CITYGATE ASSOCIATES, LLC

Folsom (Sacramento), CA | Management Consultants

Fire and Emergency Medical Services Deployment Analysis

Southern Marin Fire Protection District, CA

Volume 2 of 2 – Technical Report

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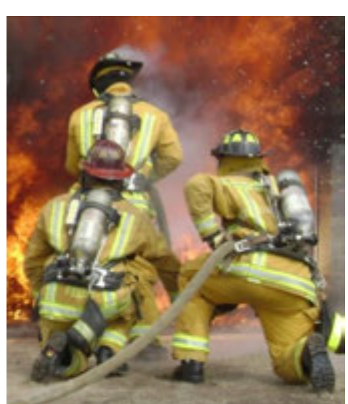

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SECTION 1—INTRODUCTION AND BACKGROUND

Citygate Associates, LLC's detailed work product for a Fire and Emergency Medical Services Deployment Analysis for the Southern Marin Fire Protection District (District) is presented in this volume. Citygate's scope of work and corresponding Work Plan was developed consistent with Citygate's Project Team members' experience in fire administration. Citygate utilizes various National Fire Protection Association (NFPA) publications as best practice guidelines, along with the self-assessment criteria of the Commission on Fire Accreditation International (CFAI).

1.1 REPORT ORGANIZATION

This report volume is structured into the following sections. The Executive Summary is separately bound as Volume 1.

Section 1 Introduction and Background: An introduction to the study and background facts about the District.

Section 2 Standards of Cover Introduction: An introduction to the Standards of Coverage (SOC) process and methodology used by Citygate in this review.

Section 3 Deployment Goals/Measures and Risk Assessment: An in-depth examination of the District's ability to meet the community's risks, expectations, and emergency needs through deployment of firefighters and apparatus.

Section 4 Staffing and Station Location Analysis: A review of: (1) the critical tasks that must be performed to achieve the District's desired outcome; and (2) the District's existing fire station locations and possible future locations.

Section 5 Response Statistical Analysis: A statistical data analysis of the District's incident responses and an overall deployment evaluation.

Section 6 SOC Evaluation and Deployment Recommendation: A summary of deployment priorities and an overall deployment recommendation.

Section 7 Summary Level Headquarters and Support Functions Staffing Adequacy Review: An analysis of key headquarters functions.

Section 8 Next Steps: A summary of short-term and ongoing steps.

1.1.1 Goals of Report

As each of the sections mentioned above imparts information, this report will cite findings and make recommendations, if appropriate, that relate to each finding. All of the findings and recommendations throughout Sections 3 through 7 of this report are numbered sequentially. To provide a comprehensive summary, a complete list of all these same findings and recommendations, in order, is found in the Executive Summary (Volume 1). Section 8 of this report brings attention to the highest priority needs and recommended next steps.

This document provides technical information about how fire services are provided, legally regulated, and how the District currently operates. This information is presented in the form of recommendations and policy choices for the District leadership to discuss.

1.2 Project Scope of Work

1.2.1 Standards of Response Coverage Review

The scope of the Standards of Response Coverage review included the following elements:

- Modeling the response time ability of the current fire station locations. Although this is not a study of fire departments adjacent to the District, the study does consider the impacts of the District's automatic and mutual aid agreements common throughout the County and, in particular, its shared command services agreement with Mill Valley.
- Establishing deployment performance time goals for the District consistent with best practices and national guidelines from the NFPA and the CFAI.
- Using an incident response time analysis program called StatsFD™ to review the statistics of prior historical performance.
- Using geographic information systems (GIS) mapping to review fire station coverage zones.

SOC Study Questions

Our study addresses the following questions:

1. Is the type and quantity of apparatus and staffing adequate for the District's deployment to emergencies?
2. What is the recommended deployment to maintain adequate emergency response times as growth continues to occur?

1.3 District Overview

The Southern Marin Fire Protection District is located on the eastern coastal corner of Marin County, covering approximately 20 square miles. The Southern Marin Fire Protection District—comprised of the City of Sausalito and unincorporated lands within Marin County—is located just north of the San Francisco, CA area. Highway 101, a major north-south state transportation artery runs through the Fire District along the bayside plain. The District includes the environs of an urban bayside suburban community, light industrial and commercial businesses, and a Wildland Urban Interface (WUI) fire threat. The City of Sausalito encompasses 7.3 square miles, of which 2.6 square miles is land and 4.7 square miles are tidelands. Approximately 42% of land use within the City is residential, with 23% commercial/industrial, and the remainder dedicated to public facilities, parks/open space, agriculture, and transportation corridors.

Geographically, many homes within the Fire District, especially in foothills within the WUI, are valued in the million-dollar range. This area, as well as the populated areas just to the north of the District, have a history of major wildfire incidents. The greater part of the Fire District's jurisdiction is at a risk from wildland fires, with the area generally described as the WUI, where structures and other human development meet or intermingle with undeveloped wildland and vegetative fuels.

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SECTION 2—STANDARDS OF COVER INTRODUCTION

2.1 STANDARDS OF COVERAGE STUDY PROCESSES

The core methodology used by Citygate in the scope of its deployment analysis work is the "Standards of Cover" (SOC) 5th Edition, which is a systems-based approach to fire department deployment, as published by the Commission on Fire Accreditation International (CFAI). Additionally, Citygate also used the 6th Edition of the Standards of Cover Manual. This approach uses local risk and demographics to determine the level of protection best fitting the District's needs.

The Standards of Response Coverage method evaluates deployment as part of the self-assessment process of a fire agency. Citygate has adopted this methodology as a comprehensive tool to evaluate fire station locations. Depending on the needs of the study, the depth of the components may vary.

In the United States, there are no federal or state government requirements for a minimum level of fire services. It is a local choice issue for each community to consider and fund as it deems necessary. The CFAI SOC systems approach to deployment, rather than a one-size-fits-all prescriptive formula, allows for local determination. In this comprehensive approach, each agency can match local needs (risks and expectations) with the costs of various levels of service. In an informed public policy debate, a governing board "purchases" the fire and emergency medical service levels the community needs and can afford.

While working with multiple components to conduct a deployment analysis is admittedly more work, it yields a much better result than using only a singular component. For instance, if only travel time is considered, and frequency of multiple calls is not considered, the analysis could miss over-worked companies. If a risk assessment for deployment is not considered, and deployment is based only on travel time, a community could under-deploy to incidents.

The Standards of Coverage process consists of the following eight parts:

Table 1—Standards of Cover Process Elements

Element	Meaning
1. Existing Deployment Policies	Reviewing the deployment goals the agency has in place today.
2. Community Outcome Expectations	Reviewing the expectations of the community for response to emergencies.
3. Community Risk Assessment	Reviewing the assets at risk in the community. (In this Citygate study, see Section 3.2 Community Risk Assessment.)
4. Critical Task Study	Reviewing the tasks that must be performed and the personnel required to deliver the stated outcome expectation for the Effective Response Force.
5. Distribution Study	Reviewing the spacing of first-due resources (typically engines) to control routine emergencies.
6. Concentration Study	Reviewing the spacing of fire stations so that building fires can receive sufficient resources in a timely manner (First Alarm Assignment or the Effective Response Force).
7. Reliability and Historical Response Effectiveness Studies	Using prior response statistics to determine the percent of compliance the existing system delivers.
8. Overall Evaluation	Proposing Standard of Cover statements by risk type as necessary.

Fire department deployment, simply stated, is about the speed and weight of the attack. Speed calls for first-due, all-risk intervention units (engines, trucks, chiefs for incident command) strategically located across a department responding in an effective travel time. These units are tasked with controlling moderate emergencies, thus preventing the incident from escalating to second alarm or greater size, which unnecessarily depletes department resources as multiple requests for service occur. Weight is about multiple-unit response for serious emergencies such as a room-and-contents structure fire, a multiple-patient incident, a vehicle accident with extrication required, or a heavy rescue incident. In these situations, enough firefighters must be assembled within a reasonable time frame to safely control the emergency, thereby keeping it from escalating to greater alarms.

This deployment design paradigm is displayed in the following table:

Table 2—Fire Department Deployment Simplified

	Meaning	Purpose
***Speed* of Attack**	Travel time of first-due, all-risk intervention units strategically located across a department.	Controlling moderate emergencies without the incident escalating to second alarm or greater size.
***Weight* of Attack**	Number of firefighters in a multiple-unit response for serious emergencies.	Assembling enough firefighters within a reasonable time frame to safely control the emergency.

Thus, small fires and medical emergencies require a single- or two-unit response with a quick response time. Larger incidents require more crews. In either case, if the crews arrive too late, or the total personnel sent to the emergency are too few for the emergency type, they are drawn into a losing and more dangerous battle. The science of fire crew deployment is to spread crews out across a community for quick response to keep emergencies small with positive outcomes, without spreading the crews so far apart that they cannot amass together quickly enough to be effective in major emergencies.

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Section 3—Deployment Goals/Measures and Risk Assessment

3.1 Why Does the District's Fire Department Exist and How Does it Deliver the Existing Fire Crew Deployment Services?

3.1.1 Existing Response Time Policies or Goals—Why Does the Fire Department Exist?

SOC Element 1 of 8*

Existing Deployment Policies

**Note: This is an overview of Element 1. The detail is provided on page 46.*

The District Board of Directors, over the decades, has not adopted best practice-based formal response time policies by risk type. However, the District has a long history of striving to provide fire services that can be documented in Fire Department annual reports, the number of fire companies, and minimum daily staffing. Thus, although no complete policy meeting the Commission on Fire Accreditation (CFAI) process requirements has been adopted by the Board of Directors, the District has been budgeting for and providing a level of services that can be documented. Additionally, in 2015, the District updated its operating policies with templates from a firm that provides such standard operating policies. In that work, *Fire Management* adopted Policy #306 "Response Time Standards." However, this policy's goal statements are not consistent with National Fire Protection Agency (NFPA) and Accreditation standards, or risks to be protected in the District. As such, it is not sufficient in and of itself to drive decisions by the District Board of Directors.

In adopting a response time goal, agencies are encouraged to no longer use an average time measure. As will be explained in the next section below, an average measure does not state performance past the average point of a data set. In addition, response time measures should specifically denote a beginning and end point response time and staffing quantity, by risk type, consistent with the recommendations of the NFPA or CFAI best practices. A complete response time goal is a fractile (percent of goal completion) measure that includes dispatch-processing time, crew turnout time, and finally, travel time, along with the type of emergency outcome or staffing needed to accomplish an outcome goal.

The District also has not identified response goals for technical rescue and hazardous material responses; in addition to firefighting and EMS, response time goals for these incident types are required to meet the Standards of Response Coverage model for the CFAI. In this Standards of Response Coverage study, Citygate will recommend revised response time goals to include all risks including fire, EMS, hazardous materials, and technical rescue responses. The goals will be consistent with the CFAI systems approach to response.

3.1.2 Existing Outcome Expectations

SOC ELEMENT 2 OF 8
COMMUNITY OUTCOME EXPECTATIONS

The Standards of Cover process begins by reviewing existing emergency services outcome expectations. This can be restated as follows: for what purpose does the response system exist? Has the governing body adopted any response performance measures? If so, the time measures used need to be understood and good data must be collected.

Current best practice nationally is to measure percent completion of a goal (e.g., 90% of responses) instead of an average measure. Mathematically this is called a "fractile" measure.[1] This is because an average only identifies the central or middle point of response time performance for all calls for service in the data set. Using an average makes it impossible to know how many incidents had response times that were way over the average, or just over. For example, if a department had an average response time of 5 minutes for 5,000 calls for service, it cannot be determined how many calls past the average point of 5 minutes were answered in the 6th minute, or way out at 10 minutes. This is a significant issue if hundreds or thousands of calls are answered far beyond the average point. Fractile measures will identify, per minute, the number of incidents that are reached up to 100%.

More importantly, within the Standards of Cover process, positive outcomes are the goal and, from that, crew size and response time can be calculated to allow efficient fire station spacing (distribution and concentrations). Emergency medical incidents involve situations with the most severe time constraints. The brain can only live 8-10 minutes without oxygen. Heart attacks are commonly known to deprive the brain of oxygen; however, heart attacks make up a small percentage of oxygen-depriving events. Drowning, choking, trauma constrictions, or other similar events have the same effect. In a building fire, a small incipient fire can grow to involve the entire room in an 8- to 10-minute timeframe. If fire service response is to achieve positive outcomes in severe emergency medical situations and incipient fire situations, ***all*** responding crews must arrive, assess the situation, and deploy effective measures before brain death occurs or the fire leaves the room of origin.

Thus, from the time of 9-1-1 receiving the call, an effective deployment system is ***beginning*** to manage the problem within a 7- to 8-minute total response time. This is right at the point that brain death is becoming irreversible, or that an incipient fire has grown beyond the room of origin and become very serious. Thus, the District needs a first-due response goal that is within a range to give the situation hope for a positive outcome. It is important to note the fire or medical emergency continues to deteriorate from the time of inception, not from the time the fire engine

[1] A *fractile* is that point below which a stated fraction of the values lie. The fraction is often given in percent; the term percentile may then be used.

actually starts to drive the response route. Ideally, the emergency is noticed immediately and the 9-1-1 system is activated promptly. This step of awareness—calling 9-1-1 and giving the dispatcher accurate information—takes, in the best of circumstances, 90 seconds. Crew notification and travel time then take additional minutes. Once arrived, the crew must walk to the patient or emergency, assess the situation, and deploy its skills and tools. Even in easy-to-access situations, this step can take two or more minutes. This time frame may be increased considerably due to long driveways, apartment buildings with limited access, multi-storied apartments or office complexes, or shopping center buildings such as those found in parts of the District.

Unfortunately, there are situations in which an emergency has become too severe, even before 9-1-1 notification and/or fire department response, for the responding crew to reverse; however, when an appropriate response time policy is combined with a well-designed system, then only issues like bad weather, poor traffic conditions, or multiple emergencies will slow the response system down. Consequently, a properly designed system will give citizens the hope of a positive outcome for their tax dollar expenditure.

For this report, "total" response time is the sum of the alarm procession, dispatch, crew turnout, and road travel time steps. This is consistent with the recommendations of the CFAI.

Finding #1:	The District Board of Directors has not adopted a complete and best practices-based deployment measure or set of specialty response measures for all-risk emergency responses that includes the beginning time measure from the point of the Communications Center receiving the 9-1-1 phone call, nor a goal statement tied to risks and outcome expectations. The deployment measure should have a second measurement statement to define multiple-unit response coverage for serious emergencies. Making these deployment goal changes will meet the best practice recommendations of the Commission on Fire Accreditation International.

