Response Time and Staffing Analysis Model for the Houston Fire Department

Table of Contents

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FACETS CONSULTING

Executive Summary

The City of Houston is the fourth most populous city in the United States with a resident population of 2.2 million people and a land area of over 600 square miles.

The Houston Fire Department (HFD), measured by total staffing, is the fourth largest fire department in the United States after New York City, Chicago, and Los Angeles County. The HFD provides a full range of fire department services including fire fighting, Emergency Medical Services (EMS) including advanced life support (paramedic) and ambulance transportation, fire prevention, fire investigations, hazardous materials response, technical rescue, and other services. The HFD is a very active emergency system, responding to over 300,000 emergency incidents in 2015.

Houston presents its fire department with a wide range of hazards, including a busy port, two major airports, many and diverse industrial occupancies, and numerous high-rise buildings. The challenges to the HFD are magnified by the lack of a single core of high rise structures common in many cities, a busy transportation system, and increases in the density of development in areas of the city.

Our consulting team approached the assessment of the HFD with an open mind and a critical eye. Many times, fire departments perform their work in a certain way because that is the way that it has always been done. Our team brought a very diverse experiential perspective to this review. We looked at HFD operations and administration with an outside perspective, unburdened by knowledge of how things have always been done in Houston. Our observations and recommendations are based on this outside view and our collective experience.

The FACETS team witnessed a high degree of dedication on the part of Houston Fire Department members to serving the people of Houston. We found a fire department that has evolved to meet the changing demands of the customers they serve.

The City of Houston, like many cities in the United States, took steps during the Great Recession to reduce expenses and preserve emergency operations. Fire department support and administrative staff were moved into emergency operations, services such as information technology, fleet maintenance, and purchasing were consolidated into citywide operations, major capital purchases such as fire apparatus replacement were deferred, and the staffing or deployment of additional response resources was delayed. These changes, meant to be temporary in most cases, have negatively impacted the ability of the Houston Fire Department to provide services to the community.

Houston is also confronted with significant limitations on its ability to generate revenue. State-mandated and locally approved caps on several revenue sources limit the ability of the city to generate the funding needed to pay for all city operations. In addition, the rapid expansion of development in the city that has been the norm for decades has slowed, although urbanization of the city's core areas provides a great deal of development activity.

There has been some discussion of converting the HFD operations work schedule to a three (3) shift system. In the absence of a requirement for HFD firefighters and fire officers to work additional hours and extend the average work week above the current level of 46.7 hours, we do not envision any appreciable cost savings in converting to a three (3) shift system.

We recommend that the HFD continue to provide emergency medical service, including the provision of Advanced Life Support (ALS) service and ambulance transportation. The

HFD Emergency Medical Service (EMS) system is fully integrated into the operations of the department. All HFD members provide emergency medical care to their customers. All emergency care, from the receipt of the 911 call at the dispatch center, to the arrival of the first emergency responder on the scene, to the arrival of the customer at the hospital, is provided under a consistent standard of care designed by and approved by the Fire Department Medical Director.

We make 48 specific recommendations in this report meant to increase the efficiency of the Houston Fire Department with the resources currently allocated to the department. We also provide recommendations for the city to implement a plan to appropriately add resources as the city continues to grow in density. The specific recommendations are:

Recommendation 1: Establish a fleet replacement fund that assures all front-line apparatus and EMS vehicles are less than 10 years old and placed in reserve for no more than 3 years.

Recommendation 2: Return fleet maintenance and repair responsibilities back to the control of the Fire Department.

Recommendation 3: Initiate a training program that requires all fleet mechanics to be certified in accordance with the Emergency Vehicle Certification (EVT) program.

Recommendation 4: Establish a Self-Contained Breathing Apparatus (SCBA) replacement program where all SCBA are replaced at one time and at 10-year intervals.

Recommendation 5: Assign a dedicated General Services Division (GSD) crew for the repair and maintenance of fire department facilities.

Recommendation 6: Install source-capture diesel exhaust systems or another effective exhaust removal system in all fire stations.

Recommendation 7: Dedicate at least two city procurement personnel exclusively to the Fire Department.

Recommendation 8: Explore partnerships with local hospitals for the purchase of EMS supplies.

Recommendation 9: Uniformed HFD members should be involved in the recruiting process, particularly when recruiting at events. These firefighters and fire officers should reflect the diversity of the HFD and of Houston.

Recommendation 10: Utilize the Candidate Physical Abilities Test (CPAT) to assess the physical ability of potential firefighters and firefighter cadets.

Recommendation 11: Analyze the causes of cadet "washouts". Develop strategies to mitigate washouts, where practical.

Recommendation 12: A standardized, department-wide, driver training and recertification program meeting the requirements of NFPA 1451 needs to be developed and overseen by the Val Janke Training Facility staff.

Recommendation 13: All fire officers should be required to participate in continuing education, specific to rank, throughout their careers.

Recommendation 14: Develop a formal, documented, Career Development Plan (CDP) that guides employees through the promotional process.

Recommendation 15: Refresh and begin to implement the Facility Master Plan for the VJTF.

Recommendation 16: Add EMS transport resources (ambulances and medic units) to improve the timely arrival of a transport unit at an emergency. These resources may be full-time or peak-time units.

Recommendation 17: Construct and staff a new fire station (901) in southwest Houston (approximately Chimney Rock and Beechnut, District C) in the areas served by fire stations 37 (7026 Stella Link, District C), 48 (11616 Chimney Rock Road, District K), and 51 (6902 Bellaire Boulevard, District J).

Recommendation 18: Construct and staff a new fire station (902) in north central Houston (approximately North Freeway and Mount Houston, District B) in the areas served by fire stations 58 (10413 Fulton Street, District H), 67 (1616 West Little York Drive, District B), and 74 (460 Aldine Bender Road, District B).

Recommendation 19: Construct and staff a new fire station (903) along the Sam Houston Parkway corridor (approximately Cullen and Beltway 8, District B) in the areas served by fire stations 47 (2615 Tidewater Drive, District K) and 55 (11212 Cullen Boulevard, District D).

Recommendation 20: Staff and equip an additional hazmat unit on the West side of Houston. This unit should be in addition to and supplement existing hazmat staffing.

Recommendation 21: Add three technical rescue units in South Central Houston, Clear Lake, and Northeast Houston.

Recommendation 22: Add three (3) additional on-duty Safety Officer units per shift to provide adequate geographic coverage for safety officer functions.

Recommendation 23: Consider hiring firefighters with current EMT certification while providing targeted outreach assistance for EMT training.

Recommendation 24: Consider an alternative training schedule for initial paramedic training where personnel are not away from the HFD for several months.

Recommendation 25: Create a comprehensive EMS Continuing Education component within the HFD.

Recommendation 26: Conduct a needs assessment/workload analysis to determine the EMS specific areas and numbers of additional EMS support staff.

Recommendation 27: Evaluate the administrative duties assigned to Paramedic Supervisors to see if they can be reallocated to other Administrative support personnel or to Station Captains.

Recommendation 28: Continue to evaluate the efficacy of the in-house medical priority dispatch system and make adjustments as needed.

Recommendation 29: Consider changes to the medical credentialing process and in the utilization of paramedics within the HFD.

Recommendation 30: Continue to monitor the results of the ETHAN program and explore alternative funding sources to continue and expand the program.

Recommendation 31: Continue participation in the Care Houston program and seek funding and opportunities for other methods to manage the use of 911 for medical emergencies.

Recommendation 32: Utilize Automatic Vehicle Location (AVL) technology for unit selection for emergency response.

Recommendation 33: Streamline the call taking process as much as practical; evaluate the efficacy of the current address validation process.

Recommendation 34: Change HFD dispatch procedures to prompt responders 60 seconds after dispatch for EMS incidents and 80 seconds after dispatch for fire and special operations incidents.

Recommendation 35: To staff current emergency response units, maintain HFD staffing in emergency operations at a minimum of 3,634 FTE.

Recommendation 36: Provide basic resources for the Fire Prevention and Life Safety Bureau commensurate with the organization's mission. This includes a reliable vehicle for each inspector and a working computer or appropriate mobile device with IT/help desk support.

Recommendation 37: Provide an information technology (enterprise software) solution for fire inspection forms, reports, notifications, and other basic and advanced inspection tasks.

Recommendation 38: Develop and implement business and organizational best practices for the Fire Prevention and Life Safety Bureau including a strategic plan, standard operating procedures, and an internal communications plan.

Recommendation 39: Provide Bureau staff with access to fire department data including the location of fires, origin and cause, fire deaths, fire loss, and outcomes of fire investigations.

Recommendation 40: Develop a community risk reduction strategy that targets risks based on loss experience and data.

Recommendation 41: Significantly increase the involvement of the Bureau in the construction and site plans review process. Utilize FPE's in the process.

Recommendation 42: Develop a mission statement for the Arson Bureau.

Recommendation 43: Develop a strategic fleet management plan for the Arson bureau.

Recommendation 44: Provide additional appropriate certifications for fire investigators.

Recommendation 45: Establish a program for providing annual medical evaluations for all firefighters.

Recommendation 46: Develop a comprehensive wellness/fitness program. Develop a dedicated medical/wellness facility.

Recommendation 47: Create a tobacco free work environment.

Recommendation 48: Establish a cancer awareness/prevention program within the HFD.

Study Process

The City of Houston issued a Request for Proposals (RFP) entitled "Response Time and Staffing Analysis Model for the Houston Fire Department" in August of 2014. FACETS Consulting of Phoenix, Arizona submitted a response to the RFP, was selected for this work, and provided with a notice to proceed in September of 2015.

The scope of work for this project is very wide, involving multiple operations within the Houston Fire Department. The Houston Fire Department is a very large organization, providing a number of emergency and non-emergency services to the people of Houston and visitors to Houston. All of these services are important.

Most of the funding for the Houston Fire Department is expended to pay for the men and women that staff Houston's engine, ladder, tower, ambulance, medic, squad, command, and special operations units. The bulk of the attention paid by FACETS in this report, therefore, is on the efficiency of the emergency operations components of the Houston Fire Department.

FACETS team members made five (5) multi-day visits to Houston to learn about Houston Fire Department resources and operations and to see the City of Houston and its fire department first-hand.

FACETS team members met with Houston Fire Department members on every level from the Fire Chief to cadets in the Fire Academy. For example, FACETS team members witnessed Emergency Medical Services (EMS) training, rode with EMS Supervisors and ambulances on emergency calls, visited numerous fire stations, and met with Finance and Human Resources staff members from the fire department and the City of Houston.

Throughout the course of our work in Houston, FACETS team members met with Houston Fire Department staff in Operations, Fire Prevention, Fire Investigations, Emergency Medical Services, Dispatch, Training, Logistics, Special Operations, and other areas. FACETS team members met with City of Houston staff in the Office of the Mayor, Finance, Emergency Management, Dispatch, Fleet, and Human Resources. Team members spoke with a Houston City Council member about fire department services in the member's district and in the city as a whole.

Team members met with the leadership of organizations affiliated with the Houston Fire Department, including the Houston Black Firefighters Association and the Houston Professional Firefighters Association, International Association of Fire Fighters (IAFF) Local 341, and a group of Houston female firefighters and fire officers.

In every meeting and contact with City of Houston and Houston Fire Department members, FACETS team members actively listened to the information provided, asked questions to expand our knowledge, and gathered appropriate documents to further explain Houston Fire Department resources, management processes, and operations.

A major part of this work is a computerized analysis of emergency incident activity and fire department response to emergencies. Data on the actual emergency incident activity in Houston and Houston Fire Department emergency response resources (firefighters, fire officers, fire apparatus, and EMS units) was provided for a period of three (3) years. This data is matched with the street and transportation network in Houston to provide a computerized model that can report on the level of service that has been provided by the Houston Fire Department and also model the impact of changes to the system on emergency response times and emergency unit activity levels.

This deployment analysis is critical in an emergency response system as active as the City of Houston. The deployment modeling system that we utilized for this report is the most advanced and reliable method to assess the efficacy of the current fire department deployment system and to assess the impact of changes to the system.

City of Houston Description

Founded in 1836 along Buffalo Bayou and named for Texas hero Sam Houston, Houston has grown from a village to the largest city in the South and the fourth most populous city in the United States. Its 2014 estimated population was 2,239,558 and it covers an area of 656.3 square miles, of which land comprises 634 and water 22.3 square miles. Houston is mostly located on the gulf coastal plain. Its climate is classified as humid subtropical, typical of the lower South. With an elevation of 43 feet above sea level, the city is low-lying and subject to flooding. Houston is the county seat of Harris County and the largest jurisdiction in the Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area.

Demographically, Houston is quite diverse. More than ninety languages are spoken in the city. Just over a quarter of the city's population (25.6 percent) identifies as white; 23.1 percent is Black/African American; 5.9 percent is Asian. Forty-three point eight (43.8) percent of Houston's residents identify as Hispanic or Latino. Houston has one of the youngest populations in the U.S.

The City of Houston has a strong mayoral form of government. Elected officials are the mayor, the city comptroller, and the 16 members of the Houston City Council. The Council consists of eleven (11) members elected from districts and five (5) at large. The Mayor acts as the City's Chief Executive Officer and is responsible for ensuring that all laws and ordinances are enforced. The comptroller is responsible for certifying available funds before they are committed and disbursed. All city elections are nonpartisan. The Mayor, council members, and the comptroller are eligible to serve two (2) four-year terms.

Houston has a large and diverse economy; twenty-three (23) Fortune 500 companies are headquartered in the city. It is known worldwide for its energy industry, particularly for oil and natural gas. The Port of Houston is the largest in the U.S. for volume of international exports and is the tenth largest port in the world. Petroleum products, chemicals, and oil and gas extraction equipment accounted for approximately two-thirds of exports in 2014. The Texas Medical Center, comprised of 49 non-profit institutions, is the largest research and medical treatment center in the world. More than 52,000 people are employed in its facilities, and they see 4.8 million people each year. Houston is home to more than forty (40) colleges, universities, and institutions of higher learning, providing options for all interests.

If Houston were an independent country, its gross area product would rank as the world's 30th largest economy. The Houston-Sugarland-Baytown MSA's gross area product ranked above the GDP of Austria, Poland, and Saudi Arabia.

Houston Fire Department Description

Demographics

The Houston Fire Department is a full service fire department providing fire suppression, basic and advanced life support emergency medical transport service, hazardous materials response, technical rescue, and aircraft rescue fire fighting to the more than 2.2 million residents and visitors to the City of Houston. The Houston Fire Department employs 3,810 uniformed members, 151 trainees, and 113 civilians (2014). Firefighters are assigned to 93 fire stations housing 88 engines, 38 ladders or towers, 58 basic life support ambulances, 34 advanced life support units, and other apparatus. The Department's budget exceeds $500 million.

Fire department administration is divided into four (4) divisions. The Executive Assistant Chief of the Emergency Response Division is responsible for the delivery of all fire department emergency services to residents and visitors to the City of Houston. Operations, Emergency Medical Services, and professional development all fall under this Chief's responsibility.

The City is divided geographically into four (4) quadrants. Two (2) Deputy Chiefs per shift are responsible for the two (2) north and the two (2) south quadrants respectively. Ten (10) District Chiefs in the northern quadrants and the Safety District Chief all report to the North Deputy. The eleven (11) District Chiefs in the south report to the South Deputy. There are a total of 24 District Chiefs on-duty at a time including an EMS District Chief and a Safety District Chief. Each District Chief is responsible for an average of four (4) stations and approximately 40 personnel. An incident command technician, who operates the District Chief's vehicle, is assigned to assist the District Chief at incidents, particularly with accountability of personnel on the emergency scene.

Figure 1 – Houston Fire Department Organizational Chart

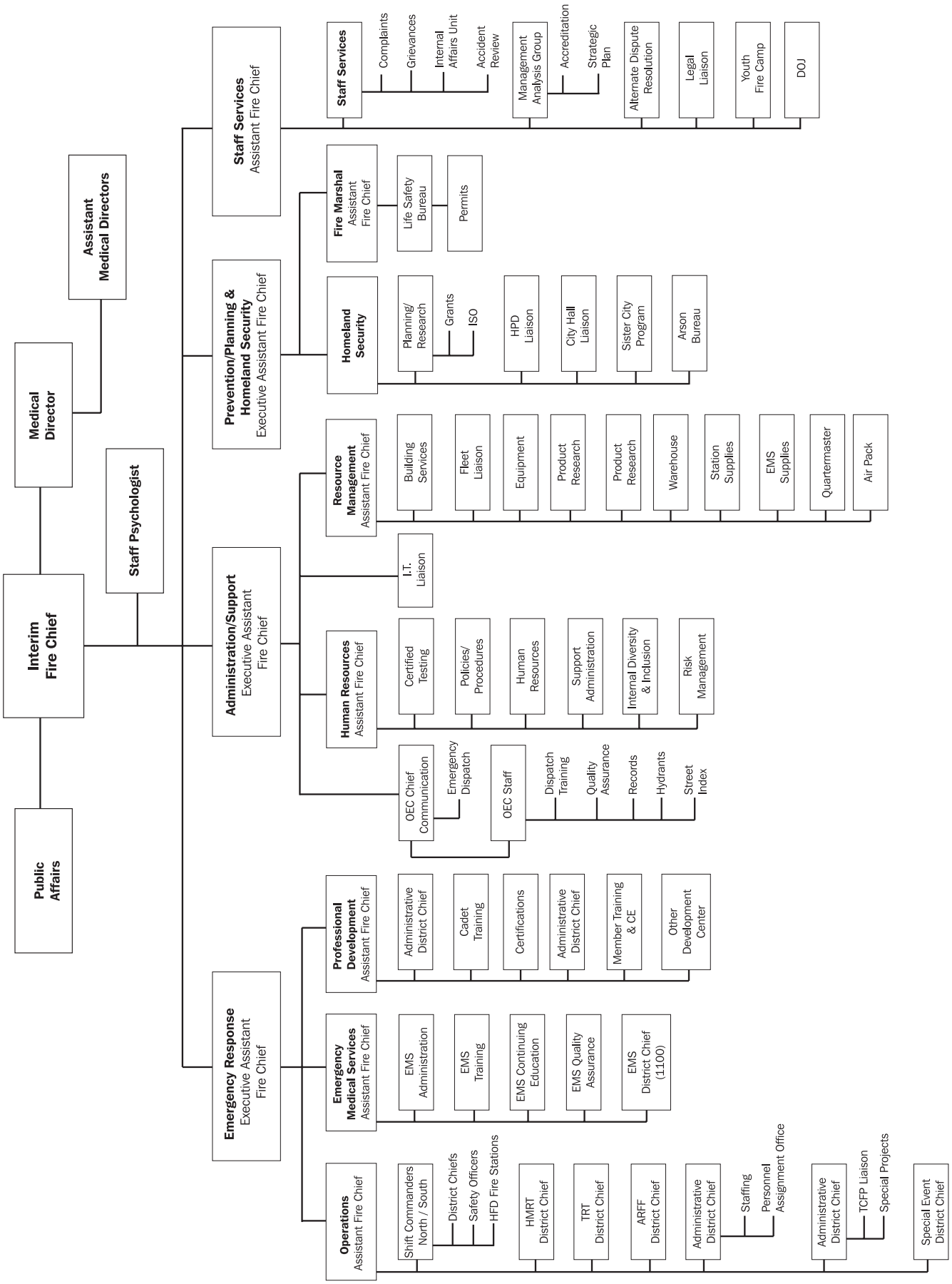


Table 1 – Houston Fire Department Staffed Emergency Response Units

Number	Unit	Staffing	EMS Level
88	Engine	4	BLS
33	Ladder	4	BLS
5	Tower	4	BLS
58	Ambulance (BLS)	2	BLS
34	Ambulance (ALS)	2	ALS
11	Squad Unit (ALS)	2	ALS
2	Hazmat Unit	10 total	
3	Rescue Company	13 total	BLS
2	Deputy Chiefs	1	
21	District Chiefs	2	
3	Safety Officers and Safety Chief	1	
10	EMS Supervisors	1	ALS
	George Bush Airport	26	
	William P. Hobby Airport	8	

Station Operation

On each of the four (4) shifts, each fire company in the City of Houston is under the command of a Captain. Stations with a ladder company include a Senior Captain who also functions as the officer of the ladder company. The other Captain in the station is the engine officer and assists the Senior Captain with station responsibilities and training.

Staffing

Each of the four (4) shifts is required, by labor agreement, to be made up of a minimum of 845 sworn firefighters and fire officers. This minimum staffing level requires four (4) personnel on each engine and ladder company. This staffing level is in accordance with the national standard on staffing and additional detail is provided in the Deployment section of this report. With a few exceptions, personnel are assigned to fire stations. The on-duty Captain decides the firefighter's riding position and rotation between the BLS ambulance, the engine and the ladder. Each apparatus has an assigned Engineer/Operator (E/O). In the absence of a Captain, the E/O may ride up as the acting Captain on the engine.

Essentially, all firefighters in the HFD are dual-trained, at a minimum, to the Emergency Medical Technician – Basic level. In the State of Texas, this requires a minimum of 110

contact training hours. This gives all personnel the commensurate training to begin treating a victim of a traumatic injury or someone that is experiencing a medical emergency. Members assigned to provide patient care on a BLS ambulance receive an additional $2,600 per year in assignment pay.

At .35, Houston has slightly more than the median number of firefighters on duty per thousand population when compared to other large fire departments with ambulance service. The median, not including New York City, is .32

Dual-certified firefighter/paramedics may ride the fire apparatus when paramedic staffing allows. This is in part to the fluctuation in the number of "credentialed" paramedics in the system. Only if there is another paramedic assigned to the station, may the other be assigned to the fire apparatus and function as a firefighter. Firefighter/Paramedics receive $7,200 per year for maintaining paramedic credentials with the medical director.

Although firefighter/paramedics may ride the fire apparatus, the apparatus is equipped to the basic life support level and therefore the paramedic only has the equipment needed to provide basic lifesaving skills when arriving on the engine or the ladder. Thirty (30) rotation stations have an ALS bag for use when a paramedic works on the engine company. The ALS bag contains some ALS equipment and supplies but not a full complement of ALS capabilities.

Part of the recruit training is to move to a field orientation after the successful completion of classroom training. Probationary firefighters are assigned to various stations to complete their field orientation. Rather than riding as an additional firefighter on the apparatus, the candidate becomes the fourth riding position and the regularly scheduled full-time firefighter is reassigned to another opening elsewhere.

Response

In a move to match the appropriate resource to the request for service, Houston Fire Department instituted an All-Hazards response protocol in August 2011. For medical requests for service deemed by dispatch protocols to be of a less emergent nature, basic life support ambulances or fire apparatus are initially sent. It has been found that in many cases, these are the only resources required to successfully handle the incident. This allows a limited number of advanced life support ambulances and squad resources to be available when those high priority calls come in. Changes were made to the program after its implementation to allow non-transport units to request a transport unit prior to their arrival on scene.

Houston responds to 19 percent more EMS incidents per thousand population than the median of large US fire departments.

Safety

Safety of personnel operating at incidents is critically important to the Houston Fire Department. A District Chief, reporting to the North Deputy Chief, leads the Safety Division. The Safety Chief's responsibilities include administering the safety program and supervising the safety staff. To assist the District Chief there are two (2) Senior Captains also assigned to respond to incidents. All of the safety personnel are certified as Incident Safety Officers (ISO).

Special Operations

With the fourth largest population in the U.S., Houston is confronted with precarious situations that call for a specialized capability to protect the public when they get in trouble. Houston Fire Department Special Operations is assigned to the Emergency Response Division, one of four (4) divisions of the department. The members of special operations

are personnel who are experienced members of the department that submit a request to become a member of these specialized forces. Once accepted into the training programs, these personnel are prepared with the necessary initial training and must go through extensive in-service training. Openings in these areas are filled with members of the specialized teams and not from the general membership of the fire department. Special operations encompass distinct and specialized areas. These include Aircraft Rescue and Fire Fighting (ARFF), hazardous materials response and technical rescue.

As one of the most populous cities in the United States, Houston contains a number of target hazards and critical infrastructure. The HFD staff includes a Homeland Security chief that works closely with other public safety agencies in the Houston area.

Aircraft Rescue Fire Fighting

Two international airports serve the City of Houston. Approximately 23 miles north of downtown, is the George Bush Intercontinental Airport (IAH). IAH and its sister airport 11 miles south of downtown, the William P. Hobby Airport (HOU), are both operated and maintained by the Department of Aviation under enterprise accounts. Although under the direction of the Department of Aviation, ARFF personnel remain a part of the Houston Fire Department.

Both airports, IAH and HOU are considered large airports and fall under the Federal Aviation Administration's Class I designation. This requires both airports to meet the FAA requirements for aircraft rescue fire fighting 14 Code of Federal Regulation (CFR) §139.319 Aircraft rescue fire fighting (ARFF): Operational requirements. This regulation requires specially trained and dedicated personnel to perform aircraft fire fighting and rescue. A moving capsule of people, filled with flammable fuel creates a unique environment to fight fire and presents specific challenges to rescuing those aboard.

A Deputy Chief, stationed at IAH, and a staff direct the ARFF operations at both airports. This staff coordinates with the airport leadership and the Aviation Department. Personnel assigned to ARFF, and ARFF stations are dedicated to the respective airport and its property. Generally, alarms outside the airport boundaries are handled by HFD stations "outside the fence" of the airport. This includes emergency medical response.

George Bush Intercontinental Airport (IAH)

Three (3) fire stations and 26 fire personnel per shift protect IAH. According to the Department of Aviation website, IAH served approximately 41 million passengers in 2014.

William P. Hobby Airport (HOU)

Although opened in 1969, HOU became an international airport with its expansion in 2015. According to the Aviation Department, HOU serves approximately 12 million passengers per year. Eight (8) fire personnel per shift from one (1) station protect Hobby and its passengers.

Hazardous Materials

According to city officials, Houston's economy is heavily based on the energy industry, specifically oil and biochemicals. Spills and leaks of materials that can be lethal to people and damage the environment must be controlled and mitigated by personnel with specialized training and equipment to handle, not only oil, but other chemicals, biological threats, and radioactive and nuclear materials. Although the neighborhood engine at the local fire station may initially respond to small

spills and leaks, the Houston Fire Department Hazardous Materials Team (Hazmat) responds with a minimum of ten (10) personnel per shift from a single station.

Ladder companies are equipped with the capability of detecting carbon monoxide. Safety Officers are equipped to detect multiple gases, including volatile organic compounds, carbon monoxide and oxygen. The Hazmat Team has much more sophisticated equipment for identifying hazardous substances. Additionally, the team also has the training and equipment to mitigate most incidents and potentially perform a rescue of someone who is incapacitated.

The HFD has a Voluntary Contribution Program that allows haulers and storage facilities to pay a fee up front to the fire department in the event of a spill or leak. This avoids charges after the incident for cost recovery. Some concerns were expressed about the efficacy of the program because of limited enrollment.

The HFD has the ability to charge responsible party(ies) for the response to hazmat incidents when the responsible party(ies) are not part of the Voluntary Contribution Program. The current charge in the ordinance is $15.00 per minute of the incident or $900 per hour. The ordinance does not include a provision to recover the direct cost of consumables. A recent hazmat incident in the Spring Branch area resulted in the use of over $60,000 in fire fighting foam to control the incident. The invoice for this incident according to the fees allowed in the current ordinance was less than $12,000.

Technical Rescue

The Houston Fire Department Technical Rescue Team (TRT) is comprised of three (3) companies distributed across the city. Two (2) companies are staffed with four (4) firefighter/rescue technicians and one (1) is staffed with five (5). Administratively, the TRT is under the direction of a District Chief and his command staff (a Senior Captain and a Captain). Once on the scene, the TRT is under the command of one (1) of the on-duty District Chiefs located throughout the city who is operating as the incident commander. Although ladder companies perform light extrication at motor vehicle crashes, TRT responds for more complicated and extensive extrication requirements.

Personnel assigned to the TRT are trained as firefighters and EMT's, as are all members of the Houston Fire Department. Additionally, personnel are trained to meet NFPA 1006, Standard for Technical Rescue Professional Qualifications and NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*. In Houston, this equates to 160 hours of additional training for TRT personnel specifically on the hazards present in the City of Houston and the equipment carried by the fire department to perform these rescues.

For Houston TRT members to meet NFPA 1670, they must be able to potentially address seven (7) rescue disciplines. They include: structural collapse, rope rescue, confined space search and rescue, vehicle and machinery search and rescue, water search and rescue, wilderness search and rescue, and trench evacuation search and rescue.

Budget and Governance

The City of Houston was originally chartered by the Congress of the Republic of Texas in 1837. The Houston Fire Department was established soon after in 1838. The city currently operates under a charter granted by the Texas legislature in 1905. Houston is a "strong-mayor" form of government, in which the mayor is the chief executive of the city. In 1971, the Houston City Council added emergency medical ambulances and related services as a function of HFD. HFD programs are reviewed annually by the Houston City Council during the budget process.

HFD programs and services are administered by a Fire Chief, who is appointed by the mayor and confirmed by the city council. In addition to the chief, there are three (3) executive assistant chiefs and seven (7) assistant chiefs, including the fire marshal. The assistant chief appointments are approved by the mayor.

The Fire Chief, like all Houston department heads, reports to the Mayor. The chief attends bimonthly meetings with the Mayor and all department heads, and also has regular and as-needed meetings monthly with the Mayor. The Mayor's Chief Operating Officer provides day-to-day oversight of the fire department, and also meets at least monthly with the Fire Chief.

The Fire Chief appoints the members of his or her executive staff. These three (3) Executive Assistant Chiefs and seven (7) Assistant Chiefs are responsible for HFD administrative and operational functions. Typically, although not necessarily, upon the election of a new Mayor, a new Fire Chief is appointed. The Fire Chief then, in turn, may retain or replace members of his or her executive staff. This turnover in executive leadership in the HFD can lead to the loss of institutional knowledge. This turnover is also possible upon the appointment of a new Fire Chief within a Mayor's term.

The HFD also operates under Chapter 143 of the Texas State Code, which includes limitations on fire department personnel actions and other functions.

Budget

Houston uses a July 1 to June 30 fiscal year and a modified zero-based-budget process for budget development. The process begins in January when instructions for both operating and capital budget development are issued to departments. Departments then submit operating and capital budget requests in February and March. In April, the finance department analyzes and consolidates operating budget requests. The Mayor proposes the operating budget in May, while the Council reviews the draft capital budget. In May and June, there are both Council workshops and public hearings on the operating budget, while the Mayor proposes the capital budget. The Council then adopts the operating and capital budgets in June.

The City of Houston has two (2) important financial policies affecting the general fund. The first is the budget stabilization or "rainy day fund." This policy states that the budget stabilization fund will have an amount not less than the greater of 1% of general fund expenditures (less debt and pay-as-you-go capital) or $20 million. Any proposed use of the fund requires approval of two-thirds of the city council present and voting. The fund must be replenished at least to minimum levels by the end of the second year following conclusion of the event that caused its use to be necessary. Houston also has a policy of maintaining a 7.5% unassigned general fund balance (less debt and pay-as-you-go capital) as additional insurance against disasters, emergencies, and economic instability.

General Fund Revenue

Houston's general fund revenue - which supports basic city services such as police, fire, emergency medical, libraries and parks - primarily consists of property and sales taxes. In the fiscal year 2015-16 budget, these two (2) categories account for nearly 80% of total revenue, and both are restricted in their growth. Sales taxes are restricted to 1% by the state of Texas, while city charter amendments 1 and H restrict the growth in property tax that can be collected. Proposition 1 is a charter amendment approved by voters in November 2004 which limits property tax growth to the lower of the increase in population plus the consumer price index (CPI) or 4.5%. Proposition H is a charter amendment approved by voters in October 2006 which provides a $90 million property tax exception above the Proposition 1 cap to be used for public safety (police, fire and courts). Over time, these limits in property tax assessments have resulted in reduced revenue to support the needed service expansions that come with growth. For example, total appraised value of real and personal property in Houston increased by almost 93% between 2005 and 2016, while property tax revenues only increased by 66%. It is assumed that much of the growth in assessed value is from commercial property, which is not represented by population growth, but does result in additional demands on city services.

Table 2 – General Fund Expenditures

(in millions)	**2011-12 Actuals**	**2012-13 Actuals**	**2013-14 Actuals**	**2014-15 Estimate**	**2015-16 Budget**
Total General Fund	$1,810.6	$1,945.7	$2,065.4	$2,254.4	$2,391.3
Fire Department	$420.2	$433.2	$452.3	$505.2	$509.6
Fire % of Total	23.2%	22.3%	21.9%	22.4%	21.3%

Table 3 – General Fund Revenues

(in millions)	**2011-12 Actuals**	**2012-13 Actuals**	**2013-14 Actuals**	**2014-15 Estimate**	**2015-16 Budget**
Total General Fund	$1,802.7	$1,944.4	$2,053.8	$2,212.8	$2,269.2
Fire Department	$62.8	$58.7	$69.8	$69.3	$75.0
Fire % of Total	3.5%	3.0%	3.4%	3.1%	3.3%

Note - total general fund revenue excludes "other resources"

Table 4 – Houston Full-Time Equivalent Position Count

	2008-09 Actual	2015-16 Budget	% Change
Police Classified	5,042.5	5,181.3	+2.8%
Fire Classified	3,861.1	3,996.9	+3.5%
Police & Fire Cadets	317.3	268.4	-15.4%
Civilian	6,587.0	4,948.4	-24.9%
Total	15,807.9	14,395.0	-8.9%

Houston Full-Time Equivalent Position Count

Many cities across the United States experienced significant drops in revenue during and after the Great Recession. The biggest part of most city budgets is staff; therefore many cities were forced to reduce their overall staff position count. Most tried to reduce the overall staff position count without impacting public safety in a material way. This was true of Houston, as shown in **Table 4**. While police and fire classified counts grew modestly over this time frame, the civilian count was cut by a full quarter. While the Fire classified count grew slightly, many uniformed staff support positions were eliminated during the Great Recession as support staff was reassigned to support emergency services.

Ambulance Revenue

Of the $75 million in the 2015-16 budget for fire department revenue, about half or $37.2 million is for ambulance transportation fees. Ambulance fees are set by the City of Houston and are generally a flat rate plus mileage and specific types of drugs and/or treatment. The fire department transports about 450 patients per day.

The city issued a request for proposals (RFP) for a new ambulance billing provider in 2013. Digitech was the winning bidder and began providing service in May, 2013. Digitech provides a variety of services to ensure bills are processed correctly, fees are collected, and payments are remitted to the City of Houston. Their fee is 8% of net billing amounts. An important measure of the effectiveness of the ambulance billing process is an agency's collection rate. Typically, collection rates are calculated by starting with the gross billing amount, subtracting any mandated and contractual adjustments (primarily for Medicare and Medicaid) and then dividing that number into the fees actually collected. Houston's ambulance collection rates, and dollars collected are shown in **Table 5** below.

Houston transports 61.7 customers per thousand population by ambulance each year. This is the median for large US fire departments providing ambulance service.

Table 5 – Ambulance Revenue Summary

	May 2013 - Jun 2013	FY 2013-14	FY 2014-15	Jul 2015 - Jan 2016	Since Inception with Digitech
Gross Receivables	$16,692,978	$166,725,476	$161,171,305	$101,517,532	$466,107,291
Contractual Adjustments	($5,980,731)	($61,553,800)	($67,718,864)	($37,344,216)	($172,597,611)
Adjusted Receivables	$10,712,247	$105,171,676	$113,452,441	$64,173,316	$293,509,680
Actual Collections	$3,683,493	$41,969,525	$44,487,580	$20,426,436	$110,569,034
Collection Rate	34.4%	39.9%	39.2%	31.8%	37.7%

Ambulance Billing Quality Assurance

In an effort to improve the ambulance collection rate, the Finance Department began an intensive quality assurance program in 2015 that by September was reviewing approximately 150 transport documents per day. When errors are found, the firefighter responsible is contacted and requested to correct the report. While this process is relatively new, it is resulting in about 17% of the records reviewed by the QA staff having the proper edits made. There is not enough data yet to determine if this program is having a positive impact on ambulance fee collections.

The goal of this program is to improve billing collection rates and no effort is made to perform QA services on the type of treatment provided. There may be some possible synergies between this program and the need for medical QA discussed later in this report.

Development Impact Fees

Development impact fees in a city's peripheral planning areas are assessed to require new development to pay its proportionate share of infrastructure costs that are required when growth occurs. The use of these fees is usually restricted to the construction of capital infrastructure within the planning area that was assessed the fee. Currently Houston assesses impact fees to collect funds from new development for water and wastewater infrastructure. Houston may consider the addition of a fire impact fee so that the capital costs of building new fire stations in growth areas is paid by the new businesses and residents that will benefit most from them.

Logistics

The Houston Fire Department is fortunate to have all its Logistics functions on one campus. These include:

- Apparatus and fleet maintenance (including paint/body shop, and a metal working shop)
- Fire fighting equipment
- Small power equipment repair
- Self-contained breathing apparatus (SCBA) maintenance
- Fire station and facilities maintenance (including a wood-working shop)
- Personal Protective Equipment (PPE)
- Warehousing/distribution of fire fighting equipment, EMS supplies, office supplies, and janitorial supplies

By having all these functions co-located on the same campus, communications are far superior to having the functions spread among different locations.

Logistical functions that are out-sourced, but overseen by HFD Logistics include:

- Issuance of uniforms ($300 per member annually)
- Fire extinguisher refilling
- SCBA mask fit-testing
- SCBA air flow testing
- Hydrostatic testing of SCBA cylinders
- Breathing air quality testing
- Ground ladder testing
- Aerial ladder testing
- Cleaning and repair of PPE

NOTE: There are separate dedicated sites for warehousing of supplies and equipment for hazardous materials and special operations responses.

Apparatus and Fleet Maintenance

The Houston Fire Department emergency services fleet consists of:

88 First-line engines
17 Reserve engines
38 First-line ladders and towers
11 Reserve ladders or towers
34 First-line Medic units
58 First-line Ambulance units
11 Squad units
23 Reserve Medic/Ambulance units
11 Booster units (brush trucks)
7 Hazmat units
6 Technical Rescue units
3 Breathing air units
16 Aircraft Rescue Fire Fighting units
27 Shift Commander/District Chief/Senior units
12 Administrative cars
4 Medical Director cars
10 EMS Supervisor cars
3 Safety Officer units (SUV's)
1 Water Supply Officer (SUV)
15 Homeland Security vehicles (typically pick-up trucks for towing trailers)
12 Reserve units (multi-purpose SUV's)
10 Evacuation boats
8 Rescue boats
6 Wave runners
8 Misc. light duty units (SUV's—manpower, honor guard, arson canine, etc.)
6 Misc. heavy duty units (mobile command post, 2 rehab units, mobile ventilation unit, funeral pumper, special events, etc.)

The overall fleet of the Houston Fire Department appears to be manufactured to the appropriate degree of design and performance specifications. The Logistics Division has chosen a wise path toward determining the types of apparatus and equipment it uses. There is an Apparatus Design and Construction Team, representing a cross-section of the fire department, which develops the specifications for fire apparatus. The six (6) person team consists of a Chair and five (5) members, each serving a three (3) year term. They have done an excellent job. This user input into the design and selection of the equipment is invaluable toward getting "buy-in" from the firefighters in the field who use the apparatus. The "buy-in" creates an atmosphere of ownership and inevitably reduces maintenance costs.

The fire department maximizes the investment in its ambulance fleet by "recycling" the patient care compartment portion (box) of the ambulance vehicle and putting them on new chassis. The boxes are re-furbished and re-mounted on new chassis by a third party (Frazier). The cost of a new ambulance is $135,000 to $140,000. The cost to recycle a box on a new chassis is half that amount.

The fire department maximizes the investment in its fire apparatus by rotating its busier apparatus with slower apparatus. The busiest 25% of the fleet is given a "light refurbishment" and then sent to one of the 25% least busy stations. The remaining apparatus stay permanently assigned to their station until they are placed in reserve. The "light refurbishment" includes items such as paint touch-up and re-upholstery of seating.

The study team noted that all accident damage is repaired. This reflects very favorably to the public about its fire department. However, the fire department should consider allowing the apparatus manufacturer to make major repairs rather than doing this in-house. This assures the damage is repaired according to the manufacturer's requirements and frees up space and staffing to handle more minor repairs.

Reserve apparatus are not equipped. This is an understandable cost containment measure as reserve apparatus become "community property" and it is difficult to maintain an inventory of equipment on a reserve apparatus. Reserve ambulances are equipped and this is also understandable as their equipment is not subject to equipment loss due to improved security in storage.

Unfortunately, the economic downturn has put the apparatus replacement program far behind schedule. The problem is compounded by the result of a spike in purchases in the late 1990's. The spike was prompted by a highly publicized incident where a fire pump on a ladder truck was out of service, but the apparatus itself was allowed to remain in service. The unit was first to arrive on a fire scene and the crew was unable to put water on the fire since the unit's pump was out of service. A large number of the apparatus that were purchased immediately following this incident are now worn out and require replacement.

There is no national standard or nationally recognized practice for determining the lifetime of a piece of fire apparatus or an ambulance that would impact a high-activity system such as the Houston Fire Department. Thirty-six (36) of the HFD front line engines are over 10 years old and 14 of these are over 15 years old. All 17 of the reserve engines are over 15 years old. Seventeen (17) of the 38 first line ladders trucks are over 10 years old and nine (9) of these are over 15 years old. All of the reserve ladder units are over 15 years old and one (1) is 20 years old. The term "reserve"' when it comes to apparatus, is somewhat of a misnomer. As in all major metropolitan fire departments, these are not apparatus that are sitting around to be used for only a few days a year. These are apparatus that are running first-line calls on a daily basis while regular first-line apparatus is in for maintenance and repair.

As a result, the fire department needs to be funded to allow for an aggressive replacement program in the immediate future. Concurrently, a replacement fund program should be developed that "levels out" the fleet replacement for sustainability. The program should be designed so there is eventual consistent funding allowing for inflation and upgrades through the years. An on-going annual fleet maintenance program allows for consistency in funding and ensures that the city is not dependent on older, worn-out, and unreliable vehicles.

Recommendation 1:

Establish a fleet replacement fund that assures all front-line apparatus and EMS vehicles are less than 10 years old and placed in reserve for no more than 3 years.

Currently, the HFD purchases all ambulance and medic vehicles from a single local manufacturer. The standardization of these units provides efficiencies to firefighters and to their customers. The same applies to fire apparatus (engines, ladders, towers). The more standardization that can be accomplished with emergency vehicles, the more familiar each vehicle is to firefighters and mechanics and fewer parts need to be in inventory.

Strong consideration should be given to make vehicle repair at the Logistics site exclusive to the fire department. By far, the majority of the vehicles on campus were fire department vehicles. However, there were a few other city vehicles on the site. This co-habitation lends itself to maintenance priority issues and less expertise in repairing fire apparatus. The study team heard a good deal of anecdotal information from HFD members about the degradation of the level of fleet service provided to the HFD since management control of these operations was consolidated with city fleet services.

Recommendation 2:

Return fleet maintenance and repair responsibilities back to the control of the Fire Department.

We heard of long out-of-service times and recurring visits to the shop for unresolved issues. Clearly, this has an impact on service delivery. In June, 2016, there were at least 6 days in the month with apparatus out of service for repairs. In the first 11 days of July, 2016, there were 4 such days. On numerous occasions, apparatus were out of service for 12 hours with 17 instances in June with out of service time in excess of 6 hours and 13 such instances in the first 11 days of July.

Out of service apparatus means that firefighters do not have the proper vehicle to deliver service to their customers. An adequate fire department fleet maintenance program must assure the continued readiness of the fire department emergency fleet.

The fire department is too large to have its fleet maintained by a city-wide fleet maintenance system. The Logistics campus was very busy and crowded with all the vehicles. The removal of non-fire department vehicles from the campus would provide for better work flow. A dedicated facility, under the control of the fire department, will assure that the department's priorities and customer service are not compromised.

Recommendation 3:

Initiate a training program that requires all fleet mechanics to be certified in accordance with the Emergency Vehicle Certification (EVT) program.

The study team noted that only three (3) of the repair technicians hold EVT (Emergency Vehicle Certification). Emergency vehicles are far more complex than other vehicles, especially in the area of electronics. Technicians must be trained to diagnose and repair these specialized vehicles in accordance with the nationally recognized criteria,

NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*. By having certified technicians perform repairs, the city lessens it liability in case of a personal injury or death from the malfunction of fire department emergency response vehicle.

Fire Fighting Equipment

The department uses an Equipment Advisory Board, representing a cross section of the department, to provide input into the equipment used. The five-person Board consists of a Chair, Co-Chair and three (3) members. As with the Apparatus Design and Construction Team, this user input into the design and selection of the equipment is invaluable toward getting "buy-in" from the firefighters.

The department has the capability to repair much of its equipment and can provide timely cost-efficient in-house tasks such as re-coupling of hose.

Small Power Equipment Repair

Fire departments depend on a variety of small engine powered equipment. This includes items such as chainsaws, rescue saws, positive-pressure blowers, lawnmowers, leaf blowers, string-trimmers, and other equipment. Repairs are conducted by one (1) full-time person and supplemented by at least three (3) trained light duty personnel. In addition to repairing of equipment, the staff handles pick-up delivery of this equipment from the stations. The department might consider using non-trained "light-duty" personnel for the delivery tasks.

Repair orders are currently being transitioned from a manual ticket system to an electronic system. This transition should enable better overall management; as well as small equipment inventory and repair/replacement costs.

SCBA and Facemask Fit-Testing

Self-contained breathing apparatus (SCBA) are core life safety equipment for firefighters. The Houston Fire Department takes its SCBA program very seriously. The department uses 45-minute rated cylinders for the most of its fire fighting. It also has 60-minute units available for target areas such as high-rise buildings and large commercial warehouses. These 45- and 60-minute durations are appropriate for the hazards facing the department.

Firefighters are fit-tested to their individual SCBA masks on an annual basis. The fit-testing is done by an outside agency (Hoyt). Each SCBA unit is flow tested every six (6) months to make sure it is performing as designed. This is also done by an outside agency (Hoyt). The breathing air quality of the compressors and storage cylinders is independently tested by a third-party agency on an annual basis. The SCBA air cylinders are hydrostatically tested, as required by the U.S. Department of Transportation, by a third-party agency.

As with almost all fire departments, the manufacturer of their SCBA is sole-sourced. However, the department is hampered because the units are of various ages, i.e. models. This has created a situation where some units are built to various revisions of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*. This standard has gone through several major changes in the past three revision cycles in 2002, 2007, and 2013. The changes include advances in electronics, communications, and thermal resistance. A prime example of the varied models is that the most recent NFPA 1981 revision requires the low-level air alarm to activate at the 33% level. Previous revisions required the alarm to activate at the 25% level. This creates compatibility issues of varying low-level air warnings for the firefighters and a safety issue.

In addition, the latest revision required increased thermal resistance for the SCBA facemask lens. To meet this standard, the manufacturer has changed the shape of their mask. This has led to the fit issues with the protective hood worn by firefighters. Consequently, the fire department has been forced to look at another hood design.

> ***Recommendation 4:***
>
> *Establish a self-contained breathing apparatus (SCBA) replacement program where all SCBA are replaced at one time and at 10-year intervals.*

The HFD would benefit by adopting a program to replace its entire SCBA inventory at one time. The frequency of the total inventory replacement could be based on every other revision of the NFPA standard. NFPA standards are revised (with rare exceptions) every five (5) years. An "every other revision replacement program" would provide an acceptable life-span of about ten (10) years per SCBA. This replacement model allows for competitive pricing among SCBA manufacturers whereas the current system binds the city and the fire department to one manufacturer. In addition, the current system has allowed for various models of the sole manufacturer to be used in the field, creating conflicting levels of safety and various logistical issues.

Air cylinders are refilled by the three (3) mobile air units that are on duty 24/7. There are racks of spare cylinders at the District Chief stations, as well as a stationary compressor at the Training Academy. This system seems to work very well for the department.

The department's 1,300 SCBA's are maintained by four (4) factory-certified technicians. Two (2) of the technicians are on the road from 0800 to 1700 Monday through Friday servicing the SCBA's. In addition to repair and testing, the technicians are also responsible for the pick-up and delivery of the SCBA to the stations. As with the small equipment delivery tasks, the department might consider using "light-duty" personnel for pick-up and delivery.

There is an SCBA Technician assigned to the training academy on a part-time basis to service an additional 140 SCBA units used at that facility. Because of the high volume of work (constant usage) required at the Academy, consideration should be given to make this a full time assignment. The full time assignment brings added value because the SCBA manufacturer offers discounts to regional fire training facilities. Due to the scope of its course offerings, the fire academy meets the criteria for a regional fire training center.

Fire Station and Facilities Maintenance

Based on tours of a few fire stations, the study team noted that the stations are very clean and the firefighters have tremendous pride in their stations. This was evidenced by the number of photos and memorabilia found throughout the stations. Cleanliness is by design, i.e., Mondays are for apparatus bay cleaning, Tuesdays for the rest of the station, and Friday is yard day. There is some station maintenance component each day.

As with other facilities, fire stations are issued a "Certificate of Occupancy" by the Fire Prevention Bureau. Stations are inspected by the District Chiefs on a quarterly basis. The fire department should consider doing a monthly self-inspection by the firefighters to enhance fire station safety and maintenance needs. The checklist could include issues commonly found by OSHA inspectors, the Texas Fire Commission, NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and station features that require occasional maintenance. NFPA 1500 (9.2.3) states that "All fire department facilities shall be inspected at least monthly to identify and provide corrections of any safety or health hazards."

Station repair requests are made through the city-wide General Services Division (GSD) on-line program called "Sprocket". The system logs requests by facility and provides a priority listing, as well as a status of the request. A protocol is in place to assure that Priority One requests are addressed in one (1) to four (4) hours. A key to the success of the system is a person (Inspector) in GSD dedicated to fire department facilities who communicates directly with the fire department contact person. The system, which has been in place since 2002, is user-friendly and seems to be working very well.

Recommendation 5:

Assign a dedicated General Services Division (GSD) crew for the repair and maintenance of fire department facilities.

Facility repair would be further enhanced by GSD assigning a dedicated crew to the fire department. A dedicated GSD (General Services Division) team to perform repair and maintenance of fire department facilities would improve repair time and provide added expertise about the unique features of fire stations to the repair crew(s). The number of facilities used by the fire department and the unique characteristics of fire stations would easily justify this change.

The study team noted that none of the fire stations have a source-capture for diesel exhaust removal. Diesel exhaust is a known carcinogen and having a source-capture diesel exhaust system is recommended by many fire service and cancer awareness organizations. NFPA 1500 states (9.1.5): "The Fire Department shall prevent exposure to firefighters and contaminations of living and sleeping areas to exhaust emissions." It was noted that the apparatus bay doors are kept open during the day and many stations had large big-box fans to circulate and exhaust air. However, these are not as effective as a source-capture system. The doors are closed at night. It was noted in at least one (1) station that the ice machine was located on the apparatus bay floor, subjecting the ice to diesel exhaust fume contamination. Details about the hazards of diesel exhaust can also be found in NFPA 1500 (A.9.1.5). *NOTE: The drawings for new station #55 include a source capture system. If the HFD finds another system that is as effective to prevent exposure to diesel exhaust that fits better into the HFD, it should be used in place of source capture.*

Recommendation 6:

Install source-capture diesel exhaust systems or another effective exhaust removal system in all fire stations.

It was noted that some fire stations have washer/dryers for firefighters to clean their uniforms, towels, bed linen, etc., so they do not take contaminated clothing home. It would be beneficial for all fire stations to have this capability. It was also noted that fire stations have hose dryers on the apparatus bays. For most departments, the need for hose dryers went away approximately 30 years ago when cotton-jacketed hose was no longer manufactured. The fire department is currently phasing out the use of these dryers.

The fire department is doing many things to manage its resources in a sustainable and cost-effective manner. For example:

1. Transitioning to LED lights where applicable in its stations. This will result in annual utilities savings.
2. Transitioning to more durable gas range-tops in lieu of electric range tops. Gas range-tops provide instant heat and are far more durable in a fire station environment than electric range tops.
3. Installing light sensors in new stations.
4. Transitioning to remote-controlled thermostats for HVAC. This is based on ambient temperatures.

5. Recycling of cooking oil so it is not dumped into the drainage system.

The fire department should develop a long-range plan to retrofit all fire stations with a generator that fully powers the station. During storms, as well as man-made disasters, the power grid can be compromised. Fire stations are a beacon to the community during such occurrences and a fully-powered fire station can be a major resource to a community.

There is a program to renovate two stations annually. The amount allocated for a single renovation is $1.25 million. The study team visited one of the recently renovated stations (#25) and found the renovation to be well-done and well accepted by the firefighters. The renovation is expected to extend the life of the station by about 30 years. In looking at the age of the fire stations, the number of annual renovations will need to increase soon. For example, 24 stations were built in the 1980's. Of these 24, 14 have not been renovated. Eleven (11) stations were built in the 1990's and only one (1) has been renovated.

The study team was able to look at the drawings of new fire station #55. It is clear that the department has given detailed thought into the design. The layout and features are consistent with the current thinking in fire station design.

The fire department only has $300,000 annually for the replacement of station furnishings, including mattresses. This equates to only $3,225 per station and is a clear indication of excellent resource management.

The city would be wise to consider involving the fire department more in long-range and short-term planning as it relates to its fire stations. For example, street construction projects can impact fire department response times and block access. One story was shared about a road construction project blocking fire apparatus in their own station. Another example provided was the installation of a new phone system that did not allow for station-wide paging—a key communication feature for any fire station.

Personal Protective Equipment (PPE)

In addition to SCBA, the personal protective equipment (PPE) worn by firefighters consist of the following: helmets, protective hoods, coats, gloves, pants, and boots. Every firefighter is issued one (1) each of those ensemble elements. It is obvious the fire department does not cut corners when it comes to PPE selection. This is a core value that should never be compromised. It is life safety equipment.

For its coats and trousers, the fire department uses the V-Force design by Lion Fire Apparel. The price is about $1,800 per set and is a very reasonable price for the components and design of this ensemble. Another vendor, Honeywell, supplies the protective gloves, helmets and hoods. Globe Manufacturing, provides the boots.

The fire department maximizes it PPE resources in a responsible manner. For example, recruits are issued rubber boots for their training. The rubber boots are re-cycled for the next recruit class. More expensive leather boots, which provide superior fit and dexterity, are issued once a recruit completes his/her training. Also, the fire department issues its recruits used gear (not suitable for live-fire suppression) to wear as they go through their non-fire training evolutions.

During the site visit, it was obvious that the inventory level for PPE was extremely low, especially protective coats and trousers. When asked about this, the study team was advised that the procurement and contract management for acquiring these items had become very cumbersome. The department had gone almost two (2) years without a contract. Some elements of the protective ensemble are easy to acquire if one size fits all, such as helmets and protective hoods. However, protective coats and trousers must

be custom-fitted with chest, sleeve, waist and leg measurements. The problem is compounded because specifications are unique to most departments and there is no inventory in a manufacturer/suppliers warehouse ready for distribution. This is a prime example of the communications and common understanding issues between the HFD and city's Procurement section of the Finance Department.

Recommendation 7:

Dedicate at least two city procurement personnel exclusively to the Fire Department.

The city should consider ways to bridge the Procurement section to the fire department for more efficiency and an understanding of the unique requirements of the fire department. Fire departments across the nation have procurement challenges that are unique to other public service departments. There is an institutional knowledge base within emergency services that must be cultivated and nurtured. An understanding and appreciation of these unique characteristics is key to providing internal and external customer in a cost effective manner. We suggest that City of Houston Procurement staff be dedicated to HFD purchasing activity. Ideally, these Procurement staff members would be posted at an HFD facility to enhance communication.

PPE is inspected annually by the District Chiefs (A-shift during the first quarter, B-shift during the second quarter, C-shift during the third quarter, and D-shift during the fourth quarter). The shift Safety Officers are continually monitoring PPE and the Texas Commission on Fire Protection does spot inspections for a couple of weeks annually.

The fire department uses an outside agency (Lion Total Care) to clean and repair its PPE. The department has been forward thinking in protecting its firefighters by having its PPE maintained. The cleaning is performed at least twice annually while firefighters are off duty. It appears the relationship between the fire department and the outside cleaning agency is very well managed and cost efficient.

Firefighters are at far greater risk of developing cancer than the general population. Proper and frequent cleaning of PPE is critical to minimize this risk. Considerable research is currently underway about PPE and cancer, especially about PPE cleaning. The fire department will be well advised to stay current with this research and modify its care and maintenance program accordingly.

Warehousing/Distribution of Fire Fighting Equipment, Office Supplies, Janitorial Supplies and Other Station Needs

This part of the Logistics section is often taken for granted. However, it is absolutely critical for the fire department to function on a daily basis. The warehousing and distribution system seems to operate very well. There are approximately 20 employees who have an appropriate workload. Warehousing is shut-down in the third week of June for an annual inventory.

Fire departments have a need to keep a strategic reserve of mission-critical equipment and supplies on-hand to be able to stay in business in case of disaster. Other supplies, such as most office supplies, are not mission-critical and the inventory for these items can be managed much like any warehouse serving any business (possible even through virtual inventory management through a supplier). We found that the HFD intelligently selected mission critical and non-mission critical items in their inventory and managed the level of these inventories appropriately.

Half of the fire stations order their supplies on the 1st day of the month and the other half of the fire stations order their supplies on the 15th day of the month. The orders are based on a standard supply list. Supplies are delivered once a month, except for EMS supplies which are delivered twice a month. Four (4) drivers

handle the deliveries. There are monetary limits set for each station dependent on the number of personnel assigned to that station (approximately $300 per station/per month). The monetary limit forces the firefighters to use their supplies in a cost-effective manner. This process appears to work very well and very efficiently.

Recently, the issuance of station work uniforms was transitioned from Logistics to an outside agency (Lone Star). The Lone Star physical facility is conveniently located around the corner from Logistics. Firefighters have an annual limit of $300 they can spend at Lone Star. The $300 limit has a one-time rollover for purchase of a dress uniform. The transition seems to have served the department very well and has saved an estimated overhead cost of $1 million annually.

Janitorial supplies are procured through a city-wide contract and individual contracts. This process did not seem to present any problems. The department is switching a concentrate dispenser for common cleaning supplies in each station. This switch should result in annual savings for cleaning chemicals. It also allows for the re-use of cleaning bottles with additional cost savings.

Office supplies are procured through a city-wide contract with an office supply company. There do not seem to be any problems with the inventory control software. It interfaces well with the overall city-wide SAP software program.

The SAP accounting software program discourages the fire department from disposing of obsolete equipment. The study team learned that items disposed of through surplus may result in charges against the HFD budget for the value of the disposed items. Therefore, a disincentive exists to dispose of surplus items and these items are taking up warehouse space. There should be efforts to identify beneficial ways for the fire department to dispose of obsolete inventory.

There is a process for handling missing and stolen equipment. The company officer submits a form to the Assistant Chief of Homeland Security, where it is determined if there is a need for restitution. The form is then forwarded to a review team for determine if any further actions are needed.

City Procurement and the fire department should explore ways to get "open" contracts for the replacement of items such as kitchen appliances and station furnishings. These are items, when broken beyond repair or worn-out, that should be replaced without delay. For warranty and warehouse space considerations, these type items do not lend themselves to be kept in inventory.

The fire department should consider using light-duty personnel for delivery of unanticipated needs for supplies and equipment. For example, one captain stated he had to take his crew and apparatus to Logistics to get a printer cartridge.

EMS Supplies

The distribution of EMS supplies is a model program. The department uses a "warehouse on wheels" concept where dedicated Logistics personnel replenish the EMS supply cabinet at each station. The Logistics personnel are thoroughly familiar with the needs of each station and supply their needs accordingly. With this concept, there is no need for firefighters to order their supplies. This eliminates hoarding of supplies and is a very cost-efficient program.

Stations are expected to keep a 30-day supply of EMS supplies. There is also extra inventory at the Medical Supervisor stations. The delivery drivers are very familiar with the appropriate inventory for each station.

The HFD is unable to procure its medical supplies in cost effective manner. The department is bound to a city contract with an overall discount from a supplier's catalog. Approximately 98% of the items in the catalog are not used by the fire department. For the 2% that are used, the supplier is often out of stock items are back-ordered. This results in having to make short-term purchases outside the catalog. The department estimates this process has caused them to go $1 million over budget for 2015.

> ***Recommendation 8:***
>
> *Explore partnerships with local hospitals for the purchase of EMS supplies.*

The department and the city should explore opportunities to work with local hospitals (such as the Texas Medical Center) for a cooperative purchasing agreement for EMS supplies. The product lines for the fire department and hospitals (especially emergency rooms) are more aligned than a comprehensive EMS supply catalog. With the purchasing power of a large hospital(s), such an agreement could result in much better pricing and supply inventories.

Miscellaneous

The HFD takes advantage of the Houston Galveston Area Council (HGAC) cooperative bid process. The Council consists of several counties in southeast Texas. The HFD is able to purchase items from various vendors on the contract. This is an efficient procurement tool that should be maintained.

All apparatus and support vehicles have a vehicle mounted radio. Portable radios are assigned to each firefighter "riding position" four (4) per fire apparatus, two (2) per ambulance and medic unit, and one (1) for each chief officer. Radio communication for fire personnel is life safety equipment. The radios belong to the fire department, but they are maintained by the city's IT Department. Four (4) years ago, the fire department performed its own maintenance. There have been problems with the city IT Department understanding the needs of the fire department. The city should consider ways to help its IT Department become a better service provider for the fire department.

Appropriate personnel are issued p-cards for emergency purchases and urgent repairs. Some cards have a $3,000 monthly limit and others have a $10,000 monthly limit. The cards cannot be used for normal inventory replenishment.

Fuel pumps are located at a few stations and units without access to the pumps use fuel cards at designated service stations.

The example of the central campus for Logistics is a model that could be similarly used with the procurement activities of the Finance Department. Procurement personnel dedicated to the fire department (and perhaps co-located) would create more efficiency, quicker turnaround, and an understanding of the unique requirements of the Fire Department.

Professional Development

The majority of the fire department's formal Professional Development Division's programs are based and delivered at the Val Janke Training Facility (VJTF). There were 28 HFD staff members assigned to the VJTF at the time of this review. Staff are assigned to the VJTF on a voluntary basis. This assignment policy has a positive benefit. It ensures that the personnel who are assigned to the training function actually want to be there. In many fire departments, assignment to the training facility is not voluntary and sometimes lands on junior officers that have recently been promoted. The fact that assignment to the VJTF is voluntary increases the likelihood that staff will be motivated and engaged in their delivery of the professional development programs that are being delivered. The following portions of this section provide information and recommendation on specific areas of the Professional Development Division program.

Use of Recognized Standards

State of Texas law requires all fire departments within the state to follow the Texas Commission on Fire Protection (TCFP) requirements on fire personnel certification. Members operating in any of the following fire department roles must be certified to the TCFP requirements:

- Structure fire suppression
- Aircraft rescue fire protection
- Marine fire protection
- Fire inspection
- Fire and arson investigation
- Fire protection instructor
- Head of a fire department

The TCFP also has optional certification requirements for the following fire department roles:

- Fire Officer
- Hazardous Materials
- Driver/Operator-Pumper
- Fire Department Safety Officer
- Wildland Fire Protection

The Professional Development Division officers emphasized the department's adherence to the TCFP certification requirements for the positions in which they serve. They also noted that all fire instructors must meet the requirements of NFPA 1041, Standard for Fire Service Instructor Professional Qualifications, Instructor I and that new fire officers may voluntarily complete course and practical work to meet the requirements of NFPA 1021, *Standard for Fire Officer Professional Qualifications, Fire Officer I.*

Employee Recruitment Process

The employee recruitment process is used to identify individuals who may become successful candidates for entry into the fire department recruit firefighter training program and then joining the ranks of the HFD. Having an effective recruiting program is one way of ensuring that the people entering into the fire department have a high probability of becoming quality employees once they are hired.

Recommendation 9:

Uniformed HFD members should be involved in the recruiting process, particularly when recruiting at events. These firefighters and fire officers should reflect the diversity of the HFD and of Houston.

Historically, recruiting functions were performed by uniformed members of the fire department. As a part of a larger city-wide consolidation process, the recruiting responsibility was turned over to civilian staff members of the City of Houston Human Resources Department. From experience with recruitment of firefighters in other fire departments, we have seen that uniformed members conducting recruitment outreach are markedly more efficient than the utilization of non-uniformed staff. Recruiters should be reflective of the diversity of Houston and the diversity of the Houston Fire Department. Uniformed firefighters and fire officers involved in the recruitment process can talk first-hand about training, the job of a firefighter, and the benefits of becoming a firefighter. Conveying these experiences to potential firefighters is important.

Recommendation 10:

Utilize the Candidate Physical Abilities Test (CPAT) to assess the physical ability of potential firefighters and firefighter cadets.

The HFD currently utilizes a locally developed Physical Capabilities Test (PAT) to assess a cadet's ability to physically perform the job of a firefighter. The use of a locally developed test brings with it the potential for legal challenges to the validity of the test as an assessment tool. The Candidate Physical Ability Test (CPAT) was developed by a consortium of fire departments and labor unions. The goal of the CPAT was to provide a fair evaluation system in the selection of firefighters to ensure that all firefighter candidates possess the physical ability to complete critical tasks of a firefighter effectively and safely. The CPAT has been endorsed by the International Association of Fire Fighters (IAFF), the International Association of Fire Chiefs (IAFC), and other fire service organizations. The United States Department of Justice (USDOJ) participated in the development of the CPAT. Although the CPAT is not officially endorsed by the USDOJ, it is a nationally recognized and validated test that is job-related.

The CPAT is a standardized process to orient potential firefighters to the requirements of the test, provide potential firefighters with the opportunity to practice for the test, and standardized methods to administer and document the test. The CPAT can be administered by the City of Houston or by another entity. In some areas of the country, the CPAT is administered by community colleges or other non-governmental entities. Many testing centers provide successful candidates with a card or certificate that can be accepted by hiring authorities such as the City of Houston as proof that the candidate has successfully completed the CPAT. Typically, these certificates are valid for a stated period of time such as six (6) months to a year. Some entities charge a fee for CPAT preparation and the administration of the test. If Houston adopts the use of the CPAT and allows other entities to administer the CPAT, the impact if this fee on the ability of potential firefighters should be taken into consideration. In some cases, the fee can be a barrier to a diverse firefighter applicant pool. Some communities have addressed this concern by reimbursing potential firefighters for the direct costs associated with taking the CPAT in cases of financial need.

Successful completion of the CPAT is also used in many fire departments as a tool to assess the physical preparation of cadets undergoing initial firefighter training in a fire department training academy.

Additional information on the CPAT can be found at http://www.iaff.org/et/becomeff/documents/cpatmanual-lorez.pdf

Recruit Training

The most basic function of any fire department training or professional development program is the training of new recruits entering onto the fire department. Recruit training is a primary focus of the Professional Development Division. This is typical of any fire department professional development or training program. Currently, six (6) recruit academy classes are conducted at the VJTF each year. Approximately 300 recruits graduate from the program on an annual basis.

There are currently two (2) levels of recruits that enter into the HFD recruit training program. Certified recruits are already Texas-certified Firefighters and National Registry EMT's. Their recruit training program consists of 12 weeks of primarily HFD familiarization. The staff members that were interviewed noted the some of these candidates who primarily got their certifications through on-line training programs struggle once they are in the training program.

The training program for candidates that do not have the previous certifications is a 21-week program that results in the candidate becoming a Texas-certified firefighter and a Nationally-Registered Emergency Medical Technician (NREMT).

In general, the recruit training programs work well and prepare the candidates to perform their roles once they graduate and are sent to the field. As noted in the previous section, the staff was concerned about the percentage of recruits who are unsuccessful in their training effort and are forced to leave the academy. The actual attrition rate for cadets from 2013 to 2016 was 12.2 percent. Almost half of the cadets that washed out during that time period did so due to the inability to gain certification as an Emergency Medical Technician.

Recommendation 11:

Analyze the causes of cadet "washouts". Develop strategies to mitigate washouts, where practical.

