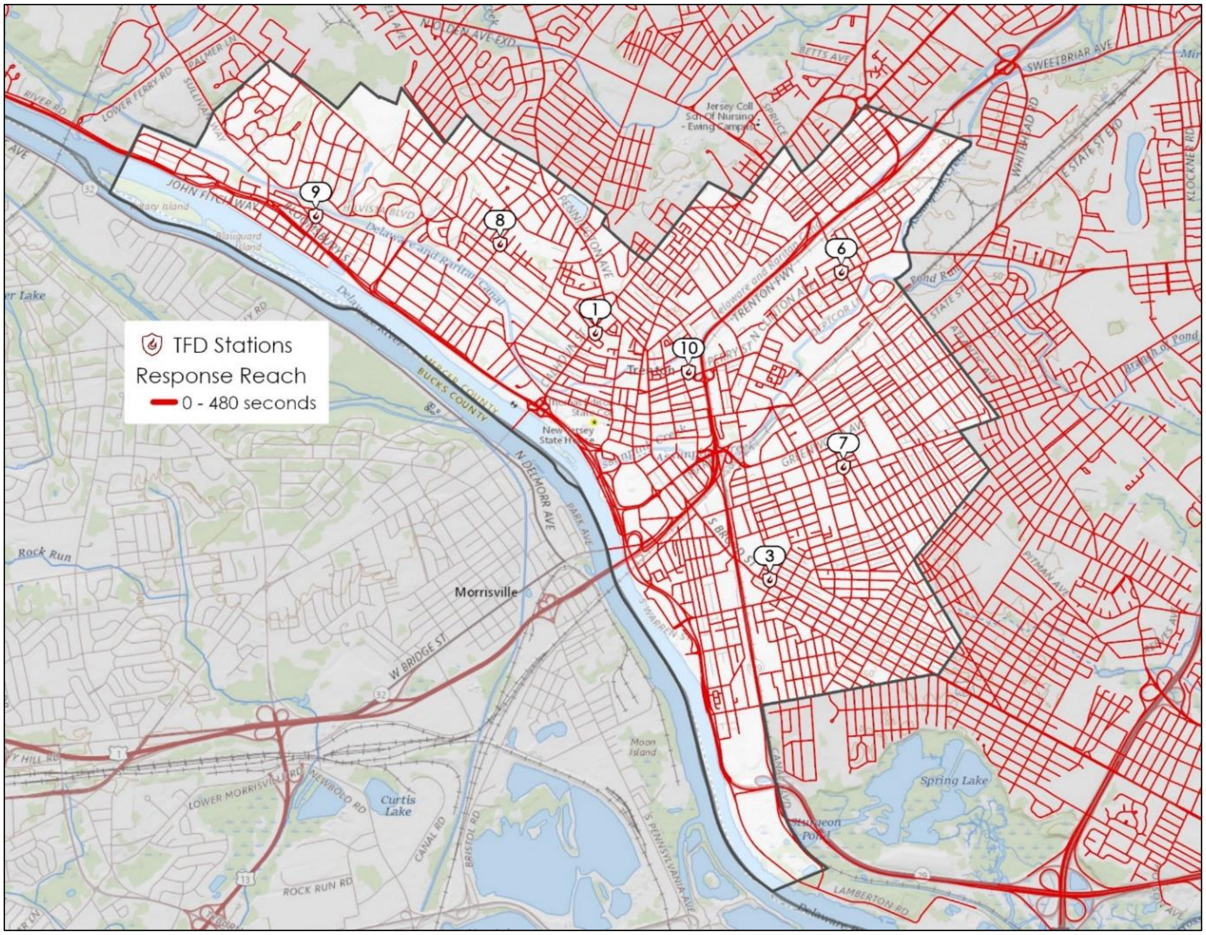
Illustrating response time is important when considering the location from which assets should be deployed. When historic demand is coupled with risk analysis, a more informed decision can be made. The following figure uses GIS mapping to illustrate 240-second travel time bleed estimates, utilizing the existing street network from each current TFESD station. As currently deployed, the entire City of Trenton falls within the first unit travel time benchmark of 240 seconds. This is a situation that CPSM only very rarely encounters. <u>The City of Trenton should be commended for maintaining a deployment of stations that achieves a first unit response time citywide of 240 seconds, which CPSM considers to be a **Best Practice**</u>. If the city's goal is to continue to have the department meet recommended response time benchmarks for the first unit on location time, this deployment configuration will continue to achieve that target. The 240-second bleeds also extend into parts of Hamilton, Ewing, and Lawrence Townships.

FIGURE 5-8: TFESD 240-Seconds Travel Time Bleeds



The benchmark NFPA 1710 standard recommends that for structure fire responses the entire first alarm assignment of resources and personnel for most types of occupancies (excluding high-rise incidents) be on the scene within 480 seconds of travel time. The following figure illustrates the 480-seconds travel time bleed estimates utilizing the existing street network from each current TFESD station. The entire city—as well as large areas of Hamilton, Ewing, and Lawrence Townships—is well within a travel time of 480 seconds.

FIGURE 5-9: TFESD 480-Seconds Travel Time Bleeds



The ISO Fire Suppression Rating Schedule also indicates that first-due ladder companies should serve areas that are within a 2.5-mile travel distance. The placement of fire stations that achieves this type of separation creates service areas that are approximately 6.25 square miles in size, depending on the road network and other geographical barriers.

The following figure illustrates 2.5 mile-square polygons around TFESD stations 1, 3, and 10, from which ladder trucks are deployed. These polygons are overlaid with "bleeds" that designate a 240 seconds first due, and 480-seconds travel time from each of these stations.

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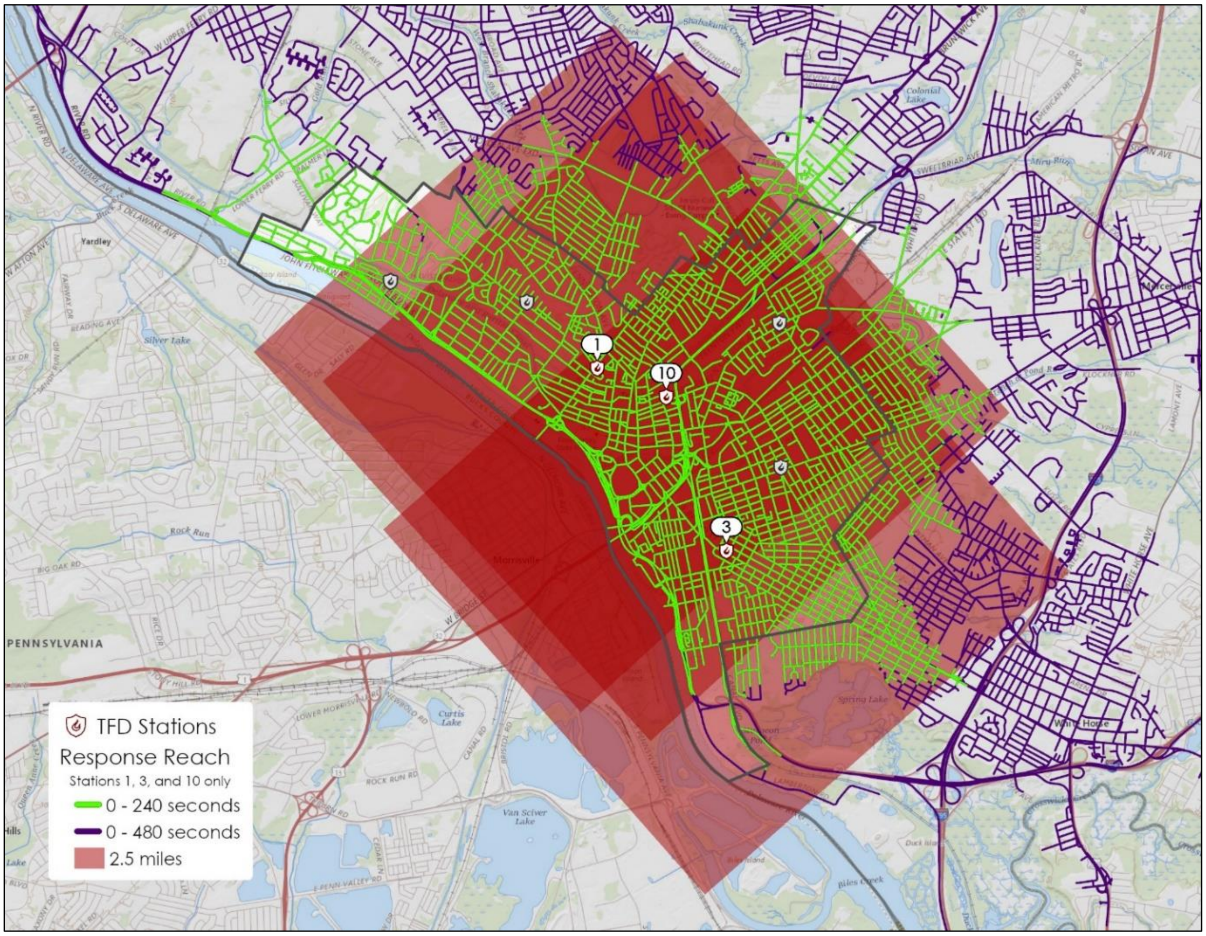
FIGURE 5-10: TFESD Ladder Company Station Locations Showing 2.5-Mile Square Response Area Polygons



Note: In the figure, the polygons are overlaid on the 240-seconds and 480-econds travel time bleeds.

The following table provides the 90th percentile dispatch, turnout, travel, and total response time for the first arriving unit to each call in the city. This information is separated into fire or EMS calls, and also shows whether the first responding unit was from the first due station or another station.

This table tells us that two stations are just below the NFPA 1710 240-seconds travel time standard, with the other five stations just above this standard. The table also displays the turnout time issues at each station, which needs to be a focus for improvement department-wide, as discussed earlier.

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TABLE 5-4: 90th Percentile Response Times by First Due Area and Station of First Responding Unit, by Call Type

First Due Area	Station of First Responding Unit	Call Type	Time in Minutes				Count
			Dispatch	Turnout	Travel	Total	
1	1	EMS	2.1	3.4	4.7	8.2	315
		Fire	2.8	3.6	3.6	7.9	238
		Total	**2.6**	**3.6**	**4.3**	**7.9**	**553**
	Other Stations	EMS	2.5	3.6	6.2	9.1	79
		Fire	3.5	3.8	4.9	10.1	95
		Total	**3.1**	**3.6**	**5.3**	**9.7**	**174**
	Total		**2.7**	**3.6**	**4.7**	**8.3**	**727**
3	3	EMS	1.8	3.8	4.7	8.0	607
		Fire	2.7	4.0	4.6	9.1	340
		Total	**2.2**	**3.9**	**4.7**	**8.3**	**947**
	Other Stations	EMS	2.4	3.5	5.6	10.0	103
		Fire	3.1	3.7	5.0	9.0	162
		Total	**2.9**	**3.7**	**5.3**	**9.1**	**265**
	Total		**2.5**	**3.9**	**4.8**	**8.7**	**1,212**
6	6	EMS	1.7	3.5	4.0	6.9	222
		Fire	2.8	3.4	3.8	7.7	242
		Total	**2.4**	**3.5**	**3.9**	**7.5**	**464**
	Other Stations	EMS	3.1	3.6	6.3	10.1	34
		Fire	3.2	4.1	6.2	11.1	107
		Total	**3.1**	**4.0**	**6.2**	**10.9**	**141**
	Total		**2.6**	**3.5**	**4.4**	**8.3**	**605**
7	7	EMS	1.8	3.8	4.7	8.0	435
		Fire	2.7	3.9	3.8	8.0	301
		Total	**2.2**	**3.8**	**4.3**	**8.0**	**736**
	Other Stations	EMS	2.1	4.0	5.2	9.4	85
		Fire	3.0	3.8	5.7	10.5	140
		Total	**2.7**	**4.0**	**5.5**	**10.0**	**225**
	Total		**2.3**	**3.8**	**4.8**	**8.5**	**961**
8	8	EMS	1.9	3.8	4.7	8.1	461
		Fire	2.9	3.8	3.8	8.3	275
		Total	**2.3**	**3.8**	**4.4**	**8.3**	**736**
	Other Stations	EMS	1.9	4.2	5.6	10.0	62
		Fire	3.0	4.3	5.6	10.0	115
		Total	**2.6**	**4.3**	**5.6**	**10.0**	**177**
	Total		**2.3**	**3.8**	**4.7**	**8.7**	**913**

(Table continued on next page)

First Due Area	Station of First Responding Unit	Call Type	Time in Minutes				Count
			Dispatch	Turnout	Travel	Total	
9	9	EMS	1.8	3.8	4.4	8.1	112
		Fire	2.7	3.7	4.8	9.3	138
		Total	**2.3**	**3.7**	**4.6**	**8.6**	**250**
	Other Stations	EMS	2.7	3.9	7.4	12.6	10
		Fire	5.0	4.3	7.4	13.1	39
		Total	**3.3**	**4.0**	**7.4**	**13.0**	**49**
	Total		**2.5**	**3.8**	**5.6**	**10.0**	**299**
10	10	EMS	1.8	3.5	4.2	7.3	458
		Fire	2.8	3.5	3.5	7.3	357
		Total	**2.4**	**3.5**	**3.9**	**7.3**	**815**
	Other Stations	EMS	3.0	3.4	5.1	9.3	36
		Fire	3.7	3.4	4.4	9.7	62
		Total	**3.2**	**3.4**	**4.8**	**9.7**	**98**
	Total		**2.5**	**3.5**	**4.1**	**7.6**	**913**
Total			**2.5**	**3.7**	**4.6**	**8.5**	**5,630**

STAFFING LEVELS AND STAFFING PATTERNS

The fire service has experienced tremendous technological advances in equipment, procedures, and training over the past 50 years. Better personal protective equipment (PPE), the widespread use of self-contained breathing apparatus (SCBA), large diameter hose, better and lighter hand lines and nozzles, and thermal imaging cameras are just a few of the numerous advances in equipment and procedures that have allowed firefighters to perform their duties more effectively, efficiently, safely, and with fewer personnel. However, the fact remains that the emergency scene in general, and the fireground involving a structure fire in particular, is a dynamic, dangerous, frequently unpredictable, and rapidly changing environment where conditions can deteriorate very quickly and can place firefighters in extreme personal danger, particularly if there are not enough on scene to handle all the critical tasks.

<u>The operations necessary to successfully extinguish a structure fire, and do so effectively, efficiently, and safely, requires a carefully coordinated and controlled plan of action where certain operations such as venting ahead of the advancing interior hose line(s) must be carried out with a high degree of precision and timing. Multiple operations, frequently where seconds count, such as search and rescue operations and trying to cut off a rapidly advancing fire, must also be conducted simultaneously. If there are not enough personnel on the incident initially to perform all the critical tasks, some will, out of necessity, be delayed. This can result in an increased risk of serious injury, or death, to building occupants and firefighters, as well as increased property damage.</u>

Staffing and deployment of fire services is not an exact science. While there are many benchmarks that communities and management utilize in justifying certain staffing levels, there are certain considerations that are data driven and reached through national consensus that serve this purpose as well. CPSM has developed metrics it follows and recommends that communities consider when making recommendations regarding staffing and deployment of fire resources.

Staffing is one component and the type of apparatus the personnel are deployed on and from where (station locations) are the other two components that determine how fire and EMS services are delivered. Linked to these components of staffing and deployment are eleven critical factors that drive various levels and models from which fire and EMS departments staff and deploy. These factors are:

Fire Risk and Vulnerability of the Community: A fire department collects and organizes risk evaluation information about individual properties, and on the basis of the rated factors then derives a "fire risk score" for each property. The community risk and vulnerability assessment evaluates the community as a whole, and with regard to property, measures all property and the risk associated with that property and then segregates the property as either a high-, medium-, or low-hazard depending on factors such as the life and building content hazard, and the potential fire flow, staffing, and apparatus types required to mitigate an emergency in the specific property. Factors such as fire protection systems are considered in each building evaluation. *Included in this assessment should be both a structural and nonstructural (weather; older, densely developed urban environment; wildland-urban interface; transportation routes; etc.) analysis.*

Population, Demographics, and Socioeconomics of a Community: Population and population density drives calls for local government service, particularly public safety. The risk from fire is not the same for everyone, with studies telling us age, gender, race, economic factors, and what region in the country one might live in contribute to the risk of death from fire. Studies also tell us these same factors affect demand for EMS, particularly population increase and the more frequent use of hospital emergency departments as many uninsured or underinsured patients rely on EDs for their primary and emergency care, utilizing prehospital EMS transport systems as their entry point.

Call Demand: Demand is made up of the types of calls to which units are responding and the location of the calls. This drives workload and station siting considerations. Higher population centers with increased demand require greater resources.

Workload of Units: The types of calls to which units are responding and the workload of each unit in the deployment model. This tells us what resources are needed and where; this links to demand and station location, or in a dynamic deployed system where to post units.

Travel Times from Fire Stations: Looks at the ability to cover the response area in a reasonable and acceptable travel time when measured against national benchmarks. Links to demand and risk assessment.

NFPA Standards, ISO, OSHA requirements (and other national benchmarking).

EMS Demand: Community demand; demand on available units and crews; demand on non-EMS units responding to calls for service (fire/police units); availability of crews in departments that utilize cross-trained EMS staff to perform fire suppression.

Critical Tasking: The ability of a fire and EMS department to comprise an effective response force when confronted with the need to perform required tasks on a fire or EMS incident scene defines its capability to provide adequate resources to mitigate each event. Department-developed and measured against national benchmarks. Links to risk and vulnerability analysis.

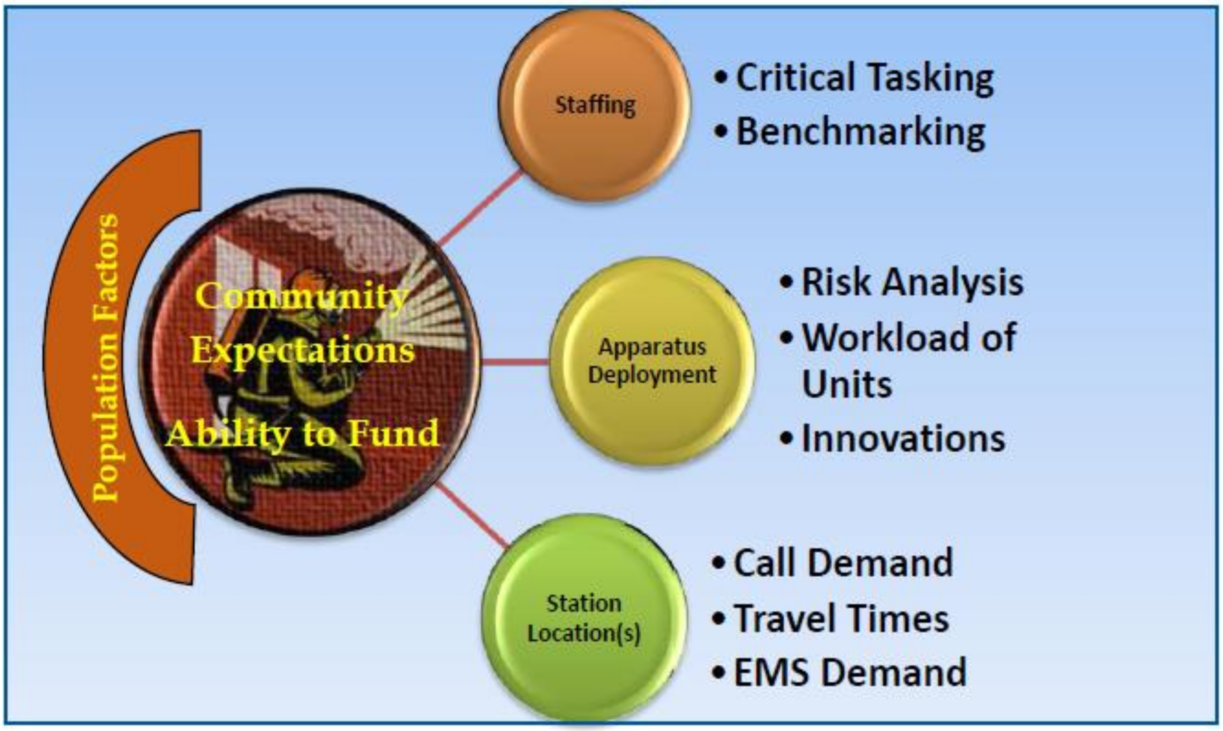
Innovations in Staffing and Deployable Apparatus: The fire department's ability and willingness to develop and deploy innovative apparatus (combining two apparatus functions into one to maximize available staffing, as an example). Deploying quick response vehicles (light vehicles equipped with medical equipment and some light fire suppression capabilities) on those calls (typically the largest percentage) that do not require heavy fire apparatus.

Community Expectations: Measuring, understanding, and meeting community expectations.

Ability to Fund: The community's ability and willingness to fund all local government services and understanding how the revenues are divided up to meet the community's expectations.

These factors are further illustrated in the following figure.

FIGURE 5-11: Staffing and Deploying Fire and EMS Departments



While each component presents its own metrics of data, consensus opinion, and/or discussion points, aggregately they form the foundation for informed decision-making geared toward the implementation of sustainable, data- and theory-supported, effective fire and EMS staffing and deployment models that fit the community's profile, risk, and expectations. The City of Trenton had not completed a comprehensive analysis of these elements prior to this study. However, part of CPSM's analysis involved the completion of a community fire risk and target hazard analysis.

In June 2002, the TFESD underwent a major reorganization that included the permanent closing of two engine companies and one ladder company. A new West Ward Station for Engine 9 was opened in the spring of 2003, improving coverage to that area of the city. After this reorganization, the seven remaining engine companies, three ladder companies, and the rescue company were always supposed to be staffed with four personnel, consisting of an officer and three firefighters.

The TFESD currently has an authorized staff of 224 sworn/uniformed emergency response personnel. All these personnel are involved at least to some degree in both fire and EMS operations, although some perform a variety of administrative and support functions as their primary responsibility. The department also employs six non-uniformed support personnel, which includes civilian office staff and mechanics in the fire apparatus shop.

The department delivers field operations and emergency response services through a clearly defined division of labor that includes middle managers (battalion chiefs), first-line operational supervisors (captains), technical specific staff (fire apparatus drivers/operators), and firefighters. The city is divided into two operational battalions, north and south, each commanded daily by a battalion chief. Field personnel work a four-platoon, 42-hour work week that is comprised of 24-hour long duty days.

The TFESD operates out of seven stations, staffing seven engines, three ladders, one heavy rescue, one support/special services (air and light) unit, and two command vehicles. The department also has several specialty units such as a dive unit, marine unit, and hazardous materials response unit along with several other staff and utility vehicles. In addition, the department maintains two reserve engines, two reserve ladders, and one reserve rescue.

When fully staffed, and with the current resource deployment, each of the department's four shifts should optimally have a minimum of 50 personnel on duty each day. This would consist of two battalion chiefs, 12 captains (which includes a training captain), and 36 firefighters. This would allow each fire suppression company to be adequately staffed with four personnel. However, at the time of this study, minimum on-duty staffing was 42 personnel, with the engines staffed with three personnel. This staffing level can result in reduced operational effectiveness and efficiency, particularly during the critical early minutes of a fire incident. It can also have an impact on firefighter safety. When the number of personnel on duty falls below 42, overtime is utilized to bring it back to that level.

TEMS, which provides EMS transport service for the city, also staffs and deploys BLS-capable ambulances from two TFESD stations. Each TEMS unit is staffed with two personnel. Two units at Station 10 and one at Station 9 are staffed and in service 24/7. TEMS also staffs and deploys a 12-hour unit from Station 10, A TEMS shift chief also responds from Station 10.

The following table illustrates how on-duty staffing is normally deployed.

§ § §

TABLE 5-5: Normal TFESD Staffing/Deployment Model

Unit	Normal Staffing
Station 1	
Engine 1	1 Captain, 2 Firefighters
Ladder 1	1 Captain, 3 Firefighters
Station 3	
Engine 3	1 Captain, 2 Firefighters
Ladder 2	1 Captain, 3 Firefighters
Station 6	
Engine 6	1 Captain, 2 Firefighters
Station 7	
Engine 7	1 Captain, 2 Firefighters
Station 8	
Engine 8	1 Captain, 2 Firefighters
Station 9	
Engine 9	1 Captain, 2 Firefighters
TEMS EMS Unit	2 EMTs
Station 10	
Engine 10	1 Captain, 2 Firefighters
Ladder 4	1 Captain, 3 Firefighters
Rescue 1	1 Captain, 3 Firefighters
SS 1	1 Firefighter
North Battalion	1 Battalion Chief, 1 Adjutant (Firefighter)
South Battalion	1 Battalion Chief, 1 Adjutant (Firefighter)
TEMS EMS Unit	2 EMTs
TEMS EMS Unit	2 EMTs
TEMS EMS Unit	2 EMTs (12-hour unit)
TEMS Shift Chief	1 Shift Chief

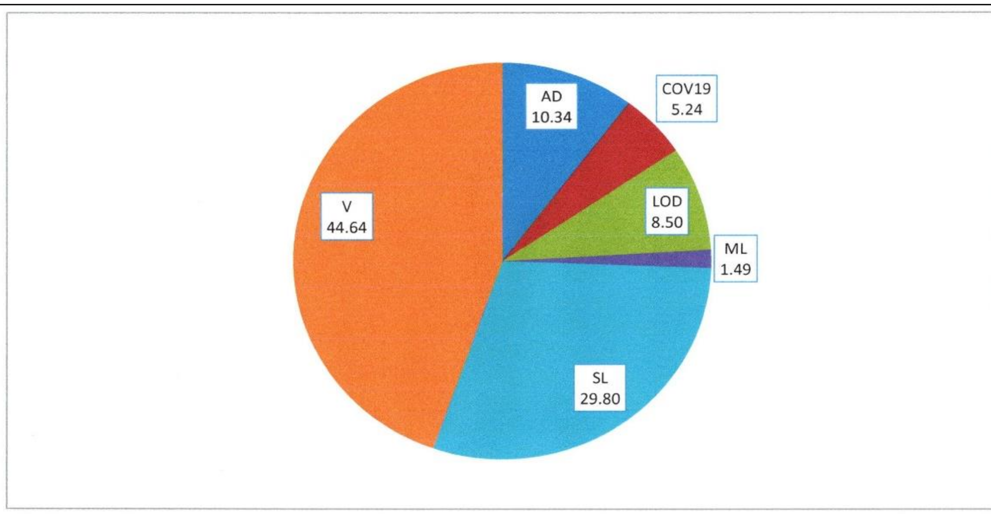
Like many urban fire departments that protect former core industrial cities that are fiscally challenged, the TFESD has not been able to maintain its authorized staffing levels for several years. In 2017, the department conducted a 20-week recruit academy for 21 new firefighters. It conducted another academy for 12 personnel in 2018. There was no academy in 2019, a year in which 25 members (11.2 percent) of the department retired.

More recently, according to information provided to CPSM by the TFESD, in June 2019, the department had 194 of authorized positions filled. By the time this study was being conducted, in June 2020, the number had decreased to 183, a loss of 11 additional personnel, making the department at least 41 personnel under its approved strength. Several additional personnel retired while this study was in progress, with several more members projected to retire prior to the end of 2020. This would place the department at approximately 50 personnel short, or about 22.3 percent below its authorized strength.

The department was scheduled to begin an academy in March 2020, but it was postponed due to the COVID-19 pandemic. This class of 11 recruits did start their training in the fall of 2020, with graduation anticipated in January 2021. However, with the department currently having somewhere between 45 and 50 vacancies, even if all 11 personnel successfully complete the academy, it will still leave the department between 35 and 40 personnel below the current authorized strength.

All members of the department are entitled to various types of leave, including vacation, personal, sick, injured on duty, and military (if applicable). Additional temporary vacancies are created by personnel who are attending various types of training or participate in other endeavors such as the members of New Jersey Urban Search and Rescue (USAR) Task Force 1. For the one-year period from July 1, 2019 through June 30, 2020, a cumulative total of 95,207 hours of vacancy were created by leave use. On average, each battalion chief used 351.15 hours, each captain 290 hours, and each firefighter 402.5 hours. The following figure provides a breakdown of the total leave hours for this time frame.