3.2 COMMUNITY RISK ASSESSMENT

SOC ELEMENT 3 OF 8
COMMUNITY RISK ASSESSMENT

The third element of the SOC process is a community risk assessment or analysis. The objective of a community risk assessment is to:

1. Identify the hazards with potential to adversely impact the community or jurisdiction.
2. Quantify the probability of occurrence for each identified hazard.
3. Determine overall risk by hazard.

A *hazard* is broadly defined as a situation or condition that can cause or contribute to harm. Hazard examples include fire, medical emergency, vehicle collision, earthquake, flood, etc. *Probability* is the likelihood of occurrence of a particular hazard, and *impacts* or *consequences* are the adverse effects that a hazard occurrence has on people, property, and/or the community as a whole. *Risk* is broadly defined as the *probability of hazard occurrence* in combination with the *likely severity of resultant impacts*, and *Risk Vulnerability* is a measure of the probability of the existing deployment model's ability to protect against or mitigate a specific hazard.

3.2.1 Risk Assessment Methodology

The methodology employed by Citygate to assess and quantify community risk as an integral element of an SOC study incorporates the following elements:

1. Identification of geographic risk assessment sub-zones (risk zones) appropriate for the community or jurisdiction.
2. Identification of the fire and non-fire natural and human-caused hazards with potential to adversely impact the community or jurisdiction.
3. Determination of probability of future occurrence for each hazard by risk zone considering historical service demand and the probability of occurrence.
4. Table 5 was also used to help determine risk based on the consequences of the fire on the population, economy, and community.

Citygate used multiple data sources for this study to understand the risks to be protected in Sacramento as follows:

- U.S. Census Bureau population data and demographics
- Insurance Services Office (ISO) building fire flow and construction data
- Marin Maps Geographical Information Systems (GIS) data

- Marin County General Plan and Zoning documents
- 2012 Marin County Local Hazard Mitigation Plan (LHMP)
- City of Sausalito General Plan and Zoning documents
- California Department of Transportation road traffic counts

3.2.2 Risk Assessment Summary

The risk assessment for this SOC is primarily focused on the Southern Marin Fire Protection District (District) with limited inclusion of the City of Mill Valley, where the data was available and easily determined. There was no in-depth risk analysis conducted for Mill Valley.

Citygate's evaluation of the various risks likely to adversely impact the Southern Marin Fire Protection District and—by extension (due to similar zoning and topography)—the City of Mill Valley, yields the following conclusions:

- The District has a very diverse suburban population density with rural population densities in the outlying areas.
- The District has a mix of residential, commercial, office, and light industrial buildings.
- The District has transportation networks including highways and other primary vehicle transportation routes, mass transportation modes, and a ferry landing.
- The District has varying levels of risk relative to nine hazards specifically relating to fire department services as follows:
  - Building Fire Risk
  - Wildland Fire Risk
  - Emergency Medical Service Risk
  - Hazardous Materials Risk
  - Technical Rescue Risk
  - Transportation Risk
  - Earthquake/Seismic Risk
  - Landslide/Mudslide Risk
  - Flood/Sea Level Rise Risk

- The District's overall risk for nine hazards related to emergency services provided by District ranges from *Low* to *High* as shown below:

Table 3—Overall Risk Summary by Hazard

Risk Type	Risk Classification
Building Fire	Moderate
Wildland Fire	Moderate
EMS	High
Hazardous Material	Low
Technical Rescue	Moderate
Transportation	Moderate
Earthquake/Seismic Activity	Moderate
Landslide/Mudslide	Low
Flood/Sea Level Rise	Moderate

The following sections will describe the analysis process and risk factors used to determine overall risk as shown in Table 3 in more detail, beginning with a discussion of growth and development in the District's service area and a profile of communities within the District.

3.2.3 Growth and Development

City of Sausalito

Overview

The City of Sausalito's General Plan[2] will continue to play its traditional role in the City as the primary center of government, employment, and culture. Downtown Sausalito will be vibrant with arts, culture, entertainment, and the City's economy will continue to strengthen, diversify, and play a larger role with a broad range of jobs in all industry sectors, including those related to small and local businesses.

The General Plan further envisions the following themes:

- Every neighborhood will be a desirable place to live because of its walkable streets, extensive tree canopy, range of housing choices, mixed-use neighborhood centers, great schools, parks and recreation facilities, and easy access to Downtown and jobs.

[2] Sausalito General Plan (2012)

Projected Growth

Growth projections in the City of Sausalito's General Plan show a very small growth of .3% from 2020-2030 and .2% from 2010-2020.

Land Use and Future Development

The City's and County's General Plan land use policies include:

- Regulating population and building.
- Promoting and facilitating infill development.
- Preserving and enhancing neighborhoods as a basic unit.
- Protecting established neighborhoods.
- Promoting complete and well-structured neighborhoods that promote livability and safety for residents of all ages and cultures.

City of Mill Valley

Overview

The City of Mill Valley's General Plan[3] plays a continual role in shaping the City and its character.

The General Plan further envisions the following themes:

The two primary goals of the General Plan remain the same as established in the 1989 General Plan. These are:

- To protect and enhance the natural beauty and small-town character of Mill Valley.
- To encourage continued diversity of housing, income levels, and lifestyles in the community.

Through the development of the General Plan, community members consistently expressed their belief in Mill Valley values of:

- Preserving the quality, diversity, and historic resources of the community's residential neighborhoods.
- Maintaining a strong, healthy economy that supports locally-owned and local-serving businesses.

[3] City of Mill Valley General Plan 2040

- Maintaining prudent municipal fiscal policies and practices and operational excellence by City officials and employees.
- Managing and restoring the scenic quality and physical character of the bayfront, ridgelines, and hillsides for open space, resource protection, and outdoor recreation.
- Preserving and enhancing creeks, marshes, woodlands, and other natural resources for health of habitat and natural species, and the use and enjoyment by current and future generations.
- Fostering sustainable policies and practices that enhance climate protection and adapt to climate change.
- Minimizing traffic congestion and encouraging safe and convenient mobility alternatives.
- Planning for, preparing for, adapting to, and responding to natural and human-made disasters.
- Accommodating more housing choices for all income levels and community needs than may be possible under conditions in the private housing market.

Projected Growth

Growth projections in the City of Mill Valley's General Plan show a moderate growth of 3% from 2020-2030.

3.2.4 Profile of Communities within the District

Political Boundaries

The Southern Marin Fire Protection District is located in Marin County. The District is comprised of unincorporated areas and the communities of Tamalpais, Homestead, Almonte, Alto, Strawberry, and the City of Sausalito.

Area and Land Use

The Southern Marin Fire Protection District covers approximately 60 square miles. District land use is comprised of:

- Residential: 45%
- Commercial: 25%
- Open/Undeveloped: 30%

Community Demographics

Population and demographics for the community of Almonte in the District were not available. The remainder of the District has several Census Data Points (CDP) used to collect data for census tracking, which are highlighted below.

Alto

The 2010 United States Census reported that Alto had a population of 711. The population density was 5,654.1 people per square mile (2,183.1/km²). The racial makeup of Alto was 619 (87.1%) White, 8 (1.1%) African American, 2 (0.3%) Native American, 30 (4.2%) Asian, 1 (0.1%) Pacific Islander, 16 (2.3%) from other races, and 35 (4.9%) from two or more races. Hispanic or Latino of any race were 51 persons (7.2%).

The Census reported that 100% of the population lived in households.

There were 297 households, out of which 108 (36.4%) had children under the age of 18 living in them, 140 (47.1%) were opposite-sex married couples living together, 34 (11.4%) had a female householder with no husband present, 6 (2.0%) had a male householder with no wife present. There were 17 (5.7%) unmarried opposite-sex partnerships, and 0 (0%) same-sex married couples or partnerships. There were 33.7% of households made up of individuals and 10.1% had someone living alone who was 65 years of age or older. The average household size was 2.39. There were 180 families (60.6% of all households); the average family size was 3.05.

The population was spread out with 177 people (24.9%) under the age of 18, 47 people (6.6%) aged 18 to 24, 188 people (26.4%) aged 25 to 44, 236 people (33.2%) aged 45 to 64, and 63 people (8.9%) who were 65 years of age or older. The median age was 41.0 years. For every 100 females there were 81.8 males. For every 100 females age 18 and over, there were 79.2 males.

There were 313 housing units at an average density of 2,489.1 per square mile (961.0/km²), of which 157 (52.9%) were owner-occupied, and 140 (47.1%) were occupied by renters. The homeowner vacancy rate was 0.6%; the rental vacancy rate was 4.1%. Owner-occupied housing units were lived in by 60.3% of the population and 39.7% lived in rental housing units.

Strawberry

The 2010 United States Census reported that 5,393 people, 2,510 households, and 1,307 families resided in the CDP. The population density was 4,094.9 people per square mile (1,581.1/km²). There were 2,729 housing units at an average density of 2,048.4 per square mile (790.9/km²). The racial makeup of the CDP was 80.2% White (76.1% non-Hispanic), 2.1% African American, 0.3% Native American, 10.9% Asian, 0.3% Pacific Islander, 1.8% from other races, and 4.3% from two or more races. Hispanic or Latino of any race was 6.5% of the population.

The Census reported that 95.4% of the population lived in households, 4.5% lived in non-institutionalized group quarters, and 0.1% were institutionalized.

There were 2,510 households out of which 25.5% had children under the age of 18 living in them, 41.0% were opposite-sex married couples living together, 8.0% had a female householder with no husband present, and 3.1% had a male householder with no wife present. 4.6% of households were unmarried opposite-sex partnerships and 0.8% were same-sex married couples or partnerships. There were 40.6% of households made up of individuals and 14.3% had someone living alone who was 65 years of age or older. The average household size was 2.05 and the average family size was 2.80.

The population was spread out with 19.9% under the age of 18, 4.2% aged 18 to 24, 27.7% aged 25 to 44, 30.8% aged 45 to 64, and 17.5% who were 65 years of age or older. The median age was 44.0 years. For every 100 females there were 90.8 males. For every 100 females age 18 and over, there were 86.5 males.

There were 2,729 housing units of which 39.2% were owner-occupied and 60.8% were occupied by renters. The homeowner vacancy rate was 1.4%; the rental vacancy rate was 2.4%. Owner-occupied housing units were lived in by 44.2% of the population and 51.2% lived in rental housing units.

Tamalpais-Homestead Valley

The 2010 United States Census reported that Tamalpais-Homestead Valley had a population of 10,735. The population density was 2,307.6 people per square mile. The racial makeup of Tamalpais-Homestead Valley was 9,449 (88.0%) White, 91 (0.8%) African American, 24 (0.2%) Native American, 592 (5.5%) Asian, 28 (0.3%) Pacific Islander, 121 (1.1%) from other races, and 430 (4.0%) from two or more races. Hispanic or Latino of any race were 499 persons (4.6%).

The Census reported that 99.9% of the population lived in households and 0.1% lived in non-institutionalized group quarters.

There were 4,447 households, out of which 1,516 (34.1%) had children under the age of 18 living in them, 2,458 (55.3%) were opposite-sex married couples living together, 312 (7.0%) had a female householder with no husband present, 149 (3.4%) had a male householder with no wife present. There were 234 (5.3%) unmarried opposite-sex partnerships, and 65 (1.5%) same-sex married couples or partnerships. There were 1,143 households (25.7%) made up of individuals and 383 (8.6%) had someone living alone who was 65 years of age or older. The average household size was 2.41. There were 2,919 families (65.6% of all households); the average family size was 2.92.

The population was spread out with 2,571 people (23.9%) under the age of 18, 345 people (3.2%) aged 18 to 24, 2,344 people (21.8%) aged 25 to 44, 3,964 people (36.9%) aged 45 to 64, and 1,511 people (14.1%) who were 65 years of age or older. The median age was 45.5 years. For every 100 females there were 94.4 males. For every 100 females age 18 and over, there were 92.2 males.

There were 4,703 housing units at an average density of 1,010.9 per square mile (390.3/km²), of which 76.1% were owner-occupied, and 23.9% were occupied by renters. The homeowner vacancy rate was 1.3%; the rental vacancy rate was 4.6%. Owner-occupied housing units were lived in by 79.5% of the population and 20.4% lived in rental housing units.

City of Sausalito

The 2010 United States Census reported that Sausalito had a population of 7,061. The population density was 3,128.5 people per square mile (1,207.9/km²). The racial makeup of Sausalito was 6,400 (90.6%) White, 65 (0.9%) African American, 16 (0.2%) Native American, 342 (4.8%) Asian, 10 (0.1%) Pacific Islander, 53 (0.8%) from other races, and 175 (2.5%) from two or more races. Hispanic or Latino of any race were 287 persons (4.1%).

The Census reported that 99.8% of the population lived in households and 0.2% lived in non-institutionalized group quarters.

There were 4,112 households, out of which 420 (10.2%) had children under the age of 18 living in them, 1,443 (35.1%) were opposite-sex married couples living together, 146 (3.6%) had a female householder with no husband present, 64 (1.6%) had a male householder with no wife present. There were 313 (7.6%) unmarried opposite-sex partnerships, and 63 (1.5%) same-sex married couples or partnerships. There were 1,927 households (46.9%) made up of individuals and 524 (12.7%) had someone living alone who was 65 years of age or older. The average household size was 1.71. There were 1,653 families (40.2% of all households); the average family size was 2.39.

The population was spread out with 615 people (8.7%) under the age of 18, 159 people (2.3%) aged 18 to 24, 1,962 people (27.8%) aged 25 to 44, 2,830 people (40.1%) aged 45 to 64, and 1,495 people (21.2%) who were 65 years of age or older. The median age was 51.1 years. For every 100 females there were 90.2 males. For every 100 females age 18 and over, there were 89.2 males.

There were 4,536 housing units at an average density of 2,009.7 per square mile (776.0/km²), of which 2,088 (50.8%) were owner-occupied, and 2,024 (49.2%) were occupied by renters. The homeowner vacancy rate was 2.1%; the rental vacancy rate was 5.8%. There were 3,783 people (53.6% of the population) that lived in owner-occupied housing units and 3,265 people (46.2%) that lived in rental housing units.

City of Mill Valley

The 2010 United States Census reported that Mill Valley had a population of 13,903. The population density was 2,868.2 people per square mile (1,107.4/km²). The racial makeup of Mill Valley was 12,341 (88.8%) White, 118 (0.8%) African American, 23 (0.2%) Native American, 755 (5.4%) Asian, 14 (0.1%) Pacific Islander, 152 (1.1%) from other races, and 500 (3.6%) from two or more races. Hispanic or Latino of any race were 622 persons (4.5%).

The Census reported that 99.5% of the population lived in households and 0.5% were institutionalized.