The staff believes that a better mechanism for decreasing the "washout" rate for cadets needs to be implemented. This will minimize the loss of cadets who fail to complete the recruit academy and maximize the efforts of the instructors trying get personnel ready for deployment to the field. A number of strategies have been used by fire departments across the nation including instruction in test taking, instruction in reading comprehension, pre-employment psychological screening, providing cadets with mental toughness skills to help them manage the stress of the firefighter job, and study hours hosted by the fire department to help prepare cadets for the EMT exam.

The HFD invests a lot of resources in cadets in the selection and training process. Some cadets leave for other jobs or they leave when they find that the job of a firefighter is not well suited for them. While some cadet attrition is to be expected, efforts to minimize attrition can pay benefits at a relatively low cost.

Engineer Operator (E/O) Training

Perhaps the area of most concern to the study team was Engineer Operator (E/O) training procedures. Driving fire apparatus is among the most hazardous functions performed by firefighters. Annually, fire apparatus and emergency vehicle collisions are the 2nd leading cause of firefighter fatalities in the United States. Improperly trained E/Os are also a serious hazard to the public. Effective E/O training is a crucial part of the overall safety program for the fire department.

Currently, the HFD has no formal testing or promotional process specific to E/Os other than a written test. All firefighters are expected to be able to serve in this role. Company officer

decides if a firefighter can step up to E/O. The HFD had a more formal training program in the past, but it was cut due to budget issues. This lack of funding has severely impacted the quality and frequency of E/O training.

Currently, basic E/O training is performed in Phase 3 of recruit academy training. A portion of it is done on-line, as opposed to being instructor-led. Once a recruit completes the recruit academy program, they are sent to the field for a six (6) month probationary assignment/evaluation on a fire company. They do not drive the apparatus during this period. Following that period, they generally work on an ambulance for a minimum of two (2) to three (3) years, during which time they rarely, if ever, ride a fire apparatus. As they gain seniority, firefighters have more opportunities to go back to a fire company upon completion of their ambulance assignment. At this point, it has been three (3) or more years since they received their initial E/O training. VJTF staff advised the study team that they do receive some E/O refresher training prior to being assigned to a fire company, but did not provide details as to the extent of that training.

VJTF staff advised the Evaluation Team the HFD accident rates were the same regardless of whether there was a formal training program or not. The Evaluation Team was never provided with any statistical data to prove this assumption and it defies the collision statistics in fire departments in the United States that have a more structured E/O training program.

Recommendation 12:

A standardized, department-wide, driver training and recertification program meeting the requirements of NFPA 1451 needs to be developed and overseen by the VJTF staff.

A standardized, department-wide, driver training and recertification program needs to be developed and overseen by the VJTF staff. This program should comply with the requirements contained in NFPA 1451, *Standard for a Fire and Emergency Service Vehicle Operations Training Program*. Upon completion of the training program, the E/O will meet the TCFP requirements for Driver Operator – Pumper and the requirements of NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications* for the type(s) of apparatus that they will be expected to operate.

Fire Officer Training Program

Current HFD policies require that members must work in their current rank at least two (2) years prior to becoming eligible to promote to the next level. Members who promote to Captain must complete a two-week training program. VJTF staff advised that this training program met some, but not all, of the requirements of NFPA 1021, *Standard for Fire Officer Professional Qualifications*, Fire Officer I. The staff did not note whether this training also met the TCFP requirements for Fire Officer certification, which is an optional certification.

Training to meet the requirements of NFPA 1021 for the Fire Officer II level is available, but optional. There is a current effort underway to develop training programs that meet the requirements of Fire Officer III and IV.

The level of training progresses as members promote to higher ranks within the department. Senior Captains require additional training in administration, truck operations, and the Incident Command System (ICS). District Chiefs require additional tactical and command training in the department's command training simulator located at the VJTF. They must also complete National Incident Management System (NIMS) Levels 300 and 400 training.

Based on the information gathered during the meeting, it appears that there are no continuing education requirements for an officer upon promoting to a certain level. Some form of officer continuing education is critical for shaping this group's development. This training is also serves as a venue for the Command Staff to communicate the ever-evolving message of what the organization's goals are, as well as the core values that are important in the HFD. A minimum of semiannual outreach offered on site at VJTF, online, or a combination of both is suggested. Such an effort should be coordinated and delivered by the fire academy with input from all city agency stakeholders.

Recommendation 13:

All fire officers should be required to participate in continuing education, specific to rank, throughout their careers.

The VJTF officials who met with the study team noted that while there are a number of training and educational opportunities available to HFD firefighters and officers, the procession through the system to higher ranks can be somewhat confusing. The entire group felt that there is a need for a formal, documented, Career Development Plan (CDP) that guides employees through the promotional process. This plan should incorporate training and educational opportunities including the completion of 2-year and 4-year college degree programs.

Recommendation 14:

Develop a formal, documented, Career Development Plan (CDP) that guides employees through the promotional process.

EMS Training

All new and refresher emergency medical training is conducted in partnership with an outside entity. This is a common practice among fire departments of all sizes. There is no need to change this policy. It is our understanding that EMS continuing education efforts including the cadaver lab, PEDISTEPS, and Lone Star College continuing education programs were cut in the FY2017 HFD budget. This would be a step backward in these training efforts.

Additional information on initial and ongoing EMS training is included in the Emergency Medical Services section of this report.

In-Service Training

The State of Texas requires all firefighters to complete at least 20 hours of training per year. Additionally, Insurance Services Office (ISO) requires all firefighters to complete at least 20 hours per month in order for the fire department to maintain their rating.

The in-service training program does include larger-scale multi-company drills as a regular practice. Each company participates in multi-company drills that are held at the VJTF twice per year. Other drills are conducted in the field during the course of the year.

In the view of the study team, the monthly training guidance that is issued by the fire academy needs to be enhanced to provide the structure, support, and oversight required for such training to be valid and effective. The academy staff needs to generate a lesson plan, issue instructional materials appropriate for the learning objectives and track each member's successful completion of monthly training utilizing the fire academy training database. NFPA 1401, *Recommended Practice for Fire Service Training Reports and Records* provides an excellent source of information on how training records should be developed and maintained. Information on how and when in-service and annual training should be managed can also be found NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, as well as in NFPA 1404, Standard for Fire Service Respiratory Protection Training.

Special Operations Training

HFD members volunteer for special operations assignments and the associated training that goes along with that assignment. In several of the specialized operations, including hazardous materials, technical rescue, and Airport Rescue Fire Fighting (ARFF), the HFD conducts their own basic and in-service training for these functions. Some of the practical training functions are conducted at other training facilities such as the Texas A&M Fire School in College Station, Texas and at the Dallas-Fort Worth International Airport Fire Training Facility.

Continuing Education

The HFD is supportive of the continuing education of their members. Members may attend National Fire Academy courses. Unless the course occurs in designated periods of the year, the individual must make arrangements to have their position covered. This policy may discourage individuals from attending courses that may benefit them and the HFD, but are only offered at other times of the year.

The HFD should consider a policy that is supportive of and assists members in attending National Fire Academy and similar courses throughout the entire course of the year. The HFD should make arrangements for these positions to be covered when the individual is attending training.

The promotional process should provide incentive to the candidate to seek continuing/higher education in order promote to a higher rank. HFD Professional Development staff noted that members with a greater level of education perform better in the field, but that they do not promote up the ranks any faster than those without a higher level of education. This is not reflective of the experiences of other fire departments. Most fire departments see that members with a higher level of education do promote up the ranks faster than members with a lesser education. These departments find that getting the most capable candidates into higher positions, as soon as possible, is of great benefit to their departments. The HFD may need to examine the promotional process to determine why it does not promote a higher level of education as a benefit to the promotional process.

VJTF Training Facility Observations

The study team was given an extensive tour of the VJTF. The facility is expansive and provides a multitude of types of training opportunities. Like most major municipal training facilities, the primary focus of the facility is clearly geared towards recruit training. The VJTF has all of the necessary facilities to provide a quality recruit training academy. The study team was impressed with two particular training props that were viewed. The first was a fire flow/behavior demonstration model that was developed by one of the instructors at the facility. It provided a very realistic demonstration of how heat, fire, and smoke travel throughout a structure under a variety of conditions. This is a very helpful tool for both recruit and officer-level training.

The exterior SCBA training maze props were also an excellent idea. Neither of the evaluators had previously seen anything like this. The exterior props allow students to build their confidence in negotiating tight spots while wearing their SCBA in a non-threatening environment. This can reduce their anxiety and increases their chances of success once they are expected to negotiate the same obstacles in the darkened interior SCBA maze building.

The Command Training Center is also a very impressive facility. It provides command officers with a very realistic training experience for managing emergency incidents of all types and sizes. The ability for command officers to drive the vehicle in which they normally operate into the facility and command the incident from that vehicle provides and extremely realistic scenario. Neither of the

evaluators were familiar with any other facility that allows this. The mock-up of the interior of the HFD mobile command post vehicle also provides for realistic training on managing larger events.

While the VJTF provides a number of state of the art components such as the props and the Command Training Center mentioned above, the VJTF facility itself has been overcome by the growth of the HFD. A number of temporary portable buildings are used, there is no provision to address large groups in an auditorium setting, and storage of firefighter personal protective clothing in cargo containers in not optimal. Several studies and master plans have been done to project the need for augmentation of the VJTF with only minimal progress toward implementation. Due to the significant capital costs involved in this type of facility, a plan to make improvements over time needs to be developed and funded.

Recommendation 15:

Refresh and begin to implement the Facility Master Plan for the VJTF.

Deployment – Emergency Operations

The Houston Fire Department operates an extremely active emergency response system. The system is made up primarily of ambulances, medics, squads, engines, ladders, towers, and command officers.

For decades in the United States, computer software has been used to depict the level of service being provided by fire and EMS systems in their communities. More recently, computer modeling software has been used to predict the impact of deployment rule changes, the addition or removal of emergency response units, and the impact of community growth or contraction.

For many, generally small and less active fire departments, the modeling of emergency response resources with every unit available and in its station prepared for response is practical. The level of emergency activity in these fire departments is low enough that it's reasonable to assume that most response units will be available to respond to most calls. This assumption is not possible with Houston.

With the number of emergency response units, the land area covered, the significant impact of traffic delays, and the sheer number of emergency incidents, the Houston response system cannot realistically be modeled on the assumption that every unit is in quarters awaiting a dispatch.

For a realistic analysis of the past performance and predictions of the future performance of the Houston Fire Department emergency response system, we utilized the Optima Predict system. Predict is a discrete event simulation system that takes a number of factors into consideration including vehicle response speed over the Houston road network based on traffic and time of day, the incidence of emergencies based on actual Houston experience, and the current and proposed level of emergency unit resources utilized by the Houston Fire Department.

Predict was able to report on Houston Fire Department performance and predict the impact of staffing and deployment changes on the services provided by the department.

NFPA 1710

National Fire Protection Association 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* sets staffing and response time standards for fire departments, like Houston, that are made up of career (not volunteer) firefighters. The most recent version of the standard is the 2016 edition.

Houston staffs its engine, ladder, and tower fire companies in compliance with the NFPA 1710 requirement for a total of four on-duty members, including the officer, for each fire company at all times.

Chapter 4 of the standard also includes a number of response time objectives. The performance of the Houston Fire Department when compared to these objectives will be discussed in this section. NFPA 1710 response time objectives are as follows:

- 240 seconds (4 minutes) or less travel time for the arrival of the first arriving engine company at a fire suppression incident.
- For other than high-rise, 480 seconds (8 minutes) or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident.
- For high-rise, 610 seconds (10 minutes 10 seconds) or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident.
- 240 seconds (4 minutes) or less travel time for the arrival of a unit with first responder with automatic external defibrillator (AED)

or higher level capability at an emergency medical incident.

- 480 seconds (8 minutes) or less travel time for the arrival of an advanced life support (ALS) unit at an emergency medical incident, where this service is provided by the fire department provided a first responder with AED or basic life support (BLS) unit arrived in 240 seconds or less travel time.
- The Fire Department shall establish a performance objective of not less than 90 percent for the achievement of each turnout time and travel time.

Summary of Findings – Current Performance

- First Unit Response Time (240 Seconds of Travel) – Houston firefighters are first on the scene of an emergency less than half the time within 4 minutes. Less than 50% of Houston emergency incidents have response times that comply with the requirements of NFPA 1710. The average travel time for the first unit to arrive at any address in Houston is just over 4 minutes but the 90th percentile is nearly 7 minutes (firefighters are on-scene within 7 minutes for 9 out of 10 emergency incidents in Houston).
- Advanced Life Support Response Time (480 Seconds of Travel) – the average ALS response time to Houston emergency incidents is just under 7-1/2 minutes but the 90th percentile is 12-1/2 minutes.
- Ambulances and medic units are deployed throughout Houston in a manner that provides good coverage, but the level of activity for these units translates to a 90th percentile response time of 11 minutes and 33 seconds.
- For residential structure fire incidents in 2015, the average time needed to assemble the required number of firefighters on the scene was 7 minutes and 18 seconds and the performance at the 90th percentile was ten minutes and 33 seconds.
- For commercial structure fire incidents in 2015, only 5 percent of incidents had the required number of firefighters on-scene within the 8-minute travel time.
- For high rise incidents in 2015, 20 percent of incidents had the required number of firefighters on-scene within the 8-minute travel time.

Summary of Findings – Projected Performance

- If 12 HFD squads were converted to medic units – shorter response time for ALS, lower workload per ambulance, shorter response time for ambulance arrival.
- The benefits of utilizing Automatic Vehicle Location (AVL) technology to select emergency units for dispatch rather than the current run card method is a reduction of approximately 30 seconds in response time on a city-wide basis given Houston's current level of emergency resources. We recommend the use of AVL for unit selection.
- Conversion of all ambulances and Squad units to medic units could provide an ALS average response time that is nearly two (2) minutes less than the current deployment and reduce ALS response times at the 90th percentile by 3 minutes and 16 seconds.

Summary of Findings – Deployment Recommendations

- Add EMS transport resources (ambulances and medic units) to improve the timely arrival of a transport unit at an emergency. These resources may be a combination of full-time and peak-time units. ***(Recommendation 16)***
- Construct and staff a new fire station (901) in southwest Houston (approximately

Chimney Rock and Beechnut, District C) in the areas served by fire stations 37 (7026 Stella Link, District C), 48 (11616 Chimney Rock Road, District K), and 51 (6902 Bellaire Boulevard, District J). ***(Recommendation 17)***

- Construct and staff a new fire station (902) in north central Houston (approximately North Freeway and Mount Houston, District B) in the areas served by fire stations 58 (10413 Fulton Street, District H), 67 (1616 West Little York Drive, District B), and 74 (460 Aldine Bender Road, District B). ***(Recommendation 18)***
- Construct and staff a new fire station (903) along the Sam Houston Parkway corridor (approximately Cullen and Beltway 8, District B) in the areas served by fire stations 47 (2615 Tidewater Drive, District K) and 55 (11212 Cullen Boulevard, District D). ***(Recommendation 19)***
- Staff and equip an additional hazmat unit on the West side of Houston. This unit should be in addition to and supplement existing hazmat staffing. For the purposes of illustration in this report, the hazmat unit was placed at Fire Station 75 (1995 South Dairy Ashford Street, District G). ***(Recommendation 20)***
- Add three technical rescue units in South Central Houston, Clear Lake, and Northeast Houston. For the purposes of illustration for this report, Houston Fire Stations 63 (5626 Will Clayton Parkway, District B), 94 (235 El Dorado Boulevard, District E), and proposed Fire Station 903 were used. ***(Recommendation 21)***
- Add three (3) additional on-duty Safety Officer units per shift to provide adequate geographic coverage for safety officer functions. ***(Recommendation 22)***

Recommendations 16 through 22:

Deployment Recommendations

Methodology

Optima US Ltd deployed a range of capabilities for the deployment analysis. These included:

- Geospatial Analysis using geographic and road network data from the City of Houston and other regional government sources.
- Optimization algorithms to determine 'best fit' solutions when evaluating the best time and location for additional resources to enhance performance
- Discrete Event Simulation to establish a baseline model performance level and evaluate various scenarios in order to confirm and further refine recommendations from the geospatial and optimization work.
- Incidents/Coverage were evaluated using a combination of three methods prior to simulation. Optima Predict has the ability to evaluate coverage via the calibrated road network (e.g. how far can I drive in 480 seconds from each station), address points (e.g. which address points/locations are within 240 seconds of an HFD station) and historic incidents (e.g. historic incidents that have a travel time of 240 seconds or less for the first arriving apparatus). This method allowed for initial review of the HFD data and infrastructure and informed areas of focus for simulation scenarios.

Simulation Methodology and Limitations

The simulation has been tuned based on historical data provided by HFD. The road network has been tuned based on call and response data provided by HFD. The final result produced a good match between the simulated travel times to scene and the historic travel times to scenes.

The EMS dispatch rules were implemented based on the rules provided by HFD. For

fire dispatch the rules were simplified and only Engines, Ladders/Towers, Ambulances, Squads, Medics and Chiefs were modelled. The final model shows a reasonable match between the overall tuned simulation and the historical results.

Simulation Limitations

The data provided contains some inconsistencies (travel times are very long at night, hospital locations appear incorrect for some calls) and AVL data was not available to confirm the location of vehicles through the various stages of a response (turn out time, travel time, at scene time, transport time, at hospital duration).

Additionally, dispatch rules within the model have been designed based on the rules provided by HFD. The standard EMS dispatch rules have been incorporated into the model, however, as in most organizations, the historic incident data reflects that in reality these rules are not always followed. Incidents where the dispatch rules differ from what has been historically dispatched have not been modelled correctly (for instance some calls that require two (2) vehicles based on dispatch rules will have two (2) vehicles dispatched in the model, while in reality the incident may have only had one (1) vehicle dispatched).

For fire related calls a basic approximation of the dispatch processes have been made. Only Engine, Ladder/Tower, Ambulance, Squad, Medic and Chief responses have been modelled.

Given the limitations in the tuning of the model all results should be taken as indicative only. Actual results may differ but are expected to be in a similar order of magnitude and direction. Further model tuning using HFD AVL data and updated incident/response and resource data will result in a more robustly tuned simulation.

Map Display Icons/Images:

The maps provided in this document have the follow display settings:

- Incidents or address points within the defined coverage area where the stated goal is achieved (green).
- Incidents or address points within the defined coverage area where the stated goal is not achieved (red).

 Vehicle

 Station location

 Vehicle in Station

 Hospital location

Scenario Results

NFPA 1710 240 Second Travel Time Initial Unit Analysis

This scenario looks at the coverage that can be provided by the current HFD station locations. Coverage is defined as the distance that a vehicle can travel within 240 seconds from a station location (where the station, at minimum, has an engine company).

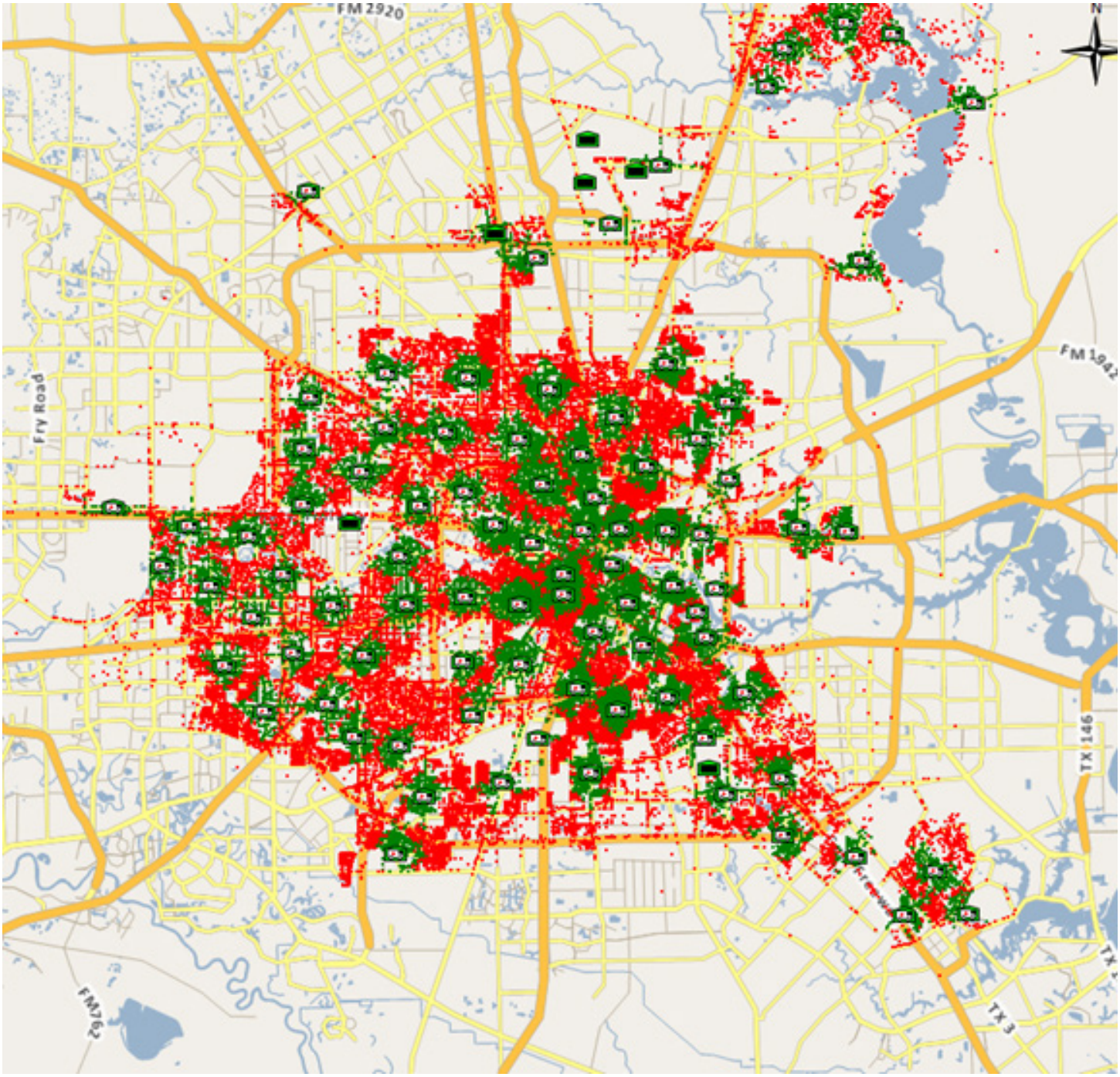
Two separate data files were used to assess the coverage:

- Historic Incidents – This data includes both EMS and Fire related calls during 2015. During this period engine and ladder vehicles were also sent to EMS incidents.
- Address points – These have data points for each address within the Houston region. The file provided for address points has not been verified and may not be completely accurate. It should however approximately replicate the areas of high/low demand.

Incident Coverage from Station Locations - 240 Second

Figure 2 shows the historic incidents that can be reached within 240 seconds from the station and those that are missed. Historic incidents that are within 240 seconds from the station are shown in green, the remaining incidents are shown in red.

Figure 2 – Incident Coverage from Station Location – 240 Seconds



The current station locations are not able to provide full coverage of historic incidents in the HFD service area and attempting to add sufficient stations would require substantial investment. There are areas between most station locations that cannot be reached within the 240 standard. HFD and the City of Houston will need to evaluate the utility of attempting to establish a capital investment strategy to achieve a 240 second coverage goal. Analysis of a 360 second travel time illustrates that the vast majority of the City of Houston is covered at that level from current stations. **Figure 3** shows this coverage. Gaps remain but this analysis also helps identify areas with the worst current coverage. These areas are addressed in the New Station Recommendations section of this analysis.

Figure 3 – Incident Coverage from Station Location – 360 Seconds

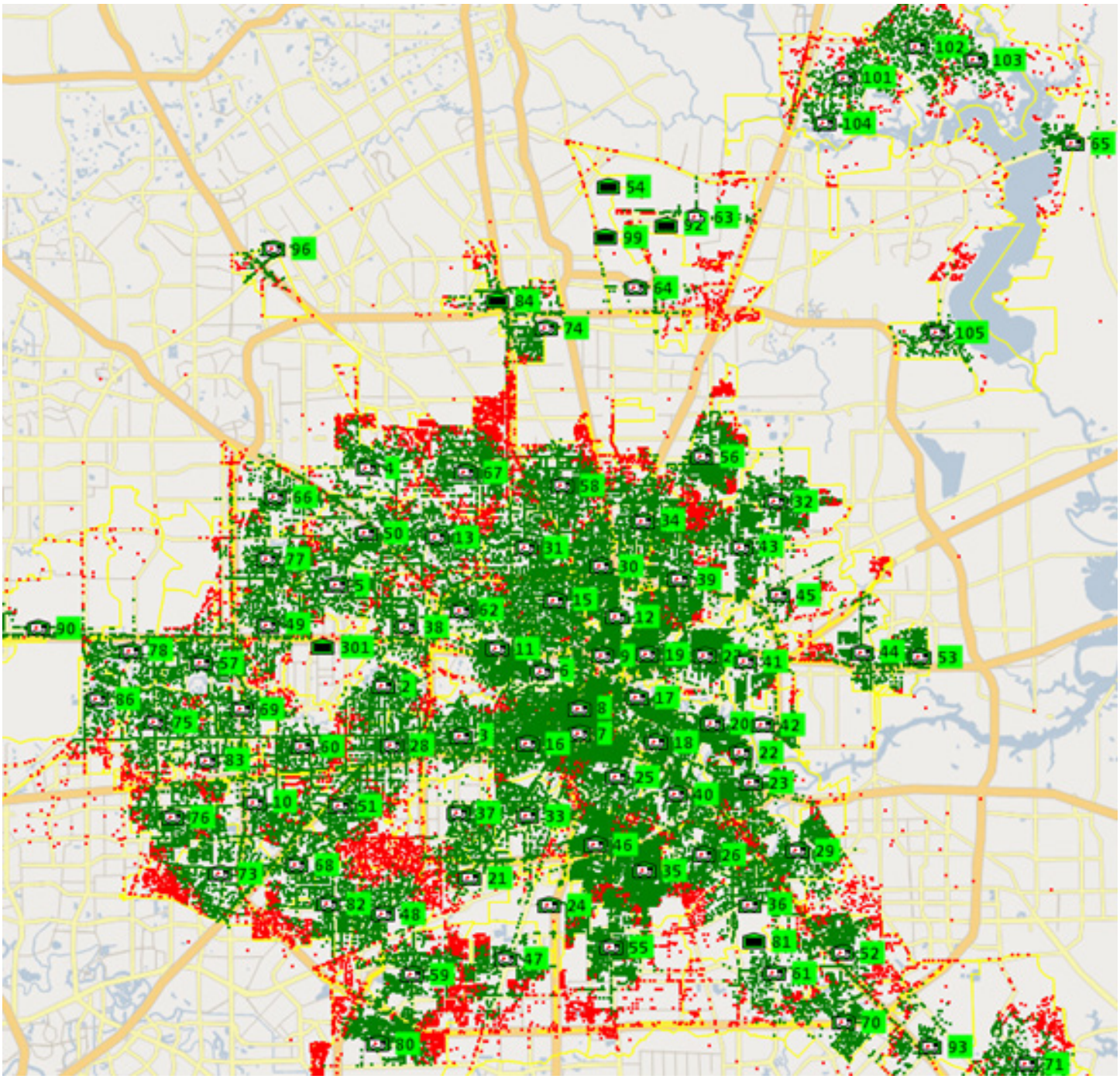


Figure 4 shows the percentage of incidents that are within 240 seconds of a station by Still Alarm region. All the regions are below the 90% standard, with some regions having quite low percentages of incidents reachable from a station location within 240 seconds.

Figure 4 — Still Alarms Regions – Percentage of historic incidents that can be reached by a station which has at minimum an engine – green > 90% coverage for region, red <70% coverage per region

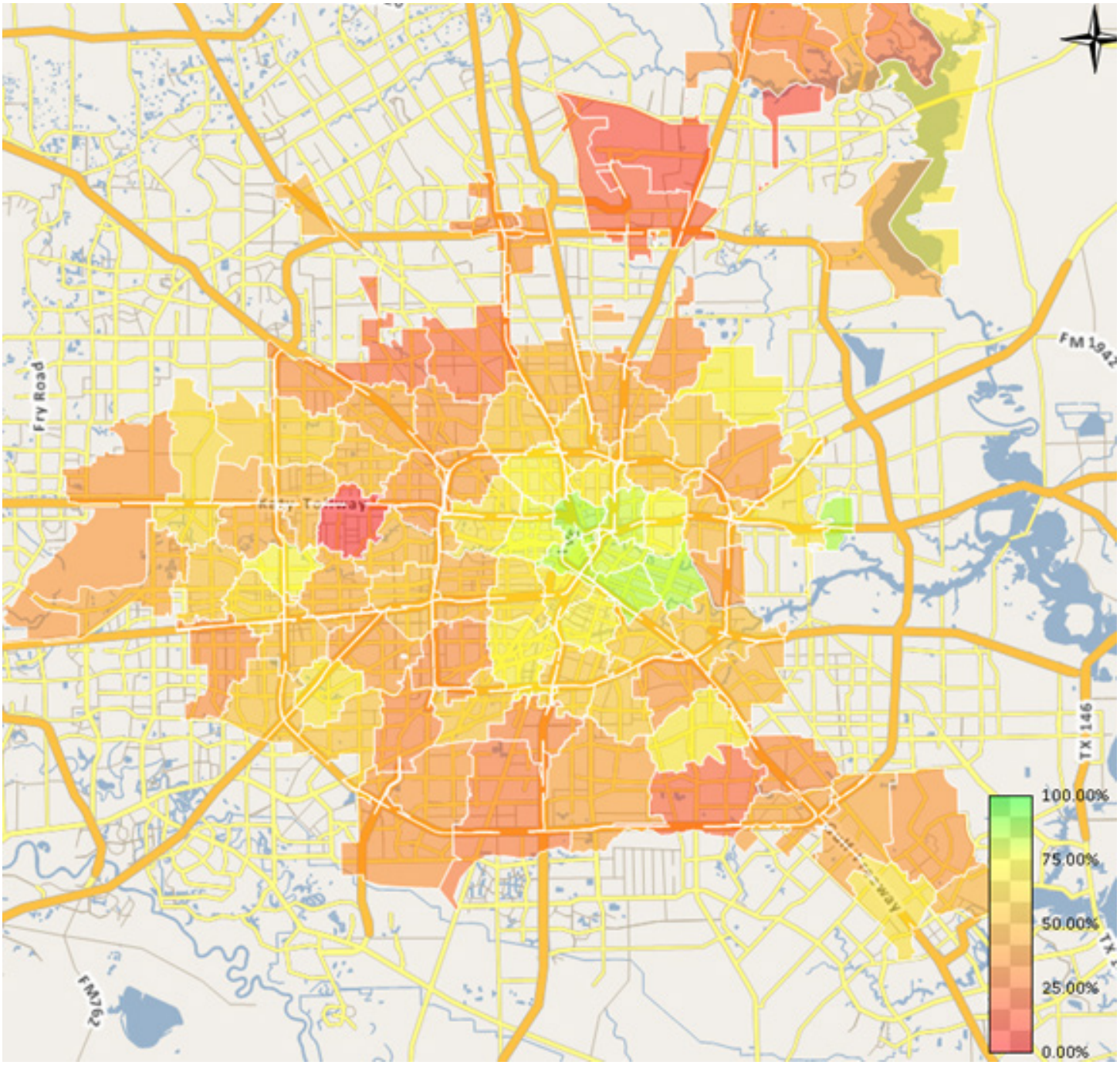
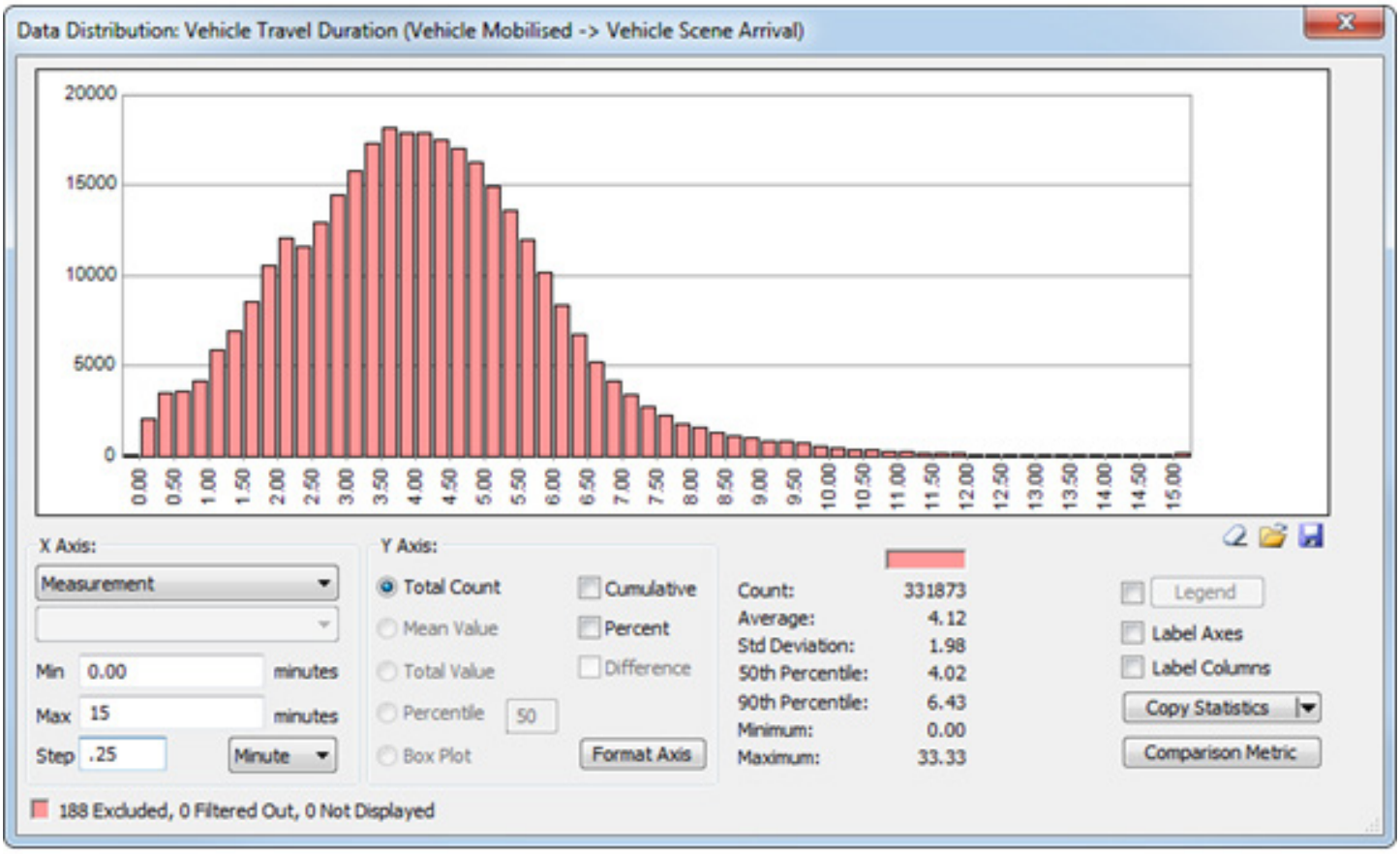


Figure 5 shows the distribution of travel times to incidents. Currently just under 50% of incidents have a travel time within 240 seconds (the 50th percentile of the distribution is 4.02 minutes).

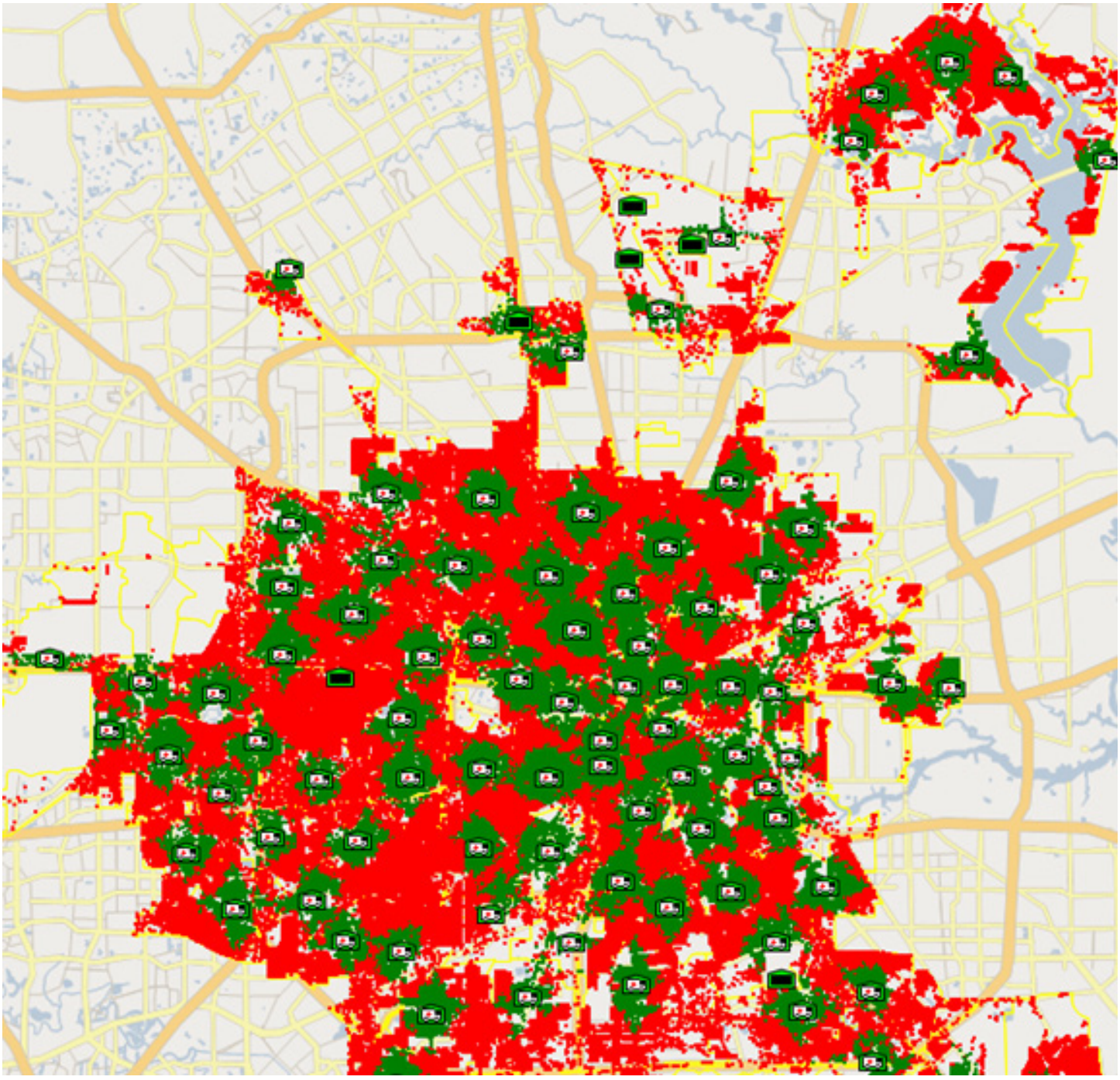
Figure 5 – Travel Times Between Station Locations and Historic Incidents



Address Point Coverage from Station Locations

Figure 6 shows the address point locations that can be reached within 240 seconds from the station and those that are missed. Address points that are within 240 seconds travel time from the station are shown in green, the remaining address points are shown in red.

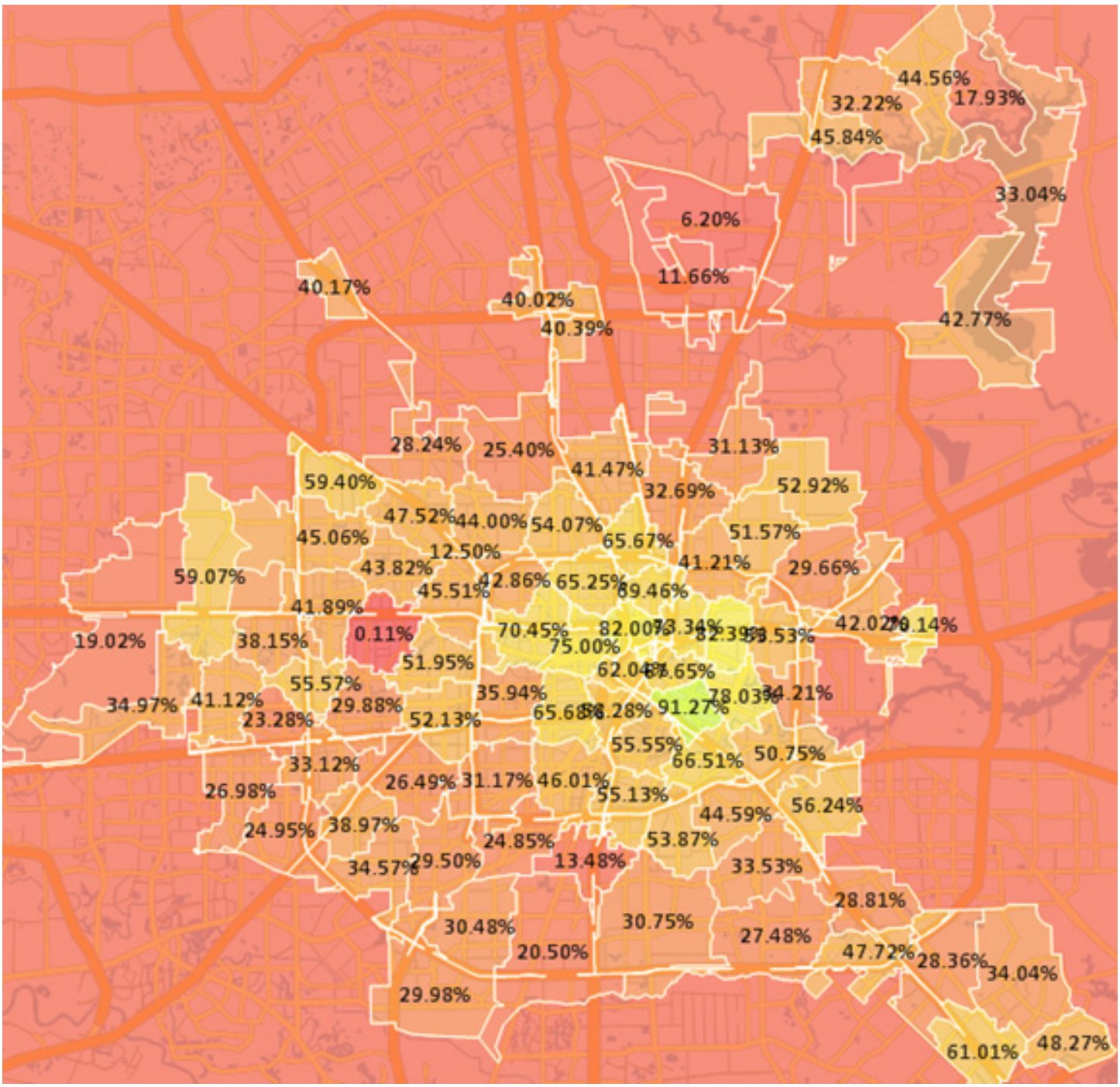
Figure 6 – Address Point Coverage – 240 Seconds



As with the historic incidents there are large areas of address points that cannot be reached within the 240 second standard (address points not within the City of Houston are included due to limitations on being able to accurately filter this data set)

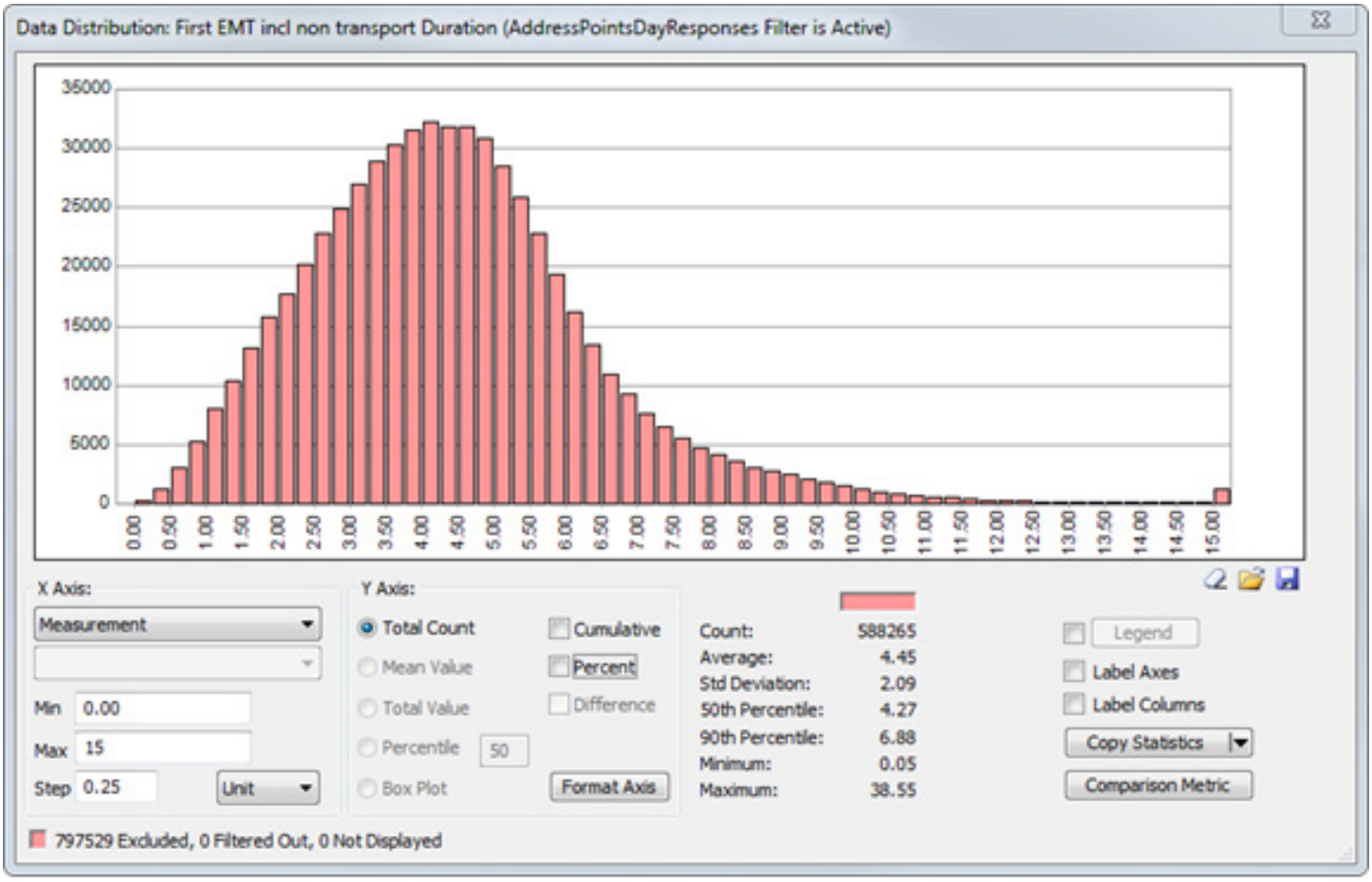
Figure 7 shows the percentage of calls (by still alarm region) that can be reached from a station containing at minimum an engine within 240 seconds. This chart shows that for the majority of regions the percentage of address points reached is well below 90%.

Figure 7 – Still Alarms Regions – Percentage of address points that can be reached by a station which has at minimum an engine within a travel time of 240 seconds



Looking at the distribution of travel times between station locations (with at least an Engine) and address point locations shows that on average the travel times are just over 4 minutes, but currently the 90th percentile is close to 7 minutes (well above the 4-minute target) (**Figure 8**).

Figure 8 – Travel Times Between Station Locations and Address Point Locations



Historic Incident Response Time Performance

Figure 9 shows the incidents where vehicles had a travel time within 240 seconds historically in green and those that had a travel time over 240 seconds in red. Comparing this picture to the previous coverage pictures shows that the stations have not historically provided the level of coverage suggested by **Figure 2** and **Figure 6**.

This difference between the coverage in **Figure 6** and **Figure 9** shows the impact of vehicles not being available at the time that incidents require them and highlights the need to not only ensure that areas can be covered by the closest station, but that the station is suitably staffed throughout the day for the demand in the area. This provides a powerful indicator of system capacity and reinforces the need for a comprehensive strategy for investment.

The earlier coverage projections are based on the assumption that a vehicle is always available to respond from the station and is, therefore, an indication of infrastructure capability. The actual performance is determined by where vehicles are, and their availability when calls are received.

Figure 9 – Historic Incident Coverage – Travel Time 240 Seconds

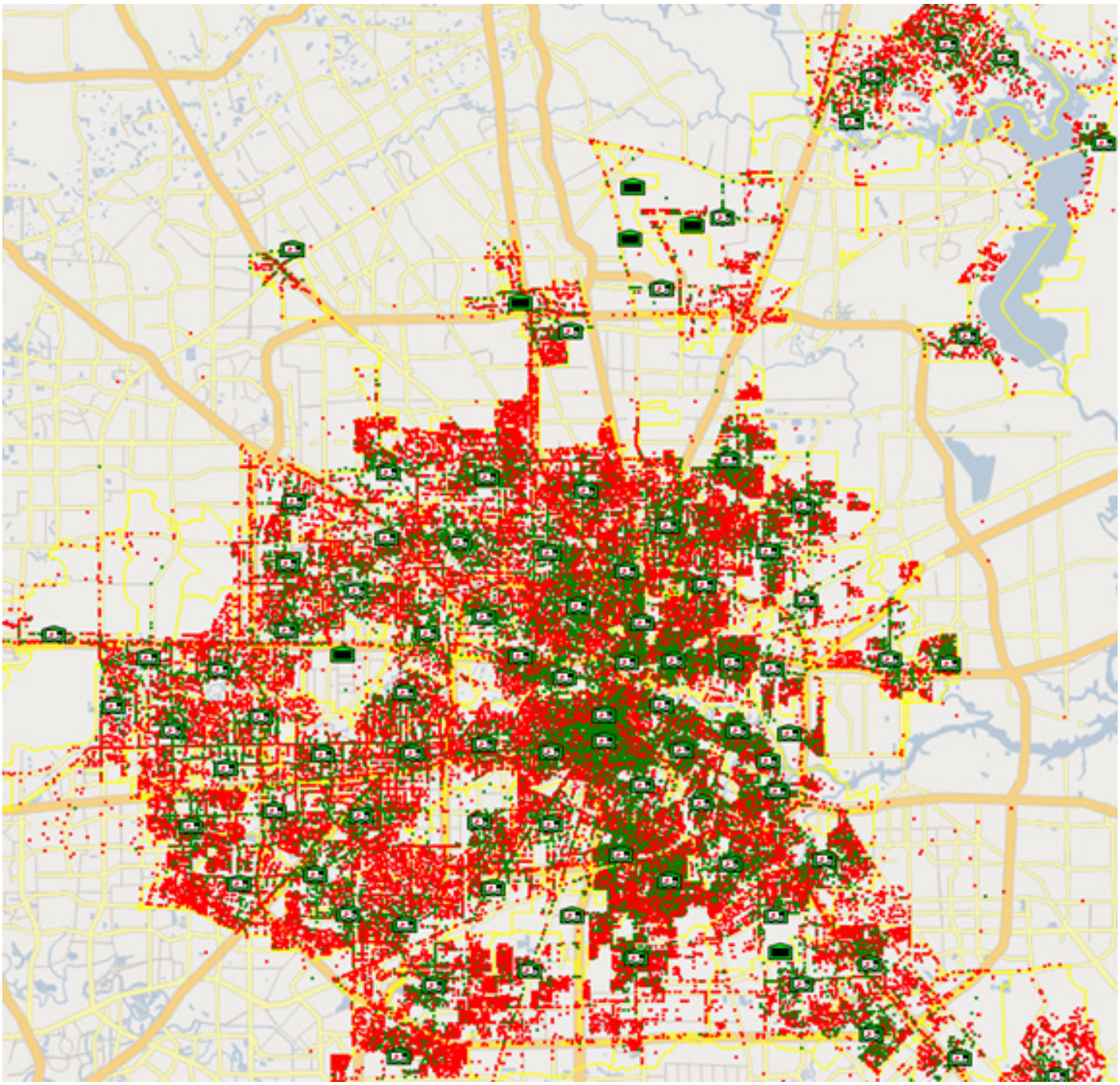


Figure 10 shows that in most of the Still Alarm regions, outside the central Houston area, the travel time for over 50% of incidents is more than 240 seconds.

Figure 10 – Still Alarms Regions – Percentage of historic incidents that were reached by a vehicle within 240 seconds

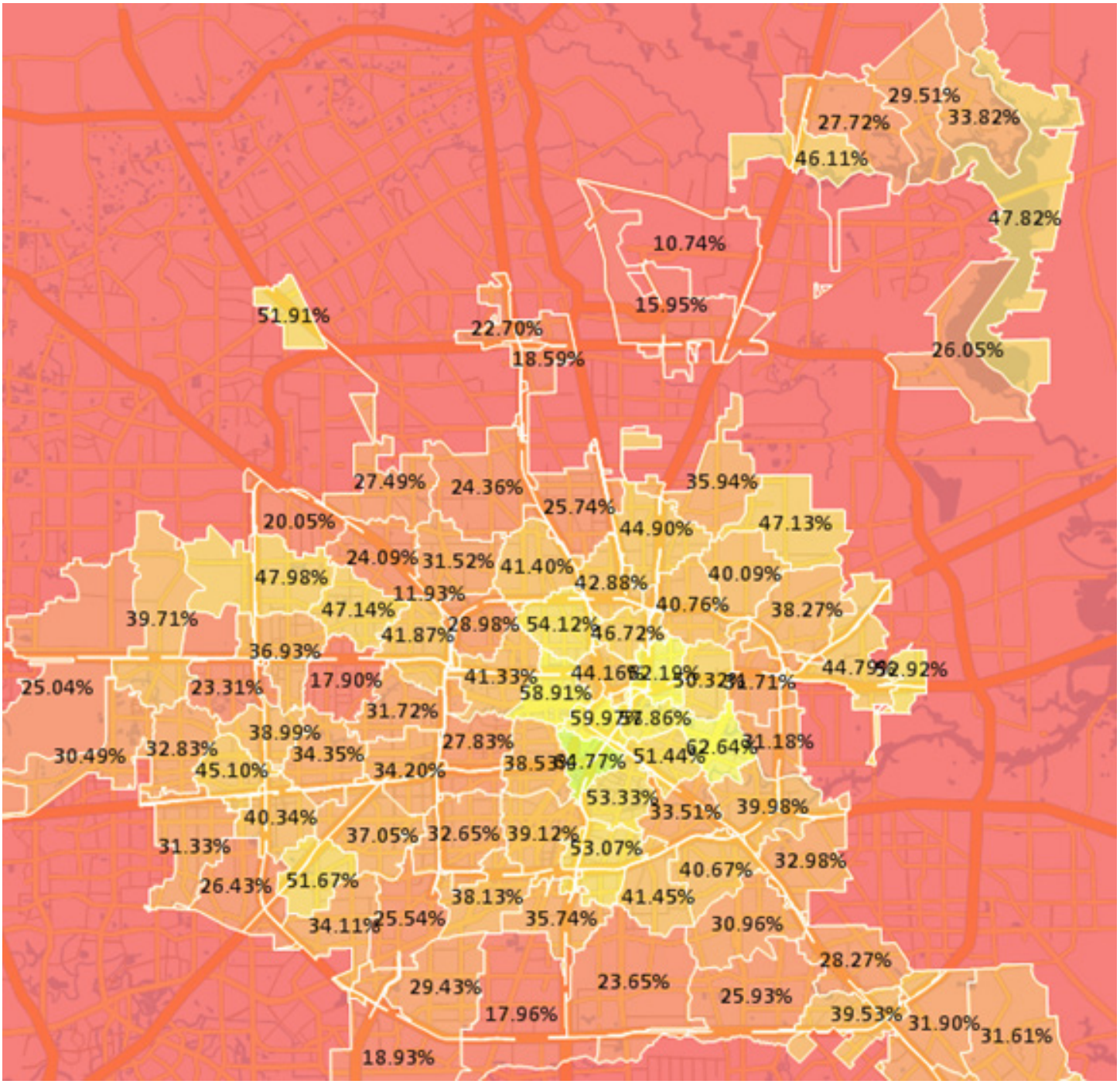
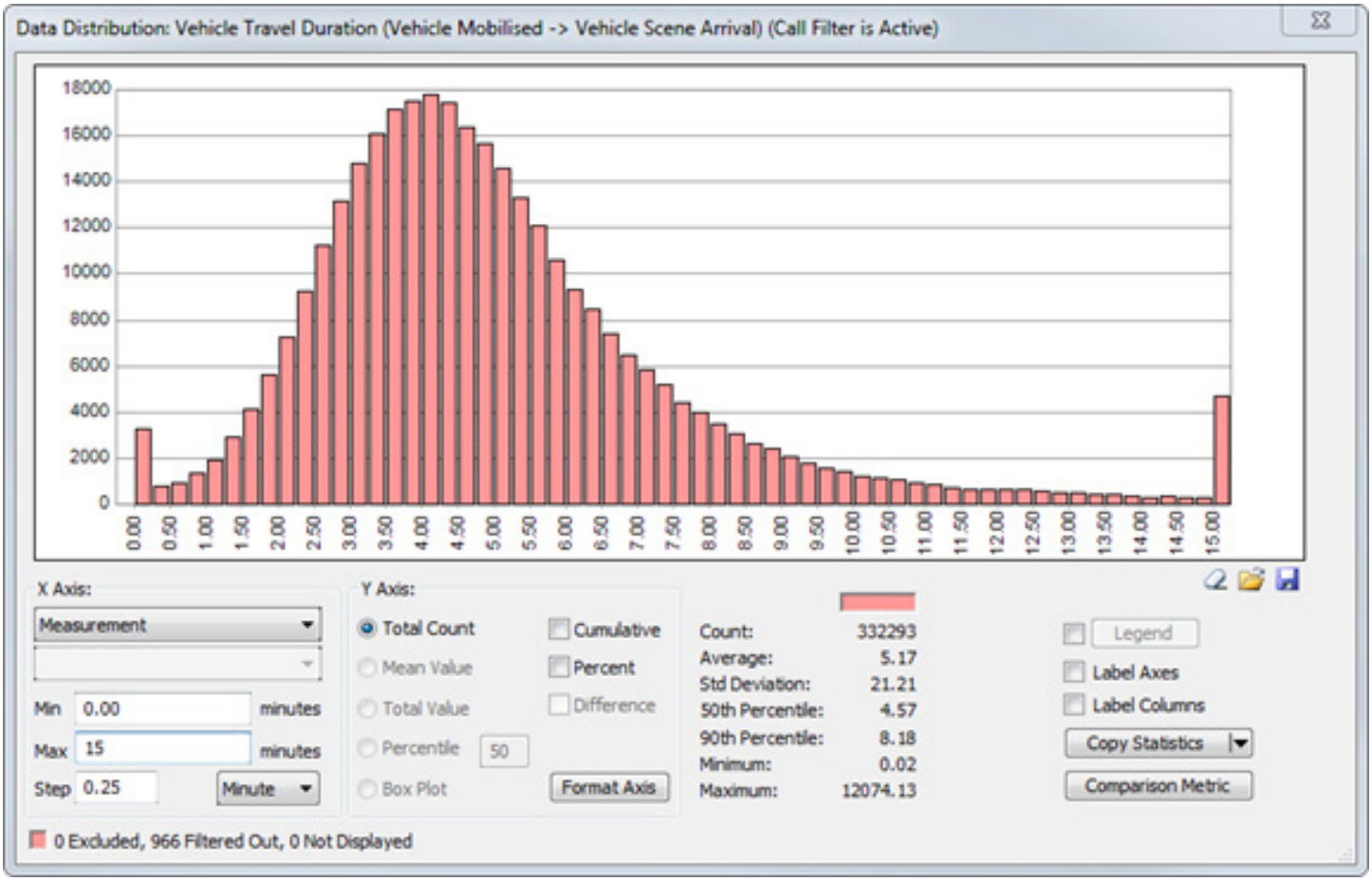


Figure 11 shows that on average it took over 5 minutes to travel to incidents, with the 90th percentile over 8 minutes. This is well outside the standard of 240 seconds.

Figure 11 – Distribution of Travel Times for Historic Calls



NFPA 1710 480 Second Travel Time ALS Unit Analysis

This scenario looks at the coverage that can be provided by the current ALS unit assignments at the current HFD station locations. Coverage is defined by the distance that an ALS vehicle (medic or squad) can travel within 480 seconds from a station location.

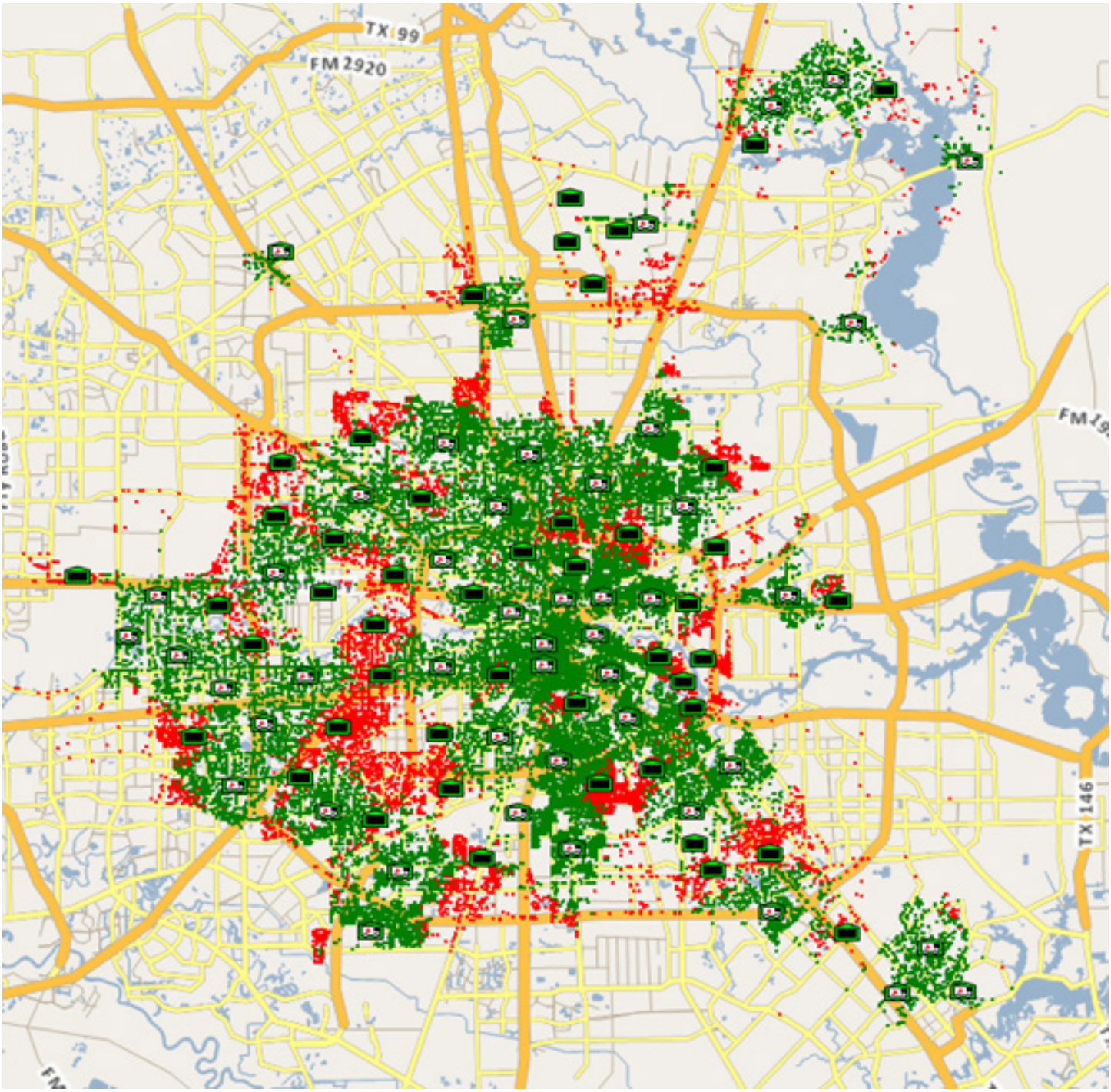
Two separate data files were used to assess the coverage:

- Historic Incidents – this file was filtered to only include calls that require an ALS vehicle. These include call types that begin with FE and end with C1, C2, C3, C6, D1, D2, D3, D4 and D6.
- Address points – these have data points for each address within the Houston region. The file provided for address points has not been verified and may not be completely accurate. It should however approximately replicate the areas of high/low demand.

Incident Coverage from Station Location

Figure 12 shows the historic ALS incidents that can be travelled to within 480 seconds from a station that has a medic or squad vehicle and those that are missed. This coverage is based on the assumption that for stations where there is an ALS unit assigned, the vehicle will always be available when required (i.e. it will never be busy responding to another incident). Historic ALS incidents that are within 480 seconds travel time from a station with an ALS vehicle are shown in green, the remaining incidents are shown in red.

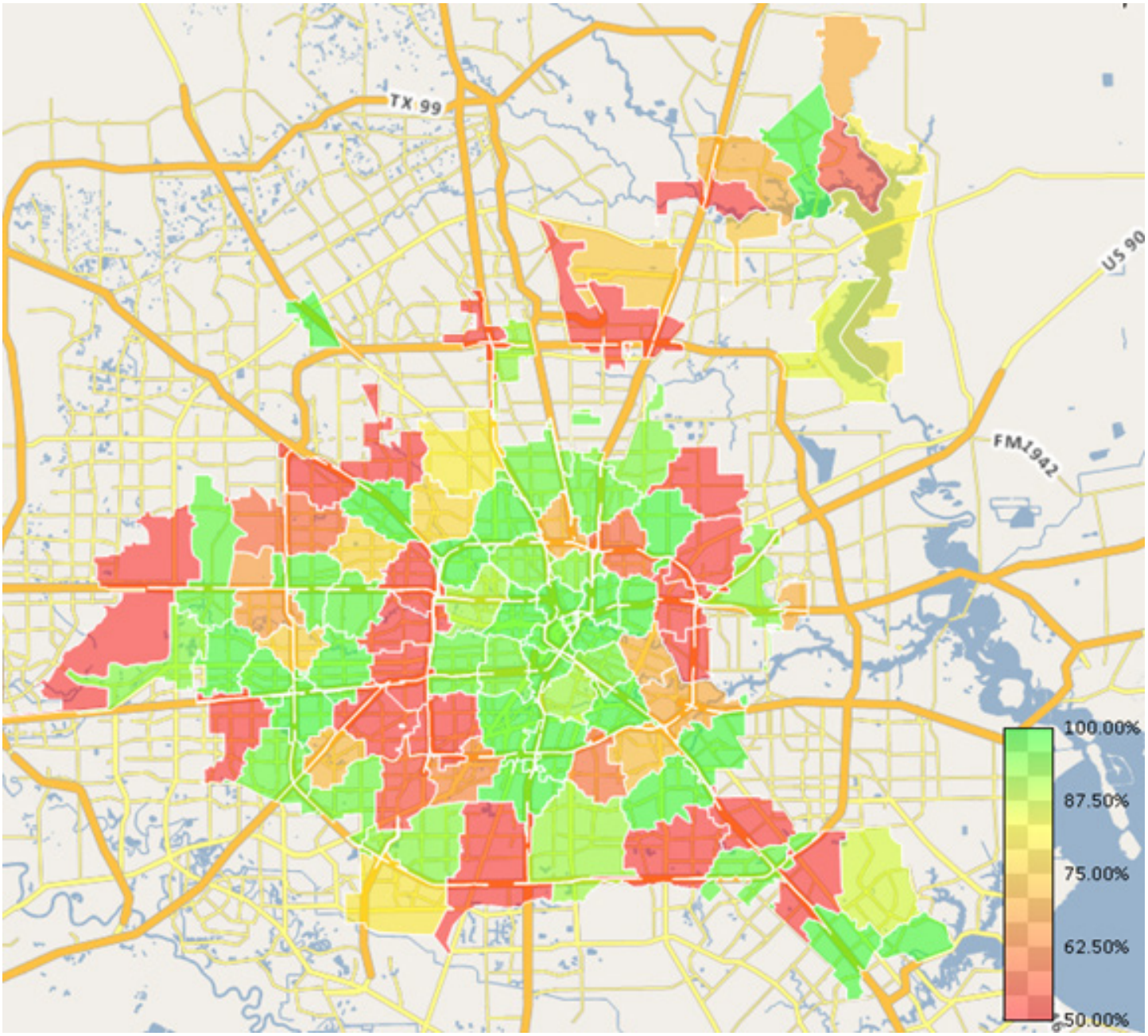
Figure 12 – ALS Incident Coverage by Medic or Squad from Station Location – Travel Time 480 Seconds



There are a number of areas that currently do not have an ALS vehicle stationed within the 480 second travel time. This causes gaps in the coverage available.