FIGURE 5-12: TFESD Leave Hour Analysis, July 1, 2019 to June 30, 2020

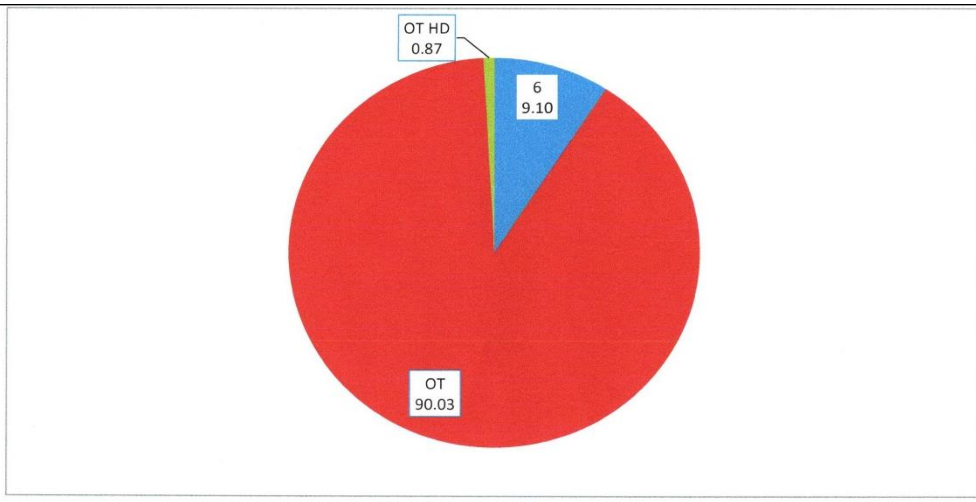


Code	Description	Percent (%)	Count	Hours
AD	2018 "A" hours (18A)	5.15	354	4,901.00
AD	2019 "A" hours (19A)	5.19	347	4,944.00
COV19	Covid-19 (Cov19)	5.24	234	4,987.00
LOD	Sick LOD Injury/sick (LOD)	8.50	361	8,089.50
ML	Military Leave (ML)	1.49	59	1,416.00
SL	Sick Leave 24 (SL24)	29.80	1307	28,368.00
V	2018 Vac - HOURS (18V)	10.34	646	9,840.75
V	2019 Vac - HOURS (19V)	26.13	1483	24,875.67
V	2020 Vac - HOURS (20V)	8.18	451	7,785.00
			5,242	**95,206.92**

One of the types of leave that often contribute to vacancies in the on-duty strength of a fire department is the use of sick leave, or in the context of concern over it, misuse or even abuse of sick leave. While personnel should have the right to use sick leave when they are legitimately unable to perform their duties due to illness or injury, or, for other accepted uses as spelled out in the collective bargaining agreement and/or department policy, they do not have the right to just consider it to be another bank of leave hours that they can use whenever it is convenient for them. Sick leave accounts for nearly 30 percent of TFESD use, which is a significant percentage. While there were differences of opinion among various stakeholders regarding whether there is a sick leave abuse problem in the TFESD, this is an issue that the department leadership should monitor closely and enact measures to investigate and take appropriate action against personnel who misuse or abuse this type of leave. Injured-on-duty leave should also be monitored for the same reasons.

While not every hour of leave taken by a department member results in the need to back fill, or hire back to fill that position, the majority of the time this is the case. During that one-year period, the department used 69,798 hours of overtime to fill leave positions, which equates to 73.3 percent of the time. On a daily basis, the number of vacancies that needed to be filled ranged from a low of eight, to a high of 42, which suggests that on that day, the entire shift needed to be filled with overtime positions. With an average of 17 vacancies needing to be filled each day, that means that on a typical day 40.4 percent of the personnel on duty with the TFESD are on overtime and working an additional shift. The following figure provides details on overtime hours.

FIGURE 5-13: TFESD Overtime Hour Analysis, July 1, 2019 to June 30, 2020



Code	Description	Percent (%)	Count	Hours
6	Covid-19 OT - Driving not perm (Cov19 OTDr)	0.33	17	229.50
6	Overtime -Driving not Perm Dr. (OTDr)	8.77	505	6,122.00
OT	Covid-19 ot (cov19 OT)	5.32	332	3,713.50
OT	Covid-19 OT Act (cov19 OTac)	0.20	14	142.00
OT	Emergency OT (Em OT)	2.27	144	1,583.50
OT	Emergency OT Act (Em OTact)	0.04	5	29.00
OT	Overtime (OT)	81.92	4704	57,178.75
OT	Overtime - Acting (OTact)	0.02	3	15.00
OT	Overtime - Training (OT TR)	0.25	22	176.50
OT HD	Overtime Hazmat/Diver not assigned (OT Tech)	0.87	51	608.00
			5,797	69,797.75

While the implications of the COVID pandemic have created some unique staffing challenges for many fire departments, Trenton included, the number of unfilled positions in the TFESD suggests that the use of large amounts of overtime would still be a regular occurrence even in more "normal" times. In addition to the financial implications to the municipality of the need for personnel to work numerous overtime shifts, there is growing evidence to suggest there are very real health and safety implications for firefighters as well, and which could end up having tragic consequences.

Chief Don Abbott is a well-known fire service leader, author, and instructor who is regarded as a leading authority regarding MAYDAY facts in the fire service in North America. Chief Abbott's analysis of data submitted to him by career fire departments noted a 35 percent increase in

MAYDAYS during a 13-week period from March through June 2020. This was during the initial surge of the COVID-19 pandemic as well as during social issues, protests, and related civil emergencies. Based upon interviews conducted with 156 personnel (primarily those firefighters who transmitted the MAYDAY) Chief Abbot identified some trends, several of which have applicability to Trenton.

1). **Lack of control over excessive overtime**, relaxing the rules because of current civil, COVID or related situations and conditions. One incident noted was where a firefighter had a MAYDAY during his 71st straight hour of being on duty**.**

2). **There have been several MAYDAYS (39 percent) where crews were working short-handed.**

3). 81 percent occurred between 9:00 p.m. and 6:00 a.m.

4). **77 percent occurred during an overtime shift, 43 percent while working a 24 hour + hour shift.**

5). Average number of runs prior to MAYDAY (24-hour period) were 16 runs/or standby on protest rallies (low 9 runs / high 26 in 24 hours).

6). **37 percent of the MAYDAY victims reported working short a crew member.**

7). 15 percent reported they did not remember the dispatch information (address, reason for the run).

8). 37 percent reported using more air than normal.

9). THE NUMBER ONE cause of a MAYDAY was becoming lost or separated from a hose line.

10). **43 percent reported difficulty sleeping during their overtime shift.**

11). Overtime ranged from working 48 hours (36%), 60 hours (23%), and 72 hours (17%) straight.

The critical message here related to staffing practices, and personnel working extended amounts of overtime to fill vacancies, is that while each community challenge is different, and Trenton is no exception, the fact is that firefighters require adequate rest (on AND off duty) to ensure they are physically and mentally prepared for duty. Thus, adequate staffing must be planned for in advance based upon the unique needs of the community.

In an effort to increase training on each shift and also reduce overtime necessary to fill officer vacancies created by captains on leave, the department assigned an additional captain to each shift that could be used to perform both of those roles. CPSM was informed that in the one-year period we examined for leave purposes, a training captain was transferred to fill a vacancy on 204 days, or 55.9 percent of the time, not counting days they were on leave. While well intentioned, CPSM did not see evidence that this program was achieving its training goals the way it was envisioned.

Recommendations regarding staffing and deployment will be made and developed later in this section of the report.

FIRE AND EMS OPERATIONS AND RESPONSE METRICS

Fire, rescue, and emergency medical system (EMS) incidents, and the fire department's ability to respond to, manage, and mitigate, them effectively, efficiently, and safely, are mission-critical components of the emergency services delivery system. In fact, fire, rescue, and EMS operations provide the primary, and certainly most important, basis for the very existence of the fire department.

Nationwide, fire departments are responding to more EMS calls and fewer fire calls, particularly fire calls that result in active firefighting operations by responders. This is well documented in both national statistical data, as well as CPSM fire studies. Improved building construction, code enforcement, automatic sprinkler systems, and aggressive public education programs have contributed to a decrease in serious fires in many communities and, more importantly, fire deaths among civilians. However, these trends are not as evident in older, densely developed northeastern cities, particularly those that struggle with a high percentage of their population comprised of at-risk groups socio-economically.

These trends and improvements in the overall fire protection system notwithstanding, fires still do occur, occur with greater frequency in older, poorer urban areas, and the largest percentage of those occur in residential occupancies where they place the civilian population at risk. Although they occur with less frequency than they did several decades ago, when they occur today, they grow much quicker and burn more intensely than they did in the past. As will be discussed next, it is imperative that the fire department is able to assemble an ***effective response force* (ERF)** within a reasonable time period in order to successfully mitigate these incidents with the least amount of loss possible.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments*, 2020 edition (National Fire Protection Association, Quincy, Mass.) outlines organization and deployment of operations by career, and primarily career fire and rescue organizations.[25] It is the benchmark standard that the United States Department of Homeland Security utilizes when evaluating applications for staffing grants under the Staffing for Adequate Fire and Emergency Response (SAFER) grant program. The ability to get a sufficient number of personnel, along with appropriate apparatus, to the scene of a structure fire is critical to operational success and firefighter safety. Accomplishing this within the eight-minute time frame specified in NFPA 1710 is an important operational benchmark.

Critical Tasking

To effectively respond to and mitigate requests for emergency services, an agency must have a thorough understanding of its community's risk factors, both fire and EMS. Once identified and understood, each category or level of risk is associated with the necessary resources and actions required to mitigate it. This is accomplished through a critical task analysis. The exercise of matching operational asset deployments to risk, or critical tasking, considers multiple factors including national standards, performance measures, and the safety of responders.

Critical tasks are those activities that must be conducted in a timely manner by responders at emergency incidents to control the situation and stop loss. Critical tasking for fire operations is

25. NFPA 1710 is a nationally recognized standard, but it has not been adopted as a mandatory regulation by the federal government or the State of New Jersey. It is a valuable resource for establishing and measuring performance objectives for the City of Trenton but should not be the only determining factor when making local decisions about the city's fire and EMS services.

the minimum number of personnel needed to perform the tasks required to effectively control a fire. The same is true for EMS as there are specific patient care tasks that must be completed in succession and often together to support positive prehospital care. The specific number of people required to perform all the critical tasks associated with an identified risk is referred to as an ***Effective Response Force*** (**ERF**). The goal is to deliver an ERF within a prescribed time frame. NFPA 1710, as a nationally recognized consensus standard on staffing and deployment for career fire departments, provides a benchmark for ERF.[26]

During fire incidents, to be effective, critical tasking must assign enough personnel so that all identified functions can be performed simultaneously. However, it is important to note that secondary support functions may be handled by initial response personnel once they have completed their primary assignment. Thus, while an incident may end up requiring a greater commitment of resources or a specialized response, a properly executed critical task analysis will provide adequate resources to immediately begin bringing the incident under control.

The NFPA *Fire Protection Handbook*[27] classifies buildings and occupancies by their relative risk and provides recommendations on the minimum ERF that will be needed to handle fire incidents in them. These include:

High-hazard Occupancies: Schools, hospitals, nursing homes, high-rise buildings, and other high life safety-hazard or large fire-potential occupancies. The City of Trenton has a significant number of these occupancies, all of which would present a high risk in a fire situation.

> Operational Response: at least 4 pumpers, 2 ladder trucks (or combination apparatus with equivalent capabilities), 2 chief officers and other specialized apparatus as may be needed to cope with the combustible involved; not less than 24 firefighters and 2 chief officers **plus** a safety officer and a rapid intervention team. **Extra staffing for high hazard occupancies is advised.**

Medium-hazard Occupancies: Apartments, offices, and mercantile and industrial occupancies, not normally requiring extensive rescue by firefighting forces. The City of Trenton also has numerous of these types of occupancies.

> Operational Response: At least 3 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities such as a quint), 1 chief officer, and other specialized apparatus as may be needed or available; not less than 16 firefighters and 1 chief officer **plus** a safety officer and a rapid intervention team.

Low-hazard Occupancies: One-, two-, or three-family dwellings and scattered small business and industrial occupancies.

> Operations Response Capability: At least 2 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities such as a quint), 1 chief officer, and other specialized apparatus as may be needed or available; not less than 12 firefighters and 1 chief officer, **plus** a safety officer, and a rapid intervention team.

Regarding the implementation of an ERF and its aggregate effect on fireground operations, there has been much research done by a number of fire departments on the effects of various staffing levels. These studies have consistently confirmed that company efficiency and

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26. It is important to note that compliance with NFPA 1710 has not been mandated in the State of New Jersey or by the federal government. It is considered a "best practice" that fire departments strive to achieve.
27. Cote, Grant, Hall & Solomon, eds., *Fire Protection Handbook* (Quincy, MA: NFPA 2008), 12-3

effectiveness decrease substantially and injuries increase when company staffing falls below four personnel. A comprehensive yet scientifically conducted, verified, and validated study titled *Multiphase Study on Firefighter Safety and the Deployment of Resources* was performed by the National Institute of Standards and Technology (NIST) and Worcester Polytechnic Institute (WPI), in conjunction with the International Association of Fire Chiefs, the International Association of Fire Fighters, and the Center for Public Safety Excellence. For the first time, quantitative evidence has been produced regarding the impact of crew size on accomplishing critical tasks. Additionally, continual research from UL has provided tactical insights that shed further light on the needs related to crew size and firefighter safety. This body of research includes:

- An April 2010 report on *Residential Fireground Field Experiments* from the National Institute of Standards and Technology (NIST).
- An April 2013 report on *High-Rise Fireground Field Experiments* from the National Institute of Standards and Technology (NIST-HR).
- A December 2010 report on the *Impact of Ventilation on Fire Behavior in Legacy and Contemporary Residential Construction* (UL).

Additional collaborative efforts such as the Governor's Island and Spartanburg Burns continue to expand upon and reinforce the findings of NIST and UL.

As stated, some of these studies' findings have a direct impact on the exercise of critical tasking. For example, as UL studied the impact of ventilation on fire behavior, it was able to obtain empirical data about the effect of water application on fire spread and occupant tenability. The research clearly indicates that the external application of a fire stream, especially a straight stream, does not "push fire" or decrease tenability in any adjacent rooms. Therefore, during the deployment of resources for the critical task of fire attack, consideration must be given to the option of applying water to the fire from the exterior when able. This approach enables a fire attack that can begin prior to the establishment of an IRIT as well as decreases the time to getting water on the fire, which has the greatest impact on occupant survivability.

The NIST studies examined the impact of crew size and stagger on the timing of fireground task initiation, duration, and completion. Although each study showed crew size as having an impact on time-to-task, consideration must be given to what tasks were affected and to what extent. For example, <u>four-person crews operating at a low-hazard structure fire completed all fireground tasks (on average) 5.1 minutes or 25 percent faster than three-person crews</u>.

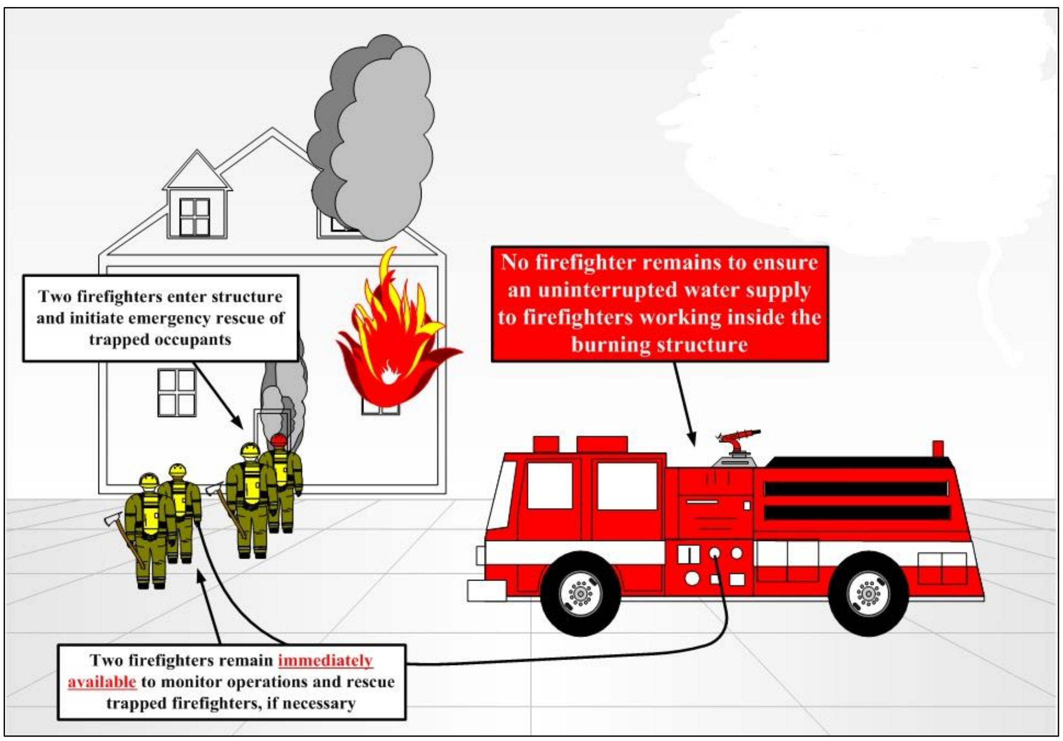
- Four-person firefighting crews were able to complete 22 essential firefighting and rescue tasks in a typical residential structure 30 percent faster than two-person crews and 25 percent faster than three-person crews.
- The four-person crews were able to deliver water to a similar sized fire 15 percent faster than the two-person crews and 6 percent faster than three-person crews, steps that help to reduce property damage and reduce danger/risks to firefighters. The latter time represents a 34-second difference.
- Four-person crews were able to complete critical search and rescue operations 30 percent faster than two-person crews and 6 percent faster than three-person crews. The latter time represents a 23-second difference. The "rescue time" difference from a four-person to a three-person crew is seven seconds.

When considering critical tasking for the deployment of an ERF for fire suppression operations, the TFESD will be able to handle most incidents with just its own resources. For larger, more significant, or complex incidents, the department will need to consider resources from surrounding automatic and mutual aid partners. It is also unlikely that the department would be capable of handling two simultaneous or significantly overlapping structure fires. It is also important to note that the impact of crew size as it relates to high-risk categories is greater than its low-risk implications and should be considered when staffing units that cover a greater amount of risk. As TFESD's engine companies are staffed with just three personnel, this will ultimately present some significant operational challenges and concerns (as it does in many other communities that utilize similar staffing models).

There is no New Jersey or federal requirement that specifies staffing levels on fire apparatus. The closest thing that approaches a requirement for staffing levels is the OSHA 29 CFR 1910.134 standard, often referred to as the ***"Two-in/Two-out"*** guideline. This standard, which is a safety mandate that has application to municipal firefighting, requires the use of four personnel (two inside the structure and two outside the structure) when conducting interior firefighting activities in a hazardous work environment (that is, an environment that is immediately dangerous to life or health, or IDLH). **It is important to note that the potential for an IDLH atmosphere to exist is not just limited to structure fires. They can exist on natural gas leaks, carbon monoxide incidents, confined space emergencies, chemical spills, and even automatic fire alarm activations where there is an actual fire in progress.**

The following figure illustrates one example of how this standard is intended to be implemented.

FIGURE 5-14: OSHA "Two-in/Two-out" Rule Illustrated



The OSHA requirement has two key provisions that allow considerable flexibility regarding staffing:

- One provision specifies that the four personnel who engage in interior firefighting are required at the incident (assembled) and are not a staffing requirement for the individual responding unit.

- The second provision is that an exception is provided when crews are performing rescue operations where there is the **potential** for serious injury or death of the occupants. In this case the standard allows the entry of two personnel to conduct the rescue activity without two firefighters outside immediately available to monitor operations and rescue trapped firefighters, if necessary.

It was consistently reported to CPSM that the TFESD does try to follow the provisions of the OSHA Two-In/Two-Out regulation regarding waiting to initiate an interior fire attack until four personnel are assembled when there are no rescues to be made. The fact that other units usually arrive quickly to assist is also an important consideration. The department should be commended for this adherence.

In addition, the 2018 edition of NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness*, section 8.8.2, states: "*In the initial stages of an incident where only one crew is operating in the hazardous area at a working structure fire, a minimum of four individuals shall be required, consisting of two individuals working as a crew in the hazardous area and two individuals present outside this hazardous area available for assistance or rescue at emergency operations where entry into the danger area required.*" This standard also stipulates the utilization of a stand-by crew member assigned another task (i.e., apparatus operator) is allowable so long as abandoning his/her task does not jeopardize the operating crews.

As with the OSHA standard, NFPA 1500 does support entry into a hazardous area with less than four personnel assembled if initial attack personnel find an imminent life-threatening situation where the immediate action could prevent loss of life or serious injury.

The Center for Public Safety Excellence (CPSE) has also established benchmarks regarding staffing and deployment. CPSE sets standards for agencies seeking and achieving accreditation through the Commission on Fire Accreditation International (CFAI). CFAI uses standards set forth in the *Community Risk Assessment Manual: Standards of Cover*, 6th edition, to provide guidance in staffing and deployment to agencies desiring accreditation through Core Competencies.

Core Competency 2C.4 requires that "*the agency conduct a critical task analysis of each risk category and risk class to determine the first due and effective response force capabilities, and to have a process in place to validate and document the results.*" The process considers the number of personnel needed to perform the necessary emergency scene operations. Completion of the process also helps to identify any gaps in the agency's emergency scene practices.

From a practical standpoint, staffing engines with three personnel rather than four forces the captain to be actively involved in hands-on tasks such as stretching a line, rather than performing size-up and other important initial fireground actions. Captains are working supervisors. They form an integral part of their company and it is often necessary for them to assume hands-on involvement in operations, particularly with companies that are minimally staffed, while simultaneously providing oversight and direction to their personnel. During structure fires and other dangerous technical operations, it is imperative that these officers accompany, and operate with, their crew to monitor conditions, provide situation reports, and assess progress toward incident mitigation. During structure fires they operate inside of the fire building. Captains need to be able to focus on the completion of specific tasks that have been assigned to their respective companies, such as interior fire attack, rescue, ventilation, and/or water supply.

When companies are staffed with three rather than four personnel, the captain often needs to either function as the nozzle person while the other firefighter backs him/her up and helps with advancing the line, or, if the roles are reversed and the captain is assisting with line advancement they cannot monitor the conditions at the nozzle—and closest to the fire—as they should. Ideally, one firefighter should be the nozzle operator, the captain should be right alongside of, or behind the nozzle, providing direction and evaluating conditions, and the third firefighter can be further back assisting with advancing the line. This is particularly important for fires on the second and third floors of buildings where the lines must frequently be advanced up narrow and winding stairways. When short staffed in fire conditions such as this, two companies often must be deployed to get a single line in service, which can then impact the completion of additional critical tasks.

CPSM advocates structural fire tactics and strategies that are both safe and effective, but sometimes staffing levels can make that dual goal difficult to achieve. Initiating offensive operations with fewer than four firefighters will place firefighters at a high level of risk; delaying operations until additional staffing arrives places occupants in greater danger and can increase property damage.

Ultimately, overall, on-duty fire department staffing is a local government decision. It is also important to note that the OSHA standard (and NFPA 1500/1710/1720) specifically references "interior firefighting." Firefighting activities that are performed from the exterior of the building are not regulated by this portion of the OSHA standard. However, **in the end, the ability to assemble adequate personnel, along with appropriate apparatus to the scene of a structure fire, is critical to operational success and firefighter safety**. How and where personnel and resources are located, and how quickly they can arrive on scene play major roles also.

All of these factors must be taken into consideration as Trenton reaches consensus on the acceptable community fire safety risk level, affordable levels of expenditure for fire protection, and appropriate levels of staffing. The city will need to consider the cost-benefit of various deployment strategies, such as continuing the current staffing and deployment model, or adopting a different one based upon recommendations contained within this report.

For TFESD, emergency responses are based on caller information provided to dispatchers at the Trenton Police Department Dispatch Center; responses depend on the nature and type of call for service. The dispatch center provides dispatch services to the Trenton Police and Fire Departments and is the public safety answering point (PSAP) for the city. Calls for TEMS are forwarded to the Mercer County Emergency Communications Center. TFESD details out its response procedures through a response plan in the dispatch center. This response plan covers both high- and low-frequency incidents that range from low to high risk. Structure fire responses represent the type of high-risk/low-frequency incidents that present the greatest challenges to an organization.

For any given emergency to which TFESD responds, there are critical tasks that must be completed. These tasks can range from the immediate rescue of trapped occupants within a burning structure to vehicle or water rescue when needed. A set of critical tasks have been developed in an effort to identify what resources are needed for each incident type. TFESD has developed response matrixes detailing the initial levels of response for varying incident types. The following critical task analysis was performed independent of these policies; however, a comparison is provided.

The intent of the risk management process is for the department to develop a standard level of safety while strategically aligning its resources with requests for service. Thus, the critical tasking presented herein will consider the EFR in relation to either a low-, moderate-, or high-risk classification.

Critical tasking has been identified for the following incident types:

- Structure Fire–Low Risk.
- Structure Fire–Moderate Risk.
- Structure Fire–High Risk.
- Structure Fire–High-Rise.
- Vehicle Fire.
- Outside Fire Grass/Brush/Rubbish Fire.
- Fire Alarm–Low Risk.
- Fire Alarm–Moderate Risk.
- Fire Alarm–High Risk.
- Motor Vehicle Crash–No Entrapment.
- Motor Vehicle Crash–With Entrapment.
- Natural Gas Leak–Interior and Exterior.
- Hazardous Materials Incident.
- Water Rescue Incident.
- Technical Rescue Incident.

Tables 5-6 to 5-8 and 5-10 through 5-21 outline the critical tasking to assemble an effective response force for the various responses to which the TFESD is likely to be dispatched.

TFESD utilizes a standard alarm assignment for most reported structure fire responses. An initial response to this type of incident includes the following:

- 3 engines.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.

This response places 19 personnel on the scene assuming that the TFESD engines are staffed each with three personnel.

Fire in high-hazard occupancies and high-rise buildings have the following additional resources dispatched on the initial alarm, which brings six additional personnel to the scene and increases staffing to 25 personnel.

- 1 ladder.
- 1 battalion chief.

Once the incident has smoke showing, or is determined to be a "working fire," the following additional resources are dispatched:

- 1 engine.
- 1 ladder.

- 1 air/light truck (staffed with 1 person).
- 1 battalion chief.
- 1 ambulance.

This brings staffing to 31 personnel, however, since they are not dispatched at the time of initial dispatch their arrival will be delayed. In addition, the ambulance personnel can only provide medical care, not engage in firefighting operations, so there are 29 personnel available for firefighting operations.

If additional personnel and/or resources are needed due to the size and/or complexity of a fire incident, a second alarm is dispatched. This includes the following resource:

- 1 engine (with 3 personnel).

In addition, a second alarm results in the response of the deputy chiefs, activates a recall of off-duty personnel, and initiates move-up or cover assignments where additional units are moved into the area where there is a fire or other significant incident to provide coverage to empty stations that are committed to the emergency. At least two battalion chiefs are recalled, one of whom responds to the fire, the other providing coverage to the city.

A third alarm results in the response of the remaining on-duty resources and personnel:

- 2 engines.
- 1 ladder.

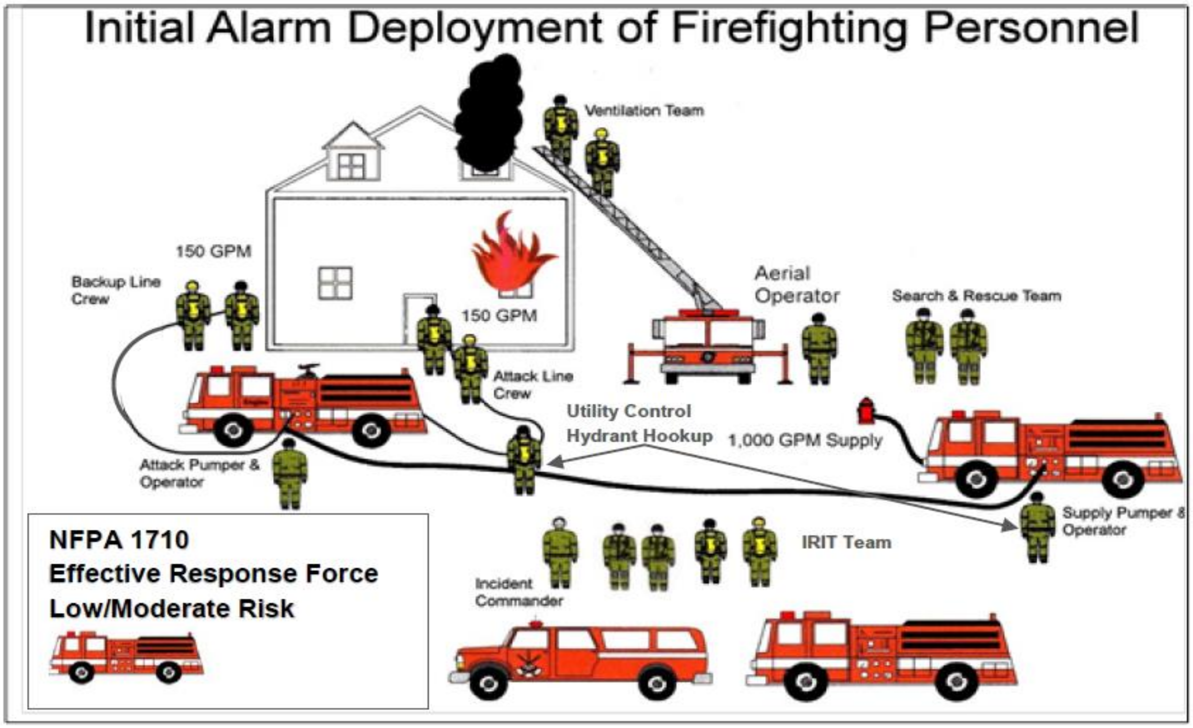
TABLE 5-6: Structure Fire – Low Risk

Critical Task	Needed Personnel
Incident Command	1
Continuous Water Supply/Pump Operator	1
Fire Attack via Two Handlines	4
Hydrant Hook-Up, Forcible Entry, Utilities	2
Primary Search and Rescue	2
Ground Ladders and Ventilation	2
Aerial Operator (if Aerial is Used)	1
Establishment of an IRIT (Initial Rapid Intervention Team)	2
Effective Response Force	**14/15**
TFESD Initial Response Provided	**19**

These tasks meet the minimum requirements of NFPA 1710 for the initial full alarm assignment to a typical low-risk, 2000 square-foot, two-story residential structure. These are the proverbial "bread and butter" structural fire incidents that fire departments respond to, and which are, by far, the most common type of structure fire. Personnel requirements for fires involving large, more complex structures such as commercial or industrial facilities or multifamily residential occupancies will require a significantly greater commitment of personnel.