There were 6,084 households, out of which 1,887 (31.0%) had children under the age of 18 living in them, 2,984 (49.0%) were opposite-sex married couples living together, 465 (7.6%) had a female householder with no husband present, 178 (2.9%) had a male householder with no wife present. There were 306 (5.0%) unmarried opposite-sex partnerships, and 55 (0.9%) same-sex married couples or partnerships. There were 2,016 households (33.1%) made up of individuals and 888 (14.6%) had someone living alone who was 65 years of age or older. The average household size was 2.27. There were 3,627 families (59.6% of all households); the average family size was 2.94.

The population was spread out with 3,291 people (23.7%) under the age of 18, 459 people (3.3%) aged 18 to 24, 2,816 people (20.3%) aged 25 to 44, 4,714 people (33.9%) aged 45 to 64, and 2,623 people (18.9%) who were 65 years of age or older. The median age was 46.6 years. For every 100 females there were 85.3 males. For every 100 females age 18 and over, there were 80.8 males.

There were 6,534 housing units at an average density of 1,348.0 per square mile (520.4/km²), of which 3,974 (65.3%) were owner-occupied, and 2,110 (34.7%) were occupied by renters. The homeowner vacancy rate was 1.2%; the rental vacancy rate was 4.5%. There were 9,861 people (70.9% of the population) that lived in owner-occupied housing units and 3,966 people (28.5%) that lived in rental housing units.

Population Density Summary and Impact

Given that EMS is such a large part of the Fire District's incident responses, it follows that population drives calls for service, including resident, employment, and transportation uses. There are no set population density definitions in the United States. The Commission on Fire Accreditation considers an area as urban when it exceeds more than 2,500 people. The National Fire Protection Association recommended Standard 1720 for Volunteer Fire Service Deployment uses:

- Urban – greater than 1,000 people per square mile
- Suburban – from 500-1,000 people per square mile
- Rural/Remote – less than 500 people per square mile

The United States Census Bureau defines an urban area has having a population density of at least 1,000 per square mile. In the communities served by the District and Mill Valley we found:

Table 4—Population Density of Communities Served by the District

Community	Population Per Square Mile (2010 Census Residents Only)
Alto	5,654
Strawberry	4,095
Tamalpais-Homestead Valley	2,308
Sausalito	3,128
Mill Valley	2,868

Given this data, by any measure, the more populated areas served by the District and Mill Valley Fire Department are urban in nature and as such, generate significant emergency demand and the threat of stopping fire spread from structure to structure must be planned for by the area's fire services.

Climate[4]

Marin County's semi-arid climate produces vegetation with specific growth as a result of local topography, proximity to the coast, and prevailing wind. In the central and eastern portions of the District's service area, the south facing exposure is primarily perennial Rye Grass with occasional clumps of California Bay and Coast Live Oak trees in the more sheltered pockets. The north facing slopes are heavily wooded from lower elevations to ridge with Oak and Bay trees and minor shrubs of the general chaparral class. Many areas in the western portion of the District are heavily forested with Bishop's Pine, Douglas-Fir, and Coast Redwood. Expansion of the residential community into areas of heavier vegetation has resulted in homes existing in close proximity to dense natural foliage. Often such dwellings are completely surrounded by highly combustible vegetation compounding the fire problem from a conflagration point of view. Southern Marin's coastal location eliminates most weather-related service delays.

Topography[5]

Marin County is a mosaic of rolling hills, valleys, and ridges that trend from northwest to southeast. Flat lands are found in the central and northern portions of the County. Most of the existing urban and suburbanized areas are on relatively flat lands (0-5% slope). The majority of the hillsides and ridges in the area have slopes ranging from 15-30%, and some are 30+%.

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4 Marin County Local Hazard Mitigation Plan 2012 Update
5 Ibid

Elevations are varied within the County; for example, Mt. Tamalpais rises 2,600 feet above sea level; Marin City and Point Reyes Station are approximately 20 feet above sea level. The City of Sausalito sits at 6 feet above sea level. With the potential for sea rise levels up to 10 feet this can create flooding problems and traffic impacts during an emergency such as a tsunami. Slope percentages are important in wildland risk assessment as it can significantly increase wildland fire spread. As a basic rule, the rate of spread will double as the slope percentage doubles, all other factors remaining the same. The City of Mill Valley is also susceptible to sea level rise and tsunamis.

Land Use and Future Development

Land use within the District and cities is predominantly suburban, residential, and commercial, with some industrial uses in the City of Sausalito. The City of Sausalito is essentially built-out with the exception of some potential minor future infill. The District is also within the City's sphere of influence.

3.2.5 Prior Risk Studies

Citygate utilizes prior risk studies where available, fire and-non-fire hazards as identified by the Commission on Fire Accreditation International (CFAI), and agency/jurisdiction-specific data and information to identify the hazards to be evaluated for this study.

In 2012, the Marin County Department of Emergency Management published its update to the Multi-Jurisdictional Local Hazard Mitigation Plan (MJLHMP) for the County. Unfortunately, the City of Sausalito does not have a Local Hazard Mitigation Plan for its community; the City of Mill Valley has adopted the County's plan.

3.2.6 Probability of Occurrence

As cited earlier, *probability of occurrence* refers to the likelihood of an incident occurring at the location of a risk. In essence, what are the hazards at the location (there could be more than one) and what is the likelihood that the hazard(s) can or will create an incident? Without determining probability, the risks cannot be categorized to help determine workload and effective response forces for mitigation.

There are five steps to evaluating probability of occurrence:

- Define the hazard(s).
- Assess the likelihood the hazard can/will create an incident.
- Define mitigating factors:
  - *Positive factors* include fire suppression/detection systems present, building construction, and demography of the occupants.

   - *Negative factors* include poor building or system maintenance or worker or resident training to respond to that emergency.
- Know and understand the infrastructure that may influence responses.
- Consider that remote area risks may exist and the expectation of service delivery may drive the responses depending on the severity of those risks.

3.2.7 Consequences

Consequences, as describer earlier, refers to the magnitude or reasonably expected loss that will be experienced by the response area, community, and the citizens should an incident occur. The magnitude of the loss is relative to risk and the relevance of the affected area and what level of response will be determined. There are six factors that help determine the consequences:

- Consequence determination can be a relative consideration to the significance of loss based on the worst-case potential of an incident to occur.
- In many cases, the consequence evaluation is a matter of establishing relative and available loss data such as employment loss, property tax revenue loss, and historical values to the community.
- A comparative analysis to other similar risk groups and levels of loss to the community.
- Mitigating factors can modify the consequences:
   - *Positive factors* include fire protection and detection systems present or good evacuation training of occupants.
   - *Negative factors* include hazardous materials on site not accounted for, or incorrect or poor building construction.
- Infrastructure impacts that may affect the control and termination of the incident such as road networks and topography.
- Agency impacts should be considered. Agency impacts can be limited resources and personnel, demand on the current response system, and the ability for the agency to handle simultaneous calls for service. Does the agency have the correct response teams and personnel to mitigate the incident or is mutual/automatic aid required? Does the agency have the funding to prepare for the incident response with training, equipment, and staffing?

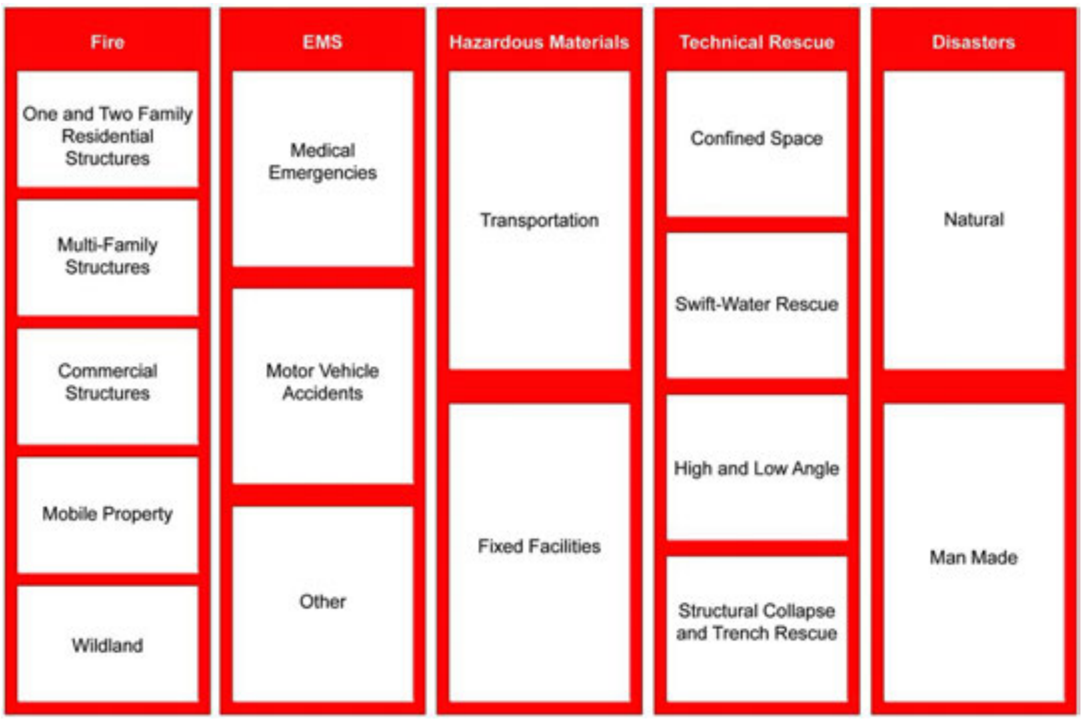
3.2.8 Risk Factors

Elements to be considered in a community risk assessment include factors that influence service demand, probability of hazard occurrence, and severity of impacts or consequences of a hazard occurrence relative to life, property, the environment, and overall community resilience.

In conducting a community risk assessment, Citygate examines prior risk studies, community demographics including current and projected population, land use, future development potential, employment, and building occupancy data as available, and prior service demand data.

Figure 1 summarizes the fire and non-fire hazards established by CFAI.

Figure 1—CFAI Fire and Non-Fire Hazards



3.2.9 Building Fire Risk

One of the primary hazards in any community is building fire. Citygate used available data from the District, the U.S. Census Bureau, and the Insurance Services Office (ISO) to assist in identifying and quantifying the District's building fire risk. The City of Mill Valley was not included in the detailed building risk assessment.

Building Risk Categories

CFAI identifies five building risk categories follows:

Low Risk Occupancies – includes detached garages, storage sheds, outbuildings, and similar buildings that pose a relatively low risk of harm to humans or the community if damaged or destroyed by fire.

Moderate Risk Occupancies – includes detached single-family or two-family dwellings, mobile homes, commercial and industrial buildings less than 10,000 square feet without a high hazard fire load, aircraft, railroad facilities, and similar buildings where loss of life or property damage is limited to the single building.

High Risk Occupancies – includes apartment/condominium buildings, commercial and industrial buildings more than 10,000 square feet without a high hazard fire load, low-occupant load buildings with high fuel loading or hazardous materials, and similar occupancies with potential for substantial loss of life or unusual property damage or financial impact.

Special Risk Occupancies – includes single or multiple buildings that require an Effective Response Force (ERF) greater than what is typically appropriate for the risk which predominates the surrounding area such as apartment/condominium complexes more than 25,000 square feet, Critical Infrastructure/Key Resource (CIKR) facilities, commercial/industrial occupancies with fire flows greater than 3,500 gallons per minute, vacant/abandoned buildings, buildings with required fire flow exceeding available water supply, and similar occupancies with high-life hazard or large fire loss potential.

Maximum Risk Occupancies – includes buildings or facilities with unusually high risk requiring an ERF involving a significant augmentation of resources and personnel, and where a fire would pose the potential for a catastrophic event involving large loss of life and/or significant economic impact to the community.

Building Fire Risk Factors

Table 5 illustrates the probability and consequences for each of the building fire risk categories. As cited earlier, *probability* is the likelihood of a fire occurring in a particular occupancy type, and *consequences* are the probable adverse impacts that the fire will have on people, property, and the community.

Table 5—Building Fire Probability/Consequence Matrix

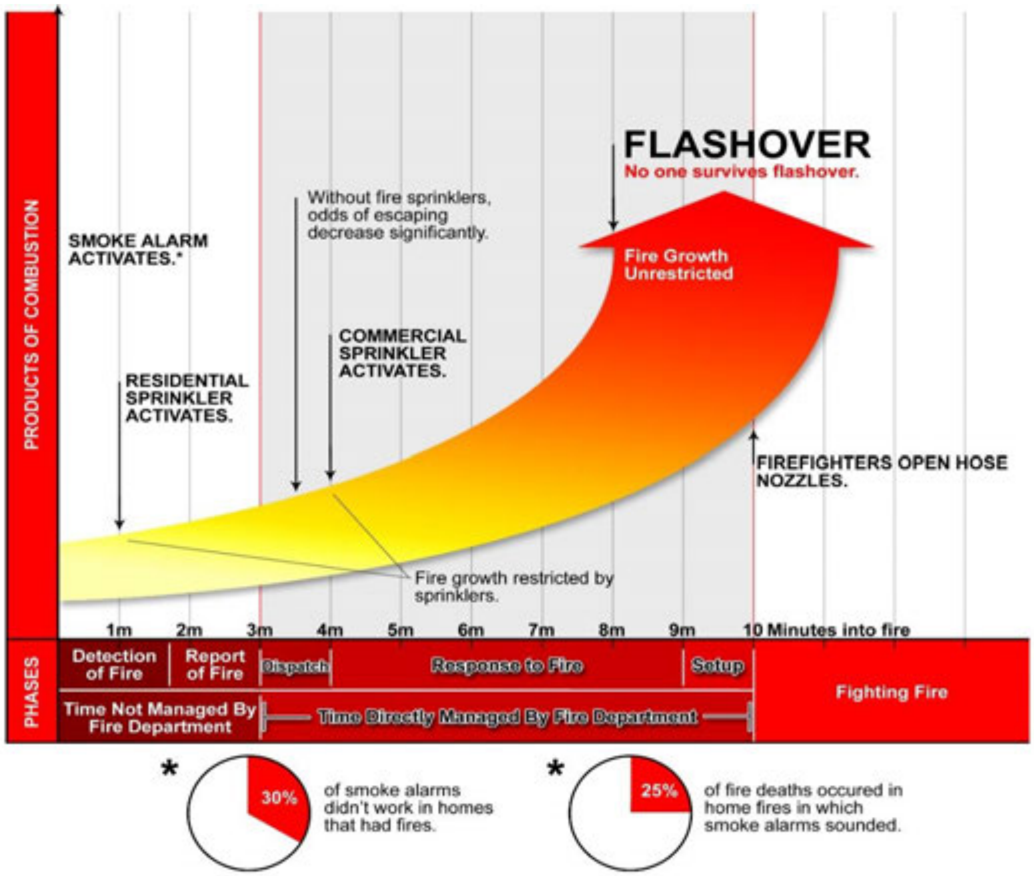
	Low Consequence	High Consequence
High Probability	**Moderate Risk** (High Probability) (Low Consequence)	**Maximum Risk** (High Probability) (High Consequence)
Low Probability	**Low Risk** (Low Probability) (Low Consequence)	**High/Special Risk** (Low Probability) (High Consequence)

Source: CFAI Standards of Cover, 5th Edition

Resource deployment (distribution/concentration), staffing, and response time are three critical factors influencing favorable outcomes for building fire risk. Figure 2 illustrates the progression timeline of a building fire, and shows that a response time[6] of 7:00 minutes or less is necessary to stop a building fire before it reaches flashover, which is the point at which the entire room erupts into fire after all of the combustible objects in that room have reached their ignition temperature. Survivability of a human in a room after flashover is extremely unlikely.