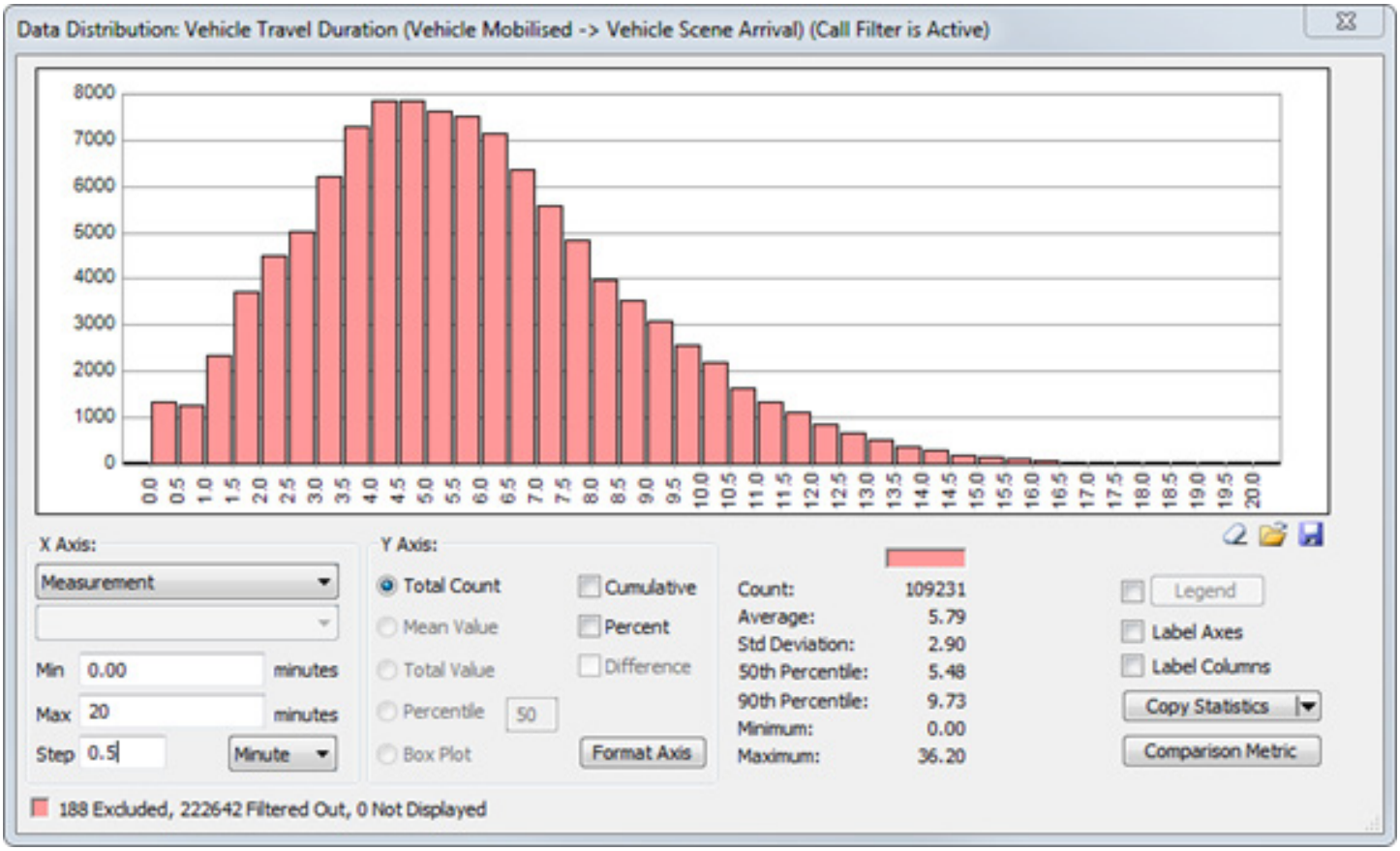
Looking at the coverage by Still Alarm region, the majority of the regions have coverage at 90% or higher (shown in green) (**Figure 13**). However, there are still a number of areas with low coverage.

Figure 13 – Still Alarms Regions – Coverage by Medic or Squad from Station Location – Travel time of transport vehicle within 480 seconds – green > 90% coverage for region, red <70% coverage per region



The distribution of travel times for ALS vehicles to ALS incidents shows that on average the travel time is under 6 minutes, but the 90th percentile is almost 10 minutes. This is above the target of 90% in 8 minutes (**Figure 14**).

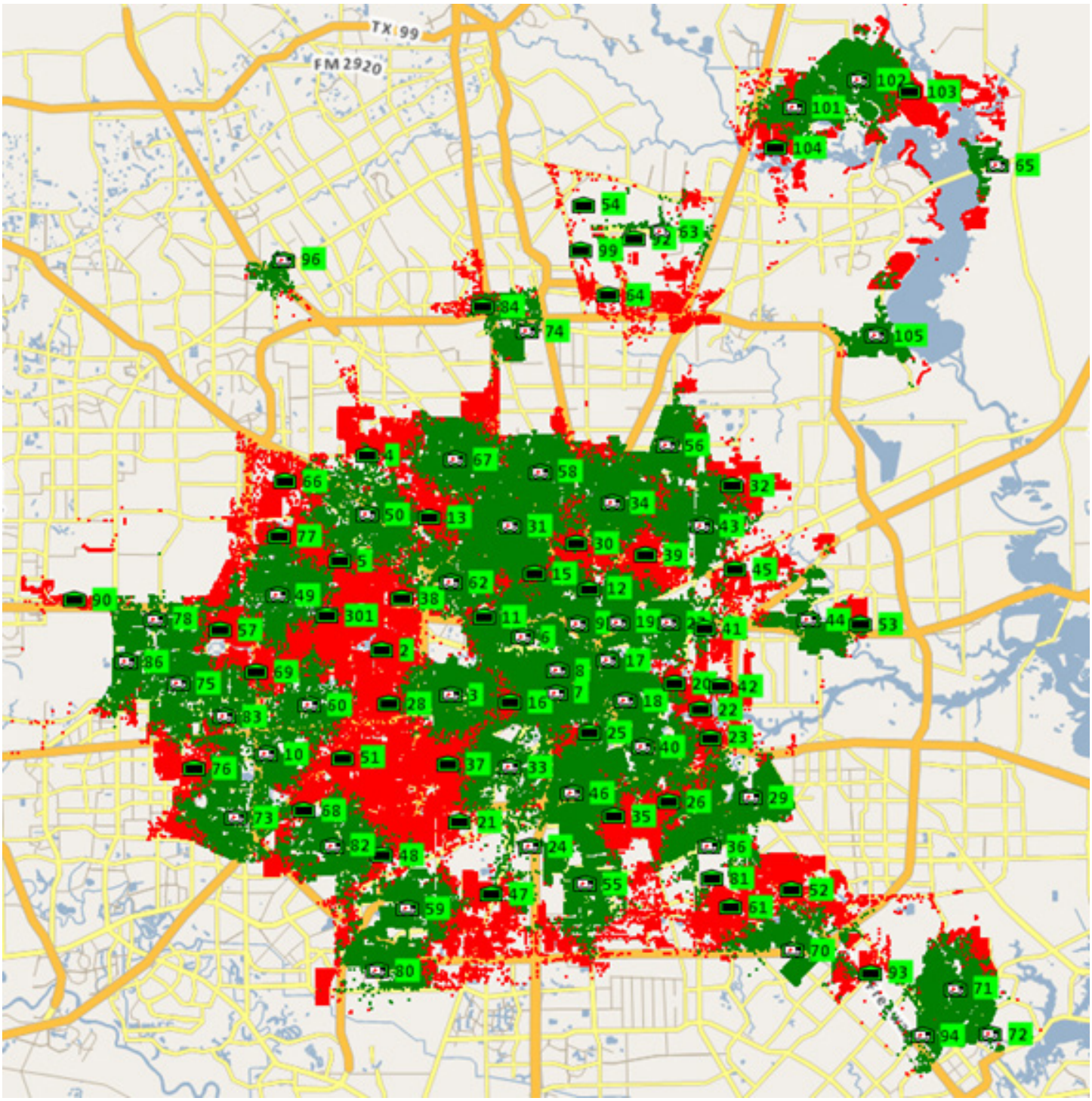
Figure 14 – Travel Time for ALS Vehicle to ALS Incidents



Address Point Coverage from Station Location

Using the address point coverage data, it is clear that there are large areas of the Houston region that do not have sufficient ALS coverage (**Figure 15**). Areas in red require additional ALS vehicles to ensure that address points can be reached within the 480 second target.

Figure 15 – Address Point Coverage by Medic or Squad from Station Location – Travel Time Within 480 Seconds



Historic Incident Coverage

Historically the pattern of ALS incidents that are responded to by an ALS vehicle within 480 seconds is not as clear compared to the theoretical pattern shown in **Figure 12** and in **Figure 16**. This is due to vehicles being busy, or away from their home station when incidents occur and clearly demonstrates the capacity issue related to EMS incidents needing ALS resources.

Figure 16 – Historic ALS Incident Coverage – ALS Vehicle Travel Time 480 Seconds

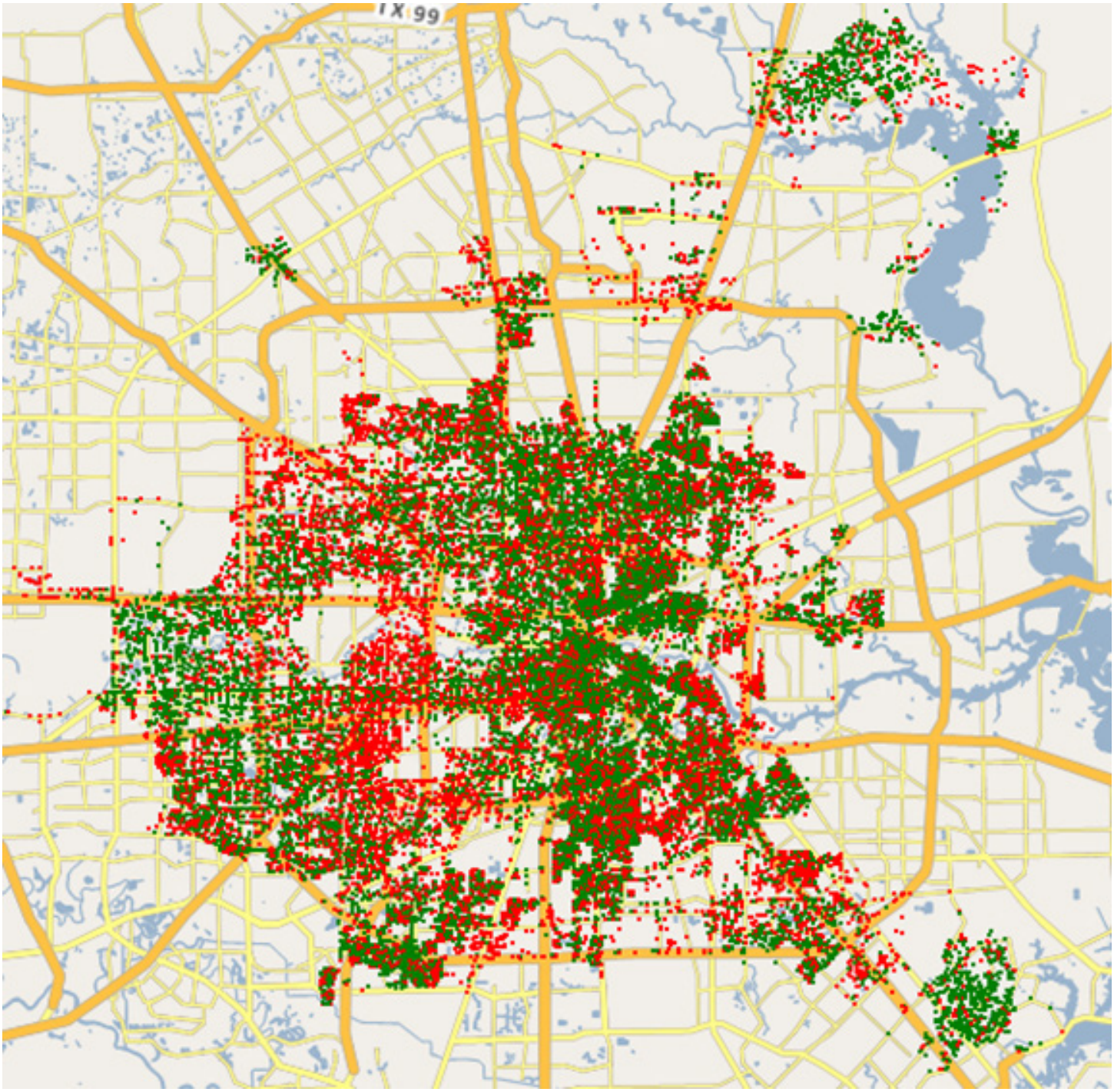
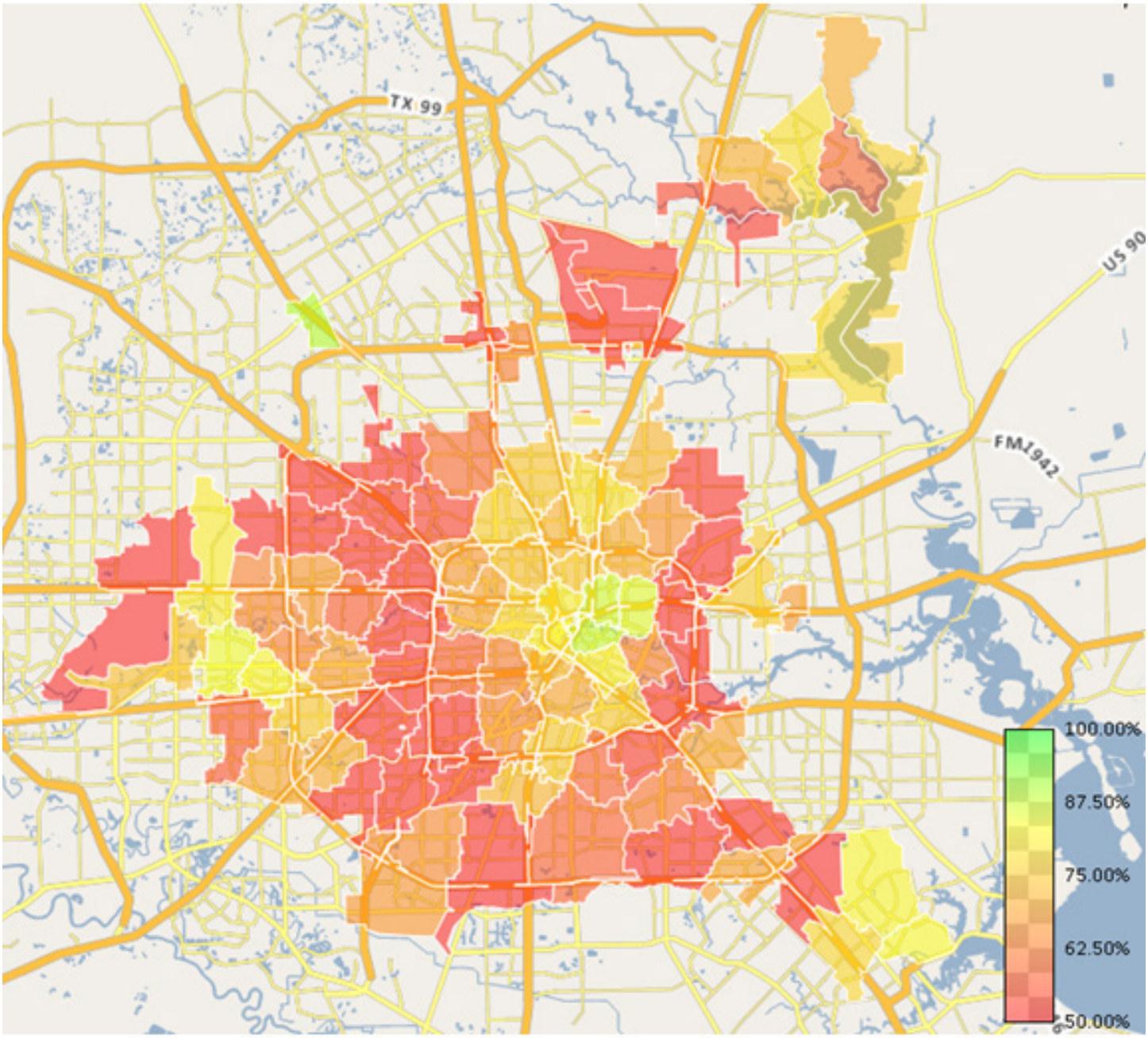


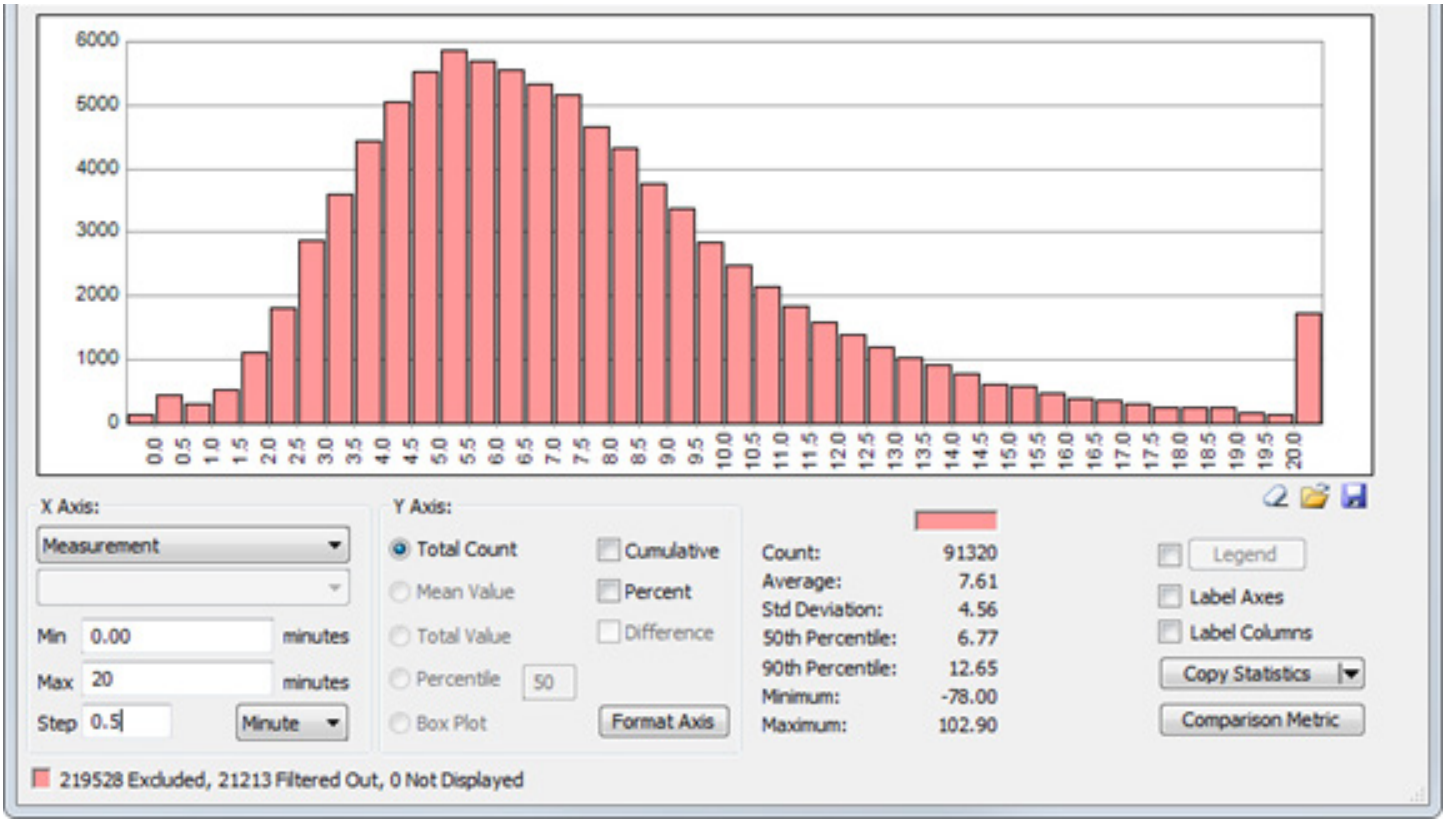
Figure 17 shows that by still alarm region, with the exception of central Houston, historically there have not been any areas that have been close to meeting the 90% target of having an ALS vehicle respond to ALS calls within 480 seconds.

Figure 17 – Still Alarms Regions – Percentage of historic ALS incidents that had a travel time for the ALS vehicle within 480 seconds – green values>90%, red values <70%



The distribution of travel times for ALS vehicles to ALS incidents shows that on average the travel time is approximately 7½ minutes, increasing to approximately 12½ minutes at the 90th percentile (**Figure 18**).

Figure 18 – Distribution of Historic ALS Vehicle Travel Times for Historic ALS Calls



Movement of ALS Vehicles

Optima Predict Resource Location Optimization (RLO) was used to identify where the best locations are for ALS (medic and squad) vehicles. This took into account the level of service required by ALS vehicles as well as the level of service required for transport EMS vehicle (ambulance and medic vehicles). The available locations were limited to current HFD stations. This resulted in movements of all EMS vehicle types around the region.

Figure 19 shows the change in travel time for ALS vehicles at the 90th percentile. Comparing the simulated results from the original ALS unit locations to the simulated results of the updated ALS unit locations. This shows a longer travel time in the central Houston area (red shaded regions) but faster travel times in the outer areas (green shaded regions)

Figure 19 – Change in 90th Percentile Travel Duration for ALS Vehicles of Simulated Results – Negative values indicate a quicker response time from updated ALS unit locations

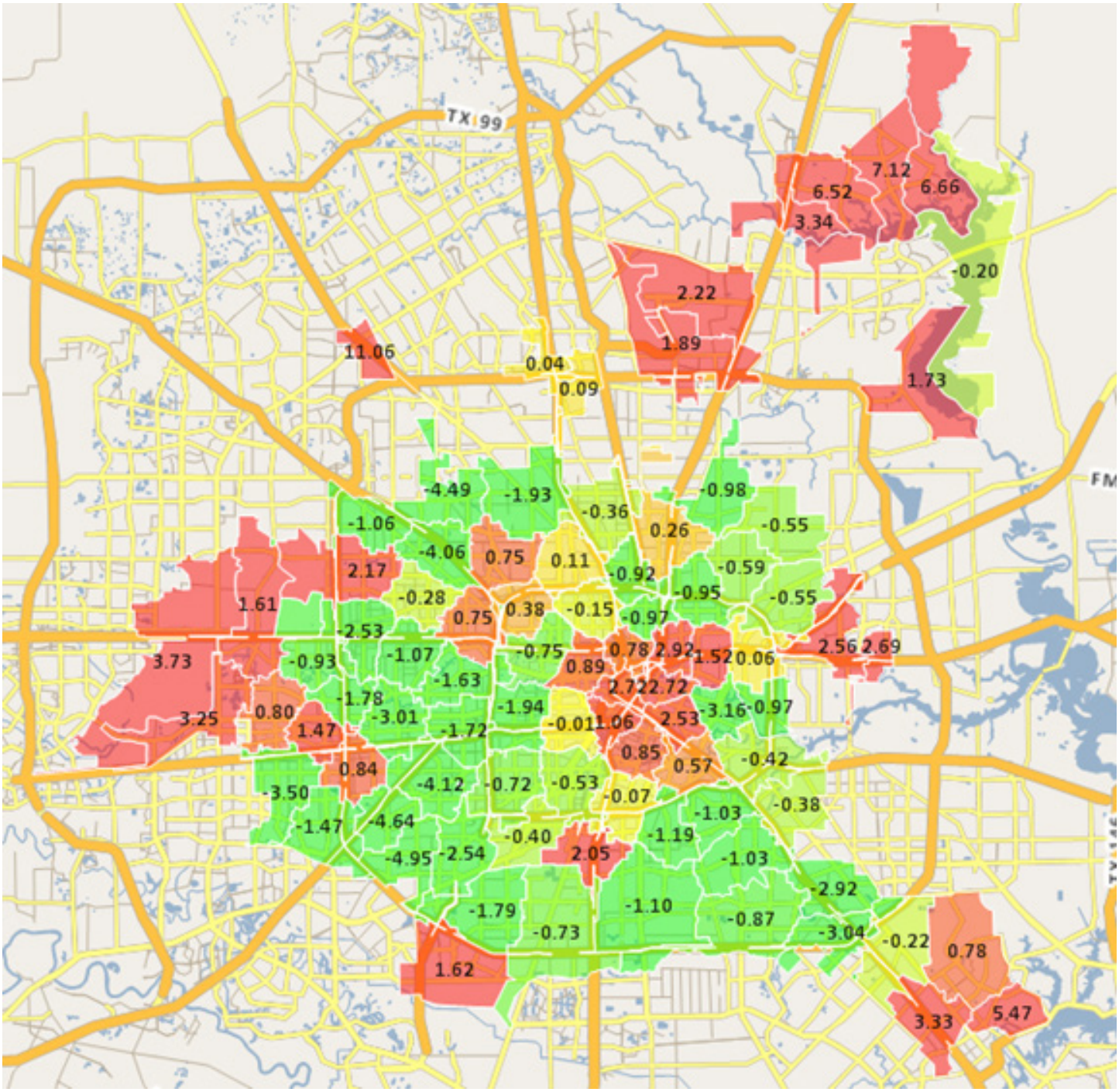
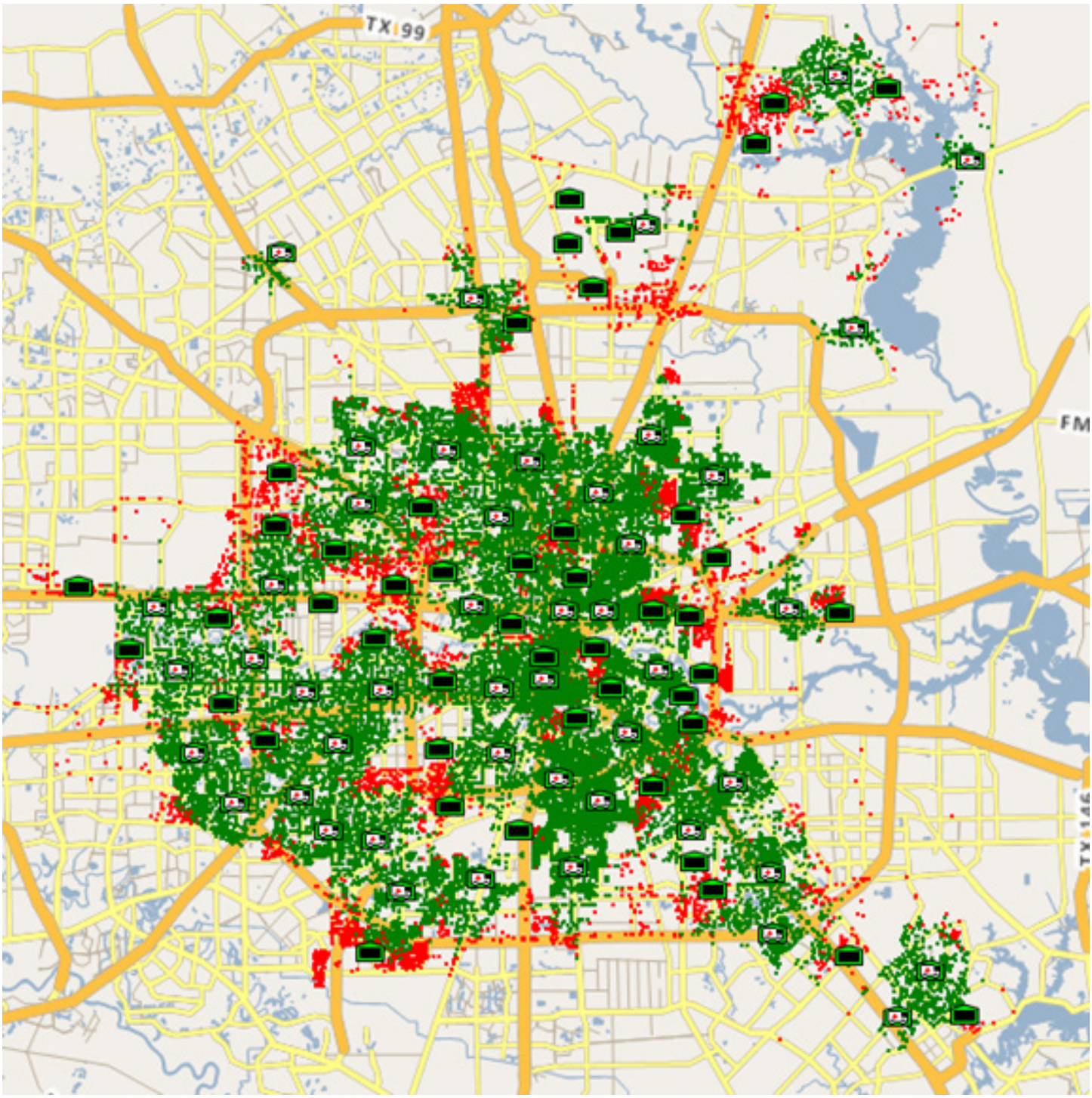


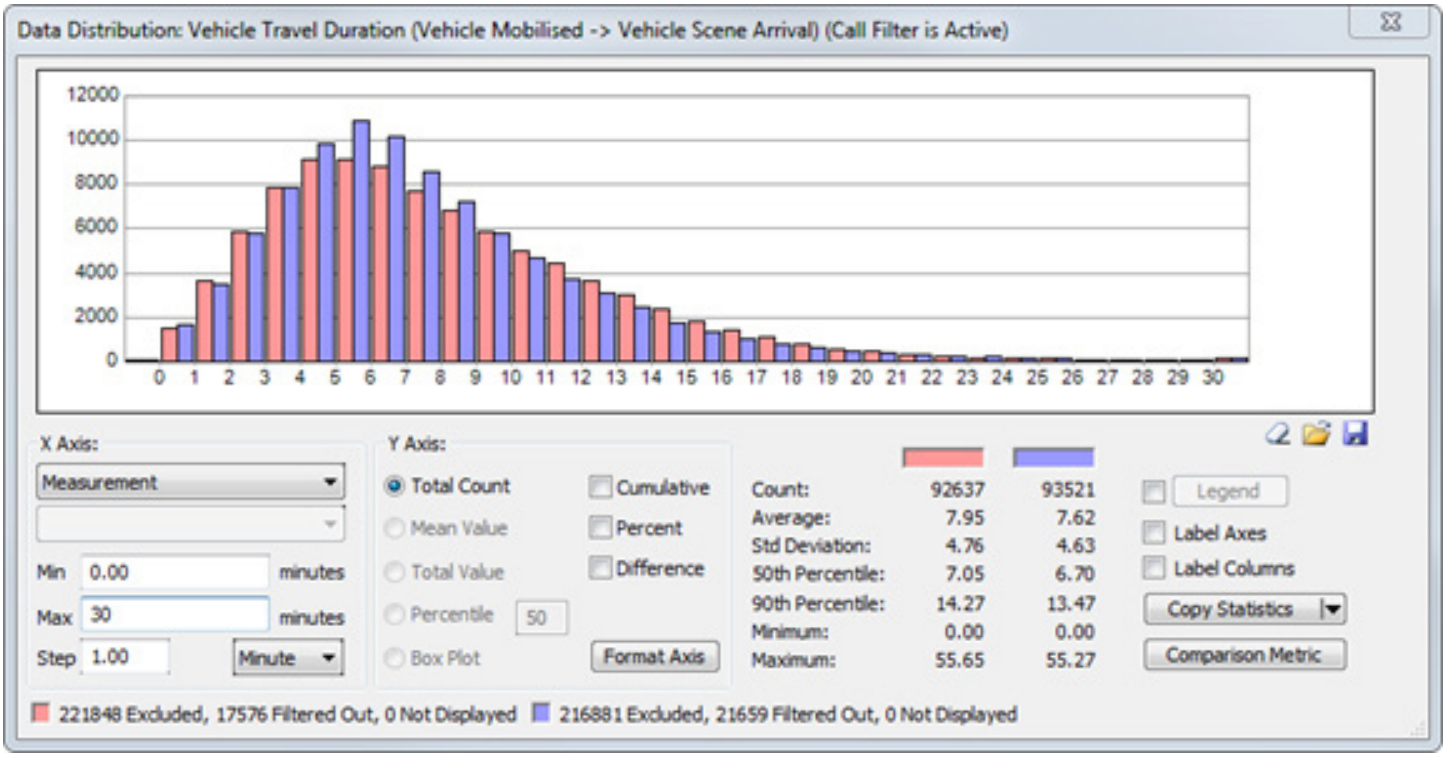
Figure 20 shows the coverage from the updated station locations for ALS vehicles. Comparing this to **Figure 12**, which uses the original locations of the ALS vehicles, shows that there is now an improved geographic coverage from the ALS vehicles, with an increase in green incidents (ALS incidents reached by an ALS in 480 seconds) and a reduction in red incidents (ALS incidents that don't have an ALS responding in 480 seconds).

Figure 20 – Generated Responses from Station Locations of Medic and Squad Vehicles to ALS Incidents – This coverage assumes the vehicle is always available



Overall the travel durations to ALS incidents are very similar, with only a very slight reduction in travel time by moving the locations of ALS units (**Figure 21**).

Figure 21 – Comparison of Travel Duration of Simulation with Original Locations (pink) vs Updated Locations (blue)



Looking at the three (3) charts together (**Figure 19**, **Figure 20** and **Figure 21**) shows that while overall moving the location of the ALS vehicles does not have a significant impact on the travel time to ALS incidents, it is possible to get better geographic coverage reducing the areas that have absolutely no coverage from the station locations. This will have an impact in the central Houston area which will have an increased travel duration for ALS vehicles (**Figure 19**), but this is offset by faster travel durations in the surrounding areas.

The updated locations for EMS vehicles are given in **Table 6**.

Table 6 – Updated EMS Vehicle Locations

Station Code	Vehicle Type	Station Code	Vehicle Type
2	Ambulance	47	Medic
3	Ambulance	48	Medic
4	Medic, Ambulance	49	Ambulance x 2, Squad
5	Ambulance	50	Medic
7	Medic	51	Medic, Ambulance
8	Ambulance	52	Medic
9	Squad	55	Medic, Ambulance
9	Ambulance x 2	56	Medic, Ambulance
10	Ambulance	57	Ambulance
11	Ambulance, Squad	58	Medic, Ambulance
13	Ambulance	59	Medic, Ambulance
16	Ambulance, Squad	60	Medic
18	Ambulance	61	Ambulance
19	Medic	62	Ambulance
20	Medic	63	Medic
21	Ambulance	64	Ambulance
23	Ambulance	65	Medic
24	Ambulance	66	Ambulance
25	Ambulance	67	Medic, Ambulance
26	Ambulance	68	Ambulance, Squad
28	Medic, Ambulance	69	Ambulance, Squad
29	Medic, Ambulance	70	Medic
30	Ambulance	71	Medic
31	Medic, Ambulance	73	Medic, Ambulance
32	Medic, Ambulance	75	Medic
33	Medic, Ambulance	76	Ambulance, Squad
34	Medic	77	Ambulance
35	Medic, Ambulance	78	Medic
36	Ambulance, Squad	80	Ambulance
38	Ambulance	82	Medic, Ambulance
39	Medic, Ambulance	83	Ambulance
40	Ambulance, Squad	84	Medic, Ambulance
41	Ambulance	86	Ambulance
42	Ambulance	94	Medic
43	Ambulance	96	Medic
44	Medic, Ambulance	101	Ambulance
45	Ambulance	102	Medic
46	Ambulance, Squad	105	Medic

Perform Impact Analysis of Transitioning all HFD Squad Units to Medic Units

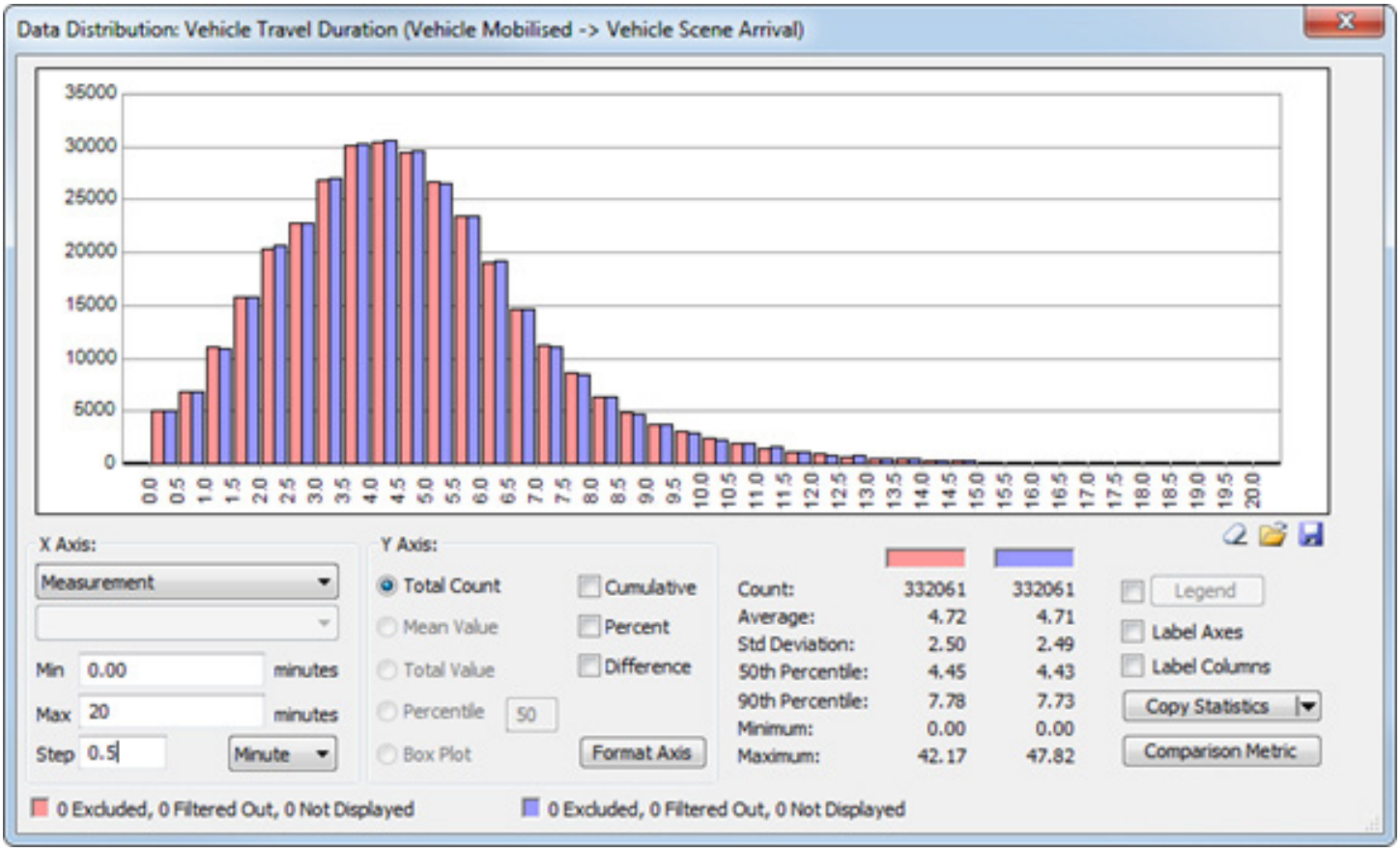
This scenario looks at the impact of transitioning squad vehicles to medic vehicles. Optima Predict has been used to simulate this change updating the existing squads to be substituted with medic units with patient transport capability and then rerunning the simulation.

The charts in this section compare to simulation output files:

- The baseline simulation – the output from the original locations which contained both squad and medic vehicle units in their existing locations.
- The squad to medic scenario simulation – the results from changing squads to medic units.

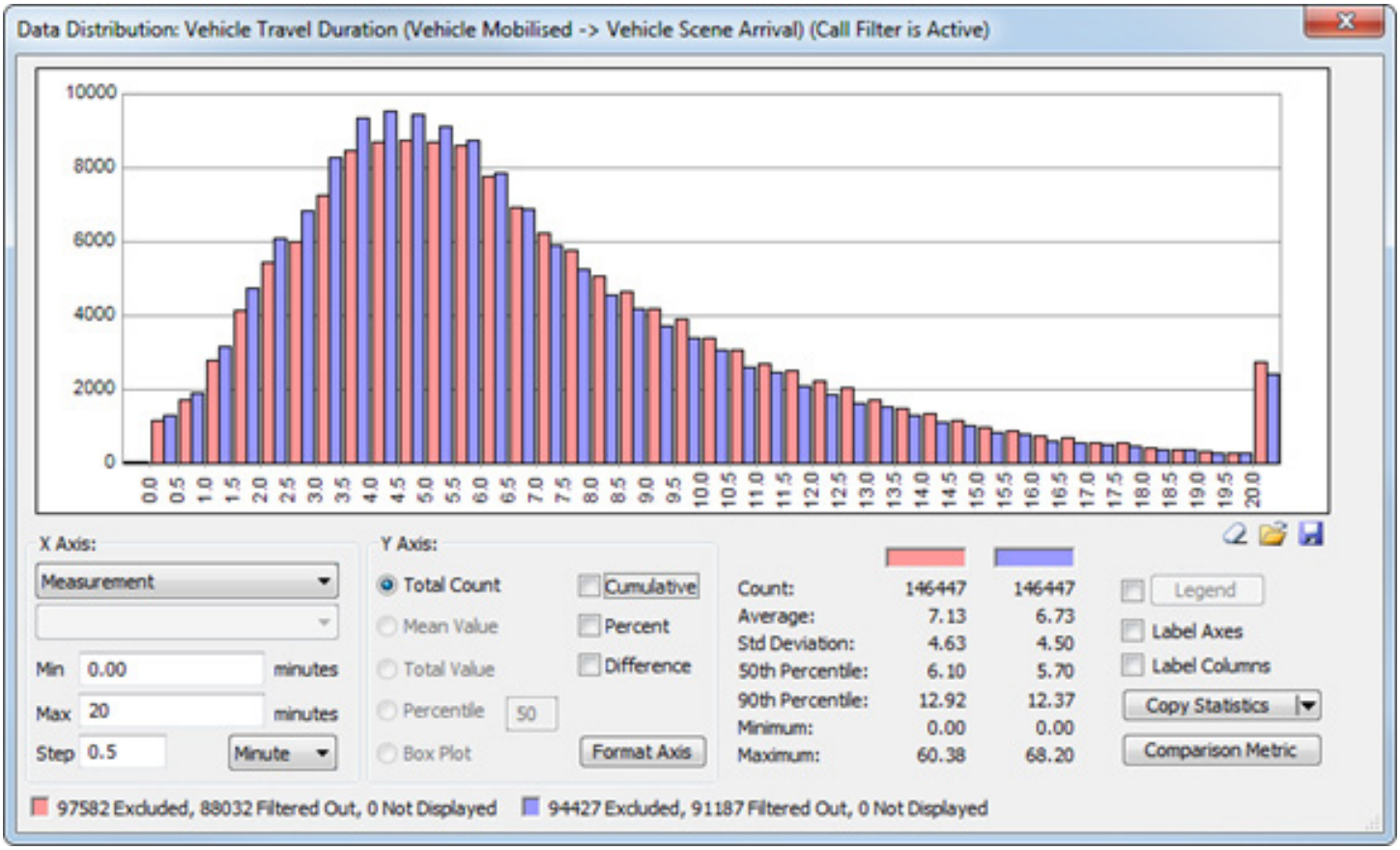
The overall travel time of the first arriving vehicle to an incident has not changed significantly with the change of squad vehicles to medic vehicles (**Figure 22**).

Figure 22 – Travel to Scene Time for First Arriving Vehicle – Baseline Simulation (pink) vs Scenario Squad to Medic (blue)



However, looking at the travel time for the transport vehicle to transport incidents there was a small improvement in travel times for transport vehicles (**Figure 23**).

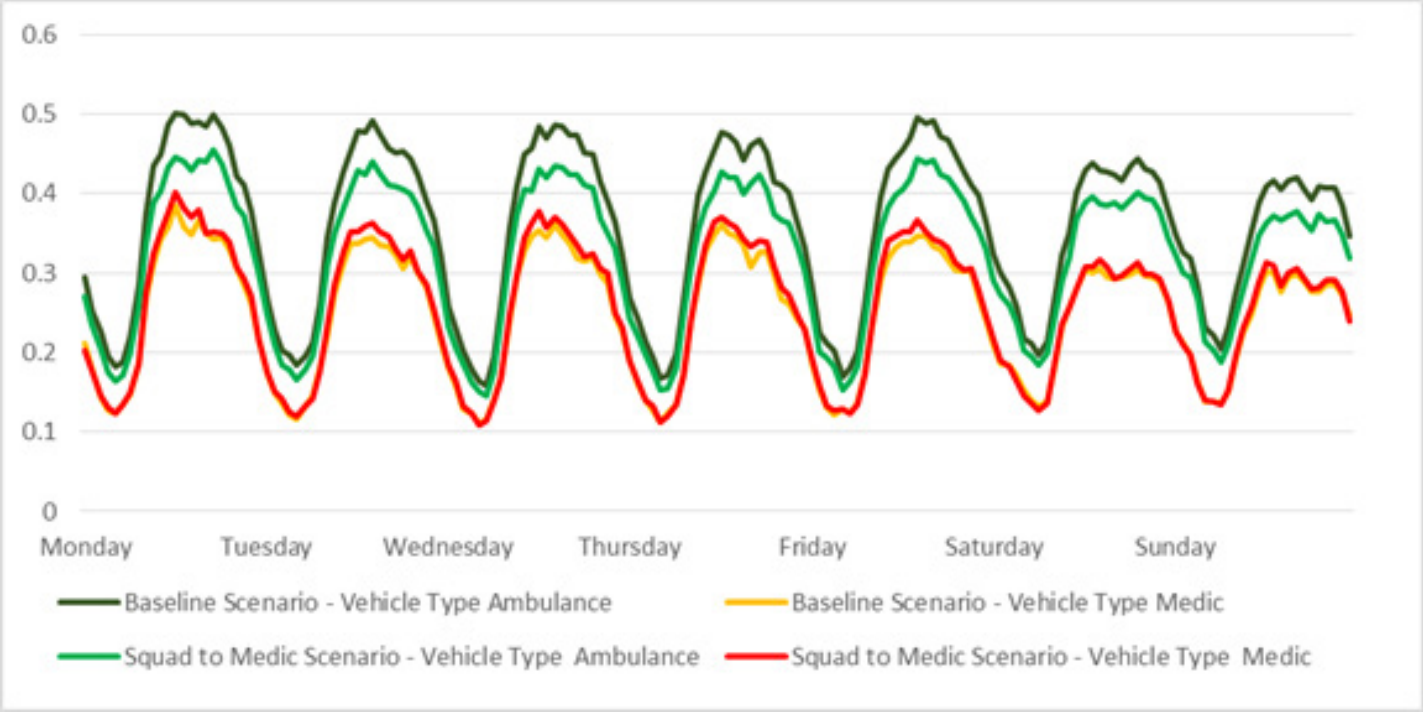
Figure 23 – Travel to Scene Time for Transport Vehicle – Baseline Simulation (pink) vs Scenario Squad to Medic (blue)



The utilization of ambulances dropped with the change from squad to medic vehicles (**Figure 24**). However, there is also a slight increase in the medic utilization, although it is minor when compared to the change in the ambulance utilization.

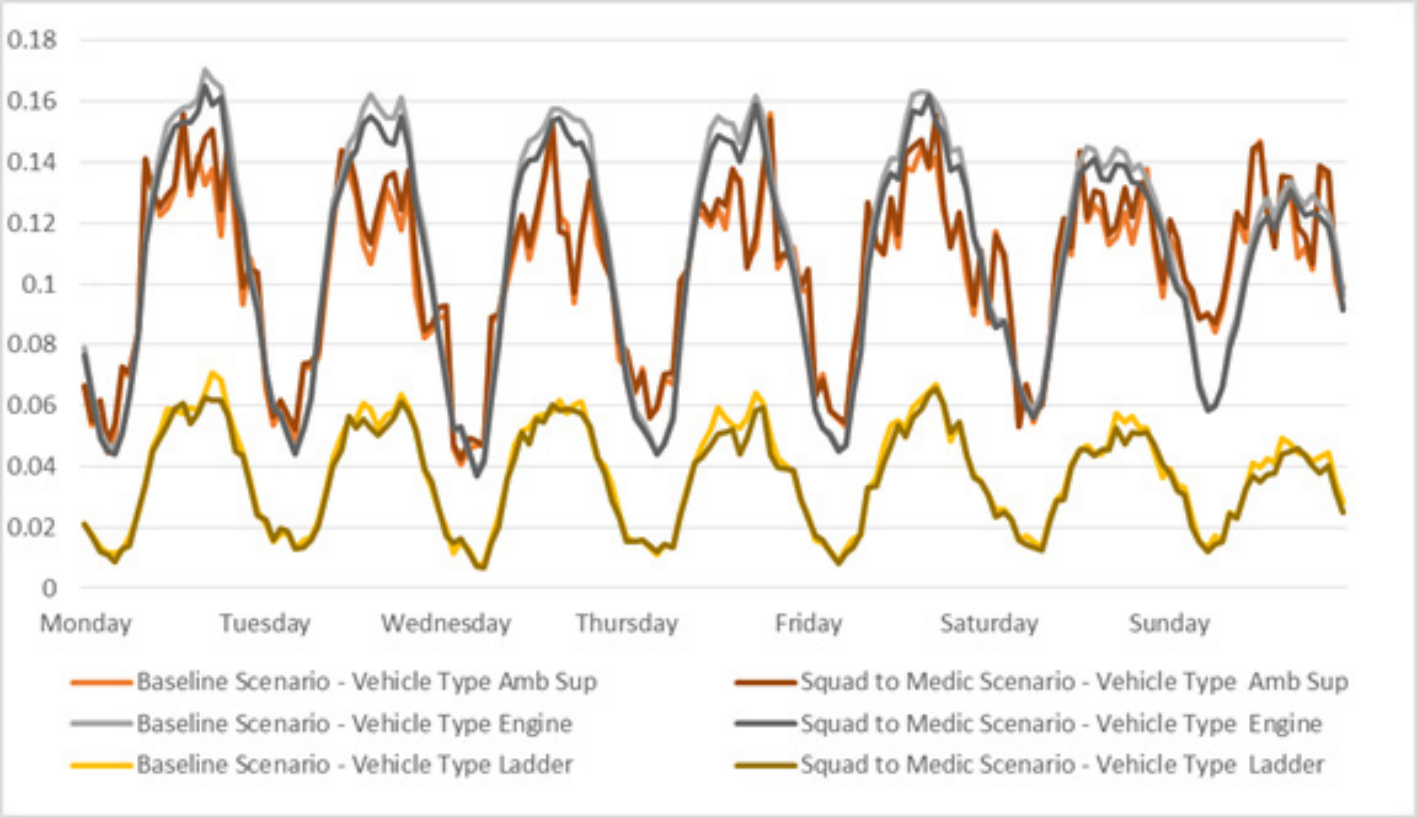
The reduction in the ambulance utilization is most likely due to no longer requiring a backup of an ambulance to calls that previously had a squad arriving as now a transport capable medic is arriving instead of the squad and can complete the transport without additional vehicles being required.

Figure 24 – Ambulance and Medic Utilization



For other vehicle types there is no significant change in the utilization level (**Figure 25**). This suggests that other vehicle types are not affected by the change from Squad to Medic vehicles.

Figure 25 – Other Vehicle Utilization



Overall there is a benefit to transport calls by having squad vehicles changed to medics as it is more likely that a transport vehicle will have a shorter travel time to the scene. The workload on ambulances is also reduced. The ALS response time performance in the first due areas with squads currently assigned was also examined. The overall response time increase in those zones at the 90% was 23 seconds (from 11:09 to 11:32) however transport unit arrival in those same first due areas decreased at the 90% from 9:31 to 8:50, an improvement of 41 seconds.

480 Second Travel Time Transport Unit (ALS and BLS) Analysis

This scenario looks at the ALS and BLS transport coverage that can be provided by the current HFD station locations. Transport coverage is defined by the distance that a vehicle can travel within 480 seconds from a station location (where the station at minimum has an ambulance or medic vehicle). This is calculated from when the vehicle is in route to the scene, to when the vehicle arrives at the scene.

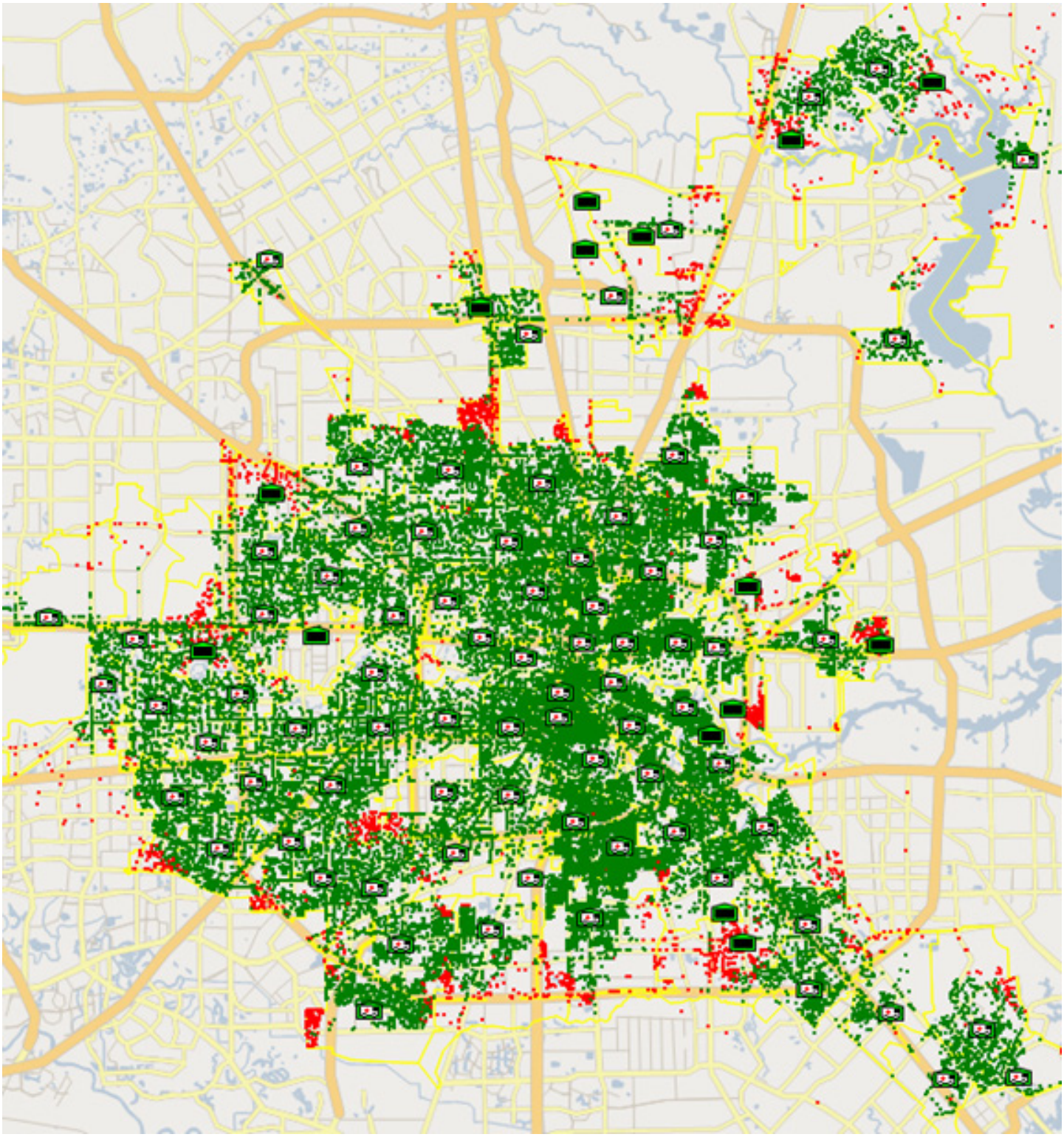
Two (2) separate data files were used to assess the coverage:

- Historic Incidents – This data includes both EMS and fire related calls during 2015. During this period engine and ladder vehicles were also sent to EMS incidents.
- Address points – These have data points for each address within the Houston region. The file provided for address points has not been verified and may not be completely accurate. It should however approximately replicate the areas of high/low demand.

Incident Coverage from Station Locations

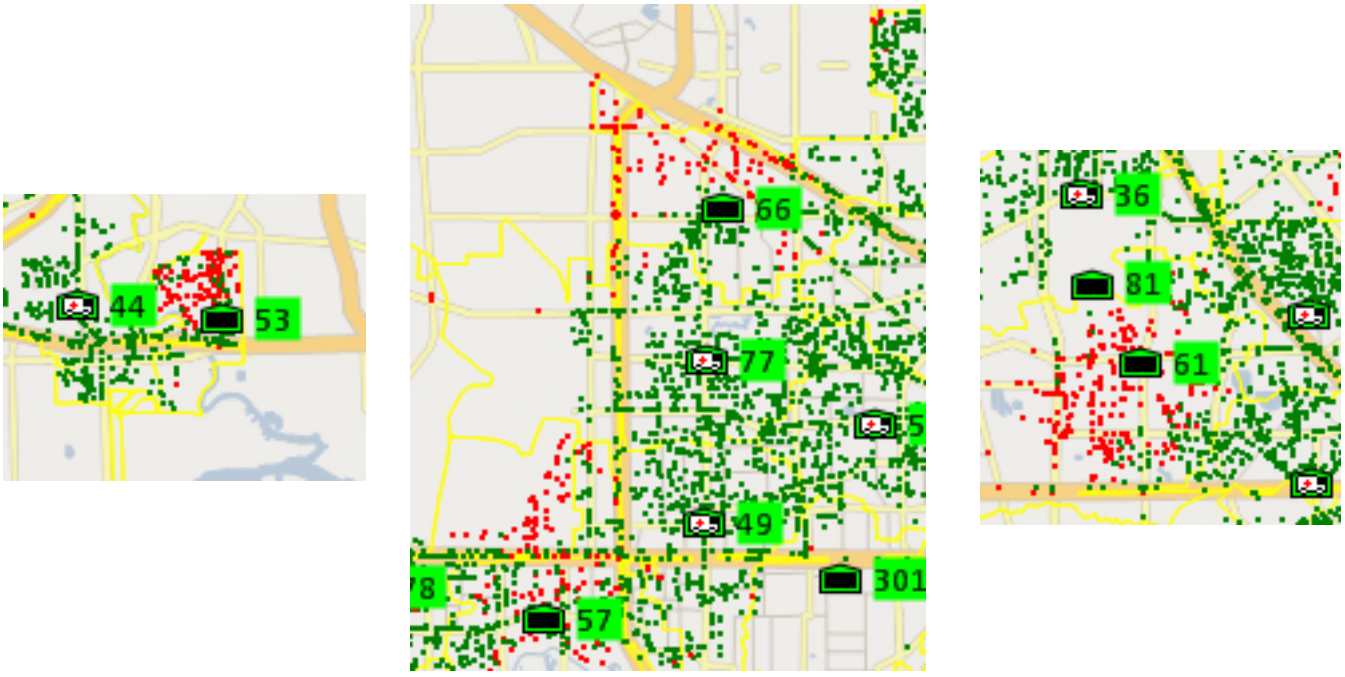
Figure 26 shows the historic transport incidents that can be travelled to within 480 seconds from a station that has an ambulance or medic vehicle and those that are missed. This coverage is based on the assumption that for stations where there is an ambulance and/or medic unit assigned, the vehicle will always be available when required (i.e. it will never be busy responding to another incident). Historic transport incidents that are within 480 seconds travel time from the station with a transport vehicle are shown in green, the remaining incidents are shown in red.

Figure 26 – Transport Incident Coverage by Ambulance or Medic from Station Location – Travel Time 480 Seconds



The locations of the stations are sufficient to deliver a reasonable level of cover, provided that suitable numbers of transport capable vehicles are available and assigned appropriately to the stations. There are a few areas that would benefit from additional resource added to existing stations (Additional coverage could be attained by having transport vehicles located at Stations 57, 66, 53, and 61 (**Figure 27**). There are also a few areas where additional stations or standby locations would be required to provide full coverage.

Figure 27 – Bases Currently Not Providing Transport Vehicle Coverage



Looking at the percentage coverage by Still Alarm region, the majority of the regions have coverage at 90% or higher (the percentage of incidents that have a travel time for the transport vehicle within 480 seconds) (**Figure 28**). However, there are still a few areas with low coverage. To improve coverage in these areas additional transport units (ambulances or medic units) would need to be added to stations that currently do not have them (this includes Stations 42, 45, 53, 54, 57, 61, 66, 103 and 104).

Figure 28 – Still Alarms Regions – Coverage by Ambulance or Medic from Station Location – Travel Time of Transport Vehicle within 480 Seconds – green > 90% coverage for region, red <70% coverage per region

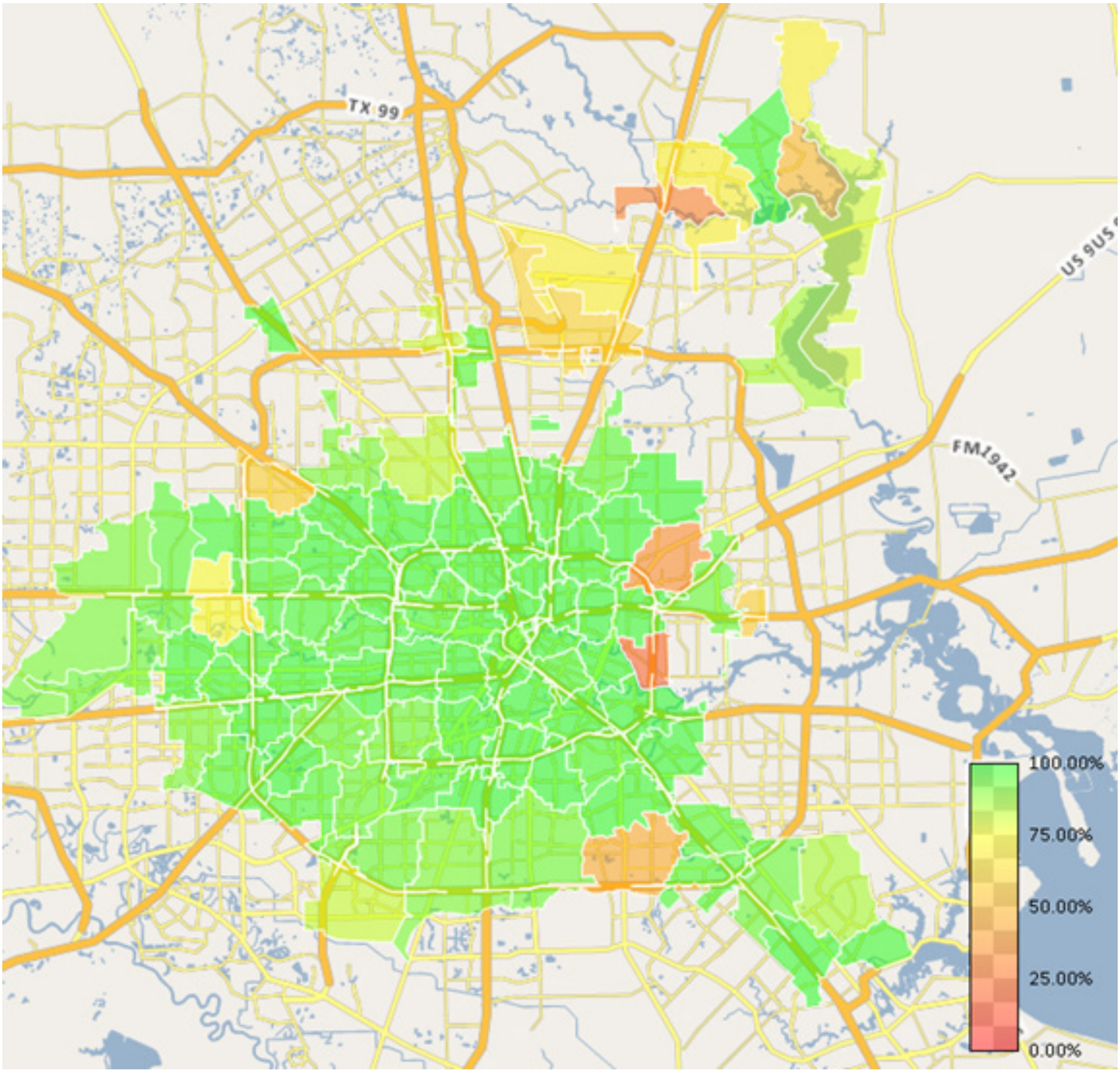
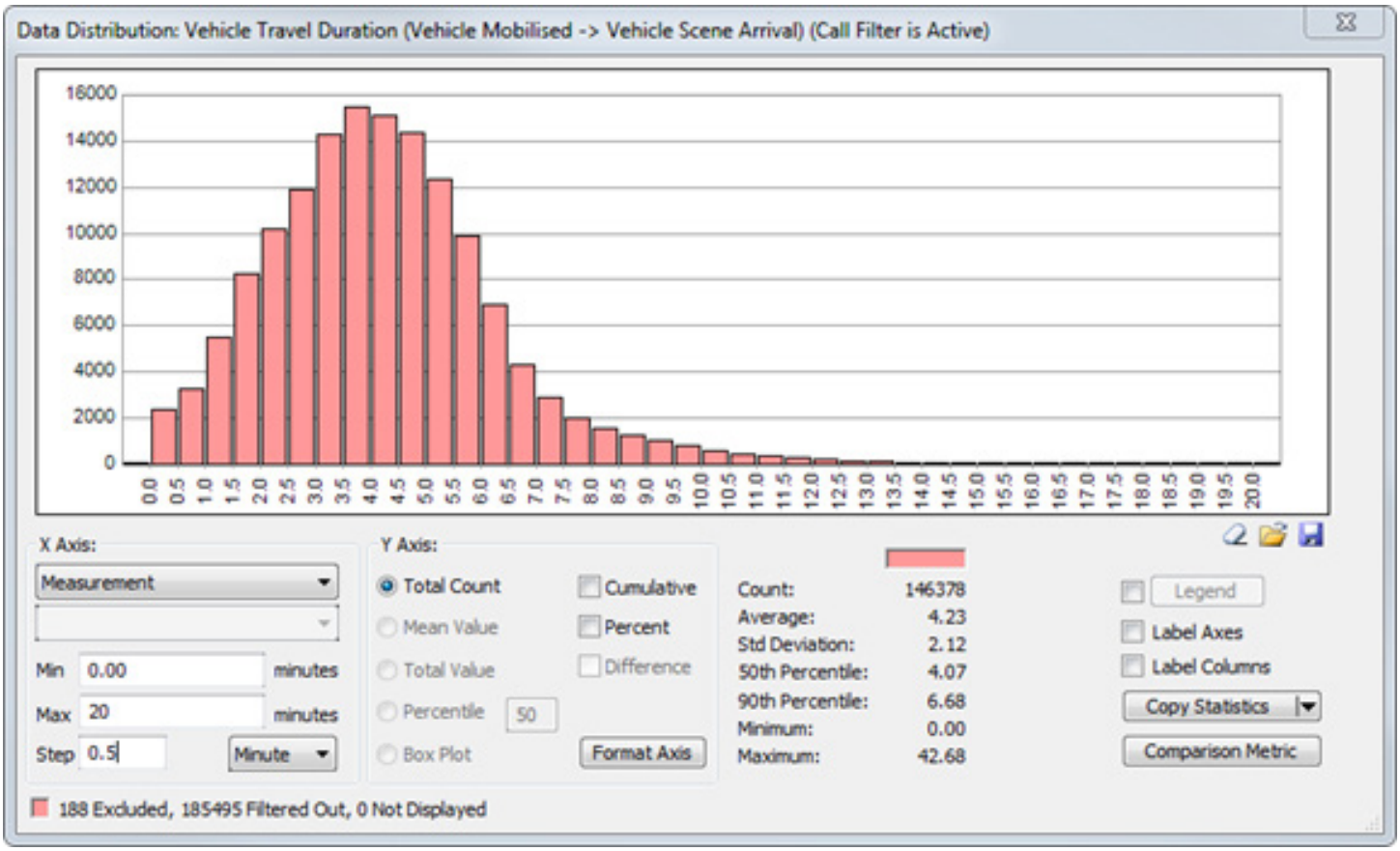


Figure 29 shows that on average travel times are under 4¼ minutes and 90% of calls are reached in under 7 minutes. So although some areas are uncovered, the 90% target coverage could be attained from the current station locations, provided that suitable numbers of transport capable vehicles are available and assigned appropriately to the stations.