This serves as a good benchmark for critical tasking that needs to be accomplished to mitigate the most common type of structural fire incident, which is the single-family dwelling. The next figure illustrates how the Effective Response Force integrates simultaneously to accomplish these fireground goals.

FIGURE 5-15: Initial Deployment of Firefighting Personnel/ERF Recommendation: Single-family Dwelling



It should be noted at this point that much of the housing stock in Trenton does not fit into this type of "typical" residential structure. A significant part of the housing stock consists of row-type dwellings, and many of the detached residential units are large, multistory and multifamily types of occupancies. In either of these types of structures the fire challenges are going to be much more complex and conducive to rapid fire spread through such areas as attics, basements, and front and rear porches. Fire extension between closely spaced, wood-frame dwellings is also a significant concern (see following figure). For this reason, the majority of Trenton's residential occupancies would be considered to be more in the moderate risk category.

FIGURE 5-16: Multiple Closely Spaced Wood Frame Dwellings Damaged by Fire

The 2020 edition of NFPA 1710 recommends a minimum of 27/28 personnel on the initial response for fires involving moderate hazard garden-style apartments and strip shopping centers.

TABLE 5-7: Structure Fire – Moderate Risk

Critical Task	Needed Personnel
Incident Command	2
2 – Independent Water Supply Lines/Pump Operators	2
Fire Attack via Three Handlines	6
Support Firefighter for each Handline	3
2 - Search and Rescue Teams	4
2 - Ground Ladders and Ventilation Teams	4
Aerial Operator (if Aerial is Used)	1
Rapid Intervention Team (1 Officer/3 Firefighters)	4
EMS/Medical	2
Effective Response Force	**27/28**
TFESD Initial Response Provided	**19**

The following table identifies critical tasking for fires involving high-risk structures such as hospitals, nursing homes, and assisted living facilities.

TABLE 5-8: Structure Fire – High Risk

Critical Task	Needed Personnel
Incident Command	2
2 – Independent Water Supply Lines/Pump Operators	2
Investigation/Initial Fire Attack Line	3
Backup Line	3
Secondary Attack Line	3
3 - Search/Rescue Teams	6
2 – Ground Ladder and Ventilation teams	4
Water Supply/Fire Department Connection	2
Aerial Operators (if Aerials are Used)	2
Safety/Accountability	2
Rapid Intervention Team (1 Officer/3 Firefighters)	4
EMS/Medical	4
Effective Response Force	**35/37**
TFESD Initial Response Provided	**25**

Based upon needed personnel for establishment of an ERF, and due to Trenton's unique risks as an older, densely populated and developed urban community, consideration should be given to an initial response for all reported structure fires of:

- 4 engines.
- 2 ladders.
- 1 rescue.
- 2 battalion chiefs.

If all units are staffed with four personnel, this would provide an initial response of 32 personnel.

For fires that require additional resources and personnel, Trenton could consider two different options for second (or greater) alarms. Option number one would be to provide a similar assignment on the second alarm as on the first alarm of:

- 4 engines.
- 2 ladders.
- 1 deputy chief.
- 2 battalion chiefs.

This option would require response of at least one engine and one ladder from surrounding mutual aid departments. This option would provide at least 27 additional personnel, assuming the fire units are all staffed with four personnel.

Option number two would be to limit the second alarm to just Trenton units, which would include:

- 3 engines.
- 1 ladder.
- 1 deputy chief.
- 2 battalion chiefs.

This option would provide 19 additional personnel if the fire units are staffed with four personnel. Additional personnel returning to work on the recall could staff additional units and respond if necessary. It is anticipated that for either scenario, additional Trenton chief officers would respond who could assist at the fire or provide city coverage.

Fires involving high-rise structures, which are generally considered to be any building more than six stories in height or more than 75 feet tall, present fire departments with significant operational challenges, particularly in buildings that are not equipped throughout with automatic fire suppression systems. The City of Trenton has a total of 34 buildings that meet this classification including 15 that are seven to ten stories in height, and nineteen that are 11 to 20 stories in height. The city also has an additional 15 buildings that are between four and six stories in height, which can present some of the same challenges in an emergency as a high-rise building. The following figure provides a view of a number of these types of buildings in the city.

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FIGURE 5-17: View of High-rise Buildings in Trenton

The following table breaks down the occupancies of the city's 34 high-rise buildings.

TABLE 5-9: Trenton High Rises by Occupancy Type

Occupancy Type	Number of Buildings
Office	16
Apartments	14
Garage	3
Hotel	1
Total	**34**

The 2020 edition of NFPA 1710 recommends a minimum of 41/42 personnel on the initial response for fires involving high-rise buildings. These personnel should arrive on location within a 10-minute (600 second) travel time. Some chief officers with considerable high-rise fire experience suggest that the actual number of personnel needed for a significant high-rise fire will be around 100 firefighters within about 30 minutes.

The following table identifies critical tasking for a high-rise fire.

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TABLE 5-10: Structure Fire – High Rise

Critical Task	Needed Personnel
Incident Command	2
Lobby Control	1
Interior Staging Officer	1
2 - Investigation/Initial Fire Attack Lines – Fire Floor	4
Backup Line – Floor Above	2
2 - Search/Rescue Teams	4
Operations Officer and aide at Fire Floor Entry	2
2 – Evacuation Management teams	4
Elevator Operations	1
Rehab Team (at least 1 ALS provider)	2
Vertical Ventilation	4
Water Supply/Fire Department Connection	1
Fire Pump Room Monitor (if building is equipped)	1
Equipment Transport	2
External Base Operations	1
Safety/Accountability	2
Rapid Intervention Team (1 Officer/3 Firefighters)	4
EMS/Medical (at least ALS provider)	4
Effective Response Force	**41/42**
TFESD Initial Response Provided	**25**

Based upon needed personnel for establishment of an ERF for high-rise fires, consideration should be given to an initial response for reported fire in a high-rise of:

- 6 engines.
- 3 ladders.
- 1 rescue.
- 2 battalion chiefs.

If all units are staffed with four personnel, the initial response would be 44 personnel.

Initial TFESD response to vehicle fires ranges from one engine and one ladder for most incidents to a full first alarm assignment of three engines, one ladder, one rescue, and one battalion chief for fires involving buses and tractor-trailers.

Initial response to outside grass/brush fires is a single engine company.

Initial response to outside rubbish fires is one engine company and one ladder.

TABLE 5-11: Vehicle Fire

Critical Task	Needed Personnel No Exposures	Needed Personnel With Exposures/Life Hazards*
Incident Command	1	1
Pump Operator	1	1
Fire Attack Line	2	2
Backup Line/Secondary Attack Line	-	2
Water Supply	-	1
Check Fire Extension	-	2
Effective Response Force	**4**	**9**
TFESD Response Provided	**7**	**7**

Note: *A reasonable alternative in this scenario is the dispatch/response of an initial first alarm structural fire assignment.

TABLE 5-12: Outside Fire – Grass/Brush/Rubbish

Critical Task	Needed Personnel
Incident Command	1
Pump Operator	1
Fire Attack Line	2
Effective Response Force	**4**
TFESD Response Provided	**3**

The TFESD dispatches different assignments to automatic fire alarm systems based on the type of occupancy. These range from a response of two engines, one ladder, and one battalion chief for residential alarms and apartments, to a full first alarm assignment of three engines, one ladder, one rescue, and one battalion chief for alarms at high-risk facilities and high-rise structures.

These types of responses need to be considered in the context of risk assessment and management. On one hand, consideration must be given to the potential risks, hazards, and even investigative complexity associated with various types of occupancies. Conversely, data and experience show that these system activations are rarely for an actual fire incident, and of those that are, they often backed up by a phone call reporting a fire.

TABLE 5-13: Fire Alarm System – Low Risk

Critical Task	Needed Personnel
Incident Command	1
Investigation	3
Effective Response Force	**4**
TFESD Response Provided	**12**

Based upon needed personnel for an ERF for a low-risk fire alarm system, consideration should be given to an initial response of:

- 1 – engine.

TABLE 5-14: Fire Alarm System – Moderate Risk

Critical Task	Needed Personnel
Incident Command	1
Pump Operator	1
Investigation	4
Forcible Entry/Ventilation (if necessary)	2
Effective Response Force	**8**
TFESD Response Provided	**12**

Based upon needed personnel for an ERF for a moderate risk fire alarm system, consideration should be given to an initial response of:

- 1 engine.
- 1 ladder.

TABLE 5-15: Fire Alarm System – High-Risk/High-Rise

Critical Task	Needed Personnel
Incident Command	1
Pump Operator	1
Water Supply/Fire Department Connection	1
Investigation	4
Search and Rescue (if necessary)	2
Annunciator Panel	2
Effective Response Force	**11**
TFESD Response Provided	**19**

Based upon needed personnel for an ERF for a high-risk fire alarm system, consideration should be given to an initial response of:

- 2 engines.
- 1 ladder.
- 1 battalion chief.

TABLE 5-16: Motor Vehicle Crash – No Entrapment

Critical Task	Needed Personnel
Incident Command	1
Hazard Abatement	1
Patient Evaluation/Care	2
Effective Response Force	**4**
TFESD Response Provided	**7***

Note: *Does not include TEMS personnel and Capitol Health paramedics.

TFESD response to a motor vehicle accident with potential/reported entrapment includes the following resources:

- 1 engine.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.
- 1 hazardous materials unit.

TABLE 5-17: Motor Vehicle Crash – With Entrapment

Critical Task	Needed Personnel
Incident Command	1
Pump Operator	1
Scene Protection Line	2
Hazard Abatement	2
Patient Extrication	4
Patient Evaluation/Care	4
Effective Response Force	**14**
TFESD Response Provided	**13***

Note: *Does not include TEMS personnel and Capitol Health paramedics.

TFESD response to an interior gas leak includes the following resources:

- 3 engines.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.
- 1 hazardous materials unit.

TFESD response to an exterior gas leak includes the following resources:

- 1 engine.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.
- 1 hazardous materials unit.

TABLE 5-18: Natural Gas Leak – Interior and Exterior

Critical Task	Needed Personnel
Incident Command	1
Investigation/Air Monitoring	3
Pump Operator/Water Supply (If needed)	1
Protection line (If needed)	2
Forcible Entry, Utility Control, Ventilation	2
Search and Rescue (If needed)	2
Establishment of an IRIT (Initial Rapid Intervention Team)	2
Effective Response Force	**13**
TFESD Response Provided (Inside)	**19**
TFESD Response Provided (outside)	**13**

TFESD initial response to a possible hazardous materials incident includes the following resources:

- 1 engine.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.
- 1 hazardous material unit.

TABLE 5-19: Hazardous Materials Incident

Critical Task	Needed Personnel
Incident Command/Safety	2
Entry Team (Haz. Mat. Technician)	2
Back-up Team (Haz. Mat. Technician)	2
Decontamination Personnel	4
Research (Haz. Mat. Technician)	1
Support Personnel	6
Medical	2
Effective Response Force	**19**
TFESD Response Provided	**13***

Note: *Does not include TEMS personnel and Capitol Health paramedics.

TFESD initial response to a water rescue incident includes the following resources:

- 1 engine.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.
- 1 marine unit 1.

TABLE 5-20: Water Rescue Incident

Critical Task	Needed Personnel
Incident Command	1
Rescue Team (Technical Rescue Technician)	2
Back-up Team (Technical Rescue Technician)	2
Shore Support	6
Safety	1
Medical	2
Effective Response Force	**13**
TFESD Response Provided	**13***

Note: *Does not include TEMS personnel and Capitol Health paramedics.

TFESD initial response to a technical rescue incident includes the following resources:

- 1 engine.
- 1 ladder.
- 1 rescue.
- 1 battalion chief.

TABLE 5-21: Technical Rescue Incident

Critical Task	Needed Personnel
Incident Command	1
Rescue Team (Technical Rescue Technician)	4
Back-up Team (Technical Rescue Technician)	4
Support	8
Safety	1
Accountability	2
Medical	2
Effective Response Force	**22**
TFESD Response Provided	**13***

Note: *Does not include TEMS personnel and Capitol Health paramedics.

Establishing an ERF for medical emergencies is significantly less labor intensive than it is for fire incidents. NFPA 1710 provides guidance regarding staffing levels for units responding to EMS incidents; however, the provision does not specify a minimum staffing level for EMS response units. Instead, section 5.3.32 of the standard states: *"EMS staffing requirements shall be based on the minimum levels needed to provide patient care and member safety."* It further recommends that resources should be deployed to provide *"for the arrival of a first responder with AED within a 240-second travel time to 90 percent of the incidents," and, "when provided, the fire department's EMS for providing ALS shall be deployed to provide for the arrival of an ALS unit within a 480-second travel time to 90 percent of the incidents provided a first responder with AED or BLS unit arrived in 240 seconds or less travel time."*

EMS calls are typically managed with fewer personnel, and the majority of EMS calls can be handled with a single ambulance staffed with two personnel. In the call-screening process, those calls that require additional personnel are typically identified at the dispatch level and additional personnel can be assigned when needed. These types of incidents could include cardiac and respiratory arrest, unconscious persons, and other incidents where the initial call seems to indicate a severe and imminent threat to life. NFPA 1710 suggests for these types of emergencies that "*personnel deployed to ALS emergency responses shall include a minimum of two members trained at the emergency medical technician—paramedic level and two members trained at the emergency medical technician—basic level arriving on scene within the established travel time.*" However, these types of emergencies constitute a small percentage of overall EMS incidents as identified herein.

Fire Operations

With a population density estimated to be around 11,102 people per square mile, Trenton is a highly urbanized city. This population density makes Trenton the 98th most densely populated incorporated community in the United States, with a population density just slightly lower than Chicago and Philadelphia. When considering just larger communities, with a population of 75,000 or higher, Trenton ranks as the 22nd most densely populated in the United States. Most areas in the city area have older multistory structures sited closely together, in many cases directly abutting, or even interconnecting with each other. Many of these structures date to the later part of the 19th and early years of the 20th century during Trenton's time as a major industrial center. Interspersed throughout the city are newer and refurbished buildings and facilities.

Much of the city's house stock is comprised of older, row-type dwelling units that are susceptible to rapid fire spread through common cockloft areas, front and rear porches, and in some cases interconnected basements. In this environment, if a fire grows to an area in excess of 2,000 square feet, or extends beyond the building of origin, initial response personnel will be taxed beyond their available resources and additional buildings can quickly become involved as the fire spreads in multiple directions (see following figure). From this perspective it is critical that a sufficient number of properly staffed TFESD units respond quickly and initiate extinguishment efforts as rapidly as possible after notification of an incident. It is, however, difficult to determine in every case the effectiveness of the initial response in limiting the fire spread and fire damage. Many variables will impact these outcomes, including:

- The time of detection, notification, and ultimately response of fire units.
- The age and type of construction of the structure. Being primarily a community where the development has occurred many years ago, the maintenance and condition of structures in Trenton are always a consideration and part of the risk benefit analysis the battalion chiefs must undertake at fire incidents.
- The presence of any built-in protection (automatic fire sprinklers) or fire detection systems.
- The contents stored in the structure and its flammability.
- The presence of any flammable liquids, explosives, or compressed gas canisters.
- Weather conditions and the availability of water for extinguishment.

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FIGURE 5-18: TFESD Three-Alarm Fire: October 2020

Subsequently, in those situations in which there are extended delays in the extinguishment effort or the fire has progressed sufficiently upon arrival of fire units, there is actually very little that can be done to limit the extent of damage to the entire structure and its contents. In these situations, suppression efforts may need to focus on the protection of nearby or adjacent structures (exterior exposures) with the goal being to limit the spread of the fire beyond the building of origin, and sometimes the exposed building. This is often termed protecting exposures. When the scope of damage is extensive, and the building becomes unstable, firefighting tactics typically move to what is called a defensive attack, or one in which hose lines and more importantly personnel are on the outside of the structure and their focus is to merely discharge large volumes of water until the fire goes out. In these situations, the ability to enter the building is very limited and if victims are trapped in the structure, there are very few safe options for making entry.

Today's fire service is actively debating the options of interior firefighting vs. exterior firefighting. These terms are self-descriptive in that an ***interior fire attack*** is one in which firefighters enter a burning building in an attempt to find the seat of the fire and from this interior position extinguish the fire with limited amounts of water. An ***exterior fire attack***, also sometimes referred to as a ***transitional attack***, is a tactic in which firefighters initially discharge water from the exterior of the building, either through a window or door and knock down the fire before entry in the building is made. The concept is to introduce larger volumes of water initially from the outside of the building, cool the interior temperatures, and reduce the intensity of the fire before firefighters enter the building. A transitional attack is most applicable in smaller structures, typically single-family, one-story detached units which are smaller than approximately 2,500 square feet in total floor area. For fires in larger structures, the defensive type, exterior attacks generally involve the use of master streams capable of delivering large volumes of water for an extended period of time.

Recent studies by UL have evaluated the effectiveness of interior vs. exterior attacks in certain simulated fire environments. These studies have found the exterior attack to be equally effective in these simulations.[28] This debate is deep-seated in the fire service and traditional tactical measures have always proposed an interior fire attack, specifically when there is a possibility that victims may be present in the burning structure. The long-held belief in opposition to an exterior attack is that this approach may actually push the fire into areas that are not burning or where victims may be located. The counterpoint supporting the exterior attack centers on firefighter safety.

The exterior attack limits the firefighter from making entry into those super-heated structures that may be susceptible to collapse. From CPSM's perspective, there is at least some likelihood that a single TFESD crew of three or four personnel will encounter a significant and rapidly developing fire situation. This situation can occur during times of high incident activity when other units may be committed on other emergencies, or in fringe areas of the city where other units responding to the incident may have longer response times to arrive on the scene and may all be coming from the same direction. These situations can also occur due to incorrect information provided

28. "Innovating Fire Attack Tactics," U.L.COM/News Science, Summer 2013.

to the dispatch center by the initial 9-1-1 caller, or because of incidents that begin as an investigation of an automatic fire alarm system.

It is prudent, therefore, that the TFESD build at least a component of its training and operating procedures around the tactical concept of the exterior fire attack when the situation warrants such an approach. In addition, with engine companies currently staffed with three personnel, unless there is a potential life hazard concern of trapped occupants, engines arriving on scene first, and with no other companies immediately available will be limited to initiating these tactics until the arrival of additional units and personnel.

The ability to quickly develop an adequate and sustainable water supply is key to successful mitigation of almost every fire incident. Trenton has a good municipal water supply system for fire department use. However, as in many older, former industrial cities, the system is more than a century old and experiences frequent maintenance issues. During the three-alarm fire in October 2020 that was mentioned previously, a hydrant directly across from the fire building was found to be inoperable, which forced firefighters to obtain water from more distant hydrants. This type of situation can certainly slow and hamper initial firefighting operations.

As currently staffed, the TFESD should be able to handle most of the fires it encounters without the need for automatic or mutual aid. However, as has been mentioned previously, and will be discussed in further detail later in this section, the city's engine companies being staffed with three personnel rather than four will limit their tactic options until the arrival of additional resources and personnel. Fire incidents in larger structures often require additional personnel and resources to successfully mitigate.

Critical staffing necessary to successfully mitigate various types of incidents will be discussed in detail later in this section of the report. In most cases, fires occurring when there are no other incidents in progress and which would reduce the immediately available number of personnel, and the fire department can arrive at the fire incident and take definitive action to mitigate the situation prior to flashover occurring, will impact how effectively and quickly incidents can be mitigated. If flashover has occurred, holding the fire to the building of origin is highly achievable as well.

One area that is of significant concern almost all of the TFESD stakeholders, from the director to firefighters, and which they expressed to CPSM, was the department's and by extension the city's overall emergency radio system. While an evaluation of the radio system is beyond the scope of this study, based upon our interviews, CPSM has significant concerns regarding the radio system and the potential negative implications that could have on personnel safety, particularly if a firefighter or EMT was in trouble and needed emergency assistance. It was widely reported to CPSM that the current radio system is not a public safety radio system and that the system has multiple operational deficiencies and areas throughout the city where coverage is very poor.

The life safety of firefighters, EMS personnel, and citizens depends on reliable, functional communication tools that work in the harshest and most hostile of environments. All firefighters, professional and volunteer, operate in extreme environments that are markedly different from those of any other radio users. The radio is the lifeline that connects the firefighters to command and outside assistance when in the most desperate of situations. To operate safely in these dynamic environments, it is imperative that firefighters have the ability to immediately communicate information accurately. This importance was not lost on the firefighting community when it adopted the internationally recognized terminology MAYDAY to signify an emergency situation. The MAYDAY is often the "last chance" to get outside assistance, and the fire service's ear is always listening for that call of distress. Some of the factors that separate fire department radio communications needs from other users include:

- Communications pace — communications on the fireground are fast-paced and may be chaotic.
- Work position — firefighters are often on the floor crawling. This is not the optimal position for radio transmissions.
- Visibility challenges — heavy smoke and dark situations require users to be intimately familiar with the equipment.
- SCBAs, which pose several challenges including:
  - Voice ports on facepieces are difficult to communicate through.
  - Visibility — restricts field of vision.
- Temperature and humidity impacts, such as high heat and high humidity.
- High noise environments — difficult to communicate from a high-noise area and difficult to hear in a high-noise environment.

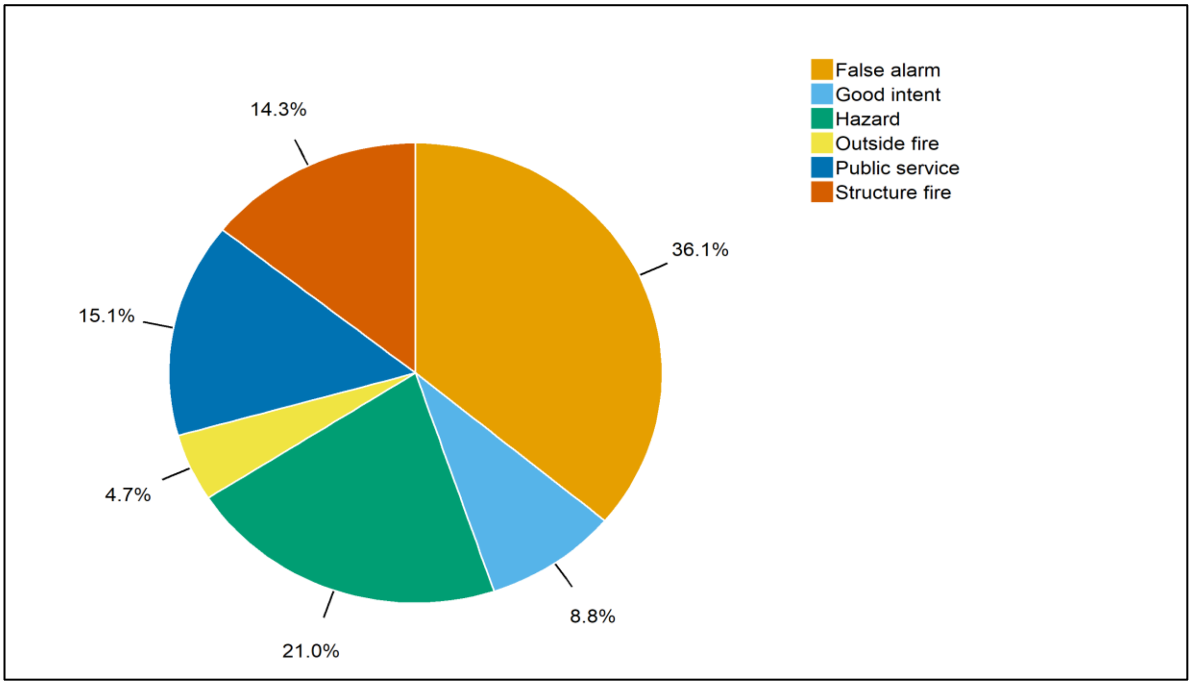
Communications and interoperability issues are frequently noted as contributing factors in National Institute for Occupational Safety and Health investigative reports on firefighter line of duty deaths. Effective and reliable communications are mission critical to fire department operations.

The following table and figure show the fire call totals for the 12-month period evaluated by CPSM, including number of calls by type, average calls per day, and the percentage of calls that fall into each call type category. During the year studied, TFESD responded to 7,726 calls. Of these, 3,581were fire calls, of which 512 were structure fire calls and 170 were outside fire calls. Fire call types were 46.3 percent of the total calls for service, a higher percentage than we normally see in departments that are heavily involved in the provision of EMS services in their community. Actual fire calls (structural and outside) were 8.8 percent of the overall calls for service (approximately 1.87 calls per day or one actual fire-type incident every 12.8 hours). The 682 actual fires represent 19.0 percent of the fire-related incidents. Hazardous conditions, false alarms, public service, and good intent calls represent the largest percentage of fire-type calls for service. This experience is typical in CPSM data and workload analyses of other fire departments.

TABLE 5-22: Fire Calls by Type and Number, and Percent of All Calls

Call Type	Number of Calls	Calls per Day	Call Percentage
False alarm	1,292	3.5	16.7
Good intent	314	0.9	4.1
Hazard	753	2.1	9.7
Outside fire	170	0.5	2.2
Public service	540	1.5	7.0
Structure fire	512	1.4	6.6
Fire Total	**3,581**	**9.8**	**46.3**

FIGURE 5-19: Fire Calls by Type and Percentage



The data in this table and figure tell us that:

- Fire calls for the year totaled 3,581 (46.3 percent of all calls), an average of 9.8 per day.
- Structure and outside fires combined for a total of 682 calls during the year, an average of 1.87 calls per day or one actual fire-type incident every 12.8 hours.
- A total of 512 structure fire calls accounted for 14.3 percent of the fire calls.
- A total of 170 outside fire calls accounted for 4.7 percent of the fire calls.
- False alarm calls were made up the highest number of fire category calls at 36.1 percent.
- The second highest number of calls were for hazardous conditions, at 21.0 percent of fire calls.

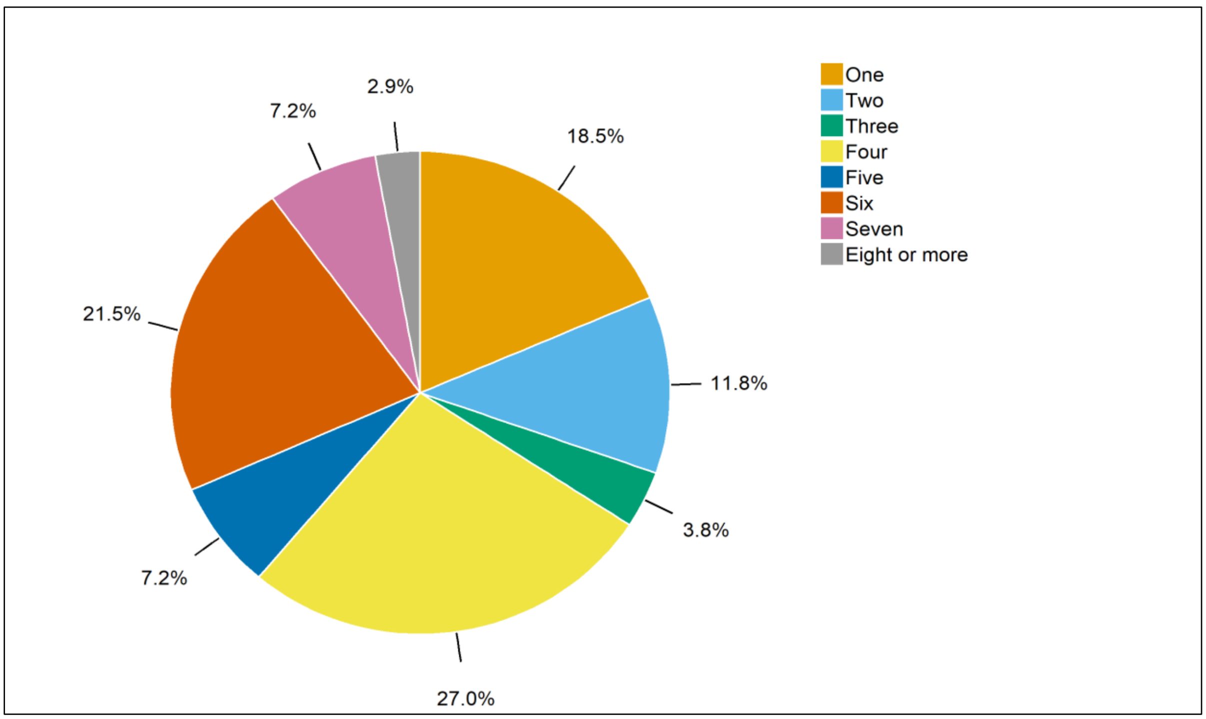
An additional analysis of fire response was conducted regarding the workload of incident types. The following table shows that the largest percentage of fire responses (75.0 percent) lasted less than 30 minutes. This suggests that the majority of fire incidents were relatively minor in nature. However, it can also suggest that a rapid and adequate response by the fire department allowed the incident to be mitigated before it escalated into a larger, more serious situation. The second largest amount of fire responses (16.6 percent) lasted 30 minutes to an hour. Just 5.9 percent of fire incidents lasted between one and two hours, while 2.4 percent were two hours or longer in duration. These longer incidents would indicate more significant events. Overall, the TFESD has about 24.9 fire incidents per month—5.75 per week or about 0.8 per day—which last longer than one hour.