[6] Time interval from time of receipt of 9-1-1 call to initiation of suppression actions

Figure 2—Building Fire Progression Timeline



Source: http://www.firesprinklerassoc.org

Building Inventory

The District has a mix of building occupancies typical of a suburban population density as shown in Table 6. Data was very limited from the District on occupancy type and classification, but from the data available, this study found the following inventory metrics:

Table 6—District Building Inventory by Use Classification[1]

Building Class	Number	Risk Category
Assembly Occupancies	43	High
Commercial Occupancies	295	Moderate
Educational Occupancies	3	High
Floating Residential Homes	44	Special
Industrial Occupancies	47	High
Residential R-1 Occupancies	6	High
Residential R-2 Occupancies	302	High/Special
Single Family Residential	6,992	Moderate

[1] Data provided by Southern Marin Fire Protection District

High Rise Buildings

The Southern Marin Fire Protection District, including the City of Sausalito, has 48 buildings three stories in height, six of which are more than four stories, exceeding the reach of the District's ladder truck.

Buildings with Fire Sprinkler Systems

The District has approximately 59 buildings protected by automatic fire sprinkler systems. This number, provided by the District Fire Prevention Bureau, is not known to be exact.

High Fire Flow Requirements

One of the factors used by ISO is "Needed Fire Flow" (NFF), which is the amount of water that would be required in gallons-per-minute (GPM) if the building were seriously involved in fire. For the Southern Marin Fire Protection District, the ISO database identifies buildings evaluated, of which 26 buildings have a needed fire flow of 1,500-3,000 GPM, 5 buildings have a needed fire flow of 3,000-5,000 GPM, and no buildings have a needed fire flow of 5,000 GPM or more. For the City of Sausalito, the ISO database identifies buildings evaluated, of which 73 have needed fire flow of 1,500-3,000 GPM, 27 buildings have a fire flow of 3,000-5,000 GPM, and no buildings need a fire flow higher than 5,000 GPM.

Fire flows at and above 2,000 GPM are significant amounts of firefighting water to deploy, and a major fire at any one of these buildings would require the total commitment of the District's on-duty force along with immediate mutual aid. Using a generally accepted figure of 50 GPM per firefighter on large building fires, a fire in a building requiring 2,000 GPM would require 40 firefighters, which is more than the District's on-duty quantity of firefighters.

Table 7—Fire Flows of 1,000 GPM by Risk Zone

Risk Zone	Number
Station 1	137
Station 4	18
Station 9	18
Total	**173**

Historic Buildings

There are five designated historical buildings in the City of Sausalito, dating from the late 1800s to mid-1960s. All five of them are listed in the National Register of Historic Places. The City has a very progressive preservation ordinance.

Building Fire Risk Service Capacity

The District's service capacity for building fire risk consists of a minimum daily on-duty response force of 15 personnel cross-staffing four firefighting apparatus from three fire stations. In addition, the District has automatic aid or mutual aid agreements with adjacent fire agencies, and is also a signatory to the Marin County Mutual Aid Agreement. This fire service delivery capacity, using automatic and mutual aid, is appropriate to mitigate the District's building fire risk exclusive of the immediate mutual aid not being available or a disaster event occurring.

Building Fire Risk Service Demand

Over the past three years, there were a total of 86 building fires comprising 0.8% of total service demand over the same time period. The insurance industry does not provide final fire loss payouts so there is not a good record of fire losses in the District. Table 8 summarizes building fire risk service demand for the District.

Table 8—Building Fire Risk Service Demand by Year

2013	2014	2015	Total	Percent of Demand
24	36	26	86	.8%

Building Fire Risk Analysis

Due to the District's size and diverse building types and occupancies present throughout the District, and a diversity of construction types and occupant loads and risk factors present in the District, the probability of a significant building fire incident is a potential, based on historical service demand. Citygate's evaluation of relevant risk factors, service capacity and historical service demand yields a ***MODERATE*** probability of a response.

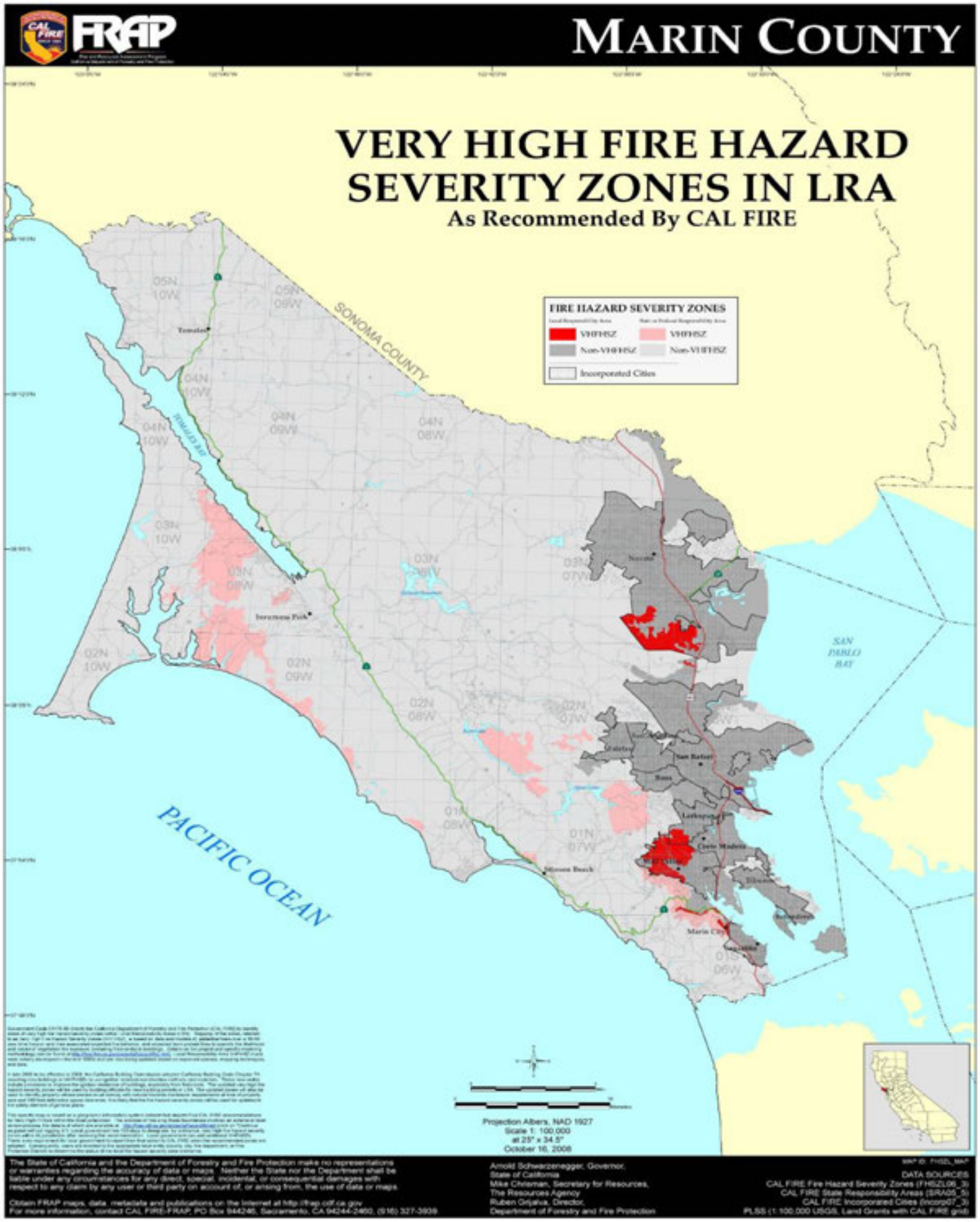
3.2.10 Wildland Fire Risk

Fire Hazard Severity Zones

The California Department of Forestry and Fire Protection (CAL FIRE) designates *Moderate*, *High*, and *Very High* Wildland Fire Hazard Severity Zones (FHSZ) throughout the state based on analysis of multiple wildland fire hazard factors and modeling of potential wildland fire behavior for State Responsibility areas (SRA) where CAL FIRE has fiscal responsibility for wildland fire protection. CAL FIRE also identifies recommended *Moderate*, *High,* and *Very High* FHSZs for Local Responsibility Areas (LRA) where a local jurisdiction bears the fiscal responsibility for wildland fire protection, including cities. CAL FIRE has identified the following areas of the District as having ***High to Very High*** wildland fire hazard severity risk as shown in Figure 3 and 4.

Figure 3—Wildland Fire Hazard Severity Zones

Figure 4—Map of Wildfire Severity Zone



Wildland Fire Risk Factors

Wildland fire behavior is influenced by fuel, weather, and topography. Wildland fuels in Southern Marin consist of a mix of annual grasses and weeds, brush, and trees. These fuels, when ignited, can burn intensely and contribute to rapid fire spread in the right weather and topographic conditions.

Weather elements such as temperature, relative humidity, wind, and lightning also affect wildland fire potential and behavior. High temperatures and low relative humidity dry out wildland fuels creating a situation where fuel will more readily ignite and burn more intensely. Wind is the most significant weather factor influencing wildland fire behavior; higher wind speeds increase fire spread and intensity. The annual wildland fire season in Marin County, when wildland fires are most likely to occur due to fuel and weather conditions, is generally from late spring through fall due to a predominant climate pattern of low annual rainfall, hot, dry summers, and moderate winds through Marin County.

Approximately 1,400 acres in the District are classified as High to Very High Fire Severity Zones. Approximately 2,500 acres of land are classified as Wildland Urban Interface (WUI) areas in the District and approximately 2,000 acres in Mill Valley. The majority of those land areas for fire suppression fall under the State of California. These areas are known as State Responsibility Areas (SRA) and are responded to by District units initially. However, the overall responsibility lies with the Marin County Fire Department for suppression.

Fuels

Plant communities in Marin County are generally defined by the northwest-trending ridges that pass through the County, where non-native annual grasslands dominate south-facing aspects and mixed evergreen forest dominates the north-facing slopes and valleys. Grassland types include coastal prairie and valley grassland; shrub land types include chamise chaparral, Manzanita chaparral, mixed chaparral, serpentine chaparral, coyote brush scrub, and coastal sage-coyote bush shrub; forestland types include coast live oak-California bay-madrone forest, tanbark oak-madrone-live oak-Douglas fir forest, Douglas-Fir Forest, coast redwood forest, bishop pine forest, eucalyptus forest, Monterey pine forest and oak woodland/savannah. Livestock grazing in western Marin County generally keeps grasslands short. Conversion of extensive, historically grazed lands in federal and state parkland areas has succeeded to shrub land and timberland. Most vegetation types in Marin County present a fire-control problem owing to overgrown 30 conditions due to years of successful fire suppression. Sudden oak death and planted fire-prone forests have also added to the fire problem.

Weather and History

The predominant summer weather pattern includes a strong coastal influence with coastal low clouds and fog in the evening and morning hours, clearing to sunshine and mild temperatures in the afternoon. The potential for large, wind-driven fires is great in the District and in Marin County, especially under Diablo (dry warm and downslope [Foen]) wind conditions that occur in autumn. Under these conditions, fire operations are limited by high fire intensities that create extreme fire behavior conditions: long-range spotting, high rates of spread, and long flame lengths.

Marin County also has an extensive history of significant wildfires. This history includes 1929's Mill Valley Fire, which destroyed 117 homes valued at over $1 million in 1929 dollars. A fire today with the same footprint would destroy approximately 1,000 structures with an assessed value of $713 million (Marin County Assessors' 2011 Parcel Data). The most recent significant wildfire in Marin County was 1995's Vision Fire. This fire destroyed approximately 50 structures, with a value of $23 million.

Wildland Fire Risk Service Capacity

The District's Response Plan for wildland fires includes Type 3 Wildland Engines or Type 1 Structure Fire Engines, 1 Medic Unit, 1 Battalion Chief, plus Marin County Fire Response for all Federal Response Area (FRA)and State Responsibility Area (SRA) incidents. Marin County will send 4-6 Type 3's, 1 Dozer, 1 Tam Fire Crew, 2 CAL Fire Hand Crews, 1 Helicopter, 1 Air Attack, 2 Air Tankers, and 1 Battalion Chief depending on the predesignated dispatch level for the day. This service capacity is appropriate to mitigate the District's current and anticipated near-future wildland fire risk.

Wildland Fire Risk Service Demand

Over the most recent three-year period evaluated by Citygate for this study, there were a total of 67 vegetation-related fires in the District comprising 0.63% of total service demand over the same time period as shown in Table 9.

Table 9—Wildland Risk Service Demand by Year

Incident Type	2013	2014	2015	Total
Natural vegetation	10	7	1	**18**
Brush or brush/grass	6	3	7	**16**
Grass	4	1	7	**12**
Forest, woods, or wildland	10	5	6	**21**
Total	**30**	**16**	**21**	**67**

Wildland Fire Risk Analysis

The District's wildland fire risk is ***MODERATE*** within the District boundaries. Typical late spring through fall weather patterns, vegetative fuel types and condition, and the topography of the wildland FHSZs in and around the District contribute to an increased probability of wildland fires in these areas with potential for erratic fire behavior and major destruction.

The majority of the wildland risk is located in the State Responsibility Area (SRA) for the Fire District. However, Fire District units would be first to respond. The SRA in the District is classified as very high risk and fuel type.

The District has approximately 2,600 acres of Wildland Urban Interface (WUI) within its boundaries. A fire in the WUI that reaches homes will have some disastrous consequences.

The District has a very aggressive WUI program and Community Wildfire Protection Program (CWPP) in coordination with Marin County.