Figure 29 – Travel Times Between Station Locations and Historic Incidents for Transport Vehicles



While **Figure 28** shows that the current placement of ambulances and medic units at stations provides sufficient coverage, this coverage does assume that vehicles will always be available at their home station. In reality, multiple calls are often received at the same time. This means that while the incident is theoretically covered by a station, the vehicle at the station may already be busy on another incident and therefore cannot respond to the new incident. Overall the actual travel time is expected to be longer than the values shown in **Figure 29**.

Address Point Coverage from Station Locations

Similar to the coverage for historic transport incidents (**Figure 26**), the coverage of address points that can be reached by a transport vehicle within 480 seconds is good for most of the region, with only areas on the peripheral not covered by either an ambulance or medic vehicle (**Figure 30**).

Figure 30 – Address Point Coverage by Ambulance or Medic from Station Location – Transport Vehicle Travel Time within 480 Seconds

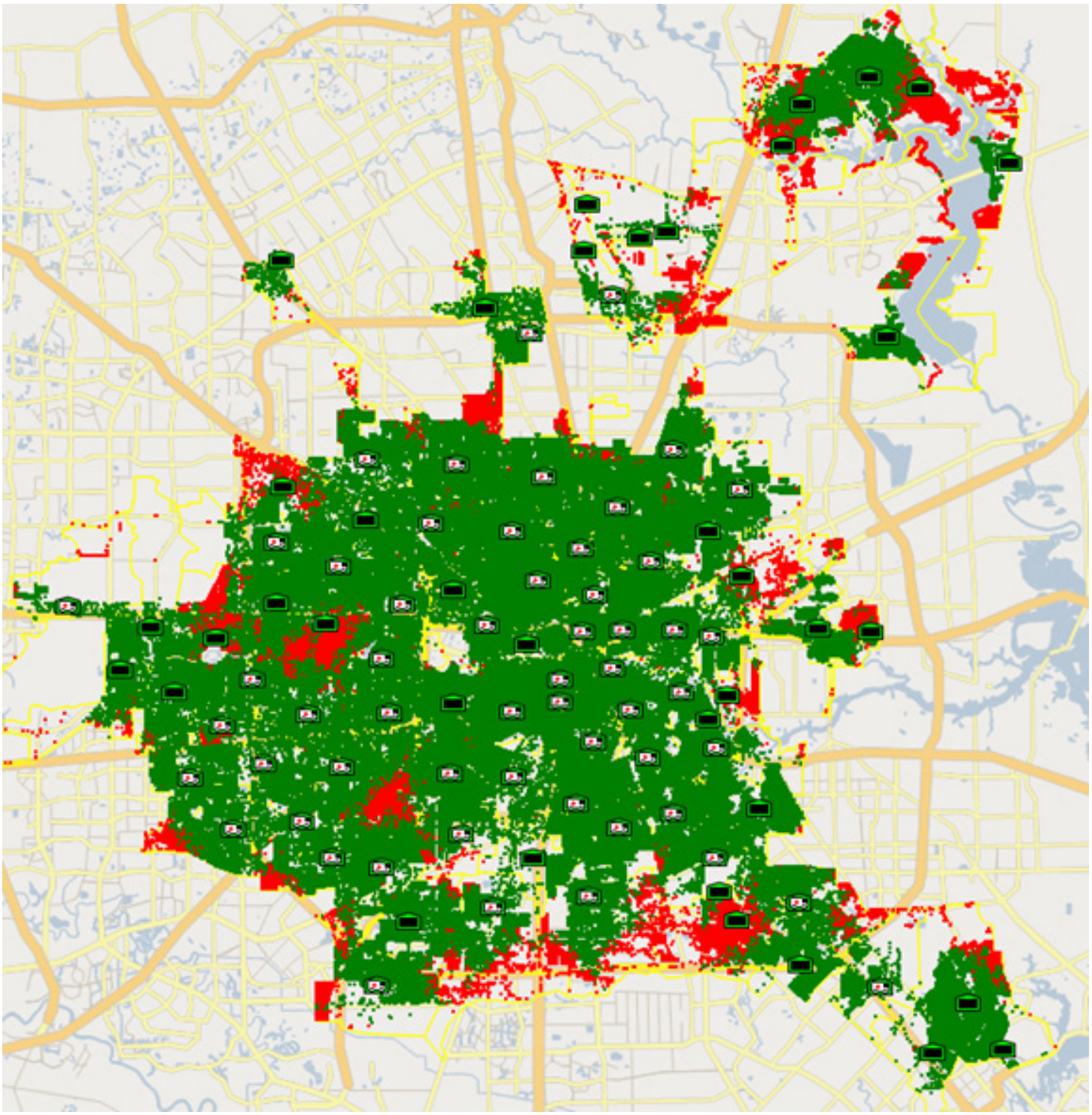
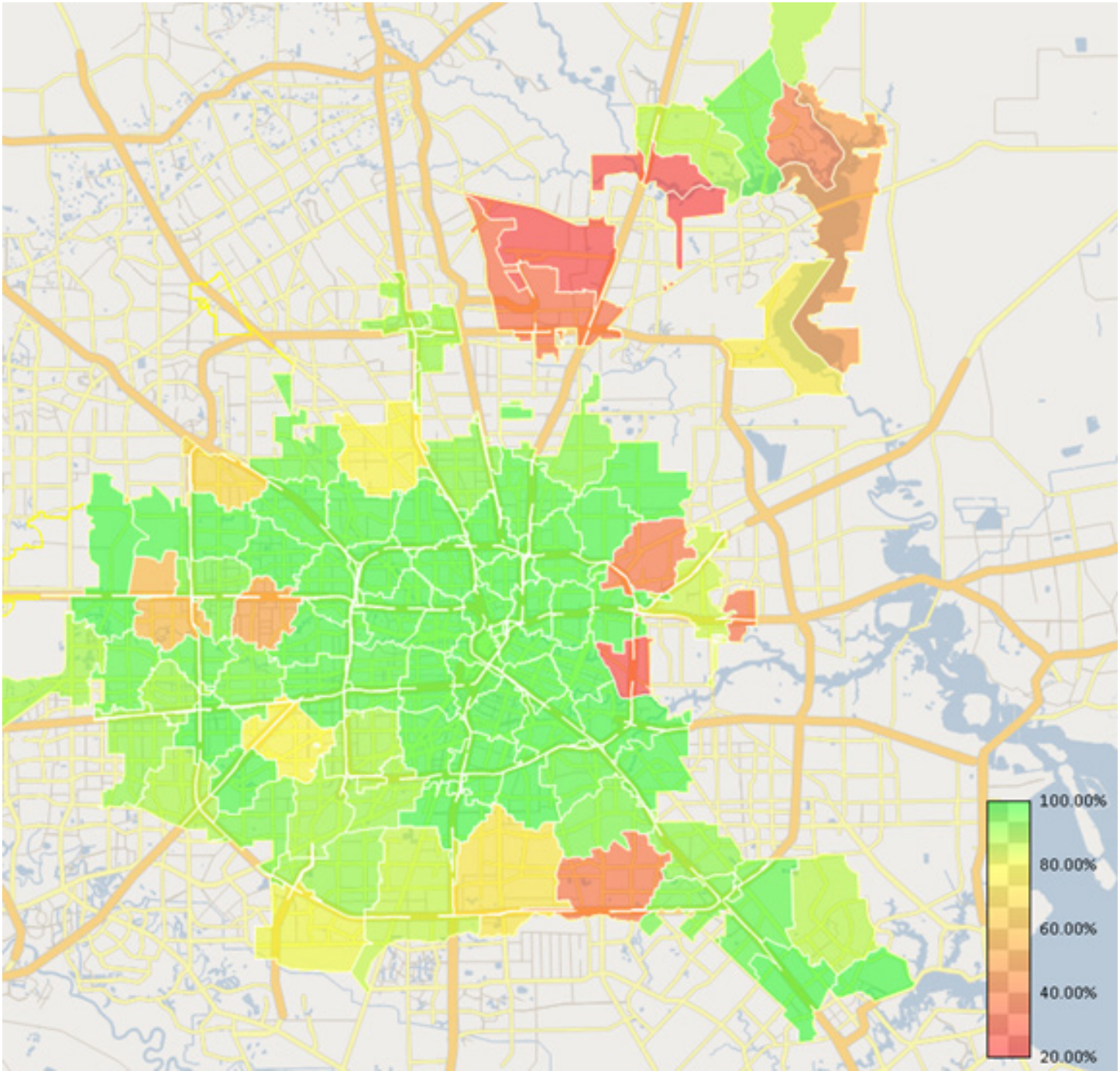


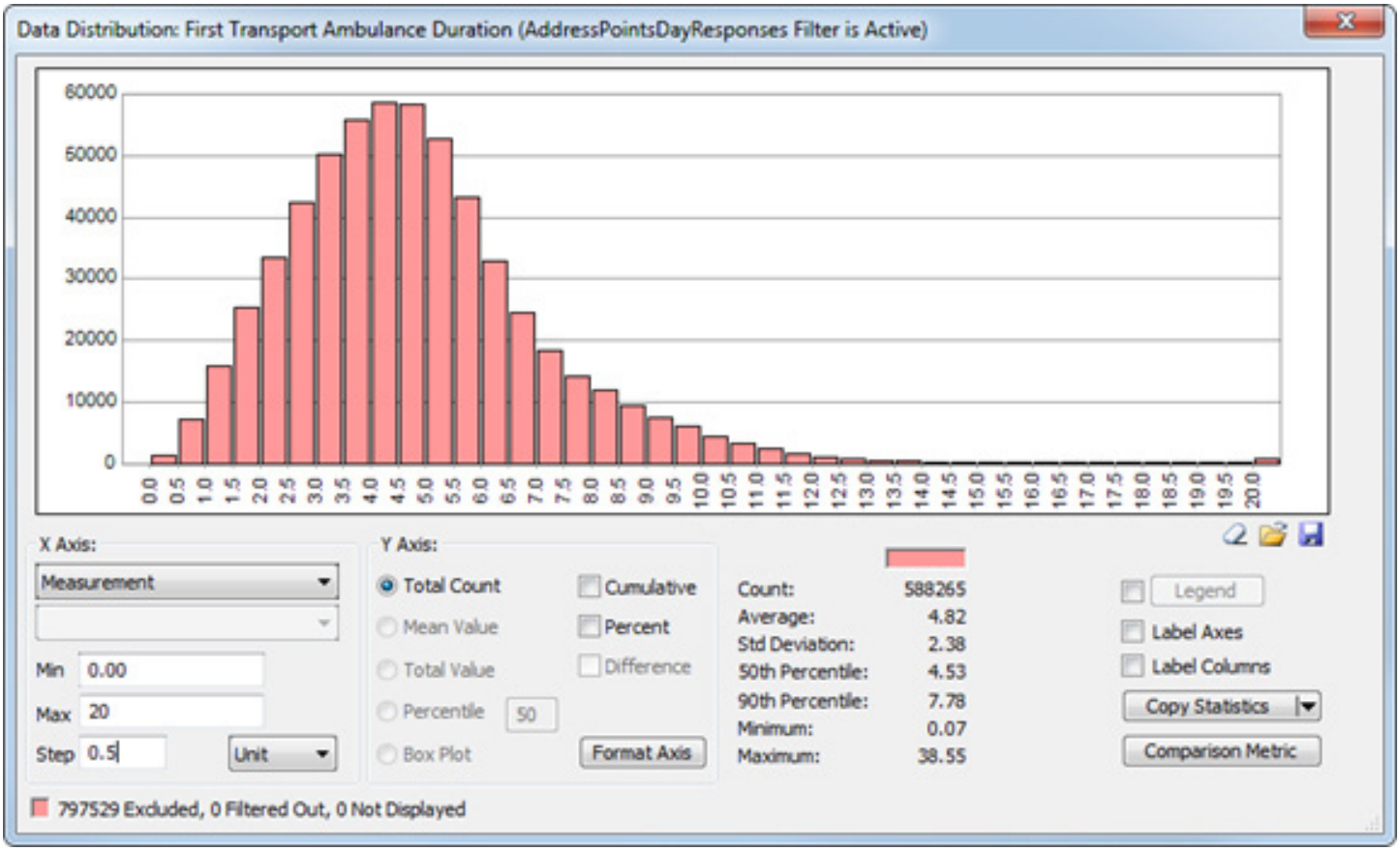
Figure 31 shows that in most of the still alarm regions, address points can be covered more than 90% of the time by a transport vehicle within 480 seconds travel time. However, there are some regions that are not well covered (shown in orange/red). To ensure coverage in these regions vehicles would need to be added to many of the stations that currently do not have an ambulance or medic unit.

Figure 31 – Still Alarms Regions – Coverage by Ambulance or Medic from Station Location – Transport Vehicle Travel Time within 480 Seconds – Green > 90% coverage for region, red <70% coverage per region



Overall, the coverage for address points is well within the 90% in 480 seconds travel time target. **Figure 32** gives the distribution of travel times, showing that 90% of address points are covered in just under 8 minutes.

Figure 32 – Transport Vehicle Travel Times between Station Locations and Address Points



Historic Incident Performance

Figure 33 shows the historic transport incidents that a transport vehicle was able to reach within 480 seconds (shown in green) and those incidents that were missed (shown in red). There are a mix of colors within all areas, showing that even though incidents may be within 480 seconds travel time of the closest station, the transport vehicle may still have a longer travel time. This once again illustrates the need for enhanced capacity of transport capable resources (BLS or ALS) in order to achieve a 480 second travel time. It is important to note, however, that there is no NFPA standard related to arrival of a transport capable vehicle and that many EMS systems have extended the response time expectation for transport capability to 12 or more minutes when BLS and ALS capability are on scene within shorter windows.

Figure 33 – Historic Transport Incident Coverage – Transport Vehicle Travel Time 480 Seconds

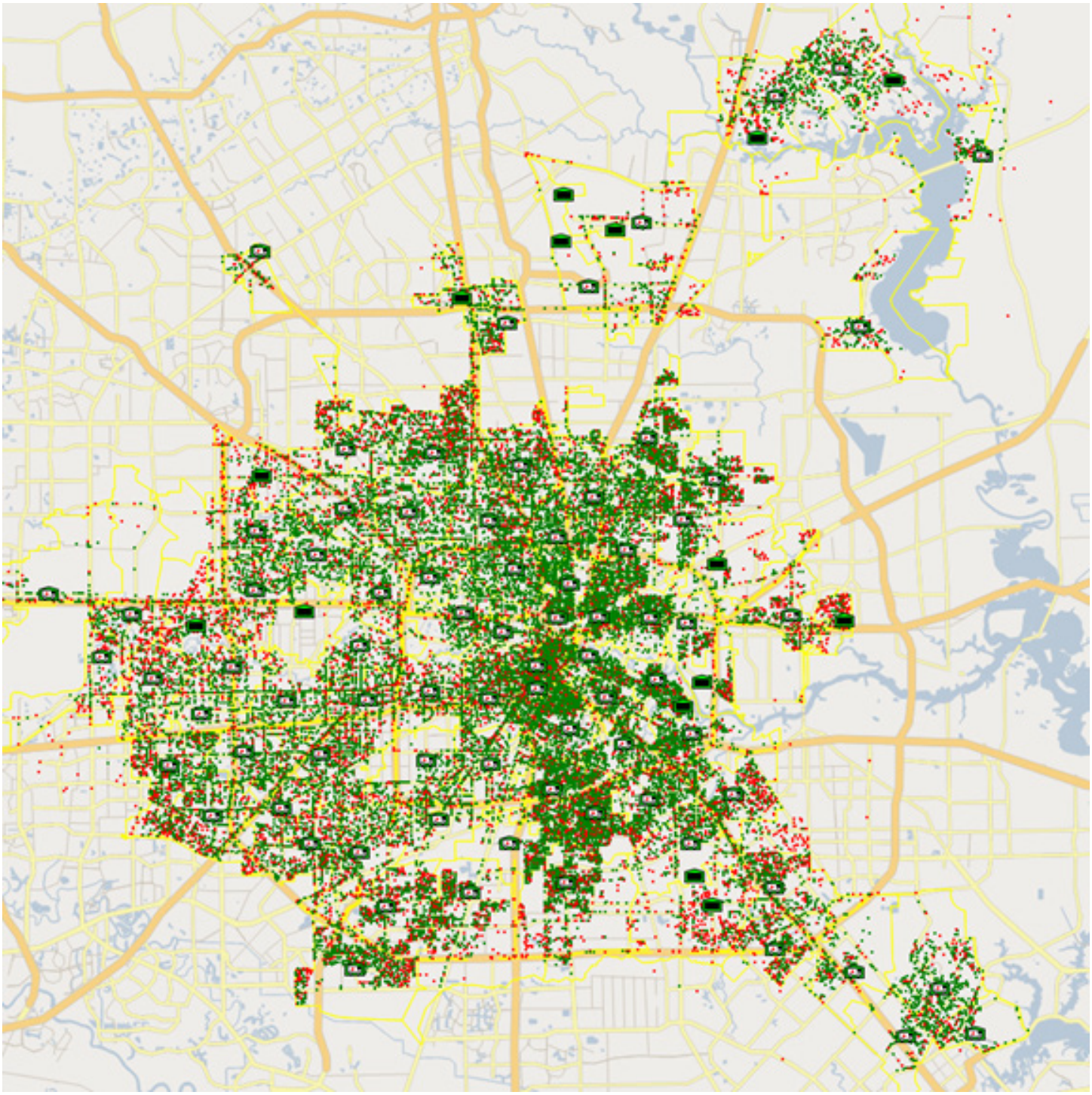
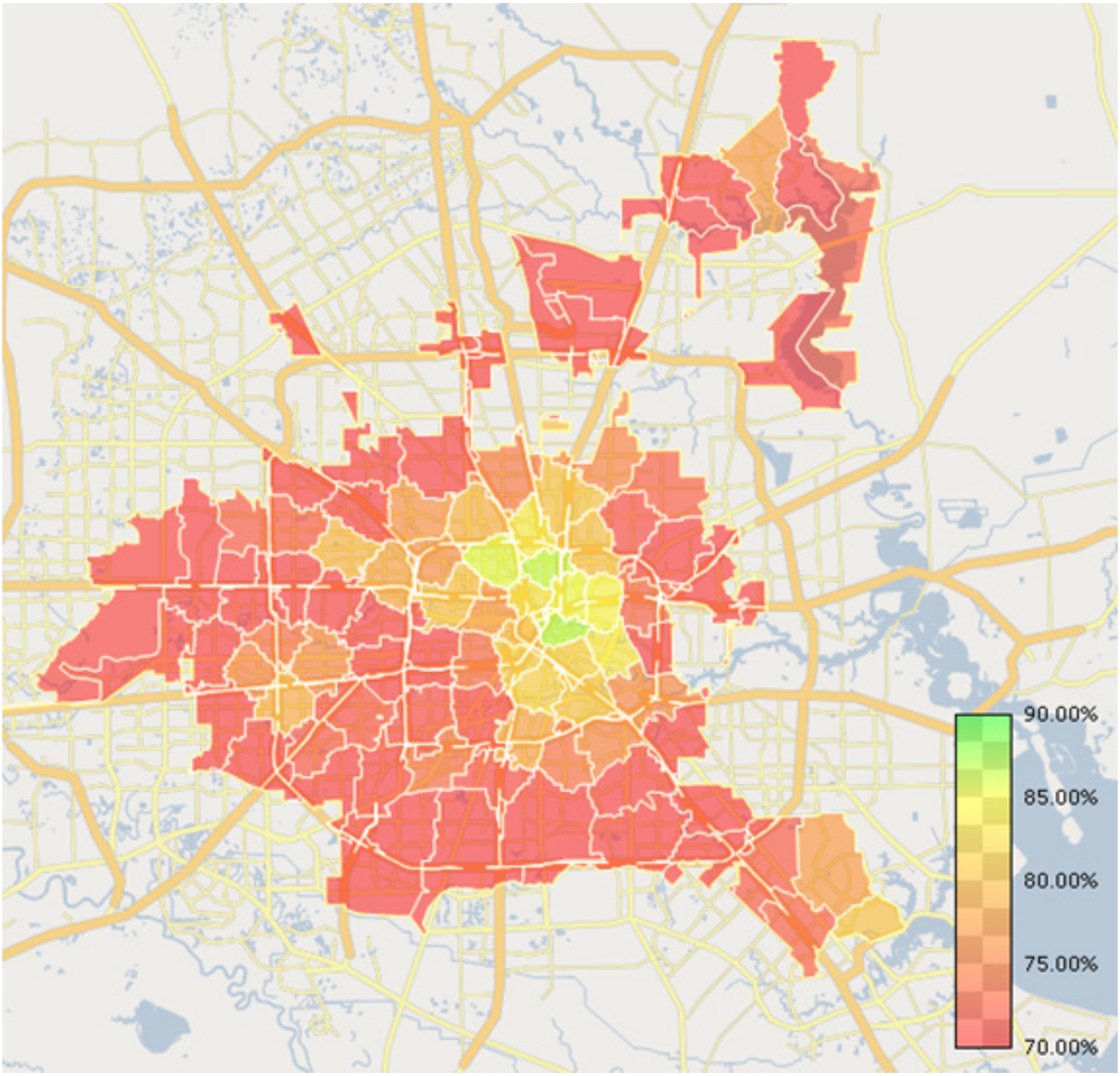


Figure 34 shows the percentage of historic transport incidents that had a travel time within 480 seconds by a transport vehicle. In the central area, incidents usually have a travel time within 480 seconds for the transport vehicle (approximately 85% of the time). Further out the percentage of incidents with a travel time within the target time diminishes. This suggests that additional resource is required in most regions.

Figure 34 – Still Alarms Regions – Percentage of historic transport incidents that had a travel time for the transport vehicle within 480 seconds

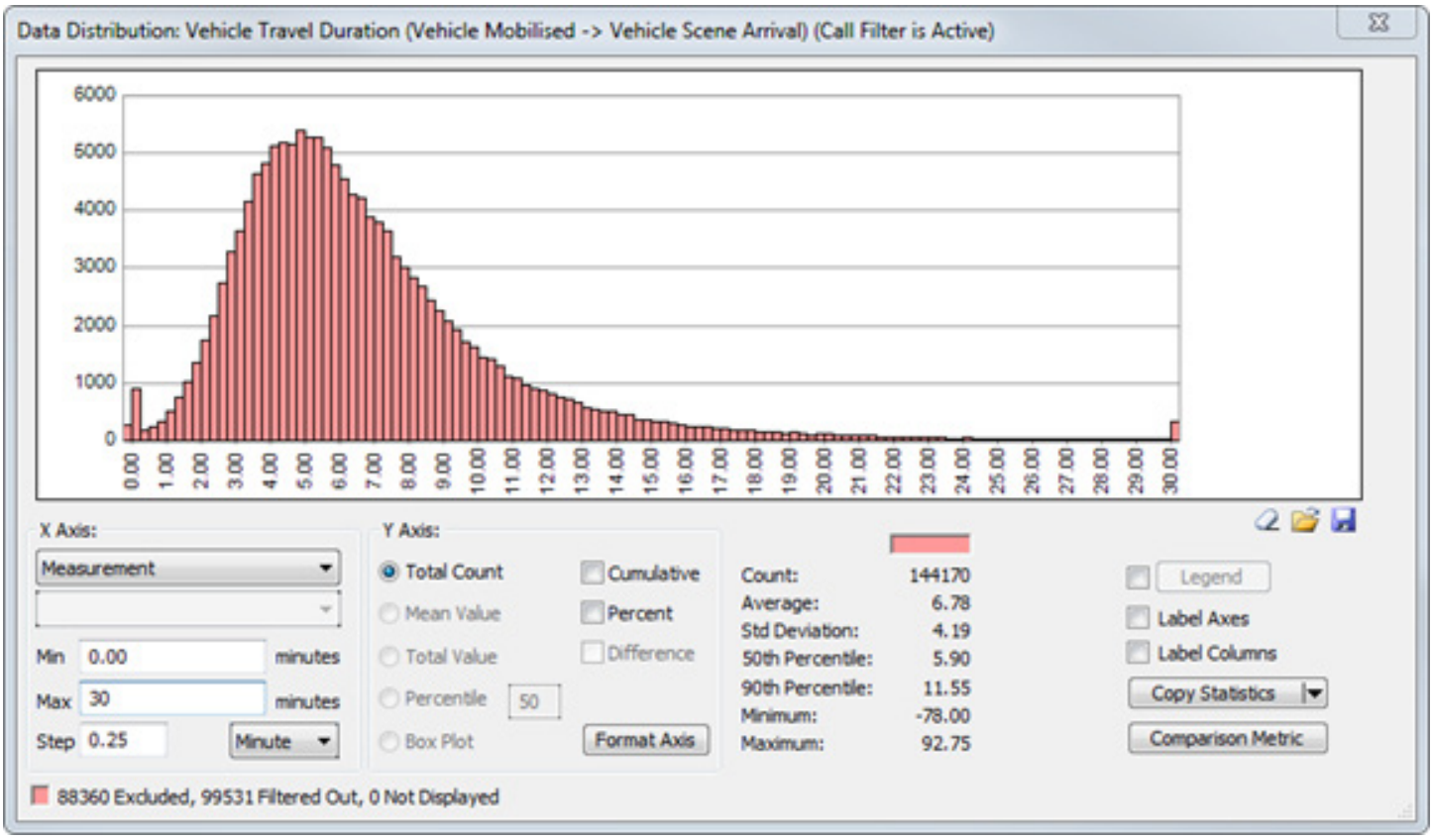


Looking at the distribution of actual travel times for transport vehicles to historic transport incidents the average travel time to the scene is 6.78 minutes (**Figure 35**). This is quite a lot longer than the theoretical average time of 4.36 minutes shown in **Figure 36**. Similarly, the 90th percentile is significantly longer and well outside the target range of 480 seconds (in this case only 73% of calls have a travel time within 480 seconds from a transport vehicle).

The theoretical coverage given by the station locations assumes that a vehicle is always available at the station. In reality multiple calls may come in at similar times resulting in the local vehicle not being available for coverage at the time of the incident. Additionally, some of the travel time in the historic data may actually be due to crews pushing their enroute button early or at scene button late.

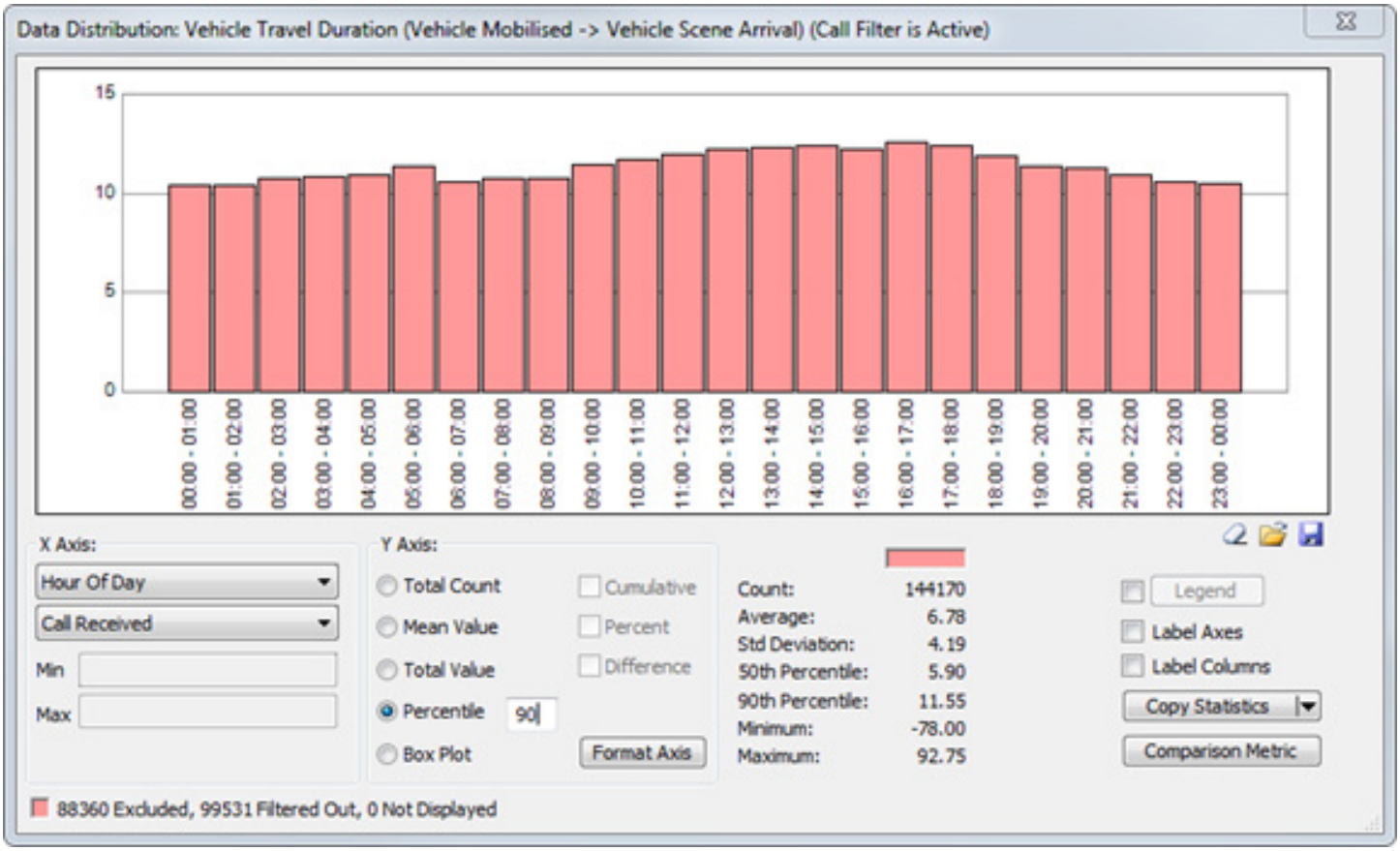
The historic results for transport responses suggest that additional vehicles may be required at some stations to provide the required coverage.

Figure 35 – Distribution of Historic Transporting Vehicle Travel Times for Historic Transport Calls



Over the period of the day, the travel time for transport vehicles slows during the afternoon (where the number of incidents is highest) (**Figure 36**). This chart infers that during the afternoon, the closest vehicle is not available and vehicles are therefore dispatched from further away. This suggests that there is opportunity, especially in the afternoon, to improve the travel time coverage.

Figure 36 – 90th Percentile Travel Time for Transport Vehicles by Time of Day



Additional 12 Hour Transport Units (Ambulance Type Used)

Optima Predict Resource Location Optimization (RLO) functionality was used to determine the best place to put additional peak-time ambulance vehicles to provide the transport coverage required (90% of incidents have a travel time within 480 seconds). RLO uses utilization and time of day demand to optimize the location of vehicles.

Model Setup

No limits were put on the number of additional peak-time ambulance vehicles, or on the time of day that they could operate. All current station locations were considered regardless of the actual ability of the fire station to accommodate another vehicle and crew. The peak-time ambulance locations were set to be 12-hours long and operate on every day of the week at the same time each day.

There was no attempt to ensure all of the still alarm region areas achieved 90% target, or that the 90% target is met across all hours of the day. Only the overall Houston area, at a weekly level, was considered. RLO will add ambulance vehicles to areas where the greatest benefit will be achieved (i.e. the vehicle will respond to the greatest number of calls with a travel time within the target time).

Historically, approximately 73% of transport incidents were responded to by an ambulance or medic vehicle with a travel time within 480 seconds. This means that an additional 17% of transport incidents need to be responded to with a travel time within 480 seconds to achieve the 90% target.

The simulation had slightly lower performance compared to the historic (simulations are intentionally tuned to be conservative in their performance), achieving 67%. Additional peak-time ambulances were added to the simulation to increase the percentage of transport incidents responded to in the simulation by approximately 17%, so that the simulation is achieving approximately 84% (which is expected to be equivalent to 90% if these ambulances were actually added to the Houston area).

Additional Peak-Time Ambulance Requirements

Based on output from RLO and the simulation an additional 70 12-hour peak-time ambulances are required to increase the percentage of incidents responded to with a travel time within 480 seconds by 17%. The additional peak-ambulances are spread around the region, starting throughout the day.

Although there are 70 additional peak-time ambulances required to reach the 8-minute goal, each additional ambulance is adding only a small performance gain. The expected performance is shown in **Table 7**. To achieve the 90% target 70 peak-time ambulances are required, although to achieve 88.5% this reduces down to 60 peak-time ambulances.

Table 7 – Expected Impact of Additional Peak-Time Ambulances

Number of additional 12-hour peak-time ambulances	Additional benefit from baseline	Expected percentage of transport vehicles travel time within 480 seconds
5	+2%	75%
10	+4%	77%
15	+6%	70%
50	+14%	87%
60	+15.5%	88.5%
70	+17%	90%

Results

The following results are based on adding 70 additional 12-hour peak-time ambulances.

There are now significantly more ambulances in the Houston area, but there are still regions which have low coverage due to their distance from the nearest station location (**Figure 37** and **Figure 38**). Posts or additional stations may be required to full these gaps.

Figure 37 – Simulated Transport Incident Coverage – Transport Vehicle Travel Time 480 Seconds

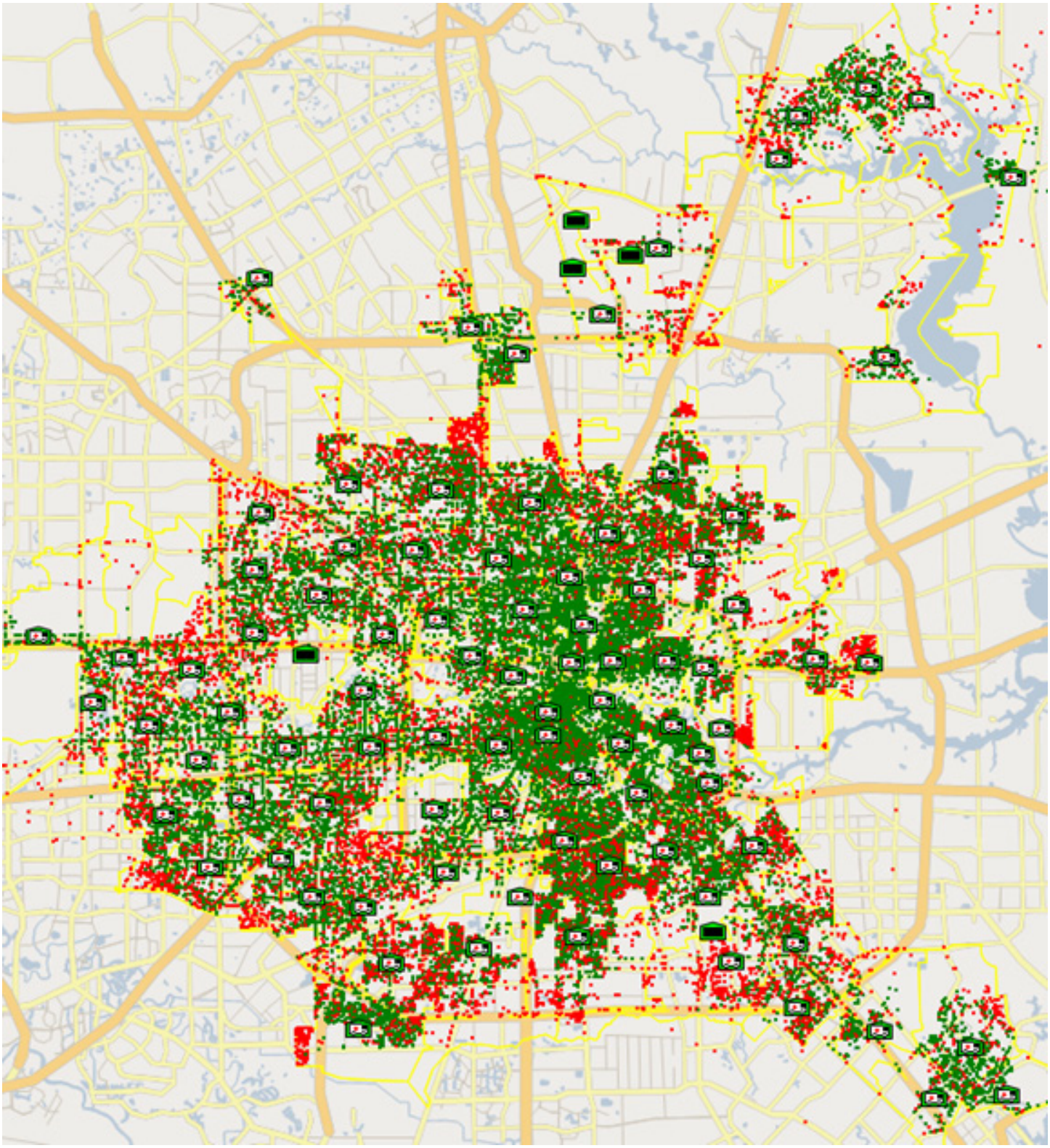


Figure 38 – Still Alarms Regions – Percentage of simulated transport incidents that were travelled to by a transport vehicle within 480 seconds (green >90%, red <70%)

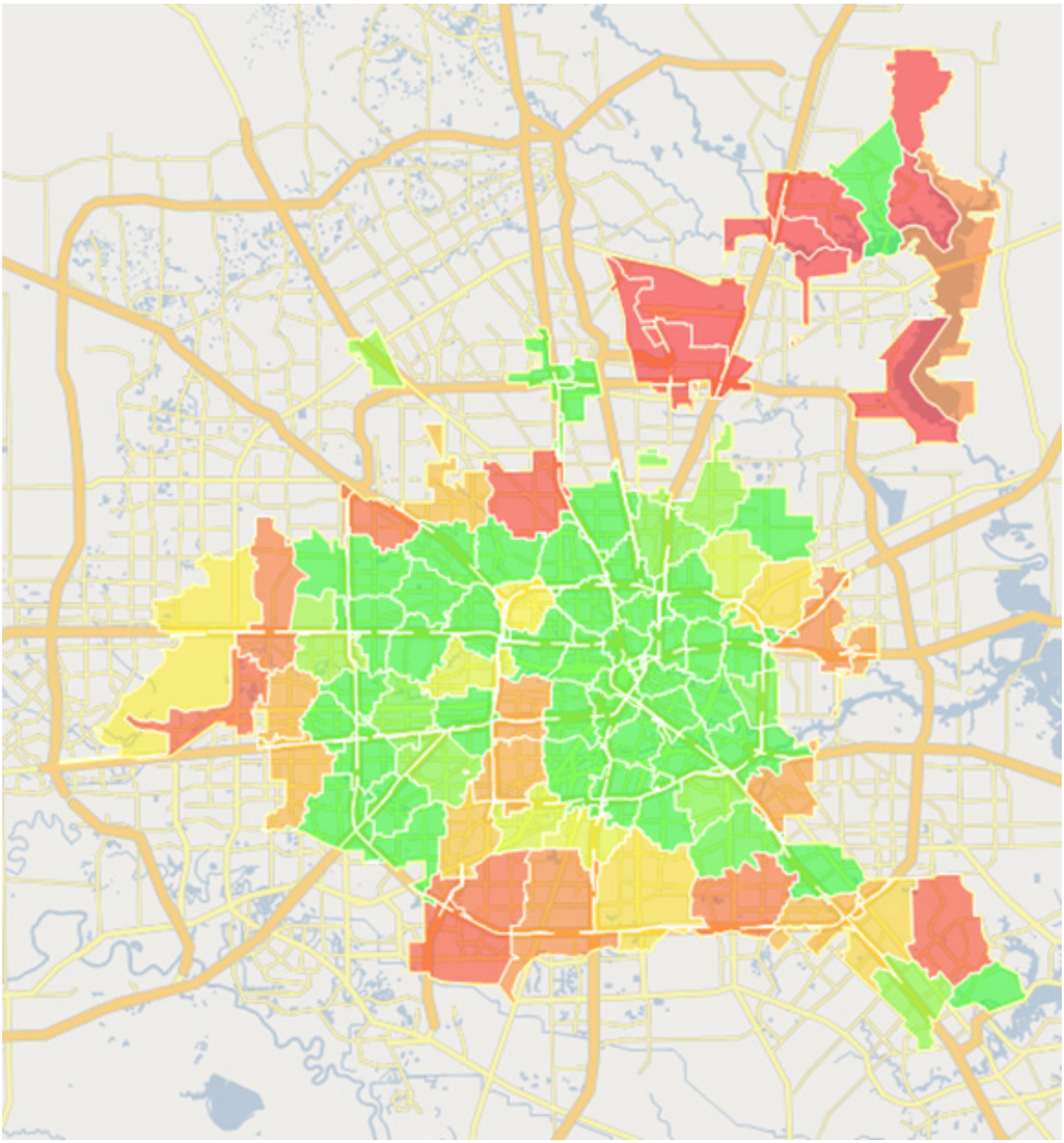
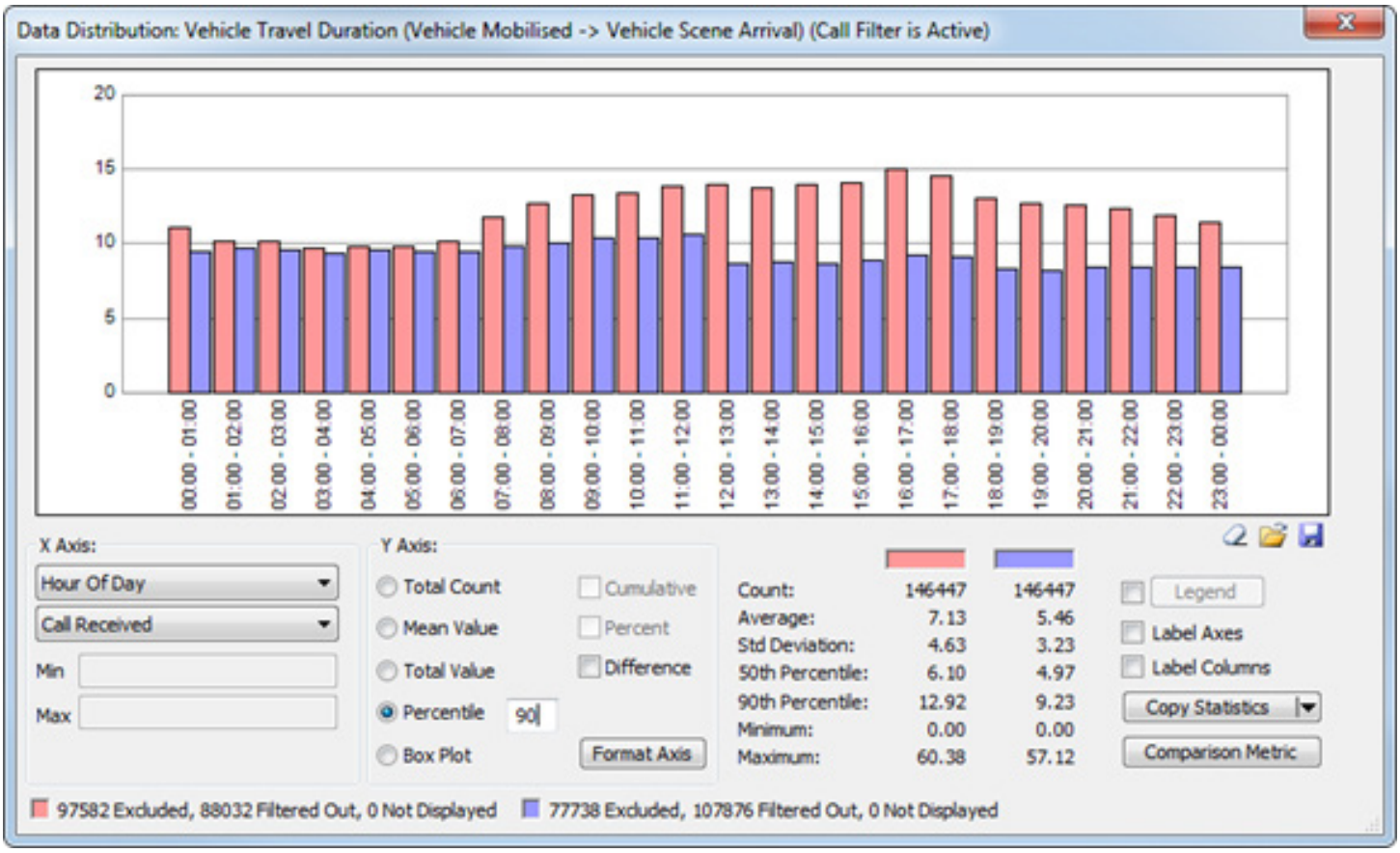


Figure 39 shows the change by time of day by implementing the peak-time ambulances. There is a large reduction in transport travel time from 7am onwards. The travel time is more stable through the day, although now slightly faster in the afternoon.

Figure 39 – 90th Percentile Travel Time for Transport Vehicles by Time of Day (pink) simulated baseline, (blue) simulated with additional 70 peak-time ambulances



The suggested peak-time ambulance in-service times and locations calculated using RLO are given in **Table 8**. Just over half of the peak-time ambulances start at midday and run through to midnight. This provides additional coverage during the afternoon where travel times have historically been slow (**Figure 36**). Based on **Figure 39**, potentially some of the peak-time ambulances that start at 12:00 p.m. could be moved to start earlier to even out the time of day performance.

Table 8 – Additional 12-hour Peak-Time Ambulances (70)

Home Station Location	Start Time	Finish Time	Home Station Location	Start Time	Finish Time
61	03:00	15:00	38	12:00	00:00
42	05:00	17:00	6	12:00	00:00
45	06:00	18:00	70	12:00	00:00
66	06:00	18:00	84	12:00	00:00
57	07:00	19:00	25	12:00	00:00
35	07:00	19:00	31	12:00	00:00
52	07:00	19:00	39	12:00	00:00
4	07:00	19:00	94	12:00	00:00
53	07:00	19:00	76	12:00	00:00
82	07:00	19:00	73	12:00	00:00
59	07:00	19:00	56	12:00	00:00
51	07:00	19:00	67	12:00	00:00
33	07:00	19:00	29	12:00	00:00
13	07:00	19:00	59	12:00	00:00
49	07:00	19:00	55	12:00	00:00
39	07:00	19:00	50	12:00	00:00
32	07:00	19:00	49	12:00	00:00
96	08:00	20:00	19	12:00	00:00
73	08:00	20:00	47	12:00	00:00
55	08:00	20:00	34	12:00	00:00
28	08:00	20:00	46	12:00	00:00
101	08:00	20:00	35	12:00	00:00
77	08:00	20:00	33	12:00	00:00
102	09:00	21:00	86	12:00	00:00
84	10:00	22:00	28	12:00	00:00
63	10:00	22:00	26	12:00	00:00
23	12:00	00:00	44	12:00	00:00
51	12:00	00:00	4	13:00	01:00
83	12:00	00:00	57	13:00	01:00
43	12:00	00:00	61	14:00	02:00
58	12:00	00:00	52	15:00	03:00
48	12:00	00:00	32	15:00	03:00
7	12:00	00:00	42	16:00	04:00
82	12:00	00:00	73	23:00	11:00
45	12:00	00:00	84	23:00	11:00

NFPA 1710 Residential Structure Fire EFF Travel Time Analysis: Historic, Address Point

This scenario looks at the response time capability to structure fires. The measure that has been assessed is:

- Structure Fire-Single Family Dwelling, 15 Personnel Required at 480 Seconds

The following personnel counts have been used:

- Engine: 4 personnel
- Ladder/Tower: 4 personnel
- Ambulance/Medic/Squad: 2 personnel
- Chief: 2 personnel

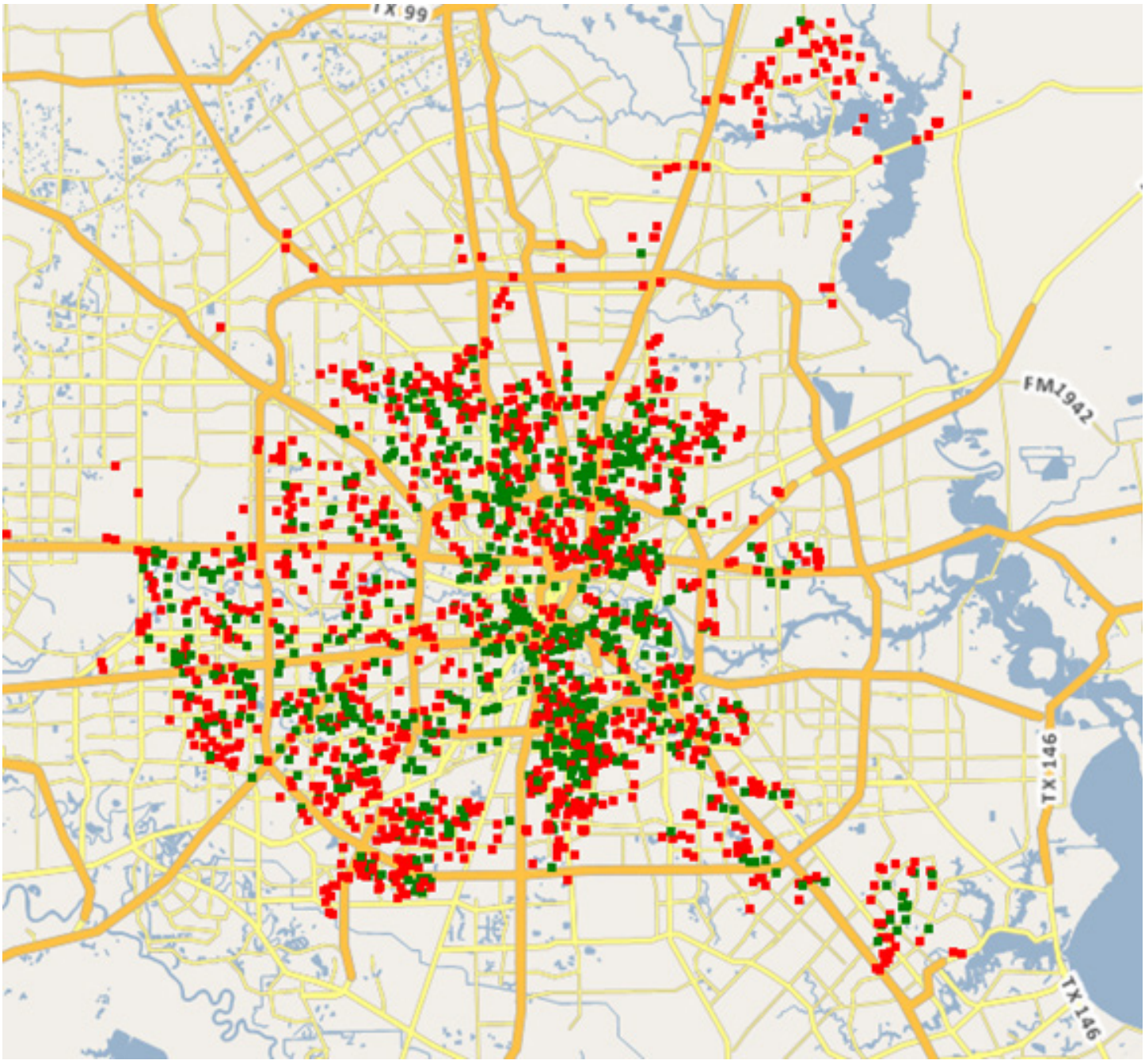
Historical information was used from 2015. The following call codes were used to identify calls for this measurement:

- FFLBJA
- FFLBJB
- FFLBJD
- FFLBCB
- FFLBCA
- FFLBIB
- FFLBIA
- FFMBBD
- FFMBAD
- FFMBED
- FFMB11
- FFMBXA
- FFMBBA
- FFMBDA
- FFMBCA
- FFMBAA
- FFMBPD
- FFMBAC
- FFMBEA
- FFMB1A

Based on the 2015 incident data, there were 2,149 incidents that were dispatched in one of the above categories. Of these incidents, 1,276 achieved 15 personnel arriving at scene. For those 1,276 incidents, the average arrival time for the full complement was slightly less than 8 minutes. The data showed 863 of the incidents (40%) having the full complement arriving within the targeted 480 seconds.

Figure 40 shows that historically the incidents that were responded to within the targeted time by a full complement of 15 people (green incidents) are spread around the geography. The performance for this measure is consistent with the 240 second coverage distribution seen in earlier scenarios.

Figure 40 – Single Family Dwelling Measure – Green incidents have full personnel requirement arriving within 480 seconds – red incidents are outside the target time



Address Point Coverage

Address points include all address points in the Houston area. Data is not available to identify residential dwellings from other dwellings.

Figure 41 shows the address points that are within 480 second coverage from stations that combined contribute the full complement of vehicles required to provide 15 personnel at the address point. There are large areas, shown in red where there is not sufficient coverage. Additional vehicles would need to be place within 480 second travel times of these areas to provide the required coverage

Note: This coverage chart assumes that all scheduled vehicles are always available at their station (i.e. they are not at another call).

Figure 41 – Address Point Coverage-Single Family Dwelling/Residential Structure Fire – green address points have full personnel quota (15) arriving within 480 minutes – red address points are outside the target time

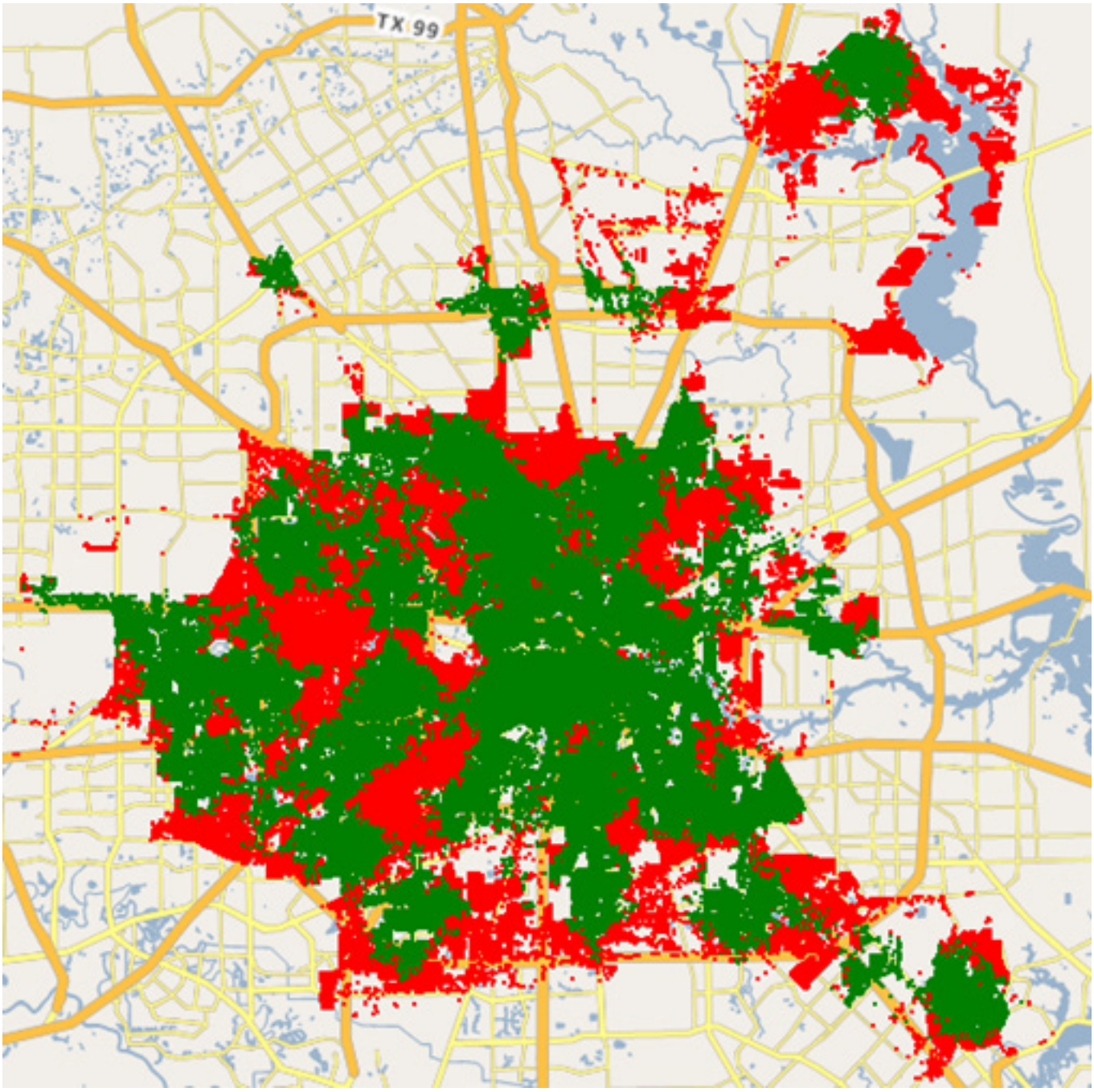
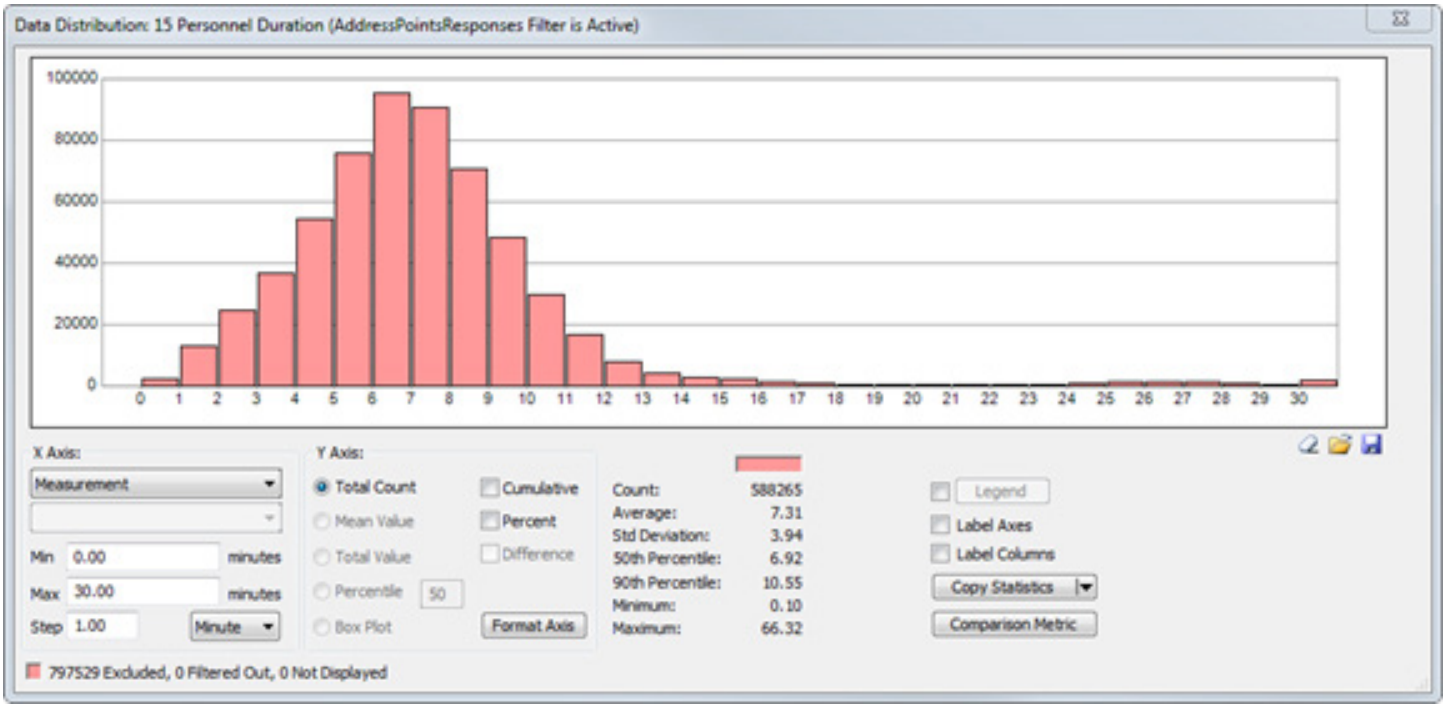


Figure 42 shows the travel time from the first vehicle enroute to the final vehicle that fills the required personnel arriving at the scene. On average this takes just under 7½ minutes, but the 90th percentile of 10½ minutes is well over the targeted 8 minute travel time.

Figure 42 – Travel Time Duration from Station Location to Address Points based on First Vehicle Enroute Time to Full Complement (15 people) Arriving at Scene



NFPA 1710 Commercial Structure Fire EFF Travel Time Analysis: Historic, Address Point

This scenario looks at the response time capability to structure fires in garden apartments and open air/strip commercial centers. The measure that has been assessed is:

- Structure Fire-Open Air/Strip Mall/Garden Apartment, 27 Personnel Required at 480 Seconds

The following personnel counts have been used:

- Engine: 4 personnel
- Ladder/Tower: 4 personnel
- Ambulance/Medic/Squad: 2 personnel
- Chief: 2 personnel

Historical information was used from 2015. The following call codes were used to identify calls for this measurement:

- FFABBA
- FFABCA
- FFABAA
- FFABAB
- FFLBAF
- FFLBXF
- FFLBAA
- FFLBAD
- FFLBXB
- FFLBXA
- FFLB1A
- FFLBPD
- FFLBLA
- FFLBGA
- FFLBFA
- FFLBBA
- FFLBBB
- FFLBDA
- FFLBDB
- FFLBEB
- FFLBEA

Based on the 2015 incident data, there were 2,246 incidents that were initially dispatch in one of the above categories. Of these incidents, 588 achieved 27 personnel arriving at scene. The average arrival time for the full complement is just over 14 minutes. 111 of these incidents (5%) had the full complement arrive within the targeted 480 seconds.

Figure 43 shows that there are very few incidents responded to with the full complement of vehicles within the target time (green incidents).

Figure 43 – Commercial Structure Fire Incidents – green incidents have full personnel quota arriving within 480 seconds – red incidents are outside the target time

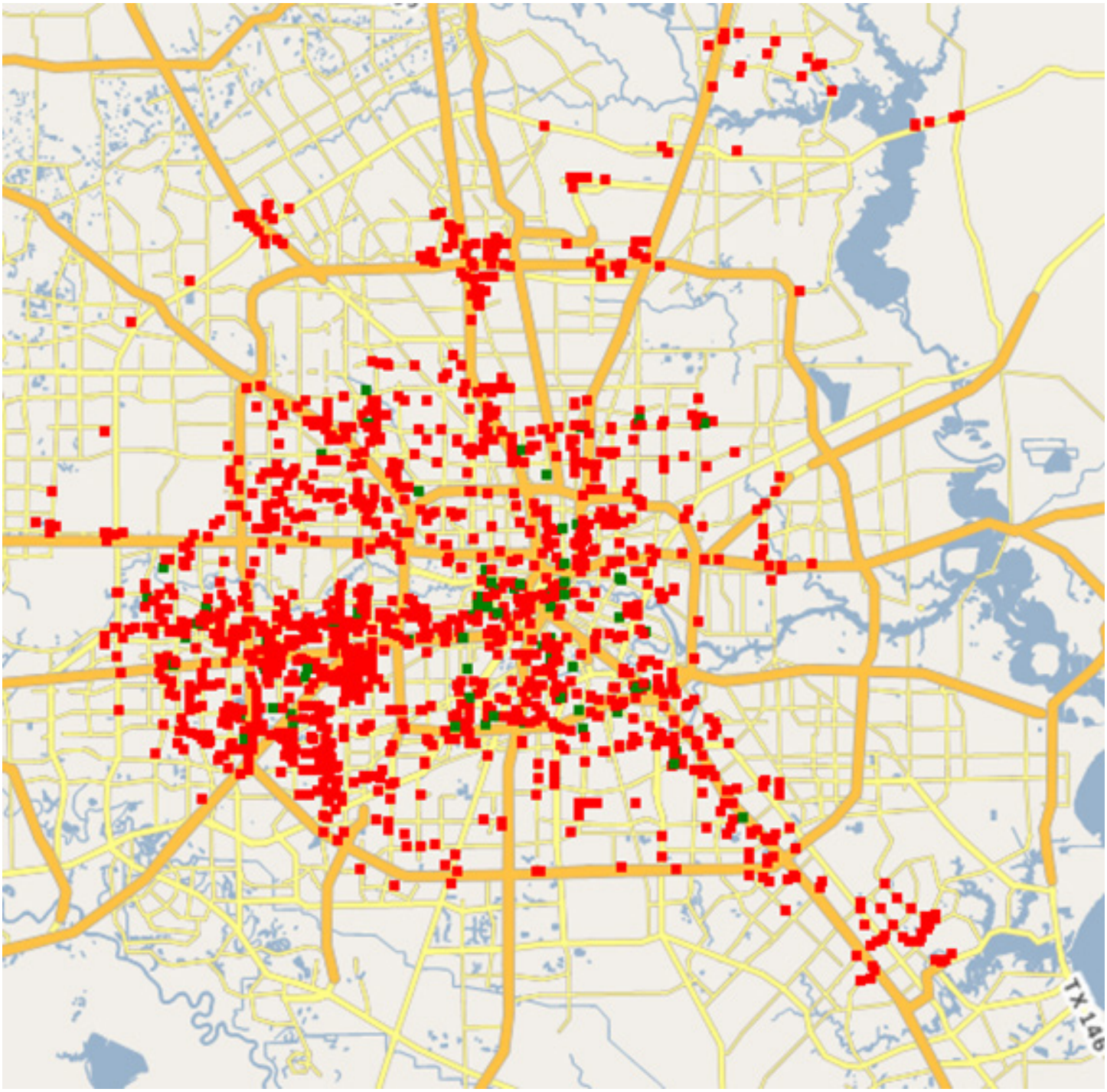
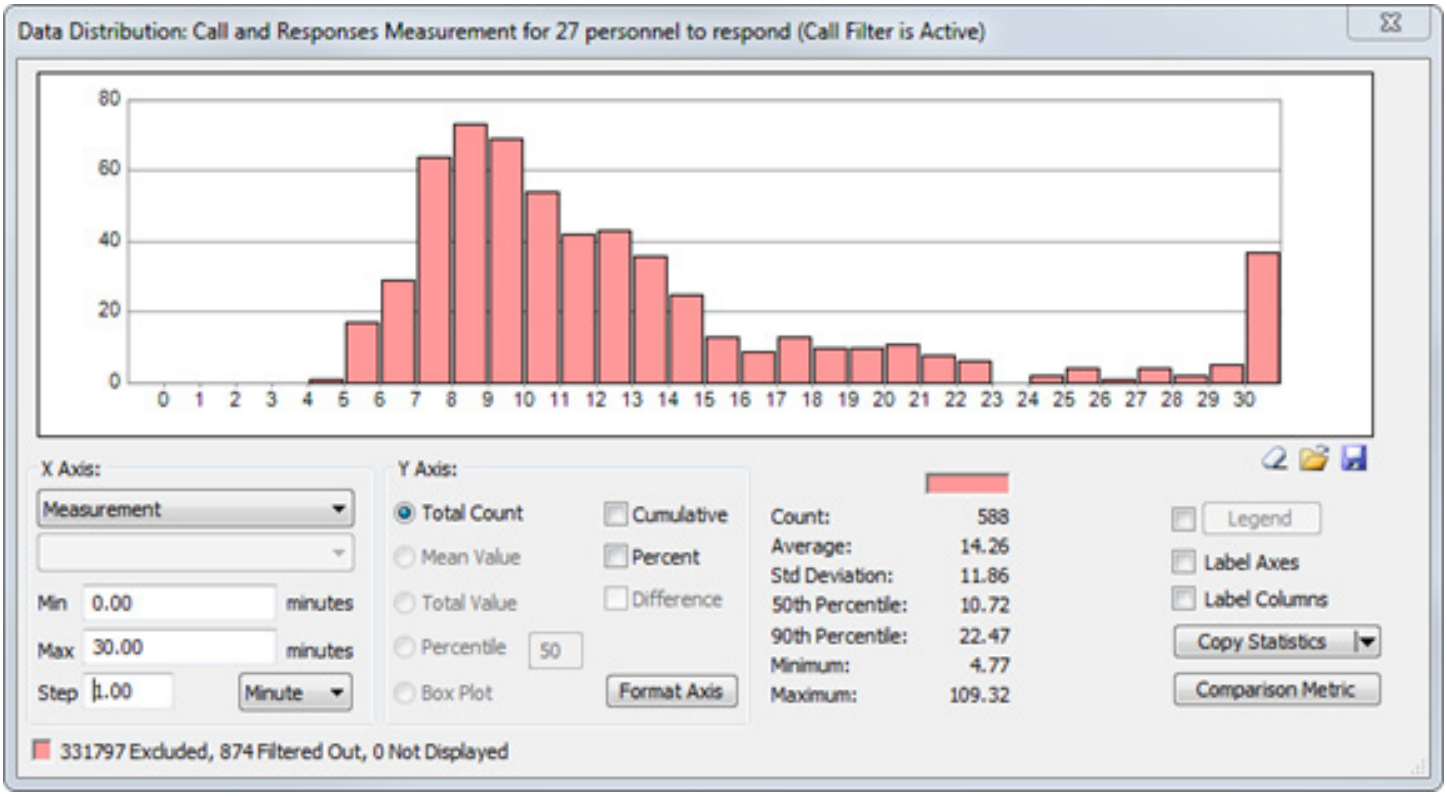


Figure 44 shows that the average travel time from first enroute vehicle to arrival of the full number of vehicles at the scene is over 14 minutes, well above the target of 8 minutes.