TABLE 5-23: Fire Calls by Type and Durations

Call Type	Less than 30 Minutes	30 Minutes to One Hour	One to Two Hours	More Than Two Hours	Total
False alarm	1,096	174	19	3	1,292
Good intent	273	36	5	0	314
Hazard	467	193	77	16	753
Outside fire	99	37	26	8	170
Public service	391	86	51	12	540
Structure fire	361	69	34	48	512
Fire Total	**2,687**	**595**	**212**	**87**	**3,581**

The following figure shows the workload of fire responses by number of units responding to these incident types. On average, 4.1 units were dispatched to each fire call. This figure tells us that four fire units responding to fire incidents (27.0 percent), followed by six units (21.5 percent) make up the largest fire response workload. For structure fire calls, three of more units were dispatched 93.7 percent of the time. For outside fires, three or more units were dispatched to 35.9 percent of the incidents. For incidents that are determined to be a false alarm, three or more units are dispatched 92.3 percent of the time. Public service calls represent the largest fire response categories for single fire unit responses at 65.9 percent. Overall, a single unit was dispatched to a fire call just 18.5 percent of the time. This is not uncommon in densely urbanized communities due to the high level of potential risk involved.

FIGURE 5-20: Calls by Number of Units Dispatched – Fire



The following table shows the number of units that responded to each structure fire call, broken down by residential property type. More than four out of five of these calls (80.7 percent) had six or fewer units respond to them, with the largest number, 226 (44.1 percent) having six units respond. This suggests that the majority of these calls were handled by the initial dispatch of three engines, one ladder, one rescue, and one battalion chief.

TABLE 5-24: Number of Units Responding to Structure Fire Calls by Property Type

Units	Single-Family	Multi-Family	Other	Unknown	Total	Cumulative Response
1	3	0	14	0	17	3.3
2	3	1	9	2	15	6.3
3	1	2	3	0	6	7.4
4	45	33	38	1	117	30.3
5	10	18	2	2	32	36.5
6	74	100	19	33	226	80.7
7	5	10	1	7	23	85.2
8	1	0	1	4	6	86.3
9	5	1	2	1	9	88.1
10	25	10	6	4	40	95.9
11	4	1	1	0	6	97.1
12	3	0	0	0	3	97.7
13	1	0	0	0	1	97.9
14	1	14	0	0	3	98.4
15	1	0	0	0	1	98.6
16	2	0	0	0	2	99.0
17	1	0	0	0	1	99.2
18	1	0	1	0	2	99.6
19	0	0	0	1	1	99.8
20	1	0	0	0	1	100.0

Of the 682 fires in Trenton, both structure and outside, 612 (89.7 percent) resulted in no reported loss. Fifty-one fires (7.5 percent) reported damage of under $20,000. This includes 22 outside fires and 29 structure fires. Nineteen fires (2.8 percent) comprised of 16 structure fires and three outside fires saw damage in excess of $20,000 each.

The following two tables break down the loss due to fire in Trenton during the period analyzed.

TABLE 5-25: Content and Property Loss, Structure and Outside Fires

Call Type	Property Loss		Content Loss	
	Loss Value	Number of Calls	Loss Value	Number of Calls
Outside fire	$184,806	21	$91,601	17
Structure fire	$1,784,351	34	$421,625	36
Total	**$1,969,157**	**55**	**$513,226**	**53**

Note: This includes only calls with a recorded loss greater than 0.

TABLE 5-26: Total Fire Loss Above and Below $20,000

Call Type	No Loss	Under $20,000	$20,000 plus
Outside fire	145	22	3
Structure fire	467	29	16
Total	**612**	**51**	**19**

Other information derived from the fire loss data for Trenton includes:

- Out of 170 outside fires, 21 had a recorded property loss, with a combined $184,806 in losses.
- 17 outside fires had a content loss with a combined $91,601 in losses.
- The highest total loss for an outside fire was $105,106.
- Out of 512 structure fires, 34 had a recorded property loss, with a combined $1,784,351 in losses.
- 36 structure fires had a content loss with a combined $421,625 in losses.
- The average total loss for structure fires with loss was $49,022. Nationally, each structure fire results in an average property loss of $22,176.
- The highest total loss for a structure fire was $550,000.

When looking at fire loss comparisons nationwide for structure fires, NFPA estimates that in 2018, the average community in the United States with a population between 50,000 and 99,999 had an average of 2.9 actual fires per 1,000 residents. For Trenton, this would equate to approximately 241 actual fires. With the number of actual amounting to 682, Trenton's fire experience is 2.8 times greater than average for its population size. Overall, the average fire department in communities with this size range averaged 191 fires. Also, while Trenton's fire loss is relatively low compared to the risks in the community it protects, it is important to keep in mind that at any time a single fire can occur that results in millions of dollars in fire loss.

EMS Operations

Emergency medical service (EMS) operations are an important component of the comprehensive emergency services delivery system in any community. Together with the delivery of police and fire services, it forms the backbone of the community's overall public safety net. As will be noted in several sections of this report, the TFESD, like many, if not most, fire departments respond to significantly more emergency medical incidents and low acuity incidents than actual fires or other types of emergency incidents.

The EMS component of the emergency services delivery system is more heavily regulated than the fire side. In addition to National Fire Protection Association (NFPA) Standard 1710, *Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* (2020 edition), NFPA 450 *Guidelines for Emergency Medical Services (EMS) and Systems*, (2017 edition), provides a template for local stakeholders to evaluate an EMS system and to make improvements based on that evaluation. The Commission on Accreditation of Ambulance Services (CAAS)[29] also promulgates standards that are applicable to their accreditation process for ambulance services. In addition, the State of New Jersey Department of Health Services Office of

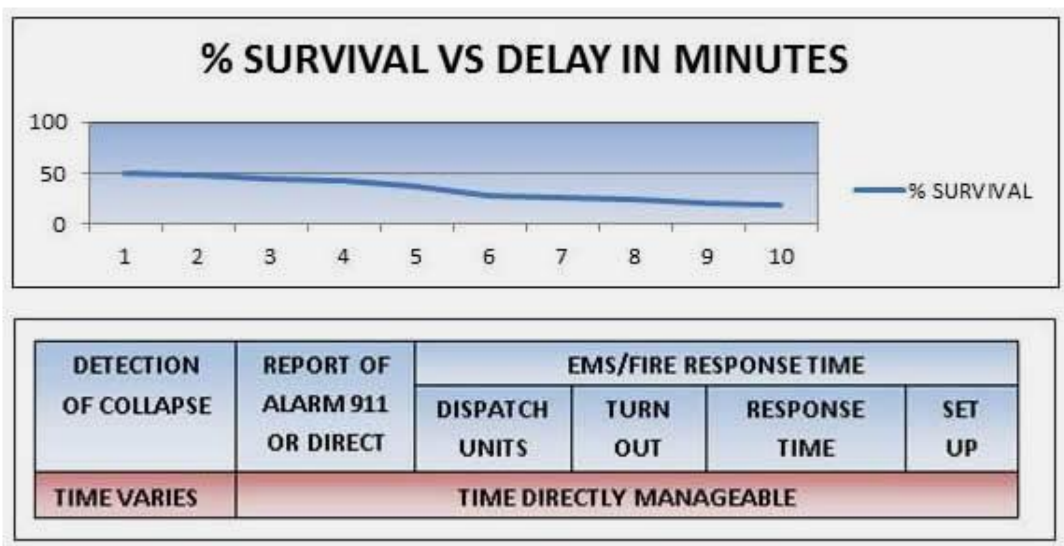
29. The Commission on Accreditation of Ambulance Services (CAAS) is an independent commission that established a comprehensive series of standards for the ambulance service industry.

Emergency Medical Services[30] regulates EMS agencies, and certain federal Medicare regulations are also applicable.

As a percentage of overall incidents responded to by the emergency agencies in most communities, it could be argued that EMS incidents constitute the greatest number of "true" emergencies, where intervention by trained personnel does truly make a difference, sometimes literally between life and death.

Heart attack and stroke victims require rapid intervention, care, and transport to a medical facility. The longer the time duration without care, the less likely the patient is to fully recover. Numerous studies have shown that irreversible brain damage can occur if the brain is deprived of oxygen for more than four minutes. In addition, the potential for successful resuscitation during cardiac arrest decreases exponentially with each passing minute that cardiopulmonary resuscitation (CPR), or cardiac defibrillation, is delayed (see following figure).

FIGURE 5-21: Cardiac Arrest Survival Timeline



The figure illustrates that the potential for successful resuscitation during cardiac arrest decreases exponentially, by 7 percent to 10 percent, with each passing minute that cardio-pulmonary resuscitation (CPR) or cardiac defibrillation and advanced life support intervention is delayed. The figure also illustrates few attempts at resuscitation after 10 minutes are successful.

Emergency medical services (EMS) for the City of Trenton are provided at the basic life support (BLS) first responder level by the TFESD. Trenton Emergency Medical Services (TEMS), an independent 503C non-profit that is a collaborative venture between the city and three hospitals, provides patient transport at the BLS level. Advanced life support (ALS)/paramedic level service is provided by paramedics from the Trenton-based Capitol Health System. Advanced life support or ALS-level care refers to prehospital interventions that can be brought into the field by paramedics. Typically, this service level includes the ability to bring much of the emergency room capability to the patient. Paramedics can administer intravenous fluids, manage a patient's airway, provide drug therapy, utilize the full capabilities of a 12-lead cardiac monitor, and provide a vital communication link to the medical control physician who can provide specific medical direction based on the situation.

30. https://www.state.nj.us/health/ems/

All TFESD personnel are minimally trained and certified to the emergency medical responder (EMR) level. Initial EMR training is 60 hours in length. Personnel must be recertified every two years, which requires 20 hours of training. There are multiple department personnel who possess the higher-level basic Emergency Medical Technician (EMT) certification and a few who are paramedics. However, the latter are not authorized to use those skills while operating in their capacity with TFESD.

At the time of this study, TEMS was staffing three 24-hour units—two of which respond from fire headquarters/Station 10, and one of which responds from Station 9—and one part time 12-hour unit, which also responds from Station 10. TEMS previously also deployed a unit from Station 2 in the southern part of the city until that station was closed during a previous department reorganization. Standard staffing for TEMS units is two EMTs per unit.

Capitol Health deploys one ALS unit in Trenton 24/7, with a second unit in service from 7:00 a.m. to 7:00 p/m. Each of these units is staffed with two paramedics. Additional units are deployed throughout Mercer County. It should also be noted that ALS units in New Jersey do not have transport capabilities. Transport of ALS criterion patients is done utilizing the BLS ambulances with the paramedics on board to provide patient care and treatment.

The public safety answering point (PSAP) for 9-1-1 calls in the City of Trenton is the Trenton Police Department. The city does not utilize an Emergency Medical Dispatch (EMD) system to classify emergency medical calls as to their severity. In an EMD system trained telecommunicators—using locally approved EMD guide cards—quickly and properly determine the nature and priority of the call, dispatch the appropriate response, then if necessary, give the caller instructions to help treat the patient until the responding EMS unit(s) arrive(s). Current practice in Trenton is for the police department to transfer EMS calls to the Mercer County Emergency Communications Center, which then dispatches TEMS. If the call meets the criterion for dispatch of an ALS unit also, or, if a TEMS ambulance is not immediately available, a TFESD unit is dispatched also. CPSM was informed that the current system is unwieldy and EMS personnel need to carry three radios to cover all their communications bases.

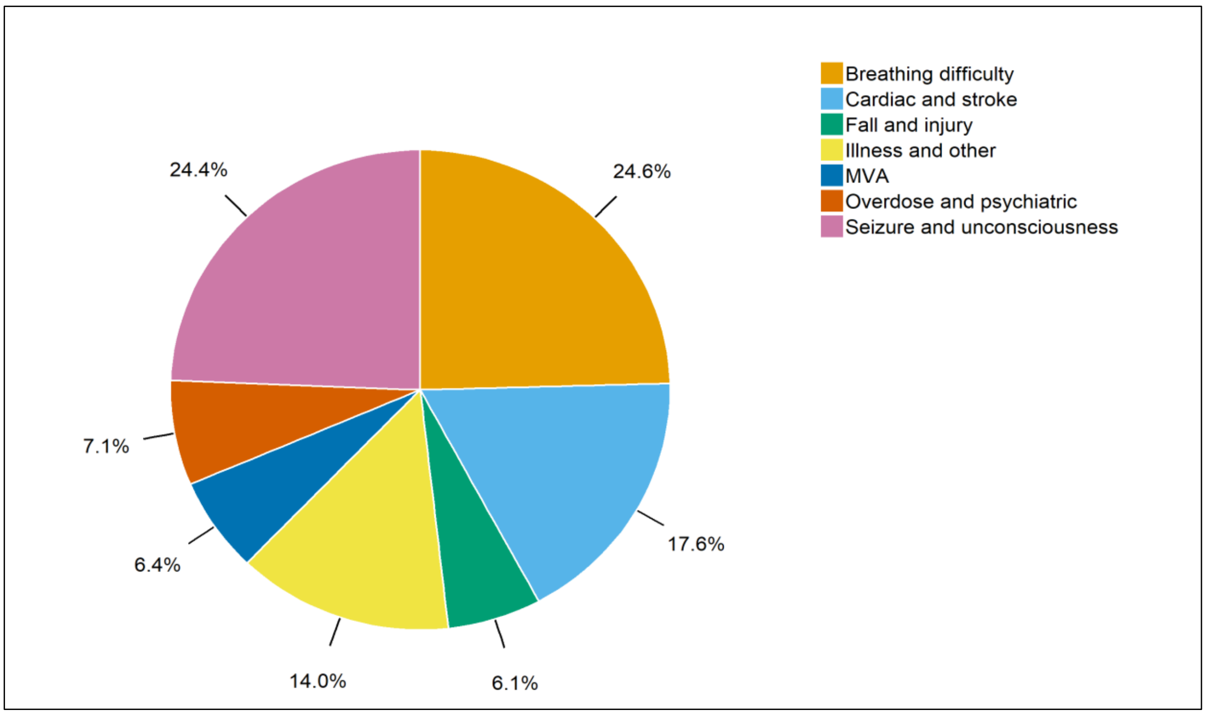
During the period of time analyzed for this study, January 1, 2019 to December 31, 2019, the TFESD responded to 4,025 EMS calls, which accounted for 52.1 percent of all incidents the department responded to. This percentage is significantly lower than what CPSM typically sees in our studies of fire departments, which is typically between 70 percent and 80 percent of calls. However, the percentage seems reasonable when we factor in the elements that TFESD is not the primary EMS provider or transport service and primarily only responds on more serious EMS incidents. Based on these factors, the lower percentage of EMS calls becomes much more reasonable. In addition, Trenton is an older, densely populated urban area where there tends to be a higher number of fire-related incidents. The following table and figure show the EMS call totals for the 12-month period evaluated for this study, including number of calls by type, average calls per day, and the percentage of calls that fall into each call type category.

§ § §

TABLE 5-27: EMS Calls by Type and Number, and Percent of All Calls

Call Type	Number of Calls	Calls per Day	Call Percentage
Breathing difficulty	989	2.7	12.8
Cardiac and stroke	707	1.9	9.2
Fall and injury	244	0.7	3.2
Illness and other	563	1.5	7.3
MVA	257	0.7	3.3
Overdose and psychiatric	284	0.8	3.7
Seizure and unconsciousness	981	2.7	12.7
EMS Total	**4,025**	**11.0**	**52.1**

FIGURE 5-22: EMS Calls by Type and Percentage



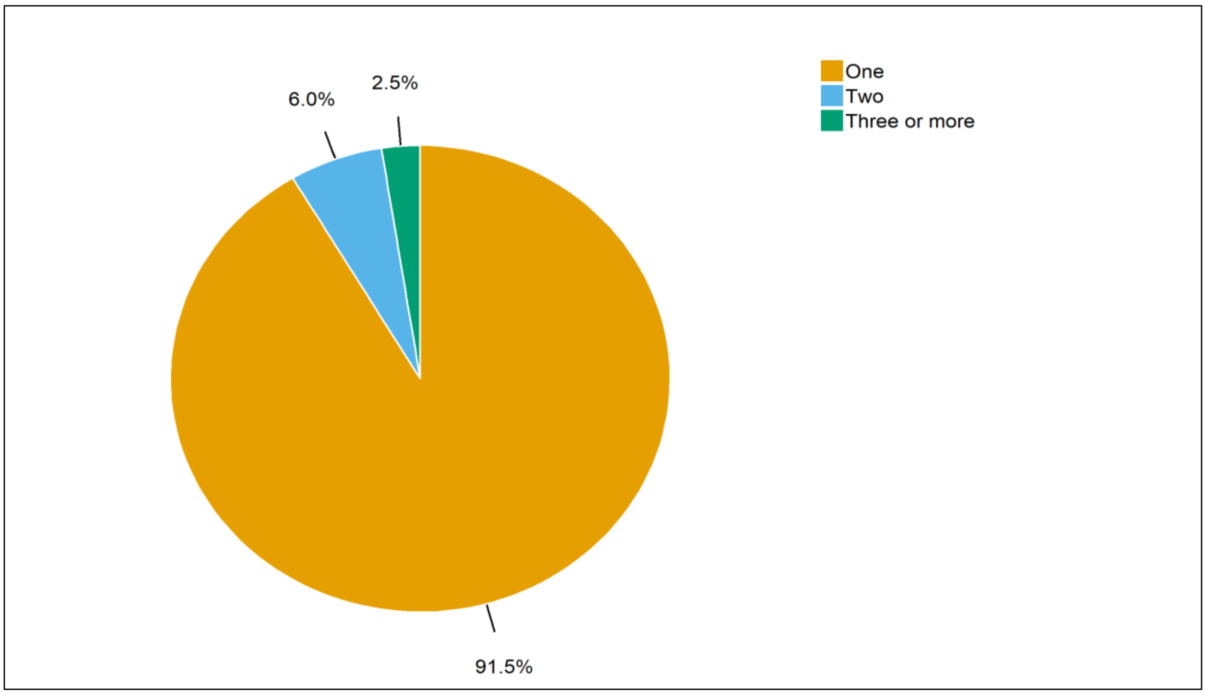
The EMS call data tells us that:

- EMS calls for the year totaled 4,025 (52.1percent of all calls), an average of 11 per day.
- Breathing difficulty was the largest category of EMS calls at 12.8 percent, an average of 2.7 per day.
- Seizures and unconsciousness were the second largest category of EMS calls at 12.7 percent of EMS calls, also an average of 2.7 calls per day.
- Cardiac and stroke calls made up 9.2 percent of EMS calls, an average of 1.9 calls per day.

Some communities have started pilot programs that incorporate trained volunteers into the emergency medical response system. The American Heart Association continues to recognize the chain of survival by early recognition, early CPR, early defibrillation, and rapid transport. PulsePoint® is an app on an iPhone that can be downloaded by anyone in the community who is willing to participate in this program, enabling them to be notified when someone is having a cardiac arrest in their vicinity. Fifty-seven percent of adults in the United States say they have had CPR training. Utilizing new technology, bystander performance, and active citizenship involvement can enhance the care provided to the community.

The following figure shows the number of TFESD units that were dispatched to various types of EMS-related incidents. <u>This analysis does not examine the number of ambulances or units from TEMS or other agencies on a call</u>. On average, 1.1 units were dispatched to each EMS call. This figure tells us that single fire unit responses to EMS incident types (91.5 percent) make up the largest EMS response workload. Illness and other types of EMS calls represent the largest EMS response categories for multiple fire unit responses (63.6 percent), followed by MVAs (28.9 percent). The data analysis shows us that Engine 3 has the highest fire apparatus EMS response workload with 885 responses out of 1,952 total responses (45.3 percent).

FIGURE 5-23: Calls by Number of TFESD Units Dispatched – EMS



An additional analysis of fire response was conducted regarding the workload of incident types. The following table shows that the largest amount of EMS responses (94.5 percent) lasted less than thirty minutes.

§ § §

TABLE 5-28: EMS Calls by Type and Durations

Call Type	Less than 30 Minutes	30 Minutes to One Hour	One to Two Hours	More Than Two Hours	Total
Breathing difficulty	963	24	2	0	989
Cardiac and stroke	688	19	0	0	707
Fall and injury	230	14	0	0	244
Illness and other	515	41	5	2	563
MVA	204	46	5	2	257
Overdose and psychiatric	275	9	0	0	284
Seizure and unconsciousness	930	50	1	0	981
EMS Total	**3,805**	**203**	**13**	**4**	**4,025**

The preponderance of short-duration deployments is most likely directly related to the fact that the TFESD generally provides just initial patient care or supports and assists the EMS crew and quickly transfers care to the TEMS ambulance crew. Just 5.5 percent of EMS calls lasted more than 30 minutes. Overall, the TFESD has about 0.6 EMS incidents per day—or three every five days—that last longer than 30 minutes. The categories of incidents with the most calls longer than 30 minutes are MVAs with 53, seizures and unconscious with 51, and illness and other with 48.

The Centers for Disease Control and Prevention (CDC) reports that 70,237 Americans died from drug overdoses in 2017, of which 47,600 were opioid-related. Also, in 2017, 11.1 million people reported misuse of prescription opioid pain medications, nearly 900,000 people used heroin, and 2.1 million people suffered from an opioid use disorder. One of the most effective treatments for someone suffering from an overdose is the timely administration of Naloxone, which is estimated to save around 15,000 lives per year.

Naloxone (sometimes referred to as Narcan, which is a brand name) is a highly effective opioid overdose-reversing drug that saves thousands of lives in the United States. Naloxone is a medication designed to rapidly reverse opioid overdoses, for instance from morphine and heroin. It is an opioid antagonist—meaning that it binds to opioid receptors and can reverse and block the effects of other opioids. Specifically, naloxone is used in opioid overdoses to counteract life-threatening depression of the central nervous system and respiratory system, enabling an overdose victim to breathe normally. It can very quickly restore normal respiration to a person whose breathing has slowed or stopped as a result of overdosing with heroin or prescription opioid pain medications. Naloxone only works if the person has opioids in their system; it has no effect if opioids are absent.

CPSM's evaluation of EMS operations determined that while both TFESD and TEMS personnel are trained in the use and administration of Naloxone, neither department is currently equipped with it. Only the Trenton Police Department, which may or may not respond to medical incidents carries it. With the country in the midst of an opioid epidemic, and that problem often amplified in urban areas, it makes no sense at all for the City of Trenton's two primary EMS providers to not be provided with this potentially life-saving treatment option.

In acknowledgement of the potential dangers involved in EMS first response to shooting incidents, the TFESD dispatches two engines and a battalion chief to any reported shooting incident. CPSM believes that this is a reasonable risk management procedure for the department. Looking at these types of incidents more broadly, considering Trenton's position as the New Jersey state capitol, and taking into account the significantly increasing number of incidents involving active shooters and other violent types of incidents that involve multiple victims and often a dynamic and rapidly involving situation where the perpetrator(s) has/have not been neutralized, the TFESD should work with its other partners in the EMS delivery system to ensure they have at least some level of tactical medical capability. In these cases, fire and EMS personnel, escorted by law enforcement personnel can begin life-saving care in areas where they would otherwise be unable to operate. The net effect of this is the ability to potentially save lives that may otherwise have not been possible in earlier eras.

TECHNICAL INCIDENT RESPONSE ON-SCENE OPERATIONS

By virtue of its position as the largest fire department in the area, along with the wide range of incidents it may experience that would require much more specialized training, skills, and capabilities, the TFESD has multifaceted technical incident operational capabilities. The special operations team represents a group of firefighter personnel that in addition to their firefighting duties and training have elected to diversify and train to meet the challenges and dangers of specific rescue environments.

The department's special operations capabilities are primarily centered at Engine 1, Engine 10, Ladder 1, Ladder 4, and Rescue 1. These capabilities include high angle, confined space, and trench collapse technical rescue capabilities, in addition to normal vehicle extrication. There is also a marine rescue unit with dive capabilities. The department also has a certified level A hazardous materials response team. All these special operations capabilities are available for response to assist on incidents throughout Mercer and surrounding counties.

Because of the specialized, often complex, and dangerous, nature of special operations, it is imperative that the personnel who engage in these endeavors are well trained and given opportunities to maintain their skills at the highest level possible. This requires training on a regular basis. One of the areas of concern that was noted by CPSM is that over the past several years budgetary constraints have reduced the training that the special operations teams and personnel have been able to conduct. This has resulted in lapses in maintaining certifications for the members' critical skills. Several members of the department were also members of the New Jersey Urban Search and Rescue Team Task Force 1, but the budgetary pressures did not allow them to continue to participate.

PRINCIPAL FINDINGS: COMMUNITY RISK / CRITICAL TASKING FOR STANDARDS OF COVER

- What are normally considered to be low-risk occupancies—that is, single family dwellings—represent a significant share of the occupancy risk in Trenton. However, much of the housing stock in Trenton does not fit into the "typical" residential structure. A significant part of the housing stock consists of row-type dwellings, and many of the detached residential units are large, multistory and multifamily types of occupancies. In either of these types of structures the fire challenges are going to be much more complex and conducive to rapid fire spread through areas such as attics, basements, and front and rear porches. Fire extension between closely spaced, wood-frame dwellings is also a significant concern. For this reason, CPSM considers the majority of Trenton's residential occupancies to be more in the moderate-risk category.
- Medium-risk occupancies consist of multiple apartment complexes and multifamily dwellings. Commercial and mixed-use type occupancies that combine both commercial and residential

use occupancies are located throughout the city. There are also still several industrial occupancies located throughout the city.

- The lowest number of occupancy risk sites but those with the highest potential fire and life safety loss are high-risk occupancies. There are three hospitals, multiple nursing homes and assisted living facilities, schools, and a maximum-security state prison in Trenton. The state capitol building could also be classified as a high-risk occupancy.
- There are 34 high-rise buildings in Trenton, and these present many more operational challenges than other types of structures. Consequently, reported fires in these buildings will require a significant commitment of personnel and should receive a larger initial response.
- In the critical tasking for structure fires, the TFESD responds a higher effective response force (ERF) to low-risk calls for service when benchmarked against NFPA 1710 (low risk) and current research.
- For medium- and high-risk occupancies, and high-rise buildings, the TFESD responds a lower effective response force when benchmarked against NFPA 1710 recommendations (Tables 5-7, 5-8, and 5-10). Consideration as to the number of resources to dispatch to these types of incidents is listed after the respective tables.
- For automatic fire alarm systems in low-, medium-, and high-risk occupancies the TFESD responds greater than a recommended ERF (Tables 5-13, 5-14, and 5-15). Consideration as to the number of resources to dispatch to these types of incidents is included after the respective tables.
- Of the remaining critical tasking categories not identified above, the TFESD responds a greater ERF on three of the ten categories. While TFESD responds a greater initial ERF than the critical tasking suggests may be necessary, many of these incidents can be complicated and require a large commitment of personnel and resources to mitigate successfully. As such, CPSM does not believe that any of the initial ERFs dispatched by TFESD are unreasonably large and we are not recommending any reductions.
- Although risk management processes and appropriate call screening are important parts of determining the appropriate number of resources that should be initially dispatched to various types of emergency incidents, it is also important that enough personnel and resources be initially available to handle all critical tasks in a timely manner should they need to be performed. For this reason, it is the widespread practice in the fire service to send multiple resources to incidents and which ultimately may not be utilized if the incident turns out to be a minor one that is easily mitigated. Even today, within reason, this remains a prudent approach. It is support of this concept that CPSM recommends modifications to the TFESD's initial dispatch of resources to reported structure fire incidents.
- Of the remaining critical tasking categories not identified above, the TFESD responds with the recommended ERF to three categories of incidents, and responds a smaller than recommended ERF to four.
- It should be noted that the numbers in these tables for TFESD response do not reflect response by TEMS and Capitol Health paramedics, so once these are calculated in, the total response force may be higher.

A critical component of the incident command system is the establishment of the role of safety officer to monitor conditions at fires and emergency incident scenes to ensure that appropriate safety procedures are being followed. <u>The incident safety officer is an important member of the incident command team.</u> The safety officer works directly under and with the incident commander to help recognize and manage the risks that personnel take at emergencies.

The concept of a command team recognizes that there is a shared responsibility for the proper and safe performance of personnel operating on the emergency scene. The fact is that one of the roles that the safety officer needs to play is that of challenging and confirming the incident commander's actions. The safety officer should be included in the development and monitoring of the incident action plan. In simple terms, <u>the incident commander and the safety officer command team</u> provide a system of checks and balance designed to keep all personnel on the emergency scene safe.

Once the incident action plan is established, the safety officer monitors the plan for effectiveness and efficiency. Current operations in Trenton have the second arriving battalion chief assume the duties of safety officer.

Fire Departments in the Phoenix, Ariz., metro area are leaders in this regard and place a high priority on the assignment of a qualified officer to fill the safety officer position during a wide range of incidents. According to Phoenix Regional Standard Operating Procedures *"Incident Safety Officer System,"* for most incidents, the safety officer provides the following functions:

- Incident recon.
- Assess the risk/benefit of operations.
- Assess and address safety concerns on the incident scene.
- Communicate and report safety issues to command.
- Intervene as necessary to provide for safety.

During larger scale incidents, the safety officer reviews the incident action plan and specific details of the safety plan. As appropriate, the safety officer confirms that a safety plan is in effect, reviews it, and provides recommendations. The incident commander may request that the safety officer develop a proposed safety plan and recommendations for command.

Beyond the specific emphasis on safety, the role of incident commander is a dynamic position and highly stressful position that has numerous critical responsibilities that must be handled simultaneously, and, in a time critical manner.

In the Phoenix area, multiple fire departments utilize Field Incident Technicians (FIT), or Battalion Safety Officers (BSO) paired with a battalion chief as part of a permanent incident management team. These are company level officers, so in the case of Trenton, this would be captains, who work in tandem with the command level officer, a battalion chief. This is a concept that the TFESD should consider implementing to provide for more effective, efficient, and safer incident command operations. When teamed with a battalion chief, in addition to normal safety officer functions, the FIT/BSO also fulfills the following roles and responsibilities:

- Assist with managing the incident.
- Define, evaluate, and recommend changes to the incident action plan.
- Provide direction relating to tactical priorities and specific critical fireground factors.
- Become the Incident Safety Officer.
- Manage personnel accountability on the incident.
- Evaluate the need for additional resources.
- Assign logistics responsibilities.
- Assist with the tactical worksheet for control and accountability.