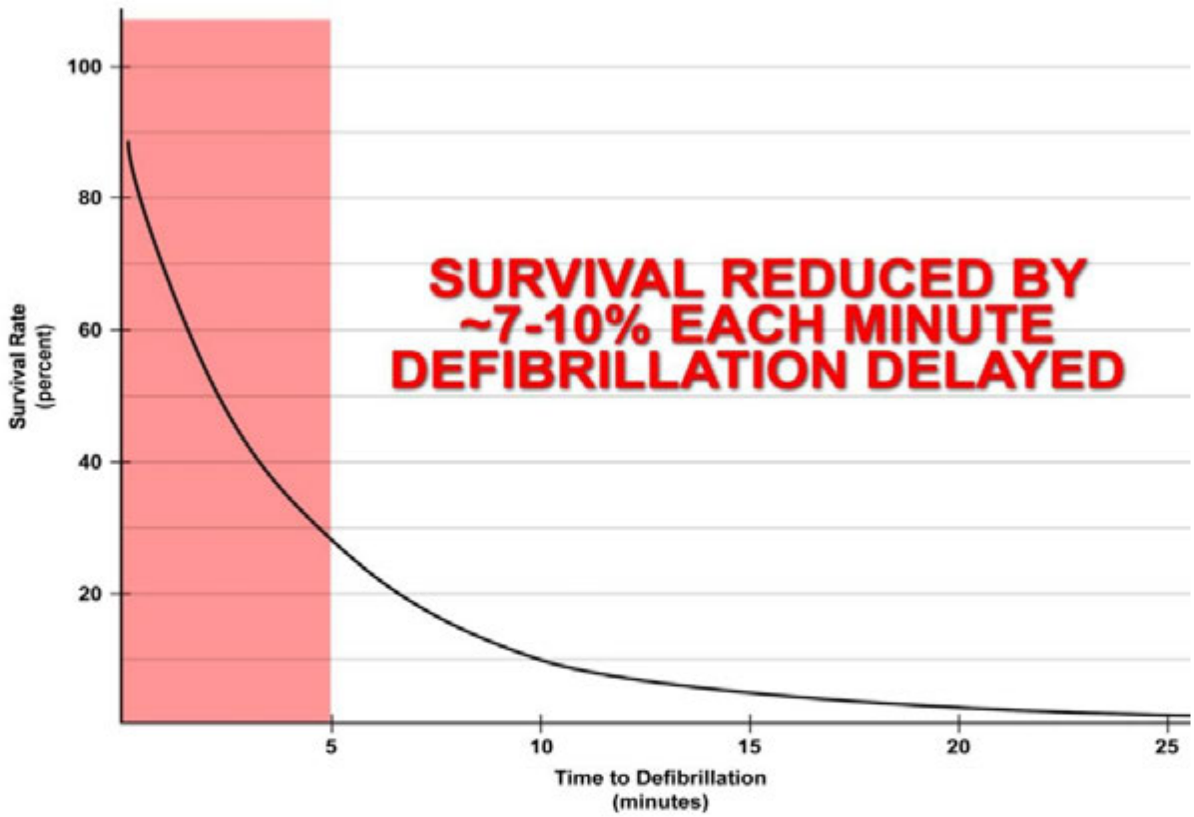
3.2.11 Emergency Medical Services Risk

EMS Risk Factors

Emergency medical services (EMS) risk in most communities is predominantly a function of population demographics, violence, and vehicle traffic. Relative to population demographics, EMS risk tends to be higher among poorer, older, less educated, and uninsured populations. As would be expected, EMS risk is also higher in communities or segments of communities with higher rates of violence. EMS risk is also higher in those areas of a community with high vehicle traffic loads, particularly those areas with high traffic volume travelling at higher speeds. The District, while having above average socio-economic factors, has a very difficult-to-serve road network that twists and turns across hilly topography. So, while incident demand is modest due to the types of populations served, providing quick urban response times is all but impossible.

EMS risk can also be categorized as either a medical emergency resulting from a health-related condition or event, or traumatic injury. One serious medical emergency is cardiac arrest or some other emergency where there is an interruption or blockage of oxygen to the brain. Figure 6 illustrates the reduced survivability of a cardiac arrest victim as time to defibrillation increases. While early defibrillation is one factor in cardiac arrest survivability, other factors can influence survivability as well, such as early CPR and pre-hospital advanced life support interventions.

Figure 5—Survival Rate vs. Time of Defibrillation



Source: www.suddencardiacarrest.org

EMS Risk Service Capacity

The District's service capacity for EMS risk consists of a minimum daily on-duty response force of 15 personnel with apparatus from three fire stations. In the District, all calls for medical assistance receive the closest Fire Department unit response, typically a medic unit with two personnel or the closest fire engine with three personnel. This level of response provides a minimum of two to five firefighters to every EMS-related call for service. All District response personnel are trained to either the Emergency Medical Technician (EMT) level capable of providing Basic Life Support (BLS) pre-hospital emergency medical care, or Paramedic level capable of providing Advanced Life Support (ALS) pre-hospital emergency medical services, and all staffed apparatus includes a minimum of one paramedic.

This service capacity is appropriate to mitigate the District's current and anticipated near-future EMS risk exclusive of a disaster event.

EMS Risk Service Demand

Table 10 shows annual EMS risk service demand for the District over the previous 3 years, which is close to 60% of total service demand over the same period.

Table 10—EMS Risk Service Demand by Year

Incident Type	2013	2014	2015	Total
EMS call excluding vehicle accident with injury	1,631	1,754	1,872	**5,257**
Assist EMS crew	42	29	19	**90**
Vehicle accident with injuries	135	101	125	**361**
Vehicle accident w/o injuries	93	102	93	**288**
Vehicle/pedestrian accident	20	20	21	**61**
EMS - Other	95	63	9	**167**
Total	**2,016**	**2,069**	**2,139**	**6,224**

Source: Fire District incident records

EMS Risk Analysis

Due to the District's size, diverse demographics, and occupancies present throughout the District, as well as transportation access and roadways in the District, the probability of a significant EMS incident is a potential, based on historical service demand. Citygate's evaluation of relevant risk factors, service capacity, and historical service demand yields a ***HIGH*** probability of a response.

3.2.12 Hazardous Materials Risk

Hazardous Materials Risk Factors

Hazardous material risk factors include fixed facilities that store, use, or produce hazardous chemicals, or produce hazardous waste; underground pipeline(s) that transport hazardous materials; and aircraft, railroad, and vehicle transportation of hazardous materials.

Other hazardous material risk factors include at-risk populations and related demographics, response capacity, historic service demand, emergency evacuation planning and effectiveness, and presence and effectiveness of mass emergency notifications system(s).

Marin County is the Certified Unified Program Agency (CUPA) and as such, the County's Environmental Health Department regulates most hazardous chemical uses in businesses. The Southern Marin Fire Protection District is a Participating Agency (PA) with the CUPA. The District has 40 facilities listed in the CUPA database and District Fire Prevention staff handle the hazardous materials safety use regulations in these businesses.

Hazardous Materials Risk Response Capacity

The Marin County Fire Chiefs have a Joint Powers Agreement (JPA) that provides a regional Hazardous-Materials Response Unit for emergencies. This is funded by all Marin County Fire

Agencies and staffed by members of these agencies who are certified Haz-Mat Technicians. The Unit was housed at Station 1 in Sausalito until recently and is now located at the Ross Valley Fire Department.

The Marin County Hazardous Materials Area Plan (HMAP) 2014 revision is a very detailed, well-written guideline for the responding agencies.

Hazardous Material Risk Service Demand

Table 16 summarizes annual hazardous material risk service demand for the District over the previous three years, which is 1.6% of total service demand over the same period.

Table 11—Hazardous Material Risk Service Demand by Year

Incident Type	2013	2014	2015	Total
Gas leak	24	33	30	**87**
Flammable liquid spill	4	5	6	**15**
Other flammable gas or liquid condition	2	5	3	**10**
Chemical spill or leak	2	0	1	**3**
Chemical hazard (no spill or leak)	1	1	1	**3**
Other toxic condition	2	0	1	**3**
Other hazard/condition	15	18	14	**47**
Total	**50**	**62**	**56**	**168**

Source: Fire District NFIRS incident records

Hazardous Materials Risk Analysis

Due to the District's size and related businesses, hazardous materials are present throughout the District, primarily in Sausalito.

With the low number of hazardous material risk factors present in the District, the probability of a significant hazardous material-related incident is unlikely based on historical service demand. Citygate's evaluation of relevant risk factors, service capacity and historical service demand yields an ***LOW*** probability of a response.

3.2.13 Technical Rescue Risk

Technical Rescue Risk Factors

Technical rescue risk factors include construction work, structural collapse, confined spaces such as tanks and underground vaults, bodies of water and rivers or streams, urban flooding, machinery, transportation accidents, and other factors that may create a need for technical rescue skills and/or equipment.

Technical Rescue Risk Response Capacity

The District participates in a regional approach to Technical Rescue responses for conducting low-angle and high-angle rope rescue, structural collapse, confined space, trench rescue, and water rescue operations.

Technical Rescue Response

<u>Coastal Technical Rescue Response for Land Based Rescue</u>: 3 Engines, 1 Rescue, 1 Medic Unit, 1 Rescue Helicopter, Marin Search and Rescue (S&R), 1 Battalion.

<u>Coastal Response for a Surf Zone Water Rescue</u>: 2 Engines, 1 Truck, 1 Rescue, 1 Medic Unit, 1 Inflatable Rescue Boat, 1 Rescue Helicopter, United States Coast Guard (USCG), Golden Gate National Recreation Area Life Guards, CA-Swiftwater/Flood S&R 11, and 1 Battalion.

<u>Coastal Response for an Open Ocean Water Rescue</u>: 2 Engines, 1 Truck, 1 Rescue, 1 Medic Unit, Fireboat Liberty, 1 Rescue Helicopter, United States Coast Guard, Golden Gate National Recreation Area Life Guards, CA-Swiftwater/Flood S&R 11, and 1 Battalion.

<u>Coastal Response for a Bay Water Rescue</u>: 1 Engine, 1 Truck, 1 Rescue, 1 Medic Unit, 2 Fireboats, USCG, 1 Rescue Helicopter, and 1 Battalion.

In the event of a possible entrapment or submersion component the Southern Marin Dive Team and Marin County Sheriff's Office Dive Team is added to the above responses.

Technical Rescue Risk Service Demand

Over the most recent three-year period evaluated for this study, there were 111 rescue incidents in the District comprising 1.05% of total service demand over the same period as shown in Table 14. It is noteworthy that the predominant rescue scenario for the District is water rescue.

Table 12—Technical Rescue Risk Service Demand by Year

Incident Type	2013	2014	2015	Total
Elevator rescue	1	1	4	**6**
Vehicle extrication	3	1	1	**5**
Extrication, rescue, other	0	3	1	**4**
Watercraft Rescue	5	6	6	**17**
Water/ice related rescue, other	9	14	11	**34**
High angle rescue	3	5	6	**14**
Watercraft rescue	5	6	5	**16**
Swimming pool/recreational water rescue	3	1	2	**6**
Confined space rescue	1	0	0	**1**
Swift water rescue	1	0	1	**2**
Search for person in water	1	0	5	**6**
Total	**32**	**37**	**42**	**111**

Source: Fire District incident records

Technical Rescue Risk Analysis

The District's technical rescue risk is ***MODERATE***. This risk rating reflects a high daily vehicle, commercial and industrial activity and water-related rescue risk, with a moderate probability of occurrence, significant consequences of life loss and very good technical rescue service capacity.

3.2.14 Transportation Risk

Transportation Risk Factors

Transportation risk factors include motor vehicle, and watercraft use in and through the District.

Primary Transportation Routes

California Highway 101 dissects the district and Sausalito as it comes north from the Golden Gate Bridge. Daily peak traffic in both directions at three locations identified by Caltrans exceeds 9,000 cars per hour.

Table 13—Average Annual Daily Highway Traffic Volume

Highway	Crossing	AADT[1]	Peak Daily Traffic	Peak Hour Traffic
HWY 101	Spencer	9,000	8,900	9,000
HWY 101	Rodeo	10,000	9000	10,000
HWY 101	SR.131	14,000	10,000	14,000

[1] Average Annual Daily Trips
Source: California Department of Transportation

Mass Transportation

Passenger ferry service to the City/County of San Francisco from the City of Sausalito is available from the south end of the City. Numerous people take the ferry on a daily basis to the City of San Francisco.

Transportation Risk Service Capacity

The District's response capacity for transportation risk consists of a minimum daily on-duty response force of 15 personnel cross-staffing specialty units including two water rescue boats from three strategically located fire stations. In addition, the Department has automatic aid and mutual aid agreements with adjacent fire agencies, and is also a signatory to the Marin County Mutual Aid Agreement. This response capacity is appropriate to mitigate the District's transportation risk exclusive of a disaster event.

Transportation Risk Service Demand

Over the most recent three-year period evaluated for this study, there were 752 transportation-related incidents in the District comprising 7.1% of total service demand over the same period as shown in Table 14.

Table 14—Transportation Risk Service Demand by Year

Incident Type	2013	2014	2015	Total
322 Vehicle accident with injuries	135	101	125	**361**
324 Vehicle accident w/o injuries	93	102	103	**298**
323 Vehicle/pedestrian accidents	20	20	21	**61**
131 Passenger vehicle fire	9	10	9	**28**
134 Watercraft fire	0	2	2	**4**
Total	**257**	**235**	**260**	**752**

Source: Fire District incident records

Transportation Risk Analysis

The District's transportation risk is ***MODERATE***. This risk rating reflects a high potential probability of occurrence based on traffic volume and number of incidents over the analysis period.

3.2.15 Disaster Risk

The 2012 Marin County Hazard Mitigation Plan (LHMP) identifies and describes the hazards likely to impact the District. Of those hazards, earthquakes and flooding ranked as the highest natural-occurring events. Disruption of lifeline utility infrastructure systems, which also ranked high, could be caused by either a natural-occurring event such as an earthquake, landslide/mudslide, and flood, or a human-caused condition or event. This section will address earthquake, landslide/mudslide, and flood risks.

The LHMP further identified 1,092 buildings as Critical Infrastructure / Key Resources (CIKR) in the County, but did not specifically identify which buildings were within the Southern Marin Fire Protection District's area. However, based on GIS mapping and layers there are 10 schools, 5 fire stations, 2 city halls, 1 county facility, 2 police stations, 2 libraries, and 2 post offices in the proximate area.

Earthquake/Seismic Activity

Faults and Probabilities

The San Andreas Fault traverses Marin County running north and south in the western quarter of the county. It enters Marin County on the Pacific Coast near Bolinas, follows the path of Highway 1 and Tomales Bay, exiting Marin at sea just west of Dillon Beach. In addition, the eastern, more heavily populated part of Marin is less than ten miles from the northern section of the Hayward fault. The northern part of Marin is less than ten miles from the Rodgers Creek fault.