Figure 44 – Historic Travel Time Duration from First Vehicle Enroute Time to Full Complement Arriving at Scene



Address Point Coverage

Address points include all address points in the Houston area. Data is not available to identify residential dwellings from other dwellings. The address point coverage is based on the travel time from station locations to each address point. It is assumed that scheduled vehicles are always available at the station. **Figure 45** shows that only the central area has reasonable coverage for this measurement (address points shown in green). The majority of the Houston area would require additional vehicles to be able to meet the 480 second target for 27 personnel.

Figure 45 – Address Point Coverage – green address points have full personnel quota (27) arriving within 480 seconds – red address points are outside the target time

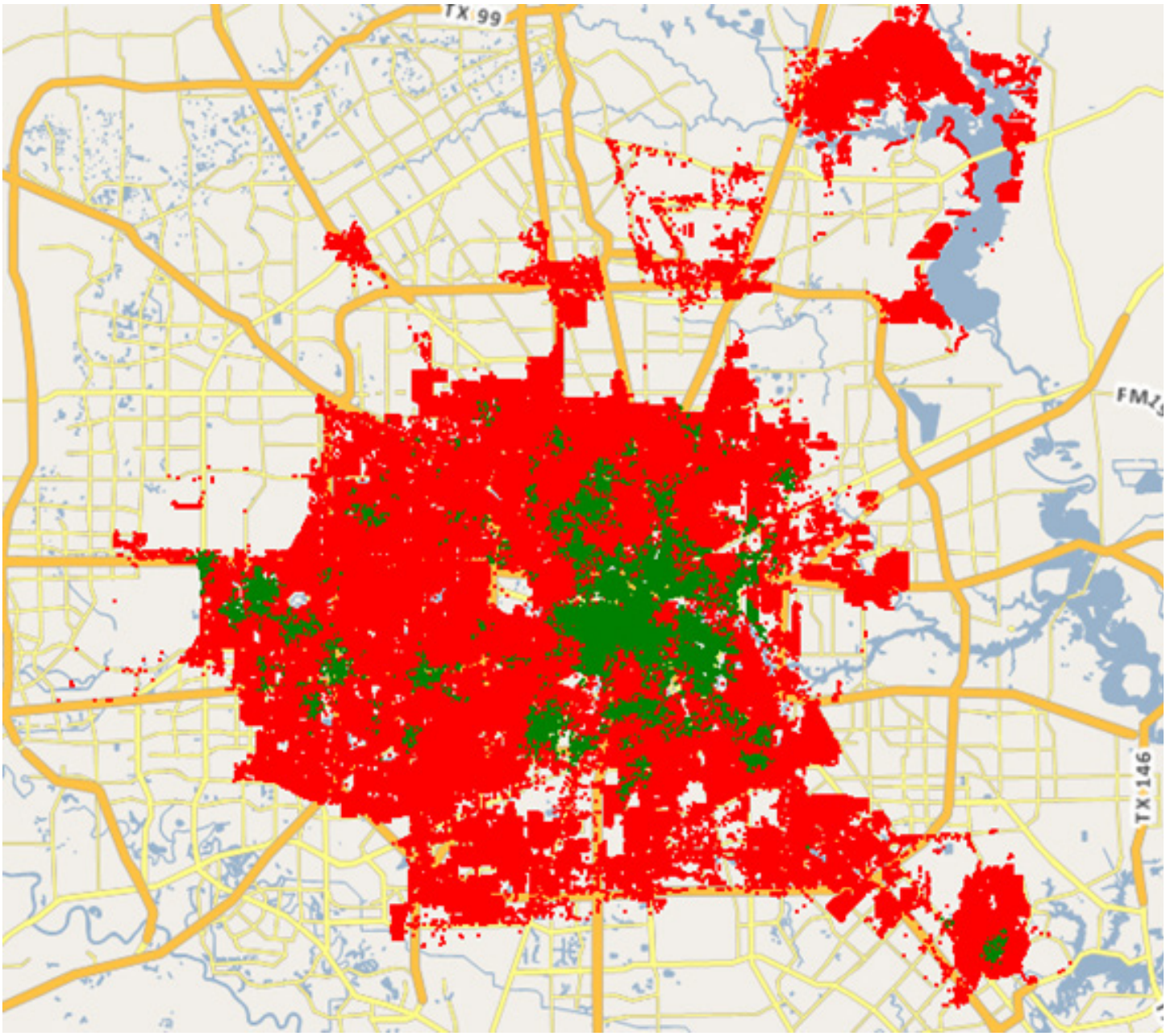
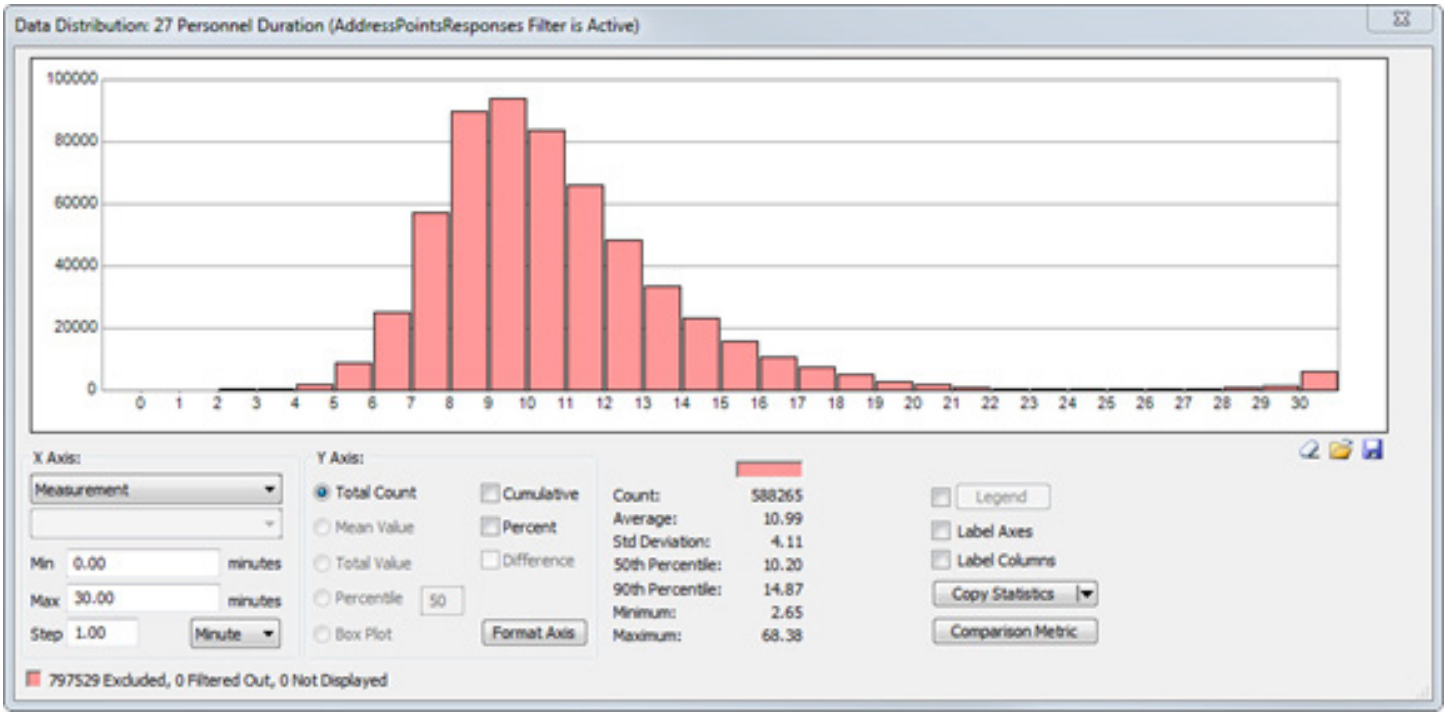


Figure 46 shows that on average the time taken from first enroute vehicle to full complement arrival at the scene is 11 minutes. This is over the 8 minute target.

Figure 46 – Travel Time Duration from Station Location to Address Points Based on First Vehicle Enroute Time to Full Complement (27 people) Arriving at Scene



NFPA 1710 High-Rise Structure Fire EFF Travel Time Analysis: Historic, Identified High Rise Structures

This scenario looks at the response time capability to structure fires. The measure that has been assessed is:

- Structure Fire-High Rise, 41 Personnel required at 610 seconds

The following personnel counts have been used:

- Engine: 4 personnel
- Ladder/Tower: 4 personnel
- Ambulance/Medic/Squad: 2 personnel
- Chief: 2 personnel

Historical incident information was used from 2015. The following call codes were used to identify Hi Rise Calls:

- FF211H
- FFHRBA
- FFHR1A
- FFHR2A
- FFHRAA
- FFHRRA
- FFHRBB
- FFHRPD
- FFLBHA
- FFLBHB

Based on the 2015 incident data there were 143 high rise incidents. Of these incidents, 64 achieved 41 personnel arriving at scene with an average response time, for the full complement, of over 15 ½ minutes. 20 incidents (14%) were able to achieve the arrival of the full complement within the 610 second target.

Figure 47 – Historical High Rise Incidents – green incidents have full personnel quota arriving within 610 seconds – red incidents are outside the target time

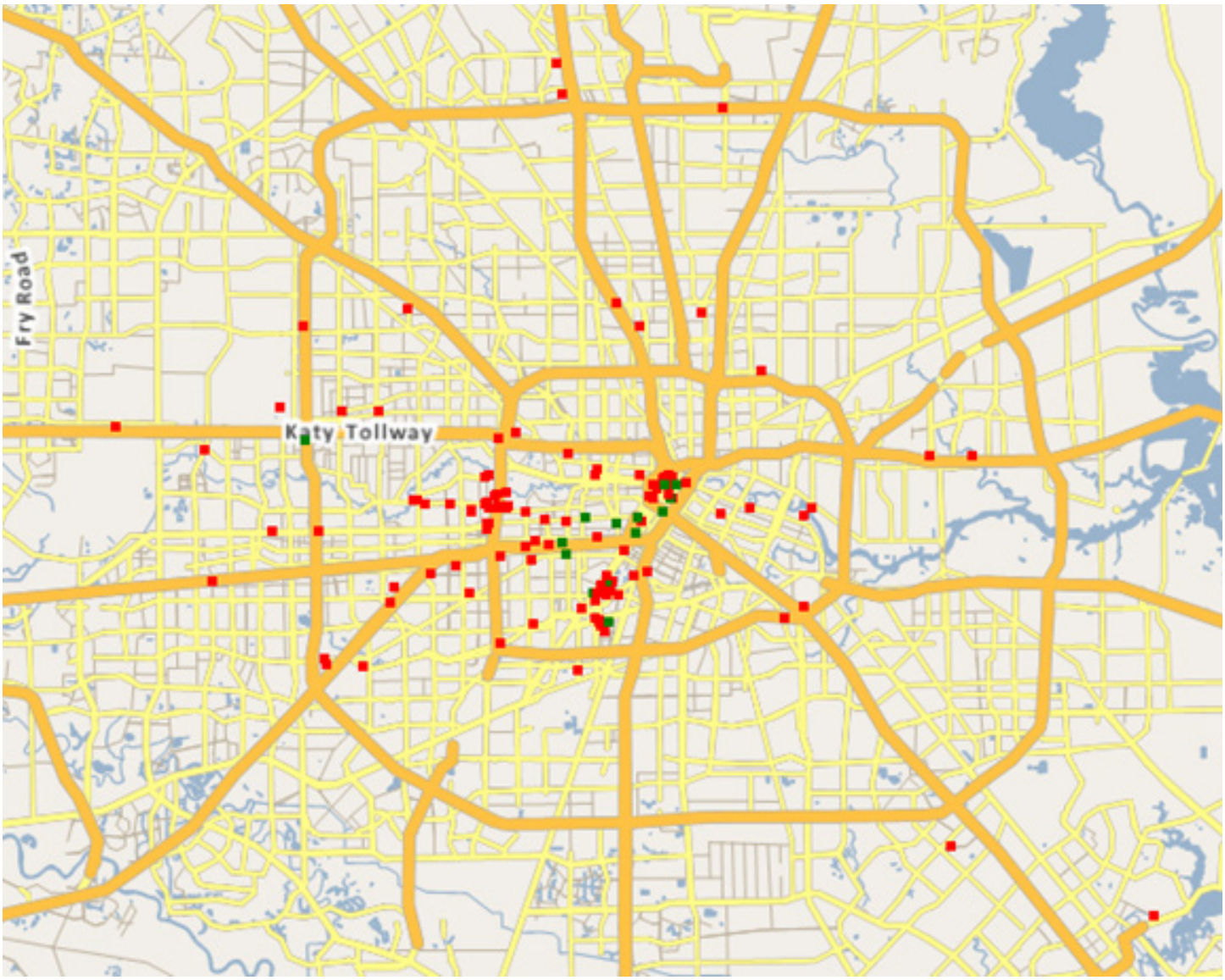
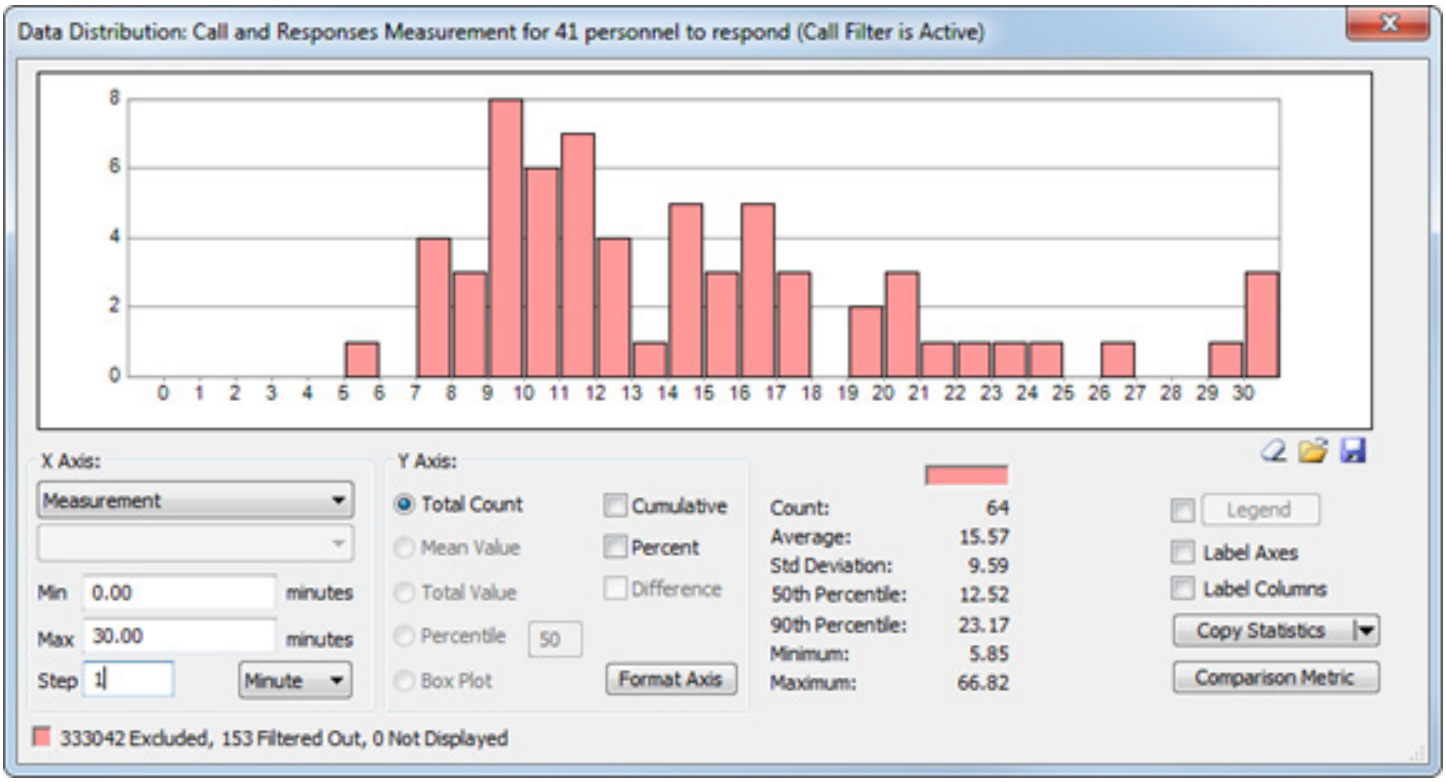


Figure 48 – Historic Travel Time Duration from First Vehicle Enroute Time to Full Complement Arriving at Scene

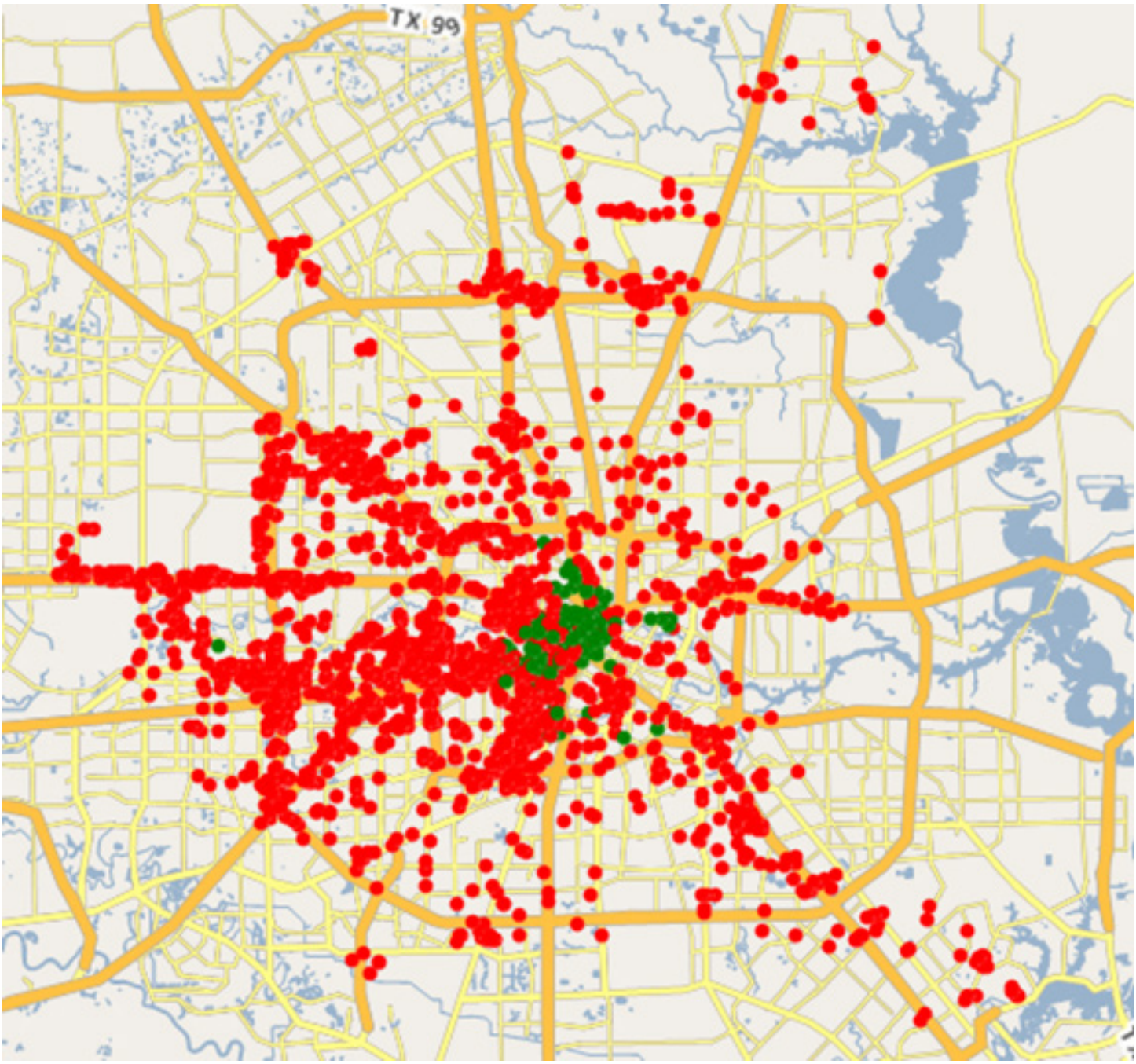


High Rise Building Coverage

For this analysis High Rise Building data (data source: emporis-houston – Jun 1, 2016) was used. This data is assumed to include all high rise buildings in the Houston region.

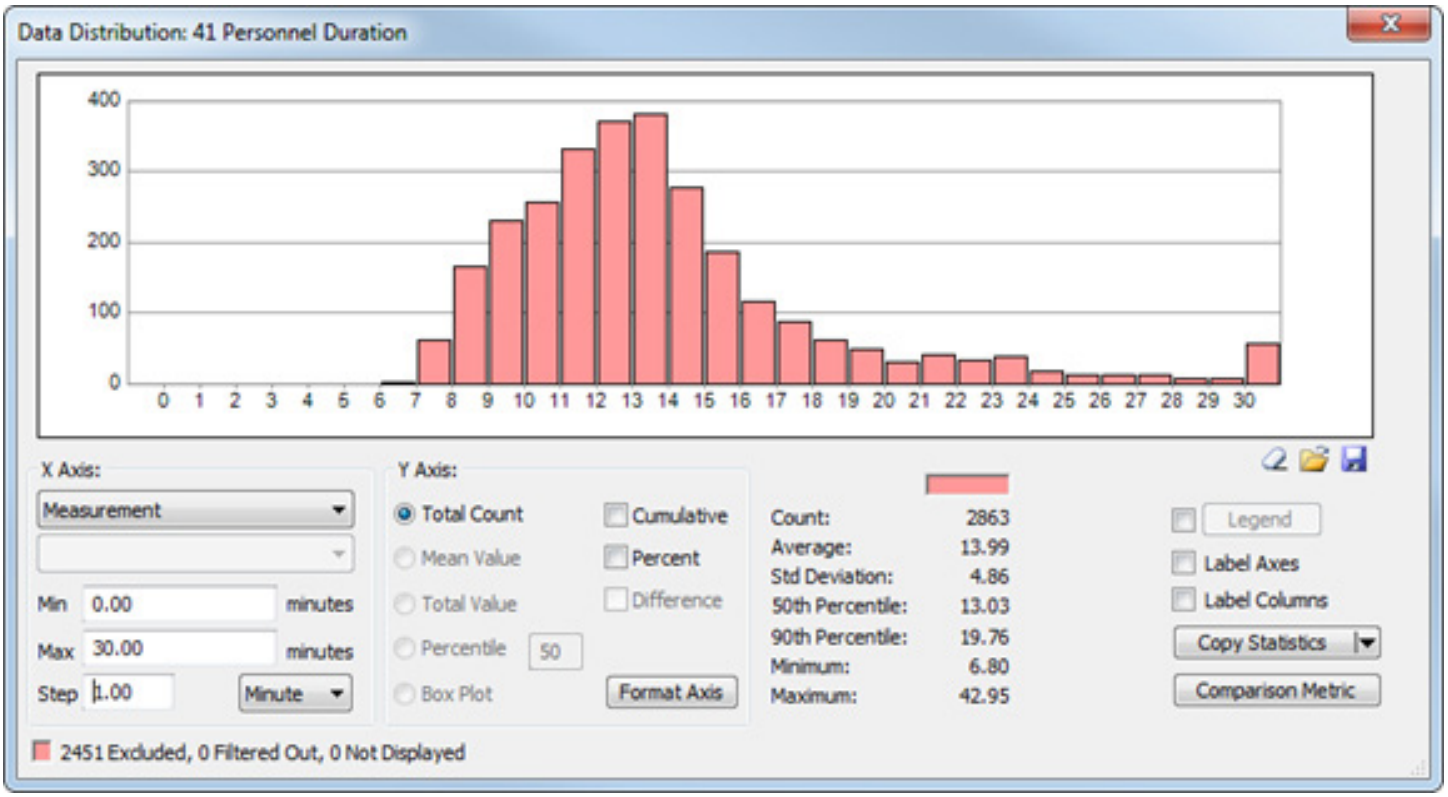
Figure 49 shows that only buildings in the central area are sufficiently covered by 41 personnel within 610 seconds. This coverage assumes that the vehicles are always available at their station (i.e. that they are not already busy on another call).

Figure 49 – High Rise Buildings Coverage – green buildings have full personnel quota arriving within 610 minutes – red buildings are outside the target time



The distribution of travel time from first enroute vehicle to full complement arriving at the scene is shown in **Figure 50**. On average the travel time is 14 minutes, with 10% of high rise buildings only able to get the full complement after approximately 20 minutes (assuming all vehicles are available in their home station).

Figure 50 – Travel Time Duration from Station Location to High Rise Building Based on First Vehicle Enroute Time to Full Complement Arriving at Scene

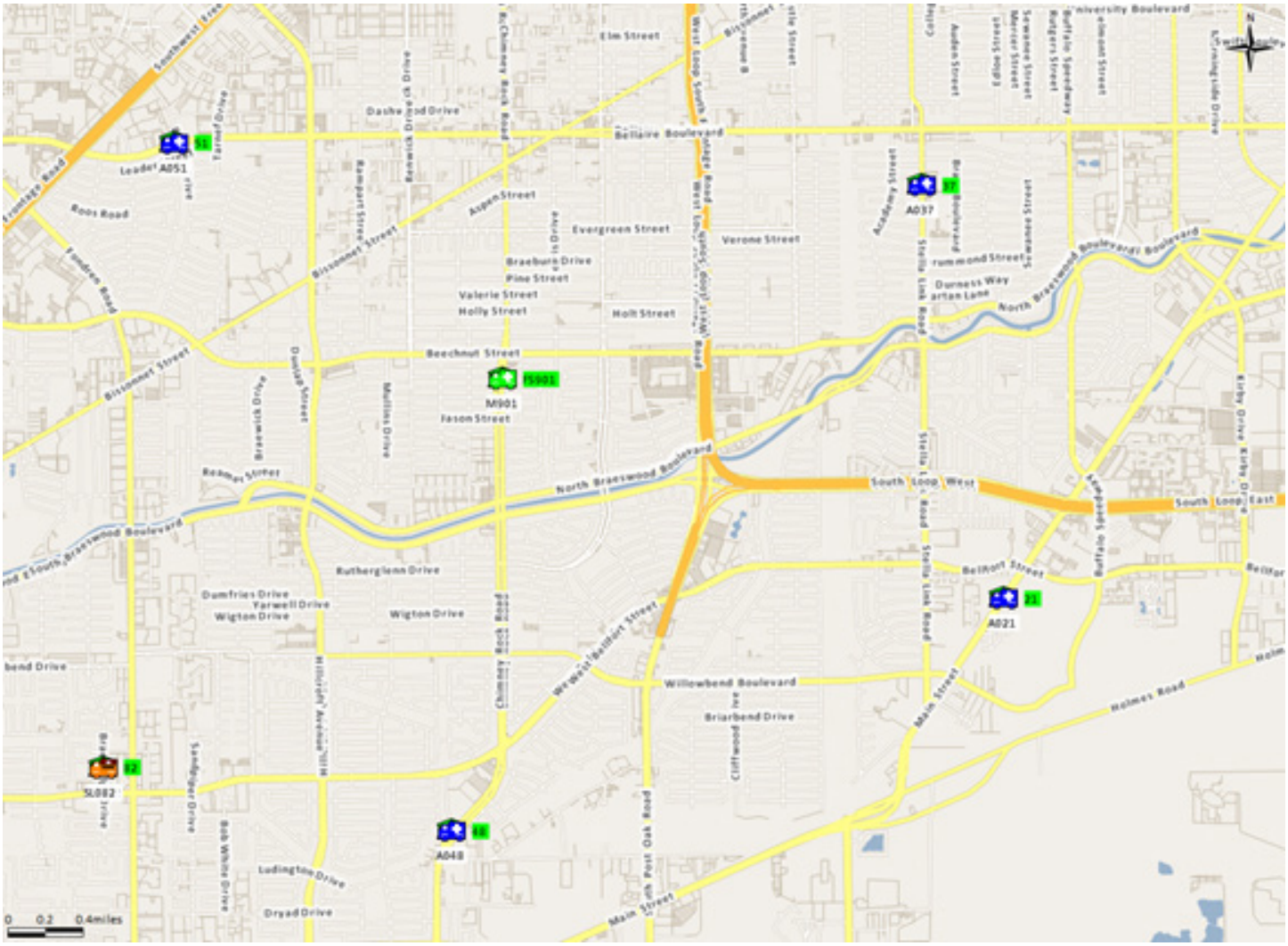


Recommend one or more new station locations and perform associated Station Impact Analysis based upon NFPA 1710 Analysis Task findings

Station 901 (Between Stations 51, 48 and 37)

Station 901 was positioned primarily to address a substantial area of southwest Houston whose infrastructure did not support the 240 travel time standard and in which there was a high number of incidents that fell outside all NFPA standards.

Figure 51 – Location – Fire Station 901 (Planning Purposes)



Apparatus: E901, L901, A901 and M901

Performance Impact:

Total Incidents Run by Station 901 Apparatus:	6097
First-Due Impacted Areas:	51, 28, 37, 48
Total Incidents in Impacted First Due Areas:	20862
Average Response Time decreased from:	5:10 to 4:43
90% Travel Time decreased from:	8:11 to 6:48

Workload Impact:

E51: 19% to 16%

E28: 22% to 23%

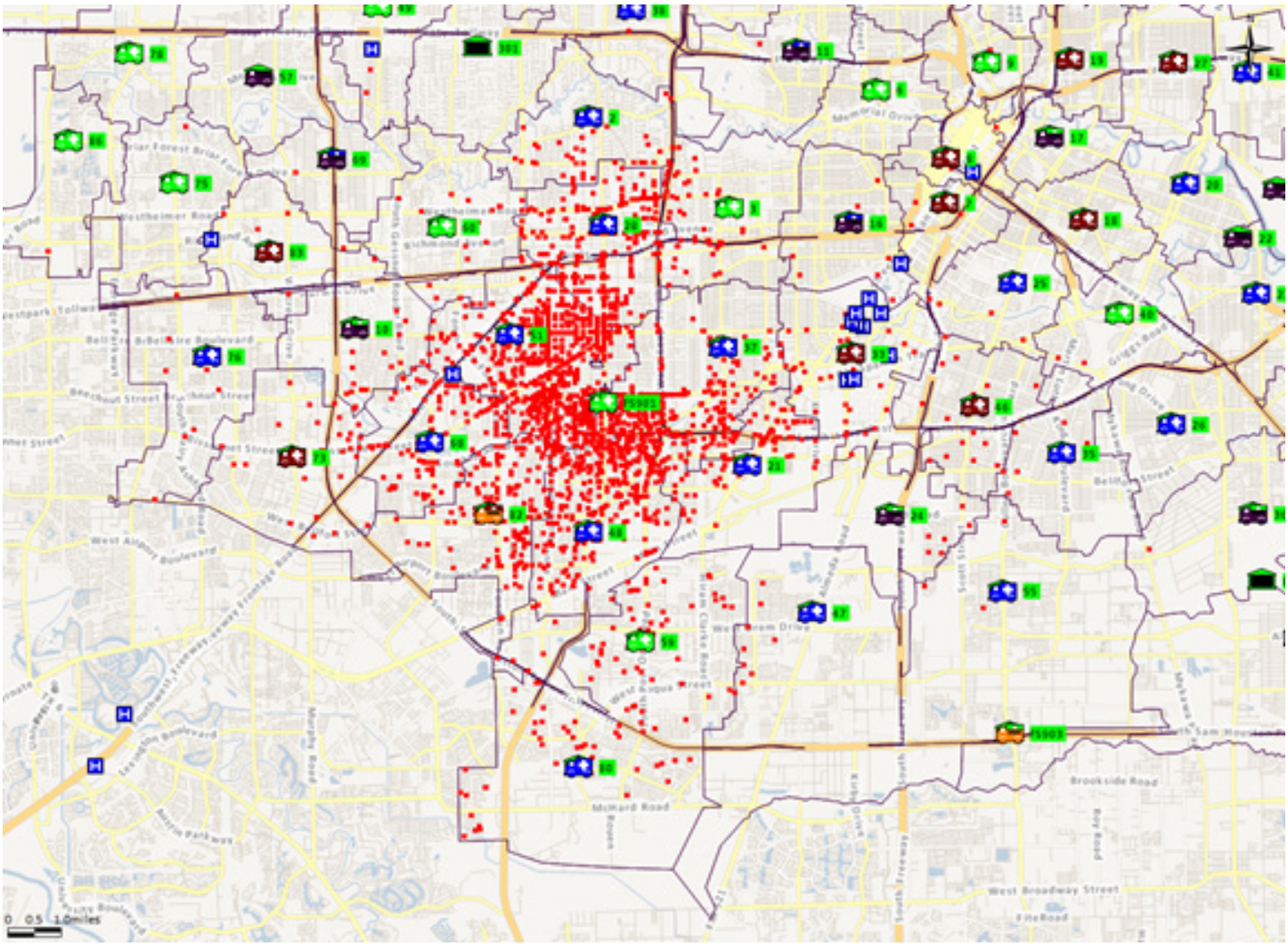
E37: 8% to 3%

E48: 12% to 10%

E901: N/A to 7%

The impact on E37 indicates that additional modeling on specific locations for this station should to be undertaken. The need for a station in the area is clearly demonstrated by the overall performance impact but a placement that better benefits Stations 51 and 28 would be optimal.

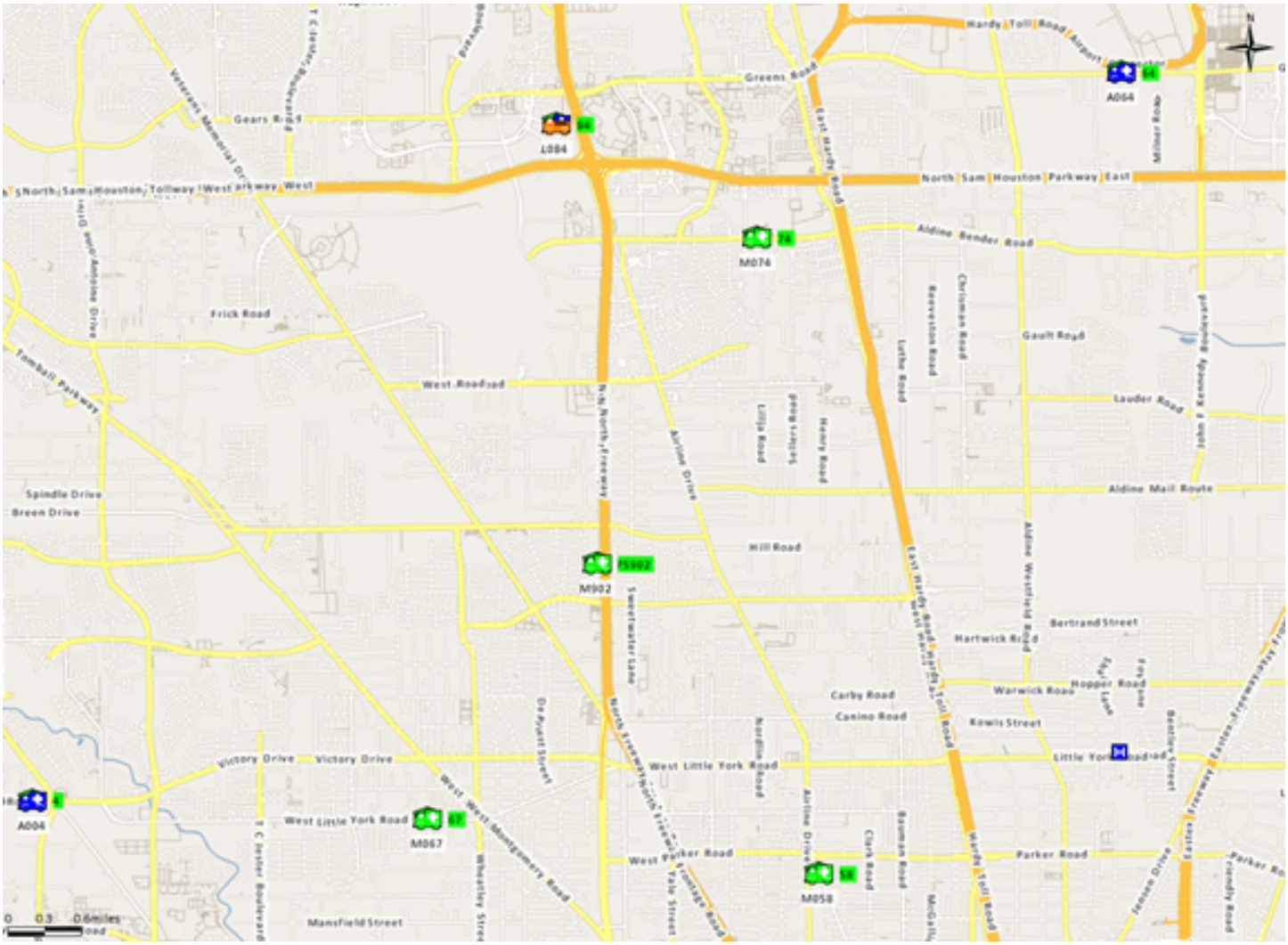
Figure 52 – Station 901 Incidents – All Incidents Responded to by Station 901 Apparatus



Station 902 (North of Stations 67 and 58 and South of Station 74)

Station 902 was positioned to address a confined area of north central Houston whose infrastructure did not support the 240 travel time standard and in which there was a high number of incidents that fell outside all NFPA standards for engine, ladder and ALS responses.

Figure 53 – Location – Fire Station 902 (Planning Purposes)



Apparatus: E902, L902, A902 and M902

Performance Impact:

Total Incidents Run by Station 901 Apparatus:	6370
First-Due Impacted Areas:	74, 67, 58
Total Incidents in Impacted First Due Areas:	18017
Average Response Time decreased from:	5:59 to 5:01
90% Travel Time decreased from:	10:01 to 7:36

Workload Impact:

E74: 12% to 11%

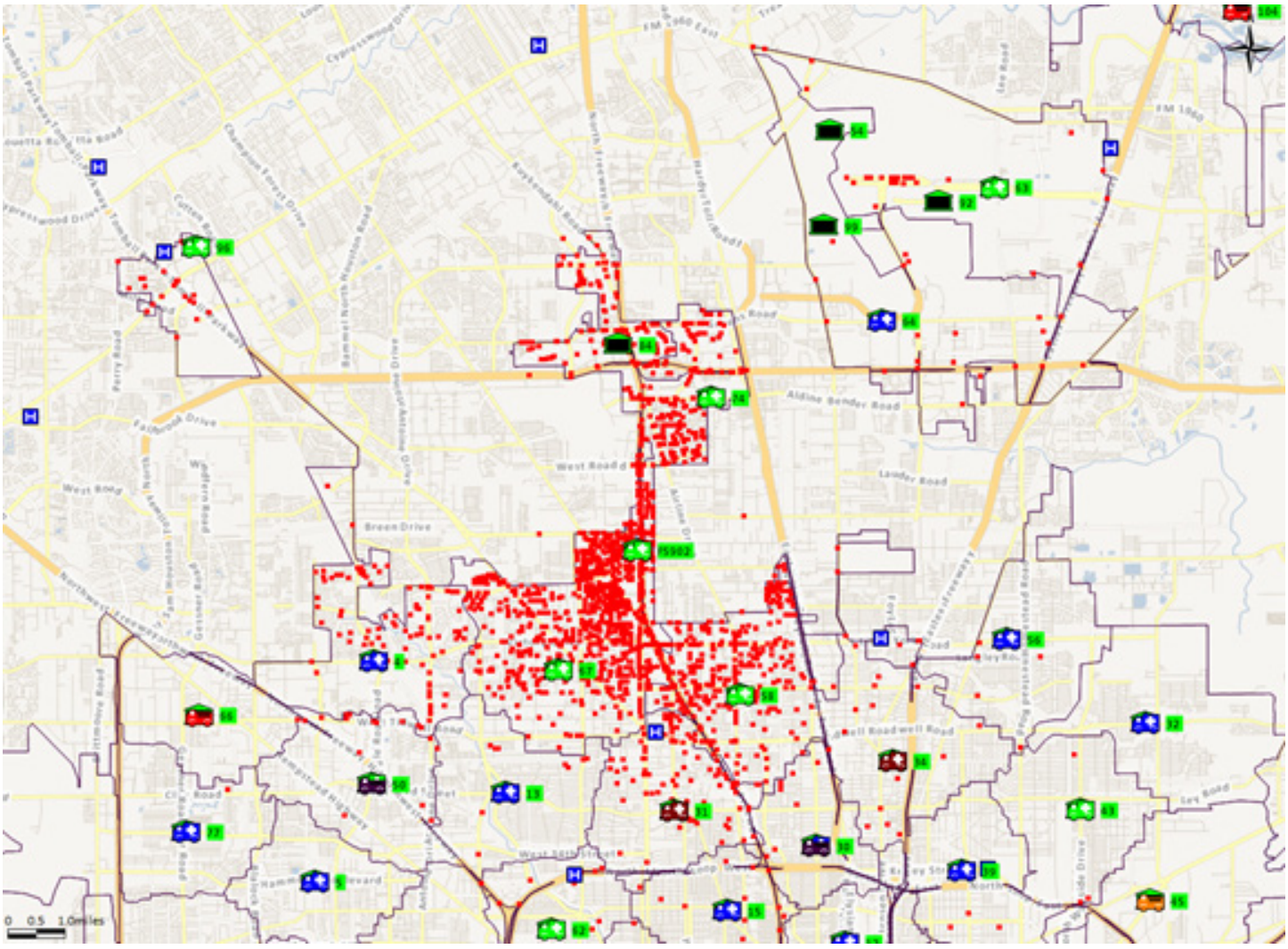
E67: 18% to 11%

E58: 14% to 12%

E902: N/A to 9%

The impact on E67 combined with the positive performance impact indicates that the placement of this station is likely very good. The need for a station in the area is clearly demonstrated by the overall performance impact. The limited area available and odd corporate boundary of the City of Houston may make finding other locations difficult.

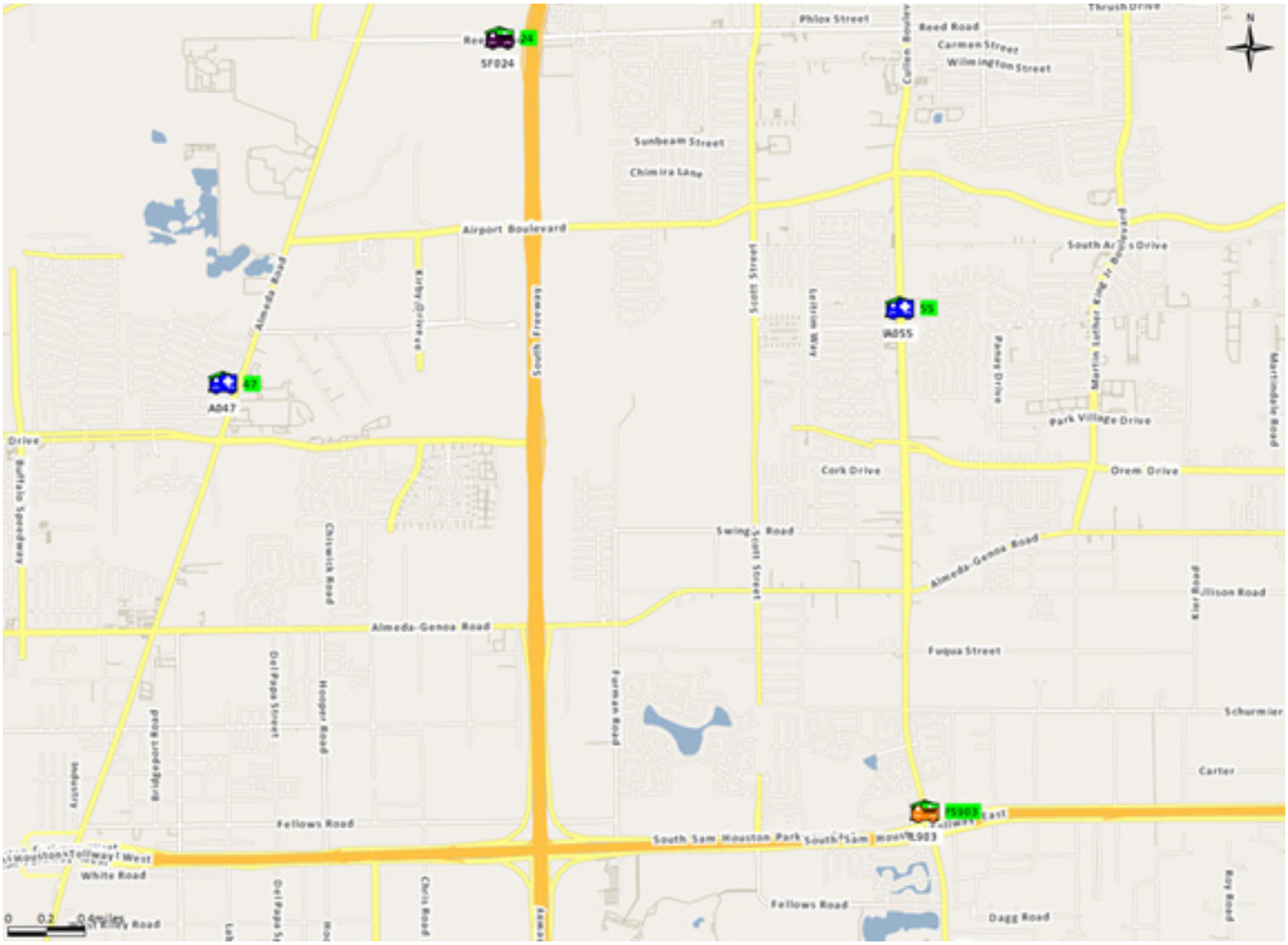
Figure 54 – Station 902 Incidents – All Incidents Responded to by Station 902 Apparatus



Station 903 (South of Stations 47 and 55 Along the South Sam Houston Parkway East)

Station 903 was positioned primarily to address new incident growth along the South Sam Houston Parkway corridor. A substantial number of incidents are located in this area and they are all outside the NFPA standards for structure fire and EMS response.

Figure 55 – Location – Fire Station 903 (Planning Purposes)



Apparatus: E903, L903, A903 and M903

Performance Impact:

Total Incidents Run by Station 903 Apparatus:	4447
First-Due Impacted Areas:	47, 55, 24, 61, 35
Total Incidents in Impacted First Due Areas:	23907
Average Response Time decreased from:	5:29 to 5:00
90% Travel Time decreased from:	8:55 to 7:55

Workload Impact:

E47: 11% to 10%

E55: 20% to 18%

E24: 11% to 9%

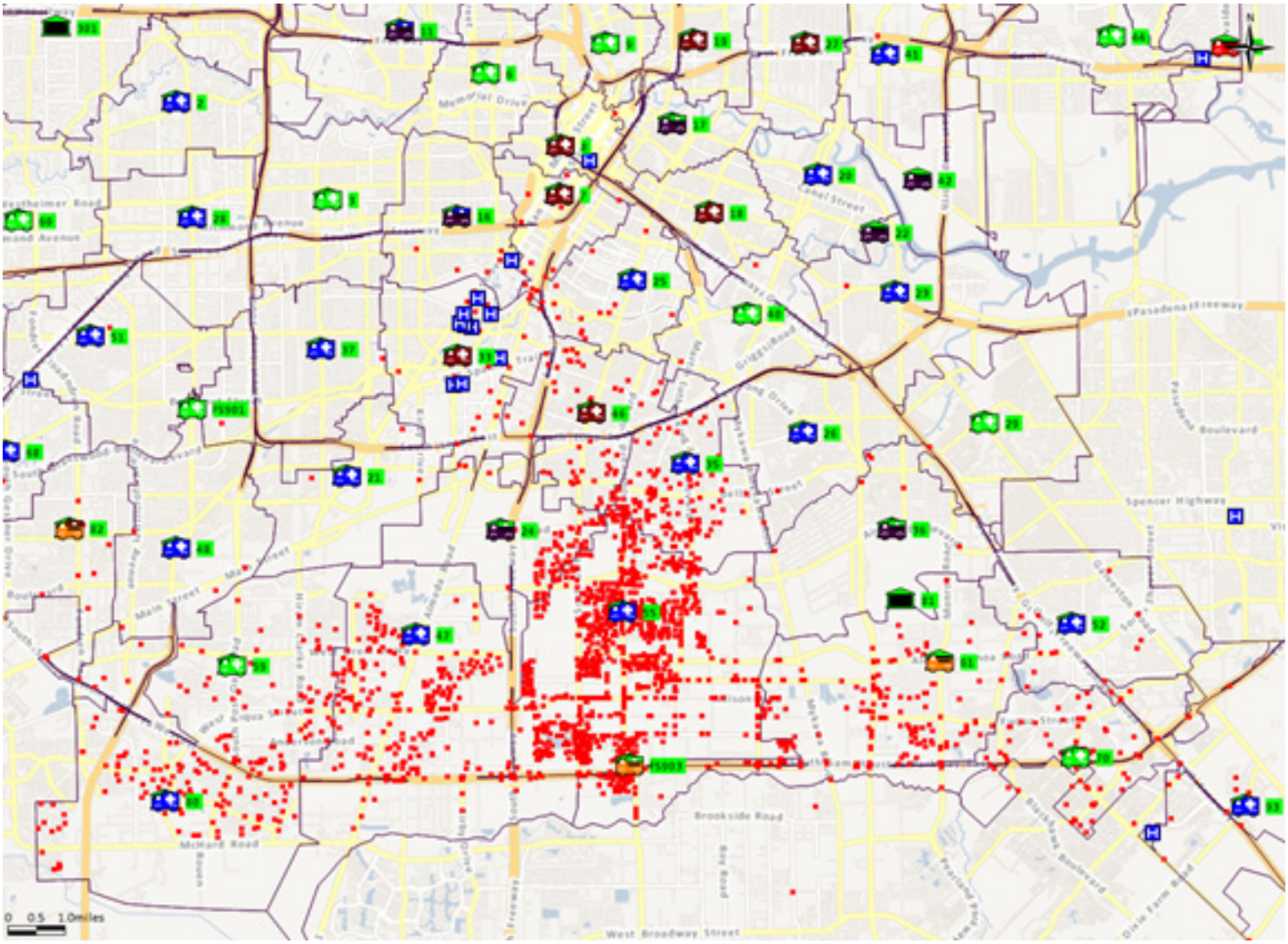
E61: 16% to 14%

E35: 20% to 18%

E903: N/A to 6%

The relatively low workload for E903 combined with the consistent impact across neighboring first due areas indicates some additional investigation of alternate locations would be helpful. The performance impact is substantial, however, and the geographic challenges appear well addressed by the current placement.

Figure 56 – Station 903 Incidents – All Incidents Responded to by Station 903 Apparatus

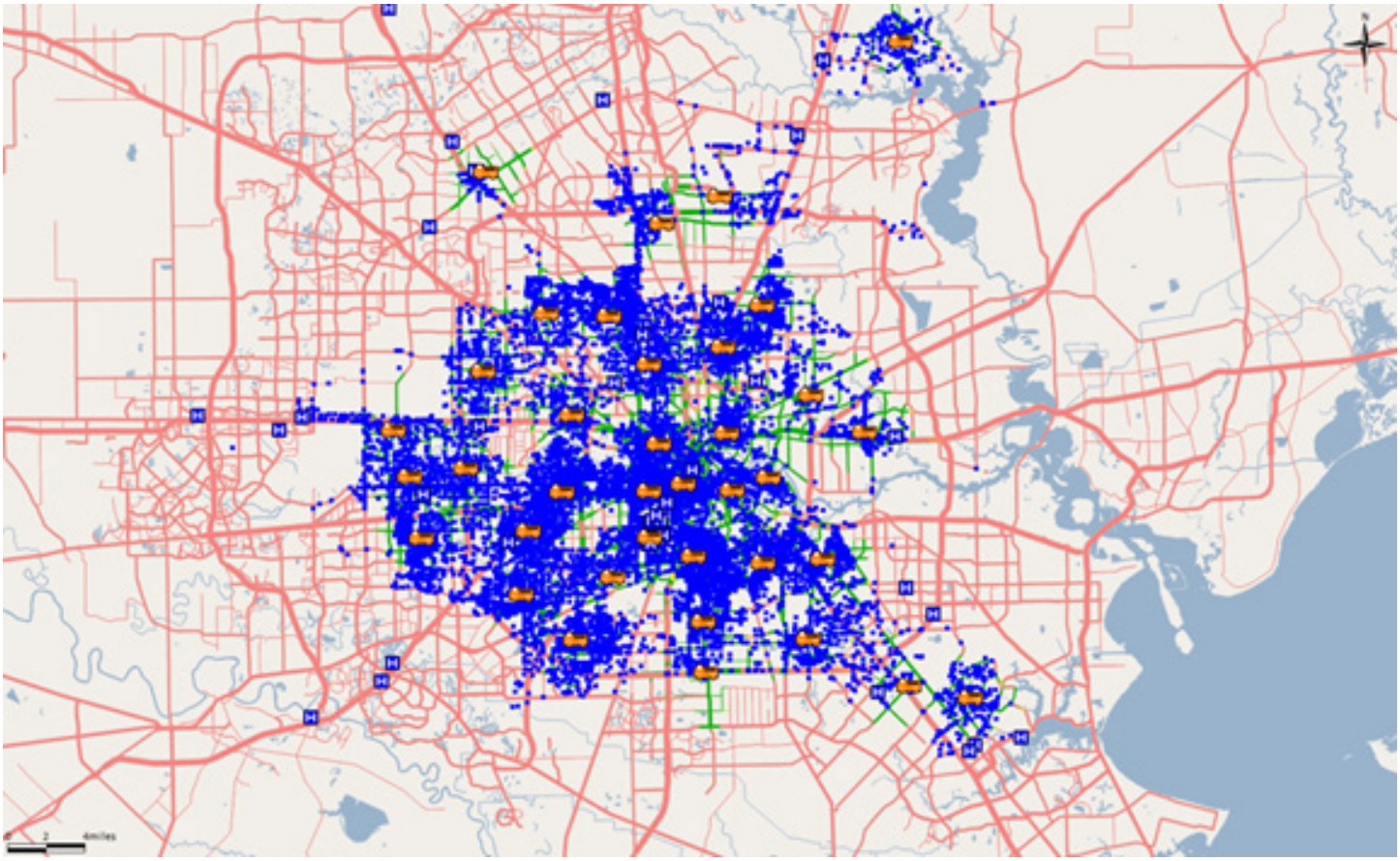


480 Second Drive Time Analysis of HFD Ladder/Tower Apparatus with recommendations for additional placements: Historic, Road Network

This scenario evaluates the current coverage capability (at a travel time of 480 seconds) for existing ladder/tower apparatus within HFD. An evaluation of drive time and historic incident performance was performed with the goal of identifying potential locations for new apparatus should coverage challenges be identified.

The drive time evaluation for ladder/tower apparatus demonstrates an overall effective deployment (**Figure 57**). This is further reinforced when examining historic performance from 2015. The 90% response time for ladder/tower companies was 9:05, very close to the goal of 8:00 (480 seconds) of travel time.

Figure 57 – Travel Time Analysis for Ladder/Tower Apparatus – green indicates effective coverage, pink indicates areas outside of the standard – blue icons represent ladder/tower incidents



The historic incidents analysis indicates several specific areas with high concentrations of travel times in excess of 480 seconds (**Figure 58**). This includes Stations 35, 73, 3 and Proposed Stations 901, 902 and 903 (see previous scenario)

The addition of these ladder companies decreases the 90% time to 8:14and shows much improved drive time coverage throughout the HFD service area (**Figure 59**). This indicates that investment in this apparatus would yield a substantial enhancement to overall performance (almost a minute at the 90th %) as well as offering additional capacity for other specialized response assignments.

Figure 58 – Areas with High Concentrations of Ladder/Tower Responses in Excess of 480 Seconds Travel Time (historic deployment in blue) and with new resources (in red)

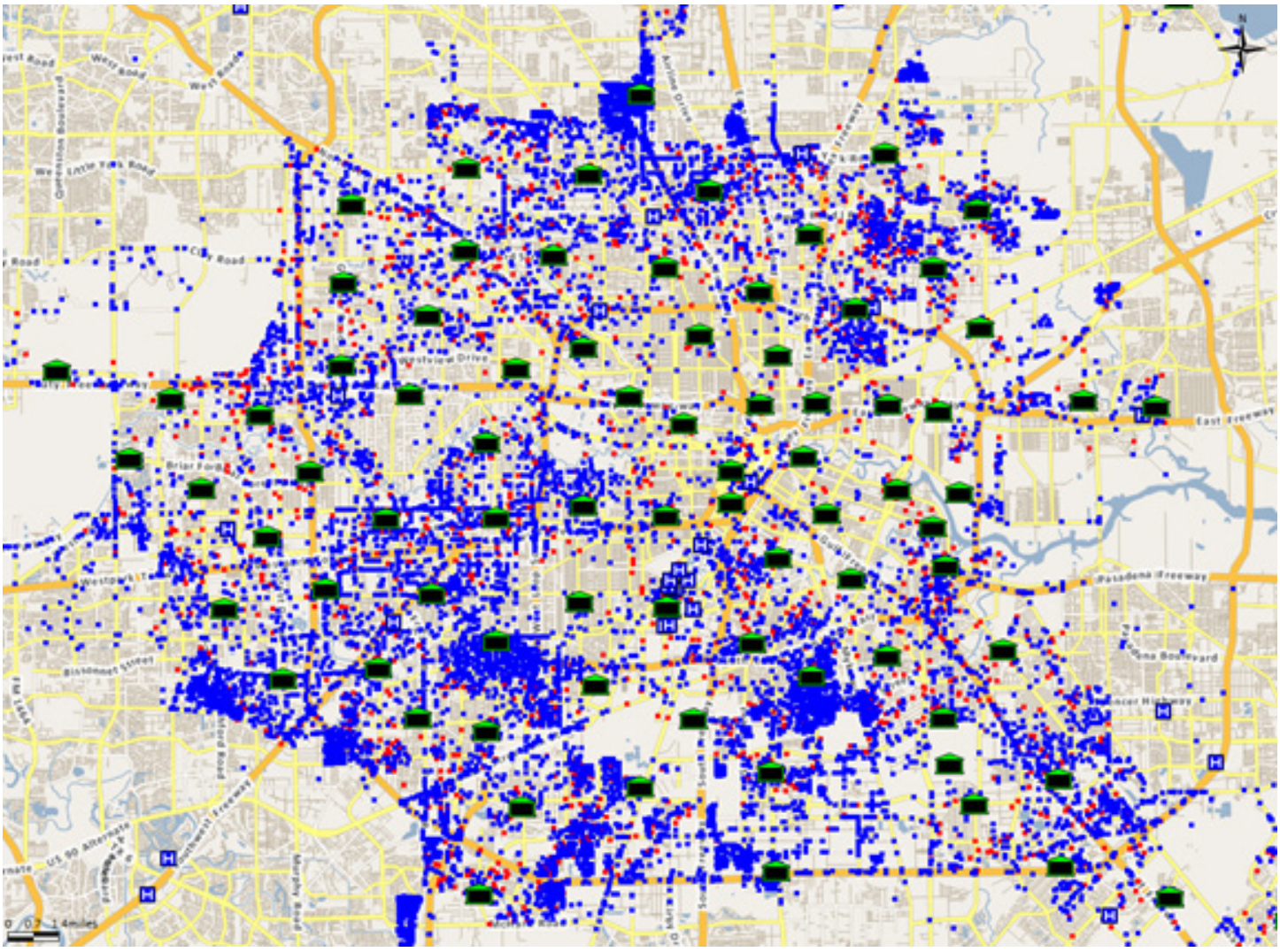
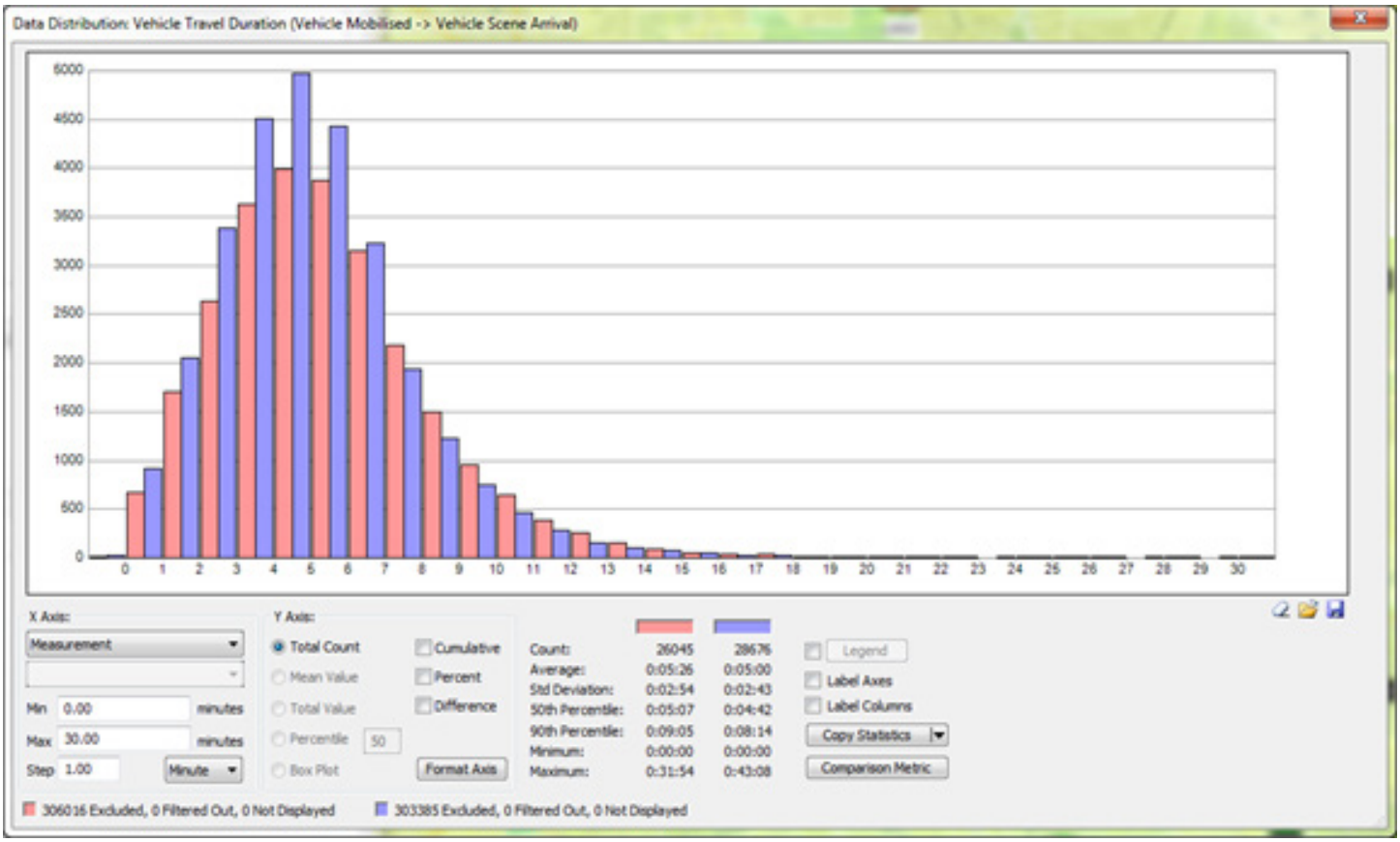


Figure 59 – Ladder/Tower Apparatus Performance for 480 Second Standard Historic performance (red) and modeled performance with new apparatus and stations (blue)



Evaluate and recommend, as necessary, the addition of heavy rescue capability and Hazmat capability based upon geographic coverage and/or historic incident distribution in cooperation with other aspects of the HFD analysis

Addition of Second Hazmat Unit on the West Side of Houston

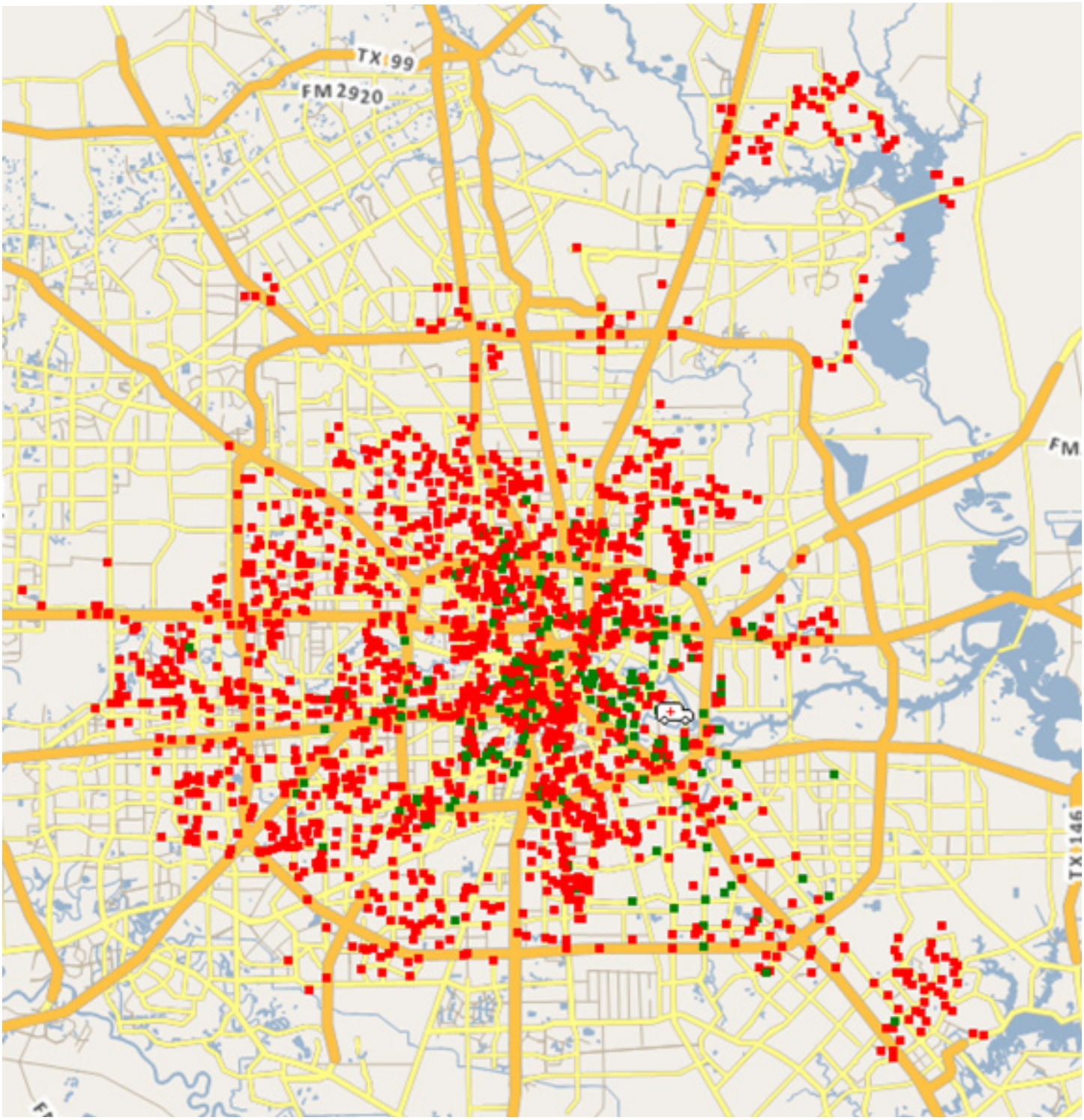
This scenario looks at the effect of adding an additional hazmat team to the West Side of Houston (Station 75 was used for illustrative purposes) to extend the coverage available from the existing hazmat team located at Station 22. This specific scenario was discussed during the presentation of initial findings in May 2016. The additional hazmat team would supplement and be in addition to the existing hazmat staffing. Houston has a relatively low number of trained on-duty hazmat responders, especially given the size of the city and the nature of the hazards found in Houston. In addition, the summer weather in Houston will only permit hazmat responders to work for short periods. Additional on-duty hazmat staffing is needed.