- Evaluate the fireground organization and span of control.
- Assist with personnel air management.
- Manage crew work/rest cycles and rehab.
- Other duties as necessary.

AUTOMATIC AND MUTUAL AID

Mutual aid is an essential component of almost every fire department's operations. Except for the largest cities, no municipal fire department can, or should, be expected to have adequate resources to respond to and safely, effectively, and efficiently mitigate large-scale and complex incidents. Mutual aid is shared between communities when their day-to-day operational fire, rescue, and EMS capabilities have been exceeded, and this ensures that the citizens of the communities are protected even when local resources are overwhelmed.

Automatic aid is an extension of mutual aid, where the resources from adjacent communities are dispatched to respond at the same time as the units from the jurisdiction where the incident is occurring. There are two basic principles for automatic aid, the first being that all jurisdictional boundaries are essentially erased, which allows for the closest, most-appropriate unit to respond to an incident, regardless of which jurisdiction it belongs to. The second is to provide, immediately and at the time of initial dispatch, additional personnel or resources that may be needed to mitigate the reported incident.

Automatic and mutual aid is generally provided without charge among the participants.

The TFESD participates in a normal automatic and mutual aid system with its surrounding departments. For the most part, this aid consists of mutual aid for additional resources for larger incidents, or for station coverage during incidents. The provisions of the New Jersey Fire Service Deployment Act set the parameters for the development of mutual aid agreements, and the deployment of mutual aid resources. As incidents escalate in size, the Mercer County Fire Coordinator, and/or a regional fire coordinator from the state fire marshal's office will respond to assist with the coordination of resources needed for the incident, as well as backfilling stations.

The following figure illustrates the location of TFESD stations along with the location of mutual aid stations in Hamilton, Ewing, and Lawrence Townships, New Jersey, along with those across the Delaware River in Buck County, Penn. The stations that are shown range from fully career stations, to stations that are staffed with career personnel at certain times of the day/week, to fully volunteer stations. For the latter two types of staffing, the reliability and timeliness of response can be impacted by the time of day and availability of personnel.

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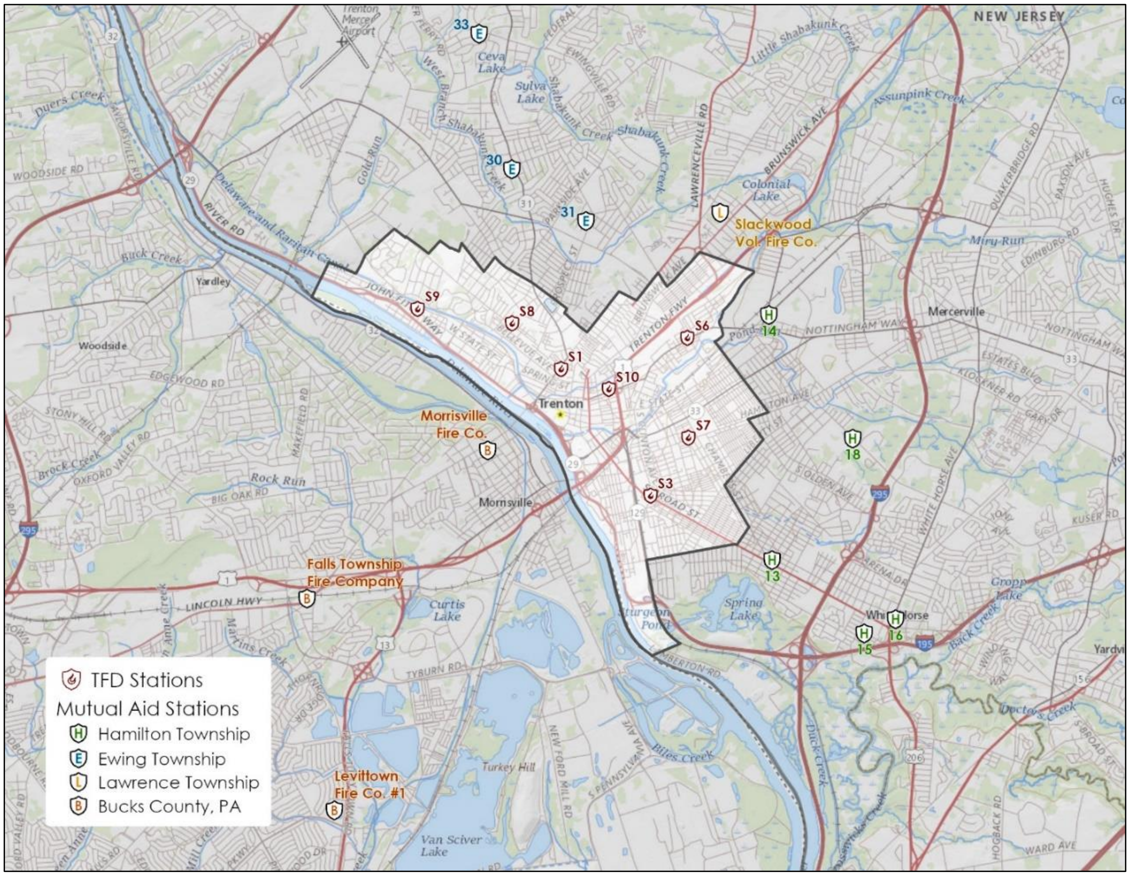
FIGURE 5-24: TFESD with Mutual Aid Stations



The following figure illustrates the 240- and 480-seconds response times from Hamilton Township Stations 13, 14, 15, 16, and 18, along with, Ewing Township Station 30. These stations are all stations that are close to the city, and are staffed 24/7 with career personnel who can provide an immediate and guaranteed response to mutual aid incidents.

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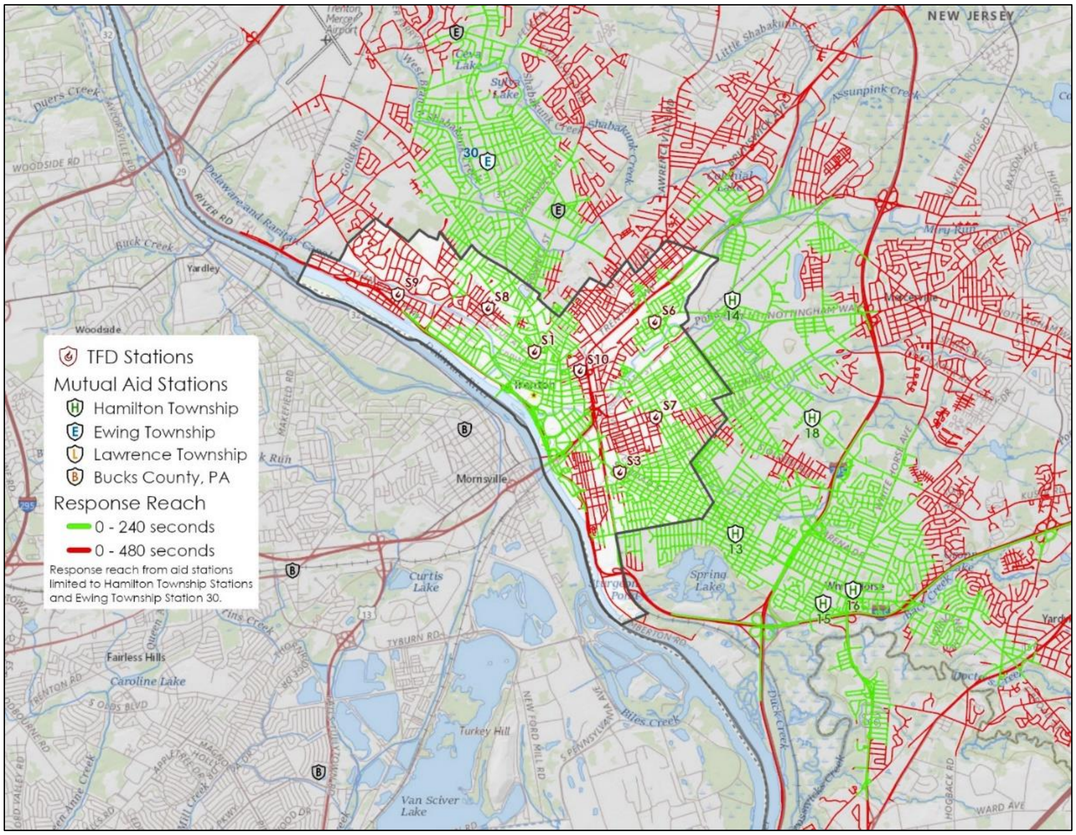
FIGURE 5-25: Select TFESD Mutual Aid Stations with 240- and 480-Seconds Response Time Bleeds



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CURRENT STATE OF THE TFESD DEPLOYMENT MODEL

The current state of the fire and EMS delivery system in Trenton, from the operational perspective of the TFESD, which includes external factors such as available staffing, risk, future city redevelopment, available funding, and demand for service is, as analyzed and observed by CPSM as follows:

- With the TFESD's current deployment model the entire city is within a 240-seconds travel time for the first responding unit as recommended by NFPA 1710. The entire city is also within the 480-seconds travel distance for the entire first alarm assignment for structure fire responses. CPSM considers this to be a **Best Practice**.
- From July 1, 2019 thru June 30, 2020 the TFESD's staffing decreased from 194 to 183. The June 2020 number put the department 41 personnel (18.3 percent) below its authorized strength. Between June and October 2020, several additional personnel retired, bringing the personnel shortage to between 45 (20.1 percent) and 50 (22.3 percent) personnel. There is currently a recruit class of 12 new firefighters in the academy and who will graduate in January 2021. This will provide at least some relief by filling a percentage of the open positions.
- On average, 17 of the TFESD personnel on duty are on overtime to maintain a minimum staffing level of 42 personnel. This equates to 40.5 percent of the on-duty staffing. During the period analyzed, the number of personnel working overtime in order to maintain minimum staffing ranged from a low of eight (19 percent) to 42 (100 percent).
- Due to the ongoing challenges with staffing, and with over 40 percent of the on-duty staffing on overtime, crews and personnel who are not familiar with each other are frequently operating together. This can impact operational efficiency and effectiveness because officers and crew members may not be familiar with each other's strengths, weakness, and even overall capabilities.
- The department utilized 69,797.75 hours of overtime to maintain staffing levels in the year studied.
- With the current minimum staffing level of 42 personnel on duty at a time, the department's seven engine companies operate understaffed with three personnel.
- When the TFESD was reorganized in June 2002, it resulted in the closing of two engines and one ladder; thus, the staffing on all remaining units was supposed to be maintained at four personnel on each, an officer and three firefighters.
- When responding to any incident with the potential for personnel to encounter an IDLH, units with staffing of three personnel have fewer tactical fire options until the arrival of additional personnel and resources.
- When units respond with just three personnel, the officers must assist with tasks such as stretching a line and therefore cannot properly perform duties such as initial size-up. In addition, the crews of two companies may need to be combined to accomplish tasks that a single engine should be able to perform, such as advancing a line to the upper floors of a building.
- The city averages about two actual fires per day. Although a limited number of these fires are significant, as detailed in this report, the city does have a high level of risk, more so than most comparable sized cities.
- With the current limited staffing on engines, the TFESD is unable to meet NFPA 1710 recommended minimum personnel benchmarks for a second fire without the need for mutual aid if simultaneous structure fires occur.

- The training captain position on each shift, while well-intentioned and needed, has not worked as envisioned as these captains have been detailed about 58 percent of the time to fill in as a company officer.
- The position of driver of SS-1, a unit that responded to just 90 incidents in the year studied, could be better utilized as staffing for another company.
- More than 20,000 people come into Trenton to work each day for the State of New Jersey, along with an unknown number of others who work in the city to be in proximity to the state government and those on state and related business.
- The city is the seat of Mercer County government, which also has a large presence in the city including the county courthouse.
- The city is also the host to a U.S. Courthouse for the Central District of New Jersey.
- Over 17 percent of the population of the city falls into higher risk categories of 65 years old or older (9.8 percent) and under age 5 (7.5 percent).
- More than one in four Trenton residents (28.4 percent) live below the poverty line.
- The TFESD enjoys strong support from many city stakeholders including the Mayor, Business Administrator, and the Capitol City Coalition. All of these stakeholders believe the department should be properly staffed.
- Approximately 50 percent of property in the city is tax exempt. As New Jersey's capital, Trenton relies heavily on state funding to provide basic services. These funds have been severely curtailed over the past decade.
- Despite the ongoing opioid crises, and members of both TFESD and TEMS being trained to administer it, neither organization carries life-saving Naloxone.
- The current practice of dispatching TFESD units only to more serious medical calls, or those where no ambulance is immediately available, is appropriate.
- The current public safety radio system is reported to have major problems and should be fully evaluated to determine if it is appropriate for the needs of the city's first responders.
- TFESD experienced overlapping calls 4.7 percent of the time.
- The first due unit arrived first on the scene of an incident 78.6 percent of the time.
- Call processing (at dispatch) and turnout (in the station) times are much higher than recommended NFPA 1710 benchmarks.

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Option 1. Maintain the Status Quo

This option would primarily follow the practice of the past several years of only occasionally hiring new firefighters to replace those that have retired or left the department. This option would continue to have engines staffed with three personnel and relies on high amounts of overtime to maintain even minimum staffing levels.

Advantages of this alternative include:

- Reduces personnel benefit costs by utilizing personnel on overtime rather than additional full-time employees to fill positions.

Disadvantages include:

- Scientifically validated studies have shown that three-person companies are less effective and efficient performing critical tasks than those staffed with four personnel. In addition, three-person companies are unable to comply with two in-two out until additional resources arrive.
- Often requires the company officer to function as a crew member rather than as a supervisor.
- On an average day, approximately 40 percent of the on-duty personnel are working overtime, which impacts crew cohesiveness and familiarity.
- There is a growing body of knowledge regarding health and safety issues associated with firefighters working excessive hours or overtime shifts.
- The overtime budget to maintain staffing levels is extremely high. The department needed overtime to fill 73.3 percent of the shift openings.
- Battalion chiefs spend hours of each duty day just trying to fill staffing needs rather than being able to concentrate on other important tasks.

Model Assumptions

Under this model, there are limited additional or "overstaff" positions to maintain minimum staffing of 42 personnel on duty at all times. This includes for employee absences resulting from scheduled or unscheduled leave, outside training, or other causes. Under this staffing model, for the most part, if employees on a shift are off because of scheduled or unscheduled leave, the additional vacant position(s) are filled through overtime. This staffing method is considered "constant staffing" and requires overtime to staff vacant full-time positions to maintain minimum staffing.

Through the development of a staffing factor, the fiscal impacts of maintaining minimum staffing by utilizing overtime, or, adding additional staff as "overstaffing" to fill vacancies can be better analyzed.

By utilizing a staffing factor calculation of: **staffing factor** $= \frac{\textbf{hours per year of operation}}{\boldsymbol{E}}$

$$E = P - A$$

E = the number of effective hours per employee per year or hours actually worked
P = the number of paid hours per employee per year
A = the average number of hours of paid absences per year per employee

For TFESD, there were 178 full time career positions assigned to shift operations in June 2020. This equates to 44.5 per shift. For a one-year period (July 1 – June 30) the number of paid hours each employee was scheduled to work was 2,190 hours. This totals 389,820 hours for 178 employees. During this same time-period, all employees aggregately utilized 95,207 hours of leave (personal, vacation, sick, medical, float, family, bereavement etc.). Utilizing the staffing factor formula above:[31]

P = 2190

A = 535 (average 95,207/178) **staffing factor** $= \frac{\mathbf{2190}}{\mathbf{1,655}}$ **= 1.32**

P – A = 1,655

E = 1,655

Therefore it takes 1 full-time and 0.32 of a full-time employee to fill each position per 24-hour shift, or aggregately 13.44 (0.32 x 42-Current Minimum Staffing) of a full-time equivalent employee per 24-hour shift to maintain minimum staffing of 42. To achieve the 13.44 aggregate staffing factor per shift, the department can either overstaff each shift with 14 FTE positions, or continue to use overtime budgeted at 13.44 per shift in overtime, or a combination of both.

Under this staffing assumption, the TFESD would need a minimum of 56 personnel assigned to each shift for a total operational deployment of 224 personnel or 168 personnel and budgeted overtime to cover all leave positions to maintain minimum staffing (not counting administrative and staff personnel).

CPSM <u>does not</u> recommend the continuation of the status quo.

31. Ammons, D., *Tools for Decision Making*,2nd edition, (Washington, DC: CQ Press, 2009), 229-230.

Option 2A. Maintain Current Operational Deployment with All Units Staffed with Four Personnel

Under this scenario all TFESD units would be staffed with four personnel, the shift training captains would remain as currently assigned, and SS-1 would continue to be staffed with one member. Minimum on-duty staffing would be 50 personnel. Under this model, there are limited additional or "overstaff" positions to maintain minimum staffing of 50 personnel on duty at all times.

Advantages of this alternative include:

- Provides effective minimum staffing of four personnel on all units.
- Provides increased operational effectiveness, efficiency, and safety during operations for both citizens and firefighters.
- Enables quicker compliance with two- in-two out and more effective assembly of an effective response force to perform critical tasking.
- Enables the department to marginally handle two structure fire incidents at a time.

Disadvantages include:

- Requires the second highest level of staffing of all the options presented.
- Costs associated with hiring full-time personnel.
- Will still require use of overtime (albeit reduced) to maintain staffing.

Model Assumptions

For TFESD to maintain minimum staffing of 50 personnel on duty at all times would total 438,000 hours per year for 200 employees. Although it may be somewhat conservative, we utilize the same aggregate total hours of leave used of 95,207 (personal, vacation, sick, medical, float, family, bereavement etc.). Utilizing the staffing factor formula above:

P = 2190

A = 476 (average 95,207/200)

staffing factor $= \frac{2190}{1,714}$ **= 1.28**

P – A = 1,714

E = 1,714

Therefore it takes 1 full-time and 0.28 of a full-time employee to fill each position per 24-hour shift, or aggregately 14 (0.28 x 50) of a full-time equivalent employee per 24-hour shift to maintain minimum staffing of 50. To achieve the 14 aggregate staffing factor per shift, the department can either overstaff each shift with at least two, possibly three FTE positions, or continue to use overtime budgeted at 14 per shift in overtime, or a combination of both.

Under this staffing assumption, the TFESD would need a minimum of 64 personnel assigned to each shift for a total operational deployment of 256 personnel or 200 personnel and budgeted overtime to cover all leave positions to maintain minimum staffing (not counting administrative and staff personnel).

CPSM believes that this is the second-best staffing alternative.

Option 2B. Maintain Current Operational Deployment with All Units Assigned Five Personnel but Minimum Staffed with Four

This scenario is similar to Option 2A, above, the only difference being that each company is assigned an extra person, so each unit would have five personnel assigned, with a four-person minimum.

Advantages of this alternative include:

- Provides effective minimum staffing of four personnel on all units.
- May, at times, allow specialized units such as ladders and the rescue to operate with five personnel during periods of low leave usage.
- Provides increased operational effectiveness, efficiency, and safety during operations for both citizens and firefighters.
- Enables quicker compliance with two- in-two out and more effective assembly of an effective response force to perform critical tasking.
- Enables the department to marginally handle two structure fire incidents at a time.
- Should significantly reduce the amount of overtime required.

Disadvantages include:

- Requires the highest level of staffing of all the options presented.
- Costs associated with hiring full-time personnel.

Model Assumptions

Under this staffing assumption, the TFESD would need a minimum of 61 personnel assigned to each shift for a total operational deployment of 244 personnel (not counting administrative and staff personnel).

CPSM <u>does not</u> recommend this alternative.

Option 3. Modify Operational Deployment with All Units Staffed with Four Personnel

Under this scenario all TFESD fire units would be staffed with four personnel. However, we would recommend several modifications to the deployment model as follows:

- Upgrade the battalion chiefs' adjutant positions to the rank of captain to serve not only as a field incident technician, but also as a battalion safety officer and training officer. This concept will be developed further in the recommendations section.
- Reassign the SS-1 driver to a company as a firefighter. SS-1 can be assigned to another station and can be brought to the scene either by that engine crew or another company when needed.

Minimum on-duty staffing would be 48 personnel. Under this model, there are limited additional or "overstaff" positions to maintain minimum staffing of 48 personnel on duty at all times.

Advantages of this alternative include:

- Provides effective minimum staffing of four personnel on all units.
- Provides increased operational effectiveness, efficiency, and safety during operations for both citizens and firefighters.
- Enables quicker compliance with two- in-two out and more effective assembly of an effective response force to perform critical tasking.
- Enables the department to marginally handle two structure fire incidents at a time.
- Provides additional support to battalion chiefs both on the emergency scene and administratively.
- Should improve training by not having the training officers reassigned to command companies.
- Improved fireground safety.

Disadvantages include:

- Costs associated with hiring full time personnel.
- Will still require use of overtime (albeit reduced) to maintain staffing.

Model Assumptions

For TFESD, to maintain minimum staffing of 48 personnel on duty at all times would total 420,480 hours per year for 192 employees. Although it may be somewhat conservative, we utilize the same aggregate total hours of leave used of 95,207 (personal, vacation, sick, medical, float, family, bereavement etc.). Utilizing the staffing factor formula above.

P = 2190

A = 496 (average 95,207/192) **staffing factor** = $\frac{2190}{1{,}694}$ **= 1.29**

P – A = 1,694

E = 1,694

Therefore it takes a full-time and 0.29 of a full-time employee to fill each position per 24-hour shift, or aggregately 13.92 (.29 x 48) of a full-time equivalent employee per 24-hour shift to maintain minimum staffing of 48. To achieve the 48 aggregate staffing factor per shift, the department can either overstaff each shift with 14 FTE positions, or continue to use overtime budgeted at 14 per shift in overtime, or a combination of both.

Under this staffing assumption, the TFESD would need a minimum of 62 personnel assigned to each shift for a total operational deployment of 248 personnel or 192 personnel and budgeted overtime to cover all leave positions to maintain minimum staffing (not counting administrative and staff personnel).

CPSM recommends this option as the most operationally and fiscally balanced.

Option 4. Switch from a Four-Platoon to a Three-Platoon Deployment

When considering ways to provide better staffing and personnel coverage, we would be remiss if we did not mention an alternative shift schedule that involves fire department personnel operating in a three-platoon system where the work week averages 56 hours per week. While there are numerous work schedule variations to this system, the most common shift, and simplest schedule, involves personnel working 24 hours, followed by 48 hours off duty. While not totally extinct, this work schedule has become very rare in the northeast and specifically in New Jersey where the vast majority of fire departments operate with a four platoon, 24-hour work schedule.

Outside of the northeast, however, the three-platoon system is widely used including in Los Angeles, Phoenix, San Antonio (three of our nation's 10 largest cities), and many of the large county fire departments in the northern Virginia suburbs of Washington, D.C. Over the past several years, Baltimore, Maryland, a large urban fire department, and, Gloucester, Massachusetts, switched to three-platoon work schedules from their traditional four-platoon rotations. Both Baltimore and Gloucester made the switch for the purposes of maintaining (Baltimore) or increasing (Gloucester) on-duty shift strength without the need for hiring additional personnel.

In New Jersey, the arbitrary (albeit permitted by state law) cancellation of the Atlantic City Firefighters' contract, which resulted in their salaries being reduced while they were simultaneously forced to move from four platoons to three, has left deep-seated and probably long-standing distrust of any proposals to consider a similar schedule change.

Under this scenario all TFESD units would be staffed with four personnel, the shift training captains would remain as currently assigned, and SS-1 would continue to be staffed with one member. Minimum on-duty staffing would be 50 personnel.

Advantages of this alternative include:

- Collapses one entire shift and provides effective minimum staffing of four personnel on all units.
- Provides increased operational effectiveness, efficiency, and safety during operations for both citizens and firefighters.
- Enables quicker compliance with two in-two out and more effective assembly of an effective response force to perform critical tasking.
- Enables the department to marginally handle two structure fire incidents at a time.
- Reduces the total number of personnel needed to staff the department by nearly 25 percent.

Disadvantages include:

- Changes the terms and conditions of employment. Requires personnel to work 33.3 percent more.
- Would require bargaining the impact of a schedule change.
- This schedule requires uniform field operations personnel to be scheduled 56-hours/week. Depending on the work cycle and what leave hours would count as productive time or non-productive time toward the overtime threshold, personnel potentially could earn overtime just for working their scheduled hours, or additional days off each "cycle" would need to be scheduled for each employee to ensure they work 53 hours/week on average over the work cycle.
- May damage department morale, both short and long term.

Model Assumptions

Under this staffing model, TFESD would operate with three platoons instead of four. Four personnel would be assigned to each operational apparatus and Battalion Chief and the Training Captain staffing remains the same as current for a total of 50 per shift or 150 operational personnel.

This model, based on other models reference leave taken, is recommended to have one additional position assigned to each operational fire apparatus, for a total of 11 additional overstaffed potions to cover leave and maintain minimum staffing. This brings the total per shift staffing to 61 personnel, and an aggregate of 183 personnel.

Under this staffing assumption, the TFESD would need a minimum of 61 personnel assigned to each shift for a total operational deployment of 183 personnel or 150 personnel and budgeted overtime to cover all leave positions to maintain minimum staffing (not counting administrative and staff personnel).

CPSM DOES NOT RECOMMEND ANY CONSIDERATION OF THIS OPTION UNLESS THE TFESD FIREFIGHTERS AND OFFICERS ARE WILLING TO COLLECTIVELY BARGAIN IT.

SECTION 5 RECOMMENDATIONS AND PLANNING OBJECTIVES

5.1 The TFESD currently operates with a minimum on-duty staffing of level of 42 personnel. This includes seven engines each staffed with three personnel, three ladders each staffed with four personnel, one rescue staffed with four personnel, one special services unit staffed with one person, and two battalion chiefs each paired with an adjutant. Considering the high level of risk that the City of Trenton has, engines being staffed with just three personnel can impact efficiency, effectiveness, and safety for both citizens and firefighters. In addition, the shift training officer program has not worked as well as anticipated, particularly from the aspect of them being able to conduct training.

- CPSM recommends as a planning objective that, over a three-year period, the department conduct a minor deployment modification and work to increase staffing levels, particularly on the engines. <u>The overall goal is to increase staffing on each shift to **51** personnel, with a **48-** person minimum.</u> Total operational staffing (not counting administrative and staff positions) would be 204 personnel. When uniformed/sworn staff and administrative personnel are included, overall personnel would be approximately 210 to 212 personnel. This does not include civilian support staff. It also does not include the potential addition of fire prevention staff/inspectors.
  - Under this this recommendation the TFESD would be staffed as follows:
    - Seven engines staffed with four personnel.
    - Three ladders staffed with four personnel.
    - One rescue staffed with four personnel.
    - Two command teams each consisting of one battalion chief and captain/training officer/field incident technician/battalion safety officer.
  - **Year One**:
    - In order to provide for more effective, efficient, and safe overall incident management, and to enhance critical incident scene safety for all personnel, the TFESD should upgrade the battalion chiefs' adjutant positions to the rank of captain to function as a part of an integrated command team with each battalion chief. These personnel will serve not only as a field incident technician, but also as a battalion safety officer and training officer. Advantages of this approach can include
      - Conduct training within their battalion on their shift.
      - Assist the battalion chief with other administrative duties.
      - Incident recon.
      - Assess the risk/benefit of operations.
      - Assess and address safety concerns on the incident scene.
      - Communicate and report safety issues to command.
      - Intervene as necessary to provide for safety.
      - Assist with managing the incident.
      - Define, evaluate, and recommend changes to the incident action plan.
      - Provide direction relating to tactical priorities and specific critical fireground factors.
      - Become the Incident Safety Officer.

    - Manage personnel accountability on the incident.
    - Evaluate the need for additional resources.
    - Assign logistics responsibilities.
    - Assist with the tactical worksheet for control and accountability.
    - Evaluate the fireground organization and span of control.
    - Assist with personnel air management.
    - Manage crew work/rest cycles and rehab.
    - Other incident scene duties as necessary.
  - Reassign training captains to battalion chiefs as recommended above.
  - Promote four captains and assign them to battalion chiefs as above.
  - Reassign the SS-1 driver to an engine company to bring staffing to four. SS-1 can be assigned to that station and can be brought to the scene, when necessary, either by that engine crew or another company.
  - Hire a minimum of 12 personnel to complete staffing the four engines that are in a station by themselves (Engines 6, 7, 8, and 9) to a four-person minimum.
- Year Two:
  - Hire a minimum of 12 personnel to bring staffing on the remaining three engines (Engines 1, 3, and 10) to four personnel.
- Year Three:
  - Hire a minimum of 12 personnel to provide three floater/additional personnel per shift to help fill position vacancies and reduce the need for overtime. This will bring shift staffing to 51 personnel with minimum on-duty staffing of 48.

5.2 One of the keys to being able to maintain increased minimum staffing levels and reduce the amount of overtime being utilized is to monitor and attempt to minimize the amount of unscheduled leave—primarily sick, and injury—that personnel utilize. CPSM is not suggesting that personnel are not entitled to legitimate use of both these types of leave; however, we are also very cognizant of the fact that there are personnel in every department who misuse, and in fact abuse this type of leave and the system. The larger the department, the more of these personnel their likely are. Monitoring these types of leave and personnel who are suspected of misusing it can assist with keeping the need for overtime down and reduce staffing costs.