According to a 2007 study of earthquake probabilities prepared by the Working Group on California Earthquake Probabilities (a multi-disciplinary collaboration of scientists and engineers) and published by the U.S. Geological Survey, the chance of a major (6.7 or greater magnitude) earthquake occurring in the Bay Area during the period of 2007 to 2037 is 63%. For the State of California at large, the chance of a major earthquake occurring is 99.7% during the period of 2007 to 2037.

The Working Group on California Earthquake Probabilities study further states that other faults in the area (including the Rodgers Creek Fault and the Hayward Fault) pose a major threat. Potential slippage of the San Andreas Fault could severely impact the County's coastal communities like Bolinas, Point Reyes Station, Stinson Beach, and Muir Beach.

An earthquake occurring in or near area faults could result in significant deaths, casualties, damage to property and environment, and disruption of normal government and community services and activities. Ground failures (fissuring, settlement, and permanent horizontal and vertical shifting of the ground such as surface breaks caused by faulting) that often accompany earthquakes could cause significant damage to network infrastructure such as water, power, communication, and transportation lines in Marin County. These effects could be aggravated by secondary emergencies such as fires, floods, tsunamis, hazardous material spills, utility disruptions, landslides, automobile accidents, transportation emergencies, and dam failures.

The Working Group also identified landslides as a potential risk for the District. Landslides are simply defined as movement of surface material down a slope. Since there are many areas in the District that are built on hills and mountains, the potential for landslide activity is especially high in Fire Station 9's area and for the station itself. Station 4's area is also identified for landslides. However, the potential of major damage and life loss is away from the residences in most cases.

Another risk associated with earthquakes and its destructive power is liquefaction. Liquefaction is defined as a process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking. Many areas in the San Francisco Bay Area are susceptible to this phenomenon. The risk potential for liquefaction in the District is high to very high in some areas should an earthquake occur. That risk determination, made by geologists, is based on research of soil type and stability, primarily in small areas in Sausalito and both Station 4's and 9's area. In Sausalito, there is approximately 310 acres identified as very high risk; in Station 9's area there is approximately 40 acres of high and very high risk; and in Station 4's area there is approximately 265 acres of high and very high risk.

Landslides – Mudslides

Landslides encompass a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on a very steep slope is the primary reason for a landslide, there are other contributing factors:

- Erosion by rivers or ocean waves create over-steepened slopes
- Rock and soil slopes are weakened through saturation by heavy rains
- Earthquakes create stresses that make weak slopes fail
- Earthquakes of magnitude 4.0 and greater have been known to trigger landslides
- Excess weight from accumulation of moisture.

In Marin County, landslide movement is a serious hazard threat to the community's infrastructure. Landslides often move slowly and thus may not threaten life directly. When they do move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of down slope support—they deform or tilt the ground surface. The result can be destruction of foundations, offset of roads, and breaking of underground pipes.

The best predictor of where movement of slides might occur where they have happened in the past. A small proportion of them may become active in any one year with movements concentrated within all or part of the landside masses or around their edges.

During heavy rainfalls, excessive water consistently triggers mudslides in the County and has caused significant infrastructure damage during the floods of 1970, 1973, 1982, 1983, 1986, 1998, and January of 2005). Additionally, the potential for a significant earthquake increases the probable impact of landslide hazard threat throughout the County. Landslide movement can be divided into four different types: (1) lateral and down-slope movement; (2) lateral spreads; (3) falls; and (4) topples. These are discussed below:

Lateral and down-slope movement of earth materials such as rock, soil, and/or artificial fill are a common type of slide. The term covers a broad category of events, including mudflows, mudslides, debris flows, rock falls, rock slides, debris slides, earth flows, and soil creep. Most losses from landslides occur in communities developed on sloping hillsides.

Lateral spreads are usually associated with loose, sandy soils that involve lateral displacement of large, superficial blocks of soil as a result of liquefaction of a subsurface layer. Displacement occurs in response to the combination of gravitational forces generated by an earthquake. Lateral spreads commonly disrupt foundations of buildings, sever pipelines, and other utilities.

Falls and topples are movements in which masses of rock or other material fall from cliffs or other steep slopes. Earthquakes or saturated soil commonly trigger this type of movement.

Flood/Sea Level Rise Risk

Waterways and Maritime Fire Risks

The District has large bodies of water to protect with a myriad of hazards. The hazards include approximately 100 houseboats, marinas with over 500 moorage slips for personal boating, and anchor points in the bay for yachts and boats. Some of the marina facilities have standpipe fire hose systems for fire department use to protect those boats and people, many of whom live aboard the boats.

The District uses several methods to protect this risk. In addition to standpipe systems, the District operates several small boats for water rescue and a 35-foot Metalcraft fireboat, capable of delivering 1,500 gallons per minute on a fire from several deluge monitors on the boat. The boat, when deployed, is staffed with a minimum of three personnel, usually more.

Floods are generally classed as either slow-rise or flash floods. Slow-rise floods may be preceded by limited warning time. Evacuation, sandbagging, and other preventative measures for a slow-rise flood may lessen flood-related damage. Conversely, flash floods are difficult to prepare for due to extremely short warning time. Flash flood warnings usually require immediate action within the hour. Flood waters can cause road closures and sweep away objects and people.

Areas that experience occasional flooding are found in various locations throughout Marin County mainly affecting roads. The County's floods historically have caused road closures, landslides, debris flows, erosion, and sewer problems. Creeks often overflow in low-lying areas when heavy rainfall is combined with high tide conditions.

Debris Flow

In Marin County, flash flooding is not as critical a threat as is the debris flow, including landslides caused by excessive rainfall that can cause serious damage. The District has some steep slope mountains and hills that would be susceptible to debris flow flooding.

Coastal Flooding

Winter storms can generate heavy wave action along the coastal areas of Marin which, combined with high tides, can initiate flooding along the ocean and bay coastlines. Utilities in flood-damaged buildings can result in gas leaks and electrical hazards. Resulting sewage and water line damage from floods are critical sanitation and health hazards.

Sea-Level Rise

Large volumes of water move into and out of San Francisco Bay as the tidal level of the Pacific Ocean just outside the Golden Gate changes each day. Marin County has a task force working on flooding cause by sea level rise. GIS mapping indicates with a 6-foot rise in sea level, District Fire Station 1 and 4 would be exposed to flooding as well as Mill Valley Station 7. Major transportation routes along Highway 1 would also be affected in all areas of the District, Sausalito, and Mill Valley. Mill Valley evacuation routes would be blocked if early warning did not occur. High astronomical tides over 7 feet are known to occur during winter storm weather causing flooding along the coast and impacting lands adjacent to bay and river fronts.

Tsunami

The greatest threat associated with tsunami is the impact on coastal structure property and threat to human lives. The Southern Marin Fire Protection District, Sausalito, and Mill Valley have areas which will be susceptible to damage should a tsunami occur in Richardson Bay. Damage to the City of Sausalito could occur up to Bridgewater St. and continue up the Bay Area towards Mill Valley. Fire Station 1 would be at risk for flooding in the event of a tsunami, as well as Sausalito City Hall.

In the City of Sausalito there are 300 acres designated as evacuation areas for pre planning for a tsunami. The area is primarily east of Bridgewater, extending south to north in the City. In Station 4's area it is approximately 128 acres.

The State of California Coastal Management Program (CCMP) under the California Coastal Act requires cities and counties lying wholly or partly within the coastal zone to prepare a Local Coastal Plan (LCP) that must be certified by the Coastal Commission as consistent with policies of the Coastal Act. (Public Resources Code, Division 20.)

Disaster risk is difficult to determine using probability. The severity factors from a disaster have very large implications, as emergency service resources will be stretched thin, even if they exist after the disaster. Response becomes a regional if not a national response. The effects of each of the disasters prevalent to the District will have an overwhelming affect. Marin County and its partner agencies, through the LHMP, have done an excellent job in identifying the issues and developing a local response plan when needed.

3.3 Existing District Deployment

3.3.1 Existing Deployment Situation—What the District Has in Place Currently

SOC Element 1 of 8*
Existing Deployment Policies
Note: Continued from page 9.

As the Board of Directors has not adopted a best practices-based response time policy, this study will benchmark the District for urban populated areas against the response time recommendations of NFPA Standard 1710 for career fire service deployment. These are:

- Four minutes travel time for the first-due unit to all types of emergencies
- Eight minutes travel time for multiple units needed at serious emergencies (First Alarm).

The District's current daily staffing plan is:

Table 15—Daily Minimum Staffing per Unit – 2016

Unit	Number F/F	Staff	Total
2 Engines	3	Firefighters per day	**6**
1 Ladder Truck or Engine[1]	2	Firefighters per day	**2**
2 ALS Medic Transport Units	2	Firefighters per day	**4**
1 Technical Rescue Squad	2	Firefighters per day	**2**
1 Shared Battalion Chief (BC)	1	Command per day	**1**
Total Firefighters and BC			**15**

[1] The ladder and engine are crossed-staffed at Station 4.

This daily staffing is only adequate for an immediate response to control low severity fires in most of the built-up, urban areas of the District, or handle a 1- to 3-patient EMS event. However, for a serious building fire, the assumption is that mutual aid will be available in a timely manner to provide the balance of the staffing needed.

Services Provided

The District is an "all-risk" fire department providing the people it protects with services that include structure and wildland fires, technical rescue, and first-responder hazardous materials response, as well as other services.

Given these risks, the District uses a tiered approach of dispatching different types of apparatus to each incident category. The District contracts for dispatching with the Marin County Sheriff's Office which selects the closest and most appropriate resource types and handles this function. As an example, here are the resources dispatched to common risk types:

Table 16—Resources Sent to Common Risk Types[7]

Risk Type	Minimum Type of Resources Sent	Total Firefighters Sent
1-Patient EMS	1 Engine and/or Medic Unit	2-5 FF
Auto Fire	1 Engine	3 FF
Building Fire	1 Truck, 3 Engines,* 1 Rescue,** 1 Medic Unit, 1 Battalion Chief***	18 FF
Wildland Fire	1 Wildland Engine, 1 Structure Engine, 1 Rescue, 1 Battalion Chief	9 FF
Technical Rescue	1 Engine, 1 Rescue, 1 Battalion Chief	6 FF

* One of these engines is provided via mutual aid, which could be staffed with two personnel.
** The rescue unit is staffed with four personnel with no pump or water capability; the truck is cross-staffed.
*** A second Battalion Chief can be dispatched on a working fire.

The deployment for structure fires relies heavily on automatic and mutual aid units, especially engine companies. The District utilizes a squad, equipped with technical rescue tools and equipment, for a regional approach to technical rescue incidents only. The unit has no pumping capacity and no water to fight fires.

Finding #2:	The District's response policy for structure fires includes the squad with four personnel to all structure fire responses outside its home district.

[7] Resources identified in this table vary depending on the location of the incident in the District.

Finding #3:	The District's response strategy for Station 9 is for both the squad and engine to respond together for all calls for service. The engine is the primary firefighting response unit.

Recommendation #1:	The District should revise the structure fire response policy and replace the squad with the engine on all structure fire calls.
Recommendation #2:	The District should revise its response policies to articulate the proper single unit responds to a single-unit event when needed.

SECTION 4—STAFFING AND STATION LOCATION ANALYSIS

4.1 CRITICAL TASK TIME MEASURES—WHAT MUST BE DONE OVER WHAT TIME FRAME TO ACHIEVE THE STATED OUTCOME EXPECTATION?

SOC ELEMENT 4 OF 8
CRITICAL TASK TIME STUDY

Standards of Coverage (SOC) studies use task time information to determine the firefighters needed within a timeframe to accomplish the desired fire control objective on moderate residential fires and modest emergency medical rescues.

4.1.1 Firefighting Critical Tasks

The District's Effective Response Force (ERF) to structure fires in built-up, suburban areas includes one ladder truck, three engines (one of which is via mutual aid), one medic unit, one rescue squad, and one Battalion Chief, for a minimum ERF total of **18** personnel—*if mutual aid is immediately available.*

NFPA 1710 recommends an ERF of 15 personnel. The following table shows what a force of 18 can accomplish (15 from District and 3 from mutual aid). The larger the force (weight of attack), the faster the tasks are completed.

Scenario: *The following is a simulated one-story residential structure fire with no rescue situation. Responding companies received dispatch information as typical for a witnessed fire. Upon arrival they were told approximately 1,000 square feet of the home was involved in fire.*

Table 17—First Alarm Structure Fire – 15 District Personnel Plus 3 Mutual Aid Personnel Totaling 18 Personnel

Company Level Tasks
1st-Due District Engine and Medic Unit (5 total personnel)
1. Lay in a hydrant supply line.
2. Stretch the 150-foot, 1¾-inch hose line to the point of access for search and rescue.
3. Operate the pump to supply water and attach hydrant supply line.
4. Assume command of initial operations.
5. Establish the Initial Rapid Intervention Crew.
2nd-Due District Engine or *Rescue Squad* (3 or 4 personnel)
1. If necessary, lay in a hydrant supply line.
2. Stretch a 2nd 200-foot hose line as a back-up line and for fire attack.
3. Establish treatment (EMS) sector if needed.
3rd-Due District Engine (3 personnel)
1. If necessary, lay in a hydrant supply line.
2. Pump 1st Engine's supply line if needed.
3. Stretch 3rd 1¾-inch hose line if needed.
4th-Due Engine – **Auto Aid** (2 personnel)
1. Establish a dedicated Rapid Intervention Crew.
1st-Due Ladder Truck – District Cross Staffed or Auto Aid depending on location (3 personnel)
1. Perform positive pressure and/or vertical ventilation.
2. Secure utilities.
3. Raise ladders, open concealed spaces, and force entry as needed.
4. Provide salvage and overhaul.
1st-Due Incident Commander (1 person)
1. Establish exterior command.

The duties in Table 17, grouped together, form an *Effective Response Force or First Alarm Assignment*. These tasks must be performed simultaneously and effectively to achieve the desired outcome; arriving on-scene does not stop the emergency from escalating. While firefighters accomplish the above tasks, the incident progression clock keeps running. However, given the District's daily staffing of only fifteen, not all few can be performed before mutual aid arrives.

Fire spread in a structure can double in size during its *free-burn* period before firefighting is started. Many studies have shown that a small fire can spread to engulf an entire room in less than 4 to 5 minutes after free burning has started. Once the room is completely superheated and involved in fire (known as flashover), the fire will spread quickly throughout the structure and into the attic and walls. For this reason, it is imperative that fire attack and search commence before the flashover point occurs if the outcome goal is to keep the fire damage in or near the room of origin. In addition, flashover presents a serious danger to both firefighters and any occupants of the building.

4.1.2 Emergency Medical Services Critical Tasks

The District responds to nearly 1,200 EMS incidents per year. These incidents include car accidents, water emergencies, strokes, heart attacks, difficulty breathing, and many other medical emergencies. The wide variety and circumstances of EMS calls makes it difficult and impractical to chart the critical tasks for each call type.