Historical Incident Coverage

Historically all hazmat cover has been from Station 22. **Figure 60** shows the incidents that have historically been reached by a hazmat team within 20 minutes (shown in green). As expected these incidents are clustered around Station 22, however, there are still a number of hazmat

incidents in the area surrounding Station 22 have not met the target of having a hazmat team on scene within 20 minutes. This suggests that despite the relatively low frequency of hazmat incidents, HFD does require enhanced hazmat capacity as well as enhanced geographic coverage.

Figure 60 – Hazmat Coverage – green Incidents have been reached by a hazmat team within 20 minutes



Incident Coverage from Station 22 and Station 75

Adding an additional hazmat team to Station 75 (Station 75 used for illustrative purposes) provides additional coverage and capacity. Using Optima Predict to generate responses based on a hazmat team always being available at Station 75 and Station 22 (**Figure 61**) shows two large coverage areas (shown in green) which can be reached within a 20 minute travel time However, there is still a large area between the two (2) stations that is not covered (shown in red).

Figure 61 – Historical Incident Coverage from Station Locations – green incidents are within 20 minutes of a station with a hazmat team

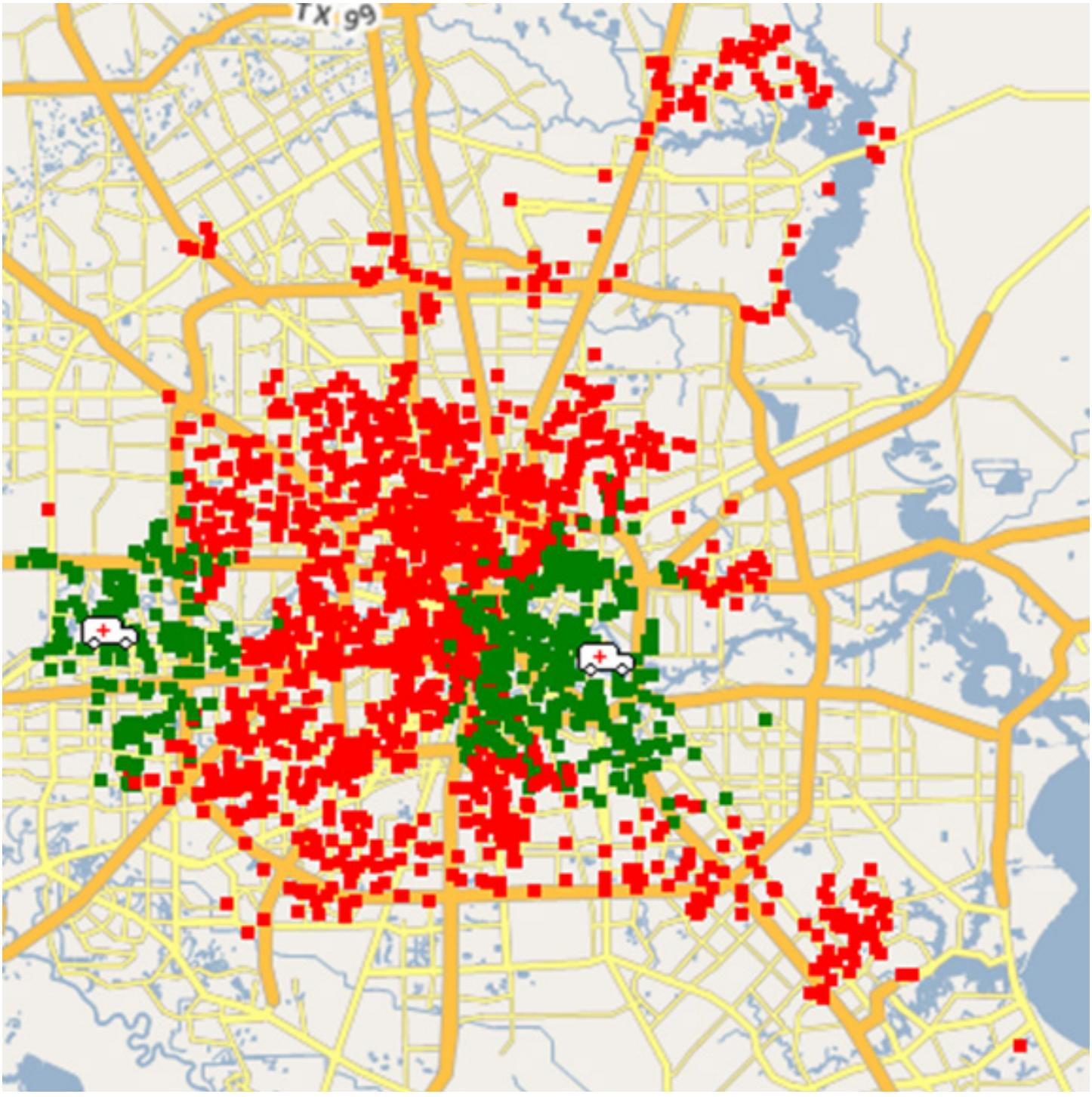
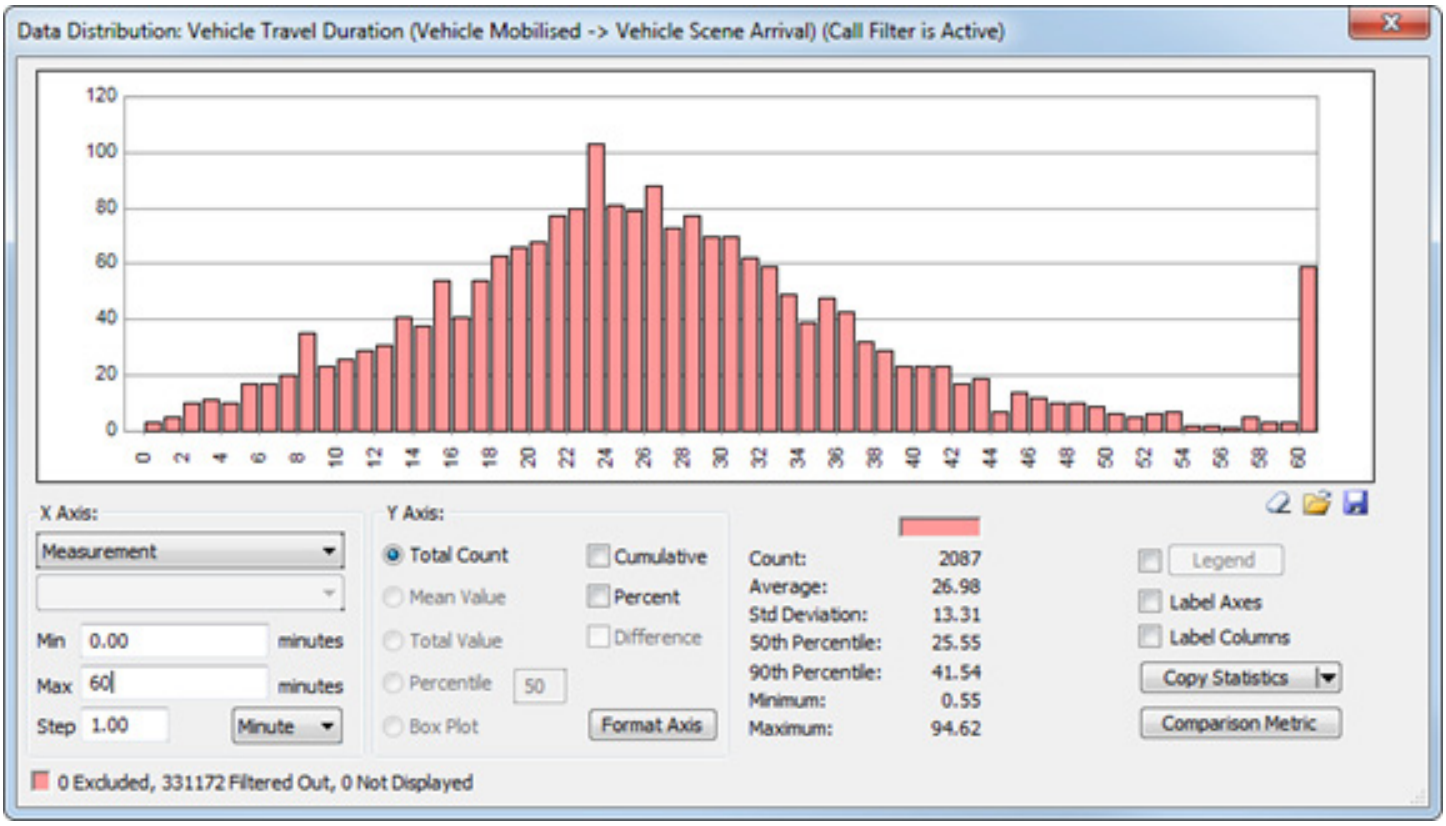


Figure 62 shows the distribution of travel times for hazmat teams to each of the hazmat incidents (assuming that the hazmat team is always available at their home Station). On average it takes over 20 minutes to reach each of the incidents, the 10% of incidents furthest from the hazmat stations take over 40 minutes to reach.

Figure 62 – Distribution of Travel Duration for Hazmat Teams to Hazmat Incidents



Technical Rescue Capability

Technical Rescue capability is currently positioned at Stations 10, 11 and 42. These locations are able to effectively reach the majority of historic technical rescue incidents within a 20 minute travel time goal. As **Figure 63** illustrates, however, there are a substantial number of incidents that fall outside of this coverage area.

In order to achieve a robust level of 20 minute coverage, 3 additional Technical Rescue units were positioned for illustrative purposes in Stations 63, 94 and 903 (Proposed Station). Other station options may be equally functional and may provide for better physical facility capability to accommodate the specialized apparatus and equipment associated with this specialty. The coverage, with these additions, was much improved. The extensive geography of the City of Houston presents a substantial challenge when attempting to determine the optima deployment locations for specialized response assets whose cost, capability and competency must be balanced against the need for a combination of geographic and incident driven coverage.

Figure 63 – Current Technical Rescue 20 Minute Travel Time Coverage (TR/HR 2015 Incidents displayed in blue)

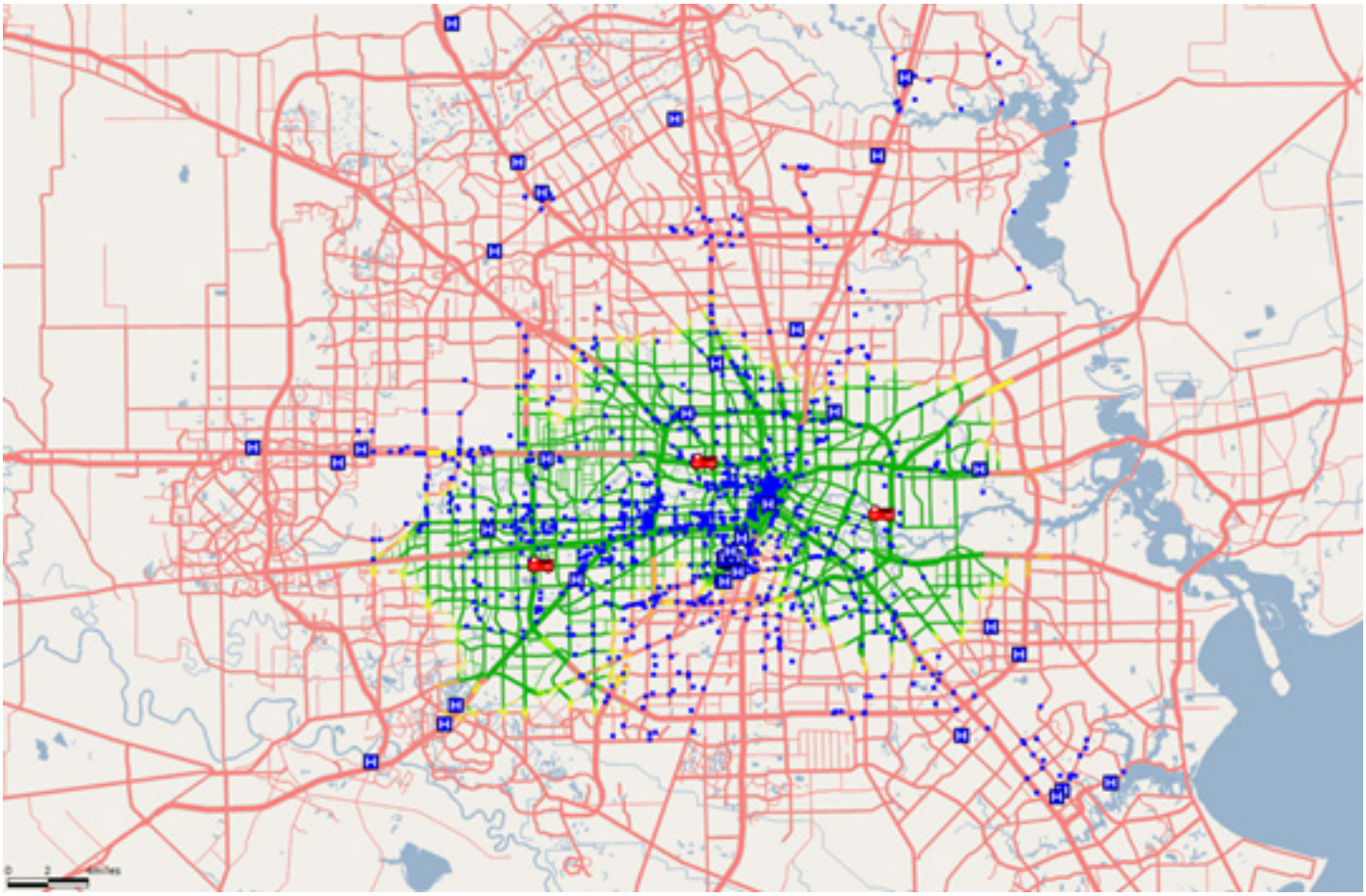
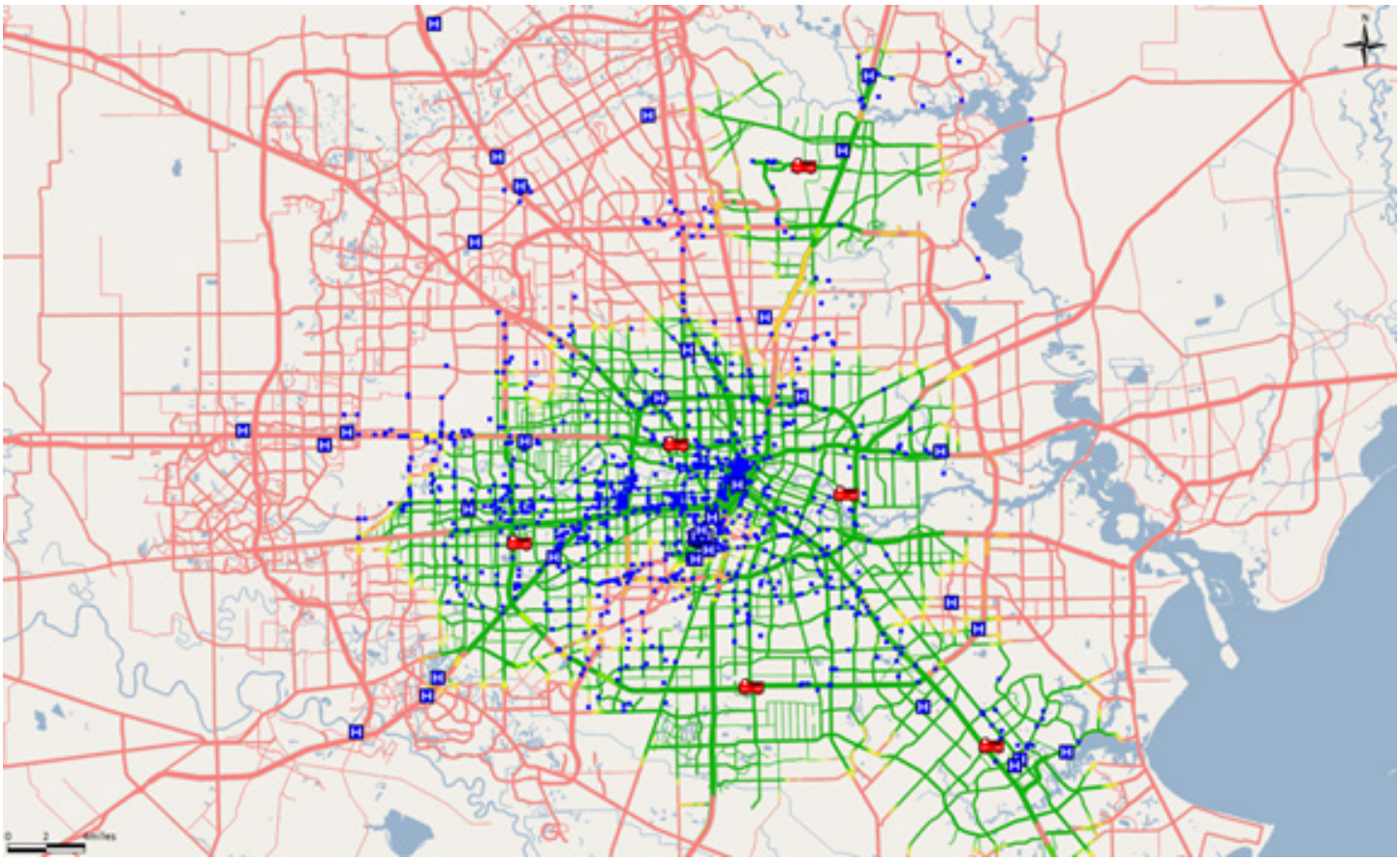


Figure 64 – Proposed Technical Rescue 20 Minute Travel Time Coverage (TR/HR 2015 Incidents displayed in blue) – New Technical Rescue Units at Stations 63, 94 and 903 (Proposed Station)



Performance Comparison: Closest Unit Dispatch (AVL Based) vs Run Card/Box Based Dispatch

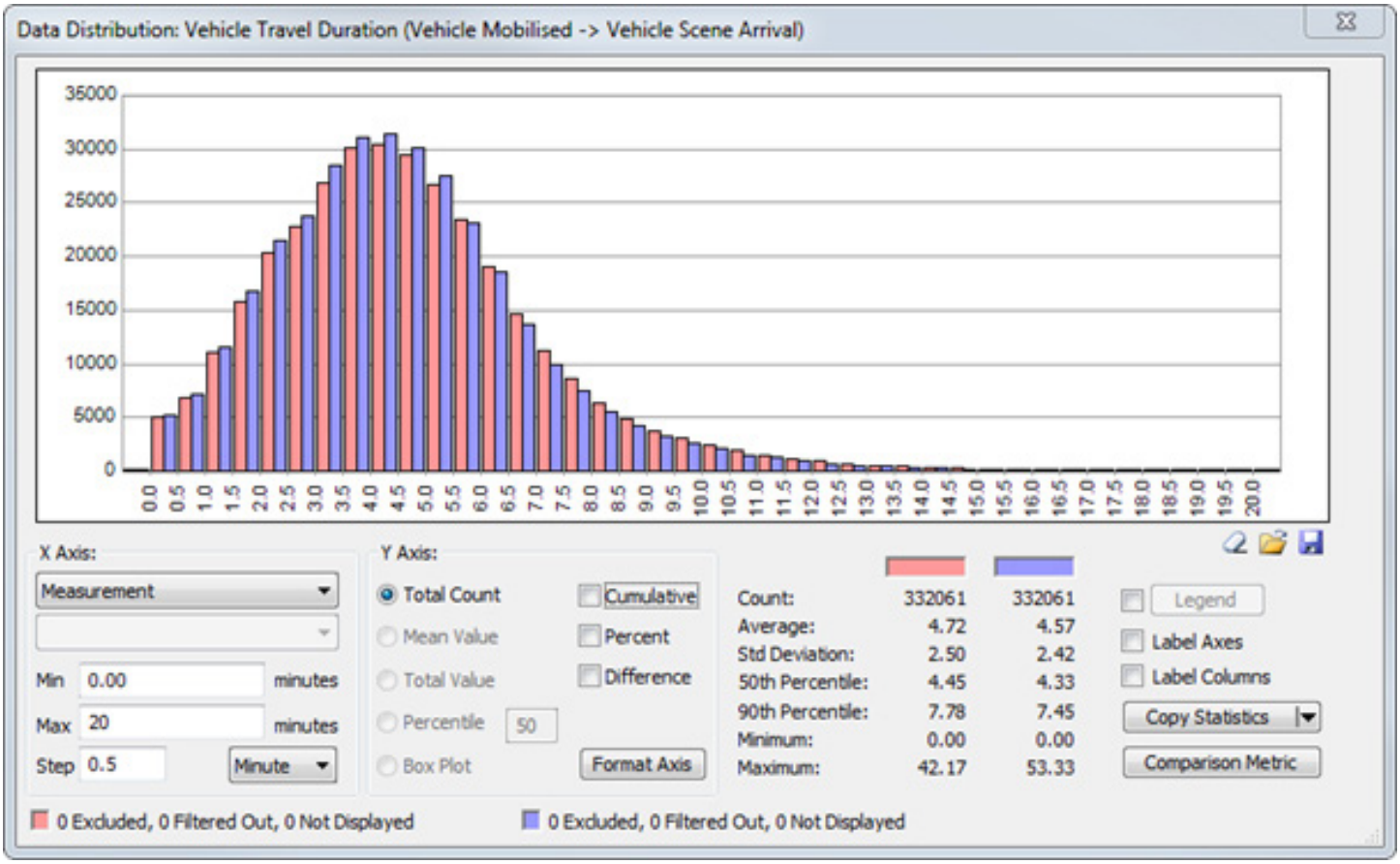
This scenario looks at changing the way which vehicle is chosen for dispatch. Optima Predict has been used to simulate the current First Due area dispatch process as well as dispatching based on the closest vehicle.

The charts in this section compare to simulation output files:

- The baseline simulation – the output from the original dispatch process of First Due Area.
- The Closest Vehicle simulation – the results from dispatching the closest vehicle to the scene.

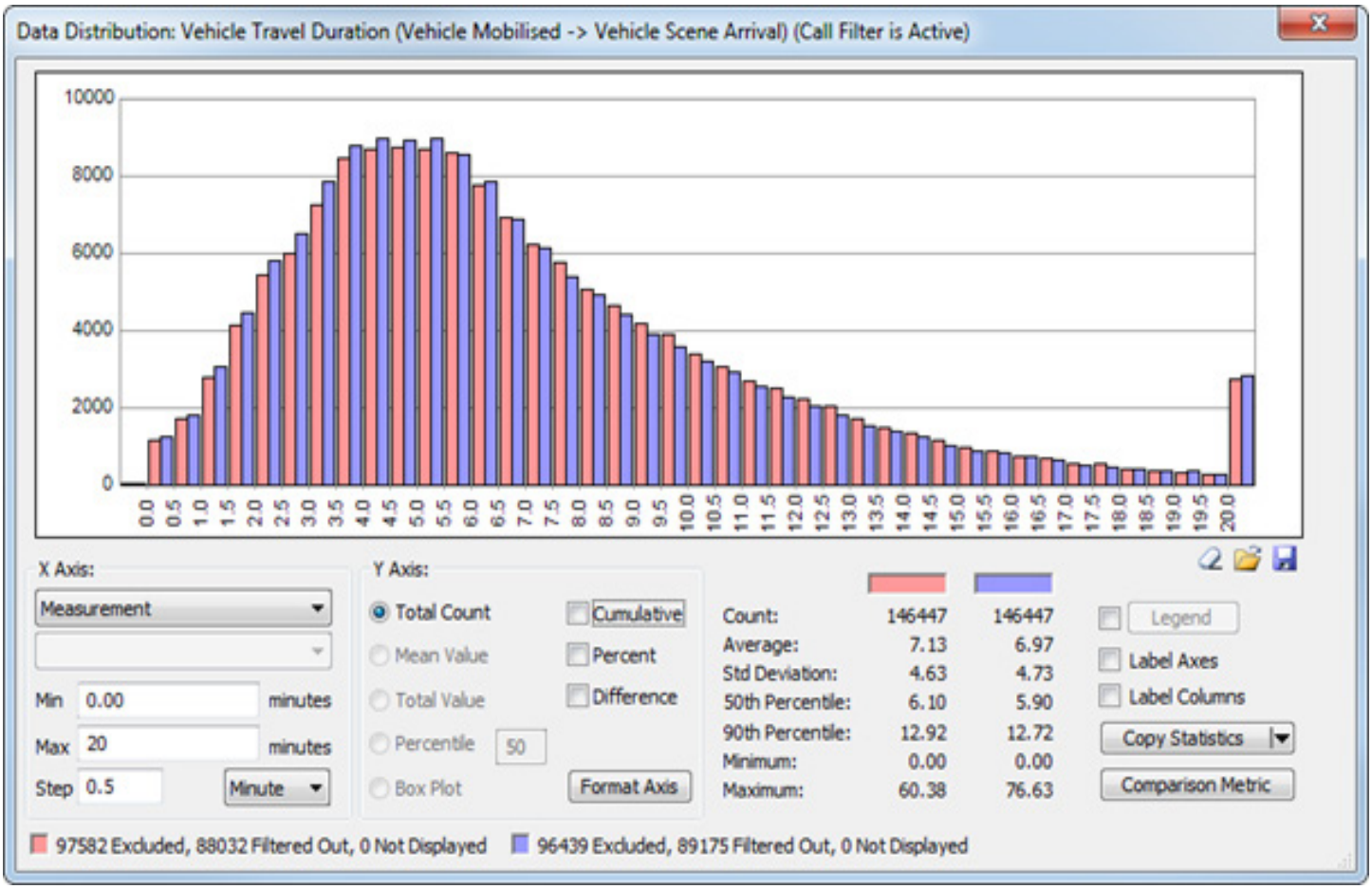
The overall travel time for the first arriving vehicle to an incident has reduced slightly with this change, however given the small change it is not definitive in suggesting that the closest vehicle option will give noticeably better results (**Figure 65**).

Figure 65 – Travel to Scene Time for First Arriving Vehicle – Baseline Simulation (pink) vs Closest Vehicle Scenario (blue)



Similarly, there has been a small reduction in the time taken for a transport vehicle to travel to a transport call (**Figure 66**). As with the travel time for the first arriving vehicle, the change is small and may not provide significant changes if implemented.

Figure 66 – Travel to Scene Time for Transport Vehicle – Baseline Simulation (pink) vs Scenario Squad to Medic (blue)



Performance Impact: Conversation to HFD All ALS System

This scenario looks at treating all EMS vehicles as ALS capable. The following changes were made to the model:

- All ambulance and squad vehicles were converted to medic units
- If two ALS vehicles are required a medic and an engine or ladder is sent
- Medic vehicles were used for calls that previously required an ambulance
- All vehicles were diverted from non-ALS calls to ALS calls if still travelling to the scene when an ALS incident occurred.

The Optima Predict simulation was used to compare the original travel durations for ALS vehicles to ALS incidents with the new scenario where all ambulances and squads are converted to medic vehicles. **Figure 67** shows that the updated scenario (blue) has quicker travel durations than the original vehicle locations (pink). Not only do the ALS vehicles arrive faster, there are also over 16,000 more ALS incidents that receive an ALS response.

Although the ALS travel to scene time has improved, the 90th percentile is still above the targeted 8 minutes.

Figure 67 – Travel to Scene Duration for ALS Vehicles to ALS incidents Original Simulation – mix of ambulance, squad and medic vehicle (pink), ALS scenario with squads and ambulances converted to medic (blue)

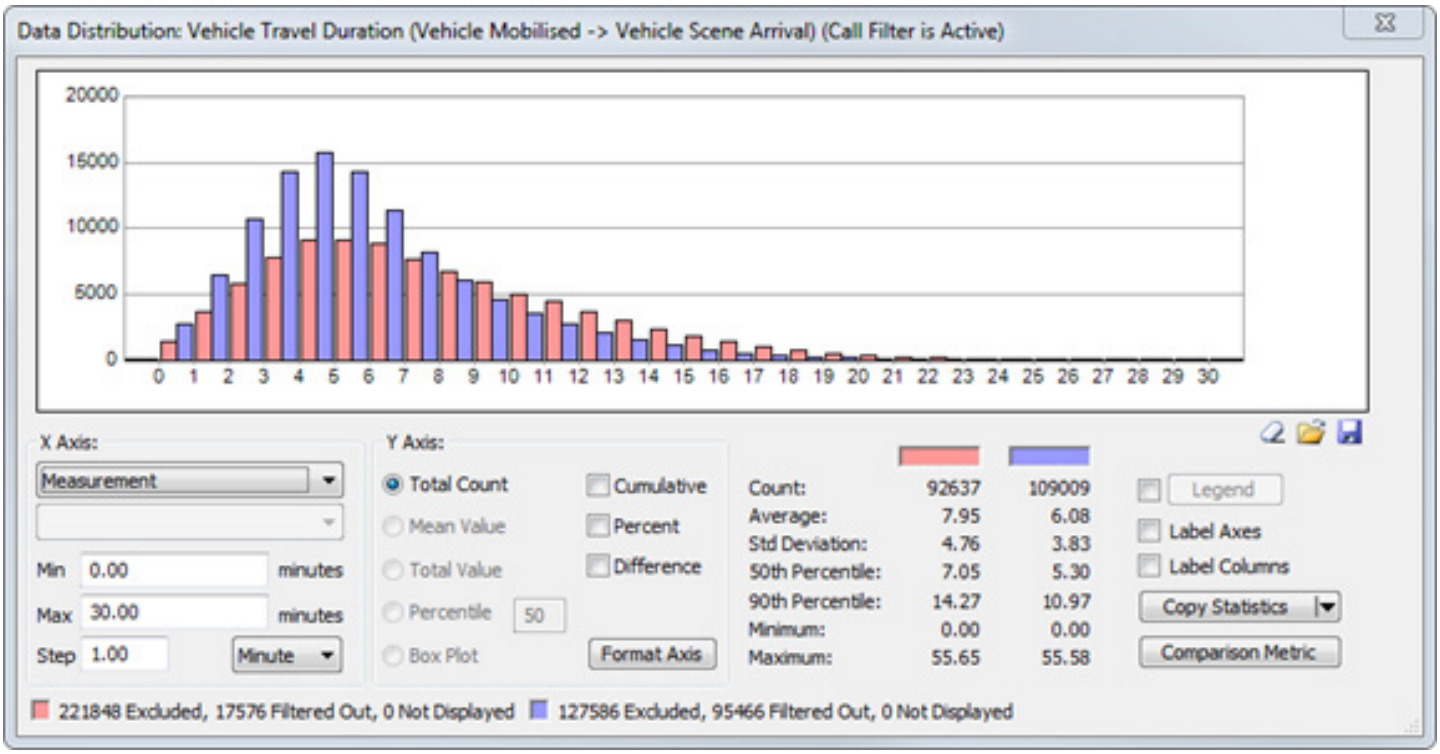
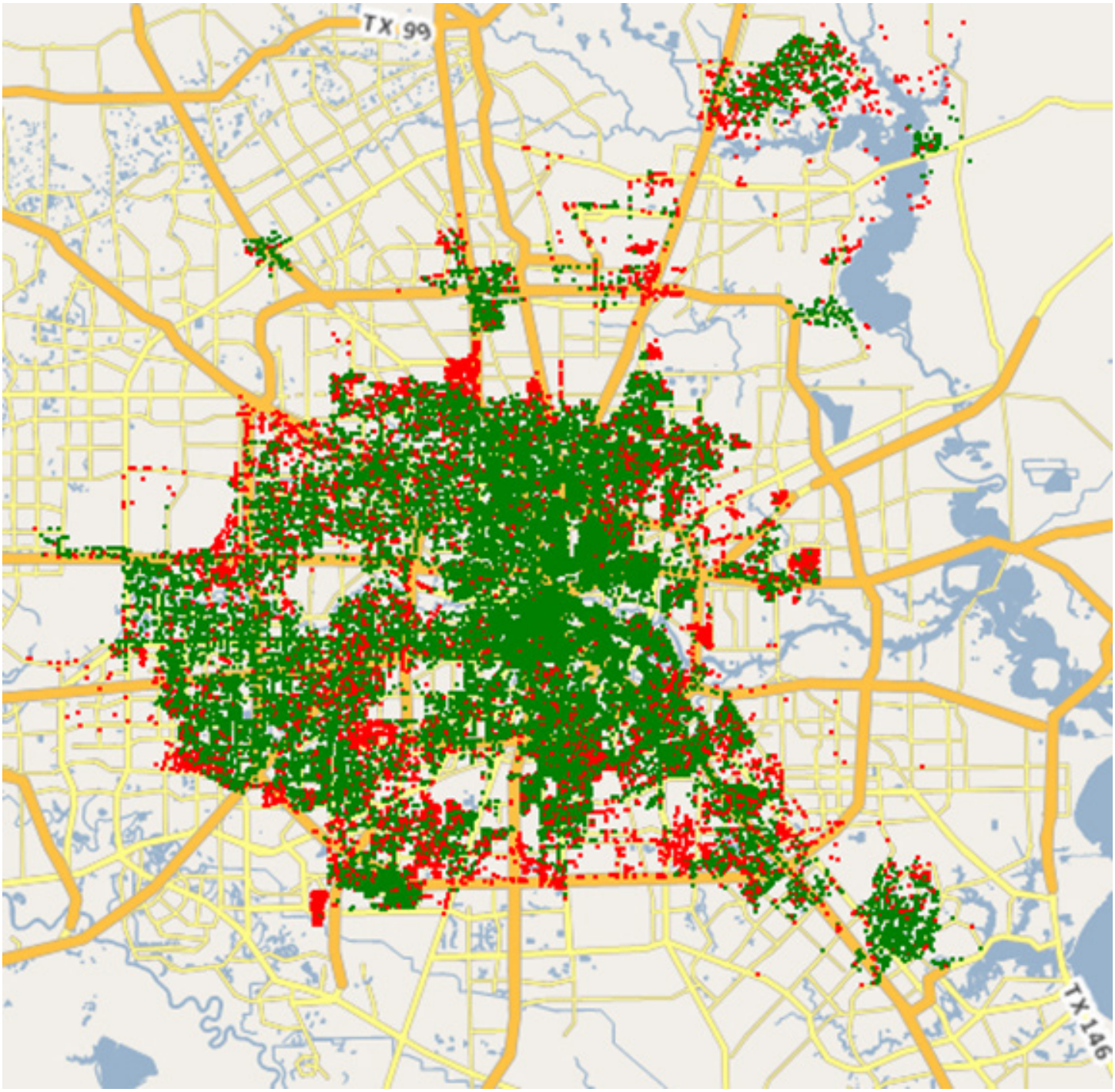


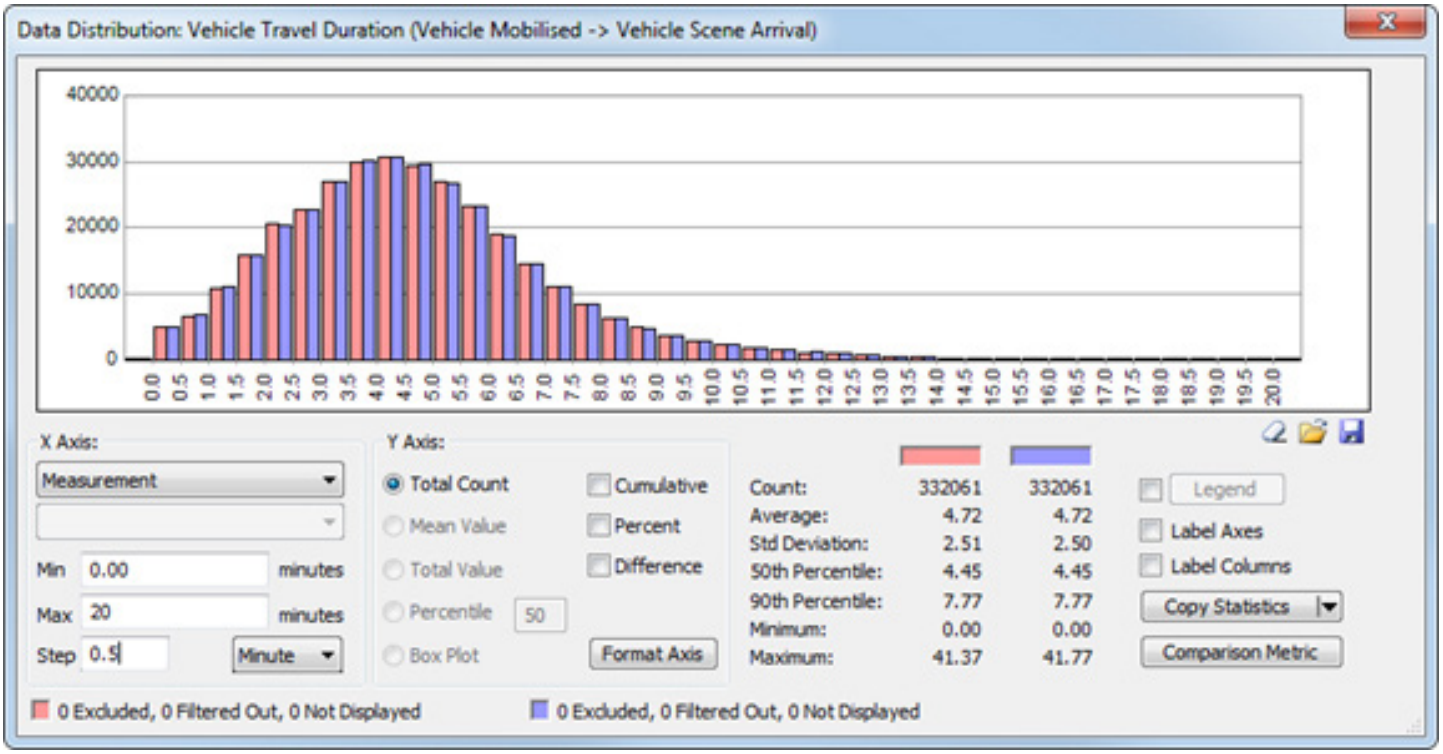
Figure 68 shows the ALS incidents that now have a travel time within 480 seconds from an ALS vehicle (incidents shown in green). The coverage from ALS vehicles is now quite high and covers most of the geography.

Figure 68 – ALS Incident Coverage by ALS Vehicle – Ambulance/Squad Converted to Medic



Overall, when looking at all incidents (rather than only ALS incidents responded to by ALS vehicles), there is no impact on all travel times by changing the ambulance and squad vehicle to medic vehicles. **Figure 69** shows that the two (2) simulations achieve very similar results.

Figure 69 – Overall Travel Durations Comparing Original Simulation Results (pink) to ALS Scenario Simulation Results (blue)



Safety Officers

This scenario used Resource Location Optimizer (RLO) to select the best location for 5 safety officer units. Each shift was 24 hours and could be located at any existing station location.

In order to establish a baseline for response planning, the NFPA 1710 travel time standard for High Rise response was used to model travel time since this standard specifically requires the assignment of a minimum of 'one trained safety officer' as part of the initial assignment. The target used for assessing the best locations was a travel time of 610 seconds.

The 5 locations selected using RLO are:

- Station 7, 1402 Elgin Street
- Station 68, 8602 Bissonnet Street
- Station 46, 3902 Corder Street
- Station 30, 6702 Irvington Blvd
- Station 28, 3000 Chimney Rock Road

Other station locations were evaluated as well and these locations provided performance to nearly the same level as the five stations above. These station locations were chosen for illustrative purposes. These specific stations may or may not be capable of accommodating these units. It is recommended that further modelling be undertaken to evaluate station locations that would meet other key logistical or operational factors that should be accounted for regarding this role.

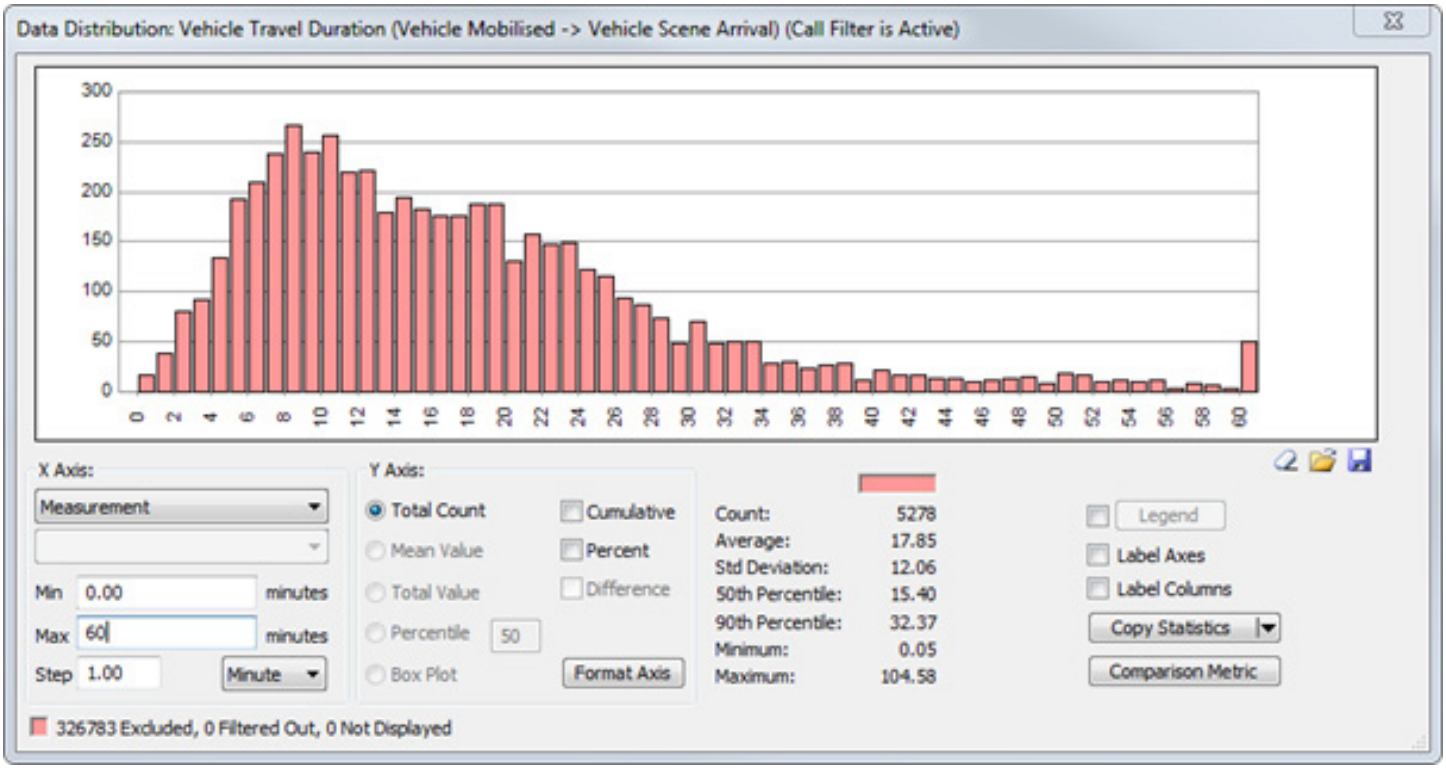
The model for this scenario was based on sending the closest Safety Officer to the incident. If a Safety Officer wasn't immediately available, no Safety Officer was sent.

The overall utilization of the Safety Officers is approximately 12% for incident response related duties. Other assignments and tasks as well as administrative work will increase this workload. This does indicate, however, that a Safety Officer will generally be available for incident response duties across the 24 hour duty cycle.

There are 5,321 incidents that were modelled to be responded to by a Safety Officer, with 5,278 having a Safety Officer arrive at the scene (if an incident was cancelled prior to SO arrival, the SO was cancelled as well).

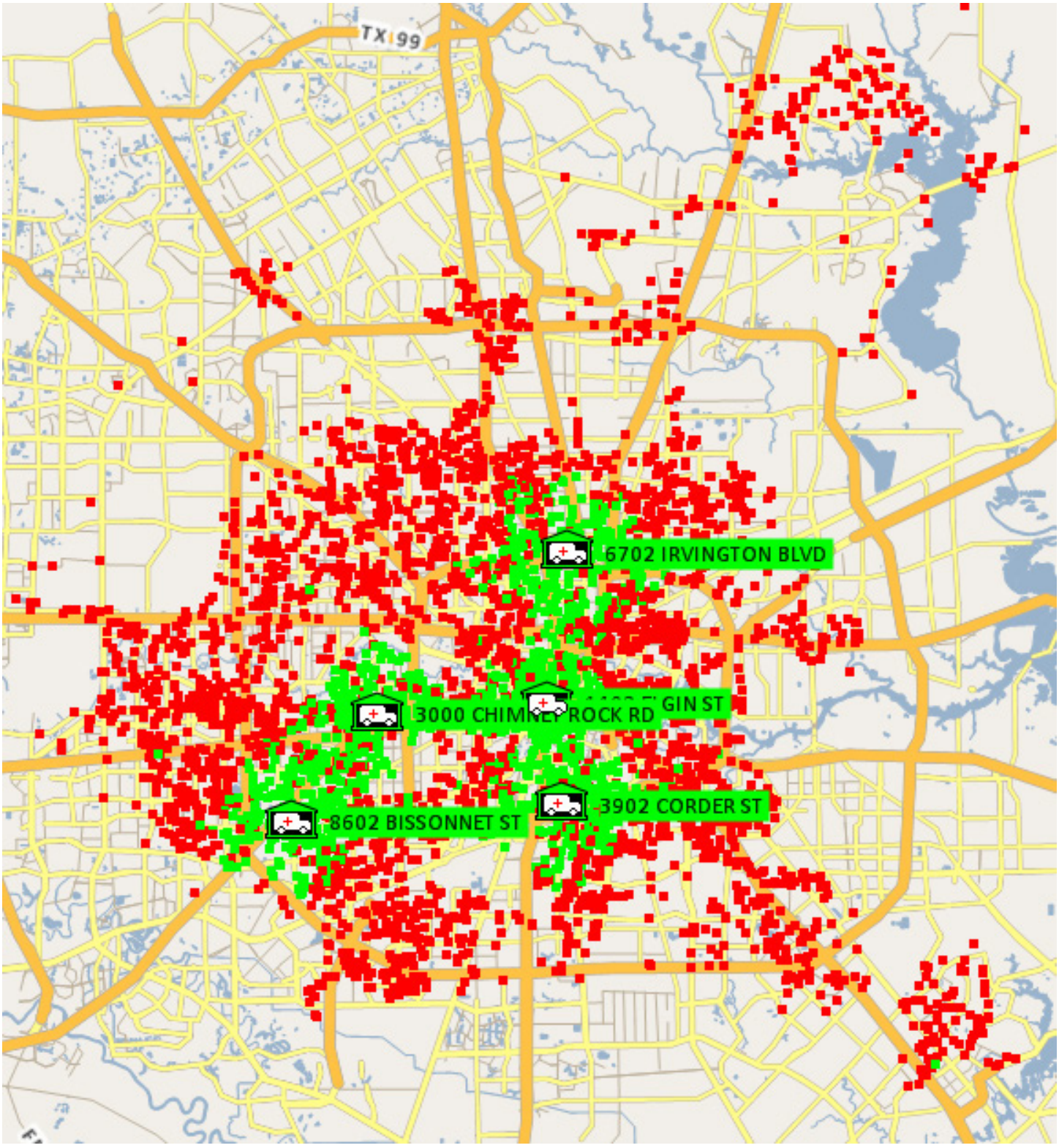
The overall simulated travel to scene duration for Safety Officers is shown in **Figure 70**. This only shows the incidents where a Safety Officer was dispatched and arrived at an incident. On average the Safety Officers had a travel to scene duration of just under 18 minutes, with the 90th percentile just under 32½ minutes. It is important to know, however, that the distribution of times is well clustered in the 10 minute or less section of the distribution (approximately 29%).

Figure 70 – Simulated Travel Duration of Safety Officers



Geographically, as expected, the calls that are responded to with a travel time of less than 610 seconds are centered on the Safety Officer base locations (**Figure 71**).

Figure 71 – Incidents with a Safety Officer Travel time < 610 seconds – green incidents are responded to within the target – red incidents outside the target



Appendix

HFD Data Issues

Hospital Transport Times

During the Road Network tuning it was noted that there appeared to be some discrepancy with transport times to hospital locations. It appears from the data that it is likely that this is due to incorrect hospital locations being recorded in the incident record (i.e. the incident record shows the patient being transported to Hospital A when in reality they were transferred to Hospital B). This makes it difficult to "tune" the road network correctly as the same trips from scene to hospital are not being used.

Some examples of hospital transport times issues are:

Med Memorial Hermann Northeast

Figure 72 – Transport Time to Med Memorial Hermann Northeast

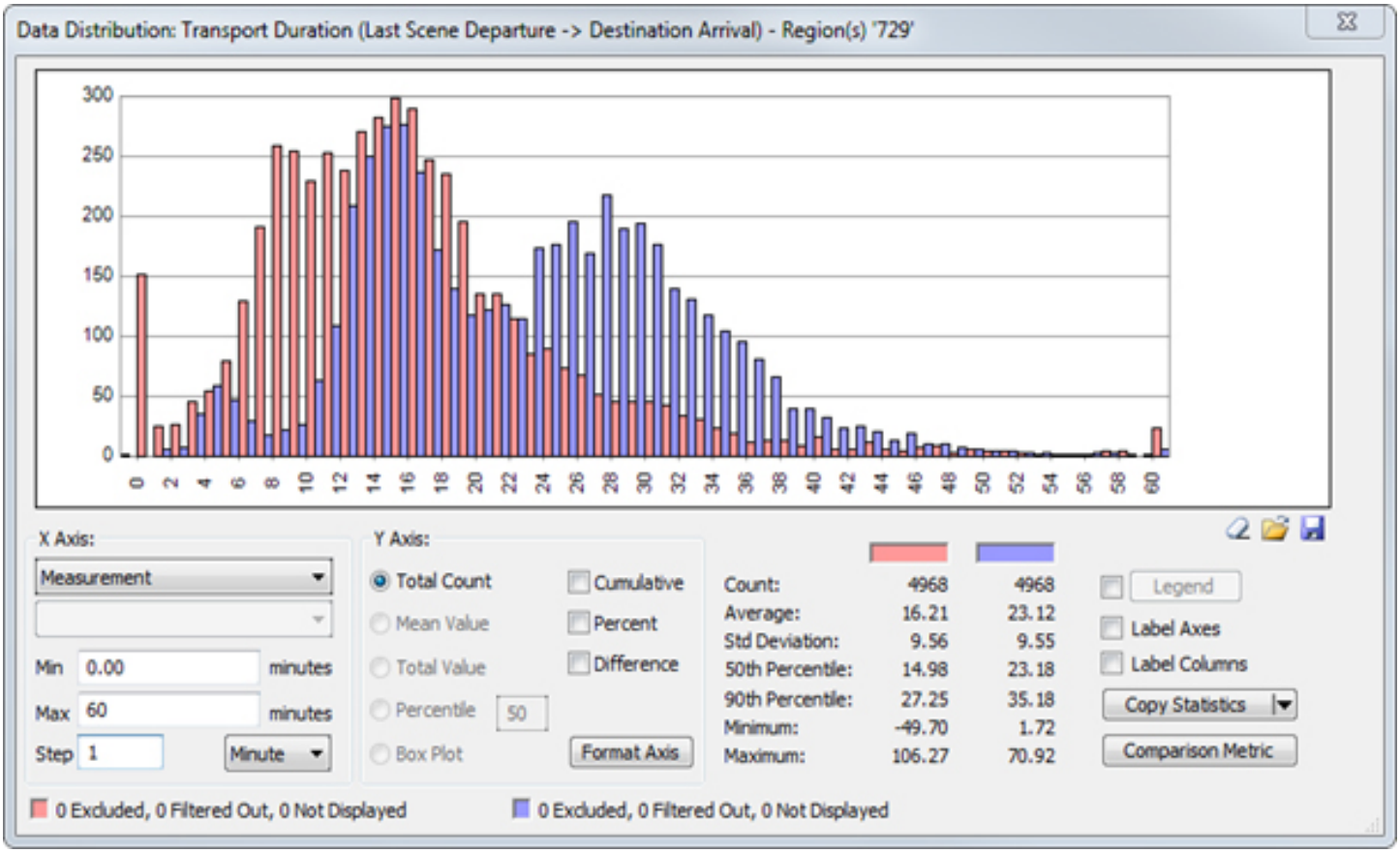
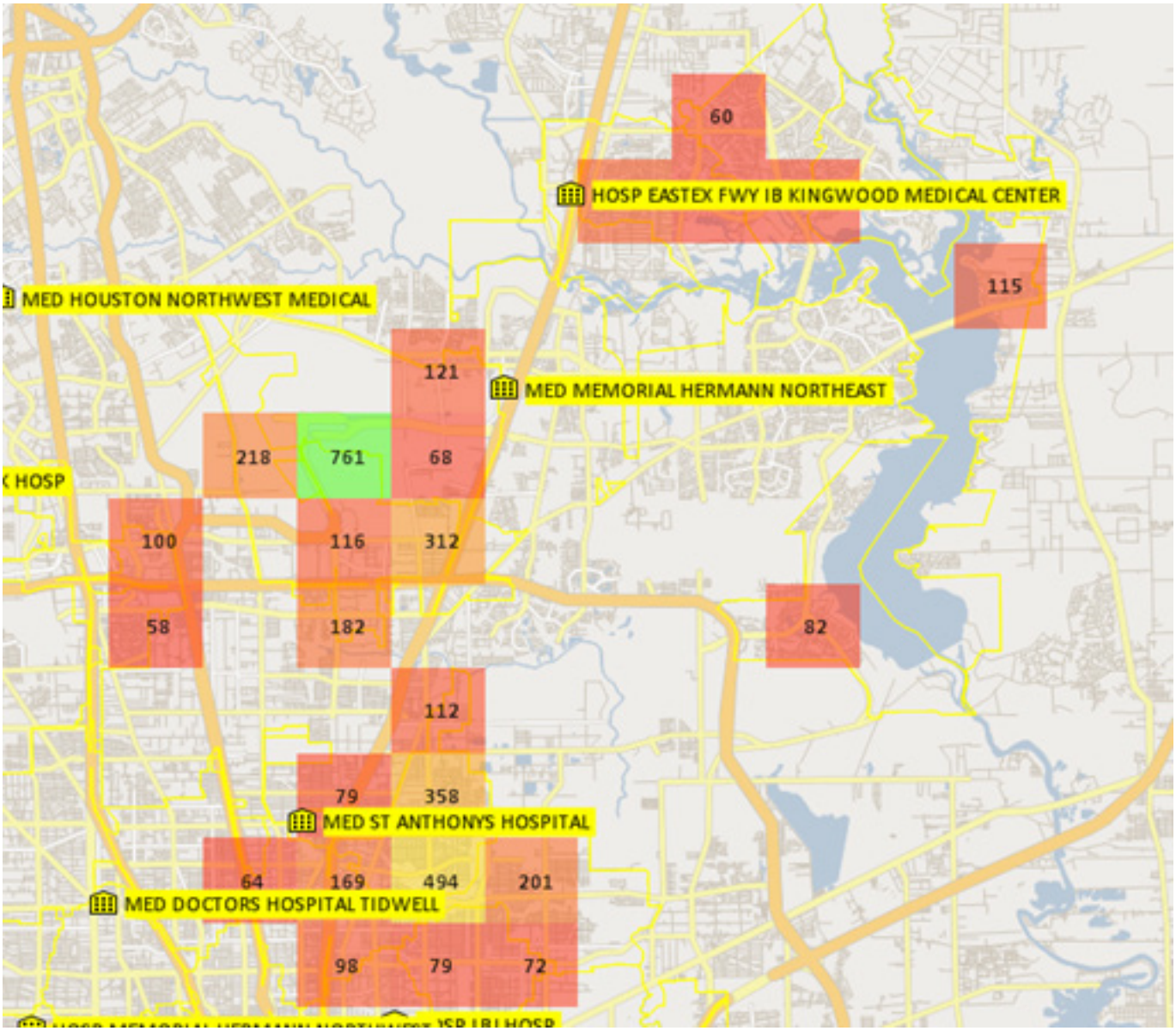


Figure 72 shows the historic transport time to Med Memorial Hermann Northeast in pink, and the simulated transport duration in blue. In the simulation there are three (3) separate peaks for transports to this location which are caused by incidents coming to this hospital from multiple different groups of incidents. The historic data does not show the same spread of times, and on average is much faster than the simulated data.

Figure 73 – Scene Locations of Calls Transporting to Med Memorial Hermann

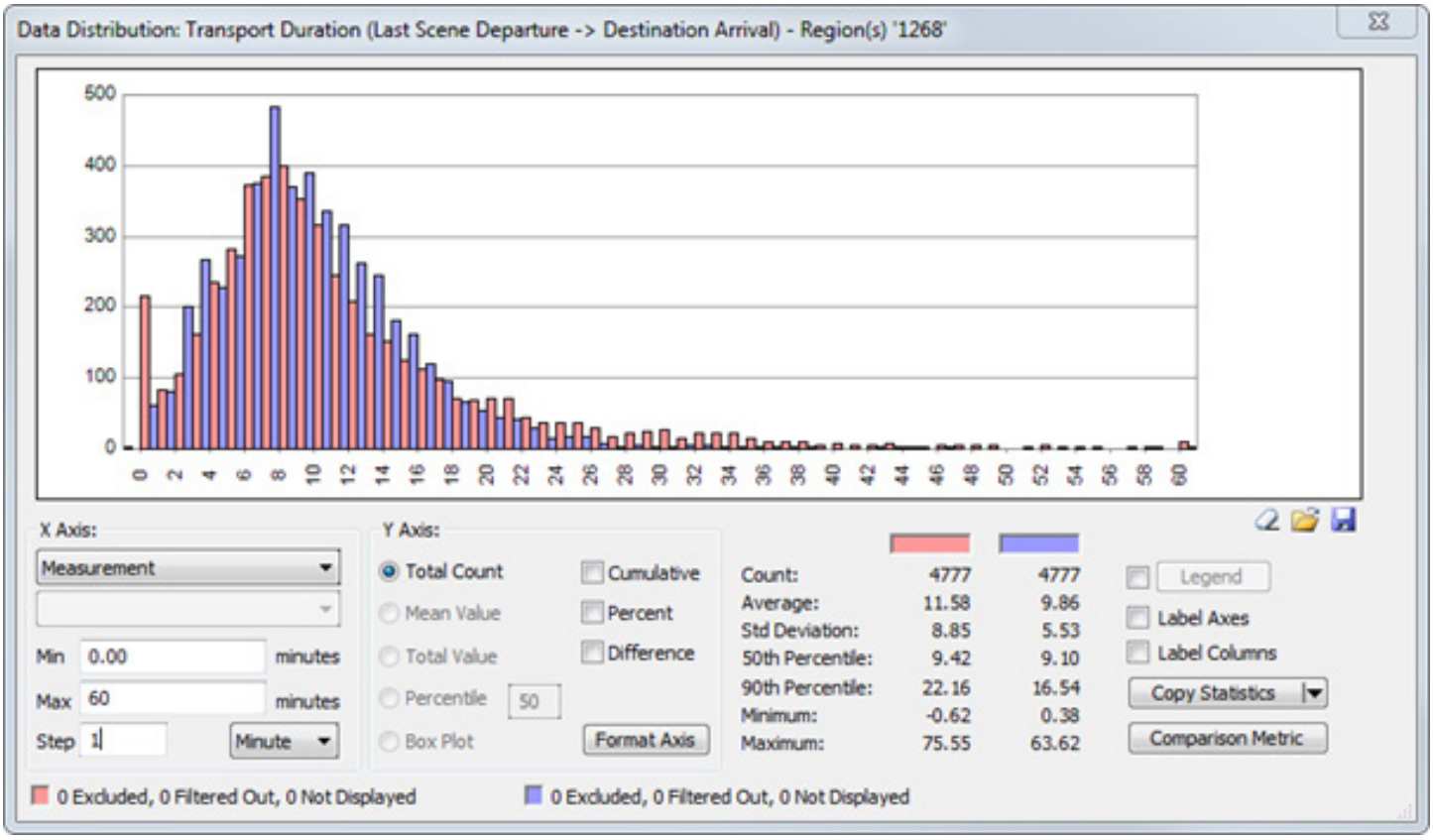


Northeast Hospital

Figure 73 shows the scene locations of calls being transported to Med Memorial Hermann Northeast. For many of the calls this hospital is not the closest hospital and there appear to be three (3) different groupings of incidents (one close to Med Memorial Hermann Northeast, the second close to Med St Anthony's Hospital and the third, a small group close to Hosp Eastex Fwy 1B Kingwood Medical Center).

Hosp West Houston Medical Center

Figure 74 – Transport Time to Hosp West Houston Medical Center



In contrast, Hosp West Houston Medical Center is faster on average for the simulation (blue), and has a similar shape, although the historic (pink) distribution has a longer tail – potentially these are incidents that were actually routed to a different hospital (**Figure 74**).

Figure 75 – Scene Locations of calls Transporting to Hosp West Houston Medical Center

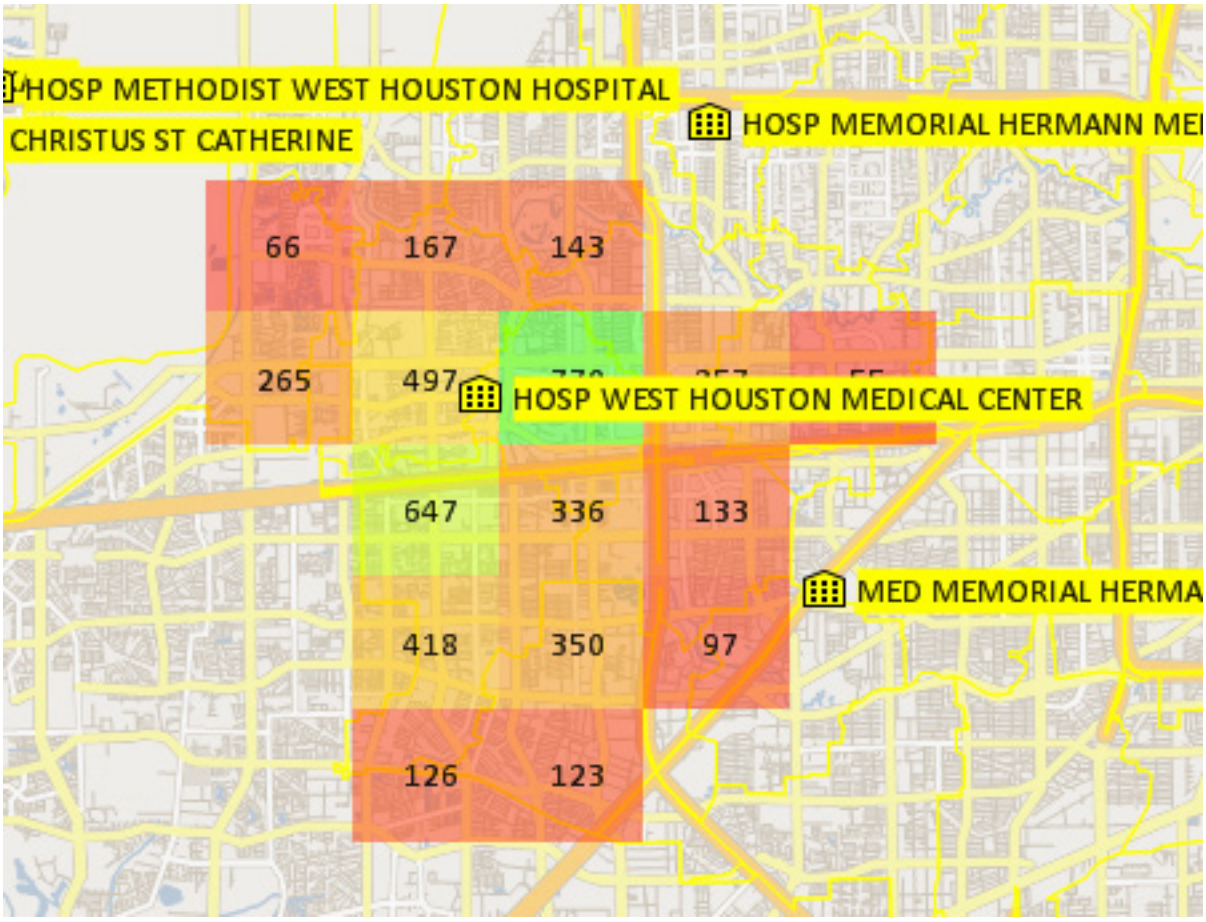
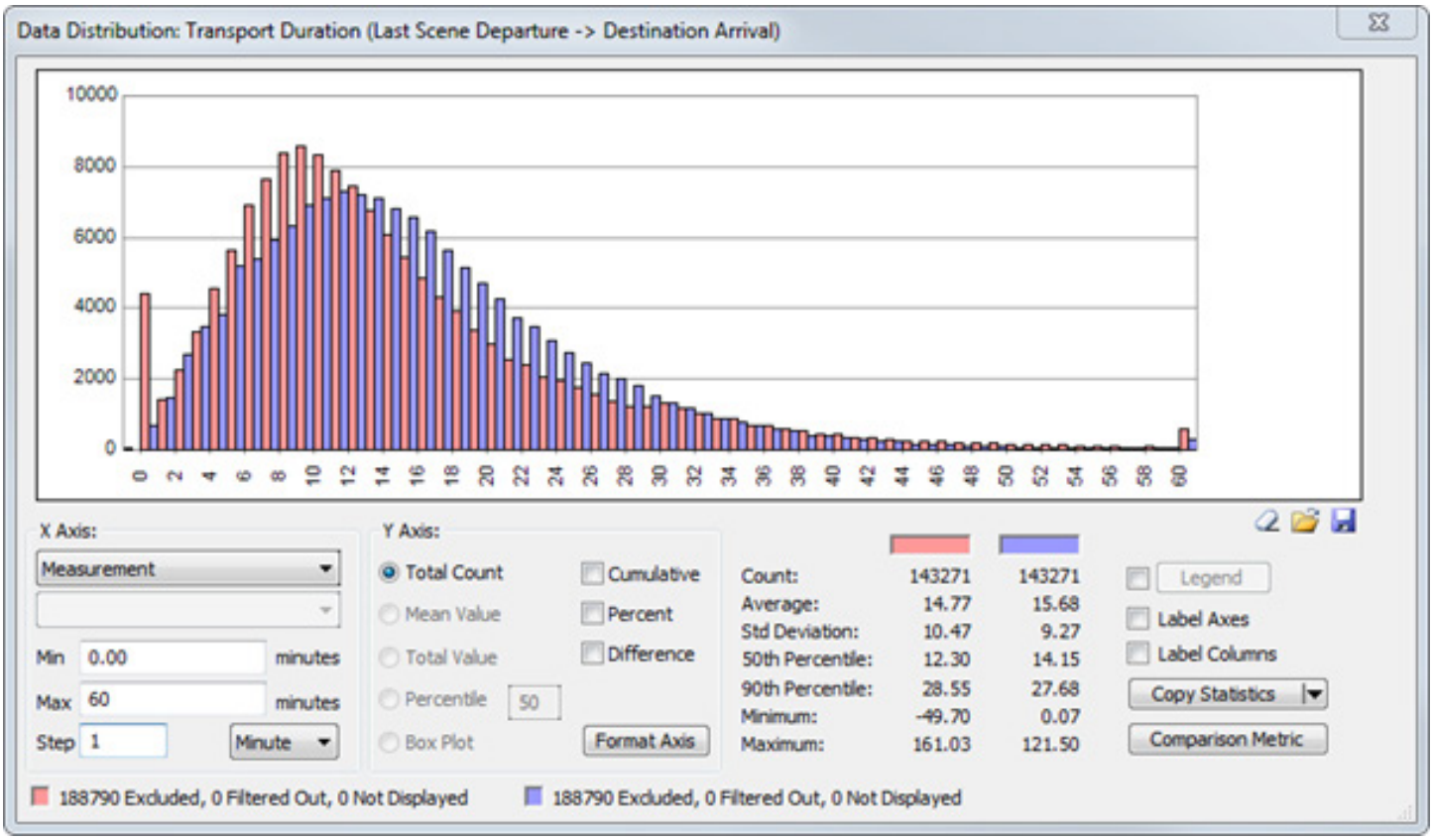


Figure 75 shows that unlike the previous example the scene locations for the calls to Hosp West Houston Medical Center surround the hospital location with the majority of the call volume directly surrounding the hospital.