- CPSM recommends as a planning objective that TFESD leadership work with the firefighters and officers' bargaining units to develop a policy for monitoring and verification of personnel who are on sick or injury leave. Examples of things that can be discussed include requiring a location where they will be for in-person verification by a chief officer, providing a doctor's note, being required to see a city-arranged doctor, and not being eligible for overtime until they have worked a regular shift after a sick call out.

5.3 The TFESD will only be marginally able to handle two structure fires simultaneously even if the staffing on all companies is maintained at four personnel.

- CPSM recommends as a planning objective that TFESD should build at least a portion of its training regimens and tactical strategies around the exterior or transitional attack for when the fire scenario and the number of available units/responding personnel warrants this approach.

- CPSM also recommends that as a planning objective—particularly if engine company staffing levels are not increased from three to four personnel—and recognizing the potential for rapid fire spread in a densely developed urban community, the TFESD should equip all of its apparatus, and develop standardized tactical operations that will enable it to quickly develop and place in service, with high-volume fire flows of at least 1200 to 1500 gallons per minute (if the water supply will permit this), utilizing multiple lines/devices. This flow should be able to be developed within four to five minutes after arrival of an engine staffed with three personnel. However, these same capabilities should be an option for an engine staffed with four personnel.

5.4 The call processing (at dispatch) and turnout (in the station) times for the TFESD are much higher than recommended by NFPA 1710 benchmarks. The latter time is the one area where the fire department has the most control over and can serve to reduce overall response times.

- CPSM also recommends that as a planning objective the TFESD should take steps to continue to improve both the dispatch time and incident turnout times for both fire and EMS incidents to reduce overall response times to emergency incidents.

5.5 The current public safety radio system is reported by fire administration to have major problems and should be fully evaluated to determine if it is appropriate for the needs of the city's first responders. All of the TFESD stakeholders expressed significant concern to CPSM regarding the department's, and by extension, the city's overall emergency radio system. CPSM has significant concerns regarding the radio system and the potential negative implications that the system could have on personnel safety particularly if a firefighter or EMT was in trouble and needed emergency assistance. It was widely reported to CPSM that the current radio system is not a public safety radio system and that the system has multiple operational deficiencies and areas throughout the city where coverage is very poor. The life safety of firefighters, EMS personnel, and citizens depends on reliable, functional communication tools that work in the harshest and most hostile of environments. To operate safely in these dynamic environments, it is imperative that firefighters have the ability to immediately communicate information accurately.

Communications and interoperability issues are frequently noted as contributing factors in National Institute for Occupational Safety and Health investigative reports on firefighter line of duty deaths. Effective and reliable communications are mission critical to fire department operations.

- CPSM recommends that as a planning objective that within a one-year period the City of Trenton have an independent, objective consultant evaluate the city's emergency communications radio system and make recommendations for improvement or replacement.
  - Because of their mission critical importance to all firefighters, EMS personnel, and police officers, any recommendations for system upgrades or replacement should be budgeted for as soon as possible.
- CPSM recommends that as a planning objective the TFESD explore the feasibility of transitioning its dispatch operations from the police department to a communications center that is more fire and EMS centric. Options could include the Mercer County Communications Center, which already handles calls for TEMS, or exploring a shared services agreement with the newly formed Hamilton Township Fire Department. Priority should be given to addressing interoperability issues, particularly between TFESD and TEMS.

5.6 Despite the ongoing opioid crises, and despite members of both TFESD and TEMS being trained to administer Naloxone, neither organization carries this life-saving treatment. Only the TPD, which may not even respond to many EMS-related incidents, carries Naloxone.

- CPSM recommends that as a planning objective that ALL TFESD and TEMS units be supplied with Naloxone ASAP to provide an additional potential life-saving option when their personnel respond to drug overdoses.

5.7 The City of Trenton has numerous large buildings where even once emergency responders arrive on the scene they may have to travel an extended distance, which takes valuable minutes, to reach the patient. A number of communities, including Jersey City, have implemented programs that incorporate trained volunteers into the emergency medical response system. Similar to Trenton, the driving factors behind these programs are often the dense population along with numerous high-rises where this type of response force can speed initial life-saving care to those in need, particularly where it may take emergency personnel some time to make their way to the patient even after arriving on location.

The American Heart Association continues to recognize the chain of survival by early recognition, early CPR, early defibrillation, and rapid transport. PulsePoint® is an app on an iPhone that can be downloaded by anyone in the community who is willing to participate in this program, enabling them to be notified when someone is having a cardiac arrest in their vicinity. Fifty-seven percent of adults in the United States say they have had CPR training. Utilizing new technology, bystander performance, and active citizenship involvement enhances the care provided to the community.

- CPSM recommends that as a planning objective the TFESD and TEMS should collaboratively explore the possibility of enhancing their technological capabilities to provide increased service to the community for serious cardiac incidents such as through the iPhone PulsePoint® app or other similar programs or apps.

SECTION 6. DATA ANALYSIS

This data analysis examines all calls for service between January 1, 2019, and December 31, 2019, as recorded in the Trenton Police Department's computer-aided dispatch (CAD) system and TFES's National Fire Incident Reporting System (NFIRS).

This analysis is made up of four parts. The first part focuses on call types and dispatches. The second part explores the time spent and the workload of individual units. The third part presents an analysis of the busiest hours in the year studied. The fourth part provides a response time analysis of TFESD units.

During the year covered by this study, TFESD operated out of seven stations, utilizing seven engine companies, three ladder companies, two utility units, two hazmat units, one air and light truck, one marine unit, one rescue, two reserve engines, two reserve ladders, one reserve rescue, and eight field battalion chiefs. Administrative staff for the department includes the fire director, emergency service coordinator, two staff battalion chiefs, and six fire marshals.

During the study period, the fire department responded to 7,726 calls, of which 52 percent were EMS calls. The total combined workload (deployed time) for all TFESD units was 6,899.9 hours. The average dispatch time for the first arriving unit was 1.4 minutes and the average response time of the first arriving TFESD unit was 6.3 minutes. The 90th percentile dispatch time was 2.5 minutes and the 90th percentile response time was 8.5 minutes.

METHODOLOGY

In this report, CPSM analyzes calls and runs. A call is an emergency service request or incident. A run is a dispatch of a unit (i.e., a unit responding to a call). Thus, a call may include multiple runs.

We received CAD data and NFIRS data for the TFESD. We first matched the NFIRS and CAD data based on incident numbers provided. Then, we classified the calls in a series of steps. We first used the NFIRS incident type to identify canceled calls and to assign EMS, motor vehicle accident (MVA), and fire category call types when available. EMS calls were then assigned detailed categories based on the CAD narrative describing each call. When NFIRS incident types were not available, we used the CAD nature field to determine the call type. Mutual aid calls were identified based on the location of each call.

Finally, units lacking en route or arrival time were removed, as were units with no clear time. Calls with no responding TFESD units at this point were not included in the analysis section of the report, resulting in 100 excluded calls. The workload of administrative units is documented in Attachment II.

In this report, canceled and mutual aid calls are included in all analyses other than the response time analyses.

AGGREGATE CALL TOTALS AND RUNS

During the year studied, TFESD responded to 7,726 calls. Of these, 499 were structure fire calls and 168 were outside fire calls within the department's jurisdiction.

Calls by Type

The following table and two figures show the number of calls by call type, average calls per day, and the percentage of calls that fall into each call type category for the 12 months studied.

TABLE 6-1: Call Types

Call Type	Number of Calls	Calls per Day	Call Percentage
Breathing difficulty	989	2.7	12.8
Cardiac and stroke	707	1.9	9.2
Fall and injury	244	0.7	3.2
Illness and other	563	1.5	7.3
MVA	257	0.7	3.3
Overdose and psychiatric	284	0.8	3.7
Seizure and unconsciousness	981	2.7	12.7
EMS Total	**4,025**	**11.0**	**52.1**
False alarm	1,292	3.5	16.7
Good intent	314	0.9	4.1
Hazard	753	2.1	9.7
Outside fire	170	0.5	2.2
Public service	540	1.5	7.0
Structure fire	512	1.4	6.6
Fire Total	**3,581**	**9.8**	**46.3**
Canceled	89	0.2	1.2
Mutual aid	31	0.1	0.4
Total	**7,726**	**21.2**	**100.0**

FIGURE 6-1: EMS Calls by Type

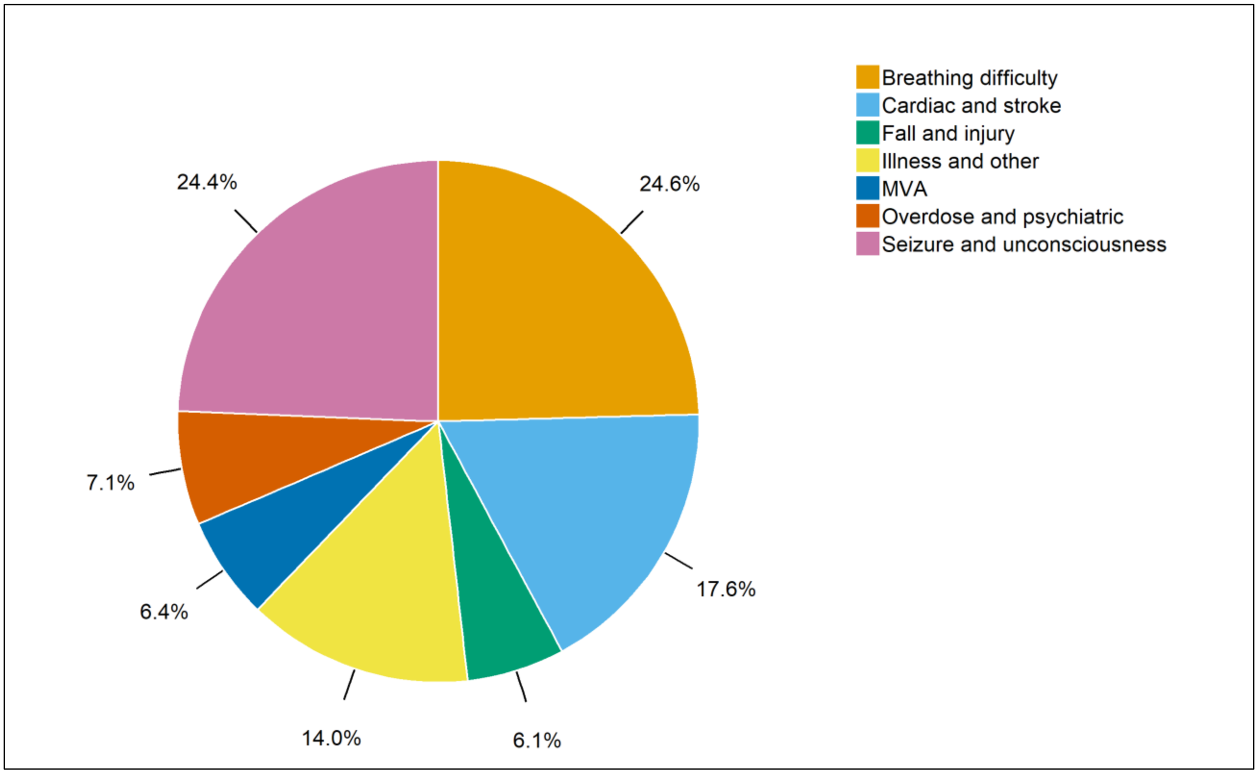
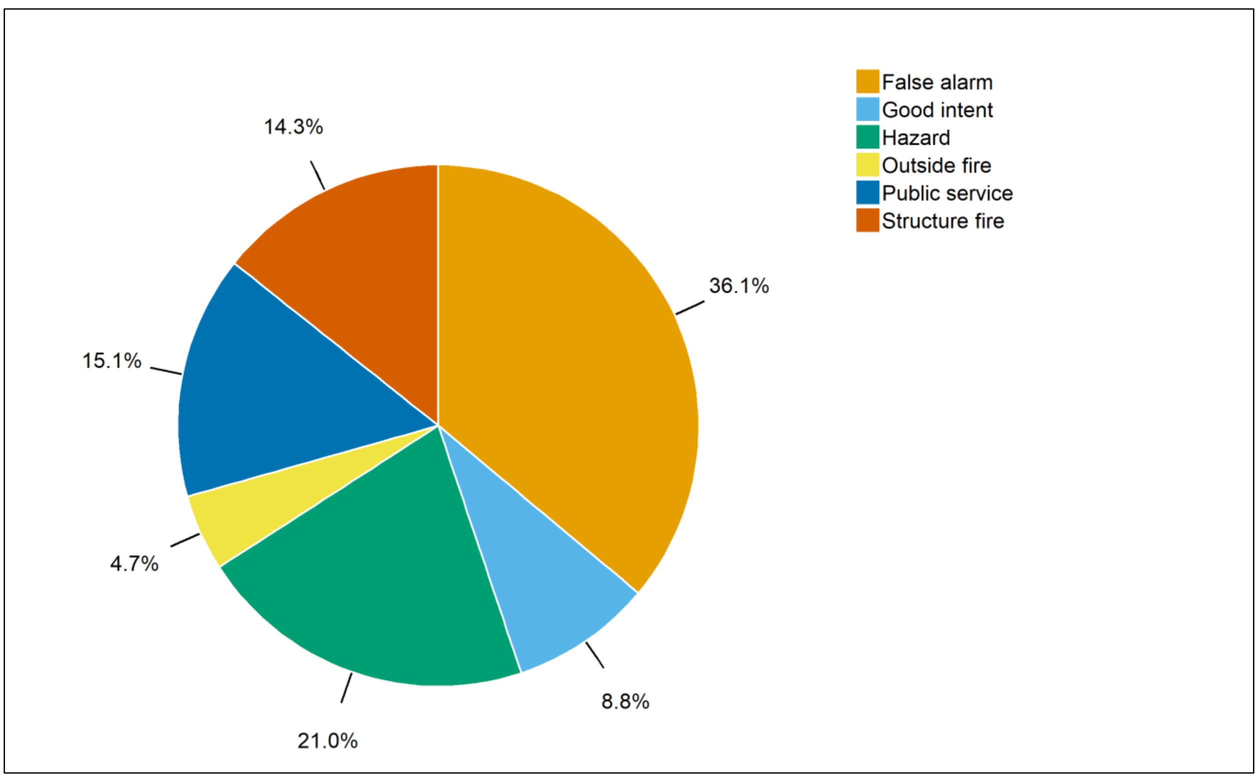


FIGURE 6-2: Fire Calls by Type



Observations:

Overall

- The department received an average of 21.2 calls, including 0.2 canceled and 0.1 mutual aid calls, per day.
- EMS calls for the year totaled 4,025 (52 percent of all calls), an average of 11.0 per day.
- Fire calls for the year totaled 3,581 (46 percent of all calls), an average of 9.8 per day.

EMS

- Breathing difficulty calls were the largest category of EMS calls at 25 percent of EMS calls, an average of 2.7 calls per day.
- Cardiac and stroke calls made up 18 percent of EMS calls, an average of 1.9 calls per day.
- Motor vehicle accidents made up 6 percent of EMS calls, an average of 0.7 calls per day.

Fire

- False alarm calls were the largest category of fire calls at 36 percent of fire calls, an average of 3.5 calls per day.
- Structure and outside fire calls combined made up 19 percent of fire calls, an average of 1.9 calls per day.

Calls by Type and Duration

The following table shows the duration of calls by type using four duration categories: less than 30 minutes, 30 minutes to one hour, one to two hours, and more than an hour.

TABLE 6-2: Calls by Type and Duration

Call Type	Less than 30 Minutes	30 Minutes to One Hour	One to Two Hours	More Than Two Hours	Total
Breathing difficulty	963	24	2	0	989
Cardiac and stroke	688	19	0	0	707
Fall and injury	230	14	0	0	244
Illness and other	515	41	5	2	563
MVA	204	46	5	2	257
Overdose and psychiatric	275	9	0	0	284
Seizure and unconsciousness	930	50	1	0	981
EMS Total	**3,805**	**203**	**13**	**4**	**4,025**
False alarm	1,096	174	19	3	1,292
Good intent	273	36	5	0	314
Hazard	467	193	77	16	753
Outside fire	99	37	26	8	170
Public service	391	86	51	12	540
Structure fire	361	69	34	48	512
Fire Total	**2,687**	**595**	**212**	**87**	**3,581**
Canceled	88	1	0	0	89
Mutual aid	21	4	2	4	31
Total	**6,601**	**803**	**227**	**95**	**7,726**

Observations:

EMS

- A total of 4,008 EMS calls (99 percent) lasted less than one hour, 13 EMS calls (less than 1 percent) lasted one to two hours, and 4 EMS calls (less than 1 percent) lasted two or more hours.
- On average, there were fewer than 0.1 EMS calls per day that lasted more than one hour.
- All cardiac and stroke calls lasted less than one hour.
- A total of 250 motor vehicle accidents (97 percent) lasted less than one hour, 5 motor vehicle accidents (2 percent) lasted one to two hours, and 2 motor vehicle accidents (1 percent) lasted two or more hours.

Fire

- A total of 3,282 fire calls (92 percent) lasted less than one hour, 212 fire calls (6 percent) lasted one to two hours, and 87 fire calls (2 percent) lasted two or more hours.
- On average, there were 0.8 fire calls per day that lasted more than one hour.
- A total of 430 structure fire calls (84 percent) lasted less than one hour, 34 structure fire calls (7 percent) lasted one to two hours, and 48 structure fire calls (9 percent) lasted two or more hours.
- A total of 136 outside fire calls (80 percent) lasted less than one hour, 26 outside fire calls (15 percent) lasted one to two hours, and 8 outside fire calls (5 percent) lasted two or more hours.
- A total of 1,270 false alarm calls (98 percent) lasted less than one hour, 19 false alarm calls (1 percent) lasted one to two hours, and 3 false alarm calls (less than 1 percent) lasted two or more hours.

Calls by Month and Hour

Figure 6-3 shows the monthly variation in the average daily number of calls handled by the TFESD during the year studied. Similarly, Figure 6-4 illustrates the average number of calls received each hour of the day over the year.

FIGURE 6-3: Average Calls per Day, by Month

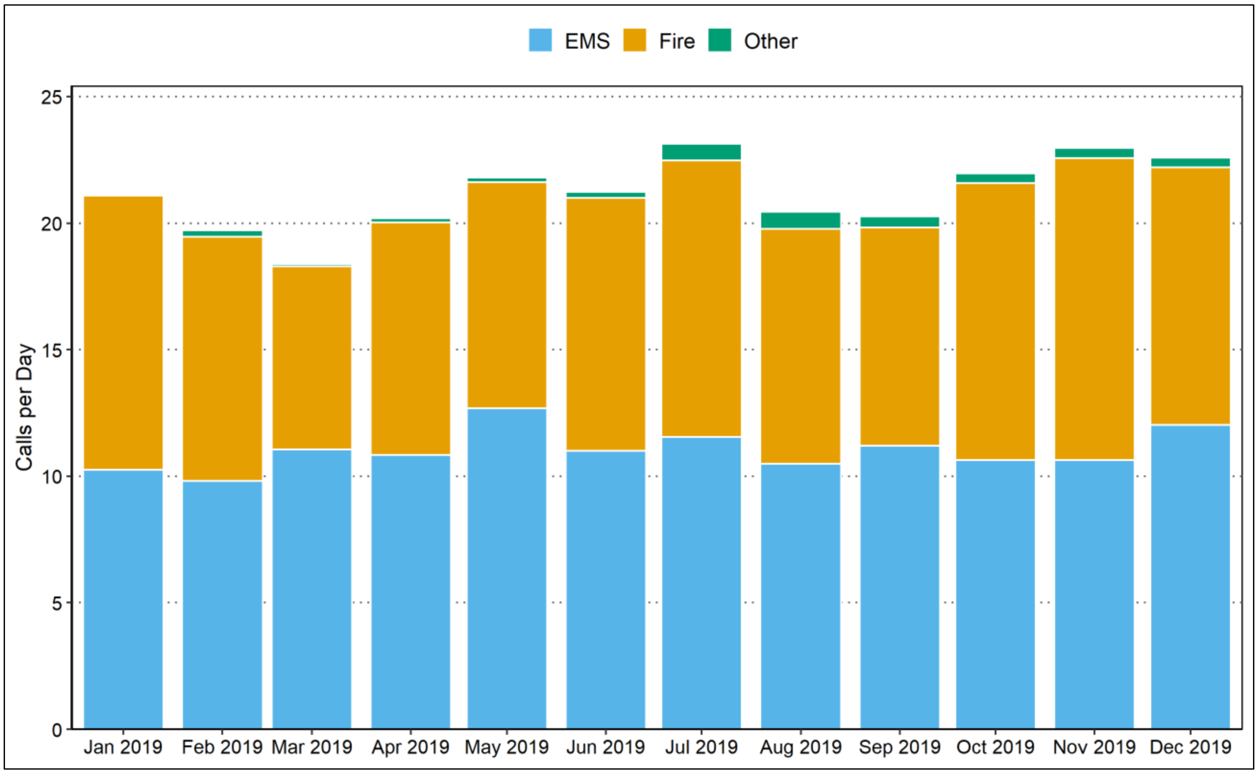
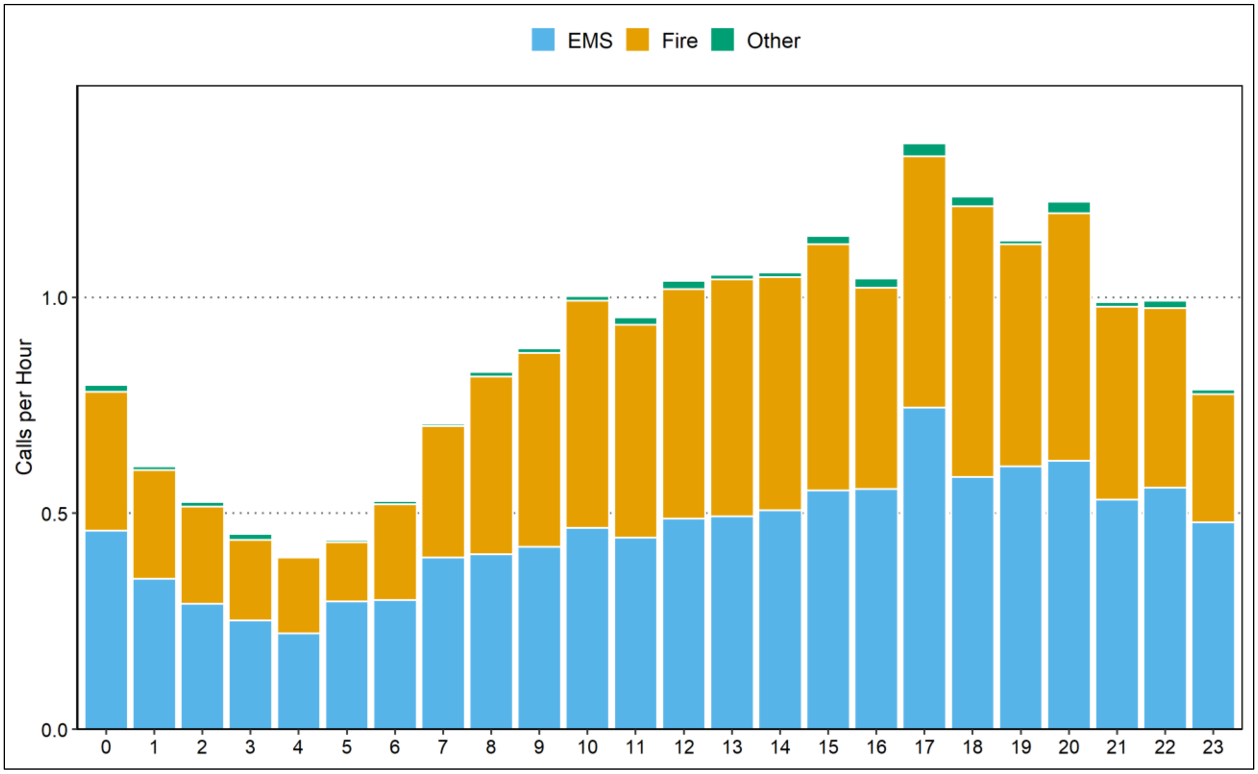


FIGURE 6-4: Calls by Hour of Day



Observations:

Average Calls per Month

- Average EMS calls per day ranged from 9.8 in February 2019 to 12.7 in May 2019.
- Average fire calls per day ranged from 7.2 in March 2019 to 11.9 in November 2019.
- Average other calls per day ranged from fewer than 0.1 in January 2019 to 0.7 in August 2019.
- Average calls per day overall ranged from 18.4 in March 2019 to 23.1 in July 2019.

Average Calls per Hour

- Average EMS calls per hour ranged from 0.2 between 4:00 a.m. and 5:00 a.m. to 0.7 between 5:00 p.m. and 6:00 p.m.
- Average fire calls per hour ranged from 0.1 between 5:00 a.m. and 6:00 a.m. to 0.6 between 6:00 p.m. and 7:00 p.m.
- Average other calls per hour were below 0.1 during all hours.
- Average calls per hour overall ranged from 0.4 between 4:00 a.m. and 5:00 a.m. to 1.4 between 5:00 p.m. and 6:00 p.m.

Units Dispatched to Calls

Table 6-3, along with Figures 6-5 and 6-6, detail the number of TFESD calls with one, two, or three or more units dispatched overall and broken down by call type. Figure 6-6 provides further detail for fire calls.

TABLE 6-3: Calls by Call Type and Number of Units Dispatched

Call Type	Number of Units			Total Calls
	One	Two	Three or More	
Breathing difficulty	983	6	0	989
Cardiac and stroke	705	1	1	707
Fall and injury	234	9	1	244
Illness and other	345	188	30	563
MVA	158	33	66	257
Overdose and psychiatric	282	1	0	284
Seizure and unconsciousness	975	5	1	981
EMS Total	**3,682**	**243**	**100**	**4,025**
False alarm	33	66	1,193	1,292
Good intent	73	67	174	314
Hazard	147	123	483	753
Outside fire	38	71	61	170
Public service	356	82	102	540
Structure fire	17	15	480	512
Fire Total	**664**	**424**	**2,493**	**3,581**
Canceled	71	6	12	89
Mutual aid	12	4	15	31
Total	**4,429**	**677**	**2,620**	**7,726**
Percentage	**57.3**	**8.8**	**33.9**	**100.0**

FIGURE 6-5: Calls by Number of Units Dispatched – EMS

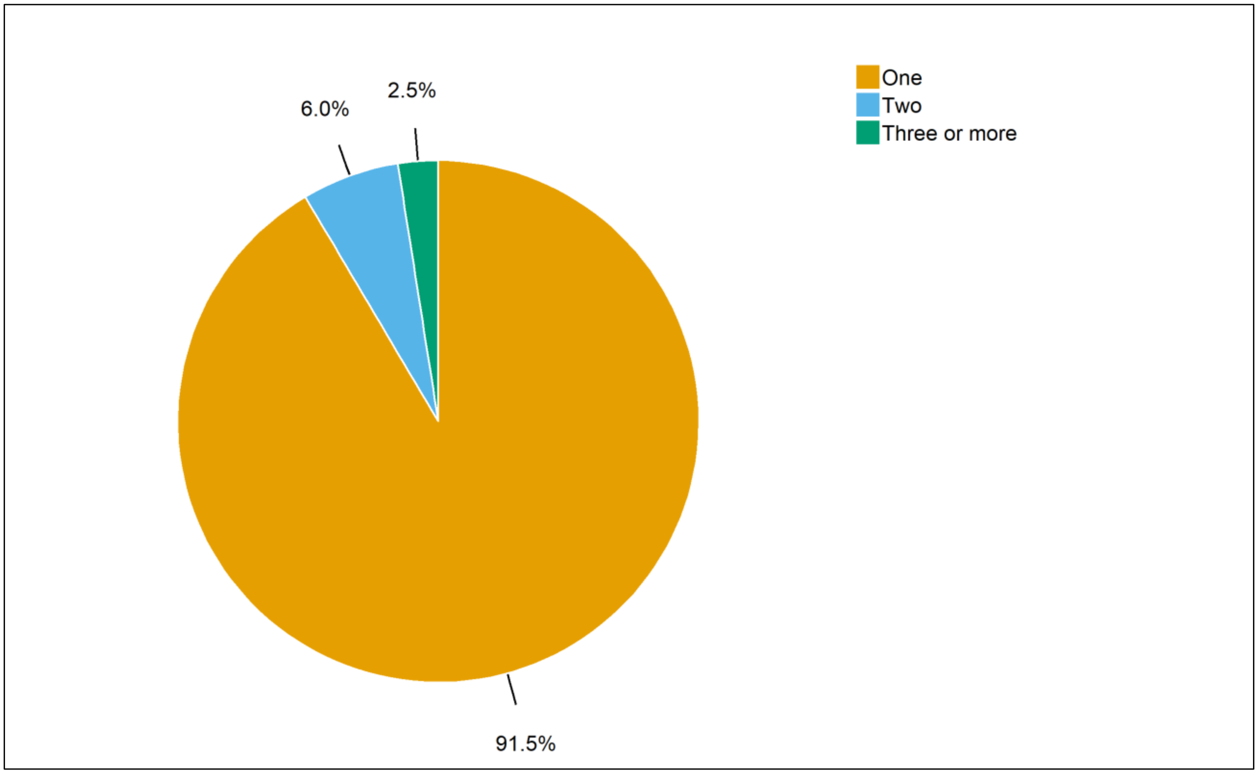
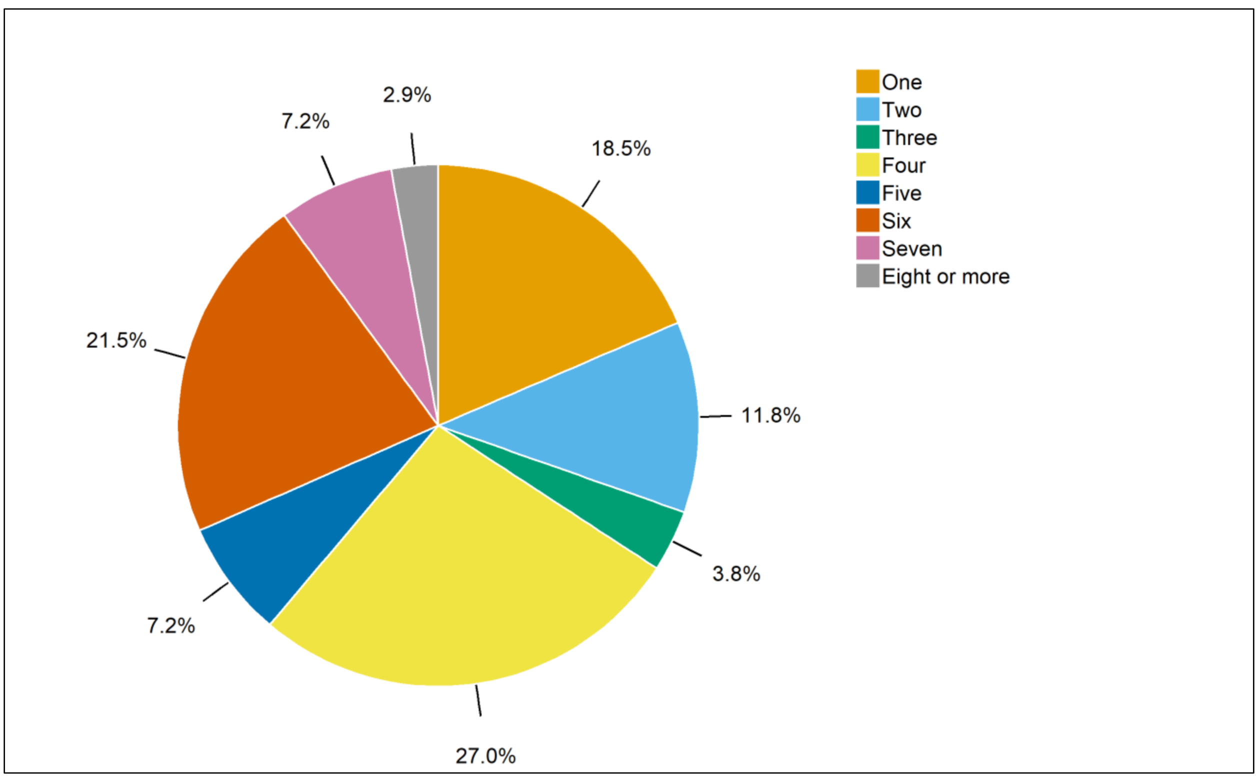


FIGURE 6-6: Calls by Number of Units Dispatched – Fire



Observations:

Overall

- On average, 2.5 units were dispatched to all calls; for 57 percent of calls, only one unit was dispatched.
- Overall, three or more units were dispatched to 34 percent of calls.