The American Heart Association (AHA) recommends a minimum of two emergency medical technicians and two certified paramedics to adequately operate an emergency cardiac scene. A 2010 EMS study conducted by the National Institute of Standards and Technology (NIST) clearly demonstrates a crew of four first responders on-scene, including two paramedics, is the most expedient and efficient means of delivering advanced emergency medical care.

The District routinely responds to EMS calls that require treatment for more than one patient. These calls include vehicle accidents, water rescues, chemical exposures, construction or industrial accidents, and any other event that occurs with several people in close proximity. Patient conditions can range from minor cuts and bruises to life-threatening injuries.

Dispatchers are responsible for screening calls to establish the correct initial response. The first fire department officer on-scene amends the response once conditions have been assessed. Standard operating procedures are used to request adequate personnel and resources.

For comparison purposes, the following critical task table reviews the tasks needed on a typical cardiac arrest.

Table 18—Cardiac Arrest – 5 Firefighters (Engine and Ambulance)

Task	Personnel Required	Type of Treatment Administered
Compressions	1-2	Compression of chest to circulate blood
Ventilate/oxygenate	1-2	Mouth-to-mouth, bag-valve-mask, apply O_2
Airway control	1-2	Manual techniques/intubation/cricothyroidomy
Defibrillate	1-2	Electrical defibrillation of dysrhythmia
Establish I.V.	1-2	Peripheral or central intravenous access
Control hemorrhage	1-2	Direct pressure, pressure bandage, tourniquet
Splint fractures	2-3	Manual, board splint, HARE traction, spine
Interpret ECG	2	Identify type and treat dysrhythmia
Administer drugs	2	Administer appropriate pharmacological agents
Spinal immobilization	4-6	Prevent or limit paralysis to extremities
Extricate patient	3-4	Remove patient from vehicle, entrapment
Patient charting	1-2	Record vitals, treatments administered, etc.
Hosp. communication	1-2	Receive treatment orders from physician
Treat en-route	2-4	Continue to treat/monitor/transport patient
Total	**5-7**	**Personnel required per patient**

4.1.3 Critical Task Analysis and Effective Response Force Size

What does a deployment study derive from a company task analysis? The total task needs (as displayed in Table 17 and Table 18) to stop the escalation of an emergency must be compared to outcomes. We know from nationally-published fire service "time vs. temperature" tables that after about 4 to 5 minutes of free burning, a room fire will grow to the point of flashover. At this point, the entire room is engulfed, the structure becomes threatened, and human survival near or in the fire room becomes impossible. Additionally, we know that brain death begins to occur within 4 to 6 minutes of the heart having stopped. Thus, the Effective Response Force must arrive in time to stop these catastrophic events from becoming worse.

The on-scene tasks discussed show that the residents of the District are able to expect positive outcomes, and have a good chance of survival, in a *moderate severity* medical emergency. This is because the District's first responding units are typically available in 5:01-7:08 minutes/seconds or less first unit ***travel*** time (as identified in Section 5).

Mitigating an emergency event is a team effort *once* the units have arrived. This refers back to the "weight" of response analogy; if too few personnel arrive too slowly, then the emergency will worsen instead of improve. The outcome times, of course, will be longer, with less desirable results, if the arriving force is later or smaller.

The quantity of staffing and the arrival time frame can be critical in a serious fire. Fires in older and/or multi-story buildings could well require the initial firefighters needing to rescue trapped or immobile occupants. If a lightly-staffed force arrives, it cannot simultaneously conduct rescue and firefighting operations.

Fires and complex medical incidents require that the other units arrive in time to complete an effective intervention. Time is one factor that comes from ***proper station placement***. Good performance also comes from ***adequate staffing*** and training. In the critical tasks identified previously, the District's firefighters can only perform well in terms of time *when mutual aid is close by*. Given how far apart the fire stations are spaced in the District and its neighboring communities, then when one unit has to cover another unit's area, or multiple units are needed, these units can be too far away and the emergency will worsen.

Previous critical task studies conducted by Citygate, the Standard of Response Cover documents reviewed from accredited fire departments, and NFPA 1710 recommendations all arrive at the need for 15+ firefighters arriving within 11 minutes (from the time of call) at a room and contents structure fire to be able to ***simultaneously and effectively*** perform the tasks of rescue, fire attack, and ventilation. Given that the District sends *at least 15* of its own personnel plus 3 others via mutual aid to an incident involving a working First Alarm building fire, it is clear that the District understands that firefighting crews arriving closely together are needed to deliver a positive outcome that protects lives and property by stopping the escalation of the emergency as found by the arriving force.

A question one might ask is, "If fewer firefighters arrive, *what* from the list of tasks mentioned would not be completed?" Most likely, the search team would be delayed, as would ventilation. The attack lines would only consist of two firefighters, which does not allow for rapid movement above the first-floor deployment. Rescue is conducted with only two-person teams; thus, when rescue is essential, other tasks are not completed in a simultaneous, timely manner. It must always be remembered: effective deployment is about the **speed** *(travel time)* and the **weight** *(firefighters)* of the attack.

Fifteen initial District firefighters plus three mutual aid firefighters could handle a moderate-risk house fire; however, even a blended Effective Response Force of 18 will be seriously slowed if the fire is above the first floor, in a hillside property that is difficult to reach, in a low-rise apartment building, or commercial/industrial building. This is where the capability to add alarms to the standard response becomes important.

Given the fact that the District's First Alarm (Effective Response Force) strives to deliver 15 of its personnel plus 3 via mutual aid to a moderate risk building fire, it reflects the District's unpublished goal to confine serious building fires near the room(s) of origin, and to prevent the spread of fire to adjoining buildings. This is a typical desired outcome in built-out areas and requires more firefighters more quickly than the typical rural outcome of keeping the fire contained to the building, not room, of origin.

Given that there is not a current District response time policy, the District's current physical response to building fires is, in effect, the District's de-facto deployment measure to built-up urban/suburban areas. Thus, this becomes the baseline policy for the deployment of firefighters.

4.2 DISTRIBUTION AND CONCENTRATION STUDIES—HOW THE LOCATION OF FIRST-DUE AND FIRST ALARM RESOURCES AFFECTS THE OUTCOME

SOC ELEMENT 5 OF 8
DISTRIBUTION STUDY

SOC ELEMENT 6 OF 8
CONCENTRATION STUDY

The District is served today by three fire stations. It is appropriate to understand what the existing stations do and do not cover, if there are any coverage gaps needing one or more stations, and what, if anything, to do about them.

In brief, there are two geographic perspectives to fire station deployment:

- **Distribution** – the spacing of first-due fire units to stop routine emergencies.
- **Concentration** – the clustering of fire stations close enough together so that building fires can receive sufficient resources from multiple fire stations quickly. As indicated, this is known as the **Effective Response Force**, or, more commonly, the "First Alarm Assignment"—the collection of a sufficient number of firefighters on scene, delivered within the concentration time goal to stop the escalation of the problem.

At the request of the Fire Chief, Citygate used geographic mapping to develop models that measured first-due unit response areas based on current fire station locations using the Insurance Services Office (ISO) recommended travel distances.

For this distance calculation, Citygate staff used the ISO recommended travel distance reach of 1.5 miles for a fire engine and 2.5 miles for a ladder truck. Using the GIS tool, Citygate ran several deployment tests and measured their impact on various parts of the District. The ISO distance measure of 1.5 miles is similar to a 4-minute driving time best practice. Thus, in addition to 4 minutes driving time, a total of 3 minutes is added for dispatch processing and crew turnout times, then the maps effectively show the area covered within 7 minutes total response time of the County 9-1-1 Communications Center receiving the request for the first-due unit, and 11 minutes (8 minutes travel) for a First Alarm Assignment.

GIS mapping was also used to evaluate the District's current fire station locations compared to incidents, as well as, the ISO-recommended response areas of 1.5 miles distance for an engine and 2.5 miles distance for ladder trucks. Figure 6 illustrates the current fire station and units' locations for both jurisdictions and the ISO engine recommended 1½-mile coverage from each fire station. Stations 1, 4, and 9 are in the District. Stations 6 and 7 are in Mill Valley.

Figure 6 illustrates that the existing District and Mill Valley fire stations reach a majority of the public streets within the 1.5-mile travel distance.

Figure 6—District and Mill Valley 1½-Mile ISO Response Areas

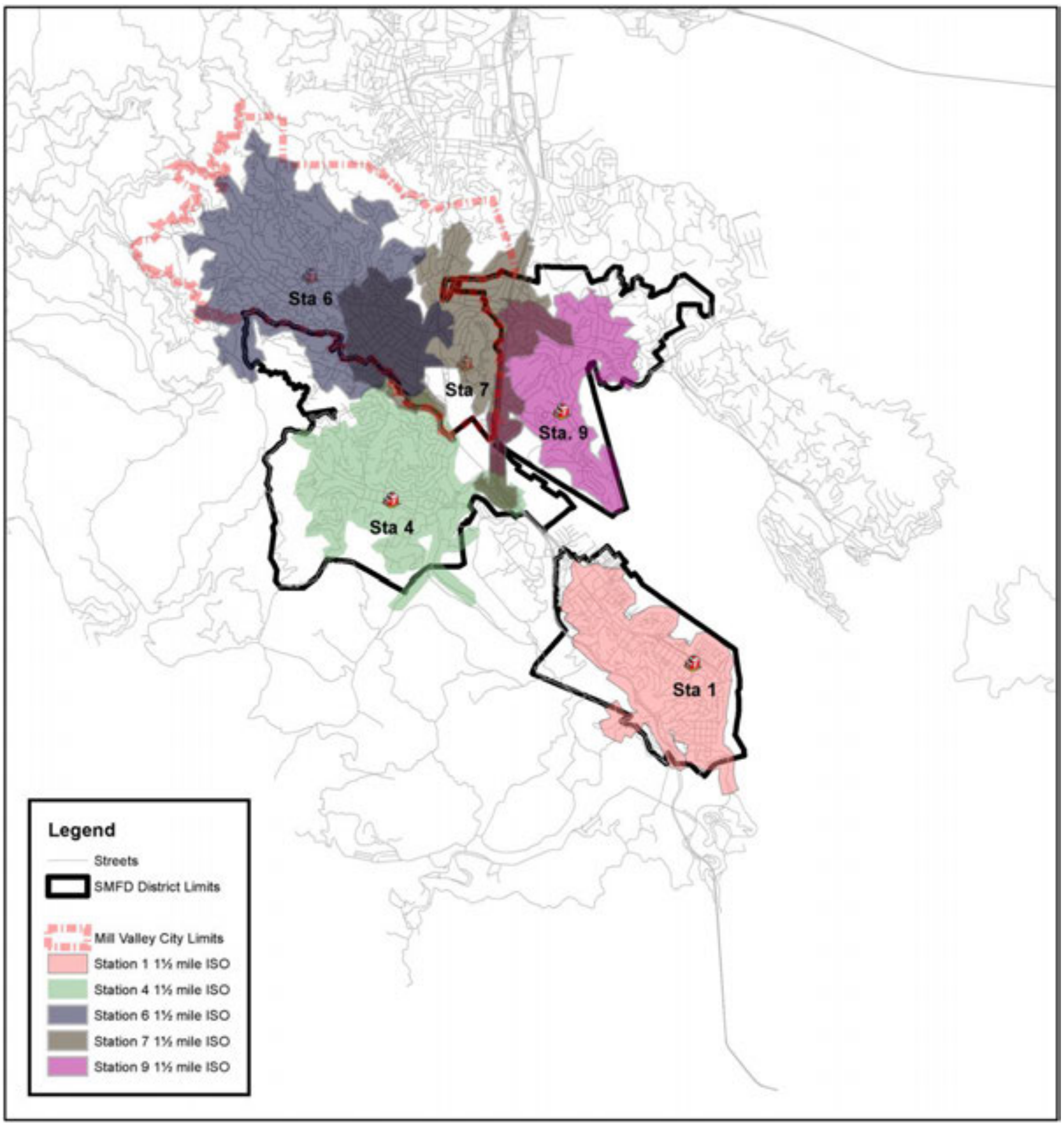


Figure 7 illustrates all District incident responses overlaid on the 1½-mile ISO response areas. Again, the majority of responses are within the 1.5-mile coverage of a current fire station.