Figure 76 – Overall Transport Durations – Historic (pink) – Simulation (blue)

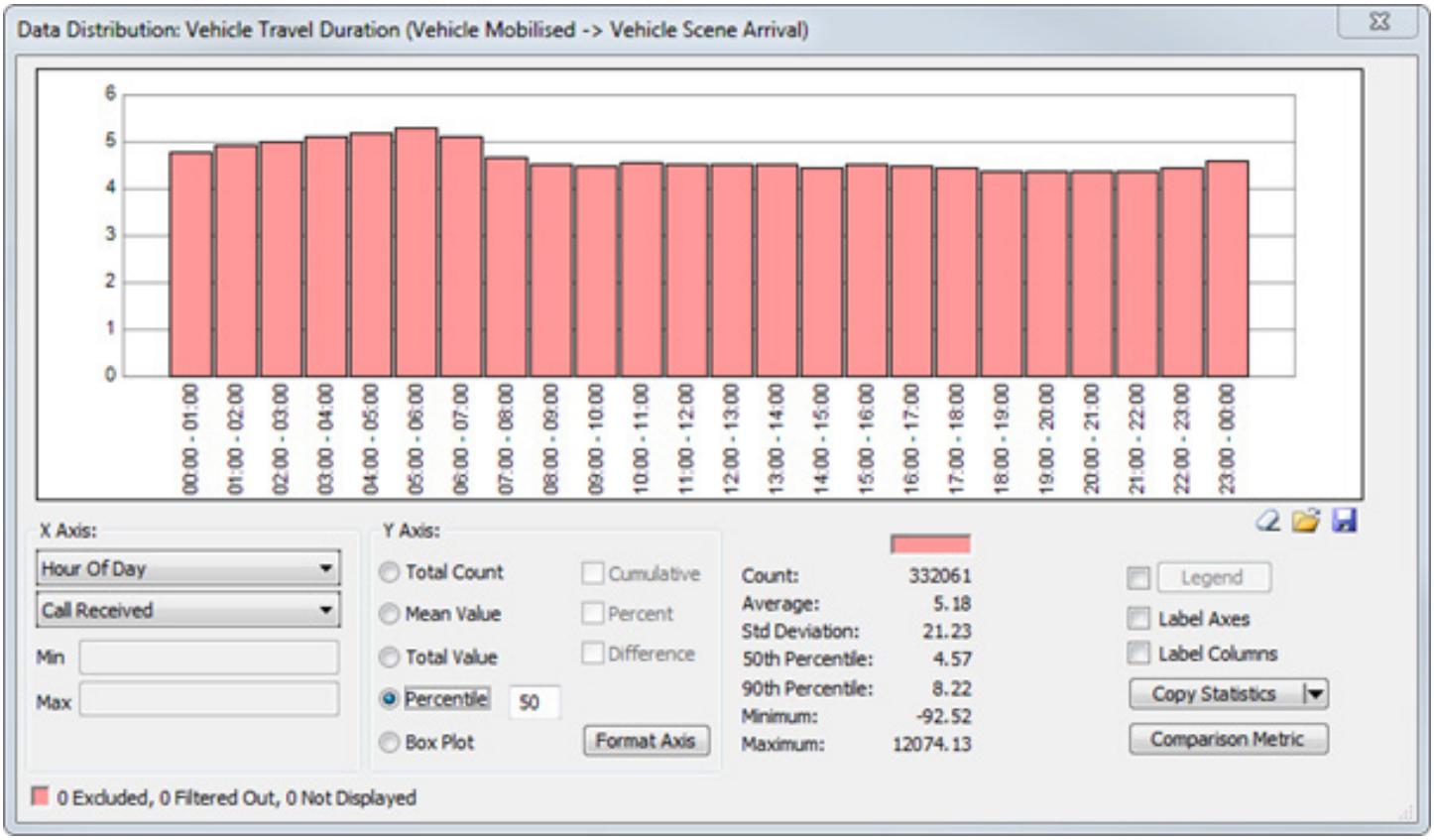


Overall the transport times are slightly too slow in the simulation (blue) versus the historic times (pink) (**Figure 76**). This cannot be corrected due to the impact on the travel to scene times as the road network tuning affects all travel times. Given the scenario work is based on the time it takes to travel to the scene, more weighting was given to the travel to scene trips.

Day and Night Travel Times

When reviewing the time of day behavior, it was noted that historically travel times are significantly longer at night then during the day (**Figure 77**). This is unusual behavior as typically vehicles are able to travel faster on roads at night time versus day time due to reduced traffic congestion. This behavior can sometimes be due to operational behaviors of crew where statuses are changed prematurely.

Figure 77 – Travel Times by Time of Day



To reflect this day and night behavior in the simulation model it has been necessary to incorporate the extra travel duration into the mobilization time of the vehicle. This means that travel times in the simulation are expected to be faster at night compared to the historical level (**Figure 78**). However, the overall simulated response times (which includes the time vehicles take to mobilize) reflects the increased response time at night (**Figure 79**).

Figure 78 – Travel Times by Time of Day (Historical – pink, Simulation – blue)

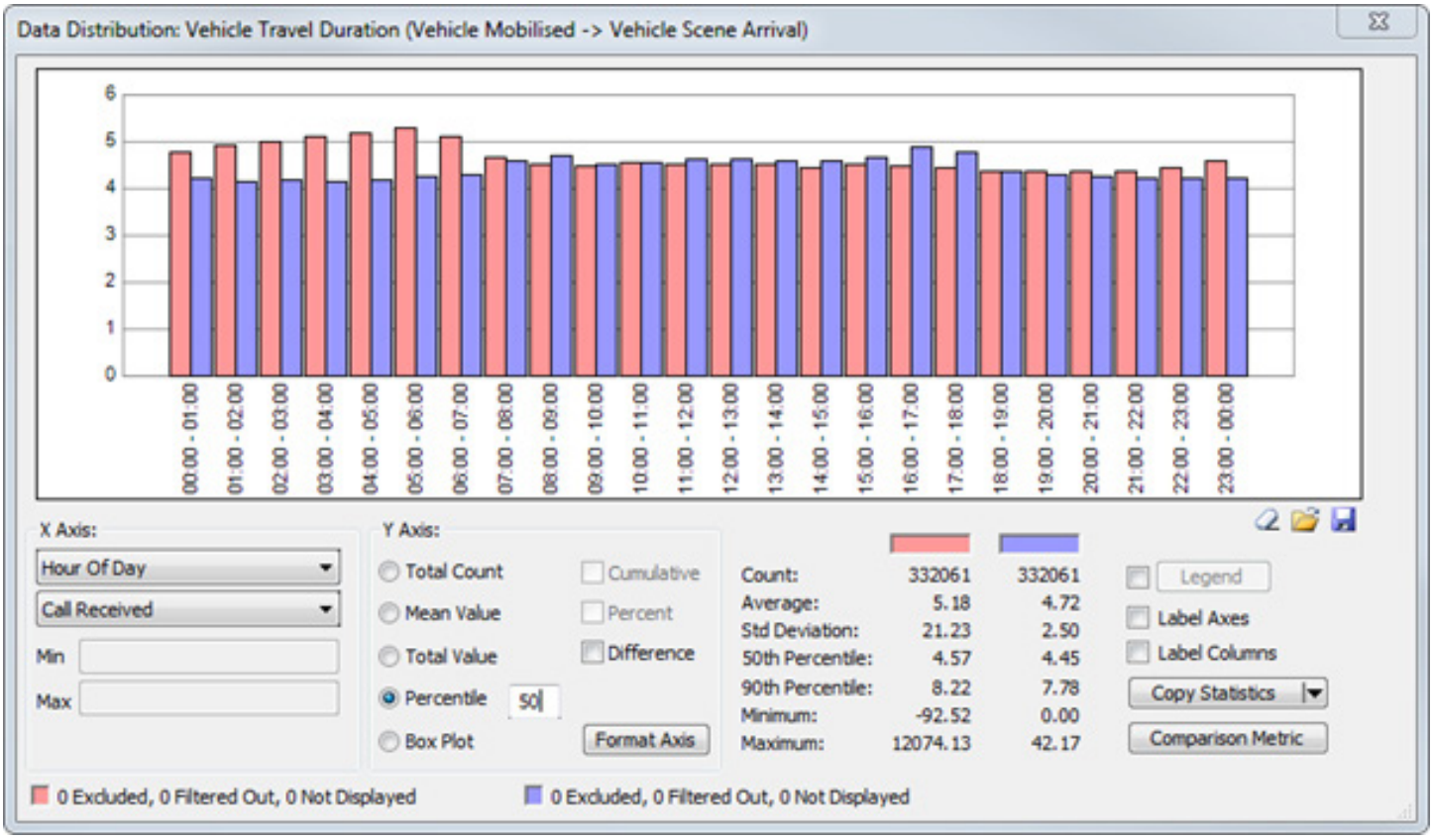
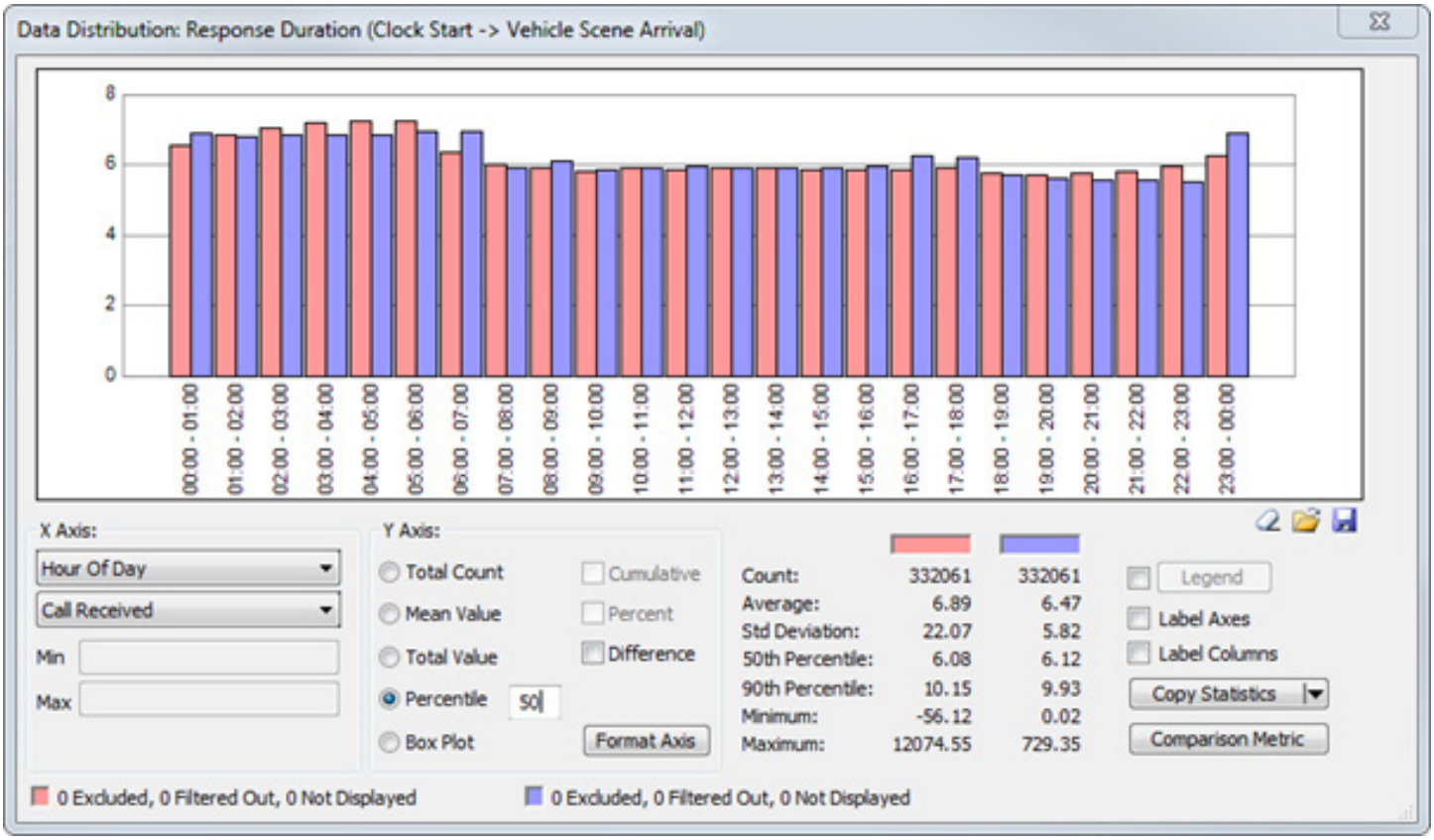


Figure 79 – Response Times by Time of Day (Historical – pink, Simulation – blue)



Additional ALS Resources to Achieve 90% 480 Second Travel Time

Optima Predict Resource Location Optimizations (RLO) functionality was used to determine the best place to put additional Medic vehicles to provide the ALS coverage required (90% of incidents have a travel time within 480 seconds). RLO uses utilization and time of day demand to optimize the location of vehicles.

6.5.1 Model Setup

No limits were put on the number of additional vehicles or on the time of day that they could operate. All current base locations were considered. The response units were set to be 24 hours long and operate on every day of the week at the same time each day.

There was no attempt to ensure all of the Still Region areas achieved 90% target, or that the 90% target is met across the hour of the day. Only the overall Houston area, at a weekly level, was considered. RLO will add vehicles to areas where the greatest benefit will be achieved (i.e. the vehicle will respond to the greatest number of calls with a travel time within the target time). Along with the ALS coverage, the transport coverage was also considered. This was to ensure that medics and squads were put in appropriate locations, along with ambulance vehicles, to not only ensure ALS travel coverage, but also to ensure that the transport coverage was as good as possible.

Historically, approximately 64% of ALS incidents were responded to by an ambulance or medic vehicle with a travel time within 480 seconds. This means that an additional 26% of ALS incidents need to be responded to with a travel time within 480 seconds to achieve the 90% target.

The simulation had slightly lower performance compared to the historic, achieving 58% (compared to 64% in the historic data). Additional ALS units were added to the simulation to increase the percentage of ALS incidents responded to in the simulation by approximately 26%, so that the simulation is achieving approximately 84%. This is expected to be equivalent to 90% if these response units were actually added to the Houston area.

6.5.2 Additional ALS Unit Requirements

Based on output from RLO and the simulation, an additional 42 medic units are required each doing 24 hour on-duty shifts to increase the percentage of incidents responded to with a travel time within 480 seconds by 26%. The additional medic units were spread around the vehicle with the best locations identified along with the best locations for the squad and ambulance vehicles.

There are an additional 42 medic units required to achieve the 90% target, however there is a significant improvement by adding half this number (rising from an expected 64% performance to 82% performance). **Table 9** gives expected performance with different levels of additional medic units added.

Table 9 – Expected Impact of Additional Medic Units

Number of additional 24 hour medic units	Additional benefit from baseline	Expected percentage of ALS vehicles travel time within 480 seconds
20	+18%	82%
30	+22%	86%
40	+25%	89%
42	+26%	90%

6.5.3 Results

The following results are based on adding 42 additional medic units and rearranging all medic, ambulance and squad locations to give the best coverage for both ALS travel times and transport vehicle travel times.

The addition of the medic units in the Houston area result in good coverage across the Houston region (**Figure 80** and **Figure 81**). There are still some regions (shaded in red in **Figure 79**) where there are not sufficient vehicles available to ensure ALS travel times are within 480 seconds. To address this deficiency, these areas could be covered by medic units moved from other stations which have multiple units. This may reduce the overall performance level slightly, but will give a better geographic coverage.

Overall, the expectation is that 90% of ALS incidents will have an ALS travel to scene time less than 480 seconds.

Figure 80 – Simulated ALS Incident Coverage – ALS Vehicle Travel Time 480 Seconds

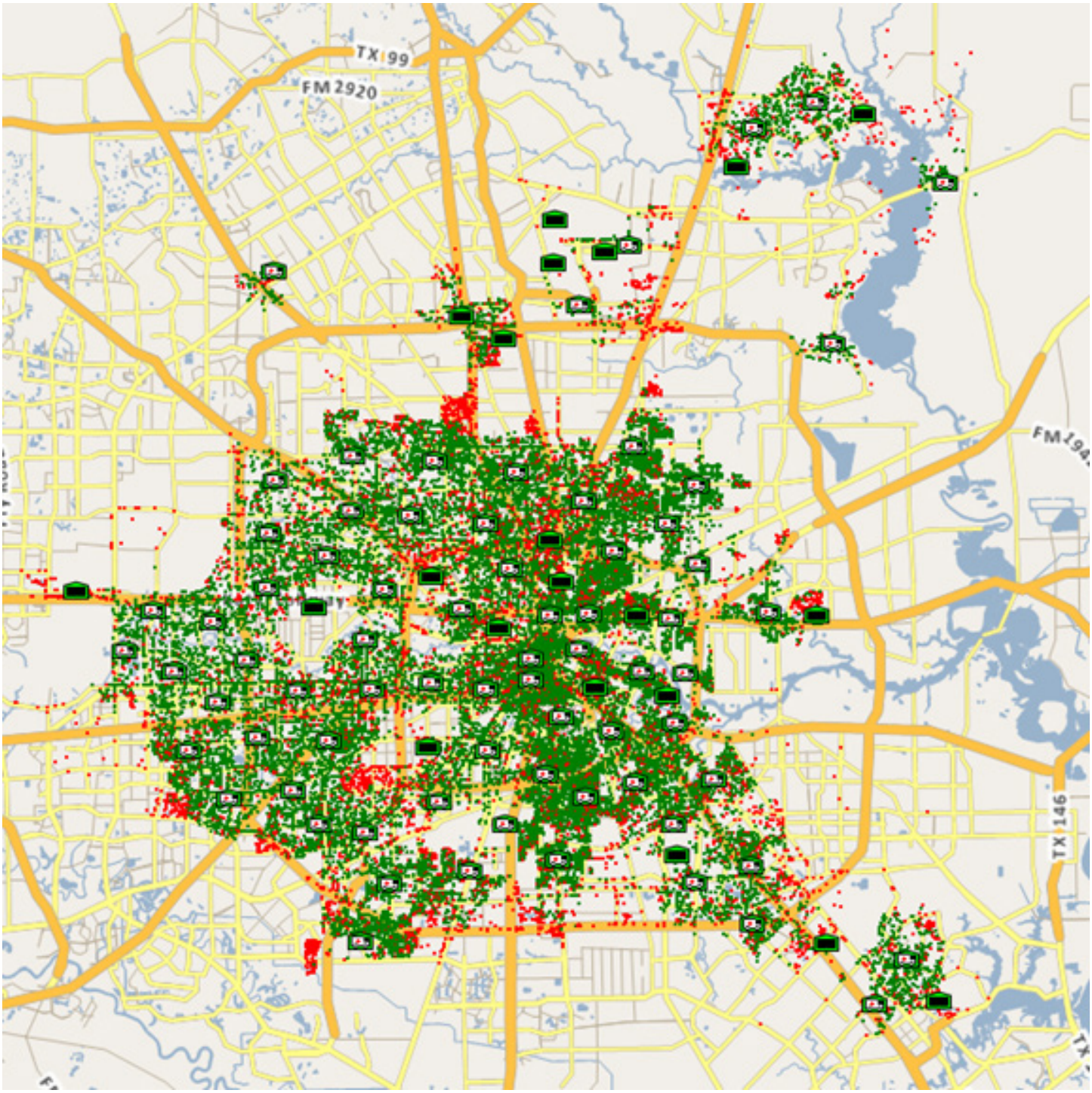
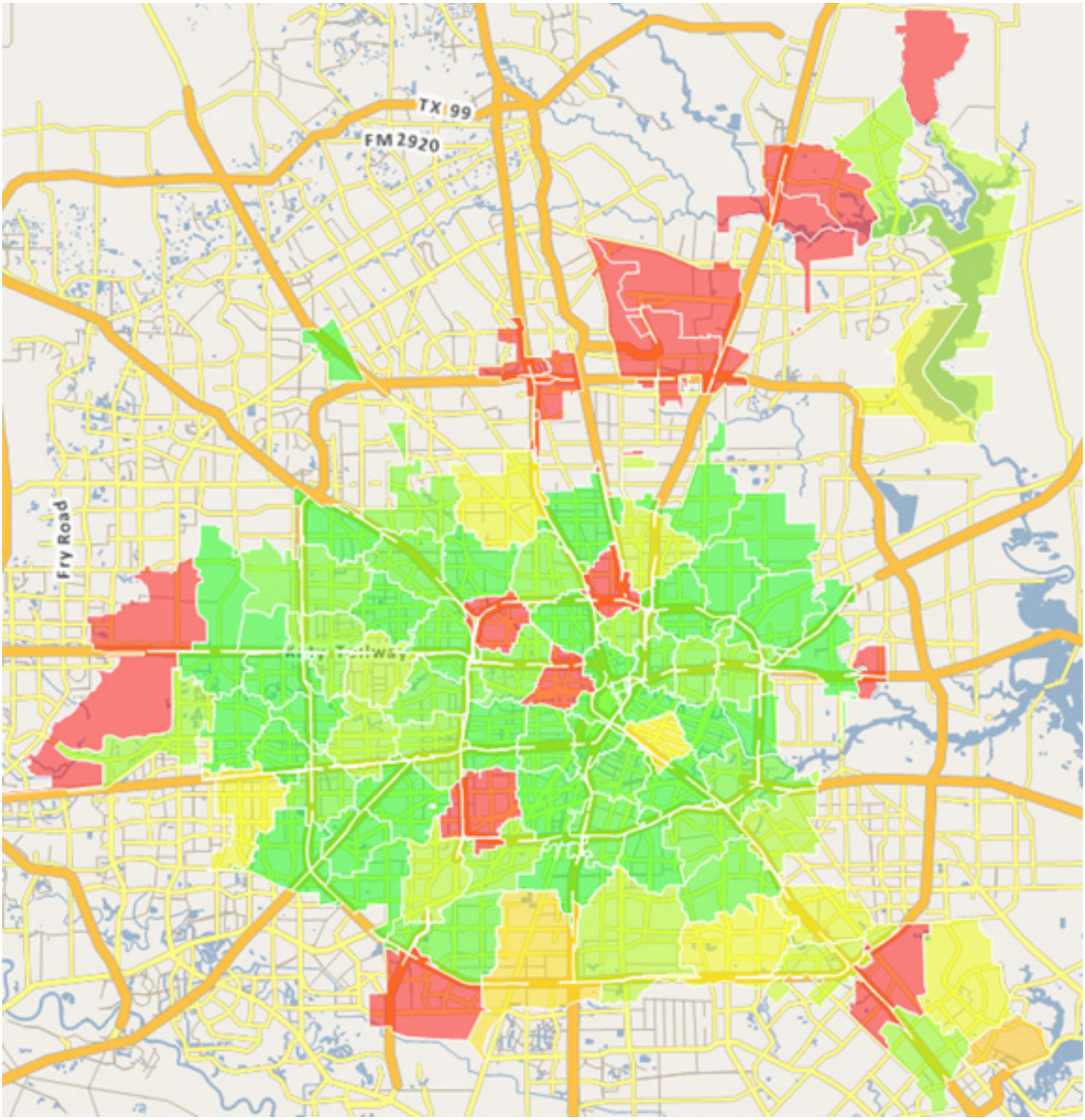


Figure 81 – Still Alarms Regions – Percentage of Simulated ALS Incidents that were travelled to by a ALS Vehicle within 480 Seconds (green >90% expected, red <70% expected)



The suggested in-service times and locations calculated using RLO for Ambulance, Medic and Squad vehicles are given in **Table 10**. The location of ambulances has changed to ensure that the transport capability as well as the ALS capability has been considered when deciding on the best location of the vehicles.

Table 10 – Ambulance, Medic and Squad Unit Locations

Fire Station	Number of Ambulances	Number of Medic Units	Number of Squads		Fire Station	Number of Ambulances	Number of Medic Units	Number of Squads
2		1			47	1	1	
3	1		1		48	1	1	
4		2			49	1	1	
5	1		1		50	1	1	
6	1				51		2	
7	1	1			52	1	1	
8			1		53	1		
9		1			55	1	2	
10	1	1			56	1	2	
11		1			57		1	
13	1		1		58		2	
15	1		1		59		2	
16	1	1			60	1	1	
17		1			61	1	1	
18	1				62	1		
19	1	1			63	1	1	
20		1			64	1	1	
21	1	1			65		1	
23	1	1			66		1	
24		1			67	3		2
25		1			68		1	
26		1			69		1	
28	1	1			70	1	1	
29	1	1			71	1	1	
30	1				73	1	2	
31	1	1			75		1	
32		2			76	1	1	
33		2			77	1	1	
34	1	1			78		1	
35		2			80	1	1	
36	1	1			82	1	2	
37	1				83	1	1	
38		1			84	1	2	
39	1	1	1		86	1	1	
40	1		1		90	1		
41	1	1			93	1		
42	1		1		94	1	1	
43	2		1		96	1	1	
44		2			101	1	1	
45		1			102	1	1	
46	1	1			105			1

Fire Command and Control Systems

Consultants met with HFD command staff and operational chief officers and found that the command and control systems utilized by the Houston Fire Department were consistent with industry standards. The level of resources assigned to incidents, including command officers and safety officers, was found to be adequate. We do recommend additional on-duty safety officer positions for geographic coverage.

The HFD is currently delivering the Blue Card incident management curriculum to fire department members. Delivery of this training will enhance the HFD's commitment to incident management, firefighter safety, and customer service.

Emergency Medical Services

Emergency Medical Services (EMS)

The Houston Fire Department has been providing emergency medical services (EMS) since April 10, 1971, recently celebrating its 45th year of providing EMS. The HFD started with twenty-four (24) ambulances in 1971 and currently utilizes ninety-one (91) ambulances, fifty-six (56) basic life support (BLS) ambulances, and thirty-five (35) advanced life support (ALS) or paramedic level ambulances. The HFD utilizes twelve (12) ALS Squads and ten (10) EMS field supervisors that also respond to EMS incidents. In addition to the dedicated EMS response units, all HFD engines and ladders respond to EMS incidents at the BLS level. The HFD responded to more than 285,000 EMS incidents in FY 2015. On average HFD responds to an EMS incident once every two and a half (2.5) minutes.

There are over 3,500 HFD firefighters certified as emergency medical technicians (EMT) and approximately 500 certified paramedics. HFD firefighters are required to maintain EMT certification throughout their employment with HFD. Paramedic personnel are obligated to maintain paramedic certification for four (4) years.

We recommend that the HFD continue to provide emergency medical service, including the provision of Advanced Life Support (ALS) service and ambulance transportation. The HFD Emergency Medical Service (EMS) system is fully integrated into the operations of the department. All HFD members provide emergency medical care to their customers. All emergency care, from the receipt of the 911 call at the dispatch center, to the arrival of the first emergency responder on the scene, to the arrival of the customer at the hospital, is provided under a consistent standard of care designed by and approved by the Fire Department Medical Director.

Houston has been a pioneer in the provision of EMS. The service has continued to evolve over the decades and recent augmentations to the service, such as the All-Hazards response protocol and the ETHAN program, where a customer and an emergency medical physician can speak face-to-face virtually, are both industry best practices.

It has been suggested that the ambulance transportation portion of the HFD emergency medical service be provided by a private entity. We do not support this suggestion. First, it is unlikely that this service would be provided by a private entity without a substantial subsidy by the City of Houston. Second, the continuity of care provided to sick and injured HFD customers would be lost. Today, a sick or injured Houstonian can count on a consistent level of care from firefighters and fire officers trained to be part of a comprehensive EMS system. A private provider cannot optimally provide an entire EMS system more efficiently nor more effectively than a fire department. The costs associated with providing EMS should not be the only consideration that decision makers evaluate and should include response time, quality of service, associated revenue, and patient outcome for an effective, cost-efficient EMS system.

Of the twelve (12) most populous cities in the United States, all provide EMS through their fire departments and ambulance transportation is provided through the fire department in nine (9) of the twelve (12). In two (2) of the three (3) cities where ambulance service is not provided by the fire department, the service is provided by public sector workers as a 3rd service.

Large cities that have privatized all or parts of their ambulance systems have been plagued by long response times, inconsistent quality of care, increased ambulance fees and in some extreme cases, the abandonment of service

as private sector providers have abruptly closed down for a variety of reasons, including profitability. In some cities using a private provider, certain areas of a community are under served and other areas over served based on ability to pay for ambulance services. HFD provides consistent and equal services throughout the City of Houston.

The HFD has been a leader in EMS for several years in the local, state and national arena. Over the years several EMS studies have been and continue to be conducted including the following.

- Hypertonic Saline Fluid Study
- Stroke Studies
- Prehospital Thrombolytic
- Hypothermic Protocols for Cardiac Arrest
- CPR Study Comparing Mechanical and Standard CPR
- High Dose Epinephrine Study
- MAST Study
- Pediatric Asthma Study (PEGASUS)

HFD EMS has a close relationship with the Baylor College of Medicine, the University of Texas Medical School at Houston, and several Houston hospital systems, including the Methodist Institute for Technology Innovation and Education (MITIE) and the Texas Children's Hospital, that provide a variety of high-quality training programs to HFD EMS personnel. HFD employs medical Fellows from the Baylor College of Medicine and the University of Texas Medical School at Houston on a part-time basis to provide real-time medical direction to HFD EMS personnel in the field.

Over the course of this study the consultants were able to ride along with HFD EMS personnel assigned to ambulances, squads and EMS supervisor units. These personnel demonstrated a high level of professionalism and medical competency. HFD's emphasis on the "Holder" rule was evident during these observations and HFD EMS personnel do "treat every patient as if they were a member of their family".

HFD Emergency Medical Education and Training

Basic EMT Training

HFD personnel receive basic Emergency Medical Technician (EMT) training during the HFD fire academy. Currently EMT training is provided by the Lone Star Community College (LSCC) through a contract with the City of Houston. The Texas Department of State Health Services (DSHS) requires all EMT students to take and pass the National Registry of EMTs exam in order to be licensed in Texas. The EMT training program is approximately 110 hours and includes classroom and clinical components as well as a HFD credentialing or internship component to assure personnel are medically competent.

The current EMT training process meets the needs of the department and is appropriate for HFD to continue. Consideration should be given to requiring EMT training as a prerequisite for potential new hires applying for a firefighter position.

Recommendation 23:

Consider hiring firefighters with current EMT certification while providing targeted outreach assistance for EMT training.

Hiring new firefighters with a current Texas or National Registry of EMTs certification can reduce the amount of training time for the Recruit Academy. A condensed EMS portion of the Academy should include EMS specific training and competency evaluation that meet the needs of HFD.

Since the HFD is committed to hiring a diverse workforce reflective of the community it serves,

there may be concerns regarding the potential impact of an EMT prerequisite on minority and female applicants. HFD should provide outreach assistance the communities that may experience barriers to obtaining EMT training. HFD can also phase in the EMT certification requirement and hire a mix of both certified EMTs and non-certified EMTs for firefighter positions. Consideration should be given to allowing non-certified EMTs to apply for firefighter/EMT positions, but require proof of certification upon being offered a position.

Paramedic Training

All new firefighters hired by HFD are subject to attending paramedic school in the event there are not enough volunteers for paramedic training. The HFD contracts with LSCC for paramedic education and training. There are times when the need for paramedics is critical and the department has the option of hiring certified paramedics that will attend the HFD fire academy. Paramedic training takes place over thirty-three (33) weeks in the classroom. There is also an extensive credentialing/ internship component for paramedic personnel as well. This credentialing/internship process takes twelve (12) weeks and new paramedics are assigned to EMS units during this process as a third person.

Currently paramedic training and credentialing takes forty-seven (47) weeks with students attending classes on a forty (40) hour work week. Typically, three (3) classes per year are offered with approximately 40 students per class.

HFD estimated the total costs to train a paramedic is $161,351 per student. These costs are described below.

Initial Paramedic Training - $119,806

- Tuition - $4,500
- Salary & Benefits (33 weeks) - $52,000
- Backfill Overtime (72 shifts) - $63,000
- Puryear Review Program - $75
- National Registry Exam Fee - $110
- Pearson VUE testing fee - $25
- SSHS Application Fee - $96

Credentialing/Internship Process - $41,545

- Cadaver Lab - $325
- Salary & Benefits (12 weeks) - $18,900
- Backfill Overtime (25 shifts) - $21,900
- Preceptor Pay - $420

The current way firefighters are trained as paramedics results in employees being away from the fire department for eight (8) to nine (9) months. This can result in a disconnect with the department and students not being aware of policy and procedure changes. The cost of overtime to backfill for each student is approximately $84,900 during the classroom and credentialing process.

Recommendation 24:

Consider an alternative training schedule for initial paramedic training where personnel are not away from the HFD for several months.

The HFD may consider changing the current schedule of 40 hours per week to 24 hours per week, i.e. class on Monday, Wednesday and Friday. Paramedic students would be assigned to BLS ambulances while attending paramedic school and allowed the time off while on shift to attend class and be paid overtime to attend class on their days off.

This recommendation will reduce the overall overtime costs and allow paramedic students to stay connected with the department as well as apply the knowledge they learned in class in a field setting and consult with current on-duty paramedic personnel. The paramedic students could be assigned an on-duty paramedic mentor or preceptor that can assist them with questions outside the classroom. This approach

for paramedic training may also improve the pass rate for HFD personnel taking the National Registry exam. Paramedic training classes could overlap allowing more firefighters to attend paramedic training. This type of schedule may be more attractive to potential paramedic students.

Credentialing/Internship Process

The current credentialing/internship process takes twelve (12) weeks and occurs over twenty-five (25) shifts. During this process, paramedic students will respond to 911 EMS incidents as a third rider assigned with two (2) paramedics. The students are oriented to the uniqueness of HFD's EMS response system, policies, procedures and HFD's EMS protocols.

EMS Continuing Education

The EMS continuing education (CE) currently provided to HFD personnel has been primarily on-line education due to the lack of funding and personnel to provide classroom or hands-on training opportunities. A recent three-year budget allocation will allow for hands-on training provided by LSCC on an overtime basis (this funding was cut in FY17, with no known plan for restoration in a future year). Firefighters will receive four (4) hours of hands-on training and paramedics will receive eight (8) hours of hands-on training. The current amount of time devoted to continuing education is inadequate. Because of the cost of providing continuing education, this training provides only the minimum number of hours required by DSHS to maintain EMS certifications.

It was also related to the consultants that there are inadequate EMS training equipment including manikins, arrhythmia generators, etc. There is an inadequate number of personnel assigned to the EMS training function.

Additional training to EMS personnel can be accomplished by adding EMS training staff or using qualified instructors on an overtime basis. A mix of on-line and face-to-face training should be incorporated. Many HFD members expressed to the consultants that continuing EMS education is lacking.

Recommendation 25:

Create a comprehensive EMS Continuing Education component within the HFD.

Given the level of activity and importance of EMS in the HFD, the department should create a comprehensive EMS Continuing Education component within the HFD, including an adequate inventory of EMS training equipment needed department wide through a needs assessment process involving all affected stakeholders. Consider HFD personnel costs versus contracted continuing education services costs, per student.

The continuing education component should incorporate more EMS skills training opportunities for all personnel, including in-station EMS hands-on training. This training can be provided by EMS supervisory personnel, EMS training staff members, or station captains.

An adequate amount and type of training aides can increase and enhance skills training opportunities. Consideration should be given to EMS training equipment being available in fire stations for in-station EMS training. This training could be provided by personnel in the station, by the EMS supervisors, or mobile EMS trainers.

EMS Quality Assurance and Quality Improvement

Over the past few years, the HFD has lost support staff because of economic reasons. Currently there are no permanent full-time staff members assigned to these functions. The Medical Director's Office does Quality Improvement (QI) focused on cardiac arrest data. The medical directors also perform

medical reviews that originate primarily from hospitals and other medical facilities. Computer generated reports based on the data entered into the electronic patient care records (ePCR) are available to review for trends. These reports use various scoring formulas and target several areas in the ePCR. There is not an adequate level of Quality Assurance/Quality Improvement (QA/QI) staff available to review these reports in detail. HFD administrators expressed concern over not meeting the mandated QI requirements of the Texas DSHS and the potential for fines as result of inadequate QI efforts.

Consideration should be given to providing a full time staff for QI/QA functions that can appropriately review the quality of care provided by HFD personnel, compliance to HFD EMS protocols, and additional areas identified through the needs assessment process. The HFD could also develop a peer review process approach to QA/QI and use paramedics and paramedic supervisors to provide some QA/QI functions.

The concerns with skill degradation can be addressed with a more comprehensive QI/QA program that identifies essential skills and then queries what paramedics have not performed those skills in a specified period of time. For paramedics not performing the skills, they would be sent to a skills lab to demonstrate competency. If the HFD accepts the recommendations related to expanding the number of certified paramedics, a comprehensive robust QI/QA program is essential.

Clinical Outcomes

HFD measures the clinical outcomes of cardiac arrest patients using the nationally recognized Utstein criteria. HFD also participates in the national Cardiac Arrest Registry to Enhance Survival (CARES) program. Additional clinical outcomes are not analyzed because of the loss of QA/QI staff. Previously, HFD had implemented a "Disease of the Month" program where clinical data was compared to the EMS protocols used by paramedics. HFD staff were also able to review ePCR data and code summaries for all cardiac arrest incidents within 48 hours with the BLS and ALS personnel that treated the patient.

HFD EMS administrators and medical directors would like to measure additional clinical outcomes such as stroke treatment, but does not have adequate QA/QI staff to perform this task. There is a significant amount of patient care data available through HFD ePCR's but there is inadequate QA/QI staff to review the data. The HFD medical director is seeking data to measure the clinical effectiveness of both BLS and ALS staff. Because of the limited number of HFD paramedic response units, the medical director would like to identify incidents at the time of the 911 call that should receive an ALS dispatch versus a BLS response.

EMS Staffing

EMS Administrative Staffing

The current EMS administrative/command staff consists of an Assistant Chief of EMS, a District Chief and two (2) Senior Captains assigned that work a forty-hour (40) work week and are responsible for the overall management of the HFD EMS program. The EMS administrative staff ensure that the department complies with the requirements of the Texas DSHS that regulates EMS systems in the state. EMS administrative staff represents the HFD EMS system and interacts with the Houston hospital systems, HFD medical directors, EMS support staff and other City departments, (i.e. Finance, Human Resources) as well as community organizations.

Considering the number of EMS response apparatus, number of certified EMS personnel and an extremely high volume of

EMS incidents in Houston, the number of administrative staff for EMS is inadequate. Over the past few years the number of administrative and support staff throughout the Department has decreased significantly. Many of the duties performed by the administrative and support staffs have been assigned to the few existing administrative or support staff as well as EMS supervisors and other emergency operations staff members. The addition of these duties has made it difficult for the remaining EMS staff to keep up on all of their duties and response capabilities.

EMS Support Staffing

HFD EMS support staff consists of personnel assigned to the various EMS programs including Quality Improvement, the CARE Houston program, and the infection control program. There are some staff assigned to EMS training functions, but the number EMS training staff is inadequate to ensure all personnel are trained and competent. Much of the recent support staff is in the form of temporary staff being assigned to EMS functions, i.e. firefighters with restricted duty because of medical conditions or other temporary assignments. This results in inconsistencies and a lack of performance when personnel in these positions change. As previously stated, support staff has decreased over the past few years.

Currently, the number of staff assigned to EMS quality assurance functions ranges from none to minimal. These duties have been redistributed to other administrative and support staff. Many of these duties have been assigned to the on-shift EMS supervisory staff taking away from their primary function of providing field supervision of personnel and EMS operations.

Infection Control Program

Although the department has a well-defined infectious disease program, exposure notification, exposure tracking and follow-up processes, the number and type of staff supporting them is inadequate. The current staff consists of a captain, a firefighter and a civilian infection control specialist. At one point HFD had registered nurses assigned to the infection control program. Concerns were expressed to the consultants that the infection control database is inadequate and they are concerned with someone falling through the cracks in relation to follow-up treatment or vaccines.

It was also mentioned that only soap and water is available for decontamination and that other disinfectants are needed. HFD uses a needleless system for intravenous therapy and most exposures result from not using goggles or face masks. Administration would like to include education for HFD family members regarding exposures to HFD personnel. EMS administrative staff on occasion has to assist with components of the infection control program, i.e. N-95 mask fit testing.

Overall, the number of administrative and support staff assigned to EMS is inadequate. Staff reductions and attrition have left EMS support operations inadequately staffed and put the HFD's customers, HFD members, and the City of Houston at risk.

Recommendation 26:

Conduct a needs assessment/workload analysis to determine the EMS specific areas and numbers of additional EMS support staff.

The HFD should conduct a needs assessment/workload analysis to determine the EMS specific areas and numbers of additional EMS support staff, including EMS training staff, administrative staff, QA/QI and Infection Control staff that are needed to effectively and efficiently provide comprehensive EMS administrative and support service functions.

EMS Emergency Response Staffing

HFD firefighters are cross-trained multi-role personnel that provide fire suppression and emergency medical services, as well as other emergency services based on the needs of each incident to which they respond, i.e. hazardous materials, technical rescue, water rescue, etc. HFD staffs all fire apparatus with firefighter/EMT personnel who are able to provide BLS level medical care. Personnel assigned to medic units and squads provide ALS level medical care. Engines and ladder apparatus are staffed with a minimum of four (4) personnel. BLS ambulances are staffed with at least two (2) EMT certified firefighters and driver/operators. Medic units and squads are staffed with a paramedic firefighter and a paramedic driver/operator.

Personnel assigned to EMS response apparatus are extremely busy responding to EMS incidents. The potential for "burn-out" of EMS personnel because of the high EMS call volumes is high. Although paramedics are required to maintain their certification for a minimum of four (4) years, we understand that that many paramedic personnel will promote out or somehow transfer to assignments that take them off a medic or squad sooner if possible. The consultants were also told that approximately fifty percent (50%) of the paramedics only maintain their certification for two (2) years. The HFD has at times not been able to recruit volunteers to attend paramedic training because of this and has to resort to mandating that personnel attend this training. We understand that a significant number of HFD members have volunteered to enter the paramedic training program to be provided in 2016. There have been critical shortages of paramedic personnel in the past, including 1996, 2006 and 2015. HFD should take the appropriate measures to reduce the workload of EMS personnel. There are a variety of measure that could be implemented to address the workload issues.

To address paramedic burnout or fatigue, the HFD should consider the following short-term and long-term deployment changes. Additional analysis and discussion of these deployment changes is included in the Deployment – Emergency Operations section of this report.

- Explore one (1) paramedic and one (1) EMT staffing on all transport units (ambulances) to allow for consistent paramedic rotations, raise the skill level of EMTs, and develop a pool of EMTs who want to be paramedics. This may be implemented as a pilot program in one district in order to assess successful implementation department-wide.
- Expand the current number of fire stations, thirty (30), that allow paramedic rotations to fire apparatus, to all fire stations. Allowing paramedics to work additional shifts on a fire company will reduce fatigue and improve the level of preparation for firefighters and driver/operators upon promotion to a company officer.
- Upgrade all fire and EMS apparatus to the ALS level of service with a minimum of one (1) EMT and one (1) paramedic, by allowing all personnel up to the rank of captain to maintain paramedic certification and function at the ALS level.

There are a number of fire personnel who were certified as a paramedic at one time in their career. Many drop their paramedic certification because of the workloads on the ambulances or because they are not permitted to utilize their paramedic skills since they are assigned to a response unit that provides only BLS-level service. HFD should, in conjunction with labor, develop incentives for maintaining paramedic certification.

- Consider eliminating squads and utilize squad staffing for additional ALS ambulances. This would bring the total number of ambulances to 103.

- If all fire apparatus were upgraded to provide ALS services, there is no need to staff the squads. With ALS engine and ladder companies the response time for ALS will improve city-wide.

EMS Supervisors

The HFD has ten (10) supervisory personnel assigned to each of the four (4) shifts. The supervision of EMS operations is provided by two (2) Senior Captains and seven (7) other Captains, sometimes referred as Junior Captains. A District Chief (1100) is also assigned to each shift that collaborates with the quadrant District Chiefs and EMS Administrative Chiefs to ensure appropriate EMS staffing for their shift as well as provide guidance and direction to the EMS supervisors.

Recommendation 27:

Evaluate the administrative duties assigned to Paramedic Supervisors to see if they can be reallocated to other Administrative support personnel or to Station Captains.

Over the past few years, paramedic supervisors have had to take on additional administrative and support functions. These additional duties take away from their ability to function effectively as field supervisors.

The HFD should evaluate the administrative duties assigned to Paramedic Supervisors to see if they can be reallocated to other Administrative support personnel or to station captains.

EMS Deployment

The HFD utilizes a tiered response system with BLS or ALS apparatus responding to EMS incidents based on a medical priority system utilized by personnel in the HFD Communications Center. This call prioritization system was developed specifically for the City of Houston and is a modified version of the national Medical Priority Dispatch System (MPDS) originally developed by Dr. Jeff Clawson in the 1970s and now maintained and updated by the National Association of Emergency Dispatch (NAED).

Given the time period that the MPDS system has been in use, the HFD should continue to evaluate the efficacy of the in-house medical priority dispatch system and make adjustments as needed. It should be noted that the staff that used to perform this analysis has been cut as a cost savings measure. The restoration of this analysis capability would allow the continual evolution of this highly utilized system and be an important component of the HFD's overall QA/QI program.

In 2011, the HFD implemented an All-Hazards deployment model where the closest fire apparatus is dispatched to the scene of a medical incident in order to reduce EMS response times. Prior to this deployment model, only dedicated EMS units were dispatched to EMS incidents resulting in long response times and, at times, no EMS units available to respond.

The HFD has increased the number of EMS capable response apparatus by moving to the All-Hazards concept for fire apparatus. Currently ALS services are not provided by engines and ladders. Some engine companies have a paramedic assigned to them and provide EMS under the Department's Paramedic Officer Program (POP). These paramedics are provided with a red bag that has advanced airway equipment and a limited medication inventory.

The same number of HFD ambulances are in service everyday regardless of incident volume. There are no peak-time ambulances utilized by the HFD.

EMS Medical Direction and Control

The HFD provides extensive medical direction and control through a team of ten (10) physicians who provide direction

and guidance to EMS personnel and the HFD administration. In contrast, the Fire Department of New York (FDNY) has six (6) full-time medical directors. In Houston, the city's Chief Health Officer is the primary fire department Medical Director, designated as MD-1, and is assisted by nine (9) Assistant Medical Directors, four (4) full-time and five (5) part-time. The part-time medical directors are medical fellows from the Baylor College of Medicine and the University of Texas Medical School at Houston and paid a small stipend of $1,000 per month, provided with a city vehicle, phone, and radio. These medical directors provide real-time medical direction to EMS personnel at the scene of an EMS incident. They also respond to quality improvement inquires and complaints regarding EMS personnel from Houston hospitals as well as provide or assist with some of the EMS training to the HFD EMS personnel. They interact and work closely with the HFD EMS supervisors. One of the full-time medical directors is funded with grant funds and one is a recognized, well known pediatrician.

The presence of physician medical directors and their involvement has enhanced the level of care and competency of Houston's EMTs and paramedics. Many fire departments in the United States have a single medical director, sometimes part-time, with limited interaction with the fire department's EMS personnel. The relationships these medical directors are able to develop with the University of Texas and the other hospital systems in Houston are beneficial to the HFD in regards to enhanced training opportunities for HFD's EMS personnel, i.e. Cadaver Lab.

The physician-provided medical direction adds to the HFD's credibility as a high-performance, high-quality EMS response agency from the perspective of Houston's medical community and facilities. Although the consultant's team was not able to ride along and observe a significant sampling of EMS incidents, all the consultants remarked that the level of professionalism and clinical competencies of the HFD EMS personnel observed was exceptional. This in part is to the credit of the medical oversight and direction provided by the Medical Directors Office.

Although recommendations on medical control issues are outside the scope of this study, and the consulting team for this project does not include a medical director qualified to make those recommendations, the consultants felt that the HFD Medical Director was open to un-biased feedback based on the makeup, expertise and experience of the consultant's team in relation to fire-based EMS delivery.

Recommendation 29:

Consider changes to the medical credentialing process and in the utilization of paramedics within the HFD.

There is a balance between the operational needs of the fire department and the medical control requirements implemented by the Medical Director's Office. Houston has seemed to achieve that balance and ensured that medical decisions are a priority component of the EMS deployment system. HFD executive staff and the Medical Director need to continuously monitor this balance of operational needs versus medical control to ensure that HFD delivers efficient and effective EMS.

The consulting team observed or were told the following.

- Every patient refusal requires consultation with the on-duty assigned EMS supervisor and the on call HFD medical director.

  The patient refusal policy is clear as to the procedure. During the ride along with EMS supervisors, the consultants observed several calls to the EMS supervisors and three-way phone calls with the medical director. Sometimes policies and procedures are enacted because of the lowest skill level

of personnel. The consultants would suggest that the HFD review the current patient refusal policy and seek input from the EMS supervisors and EMS staff using the policy.

- Mandated credentialing/internship process tied to time requirements and not competency requirements.

  Because the HFD credentialing/internship process is based on a time frame the HFD has limited control of the full use of a previously trained paramedic with prior experience. An experienced paramedic may be able to demonstrate competency in less than twelve (12) weeks.

- Quality Improvement (QI) focuses primarily on cardiac arrest incidents.

  Since cardiac arrest incidents are a very small subset of all EMS incidents the QI process is extremely limited and other skills or protocol compliance issues may be missed. (See discussion above regarding QI in the EMS Training section).

- The belief that the HFD must limit the total number of certified paramedics.

  This topic was discussed with HFDs Medical Director during one of the site visits to Houston. The Medical Director expressed preference to limit the number of paramedics because of concerns with skill degradation. The Medical Director felt that paramedics would have less opportunities to utilize their skills if paramedics were assigned to all HFD apparatus. The consultants disagree with this theory. There are several EMS journal articles discussing this issue.

  The problem HFD has is that some paramedics quickly burn out because of the high call volume and workloads they experience and find ways to move off a medic unit as soon as possible, either by promotion or temporary assignment. This has resulted in an extremely high turnover of paramedics forcing firefighters to attend paramedic school against their will who may or may not have the aptitude to become a paramedic or be successful. The end result is many new paramedics with little to no experience and minimal skills. HFD should allow all personnel up to the rank of Captain to maintain, or reinstate their paramedic certifications striving for two (2) paramedics being assigned to all fire apparatus for response to EMS incidents.

  Recent developments in the HFD have helped to limit the damaging effects of paramedic burnout. In fact, a number of current HFD members have volunteered to attend paramedic training.

- The belief that a tiered BLS and ALS system is more efficient and effective than an all ALS system.

  The Medical Director has participated in studies regarding this issue and HFD specifically. The differences between an all ALS system and tiered response system in terms of outcomes is minimal. A case can be made for both models. The high number of paramedics who have EMS experience that are leaving through promotions or other means, is wasteful considering the cost, $161,351, to train them. The HFD should capitalize on the experience these men and women have with the Houston EMS system and the impact they could have on new Houston paramedics. The department will demonstrate its firm commitment to EMS by encouraging and rewarding personnel with paramedic certifications who actively respond and participate as a paramedic. This staffing model will also ensue that two (2) or more paramedics are on the scene of all EMS incidents. These additional paramedics also can enhance EMS training delivery.

Online Medical Direction

In addition to the physician medical directors, online medical direction is provided to HFD paramedics in the field through a telemetry function provided by the Baylor College of Medicine. HFD pays a flat fee to Baylor for this "Base Station" service.

Approximately forty (40) HFD paramedics are employed as part-time employees of the University. These paramedics staff the telemetry room located at the Houston OEC and receive radio calls from HFD paramedics in the field. Telemetry contact is made when patients are being transported to a hospital and hospitals are notified. They also track the number of units transporting to hospitals in an effort to control or limit the number of patients going to any one facility to lessen the chance of overcrowding.

Paramedics also contact the Base Station for treatment advice outside of the written patient care guidelines and for additional pain medication orders over and above the authorized use initially given based on the patient guidelines. Contact is made for cardiac arrest patients and the Base Station assists with tracking times and treatment modalities.

New EMS Programs

As previously mentioned, the Houston Fire Department has been a leader in fire-based EMS. Two (2) new programs that are having a positive impact in the community and department are the Emergency TeleHealth and Navigation (ETHAN) program and the Care Houston program.

Emergency TeleHealth and Navigation (ETHAN) Program

This program was created by the HFD Medical Director and it uses technology to connect emergency responders and their patients to a physician through a real time video and audio interface. Based on the interaction between the three (3) parties, in most cases unnecessary transport by ambulance to the hospital is avoided. The program is also able to schedule alternative transportation and scheduled or urgent clinic appointments.

Recommendation 30:

Continue to monitor the results of the ETHAN program and explore alternative funding sources to continue and expand the program.

There have been several written and video articles on the ETHAN program appearing in the national EMS communication platforms. There have been a few presentations on the ETHAN program at national EMS meetings. The program has generated a lot of interest among EMS delivery agencies nationwide. The preliminary results are positive. Unfortunately, the program is funded with grant funds and will need additional funding to continue.

Care Houston Program

In 2006, Care Houston was launched as a pilot program in the Sunnyside area of the city. HFD EMS analysis showed that 26 percent of all 911 calls were non-emergency related in this neighborhood. This program was implemented citywide in January of 2007.

Care Houston is a collaborative project between the HFD and Houston Department of Health and Human Services (HDHHS) to decrease the high volume of non-emergency EMS calls. EMS identifies residents who have made more than five (5) emergency calls in a 90-day period and forwards that information to HDHHS. Health department staff contact the resident and if he or she agrees to participate, a Nurse Case Manager makes a home visit. Additional services are provided as well a medical education related to the customer's situation.

Currently HFD has a Captain assigned to this program on a temporary basis and additional temporary staff are assigned inconsistently.

Recommendation 31:

Continue participation in the Care Houston program and seek funding and opportunities for other methods to manage the use of 911 for medical emergencies.

Program staff has been researching other approaches to reducing unnecessary 911 medical calls including the existing mobile integrated healthcare/community paramedicine (MIH/CP) programs. There are successful MIH/CP programs in Dallas, San Antonio, and Fort Worth. There other MIH/CP programs throughout the country.

This recommendation is based on the continuing need to reduce the number of unnecessary 911 medical calls and to improve the overall health of Houston's residents by removing barriers to access appropriate healthcare. With the vast medical resources and related services and facilities located in and around Houston and the participation by the HFD and other surrounding EMS responders, it is possible to develop a comprehensive MIH/CP program that will greatly reduce the number of unnecessary 911 medical calls. The HFD Medical Director should consider the appointment of a citywide MIH/CP panel consisting of the key stakeholders to develop this program.

While HFD management supports Care Houston and any effort to reduce unnecessary EMS incident responses, consideration needs to be given in any such program to the appropriate and effective use of uniformed HFD members.

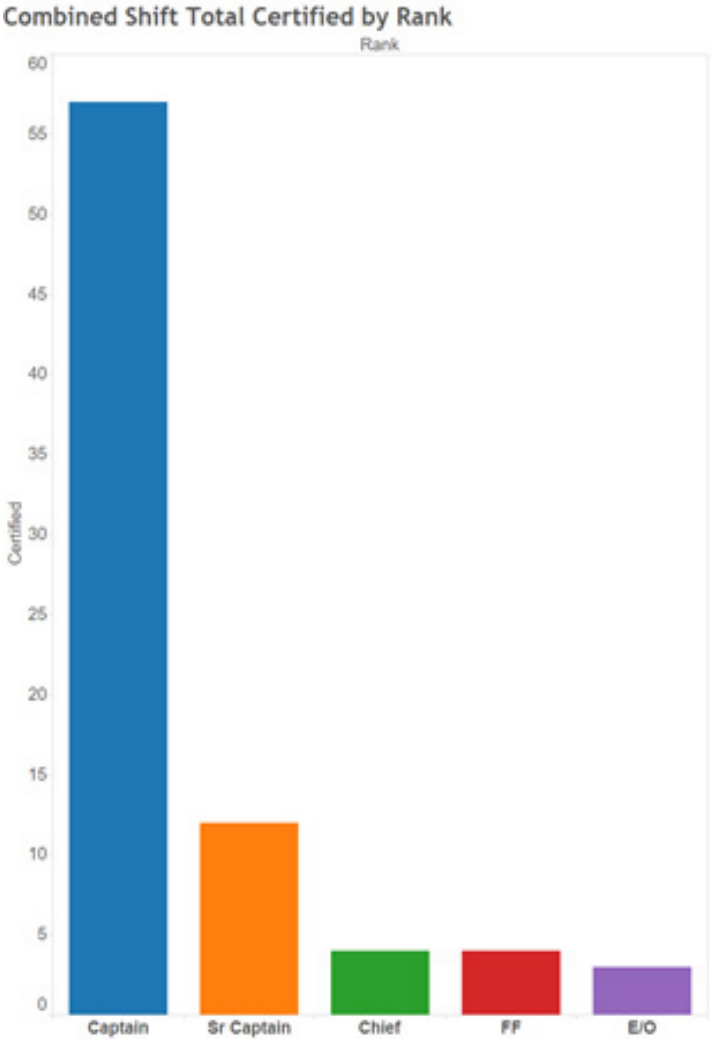
Dispatch and Technology

The HFD collocated their Office of Emergency Communication (OEC) into a new building called the Houston Emergency Center in 2013. The Houston Emergency Center houses the Houston Police communication center, Houston Fire Department's OEC, and the Office of Emergency Management's Emergency Operations Center (EOC). While the fire department utilizes the same building, they maintain their own area within the building and maintain their own staff for emergency communication.

Staffing and Schedule

The HFD maintains a 24-hour operational staffing for the dispatch center. The operation staff totals 80 personnel distributed over 4 shifts (A, B, C, D), with shift totals averaging 20 personnel. The administrative staff consists of 13 personnel including 1 Deputy Chief, 4 Division Chiefs, and 8 Captains. A breakdown of the staff is included in **Figure 82**.

Figure 82 – Dispatch Staffing



Shift Staffing

Administrative Staffing

System Performance

According to the OEC website: An End-to-End Houston Emergency System Performance and Process Assessment was completed in March 2005 by MITRE Corporation, a not-for-profit company that identified single points of failure and recommended mitigation actions which supported the center's quest to achieve system stabilization. Access to this report is available at: http://www.houstontx.gov/hec/.

CAD Technology and Dispatch Protocol

Houston's current CAD system was implemented in 2003. It utilizes Altaris™ CAD by Northrop Grumman and employs a station location-based dispatch model. This model references station location, along with call type, to determine the closest appropriate units. HFD follows an All-Hazards response protocol and fire related call for service requirements are built into the CAD system. EMS calls for service also work in this manner.

The emergency medical dispatch (EMD) system that is used to determine resources for EMS calls was developed by the Houston Fire Department Medical Director and is a modified version of the national Medical Priority Dispatch System (MPDS) originally developed by Dr. Jeff Clawson in the 1970's. The EMD rules work in concert with the CAD system for dispatching. The logic (what resources are required for EMS emergency type) is determined through the EMD rules, then the system utilizes available resources and station locations in CAD relative to the incident location in order to fulfill the assignment and dispatch units to the EMS call for service. A recommendation relative to this system is contained in the Emergency Medical Services section of this report.

Current HFD unit selection processes utilize a station order model where units are selected for response based on the proximity of fire stations to the emergency. Many fire departments utilize Automatic Vehicle Location (AVL) technology to determine the closest unit for response based on the Global Positioning System (GPS) location of the response unit. An analysis completed for this report found that the use of AVL technology for dispatch unit selection would have a positive impact on the HFD system as a whole and this change could have significant impact on individual calls for service.

> ***Recommendation 32:***
>
> *Utilize Automatic Vehicle Location (AVL) technology for unit selection for emergency response.*

Call Processing Flow

Civilian call takers (who work for the Houston Emergency Center) follow the Medical Director's call screening protocol and ask a series of questions to determine the severity of the emergency call for service. These call takers provide pre-arrival instructions to the caller and stay on the line if necessary to give resuscitation or other medical related instructions. Call takers are also EMD-certified through Association of Public Safety Communications Officials (APCO), an industry standard organization.

Directly after the series of questions, call takers queue the call for response. At this point the call for service moves to Houston Fire Communications Captains who staff the fire department side of the center. The certified Captains then dispatch operational field units consistent with the All-Hazards protocols and the Medical Director's response protocol using the Altaris CAD system. After the Captain dispatches the call for service they continue to provide radio communication with field units.

The 2015 HFD dashboard shows the 90% call processing time is greater than 2:00, well above the standard. Currently, OEC does not meet the processing times required in NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*. The standard requires 90% of all emergency calls processed within 60 seconds or less, and 99% of all emergency calls processed within 90 seconds or less.

Recommendation 33:

Streamline the call taking process as much as practical; evaluate the efficacy of the current address validation process.

Our analysis and interviews with OEC staff indicated the address validation process may contribute significantly to this delay. We recommend HFD engage in Business Process Improvement for the call processing at the OEC, considering a more efficient address validation process in order to meet NFPA 1221 standards.

Turnout Time

Turnout time is the increment of time between unit dispatch and travel time (from notification of the need to respond to the movement of the vehicle). NFPA 1710-16 establishes turnout time objectives for fire departments. The standard requires turnout time be 60 seconds or less at the 90th percentile for EMS responses and 80 seconds or less at the 90th percentile for fire and special operations responses.

In the most recent HFD Standards of Cover report, the turnout times for the HFD in 2015 were reported to be 95 seconds at the 90th percentile for EMS and 90 seconds at the 90th percentile for fire.

The least expensive ways to improve overall fire department response times are at call processing and turnout. While a safe response at all stages is appropriate, efforts on the part of firefighters to move with deliberate speed to their apparatus or EMS vehicle is important. Currently, HFD dispatchers will prompt units that have not begun their response within 90 seconds of dispatch to assure that they have the call and are responding. We recommend that responders be prompted by dispatch after 60 seconds for EMS incidents and after 80 seconds for fire and special operations incidents. The HFD may also consider utilizing AVL to collect response information to add a level of precision to these important data points. The HFD may also consider communications from department leadership to firefighters on the importance of a prompt response upon dispatch.

Recommendation 34:

Change HFD dispatch procedures to prompt responders 60 seconds after dispatch for EMS incidents and 80 seconds after dispatch for fire and special operations incidents.

Staffing of Emergency Operations

The Houston Fire Department staffs its emergency response units (engines, ladders, towers, squads, ambulances, medic units, command officers) in the same manner as most large metropolitan fire departments. Operational personnel are assigned to fire department emergency apparatus and respond to emergencies on a 24-hour shift basis. In the Collective Bargaining Agreement (CBA) between the City of Houston and IAFF Local 341, Article 18 specifies minimum staffing for operational positions and units within the fire department. It specifies the number of personnel by unit type and when totaled there is a minimum of 845 on-duty firefighters and fire officers in operational positions at all times. The HFD staffs in accordance with 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*, which is the national deployment standard for career fire departments.

Staffing Model

The 845 on-duty positions in HFD operations are constant staffed. Every position is filled every day for the full 24-hour on-duty period. If a firefighter or fire officer is off-duty for any reason (sick, injured, vacation, etc.), that position must be filled with another firefighter or fire officer. If a firefighter or fire officer is absent, HFD reallocates on-duty firefighters and fire officers within the on-duty shift to cover for those vacancies. If the number of on-duty firefighters and fire officers is insufficient to cover vacancies, firefighters and fire officers from other shifts are hired on an overtime basis to bring on-duty staffing up to 845. The CBA and HFD standard operating procedures provide additional structure to this process.

Occasionally, there are more than 845 fire officers and firefighters on a given day that report for duty (depending upon leave usage). When this occurs, HFD allows firefighters and fire officers to voluntarily use paid leave to take the shift off. This is a very efficient practice as overtime is not required and paid leave time is consumed at a lower cost.

Constant staffing for emergency operations is different than the staffing model used for non-emergency fire department positions or most other municipal classifications. Unlike operational firefighters, if an employee is absent for any reason from a non-emergency operations position in the fire department or from most general government positions, that position is simply vacant for the day. In a constant staffing model such as in HFD emergency operations, each on-duty position is staffed each day. Employee absences are accommodated within the on-duty shift staffing or with overtime when the number of on-duty staff is insufficient to fill each of the 845 positions.

In a constant staffing model, vacancies in firefighter and fire officer FTEs must be filled as soon as practical. When a firefighter or fire officer in operations retires or separates from the fire department for any reason, the HFD and the City of Houston have three (3) choices – replace that firefighter or fire officer with a new firefighter, utilize overtime to replace that firefighter or fire officer, or implement cuts to service so that the position is no longer filled.

Many fire departments have three (3) 24-hour rotating shifts, while HFD and some other fire departments use four (4) 24-hour rotating shifts. Houston firefighters and fire officers in operations work a one on and three off schedule. This one on, three off schedule results in an average work week of 42 hours.

In addition, Houston firefighters and fire officers work ten (10) additional "debit days" each year. The addition of these 240 hours of work brings the average work week for Houston firefighters and fire officers up to 46.7 hours per week.

There has been some discussion of converting the HFD operations work schedule to a three (3) shift system. In the absence of a requirement for HFD firefighters and fire officers to work additional hours and extend the average work week above the current level of 46.7 hours, we do not envision any appreciable cost savings in converting to a three (3) shift system.

If HFD were to convert to a three (3) shift schedule, firefighters and fire officers would work a one on and two off schedule. This schedule results in an average work week of 56 hours. To reduce the average work week to the contractual 46.7 hours, operational firefighters and fire officers would have additional time off from their regular schedule. These additional days off, called Kelly Days in many fire departments, reduce the average work week. If the HFD were to convert to a 3-shift system and maintain the average work week at 46.7 hours, each firefighter and fire officer would have 20 Kelly Days per year.

The elimination of the fourth shift would result in the redistribution of the firefighters and fire officers from the fourth shift into the three (3) remaining shifts. These firefighters and fire officers would be utilized to work in place of firefighters that are absent for any leave type (sick, injured, vacation, etc.) and to work in place of firefighters and fire officers absent due to a Kelly Day.