EMS

- For EMS calls, one unit was dispatched 91 percent of the time, two units were dispatched 6 percent of the time, and three units were dispatched 3 percent of the time.
- On average, 1.1 units were dispatched per EMS call.

Fire

- For fire calls, one unit was dispatched 19 percent of the time, two units were dispatched 12 percent of the time, three units were dispatched 4 percent of the time, four units were dispatched 27 percent of the time, five units were dispatched 7 percent of the time, six units were dispatched 22 percent of the time, seven units were dispatched 7 percent of the time, and eight or more units were dispatched 3 percent of the time.
- On average, 4.1 units were dispatched per fire call.
- For outside fire calls, three or more units were dispatched 36 percent of the time.
- For structure fire calls, three or more units were dispatched 94 percent of the time.

WORKLOAD: RUNS AND TOTAL TIME SPENT

The workload of each unit is measured in two ways: runs and deployed time. The deployed time of a run is measured from the time a unit is dispatched through the time the unit is cleared. Because multiple units respond to some calls, there are more runs than calls and the average deployed time per run varies from the total duration of calls.

Runs and Deployed Time – All Units

Deployed time, also referred to as deployed hours, is the total deployment time of all units deployed on all runs. The following table shows the total deployed time, both overall and broken down by type of run, for TFESD units during the year studied.

TABLE 6-4: Annual Runs and Deployed Time by Run Type

Call Type	Deployed Minutes per Run	Total Annual Hours	Percent of Total Hours	Deployed Minutes per Day	Total Annual Runs	Runs per Day
Breathing difficulty	12.0	199.0	2.9	32.7	995	2.7
Cardiac and stroke	11.8	139.2	2.0	22.9	710	1.9
Fall and injury	12.8	54.4	0.8	8.9	255	0.7
Illness and other	18.7	273.4	4.0	44.9	877	2.4
MVA	18.2	148.3	2.1	24.4	490	1.3
Overdose and psychiatric	11.9	57.6	0.8	9.5	290	0.8
Seizure and unconsciousness	13.1	216.0	3.1	35.5	990	2.7
EMS Total	**14.2**	**1,087.9**	**15.8**	**178.8**	**4,607**	**12.6**
False alarm	15.8	1,462.6	21.2	240.4	5,569	15.3
Good intent	16.0	318.4	4.6	52.3	1,193	3.3
Hazard	23.9	1,277.7	18.5	210.0	3,205	8.8
Outside fire	28.6	264.3	3.8	43.4	554	1.5
Public service	24.3	413.4	6.0	68.0	1,021	2.8
Structure fire	39.4	1,993.8	28.9	327.8	3,035	8.3
Fire Total	**23.6**	**5,730.2**	**83.0**	**941.9**	**14,577**	**39.9**
Canceled	10.3	25.4	0.4	4.2	148	0.4
Mutual aid	39.4	56.5	0.8	9.3	86	0.2
Other Total	**21.0**	**81.8**	**1.2**	**13.4**	**234**	**0.6**
Total	**21.3**	**6,899.9**	**100.0**	**1,134.2**	**19,418**	**53.2**

Observations:

Overall

- The total deployed time for the year was 6,899.9 hours. The daily average was 18.9 hours for all units combined.
- There were 19,418 runs, including 148 runs dispatched for canceled calls and 86 runs dispatched for mutual aid calls. The daily average was 53.2 runs.

EMS

- EMS runs accounted for 16 percent of the total workload.
- The average deployed time for EMS runs was 14.2 minutes. The deployed time for all EMS runs averaged 3.0 hours per day.

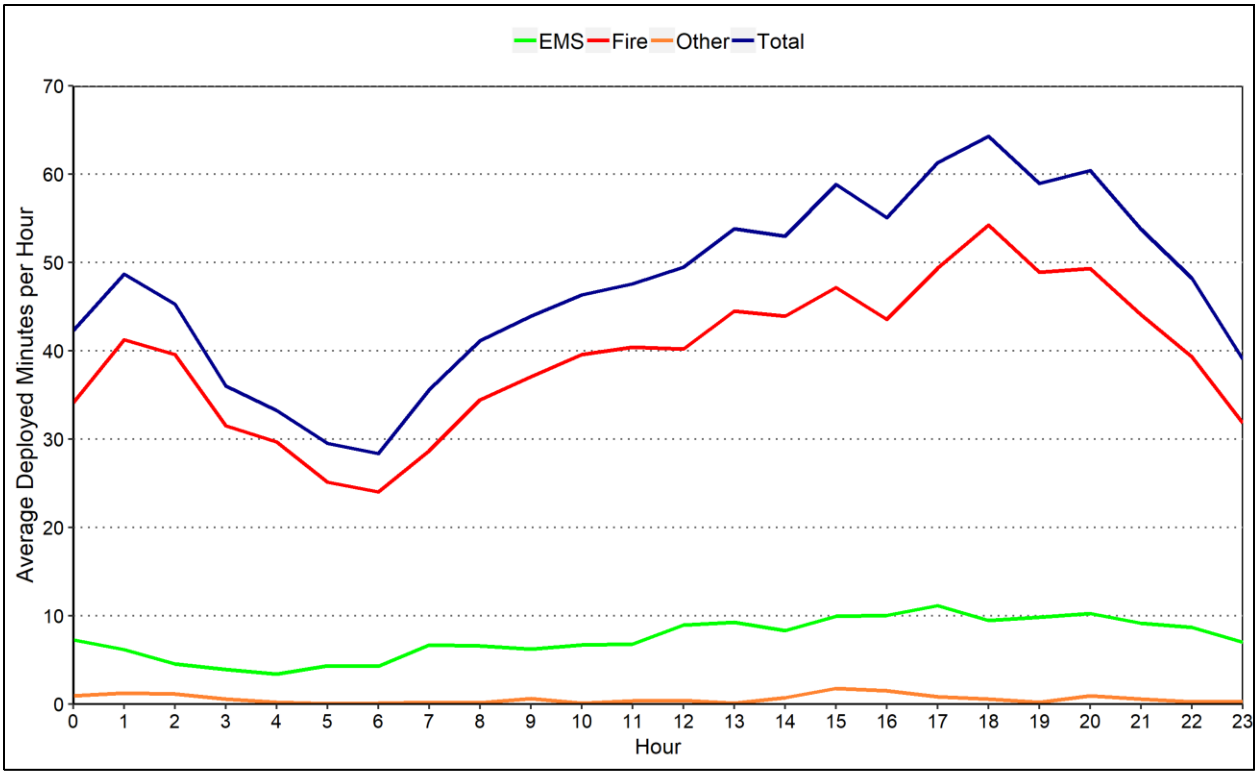
Fire

- Fire runs accounted for 83 percent of the total workload.
- The average deployed time for fire runs was 23.6 minutes. The deployed time for all fire runs averaged 15.7 hours per day.
- There were 3,589 runs for structure and outside fire calls combined, with a total workload of 2,258.1 hours. This accounted for 33 percent of the total workload.
- The average deployed time for outside fire runs was 28.6 minutes per run, and the average deployed time for structure fire runs was 39.4 minutes per run.

TABLE 6-5: Average Deployed Minutes by Hour of Day

Hour	EMS	Fire	Other	Total
0	7.3	34.1	0.9	42.3
1	6.2	41.3	1.2	48.7
2	4.5	39.6	1.2	45.3
3	3.9	31.5	0.6	36.0
4	3.4	29.7	0.2	33.2
5	4.3	25.1	0.1	29.5
6	4.3	24.0	0.1	28.3
7	6.7	28.7	0.2	35.6
8	6.6	34.4	0.1	41.1
9	6.2	37.1	0.6	43.9
10	6.7	39.6	0.1	46.3
11	6.8	40.4	0.3	47.6
12	8.9	40.2	0.4	49.5
13	9.3	44.5	0.1	53.8
14	8.3	43.9	0.7	53.0
15	9.9	47.1	1.7	58.8
16	10.0	43.5	1.5	55.0
17	11.1	49.3	0.8	61.3
18	9.4	54.2	0.6	64.3
19	9.8	48.9	0.2	58.9
20	10.2	49.3	0.9	60.4
21	9.2	44.0	0.6	53.8
22	8.7	39.3	0.2	48.2
23	7.0	31.8	0.3	39.0
Total	**178.8**	**941.6**	**13.4**	**1,133.9**

FIGURE 6-7: Average Deployed Minutes by Hour of Day



Observations:

- Hourly deployed time was highest during the day from 3:00 p.m. to 9:00 p.m., averaging between 55 and 64 minutes.
- The average deployed time peaked between 6:00 p.m. and 7:00 p.m., averaging 64 minutes.
- The average deployed time was lowest between 6:00 a.m. and 7:00 a.m., averaging 28 minutes.

Workload by Unit

Tables 6-6A and 6-6B provide a summary of each unit's workload overall. Tables 6-7A, 6-7B, 6-8A, and 6-8B provide a more detailed view of workload, showing each unit's runs broken out by run type (Tables 6-7A and 6-7B) and the resulting daily average deployed time by run type (Tables 6-8A and 6-8B).

TABLE 6-6A: Call Workload by Station and Unit

Station	Unit ID	Unit Type	Deployed Minutes per Run	Total Annual Hours	Deployed Minutes per Day	Annual Runs	Runs per Day
1	ENG1	Engine	19.2	551.1	90.6	1,726	4.7
	LAD1	Ladder	23.9	434.5	71.4	1,089	3.0
	MAR1	Marine	44.4	23.7	3.9	32	0.1
		Total	**21.3**	**1,009.3**	**165.9**	**2,847**	**7.8**
3	ENG3	Engine	20.1	654.6	107.6	1,952	5.3
	LAD2	Ladder	25.0	391.4	64.3	938	2.6
		Total	**21.7**	**1,046.0**	**171.9**	**2,890**	**7.9**
6	ENG6	Engine	21.4	375.5	61.7	1,054	2.9
		Total	**21.4**	**375.5**	**61.7**	**1,054**	**2.9**
7	ENG7	Engine	20.3	571.6	94.0	1,690	4.6
	RE7	Reserve engine	0.1	0.0	0.0	1	0.0
		Total	**20.3**	**571.6**	**94.0**	**1,691**	**4.6**
8	ENG8	Engine	19.7	494.6	81.3	1,509	4.1
		Total	**19.7**	**494.6**	**81.3**	**1,509**	**4.1**
9	ENG9	Engine	22.5	294.8	48.5	785	2.2
	RE9	Reserve engine	92.7	1.5	0.3	1	0.0
	SS2	Utility	68.1	7.9	1.3	7	0.0
		Total	**23.0**	**304.3**	**50.0**	**793**	**2.2**
10	ENG10	Engine	18.0	677.0	111.3	2,255	6.2
	HM1	Hazmat	19.7	117.4	19.3	358	1.0
	LAD4	Ladder	22.2	488.7	80.3	1,319	3.6
	RES1	Rescue	18.3	580.4	95.4	1,904	5.2
	RL2	Reserve ladder	105.0	5.2	0.9	3	0.0
	RL4	Reserve ladder	37.6	3.1	0.5	5	0.0
	RR1	Reserve rescue	80.3	10.7	1.8	8	0.0
	SS1	Air and light truck	80.9	121.4	20.0	90	0.2
	U12	Utility	224.4	15.0	2.5	4	0.0
		Total	**20.4**	**2,018.9**	**331.9**	**5,946**	**16.3**

TABLE 6-6B: Call Workload – Battalion Chiefs

Unit ID	Deployed Minutes per Run	Total Annual Hours	Deployed Minutes per Day	Annual Runs	Runs per Day
BC1	23.5	91.2	15.0	233	0.6
BC1A	39.3	11.1	1.8	17	0.0
BC2	25.7	130.6	21.5	305	0.8
BC2A	30.2	6.5	1.1	13	0.0
BC3	23.6	110.0	18.1	280	0.8
BC3A	17.1	2.8	0.5	10	0.0
BC4	24.2	134.5	22.1	333	0.9
BC4A	11.5	0.4	0.1	2	0.0
BC5	21.1	77.4	12.7	220	0.6
BC5A	16.6	8.3	1.4	30	0.1
BC6	25.2	72.6	11.9	173	0.5
BC6A	27.9	73.5	12.1	158	0.4
BC7	26.2	104.5	17.2	239	0.7
BC7A	21.8	29.8	4.9	82	0.2
BC8	18.7	116.7	19.2	374	1.0
BC8A	22.4	4.1	0.7	11	0.0
BC9	33.8	46.1	7.6	82	0.2
BC10	19.3	32.7	5.4	102	0.3
CAR1	36.4	6.1	1.0	10	0.0
CAR2	88.2	20.6	3.4	14	0.0
Total	**24.1**	**1,079.7**	**177.5**	**2,688**	**7.4**

TABLE 6-7A: Total Annual Runs by Run Type, Station, and Unit

Station	Unit ID	Unit Type	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
1	ENG1	Engine	480	519	88	242	39	67	258	26	7	1,726
	LAD1	Ladder	127	377	65	186	29	114	180	6	5	1,089
	MAR1	Marine	20	0	2	0	0	7	0	0	3	32
		Total	**627**	**896**	**155**	**428**	**68**	**188**	**438**	**32**	**15**	**2,847**
3	ENG3	Engine	885	401	81	210	49	67	227	17	15	1,952
	LAD2	Ladder	104	333	59	135	40	96	157	11	3	938
		Total	**989**	**734**	**140**	**345**	**89**	**163**	**384**	**28**	**18**	**2,890**
6	ENG6	Engine	306	288	63	156	45	36	152	7	1	1,054
		Total	**306**	**288**	**63**	**156**	**45**	**36**	**152**	**7**	**1**	**1,054**
7	ENG7	Engine	656	356	91	222	49	99	200	11	6	1,690
	RE7	Reserve engine	0	0	0	0	0	0	1	0	0	1
		Total	**656**	**356**	**91**	**222**	**49**	**99**	**201**	**11**	**6**	**1,691**
8	ENG8	Engine	627	337	101	182	25	62	166	8	1	1,509
		Total	**627**	**337**	**101**	**182**	**25**	**62**	**166**	**8**	**1**	**1,509**
9	ENG9	Engine	184	242	48	124	12	49	123	2	1	785
	RE9	Reserve engine	0	0	0	0	0	0	1	0	0	1
	SS2	Utility	0	0	1	1	0	5	0	0	0	7
		Total	**184**	**242**	**49**	**125**	**12**	**54**	**124**	**2**	**1**	**793**
10	ENG10	Engine	681	644	104	324	69	76	331	22	4	2,255
	HM1	Hazmat	7	17	61	248	1	11	6	5	2	358
	LAD4	Ladder	141	499	76	182	37	115	252	8	9	1,319
	RES1	Rescue	282	354	186	520	83	122	330	13	14	1,904
	RL2	Reserve ladder	0	0	0	0	0	0	3	0	0	3
	RL4	Reserve ladder	0	2	0	1	0	0	2	0	0	5
	RR1	Reserve rescue	2	0	0	0	0	0	6	0	0	8
	SS1	Air & light truck	2	3	0	7	5	4	69	0	0	90
	U12	Utility	0	0	0	0	0	0	4	0	0	4
		Total	**1,115**	**1,519**	**427**	**1,282**	**195**	**328**	**1,003**	**48**	**29**	**5,946**

TABLE 6-7B: Total Annual Runs by Run Type – Battalion Chiefs

Unit ID	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
BC1	6	102	10	47	3	4	58	1	2	233
BC1A	1	11	2	1	0	1	1	0	0	17
BC2	17	128	21	55	5	8	67	1	3	305
BC2A	1	6	1	1	2	1	1	0	0	13
BC3	9	117	16	56	6	11	63	0	2	280
BC3A	0	4	0	1	0	0	5	0	0	10
BC4	17	158	21	51	9	4	69	3	1	333
BC4A	0	2	0	0	0	0	0	0	0	2
BC5	5	103	8	37	4	13	50	0	0	220
BC5A	0	15	5	6	0	1	3	0	0	30
BC6	7	78	17	30	7	3	28	2	1	173
BC6A	6	78	11	21	4	5	31	1	1	158
BC7	6	98	18	33	7	13	59	2	3	239
BC7A	1	43	10	16	2	3	7	0	0	82
BC8	17	154	12	82	8	20	80	0	1	374
BC8A	0	6	1	0	1	0	3	0	0	11
BC9	6	36	5	11	4	0	20	0	0	82
BC10	4	44	7	15	6	3	20	2	1	102
CAR1	0	6	1	1	1	0	1	0	0	10
CAR2	0	8	1	1	2	1	1	0	0	14
Total	**103**	**1,197**	**167**	**465**	**71**	**91**	**567**	**12**	**15**	**2,688**

TABLE 6-8A: Daily Average Deployed Minutes by Run Type, Station, and Unit

Station	Unit ID	Unit Type	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
1	ENG1	Engine	18.7	21.1	3.9	16.5	2.8	3.8	22.0	0.7	1.2	90.6
	LAD1	Ladder	6.8	17.3	3.3	12.4	2.1	9.6	18.9	0.1	0.8	71.4
	MAR1	Marine	2.3	0.0	0.1	0.0	0.0	0.7	0.0	0.0	0.8	3.9
		Total	**27.9**	**38.4**	**7.2**	**28.9**	**4.9**	**14.1**	**40.9**	**0.8**	**2.8**	**165.9**
3	ENG3	Engine	32.6	18.9	4.0	15.6	3.8	5.7	25.8	0.4	0.9	107.6
	LAD2	Ladder	4.6	16.4	3.0	9.9	3.0	5.8	21.3	0.2	0.1	64.3
		Total	**37.2**	**35.3**	**7.0**	**25.5**	**6.8**	**11.5**	**47.1**	**0.7**	**1.0**	**171.9**
6	ENG6	Engine	10.3	14.3	2.6	9.7	4.3	2.2	18.1	0.2	0.0	61.7
		Total	**10.3**	**14.3**	**2.6**	**9.7**	**4.3**	**2.2**	**18.1**	**0.2**	**0.0**	**61.7**
7	ENG7	Engine	24.3	15.7	3.8	16.2	4.8	5.2	23.5	0.3	0.2	94.0
	RE7	Reserve engine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	**24.3**	**15.7**	**3.8**	**16.2**	**4.8**	**5.2**	**23.5**	**0.3**	**0.2**	**94.0**
8	ENG8	Engine	24.0	15.3	4.7	13.9	2.7	4.4	16.1	0.1	0.0	81.3
		Total	**24.0**	**15.3**	**4.7**	**13.9**	**2.7**	**4.4**	**16.1**	**0.1**	**0.0**	**81.3**
9	ENG9	Engine	8.2	10.1	2.2	9.3	1.2	4.7	12.6	0.1	0.0	48.5
	RE9	Reserve engine	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
	SS2	Utility	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.3
		Total	**8.2**	**10.1**	**2.3**	**9.3**	**1.2**	**6.0**	**12.9**	**0.1**	**0.0**	**50.0**
10	ENG10	Engine	19.6	27.4	4.5	19.8	5.2	4.1	29.5	0.6	0.6	111.3
	HM1	Hazmat	0.4	0.5	2.4	14.6	0.2	0.6	0.2	0.2	0.1	19.3
	LAD4	Ladder	6.4	23.1	3.2	10.6	2.4	7.8	25.2	0.3	1.2	80.3
	RES1	Rescue	14.1	11.3	7.3	29.1	4.2	5.0	22.5	0.4	1.5	95.4
	RL2	Reserve ladder	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.9
	RL4	Reserve ladder	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.5
	RR1	Reserve rescue	0.1	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	1.8
	SS1	Air & light truck	0.5	0.1	0.0	0.6	0.3	1.3	17.3	0.0	0.0	20.0
	U12	Utility	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	2.5
		Total	**41.1**	**62.5**	**17.4**	**74.7**	**12.2**	**18.9**	**100.1**	**1.6**	**3.4**	**331.9**

TABLE 6-8B: Daily Average Deployed Minutes by Run Type – Battalion Chiefs

Unit ID	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
BC1	0.3	4.1	0.3	3.1	0.1	0.3	6.4	0.0	0.4	15.0
BC1A	0.0	0.6	0.1	0.0	0.0	0.0	1.1	0.0	0.0	1.8
BC2	0.6	5.3	0.8	3.7	0.4	0.5	9.6	0.1	0.5	21.5
BC2A	0.0	0.3	0.1	0.1	0.3	0.0	0.3	0.0	0.0	1.1
BC3	0.7	4.0	0.6	3.0	0.5	0.7	8.4	0.0	0.3	18.1
BC3A	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5
BC4	1.1	6.2	1.1	4.0	0.6	0.1	8.7	0.1	0.0	22.1
BC4A	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
BC5	0.1	3.4	0.2	2.3	0.1	0.7	5.8	0.0	0.0	12.7
BC5A	0.0	0.6	0.2	0.5	0.0	0.0	0.1	0.0	0.0	1.4
BC6	0.3	3.5	0.8	2.2	0.4	0.1	4.4	0.0	0.0	11.9
BC6A	0.4	3.4	0.4	2.5	0.7	0.5	4.0	0.0	0.1	12.1
BC7	0.4	4.3	1.0	2.9	1.3	1.3	5.5	0.1	0.4	17.2
BC7A	0.1	2.1	0.5	1.4	0.4	0.1	0.3	0.0	0.0	4.9
BC8	1.2	6.2	0.4	4.7	0.5	0.9	5.3	0.0	0.0	19.2
BC8A	0.0	0.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7
BC9	0.4	1.1	0.2	0.4	0.5	0.0	4.9	0.0	0.0	7.6
BC10	0.2	1.7	0.4	1.0	0.3	0.2	1.4	0.1	0.0	5.4
CAR1	0.0	0.4	0.0	0.1	0.0	0.0	0.5	0.0	0.0	1.0
CAR2	0.0	1.3	0.0	0.0	0.3	0.2	1.6	0.0	0.0	3.4
Total	**5.9**	**48.8**	**7.3**	**32.0**	**6.5**	**5.7**	**69.1**	**0.4**	**1.8**	**177.5**

Observations:

- On a station level, station 10 made the most runs (5,946, or an average of 16.3 runs per day) and had the highest total annual deployed time (2,018.9 hours, or an average of 5.5 hours per day).
  - EMS calls accounted for 19 percent of runs and 12 percent of total deployed time.
  - Structure and outside fire calls accounted for 20 percent of runs and 34 percent of total deployed time.
- On a station level, Station 3 made the second-most runs (2,890, or an average of 7.9 runs per day) and had the second-highest total annual deployed time (1,046.0 hours, or an average of 2.9 hours per day).
  - EMS calls accounted for 34 percent of runs and 22 percent of total deployed time.
  - Structure and outside fire calls accounted for 16 percent of runs and 31 percent of total deployed time.
- On a unit level, ENG10 made the most runs (2,255, or an average of 6.2 runs per day), and had the highest total annual deployed time (677.0 hours, or an average of 111.3 minutes per day).
  - EMS calls accounted for 30 percent of runs and 18 percent of total deployed time.
  - Structure and outside fire calls accounted for 18 percent of runs and 31 percent of total deployed time.
- On a unit level, ENG3 made the second-most runs (1,952, or an average of 5.3 runs per day), and had the second-highest total annual deployed time (654.6 hours, or an average of 107.6 minutes per day).
  - EMS calls accounted for 45 percent of runs and 30 percent of total deployed time.
  - Structure and outside fire calls accounted for 14 percent of runs and 27 percent of total deployed time.

ANALYSIS OF BUSIEST HOURS

There is significant variability in the number of calls from hour to hour. One special concern relates to the resources available for hours with the heaviest workload. We tabulated the data for each of the 8,760 hours in the year. Table 6-9 shows the number of hours in the year in which there were zero to five or more calls during the hour. Table 6-10 examines the number of times a call within a station's first due area overlapped with another call within the same area. Table 6-11 examines the availability of a unit at a station to respond to calls within its first due area. Table 6-12 shows the 10 one-hour intervals which had the most calls during the year.

TABLE 6-9: Frequency Distribution of the Number of Calls

Calls in an Hour	Frequency	Percentage
0	3,783	43.2
1	3,016	34.4
2	1,373	15.7
3	442	5.0
4	120	1.4
5+	26	0.3
Total	**8,760**	**100.0**

TABLE 6-10: Frequency of Overlapping Calls

Station	Scenario	Number of Calls	Percent of All Calls	Total Hours
1	No overlapped call	986	97.0	346.6
	Overlapped with one call	30	3.0	6.3
3	No overlapped call	1,667	91.8	615.1
	Overlapped with one call	137	7.5	24.8
	Overlapped with two calls	10	0.6	1.5
	Overlapped with three calls	1	0.1	0.0
6	No overlapped call	754	97.2	270.0
	Overlapped with one call	21	2.7	4.4
	Overlapped with two calls	1	0.1	0.2
7	No overlapped call	1,198	96.2	408.1
	Overlapped with one call	46	3.7	8.5
	Overlapped with two calls	1	0.1	0.1
8	No overlapped call	1,138	96.1	393.3
	Overlapped with one call	45	3.8	7.7
	Overlapped with two calls	1	0.1	0.1
9	No overlapped call	401	97.6	170.2
	Overlapped with one call	9	2.2	3.5
	Overlapped with two calls	1	0.2	0.2
10	No overlapped call	1,222	96.1	345.0
	Overlapped with one call	47	3.7	8.8
	Overlapped with two calls	2	0.2	0.2

TABLE 6-11: Station Availability to Respond to Calls

Station	Calls in Area	First Due Responded	First Due Arrived	First Due First	Percent Responded	Percent Arrived	Percent First
1	998	857	854	755	85.9	85.6	75.7
3	1,773	1,584	1,581	1,394	89.3	89.2	78.6
6	765	648	642	568	84.7	83.9	74.2
7	1,213	1,008	1,001	905	83.1	82.5	74.6
8	1,172	1,017	1,013	913	86.8	86.4	77.9
9	403	360	357	323	89.3	88.6	80.1
10	1,234	1,154	1,154	1,082	93.5	93.5	87.7
Total	**7,558**	**6,628**	**6,602**	**5,940**	**87.7**	**87.4**	**78.6**

Note: For each station, we count the number of calls occurring within its first due area. Then, we count the number of calls to where at least one TFESD unit responded. Next, we focus on units from the first due station to see if any units responded, arrived, or arrived first.

TABLE 6-12: Top 10 Hours with the Most Calls Received

Hour	Number of Calls	Number of Runs	Total Deployed Hours
5/29/2019, 6:00 p.m. to 7:00 p.m.	14	40	8.2
7/22/2019, 6:00 p.m. to 7:00 p.m.	14	31	12.1
11/1/2019, 6:00 a.m. to 7:00 a.m.	7	16	4.2
2/3/2019, 5:00 p.m. to 6:00 p.m.	6	16	3.9
10/21/2019, 5:00 p.m. to 6:00 p.m.	6	13	5.6
7/22/2019, 7:00 p.m. to 8:00 p.m.	6	10	4.9
5/25/2019, 10:00 p.m. to 11:00 p.m.	6	9	1.8
9/15/2019, 10:00 p.m. to 11:00 p.m.	6	7	1.2
12/13/2019, 10:00 p.m. to 11:00 p.m.	6	6	1.7
8/7/2019, 3:00 a.m. to 4:00 a.m.	6	6	1.3

Note: Total deployed hours is a measure of the total time spent responding to calls received in the hour, and which may extend into the next hour or hours. The number of runs and deployed hours only includes TFESD units.

Observations:

- During 26 hours (0.3 percent of all hours), five or more calls occurred; in other words, the department responded to five or more calls in an hour roughly once every 14 days.
  - The highest number of calls to occur in an hour was 14, which happened twice.
- One of the two hours with the most calls was 6:00 p.m. to 7:00 p.m. on May 29, 2019.
  - The hour's 14 calls involved 40 individual dispatches resulting in 8.2 hours of deployed time. These 14 calls included six public service calls, five illness and other calls, two false alarm calls, and one hazard call.
- The other hour with the most calls was 6:00 p.m. to 7:00 p.m. on July 22, 2019.
  - The hour's 14 calls involved 31 individual dispatches resulting in 12.1 hours of deployed time. These 14 calls included five public service calls, four hazard calls, three false alarm calls, one canceled call, and one good intent call.

RESPONSE TIME

In this part of the analysis, we present response time statistics for different call types. We separate response time into its identifiable components. *Dispatch time* is the difference between the time a call is received and the time a unit is dispatched. Dispatch time includes call processing time, which is the time required to determine the nature of the emergency and types of resources to dispatch. *Turnout time* is the difference between dispatch time and the time a unit is en route to a call's location. *Travel time* is the difference between the time en route and arrival on scene. *Response time* is the total time elapsed between receiving a call to arriving on scene.

In this analysis, we included all calls to which at least one non-administrative TFES unit responded while excluding canceled and mutual aid calls. Also, calls with a total response time of more than 30 minutes were excluded. Finally, we focused on units that had complete time stamps, that is, units with all components recorded, so that we could calculate each segment of response time.

Based on the methodology above, we excluded 120 canceled and mutual aid calls, 248 calls where no units recorded a valid on-scene time, 15 calls where the first arriving unit response was greater than 30 minutes, and 1,709 calls where one or more segments of first arriving unit's response time could not be calculated due to missing or faulty data. As a result, in this section, a total of 5,634 calls are included in the analysis.

Response Time by Type of Call

Table 6-13 provides average dispatch, turnout, travel, and total response time for the first arriving unit to each call in the city, broken out by call type. Figures 6-6 and 6-7 illustrate the same information. Table 6-14 gives the 90th percentile time broken out in the same manner. A 90th percentile time means that 90 percent of calls had response times at or below that number. For example, Table 6-14 shows a 90th percentile response time of 8.5 minutes which means that 90 percent of the time a call had a response time of no more than 8.5 minutes.

TABLE 6-13: Average Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.1	2.3	2.8	6.2	772
Cardiac and stroke	1.1	2.2	2.8	6.1	552
Fall and injury	1.0	2.1	2.6	5.7	167
Illness and other	1.3	2.3	3.0	6.7	402
MVA	0.7	2.1	2.4	5.2	164
Overdose and psychiatric	0.9	2.2	2.6	5.7	209
Seizure and unconsciousness	1.1	2.1	2.7	5.9	753
EMS Total	**1.1**	**2.2**	**2.8**	**6.1**	**3,019**
False alarm	1.8	2.2	2.2	6.3	944
Good intent	1.7	2.2	2.6	6.5	237
Hazard	1.7	2.3	2.6	6.6	570
Outside fire	1.6	2.2	2.4	6.3	112
Public service	1.6	2.6	3.8	7.9	377
Structure fire	1.5	2.0	2.1	5.7	375
Fire Total	**1.7**	**2.2**	**2.6**	**6.5**	**2,615**
Total	**1.4**	**2.2**	**2.7**	**6.3**	**5,634**

FIGURE 6-8: Average Response Time of First Arriving Unit, by Call Type – EMS

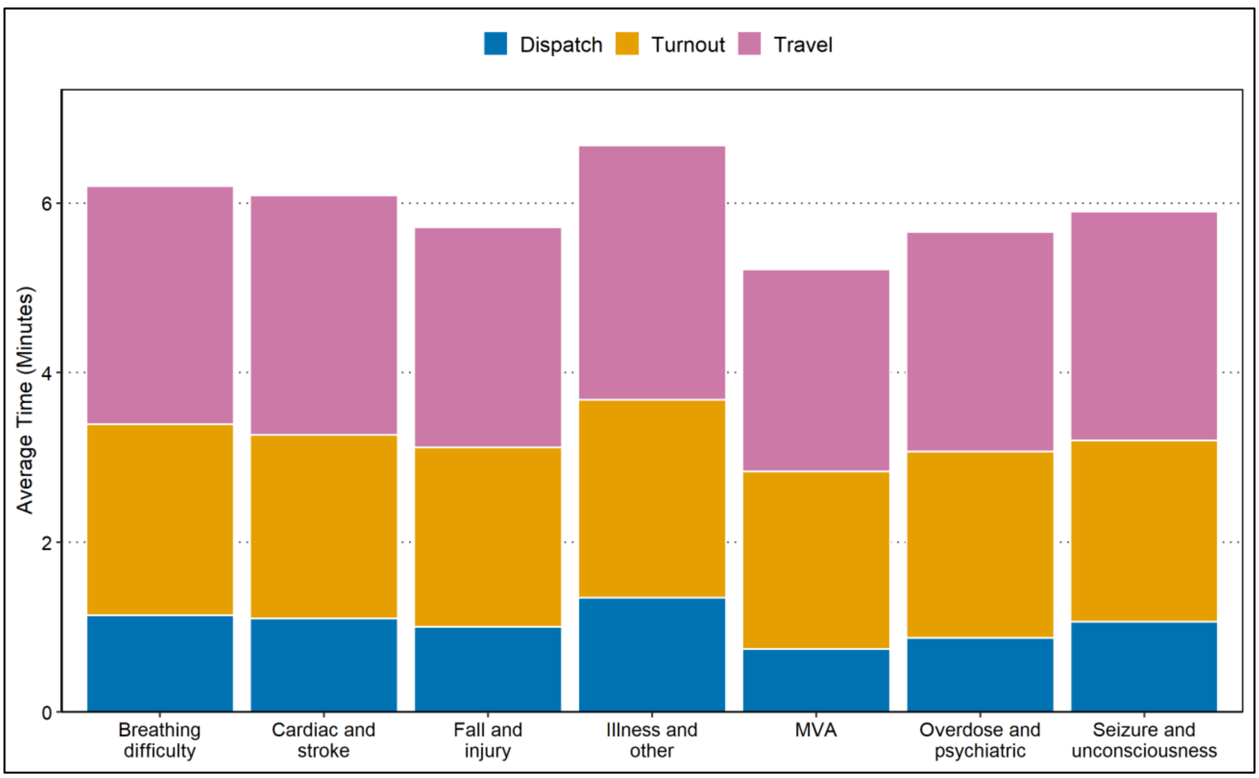


FIGURE 6-9: Average Response Time of First Arriving Unit, by Call Type – Fire

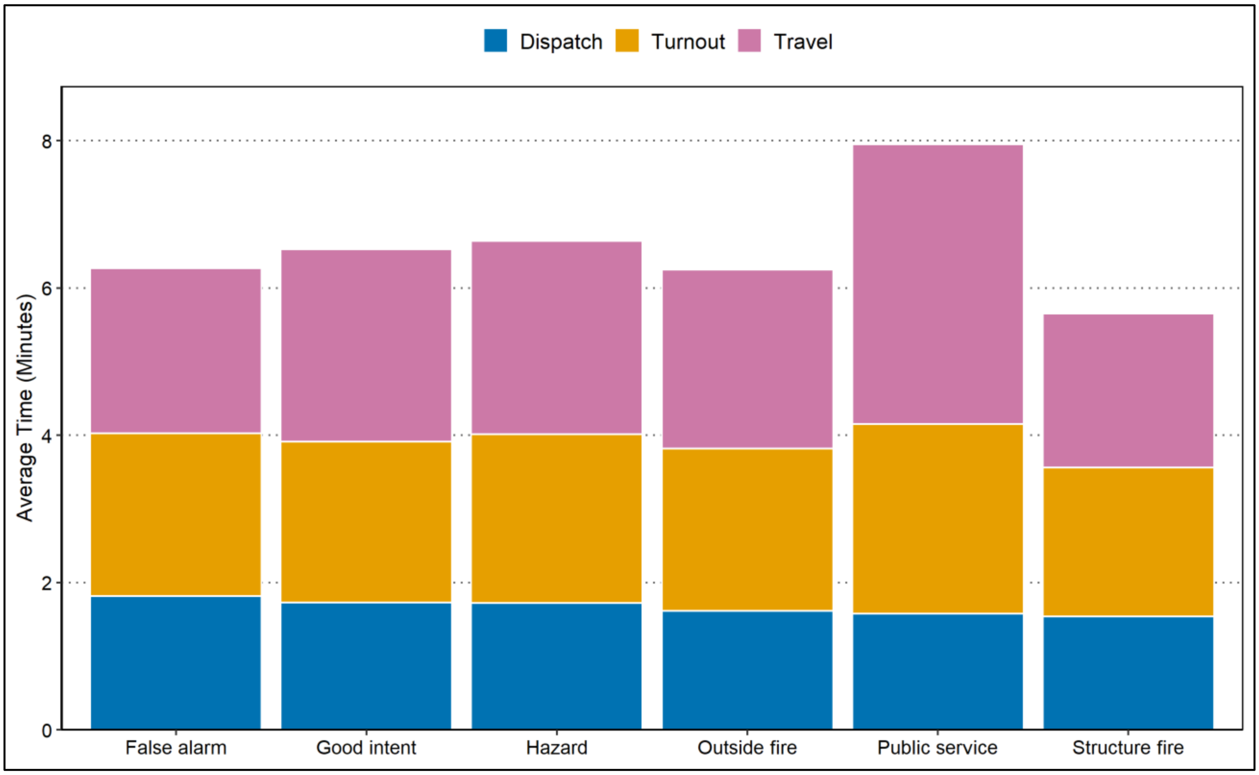


TABLE 6-14: 90th Percentile Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.9	3.8	4.8	8.5	772
Cardiac and stroke	1.8	3.5	4.6	7.9	552
Fall and injury	2.1	3.6	4.4	7.8	167
Illness and other	2.2	3.8	5.0	8.9	402
MVA	1.4	3.4	4.3	7.1	164
Overdose and psychiatric	1.6	3.6	4.4	7.9	209
Seizure and unconsciousness	1.8	3.7	4.7	7.7	753
EMS Total	**1.9**	**3.7**	**4.7**	**8.2**	**3,019**
False alarm	2.9	3.7	3.8	8.2	944
Good intent	3.1	3.5	4.7	8.7	237
Hazard	3.0	3.8	4.6	9.1	570
Outside fire	2.7	3.5	4.0	8.0	112
Public service	2.8	4.2	7.3	11.7	377
Structure fire	2.7	3.4	3.4	7.2	375
Fire Total	**2.9**	**3.8**	**4.5**	**8.8**	**2,615**
Total	**2.5**	**3.7**	**4.6**	**8.5**	**5,634**

Observations:

- The average dispatch time was 1.4 minutes.
- The average turnout time was 2.2 minutes.
- The average travel time was 2.7 minutes.
- The average total response time was 6.3 minutes.
- The average response time was 6.1 minutes for EMS calls and 6.5 minutes for fire calls.
- The average response time was 6.3 minutes for outside fires and 5.7 minutes for structure fires.
- The 90th percentile dispatch time was 2.5 minutes.
- The 90th percentile turnout time was 3.7 minutes.
- The 90th percentile travel time was 4.6 minutes.
- The 90th percentile total response time was 8.5 minutes.
- The 90th percentile response time was 8.2 minutes for EMS calls and 8.8 minutes for fire calls.
- The 90th percentile response time was 8.0 minutes for outside fires and 7.2 minutes for structure fires.

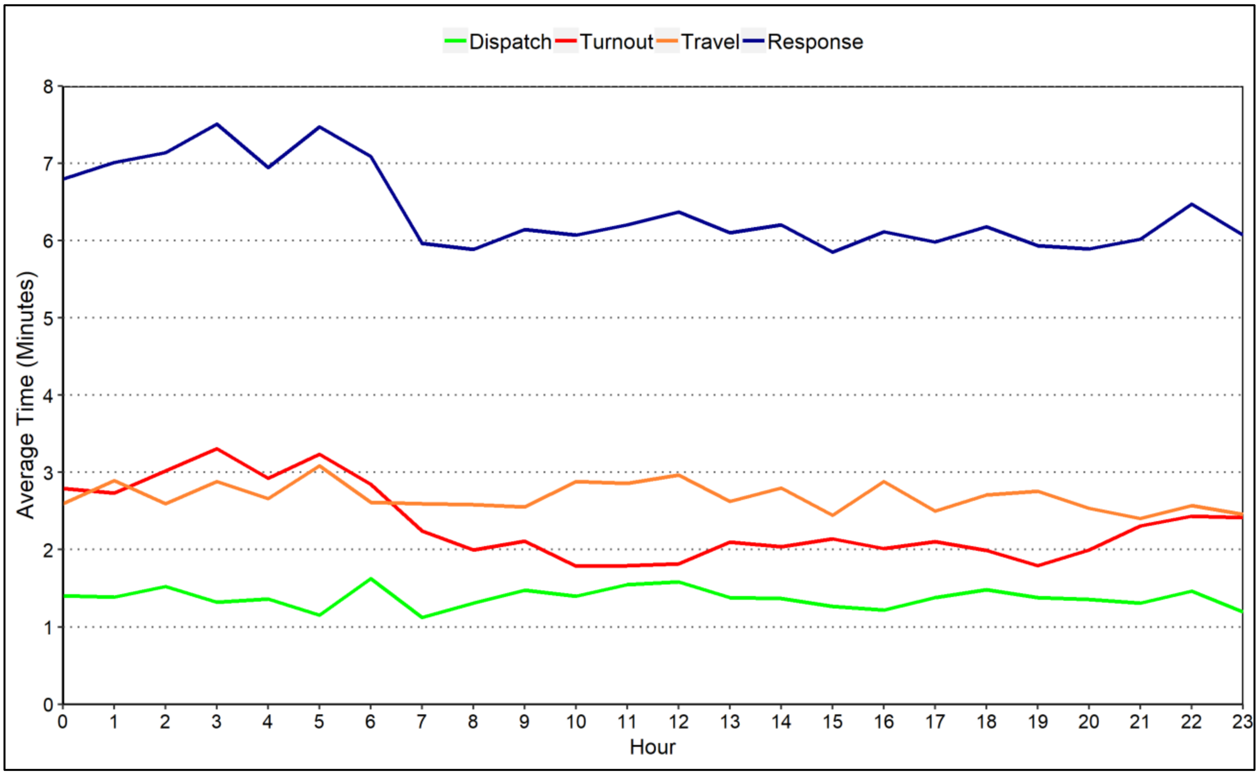
Response Time by Hour

The average dispatch, turnout, travel, and total response times by the hour of the day are shown in Table 6-15 and Figure 6-8. The table also shows the 90th percentile response times.

TABLE 6-15: Average and 90th Percentile Response Time of First Arriving Unit, by Hour of Day

Hour	Time in Minutes					Number of Calls
	Dispatch	Turnout	Travel	Response Time	90th Percentile Response Time	
0	1.4	2.8	2.6	6.8	8.9	207
1	1.4	2.7	2.9	7.0	9.4	171
2	1.5	3.0	2.6	7.1	9.8	140
3	1.3	3.3	2.9	7.5	10.2	125
4	1.4	2.9	2.7	6.9	9.0	113
5	1.2	3.2	3.1	7.5	9.6	132
6	1.6	2.8	2.6	7.1	9.4	150
7	1.1	2.2	2.6	6.0	8.1	195
8	1.3	2.0	2.6	5.9	7.9	235
9	1.5	2.1	2.6	6.1	8.8	249
10	1.4	1.8	2.9	6.1	8.1	277
11	1.5	1.8	2.9	6.2	8.7	231
12	1.6	1.8	3.0	6.4	8.8	270
13	1.4	2.1	2.6	6.1	8.5	272
14	1.4	2.0	2.8	6.2	8.2	261
15	1.3	2.1	2.4	5.9	7.8	299
16	1.2	2.0	2.9	6.1	8.1	272
17	1.4	2.1	2.5	6.0	7.7	337
18	1.5	2.0	2.7	6.2	8.7	315
19	1.4	1.8	2.8	5.9	7.7	299
20	1.4	2.0	2.5	5.9	8.1	327
21	1.3	2.3	2.4	6.0	7.7	257
22	1.5	2.4	2.6	6.5	8.6	276
23	1.2	2.4	2.5	6.1	7.8	224
Total	**1.4**	**2.2**	**2.7**	**6.3**	**8.5**	**5,634**

FIGURE 6-10: Average Response Time of First Arriving Unit, by Hour of Day



Observations:

- The average dispatch time was between 1.1 minutes (7:00 a.m. to 8:00 a.m.) and 1.6 minutes (6:00 a.m. to 7:00 a.m.).
- The average turnout time was between 1.8 minutes (10:00 to 11:00 a.m.) and 3.3 minutes (3:00 a.m. to 4:00 a.m.).
- The average travel time was between 2.4 minutes (9:00 p.m. to 10:00 p.m.) and 3.1 minutes (5:00 a.m. to 6:00 a.m.).
- The average response time was between 5.9 minutes (3:00 p.m. to 4:00 p.m.) and 7.5 minutes (3:00 a.m. to 4:00 a.m.).
- The 90th percentile response time was between 7.7 minutes (7:00 p.m. to 8:00 p.m.) and 10.2 minutes (3:00 a.m. to 4:00 a.m.).

Response Time Distribution

Here, we present a more detailed look at how response times to calls are distributed. The cumulative distribution of total response time for the first arriving unit to EMS calls is shown in Figure 6-11 and Table 6-16. Figure 6-11 shows response times for the first arriving TFESD unit to EMS calls as a frequency distribution in whole-minute increments, and Figure 6-12 shows the same for the first arriving unit to outside and structure fire calls.

The cumulative percentages here are read in the same way as a percentile. In Figure 6-11, the 90th percentile of 8.2 minutes means that 90 percent of EMS calls had a response time of 8.2 minutes or less. In Table 6-16, the cumulative percentage of 88.9, for example, means that 88.9 percent of EMS calls had a response time under 8 minutes.

FIGURE 6-11: Cumulative Distribution of Response Time – First Arriving Unit – EMS

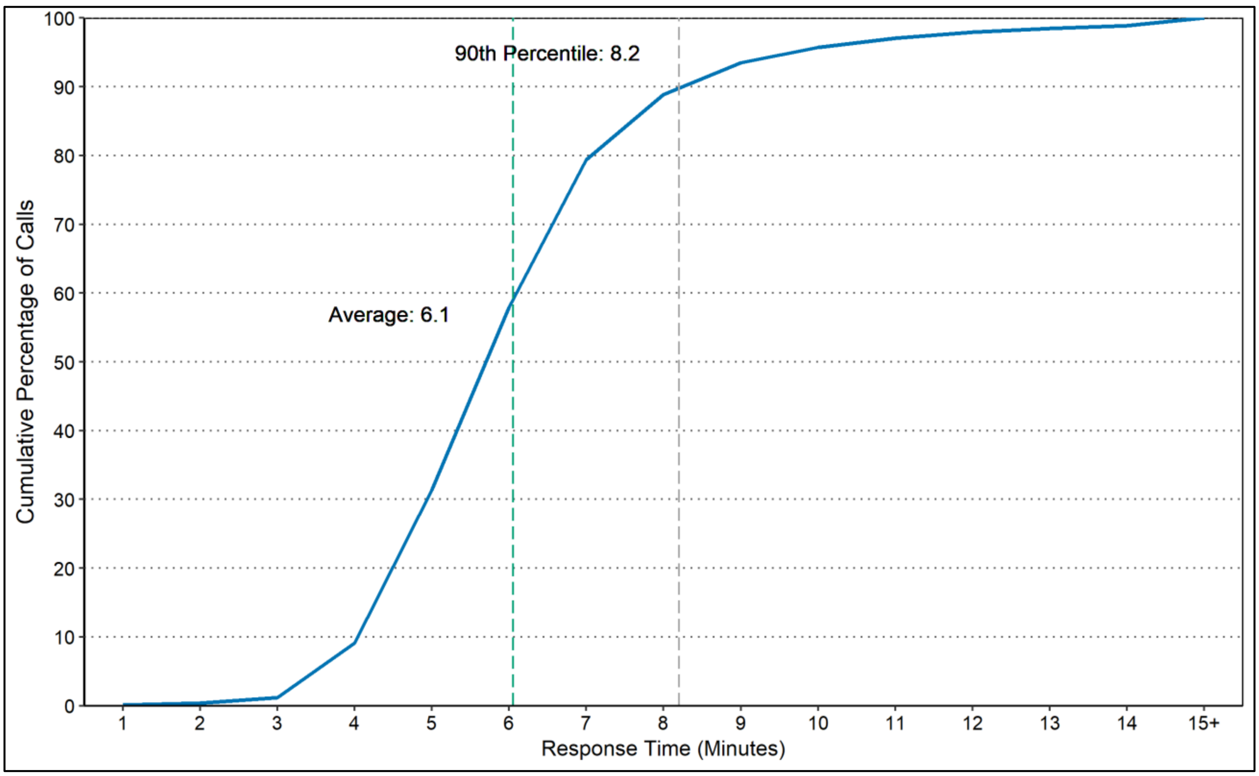


FIGURE 6-12: Cumulative Distribution of Response Time – First Arriving Unit – Outside and Structure Fires

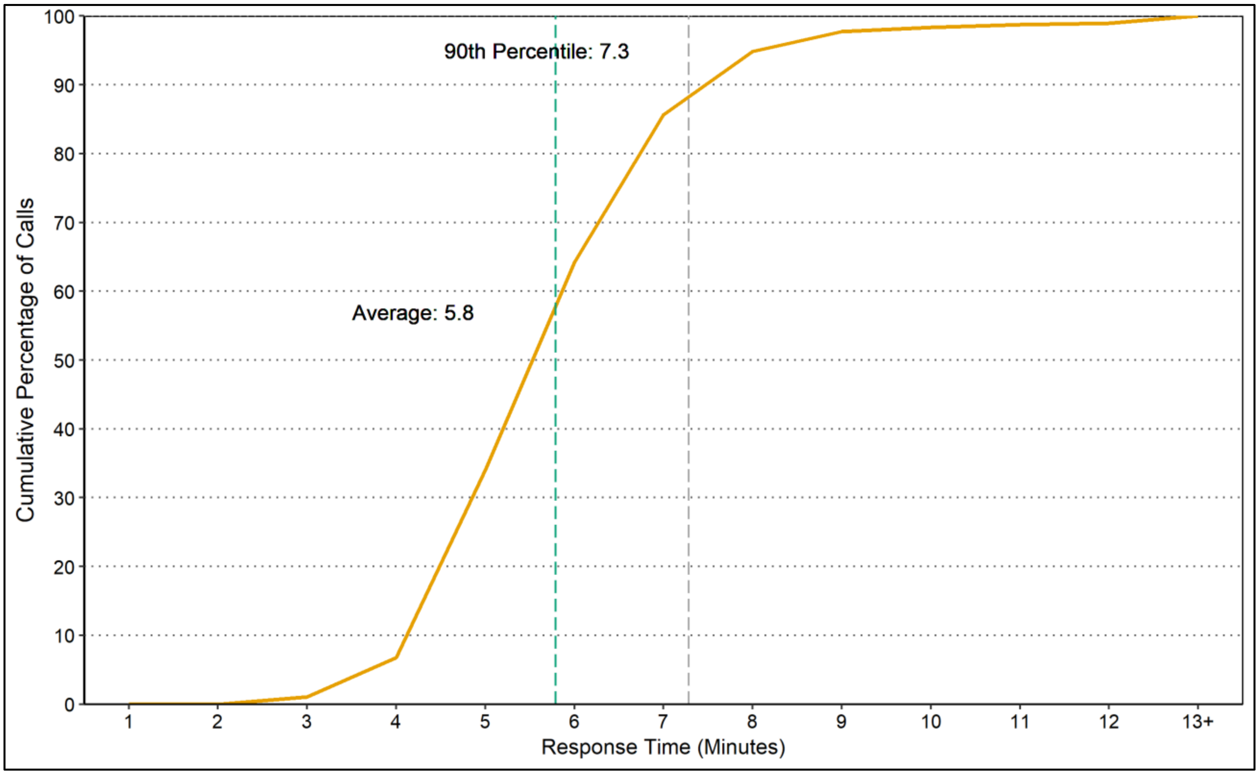


TABLE 6-16: Cumulative Distribution of Response Time – First Arriving Unit – EMS

Response Time (minute)	Frequency	Cumulative Percentage
1	3	0.1
2	9	0.4
3	24	1.2
4	240	9.1
5	671	31.4
6	802	57.9
7	647	79.4
8	287	88.9
9	139	93.5
10	68	95.7
11	41	97.1
12	25	97.9
13	18	98.5
14	12	98.9
15+	33	100.0

TABLE 6-17: Cumulative Distribution of Response Time – First Arriving Unit – Outside and Structure Fires

Response Time (minute)	Frequency	Cumulative Percentage
1	0	0.0
2	0	0.0
3	5	1.0
4	28	6.8
5	133	34.1
6	147	64.3
7	104	85.6
8	45	94.9
9	14	97.7
10	3	98.4
11	2	98.8
12	1	99.0
13+	5	100.0

Observations:

- For 88.9 percent of EMS calls, the response time of the first arriving unit was less than 8 minutes.
- For 94.9 percent of outside and structure fire calls, the response time of the first arriving unit was less than 8 minutes.

ATTACHMENT I: ACTIONS TAKEN ANALYSIS

TABLE 6-18: Actions Taken Analysis for Structure and Outside Fire Calls

Action Taken	Number of Calls	
	Outside Fire	Structure Fire
Action taken, other	2	4
Assistance, other	0	1
Confine fire (wildland)	1	0
Contain fire (wildland)	1	0
Control traffic	1	0
Establish safe area	0	2
Extinguishment by fire service personnel	77	86
Fire control or extinguishment, other	28	23
Forcible entry	2	5
HazMat detection, monitoring, sampling, & analysis	0	1
Identify, analyze hazardous materials	0	2
Incident command	0	12
Information, investigation & enforcement, other	6	10
Investigate	37	245
Investigate fire out on arrival	7	29
Notify other agencies.	7	9
Provide first aid & check for injuries	0	1
Provide information to public or media	0	1
Refer to proper authority	2	6
Remove hazard	1	0
Remove water	0	1
Restore fire alarm system	2	56
Salvage & overhaul	17	35
Search	2	11
Search & rescue, other	0	2
Shut down system	0	7
Ventilate	7	93
Total	**256**	**735**

Note: Totals are higher than the total number of structure and outside fire calls because some calls had more than one action taken.

Observations:

- Out of 170 outside fires, 77 were extinguished by fire service personnel, which accounted for 45.3 percent of outside fires.
- Out of 512 structure fires, 86 were extinguished by fire service personnel, which accounted for 16.8 percent of structure fires.

ATTACHMENT II: ADMINISTRATIVE AND FIRE MARSHAL WORKLOAD

TABLE 6-19: Workload of Administrative Units

Unit ID	Unit Type	Annual Hours	Annual Runs
DC1	Deputy chief	27.2	11
DC2	Deputy chief	1.0	1
DIR1	Director	1.0	1
ESC1	Emergency service coordinator	8.5	6

TABLE 6-20: Workload of Fire Marshal Units

Unit ID	Unit Type	Annual Hours	Annual Runs
FM1	Fire marshal	32.3	13
FM2	Fire marshal	18.0	8
FM3	Fire marshal	11.7	9
FM4	Fire marshal	18.2	12
FM5	Fire marshal	44.9	18
FM7	Fire marshal	8.1	5
FM8	Fire marshal	3.8	3
FM9	Fire marshal	6.3	3

ATTACHMENT III: FIRE LOSS

TABLE 6-21: Content and Property Loss – Structure and Outside Fires

Call Type	Property Loss		Content Loss	
	Loss Value	Number of Calls	Loss Value	Number of Calls
Outside fire	$184,806	21	$91,601	17
Structure fire	$1,784,351	34	$421,625	36
Total	**$1,969,157**	**55**	**$513,226**	**53**

Note: This includes only calls with a recorded loss greater than 0.

TABLE 6-22: Total Fire Loss Above and Below $20,000

Call Type	No Loss	Under $20,000	$20,000 plus
Outside fire	145	22	3
Structure fire	467	29	16
Total	**612**	**51**	**19**

Observations:

- Out of 170 outside fires, 21 had a recorded property loss, with a combined $184,806 in losses.
- 17 outside fires had a content loss with a combined $91,601 in losses.
- The highest total loss for an outside fire was $105,106.
- Out of 512 structure fires, 34 had a recorded property loss, with a combined $1,784,351 in losses.
- 36 structure fires had a content loss with a combined $421,625 in losses.
- The average total loss for structure fires with loss was $49,022.
- The highest total loss for a structure fire was $550,000.

- END -