Full-Time Employee/Overtime Balance

The most efficient use of taxpayer funds is to have a balance between firefighter and fire officer employees that work full-time (FTEs) and overtime. Too few FTEs results in higher overtime costs and an increase in overall cost (the cost of FTEs and overtime added together). Too many FTEs results in more staff than needed to staff all response units on a given day and higher overall costs than an appropriate blend of FTEs and overtime. The optimum number of firefighter and fire officer FTEs will utilize overtime to supplement staffing on high leave usage days and limit the need for overtime on low leave usage days. The optimum number of firefighter and officer positions may be increased or decreased through changes to the CBA, and/or changes in some management practices.

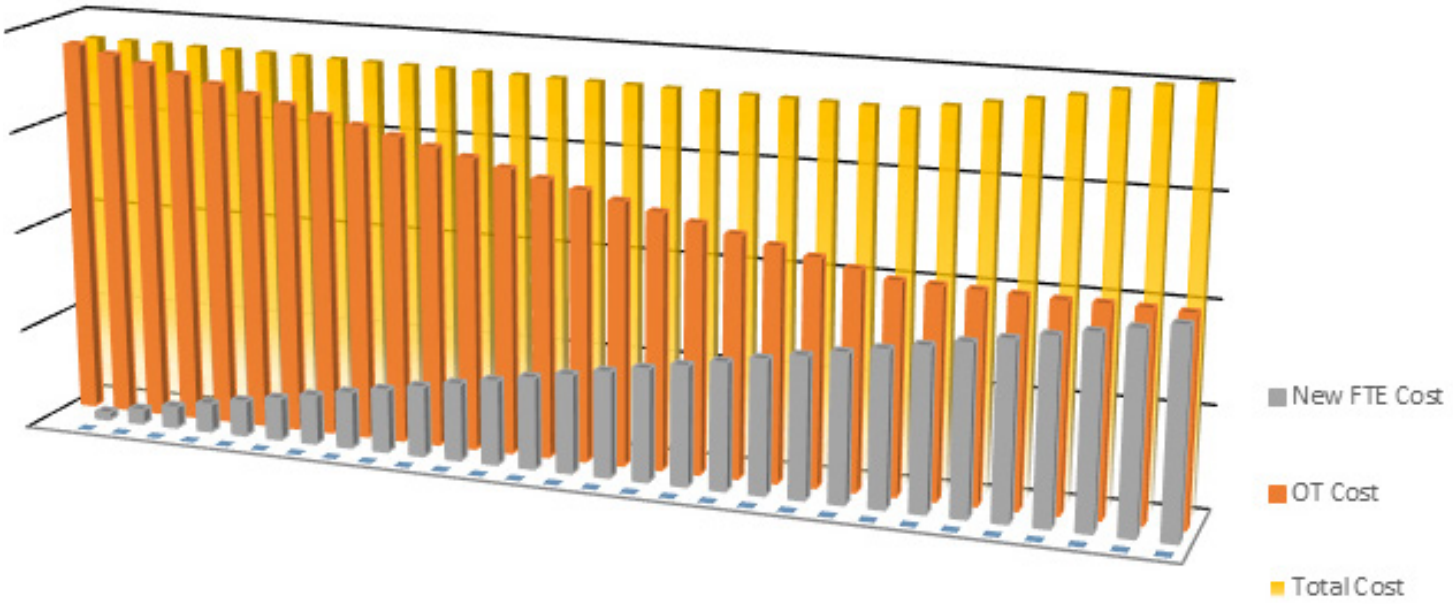
Leave usage in the HFD fluctuates by the day of the week. **Table 11** - Use of Overtime by Day of Week shows that the lowest day for HFD overtime use is Tuesday with 22 positions being hired on average in 2015. The most efficient overtime plan for the HFD comes as close as possible to eliminating overtime on the lowest use day of the week without overstaffing. If the HFD was to hire too many additional FTEs per shift, there is the potential that the department would be overstaffed on the lowest average overtime usage days of the week - Mondays, Tuesdays, and Wednesdays. Over hiring to eliminate overtime can actually cost more than the use of a balance between FTEs and overtime.

Table 11 – Use of Overtime by Day of Week 2015

	Daily OT Positions
Monday	28
Tuesday	22
Wednesday	25
Thursday	35
Friday	60
Saturday	97
Sunday	64
Weekly Totals	332

Figure 83 below depicts FTE costs combined with overtime costs to show overall cost. As the number of FTEs rises, overtime use is reduced. If too many FTEs are hired, the HFD can actually be overstaffed on some days. Overstaffing is when more than 845 firefighters and fire officers are available for duty on a given day. Any day with more than 845 firefighters and fire officers present for duty is inefficient because they exceed the daily minimum needed to staff all emergency response units.

Figure 83 – Overtime, FTE's, and Total Staffing Cost at Various Staffing Levels



Relief Factor

The number of employees required on the payroll to fill one (1) position 24-hours per day, seven (7) days per week is called the "relief factor." The relief factor for any fire department must be calculated based upon paid time off from the normal work week for the entire operational division of that department, averaged down to hours per-employee per week. This number will generate the average time during a workweek that employees are on-duty taking all leave use into account. Once the "true" work week is known, it is divided into the total hours in a week (168) and results in the number of firefighter and fire officer FTEs required to fill one (1) position every day. HFD's most recent relief factor is 4.3. This means that there are 4.3 FTEs needed to fill each of the 845 daily positions in operations.

HFD Calculations

After calculating the total time taken off while in "paid status" by operational personnel in 2015 (including sick, vacation, funeral leave, military leave, on duty injuries, FMLA, etc.), it was determined that the average amount of time an operations employee works per week is 39 hours. After dividing the total weekly hours of 168 by the average number of work hours of 39 hours, the result is 4.3 which is HFD's relief factor. This number must be monitored and should be recalculated annually or whenever there is a material change to contracts, leave patterns, or other impacts. To get the total number of FTEs needed in operations, multiply the daily count of 845 by the relief factor of 4.3, and the result is 3,634 FTE.

Fluctuations above and below this number need to be managed and take into account pending retirements and any other development that could increase or decrease attrition. Current discussions about changes in the retirement benefits afforded to Houston firefighters and fire officers could have a dramatic impact on attrition. Fire departments around the nation that have implemented changes to their retirement systems (incentives for senior members to retire, changes in benefit calculation methods, changes in the eligibility of pay to be pensionable) have seen waves of retirements and other types of unplanned separations. Depending on the specific changes to retirement benefits, these unplanned separations are typically composed of the most senior and the most junior members of the department.

It must be noted that the 3,634 staffing number only includes firefighters and fire officers assigned to emergency operations. Uniformed HFD members not assigned to emergency operations, such as command and support staff, fire prevention staff, and fire investigations staff would be in addition to this staffing number.

The staffing factor number is also useful when a new staffed emergency response unit is added. For example, a new engine company that is constant staffed with a Captain, an E/O, and two (2) firefighters would generate the need for 17.2 FTEs.

The use of the HFD staffing factor of 4.3 and 845 positions on-duty yields a recommendation of 3,634 firefighter and fire officer FTEs.

Based on all factors described, the number of operational shift personnel should be maintained as closely as possible to 3,634. At this number the City of Houston pays the least amount possible when both the cost of full-time employees and overtime costs are added together for the total cost.

Recommendation 35:

To staff current emergency response units, maintain HFD staffing in emergency operations as near to 3,634 as possible.

By keeping operational staffing as close to the optimum number as possible the overtime needed to staff HFD operational positions should hover around $10 million per year. To eliminate more overtime by hiring additional FTEs will result in a higher total cost.

When these calculations were first done in December of 2015 the Houston Fire Department had 3,529 firefighters and officers staffing operational positions. This number frequently fluctuates due to retirements, separations, and new hires. As of August 4, 2016, HFD had increased operational staff positions to 3,674. The HFD staff has advised that this number is being hired in anticipation of upcoming retirements and vacancies and will be reducing soon.

It is very difficult to keep the FTE count at exactly 3,634. The FTE count is impacted by retirements, terminations, resignations, the hiring of cadet classes, and other factors. HFD makes significant efforts to forecast employee attrition but it is impossible to predict exact attrition – especially in a fire department as large as the HFD. It may be impossible to manage the total number of HFD FTEs in operations at exactly 3,634. Fluctuations above and below this number are to be expected. In the absence of the ability to reliably predict attrition, the total number of operational FTEs should be managed within a fairly tight range, approximately 3 percent.

Relief Factor Changes

Anything that reduces the amount of time taken off, or which day of the week the leave is used, results in lowering the relief factor number and saves money. Some actions that may decrease the relief factor are:

- Implement a buyback of vacation when scheduled on Friday, Saturday or Sunday (and some holidays). Under this scenario, employees agree to work their shift on a scheduled vacation day and receive additional pay for the day at their straight hourly rate. Their vacation leave bank would be reduced commensurately. If this were done the city would pay out straight hourly rates instead of time and a half and save one-third (1/3) of the cost.
- Develop a system of eliminating excessive or inappropriate use of sick time. Sick time is the way many employees take off when they can't get approval for scheduled time off. From reviewing HFD sick leave use patterns, it is clear that weekends are prime days when inappropriate or excessive use of sick leave occurs. There are programs of visitation and observation that can be effective and have been implemented in other fire departments.
- Structure a program to review and manage (to the extent that it is possible) the use of FMLA leave. Many fire departments are challenged to provide FMLA as required for their employees and at the same time prevent overuse or inappropriate use of this benefit.
- Review of the CBA to determine ways to reduce time taken off. One of the big reasons it is hard to balance heavy leave-usage days versus light leave-usage days is the work schedule. If a work schedule could be negotiated where all debit day shifts were worked on heavy leave-usage days, there would be a significant opportunity to save. Such a shift could be bid by seniority or assigned by reverse seniority.
- Review on-duty and off-duty injuries and programs to return employees back to full duty sooner.

Fire Prevention

The HFD has a Fire Prevention and Life Safety Bureau (Bureau) that includes approximately 126 uniformed staff and 22 support staff. The Bureau provides fire code compliance inspections and permit inspections services to the City of Houston. . The Bureau also has staff housed in the Building Department for some limited plans review activity.

The HFD Fire Prevention and Life Safety Bureau (Bureau) has been the subject of a number of reports in the Houston media in the recent past. These media reports, as is often the case, portray only part of the story. We found that HFD Bureau staff and leadership have a profound concern for the safety of the people of Houston, visitors to Houston, and for the safety of Houston firefighters.

While Bureau personal were passionate about their work, the Bureau is limited by two significant barriers. The first is a lack of support resources that cannot be fully ascribed to Bureau management. The second is a lack of an overall management approach to their work that is risk-based and includes input from the people that do the work. Neither of these barriers was created overnight and a comprehensive solution to these issues will take time.

The Bureau is limited by the lack of appropriate hardware and software to complete the basic tasks of the Bureau. This includes basic tools such as vehicles for inspectors and a functional digital inspection data management system. A functional inspection management system is a force multiplier that can dramatically improve efficiency, promote standardization of inspections, and allow management to monitor inspector performance, track recurring violations, and focus fire prevention efforts on risk.

The Bureau is also limited by a lack of management direction for Bureau operations. This lack of direction is not attributable to any failing on the part of the current Fire Marshal; it has developed over time. Many Bureau operations are the result of tradition or a reflex reaction to the way things have always been done. The Bureau is fragmented in its mission and individual staff members are sometimes forced to or allowed to develop their own work rules and approaches. This can be frustrating to the Bureau's customers as they expect consistency in the application of the Houston Fire Code.

We found that the Bureau is in need of some basic management tools – a mission statement and a strategic plan. It is important that these management tools be developed as a collaborative effort between the Bureau's customers, the Mayor's Office, other Houston departments with a stake in the development process, HFD executive staff, and – very importantly – the rank and file people in the Bureau that do the work.

The observations and recommendations in this report are intended to allow the HFD and the City of Houston to assess the current situation in the Bureau, make the changes necessary to improve the level of service provided, and make organizational changes needed to succeed.

While only a part of this larger study, the assessment and development of a path forward for the Bureau could be the subject of a more focused and thorough study.

The Bureau is divided into the following functional areas:

- Permit Inspections
- Night and Weekend Inspections (Bars and Assembly Inspections)

- Special Operations Inspections (events at the Convention Center, 3 airports)
- Institutional Inspections (hospitals, schools, foster homes)
- Plan Review (hazardous materials, high pile storage, and tank farms only)
- Hazardous Materials and High-Pile Storage Inspections
- Apartment (Multi-Family) Inspections
- High-Rise Inspections
- Inspections Resulting from Complaints (of code violations)
- District Inspections (general occupancies such as day care, strip malls, hot work)
- General Problem and Code Interpretation Resolution

The FACETS fire prevention study team included two (2) fire prevention subject matter experts who spent 2½ days interviewing the fire prevention staff. During this time, they interviewed about thirty (30) members of the Bureau including the Fire Marshal and most supervisors. Some interviews included multiple Bureau staff members and some were one on one. No support staff members were interviewed.

It was very evident to the consultants that the Bureau staff that we had contact with were very passionate about their work. The personal commitment to their work was apparent. The positive attitude about their work is to be commended.

The FACETS fire prevention assessment team reviewed no reports, data or documents generated by the Bureau. These common documents to reflect the generated work and the outcomes of that work are not available. The fact that these do not exist demonstrates the lack of information collected and used to manage the Bureau.

Many inspectors spoke of the responsibility they have in fire prevention for keeping Houston firefighters safe. Many inspectors have been innovative in getting information needed to accomplish their job responsibilities such as using an open records request to get a list of high-rise buildings from Harris County and working with the Houston Apartment Association.

One supervising inspector requires the staff to scan all records and reports to ensure an electronic back up copy is available. This is a best practice that will benefit the Bureau if implemented by all work groups. It demonstrates the personal initiative observed of inspectors to achieve even when restrained by too few resources and a cumbersome information management system (ILMS) used by the Houston Building Department.

The inspectors interviewed reflected excellent customer service in their interaction with building owner/occupants in conducting their inspections. “We sell fire prevention first and we enforce the code second” was one memorable statement. This customer service includes staff spending much time learning about the code of record to ensure the code requirements at the time the building was constructed are applied to inspections.

The city is to be commended for the life safety provided to the people of Houston through the retroactive high-rise building fire sprinkler ordinance requiring all high-rise buildings to be protected.

Inspections

The Bureau staff is organized and work assigned based on inspecting different type/classification of occupancies. This includes high-rise inspectors, hazardous materials inspectors, school inspectors and others. The work assignments of some inspectors is based on geography. This division of labor has merit, with staff specializing in the specific fire codes and hazards associated with those occupancies.

Staff working in a finite geographical area is also efficient.

Some inspections are also prompted by complaints of fire code violations/hazards, with some of these coming to the Bureau from Houston firefighters. There is no uniform or consistent method for fire department emergency responders to report fire code violations (called complaints) they observe to the appropriate Bureau staff for follow-up.

The Bureau needs to know the number of inspections required, the number of inspections completed, the number of code violations corrected, the number of permits issued, the number of citations, the number of re-inspections, and other measurements of the Bureau workloads and effectiveness. This will provide a basis to assess appropriate staffing for the Bureau.

Each of these inspection units operates independently. There is no standard inspection form or methods in the Bureau. Individual inspectors have developed their own forms within some units. Efficiency and effectiveness are hindered by these practices.

The actual number of high-rises, hazardous material, and other types of occupancies in Houston was stated to the team as unknown. It appears that the Building Department may have an inventory of that data, but it was not readily available for this assessment from the Bureau staff. It was reported that there are 6,800 apartments in Houston, but other staff says the number is unknown to the Bureau. This is another example of the isolation of inspection units.

Other assessment about some of the specific inspection categories is below

Institution Inspections

Within the Bureau there are a number of assigned inspectors who target special locations/occupancies. These occupancies include hospitals, jails, nursing homes, assisted living facilities, and schools. These can be important inspections, but are also locations that can be specifically managed utilizing a risk assessment and mitigation process. Indications are that most inspectors have high, but manageable, inspection numbers per individual. However, school inspectors seemed to report a lower than normal load of 60 to 70 schools (or locations) per inspector. These could likely be increased if managed appropriately.

Apartment Inspections

There are an exceptionally large number of apartments in Houston. As throughout the United States, these are high risk occupancies based on the type of construction, concentration of life hazard and frequently unmonitored activities that occur within each apartment unit. A unique program that was rolled out as the 360 Inspection program is a good attempt to address the issues related to this overwhelming number of inspections. It seemed that buy-in from the entire staff was limited, but the approach had merit for consideration.

District Inspections

Bureau staff inspects general business occupancies for fire and life safety hazards and code compliance. These types of inspections are typically the bulk of a Bureau's workload and include all types of businesses such as stores, restaurants, and offices. Staff reports that less than 20% of the inventories of existing businesses are being inspected regularly. This is principally due to limited staff and large geographical areas to cover. Each district inspector conducts about 1,100 inspections each year. This number is anecdotal. This is on par with typical workloads for other similar sized departments. This staff also is responsible for inspections for certificate of occupancy to insure the owner/occupant has required permits.

High-Rise Inspections

There were reported to be six (6) high-rise inspectors assigned to this unit. The total inventory of high rises in the City of Houston was reported to be around 600 to 700 structures. This group utilizes Google Maps to mark the assigned high rise locations and cover around 115 inspections per inspector per year. Some comments seemed to indicate that standard operating procedures for inspections of these occupancies were inconsistent, if available at all. This could be an area for more focus and improvement.

The bureau needs an inventory/census to know exactly how many high rise buildings are in Houston. This exact count can be used as the basis to manage the unit. When this and other essential data is in hand then the 360 Degree Program will have the elements to be successful.

Fire Prevention Resources

The level of support resources provided to the Bureau is minimal and it impacts the Bureau's ability to work efficiently. For example, there are currently more Bureau staff members assigned to work in the field than there are vehicles available for them to use.

Computer hardware failure is a reality that constrains the capability of the staff to perform basic tasks. Mobile devices may be part of the information technology solution for the Bureau.

Internal and external decision makers will benefit from regular financial reports about the city revenue generated by fire permit fees. It is important that the impact of these fees be considered a revenue offset for necessary Bureau resources as the Bureau budget is determined. Additional resources for the Bureau will improve fire prevention productivity and increase revenue from the fire permit fees.

The Bureau is constrained by the use of a city data management system, Integrated Land Management System (ILMS), used principally by the Planning and Building (P&D) departments. This system is available to and used by the Bureau staff but the functionality for fire inspections appear limited. We were told that any requests for modifications or upgrades, including ad hoc reports are costly. Building stock and occupancy classifications, as well as land use data is critical for determining risk information and conducting risk analysis. Providing access to necessary components of ILMS or procuring other enterprise software that allows this data collection and analysis is essential for efficient and cost effective fire prevention program management. It is evident that the lack of an information management system that meets the needs of the Bureau is a major hindrance to their work. The work of the Bureau is made more difficult by the necessity to develop a work-around to make ILMS "work" for their applications. The time and effort to use this system is a detriment on a daily basis to the work of the Bureau.

Recommendation 36:

Provide basic resources for the Fire Prevention and Life Safety Bureau commensurate with the organization's mission. This includes a reliable vehicle for each inspector and a working computer or appropriate mobile device with IT/help desk support.

This solution will impact the entire scope of the Bureau. It will include transitioning from paper inspection forms to electronic and to standardizing the many different inspection forms used throughout the Bureau. When this recommendation is fully implemented, Bureau staff will complete an inspection, receive the owner/occupant signature (electronically on a tablet, for example), and print or email the report for the owner/occupant on site, removing the necessity to travel to Bureau offices and then return to the location to provide a report to the owner/

Recommendation 37:

Provide an information technology (enterprise software) solution for fire inspection forms, reports, notifications, and other basic and advanced inspection tasks.

occupant. This solution should also provide reporting on inspection activities and common problems found during inspections to enhance Bureau management and analysis of information.

The inspection staff operates with a high level of inefficiency using various paper forms for actual inspections and then entering the same data a second time electronically, printing the report, preparing the notice of violations for the owner/occupant. The inspectors then return to the property to deliver the notice for signature. These functions are managed with high efficiency in fire departments across America using common information technology (computers, mobile devices and software). This is a priority for the Bureau.

The HFD currently uses the commercial fire department management software, FIREHOUSE, but it is not available to the Bureau. This software should be considered to meet the records management needs of the Bureau. It also could be used for communication between the Bureau and emergency responders in fire stations when inspectors identify hazards. The city P&D Department also has GIS available to all departments that may have capabilities to support some needs of the Bureau. The Bureau does not utilize these capabilities. This is information directly from the City of Houston web site:

GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information or data. The P&D Department has developed an enterprise level GIS to serve the entire City of Houston. The goal of the GIS division is to serve the geographic information system and geospatial needs of the City of Houston across departments and among all staff and the people of Houston. (http://www.houstontx.gov/planning/GIS/GIS.html)

In mid-2016, the Bureau began to roll out tablet computers to Bureau inspection staff. These tablets incorporate software that allows inspectors to record the results of their inspections and FAX or email reports directly to the building's responsible party. The tablets interface with the ILMS system.

The distribution of this technology began with high rise inspectors and will proceed through inspectors in other occupancy types. The Bureau has 120 of the ruggedized tablets in hand, enough to provide this tool to all field inspections staff. There are also plans to use the same technology for Arson Investigations staff in the future.

Organizational Management

During the interviews FACETS staff conducted with Bureau personnel, it was immediately apparent that there are some significant organizational obstacles within the Bureau. Many organizations have some disconnect between lower level staff and upper management. There appears to be significant communication gaps and philosophical issues that are barriers to accomplishing the prevention and life safety mission within the Bureau. Communication is most often the root of many organizational issues and it appears that a lack of good communication practices is endemic within the Fire Prevention and Life Safety Bureau. As an example, Bureau staff commented that they were unfamiliar with the current organizational structure and personnel assignments due to changes that occurred in April of 2015. In December 2015, when we referred to organizational charts provided to the FACETS Team, staff asked for copies saying they had not seen the new Bureau organization charts.

Bureau staff expressed general discontent with the leadership practices within the Bureau. It is assumed that the history of the Bureau, human resource management, and other factors contribute to this perception and while noted by the consultant team, it was not within the scope of this assessment to arbitrate.

The Bureau staff interviewed claimed to not be aware of the current organizational structure including which programs have been eliminated/stopped or even the status of the 2012 code adoption by the city. The staff seemed generally unaware of Bureau policies and procedures. The Bureau inspection groups work in isolation from one another.

Recommendation 38:

Develop and implement business and organizational best practices for the Fire Prevention and Life Safety Bureau including a strategic plan, standard operating procedures, and an internal communications plan.

Implementing personnel and business best practices may result in a new organizational structure for the Bureau. It is strongly recommended this be considered in an effort to improve customer service and improve the efficiency of the Bureau. A good standard of reference for doing this is NFPA 1730, Standard on Organization and Deployment of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigation and Public Education Operations. This standard provides a good methodology for analyzing bureau functions, needs, and how to organize it based on a strategic risk analysis approach.

The Bureau will benefit from implementing business/organization management best practices. This includes a strategic plan, standard operating procedures, participatory management, regular command staff meetings and communications to all staff to include the following: Bureau organization chart, city and department policies, Bureau program familiarization, changes in organization structure and programs.

The Bureau will benefit from an increase in the general knowledge of the staff about fire department and city policies and programs. This will benefit the Bureau program outcomes and efficiencies.

A defined work plan and Bureau goals must be articulated in a strategic plan for the division. It is best for this to be an outcome of community risk reduction.

Each inspector uses their own forms and develops their own inspection practices. The Bureau will benefit from a set of baseline standard operating procedures implemented across the organization.

The 360 Degree Program is integral to meeting the Fire Marshal's mandate (dated March 2015). The program will be most effective to streamline process, improve production and efficiencies when the selection of vulnerable target areas is supported by essential data.

360 Degree Plan was designed to target the city's most vulnerable and most populated facilities for inspection. This concept is exactly the goal of fire prevention/community risk reduction. The bureau needs to ensure that these efforts are supported with essential data that is unique to the Houston Fire Department emergency response experience, the data collected by the Bureau from previous inspections, community demographics, fire company pre-fire plans, occupancy changes, community input, and other factors that impact the vulnerability of the Houston populations.

Mission and Planning

The Bureau staff interviewed had no awareness or ability to describe the fire problem in Houston. Anecdotally, the staff had beliefs of where their mission objectives should be directed. However, these appeared to be more related to outdated or historical task assignments based on perceived risk by number (quantity) of occupancies or hazardous operations, as opposed to addressing actual risk and targets for mitigation.

Direct access to fire department records and reports is best, but hard copies of monthly or quarterly reports can be substituted and implemented promptly.

The Bureau staff needs a working knowledge of the fire problem in the community. They should be provided access to fire department data, including the location of fires, origin and cause, fire deaths, fire loss and outcomes of fire investigations. The Bureau must manage the limited resources in the occupancies and geographic areas of the City with the highest risk for fire loss.

This information is critical to determining community risk reduction strategies for the Bureau and to managing the Bureau resources.

Community Risk Reduction

The City of Houston and the fire department will benefit from a community risk reduction strategy that targets risks based on loss experience and data. The targets of fire loss reduction, fire death and injury reduction can be identified and direct/guide the fire prevention goals and the activities of the Bureau.

The Bureau process explained by the Bureau staff describes a system of inspections and the frequency of inspections driven by a list of occupancies and not based on deploying fire prevention resources in the highest risk locations and occupancies. We applaud the 360 Degree Program with the goal to target the most vulnerable and most populated facilities. At the time of the interview with the Bureau staff there was little support or understanding of the Program. Supporting the Program with essential data that documents the risk in Houston is a first step to continuing to build staff support.

Recommendation 40:

Develop a community risk reduction strategy that targets risks based on loss experience and data.

The inspections currently targeted by the HFD are reasonable, based on a traditional general approach to fire prevention techniques and practices. However, given budget constraints and limitations on the number of staff assigned to inspect the already large and increasing number of high-rise buildings in addition to other new construction, this approach is likely missing other hazards in the community that may pose a greater risk. A community risk reduction strategy will highlight these hazards. The 360 Degree Program is based on similar goals but the data to support the selection of targeted risks is absent.

The data needed includes Bureau inspection, violation, and enforcement data, a common inspection form, time on task information, common training, a precise number of occupancies in the jurisdiction, and an enterprise software system to make all the work more efficient. The Operational Plan for Hospitals, Nursing Homes and Jails lists the exact number of each of these occupancies.

Implementing a data system to enter inspection information and keep records will be difficult to implement if every unit and sometimes people within a unit continue to use their personally developed inspection forms.

Modifying the approach to fire prevention and inspections in protected (built-in detection and suppression systems, such as a fire

sprinkler system) and unprotected (no systems) occupancies in a manner that better addresses the actual risk is a more appropriate method as opposed to inspecting all buildings the same way. This is another example of how risk assessment can impact the function of the Bureau and improve fire safety for the people of Houston.

A self-inspection program that provides the opportunity for some owner/occupants to prepare for a fire inspection using information provided by the Bureau prior to the inspector arriving has merit but must be based on a community risk reduction plan. The current 360 Degree Program, seen in December by the consultants, includes these self-inspections. A standardized self-inspection program that requires no follow up or follow up within an extended time frame by an inspector should be considered as an addition to the 360 Degree Program. For example, newer low-risk buildings or occupancies that have limited or no previous code violations, are excellent candidates for such a program.

This type of assessment will also lead decision making to prioritize Bureau staff time and may eliminate some tasks currently considered basic to the work. For example conducting portable fire extinguisher training is a task that can be returned to the owner/occupant to supply based on a list of qualified vendors vetted by the Bureau. This training is the responsibility of the owner/occupant. If the Bureau continues providing this training it should be provided as a fee based service.

Training

Concern about training was initiated by staff. The current level of initial training for staff entering the Bureau is not acceptable. Training for new inspectors is a high priority. The training program requires additional assessment and resources to implement a new and improved curriculum. The past and current training to prepare new Bureau staff to pass the Texas Commission on Fire Protection inspector certification exam receives comments ranging from "great" to "inadequate" from the current staff. Informal on-the-job training is currently how new inspectors are trained to do their job. This is seen by most as sufficient, however, formal training and testing during this process should be standardized and demonstration of knowledge and skills should be documented prior to allowing new staff to function alone. The current edition of NFPA 1031, *Standard for Professional Qualifications for Fire Inspector and Plans Examiner* should be the guide for all initial and on-the-job training. Recently, the first graduating class of fire inspectors trained in-house at the Houston Fire Department Training Academy was successful. All nine (9) newly promoted fire inspectors passed the Texas Commission on Fire Protection inspector certification exam on their first try.

Informal, on-the-job training is currently how new inspectors are actually trained to do their job. This is seen by most as sufficient. However, formal training and testing during this process should be standardized and demonstration of knowledge and skills should be documented prior to allowing new staff to function alone. NFPA 1031, Standard for Professional Qualifications for Fire Inspector and Plans Examiner, should be the guide for all initial and on-the-job training. The Texas Commission on Fire Protection inspector certification system uses this standard as the basis for their testing.

As fire codes change and fire protection and suppression systems incorporate more sophisticated technologies, continuing education for the Bureau staff should be an organizational priority. Continuing education is also required to maintain staff certifications. Currently, this is all in-house training and budget to travel to any outside training has been eliminated. The HFD should consider initial training and continuing education for fire inspectors to be a priority.

There is a strong desire by staff to receive quality initial training and continuing education. The staff is aware that lack of training has an impact on the efficiency of their work.

The Bureau staff has no known current involvement in national or international code development groups. This is an excellent way for HFD to share their knowledge and expertise with other cities, as well as provide staff the opportunity to learn about current fire prevention best practices established in other similar metropolitan fire departments.

It is recommended that the past practice of assigning some inspectors to participate in the development of the national fire codes be reinstated as a best practice that is important to the professional development of the staff. Other training opportunities should be included in the budget including attending fire prevention courses at the National Fire Academy.

Since the consultants discussion with Bureau staff the Fire Marshal reports that all nine new inspectors were successful in passing the state certification exam. He credits the new training method which partners half a day of classroom teaching with half a day in the field conducting inspections. The Fire Marshal also reports that there is budget for continuing education for inspectors as well as access to on line training for continuing education.

Plan Review

The Bureau staff (about 10 staff members) located in the Houston Building Department performs plan review functions. These are limited to hazardous materials, high-pile storage, and tank farm occupancies. A city engineer reviews fire protection systems, such as fire sprinkler systems. Bureau staff communicated the need for the fire department to review all plans for emergency vehicle access and fire protection water supply. The need for fire protection engineers in the plan review process was a theme that was repeated by numerous Bureau staff. They also discussed the reality that to recruit and retain fire protection engineers, the city must establish a competitive salary range.

A staff of fire protection engineers should conduct technical plan review functions. These are commonly performed by the fire department in other jurisdictions. Degreed fire protection engineers can provide a myriad of services, including solving design and fire protection problems, technical level evaluation of hazards and risks and detailed evaluation of various fire protection systems. This would provide a higher level of customer service not only externally, but also internally for fire prevention Bureau staff. Staff reports they spend significant time researching code and system requirements that could be more efficiently performed by fire protection engineers who have inherent understanding and knowledge of codes and standards.

Building plan review best practices specify that the fire department must be involved from the onset of developments such as concept and development plans followed by water distribution plans, construction plans and all relevant fire protection system plans. This enables the fire department to evaluate fire department access, fire water supplies, and fire hydrant spacing. Evaluating these plans enable rapid feedback on deficiencies that enable developers and designers a chance to modify designs prior to expensive change orders. This not only facilitates the ease by which new businesses are started, but also provides a much more reasonable business friendly approach to regulatory service delivery.

Recommendation 41:

Significantly increase the involvement of the Bureau in the construction and site plans review process. Utilize FPE's in the process.

Pre-Fire Plans

The fire department should connect emergency responders (engine and truck companies) pre-fire planning (pre-fire surveys) and the Bureau fire code compliance inspections. The safety of fire department emergency responders will be improved when fire stations have access to information about buildings, code compliance and code violations, as well as changes in occupancies as tenants change.

An IT/electronic connection is ideal but can be facilitated in other ways.

Some inspectors are in communication with fire companies and District Chiefs about the findings of the inspections, but this is not a uniform practice in the Bureau.

Public Affairs Fire and Life Safety Education

The consultants also interviewed the Public Affairs Captain about the fire and life safety education (FLSE) programs delivered by the HFD. This is a fire prevention function recently moved from the Bureau to Public Affairs.

The captain responsible for that unit is very aware of where high-risk areas are in Houston, based on fire response in the city. The programs follow national best practices, including canvassing neighborhoods installing smoke alarms and delivering home fire safety information immediately after a fire in the area.

He is an active user of Arc GIS in identifying and mapping these locations. This technology is also used to report the delivery of educational programs and smoke alarm installation.

He appears to have a good grasp of proper messaging strategies and targets. This individual utilizes strategies and techniques that would be beneficial in overall fire prevention efforts including in the Bureau.

It is recommended that the fire and life safety education (FLSE) programs continue under the direction of the Public Affairs Captain.

The leadership is dynamic and finds ways to leverage resources to the maximum benefit for the people of Houston. The fire department should consider increase staffing in Public Affairs to deliver educational programs to reduce the risk for high fire death and injury target audiences. It is recommended that the youth firesetter intervention program be part of other FLSE programs in Public Affairs or work in cooperation with the Arson Unit's program.

It is also recommended that the FLSE staff be certified according to the appropriate chapters of NFPA 1035, *Standard on Fire and Life Safety Educator, Public Information Officer, Youth Fire Intervention Specialist, and Youth Firesetter Program Manager Professional Qualifications*.

Other training opportunities should be included in the budget including attending fire prevention courses at the National Fire Academy.

Arson Bureau

The Houston Fire Department has an exceptionally large Arson Bureau. It is rich in human resources, but somewhat limited on support equipment and vehicles.

The Arson Bureau services the city, experiencing approximately 2,500 to 3,000 working fires of significant size or complexity per year. Of these fires, approximately 1,200 fires require fire investigators to respond in order to determine origin and cause. The number of incendiary fires average around 500 per year with an arrest closure rate running just above 17%. This is slightly lower than the last national average closure rate of about 19% as cited by the Federal Bureau of Investigation (FBI) in a 2014 publication provided by the National Fire Protection Association (NFPA).

The operating budget for the Arson Bureau is approximately $500,000.00 annually. This appears to handle the basic needs, however insufficient detail was provided regarding strategic plans or needs that may require an adjustment in that number.

The case load per year, per investigator is between 15 and 30 cases. As a contrast, many large city major crimes units often handle caseloads in excess of 150 to 200 cases per officer per year. While no average amount of time can factually be attributed to a fire investigation due to the variables and complexities involved, it does appear that the load per investigator is somewhat light for a city this size.

The Arson Bureau staff is very passionate about their mission and does a good job of determining fire origin and cause for the people of Houston. However, due to the number and types of various tasks, a clear and concise mission statement for the bureau could be very helpful in better defining the roles/responsibilities and duties of the investigations staff. The mission should also maintain statements of quality and characteristics that are desired by each member so as to strive for excellence in all they perform.

The development of a mission statement that reflects the purpose for the Arson Bureau's existence would provide focus for the Arson Bureau. The mission statement should define why the work is performed, as well as the quality and characteristics of the Arson Bureau. This statement should be formed collaboratively with all members of the Arson Bureau so as to capture the group's input on purpose, practices and quality statements.

Recommendation 42:

Develop a mission statement for the Arson Bureau.

Sedans are the primary means of transportation for fire investigators who respond to scenes. Currently, there is no standardized set of equipment provided; rather it is determined on the individual preference of the investigator. One element of concern is the storage of personal protective equipment (PPE) and how that is handled within the car. Recent studies have shown that volatile chemicals and off-gassing of contaminated PPE and equipment can potentially increase the risk of chemical exposure to the investigator. To minimize the potential risk of exposure, a standardized decontamination policy that addresses transportation and storage of PPE should be developed. We were advised that to enhance response time, investigators are permitted to take their vehicles home. However, bringing gear and equipment home provides an opportunity for individuals to clean their gear at home which can contaminate their living space and expose family members to the same potential chemical risk.

The development of a strategic fleet management program for the Arson Bureau would be helpful in providing appropriate vehicle resources for the Bureau. The Arson Bureau's response area is currently served by one Heavy Investigations Support vehicle, backed by individual investigator's sedans. Specialized pickups, vans or similar vehicles should be considered in place of sedans so that appropriate types and amounts of tools, evidence collection containers, decontamination equipment, as well as properly separated PPE may be properly isolated and stored. This is necessary in order to provide adequate redundant support for large, multiple, or complex incidents as well as protect the investigators from exposure to hazardous chemicals.

Recommendation 43:

Develop a strategic fleet management plan for the Arson bureau.

Staffing of the bureau occurs after a significant testing and training process. There are required examinations that were noted to have a roughly 80% failure rate for first time applicants.

Once an applicant is accepted into the bureau, they are required to pass an extensive background and fingerprint process. They are also subjected to a psychological profiling test and must attend one of the regional police academy or college courses in order to receive their peace officer certification.

Basic fire investigation courses are then mandated along with extensive on the job training. Field training officers then monitor their progress and proficiency until they sufficiently prove their competencies and proficiencies. This process takes roughly one (1) year to complete, after which time the candidate is generally released to work independently.

Professional certifications are very important, particularly in light of the increasingly litigious nature of investigative work. Arson investigators are not only responsible for determining what causes fires, but they are also responsible for identifying instances of arson and prosecuting the criminals that use fire as a weapon. In doing so, the investigators are trained and certified as peace officers. This responsibility should be supported by the greatest degree of education and training reasonably available in addition to the highest levels of reasonable certification that is available. The International Association of Arson Investigators (IAAI) utilizes various certifications to substantiate and verify that individuals have met nationally prescribed levels of training and experience based on national standards and good practice.

It is imperative that the HFD and the City of Houston strive to provide trained and certified personnel to reduce and mitigate potential liability exposure and provide a high level of professionalism. As such, there are four IAAI certifications that would be beneficial for HFD. The IAAI certifications provide an unbiased, independent third-party evaluation of competencies, verifies experience and competencies, and demonstrates that the individuals are maintaining currency in educational aspects of their profession.

Recommendation 44:

Provide additional appropriate certifications for fire investigators.

- Certified Fire Investigator (CFI) – This is the highest level of fire investigator certification available from IAAI. This should be the target for all fire investigators to achieve.
- Fire Investigation Technician (FIT) – This is an intermediate investigations certification that verifies the basic

fundamental requirements of the position have been met and again, ensures current and relevant training is being maintained.

- Evidence Collection Technician (ECT) – This certification verifies that those individuals responsible for evidence collection and processing are capable in the fundamentals of evidence collection and handling.
- Certified Instructor (CI) – This certification ensures that the individual is competent and capable of conducting technical instruction in the field of fire investigations. One approach HFD could consider may include all Senior Captains in the Arson Bureau receiving this certification so as to be able to provide ongoing continuing education as well as mentoring and training apprentice members in the bureau.

Standard operating policies, procedures and guidelines are fairly well represented in the Houston Arson Bureau Guidelines. These appear to be mostly up-to-date all though some members in the bureau believe they should be more refined and potentially separated from what may be considered general fire department policies or contractual mandates. These appear to be fairly well compiled, but it seemed that all are not being followed or rigidly enforced based on interviews. While the guidelines we reviewed seemed good, we believe more reference to national standards should be made.

Turnover in the unit is very light, generally only occurring as a result of retirements. This speaks well to the unit as people who work to get into the bureau want to stay there. This ensures that the money invested in training and qualifications will not be lost over time, which is a very strong attribute to the Arson Bureau.

There is one K-9 accelerant dog in the Arson Bureau. This is an exceptional tool to assist investigators in identification of potential accelerant locations. The number of responses for this unit appears typical for other parts of the United States and the capabilities and program management by the handler appear good.

The process of initiating and conducting fire investigations is typical to most parts of the United States. Initial origin and cause investigations are the responsibility of the company officer or the incident commander, depending on the type of fire incident. At such time the company officer or incident commander is not comfortable with establishing the origin and cause, an investigator is requested. This request goes to a senior investigator who then notifies a minimum of two (2) investigators to respond. There may be occasions where only one (1) investigator is sent; however, typically two (2) are assigned. This is a standard of good practice not only for cross checking the work, but providing scene safety for personnel who respond. Senior Captains or chiefs are contacted and advised in situations of complexity which allows for adjustment in scene resources or activities.

The allocation of personnel for covering various sectors, shifts, and times of the day is appropriate. The management of these assignments appears to cover the needs of the city.

There is a professional photographer in the Arson Bureau who is used when complex scenes are discovered or additional assistance on large scenes is requested. This individual also works to retrieve and enhance various surveillance videos for assisting the investigators, as well as enhancing other types of photographic mediums to assist in trials, analysis or general investigation work.

There is a latent fingerprint lab where prints can be pulled from various surfaces and then forwarded to the Houston Forensic Science Center for processing and storage. This is a progressive step in the investigative process which saves time and expedites the potential identification or clearing of suspects. If possible, regular certification and evaluation of the equipment and processes would be advisable to ensure quality assurance and liability protection.

The facility that houses this lab also is used to store all evidence collected from fire scenes. There is a good process for checking in and logging evidence as it is collected and stored. A new records management system has been purchased and the assimilation of old data into this new system is currently under way. This process and system will make evidence cataloging and retrieval much easier and stable.

There are collaborative relationships with outside agencies: local, regional and federal. Various incidents have occurred over time which has necessitated the use of agencies such as the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), Federal Bureau of Investigation (FBI), Texas State Fire Marshal's Office and Houston Police Department (HPD). These relationships have at times been strained; however, they have been improving and appear to be working well at this time.

Data collection and retrieval on fire investigations are principally handled through the free federal Bomb Arson Tracking System (BATS). There are other software packages being used to track evidence and log photos, but most significant incident investigation tracking information is kept in BATS. This is an adequate case management system that can be shared and observed by all users of the system to track trends, monitor cases, and compare findings. If regional partners are utilizing this software, they are able to communicate effectively across organizational lines to track incidents, suspects and compare data. This is a good program and we encourage its use to the fullest extent possible.

Analyzing data is a critical function of fire investigation. There appears to be no geographic information system (GIS) use in this bureau. The use of mapping, time stamping of fires, types of fires, and types of targets all can be highlighted utilizing this too. We have been told that the City of Houston utilizes the ArcGIS suite of applications, but apparently it is not being used by the Arson Bureau. This tool not only can be used to identify potential "hot spots" or scope of problems but it can be very useful for graphically representing fire experience visually for jurors, the District Attorney, city management and certainly fire department management.

Graphical depiction of fire experience can and should be coupled with inspection and fire code violation history that the Life Safety Bureau is, or should be, collecting. Comparing statistics and analytical findings across all fire prevention and investigation groups enables management to evaluate the overall loss experience and develop a more strategic plan for community risk reduction. The total work of HFD in their prevention and arson bureaus is extensive. However, there is no clear definition of what the real problems are, where they are located and then how to properly address them given limitations on staffing, resources and time. Developing a good data set and then mining this data would provide exceptionally clear pictures of what risks in the community are present, how they should be addressed and when.

The juvenile or youth firesetter arson problem in Houston is significant. We were told that one (1) fire investigator is working on a Youth Firesetter program, however, the details and information was limited. Identification of youth firesetter problems in any large community will generally yield a telling picture of the complexity and involvement of the community arson problem. Providing education and awareness to youth who have or may set fires, whether intentional or out of curiosity, is essential.

However, an aggressive program for identifying the problem and providing outreach services for correcting these behaviors or holding parents and the affected children accountable is paramount. Based on the number of investigators in this bureau, it should be easy to accomplish a very intensive task of expanding and implementing a variety of youth firesetter programs. This development and the awareness of the program(s) should be broadly spread through the Arson Bureau so that all members know how it works, why it works and how to initiate program elements.

Overall, the Arson Bureau of the Houston Fire Department does a good job of accomplishing their established mission. It is apparent that there are many opportunities for improvement. Some of these will require significant financial and resource investment. However, in order to minimize overall risk to the individuals, the department and the city, we find some recommendations to be more critical than others. The bureau has dedicated staffs who want to do a good job as is evidenced by the collaboration and dedicated work of its various members.

Safety and Health Programs

The fire department has many programs in place to address firefighter safety and health. These include:

- Medical evaluations for recruits
- Medical evaluations for hazmat and special rescue teams
- Physical fitness program for recruits
- Infectious disease and control
- Joint Labor-Management Safety Committee
- Occupational wellness program
- Incident-scene rehabilitation
- Motor vehicle accident review
- Operational Safety Officers
- Staff psychologists
- "Courage to be Safe®" program for recruits
- "Fireground Survival Program"
- Accident and Injury Data Base

Medical Evaluations for Recruits

The department currently offers medical evaluations to recruit firefighters. The medical evaluation is conducted by a contractor and is consistent with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

Medical Evaluations for Incumbent Firefighters

The department currently offers medical evaluations to incumbent firefighters assigned to Hazardous Materials and Special Rescue teams. The medical evaluation is conducted by a contractor and is consistent with NFPA 1582.

Physical Fitness Program for Recruits

The Training Academy has a policy in its "Code of Conduct & Standards" for recruit physical fitness. This program assures the department that recruits are fit for duty when they graduate from the academy.

Infectious Disease and Control

The infectious disease and control program is under the direction of the EMS section and appears to run in a very comprehensive and professional manner. This program is discussed more fully in the Emergency Medical Services section of this report.

Joint Labor-Management Safety Committee

The Department has a "Joint Labor-Management Wellness-Fitness" committee that reviews safety related existing and proposed guidelines, equipment and facilities. Any concerns are addressed to fire department management and the local union.

Occupational Wellness Program

This program is designed to help members with a healthy and physically fit lifestyle. The several components to this program are administered through the Assistant Chief in charge of Professional Development.

Incident-Scene Rehabilitation

Incident-scene rehabilitation of firefighters during and after a working incident is critical to the overall health of firefighters. Heat exhaustion and cardiac problems must be closely monitored, especially in a hot and humid climate such as Houston. The HFD rehabilitation policy is appropriate with specific responsibilities and guidelines provided.

Motor Vehicle Accident Review

All fire department vehicle accidents are investigated, and a Review Board meets twice a month. The Review Board consists of a Deputy Chief and two District Chiefs. Accidents found to be the fault of a fire department operator can result in additional training or disciplinary action. Additional training consists of an 8-hour training session (4 hours of classroom and 4 hours of hand-on).

Operational Safety Officers

The department has three (3) operational Safety Officers for each of the four (4) shifts. The Safety Officers assist the incident commanders to minimize the risk of a firefighter injury or death. The provision of additional Safety Officers for geographic coverage is recommended earlier in this report.

Staff Psychologists

The fire department has two (2) staff psychologists to address behavioral health issues such as PTSD (Post-Traumatic Stress Disorder). The study team found this to be an outstanding program that is highly regarded by the firefighters as the psychologists assist rather than diagnose.

"Courage to be Safe®" Program for Recruits

All recruits are provided the "Courage to be Safe" program developed by the National Fallen Firefighters Foundation. This program trains firefighters to have not only the courage to save lives, but a different kind of courage to stay safe in dangerous situations to avoid needless risk.

"Fire Ground Survival Program"

All current members of the fire department have received, or are receiving, the highly acclaimed "Fire Ground Survival Program" developed by the International Association of Fire Fighters (IAFF). This course stresses MAYDAY protocols to make sure all city firefighters, company officers, and chief officers are aware of MAYDAY protocols. The course also emphasizes ways to avoid MAYDAY situations.

Accident and Injury Database

The department has access to very good databases to track vehicle accidents and personal injuries. HFD staff are able to categorize each type of accident and injury and identify trends. From this data, they are able to develop programs to reduce the frequency and severity of vehicle accidents and personal injuries. Two (2) primary examples include identification of the need for extra training on the proper lifting of stretchers and illustrating proper techniques for entering and exiting a vehicle while wearing full PPE without injury.

All of these programs are well-documented and serve the city, the fire department and firefighters well.

Missing Health and Safety Components

There are four (4) missing components that deserve attention:

Medical Examinations

Annual medical examination should be performed for all current firefighters. This medical examination should be performed in accordance with NFPA 1582. This examination is currently only provided to new hires and members of the Hazardous Materials and Rescue team. It should be provided to all firefighters. By far the leading causes of line-of-duty deaths among firefighters are medically related, primarily cardiac events and cancer. Though the idea of annual medical evaluations is often initially not well-received initially by firefighters for fear of losing their job or being assigned to modified duty, many departments provide the medical evaluations and after time, they are well-received by

the firefighters. Medical evaluations are strongly supported by both the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC). Furthermore, there is strong evidence that the cost of annual medical evaluations is more than offset by a reduction in medical costs, insurance costs, and lost time.

Recommendation 45:

Establish a program for providing annual medical evaluations for all firefighters.

A key component of the annual medical evaluations is the inclusion of on-staff physicians or contract physicians, who are thoroughly familiar with NFPA 1582 and the rigors and health risks of firefighters, to administer the program. Trust between the physicians and the firefighters cannot be over emphasized.

Consultations with fire departments that have been providing such medical examinations are recommended. In addition, the IAFF has valuable information and is a strong advocate on the union side for medicals. All the major national fire service organizations are advocates for ongoing annual medical examinations.

Comprehensive Wellness/Fitness Program

In conjunction with the need for annual medical examinations, there is also a need for a comprehensive wellness/fitness program. This program should integrate the physician who oversees medical evaluations, fire department psychologists, individuals trained in exercise physiology, and/or peer fitness trainers. The programs may be housed in a designated facility or delivered through contract services. The success of these programs is dependent upon close coordination of the critical components of the program. Furthermore, there is evidence that firefighters gain trust and confidence in the program when they believe it is tailored to their needs – this is often accomplished by housing the components of the program in a dedicated facility. This facility could house the physicians, the fire department psychologists, rehabilitation/therapy area, and full fitness equipment area. The facility could be built on available land at the Training Academy. A dedicated facility such as this provides a focused approach to overall firefighter wellness and is crucial to building trust among the firefighters. The Phoenix, Arizona and Austin, Texas Fire Departments are good benchmarking departments for this recommendation. Another benchmarking facility is the IRONMAN Sports Medical Institute.

Recommendation 46:

Develop a comprehensive wellness/fitness program. Develop a dedicated medical/wellness facility.

Tobacco-Free Work Place

The department should consider becoming a tobacco free-work place. Such a step would likely include requiring new hires to sign a tobacco abstinence policy, enacting policies to prohibit smoking in fire stations and offering a tobacco cessation program. Policies should include all forms of tobacco and e-cigarettes. Immediately, all new hires should sign an agreement that they will never use tobacco or e-cigarettes during their employment with the HFD. A quote from the IAFF states: "Quitting tobacco is the single most important thing anyone can do to improve their health. But due to the special hazards facing firefighter who use tobacco, quitting is even more important for our members." Many fire departments have developed such policies and found them to be very effective. Tobacco use among those

Recommendation 47:

Create a tobacco free work environment.

departments is almost non-existent. This is a no-cost recommendation that will pay dividends forever.

The implementation of a tobacco-free work environment that includes appropriate polices and a tobacco cessation program for members (including e-cigarettes). The harmful effects of tobacco use are well-documented and those risks are compounded among firefighters because of the environments they encounter.

Cancer Awareness/Prevention

Many awareness and prevention programs are now available. The fire department should consider developing a cancer awareness and support program for its members. Two (2) organizations, the Firefighter Cancer Support Network and the International Firefighter Cancer Foundation, are excellent resources for assistance.

Recommendation 48:

Establish a cancer awareness/prevention program within the HFD.

The development of a cancer awareness/prevention program will serve the fire department well – both in terms of protecting members and also in terms of conveying concern about an issue that is gripping firefighters. Research has shown that firefighters are at a greater risk of developing various types of cancers than the rest of the population. Cancer is a leading cause of firefighter deaths. Having policies in place, including medical screening, personal hygiene, and gear cleaning are critical to addressing this pressing health concern.

Team Biographies

The following FACETS team members participated in the development of this report:

William "Shorty" Bryson – Chief Bryson has served as the Fire Chief of two large fire departments, the City of Miami and Miami-Dade County Fire Rescue. Chief Bryson retired in 2013 after nearly 40 years of experience in the fire and emergency services.

Shorty is an expert in labor relations having served extensively on both sides of the table. Chief Bryson serves as the chairman of the National Fire Protection Association (NFPA) 1710 technical committee on career fire department deployment. NFPA 1710 sets unit staffing and response time standards for career fire departments.

Christian E. Callsen, Jr. – Chris Callsen is the Vice President, Optima Solutions, Analytics Division for Intermedix. Mr. Callsen's expertise is in the area of operations research with a specialization in assisting emergency services organizations with planning, system design/standards of cover, system performance modeling and resource management.

Mr. Callsen previously served as the North America COO for the Optima Corporation and assisted in the growth and eventual sale of this New Zealand organization to Intermedix. Formerly Assistant Chief-Operations with Austin-Travis County Emergency Medical Services Department (ATCEMS) in Austin, Texas, he was educated at Georgetown University is Washington, DC and the John F. Kennedy School of Government at Harvard University. He has more than 30 years of Emergency Services and Information Technology experience, He is also a published author with his most recent contribution being the textbook National Incident Management System / Principles and Practice, now in its second edition.

Amos Chalmers – Amos Chalmers is a 20 year veteran with Phoenix Fire Department (PFD) currently assigned a Deputy Chief managing the Technology Services Division. He and his staff support technology and data needs for the PFD along with the Central Arizona Life Safety System Response Council (a 26 City automatic-aid system), specifically their shared Computer Aided Dispatch and Radio systems.

Amos was hired directly out of the United States Marine Corps where he served as an Aerial Navigator on the KC130 aircraft and was honorably discharged after 8 years. He has a Bachelor's degree in Organizational Behavior, a Master's Degree in Management, and is currently midstream of a second Master's degree in Data Analytics, all from Arizona State University. He is originally from Cape Cod, Massachusetts and now lives in Phoenix with his wife Gretchen and their two children.

Cathleen Gleason – Cathleen Gleason has almost 30 years municipal experience with the City of Phoenix, and retired in 2011 as the City's Budget and Research Director. In this position, she was responsible for an annual operating and capital budget of more than $5 billion. In addition to her experience in the Budget and Research Department, Cathleen also worked for the Public Works and Fire Departments.

Cathleen's most significant accomplishment was guiding Phoenix through the worst financial crisis in its 125+ year history, including helping the City maintain its AAA investment grade rating even as revenues were plummeting, and working with labor and management to find solutions to a variety of substantial financial issues.

Cathleen served as a trustee on the City of Phoenix Employees' Retirement System (COPERS) Board for almost 20 years. She also volunteered her time as a Board Director for the Arizona Federal Credit Union for more than 20 years and currently serves as the Board Chair. Cathleen has a Bachelor of Science degree in Business and a Master's degree in Public Administration.

Randall Griffin – Randall Griffin's career spans nearly thirty years of public safety experience in the local career fire service, federal service and academia. After 9/11/2001, Captain Griffin was detailed to the U.S. Department of Homeland Security, in Washington, DC where he worked with other federal agencies to develop technologies to protect first responders from emerging threats. Since 2007, Mr. Griffin has taught graduate courses in leadership and public administration at Syracuse University's Maxwell School and in 2013 he helped to establish the Executive Masters in Emergency and Disaster Management at Georgetown University, where he continues to teach.

A native of New York, Mr. Griffin earned a Master's degree in Public Administration from the Maxwell School of Citizenship and Public Affairs at Syracuse University. He also holds a Bachelor's degree in Political Science from Oswego State University and an Associate's degree from the fire protection program at Corning Community College. Mr. Griffin serves on a number of national boards, including the U.S. Attorney General sanctioned, Inter Agency Board for Equipment Interoperability and Standardization. Mr. Griffin has received numerous awards for his work including that for valor and for distinction in teaching.

Charles Hood – Charles N. Hood serves as the Fire Chief of the City of San Antonio, Texas. His fire service career began as a member of the Tucson Fire Department. Charles moved to Phoenix and served for 23 years as a member of the Phoenix Fire Department. He moved through the ranks in Phoenix and retired as an Assistant Fire Chief.

Chief Hood leads one of the largest fire departments in the nation, commanding approximately 1,900 personnel with a budget of over 250 million dollars. He is ultimately responsible for providing fire, emergency medical, special operations, emergency management, and fire prevention services to over 1.4 million citizens.

Chief Hood's educational credentials include a Bachelor of Science in Fire Service Management from Ottawa University. He was also selected to attend the Harvard Kennedy School of Executive Education on two occasions. He is an Adjunct Faculty member at the Texas A&M University National Emergency Response and Rescue Training Center.

Charles Jennings, Ph.D. – Charles Jennings is Director of the Christian Regenhard Center for Emergency Response Studies (RaCERS) at John Jay College of Criminal Justice, and Associate Professor in the Department of Security, Fire, and Emergency Management. He has a unique and distinguished career spanning 30 years as a fire and emergency service consultant, practitioner, and researcher. Jennings has served most recently as Deputy Commissioner of Public Safety for the City of White Plains, NY, where he also led many initiatives as acting fire chief.

Jennings consults with governments across North America on management and deployment issues. His research has examined socioeconomic characteristics of fire risk, high-rise building safety, and fire prevention. He most recently co-edited Managing Fire and Emergency Services, published by the International City/County Management Association. He is a Fellow of the Institution of Fire Engineers, and a Chief Fire Officer designee. He earned his PhD in City and Regional Planning at Cornell University.

Brett Lacey - Brett is the Fire Marshal for the Colorado Springs, Colorado Fire Department. He is a graduate of Oklahoma State University and is a registered professional engineer and certified safety professional. He has worked in the fire service for over 36 years serving in the ranks of firefighter, paramedic, and fire protection engineer up to his current position. He has also worked for Fire Protection Publications of the International Fire Service Training Association and has served on various technical validation committees as well as a current Executive Board Member and chairing the technical committee for the Fire Inspection and Code Enforcement manual re-write for the 8th Edition. He currently serves on the NFPA Technical Committees for 1031 Professional Qualifications for Fire Inspector and Plan Examiner and 1730 Standard on Organization and Deployment of Code Enforcement, Plan Review, Fire Investigation, and Public Education Operations to the Public.

He is co-author of a Fire Protection Publication text book Fire Prevention Applications and Fire prevention Applications for the Company Officer and has co-authored articles for Firehouse.com magazine and Fire Journal He has served on the Colorado Fire Marshal's Association Code Committee as well as various other state committees. He has completed various curriculums at the Center for Creative Leadership and served as a member of the City of Colorado Springs Strategic Leadership Team which was responsible for major change and leadership initiatives for the City.

Gary Ludwig – Gary Ludwig currently serves as the Fire Chief of the Champaign, Illinois Fire Department. He is a well-known author, lecturer, and consultant who has successfully managed two large award-winning metropolitan fire-based EMS systems in St. Louis and Memphis. Gary has a total of 39 years of fire, rescue, and EMS experience and has been a paramedic for over 36 years.

Gary writes the monthly EMS column in Firehouse Magazine and the monthly leadership column in JEMS Magazine. He is Past Chair on the EMS Executive Board for the International Association of Fire Chiefs and is a member of the IAFF EMS Standing Committee. He has a Master's degree in Business and Management, and is a licensed paramedic. He is a frequent speaker at EMS and fire conferences nationally and internationally. He is the co-author on several books and is the author of Blood, Sweat, Tears, and Prayers – Firefighting and EMS in Some of the Toughest Cities in America. In 2014, he was awarded the James O. Page EMS Leadership Award.

Richard Marinucci – Rich Marinucci has been in the fire service for over 39 years. He is currently serving as the Executive Director of the Fire Department Safety Officers Association. Previously he served 31 years as fire chief. He was the editor of the 7th edition of the Fire Chief's Handbook from PennWell publishing and authored the Fire Chief's Guide to Administration and Management from Brady publishing.

He was President of the International Association of Fire Chiefs and served 7 months as the Chief Operating Officer of the United States Fire Administration. He holds a Master's degree from Eastern Michigan University and three Bachelor of Science degrees. He is a monthly columnist for Fire Apparatus Magazine and writes for Fire Engineering. He was the recipient of the Ronny J. Coleman Leadership Legacy Award from the Center for Public Safety Excellence.

Ken Riddle – Chief Ken Riddle has over forty-years of experience in EMS and fire services. He retired from the Las Vegas Department of Fire & Rescue (LVF&R) after 28 years of service. He served as the Assistant Fire Chief and the Deputy Fire Chief of every Division including the Operations Division, Emergency Medical Services Division, Support Services Division, and the Fire Prevention Division where he served as the Fire Marshal. While serving in those positions, he designed and developed several major programs, including the Department's infection control program, a comprehensive in-house firefighter health and wellness program, and a fire-based EMS ambulance transport service.

Chief Riddle has been extremely active in national fire and EMS issues since 1992, serving as an elected officer on the Executive Committee for the International Association of Fire Chief's (IAFC) EMS Section including the chairman of the Section and as the International Director for EMS on the IAFC Board of Directors. He also served as the President of the Southern Nevada Fire Chiefs Association. He is currently the Executive Director for the Nevada Fire Chiefs Association.

Chief Riddle has two associate degrees; fire service management and fire science technology. He is also a graduate of the National Fire Academy's Executive Fire Officer Program.

Kevin M. Roche – Kevin Roche is a FACETS partner. He retired in 2014 as Assistant to the Fire Chief for the Phoenix Fire Department in Arizona. Kevin has over 30 years of fire service management and consulting experience. Kevin has experience as a leader and member of a number of management consulting projects in large fire departments. During his career in Phoenix, Kevin managed the fire department's planning, fire prevention, and logistics operations. Kevin earned a B.S. degree in Fire Protection and Safety Engineering Technology from Oklahoma State University and a Master's degree in Political Science with a Certificate in Public Administration from the University of Florida.

Larry Schwarz – Larry Schwarz has over 24 years of fire investigative experience in the public and private sector. Larry is a Certified Fire Investigator, with the prestigious certification achieved through the International Association of Arson Investigators. He is currently working as a Fire Investigator with Unified Investigations & Sciences a trusted business that provides origin and cause and technical services from highly skilled engineers. In addition, he is a recently retired Battalion Chief from the Colorado Springs Fire Department with 30 years of professional experience. He earned a Bachelor of Science Degree in Organizational Management in Christian Leadership from Colorado Christian University and an Associate's Degree in Fire Science Technology from Pikes Peak Community College.

Denise L. Smith, Ph.D. – Denise Smith is a Professor of Health and Exercise Sciences at Skidmore College where she directs the First Responder Health and Safety Laboratory, and a Research Scientist at the University of Illinois Fire Service Institute. Dr. Smith has coauthored an Exercise Physiology textbook, an Advanced Cardiovascular Exercise Physiology textbook, and contributed to a textbook on live fire training. She has conducted far-reaching research on the cardiovascular strain associated with fire fighting, and has published over 60 peer-reviewed articles. She has been awarded nearly $10 million in funding from DHS-FEMA, DHS S&T, NIOSH and DOD. She is a fellow of the American College of Sports Medicine and a member of the National Fire Protection Association Fire Service Occupational Safety and Health committee. Dr. Smith regularly lectures and gives seminars related to health and safety issues in the Fire Service.

Eric C. Tade – Fire Chief Eric C. Tade is a second generation firefighter who is currently in his 25th year of service with the Denver Fire Department. Chief Tade was first appointed to position of Fire Chief by Mayor Hickenlooper in 2010 and was most recently reappointed by Mayor Michael Hancock in 2011.

Chief Tade has risen through the ranks of the Denver Fire Department, serving in a variety of assignments which include the Operations Division, Dispatch, DIA/ARFF, and the Administration Division. Fire Chief Tade has previously served for ten years as the Director of Governmental Affairs for Local 858, helping to improve communications between the Union, the Department Administration, and elected officials. Chief Tade also serves as a member of the National League of Cities' Public Safety and Crime Prevention Steering Committee.

Chief Tade has a degree in Fire Science and has served as an instructor at various fire leadership conferences. Chief Tade is a graduate of the International Association of Fire Chiefs' Officers Leadership Program. Fire Tade has become a recognized leader in regionalism and intergovernmental agreements relating to fire protection services.

Nancy J. Trench – Nancy Trench is the Assistant Director for Research for Fire Protection Publications, the publisher of IFSTA training materials, at Oklahoma State University where she has worked for more than 35 years.

Mrs. Trench is recognized nationally as a leader in fire prevention and fire and life safety education. She is an expert in the design, implementation and evaluation of fire and life safety education programs. Her expertise includes programs for those at highest risk for home fire deaths and injuries: young children and people with disabilities. She is an advocate for partnerships to build effective risk reduction programs and for risk assessments to target program planning and delivery. Mrs. Trench received the second annual Dr. Anne W. Phillips Award for Leadership in Fire Safety Education from The Home Safety Council in 2008.

Mrs. Trench formerly managed the state fire training system in Oklahoma. She has experience designing and delivering training and certification programs for the fire and emergency response community.

Nancy served as an appointed member of the Board of Visitors for the National Fire Academy, an elected member of the National Fire Protection Association (NFPA) Board of Directors, and A Trustee for the Learn Not to Burn Foundation. She currently serves as the chair of the NFPA 1035, standard for Professional Qualifications for Fire and Life Safety Educator, Public Information Officer and Juvenile Firesetter Intervention Specialist. She is an alumnus of OSU in Fire Protection and Safety Engineering Technology.

Nancy is active with Vision 20/20, National Strategies for Fire Loss Prevention.

Robert D. Tutterow, Jr. – Robert Tutterow is President of F.I.E.R.O (Fire Industry Education Resource Organization). He retired in 2011 from the Charlotte Fire Department, having served in the roles of Logistics Officer and Health & Safety Officer. Prior to this, he was in various positions of materials management and purchasing for Ingersoll-Rand. Robert has been involved with the NFPA for 27 years, serving on technical committees responsible for apparatus, PPE and fire fighter health and safety. He is currently vice-chair of the NFPA Fire Service Section. Robert received his A.A. degree from Brevard College and his B.S. Degree from the University of North Carolina.

Andrew Whitehead – Andrew Whitehead has been a member of the fire service since 1983. He has served with industrial, volunteer, combination and career fire departments. He has worked in the Baltimore City, Maryland Fire Department for the past 14 years. He holds the rank of Lieutenant and is assigned to Engine Company 36. He earned a Bachelor's Degree in Fire Protection and Safety Engineering Technology from Oklahoma State University in 1991, he has a variety of Pro-Board certifications, and he is a Certified Fire Protection Specialist (CFPS).

Michael A. Wieder – Mike Wieder serves as the Associate Director at Fire Protection Publications and Executive Director of the International Fire Service Training Association (IFSTA), both located at Oklahoma State University in Stillwater, Oklahoma. He holds an AAS Degree in Fire Science from Northampton (PA) Community College. He also has an AS Degree in Fire Technology, BS Degree in Fire Protection and Safety Engineering Technology, and MS Degree in Occupational and Adult Education, all from Oklahoma State University.

Mike is a 37 year veteran of the fire service. He has written 38 fire service training manuals, 10 federal government research reports, and more than 150 academic papers and trade journal articles. He was a recipient of the George D. Post National Fire Service Instructor of the Year Award from the International Society of Fire Service Instructors (IFSFI) and is a Fellow of the Institution of Fire Engineers (IFireE). He is an active fire service speaker and consultant. He is a past member of the Pennsburg, PA Fire Company No. 1 and the Stillwater, OK Fire Department.

Sally Young – Sally holds a Bachelor of Arts in English and a Master of Urban Administration, both earned at the University of North Carolina at Charlotte. She was employed by the Charlotte Fire Department in 1979 and held the position of Fire Department Planner from 1980 until her retirement at the end of 2006. She oversaw the Charlotte Fire Department's planning and performance measurement processes, as well as the incident reporting system and the annexation process.

She was responsible for selecting the sites for eighteen fire stations, several deployment studies, and other administrative functions. Currently, Sally is secretary/treasurer of FI.E.R.O., an organization dedicated to providing educational conferences on fire station design and personal protective equipment. She has also consulted with fire departments on locating fire stations and written on deployment, safety, and administrative issues for several books.