Figure 7—District 2015 Incident Locations Over 1½-Mile ISO Areas

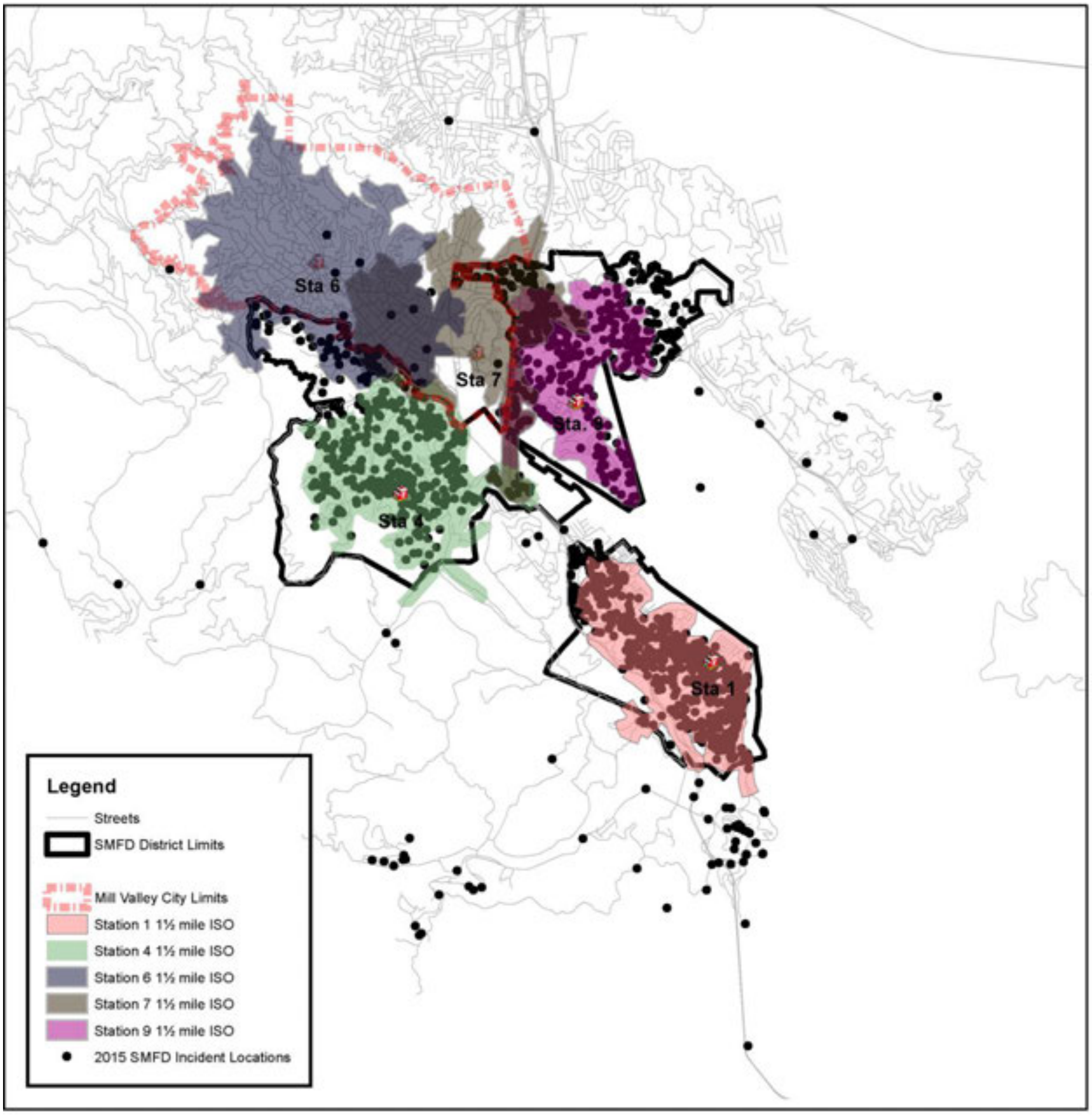
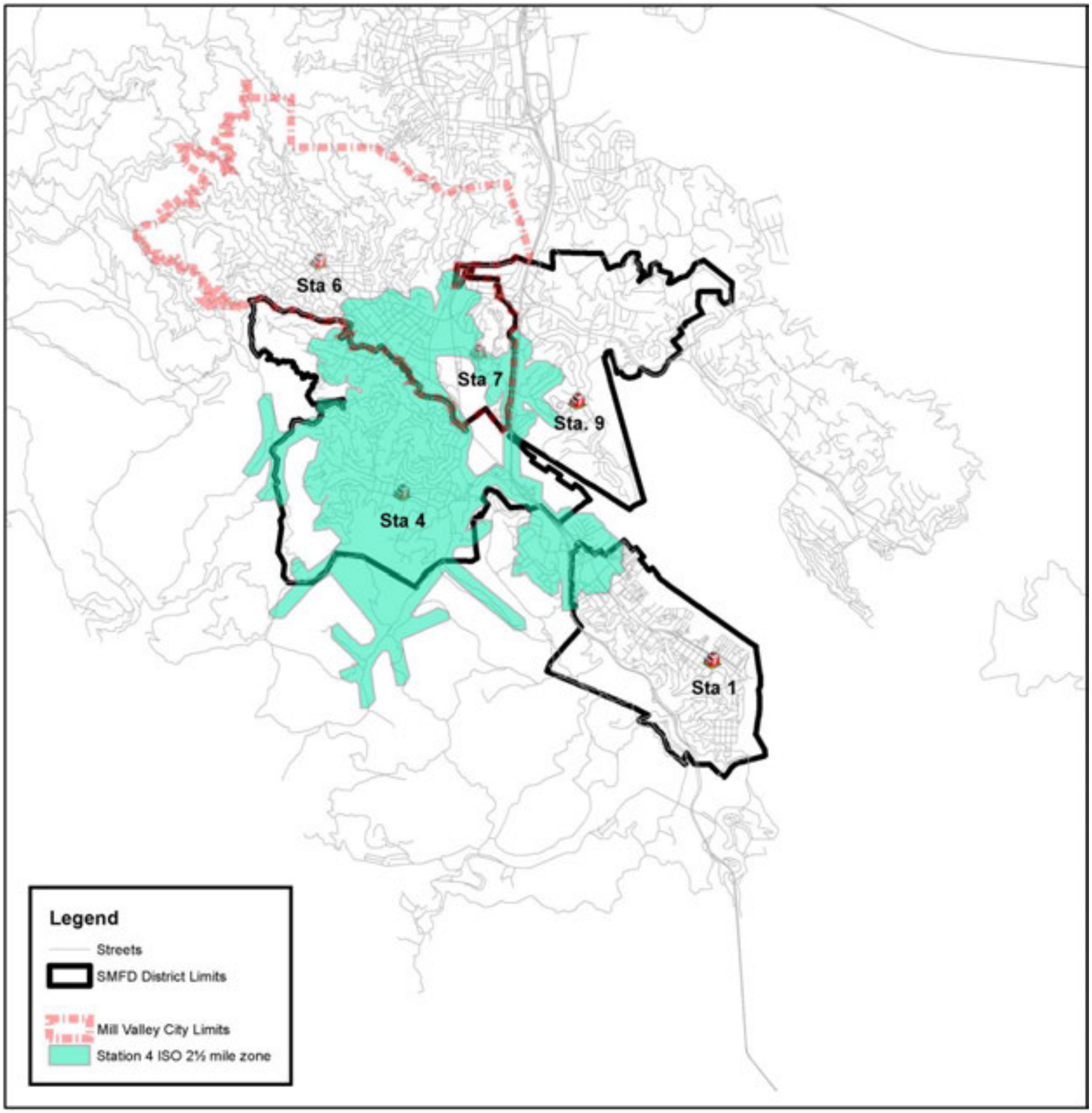


Figure 8 was developed to illustrate the current travel distance coverage for Truck 4 using the ISO recommendation of a 2.5-mile response area. As shown, the ladder only covers a portion of the District and some of Mill Valley; additionally it covers the northern portion of Sausalito and Station 9's area.

Figure 8—District Truck 4 and ISO 2½-Mile Response Area



Finding #4:	The current locations for the District's fire engines are adequate to meet the needs of the District.

Citygate, at the District's request, performed several tests of relocating Stations 4 and 9. Moving Station 4 slightly to the northeast did not improve coverage much, if any, due to the road network layout. As for Station 9, a northeast movement did not appreciably cover more incidents at the expense of coverage along the highway. Relocating or adding fire stations is very expensive. Given that the maps show the current locations cover the highest density of incident locations, and due to the challenging topography, very little gain will be seen from relocating any of the fire stations or equipment.

Finding #5:	Relocating or adding a fire station in the District is not a necessary or cost-effective investment.

Section 5—Response Statistical Analysis

5.1 Historical Effectiveness and Reliability of Response—What Statistics Say About Existing System Performance

SOC Element 7 of 8
Reliability & Historical Response Effectiveness Studies

The maps described in Section 4 above show the GIS-response distance times given perfect conditions with no competing calls, with and without traffic congestion, and units all in place. Examination of the actual response time data in this section provides a picture of how response times are in the "real" world of simultaneous calls, rush hour traffic conditions, units out of position, and delayed travel time for events such as periods of severe weather.

5.1.1 Data Set Identification

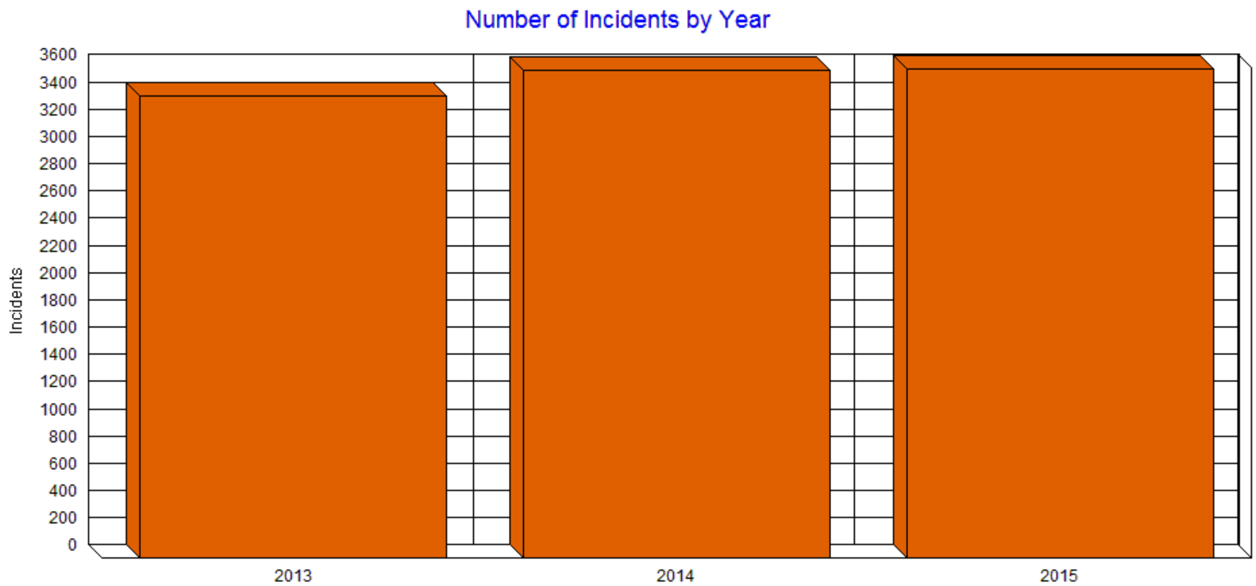
The Southern Marin Fire Protection District provided NFIRS 5 incident and CAD apparatus response data for the time period 1/1/2013-12/31/2015. NFIRS 5 data was loaded for the three years and resulted in 10,573 incidents and 26,726 apparatus response records.

5.2 Service Demand

In 2015, the Southern Marin Fire Protection District responded to 3,591 incidents. During this time period, the District had a daily demand of more than 9.84 incidents, of which 2.42% were fire, 61.13% were EMS, and 36.45% were "Other" incident types.

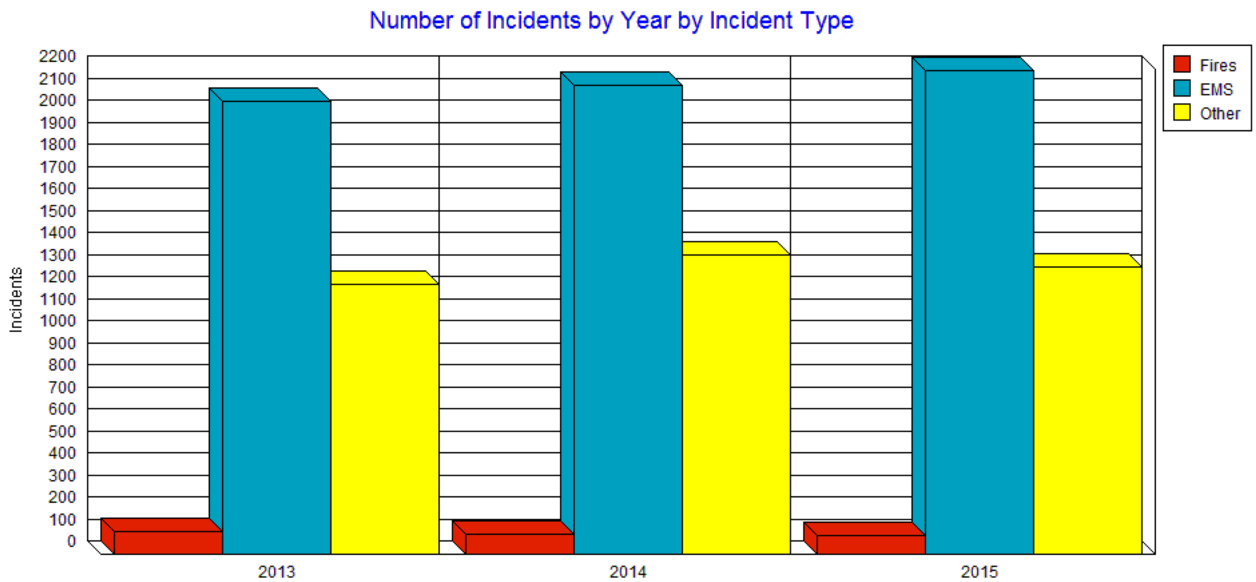
The District experienced an increase in incidents from 2013 to 2014, but a very slight increase from 2014 to 2015.

Figure 9—Number of Incidents by Year



The following graph depicts the number of incidents by incident type by reporting year. The number of EMS incidents is rising year to year. The number of fires is declining slightly from year to year:

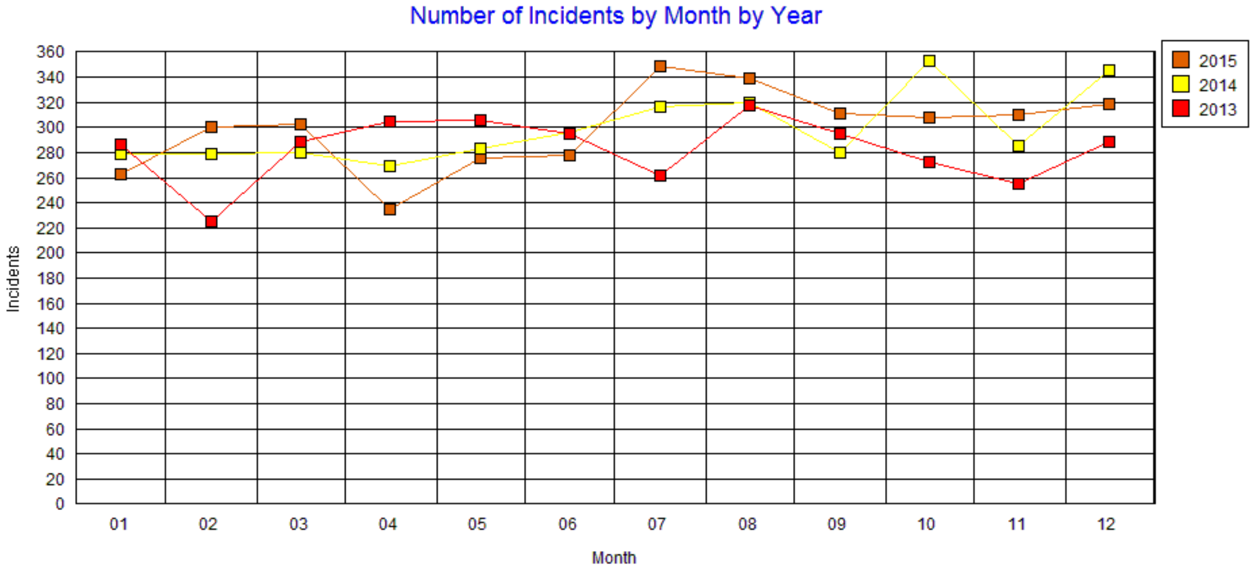
Figure 10—Number of Incidents by Incident Type in 2015



5.2.1 Breakdown of Incident Demand Over Time

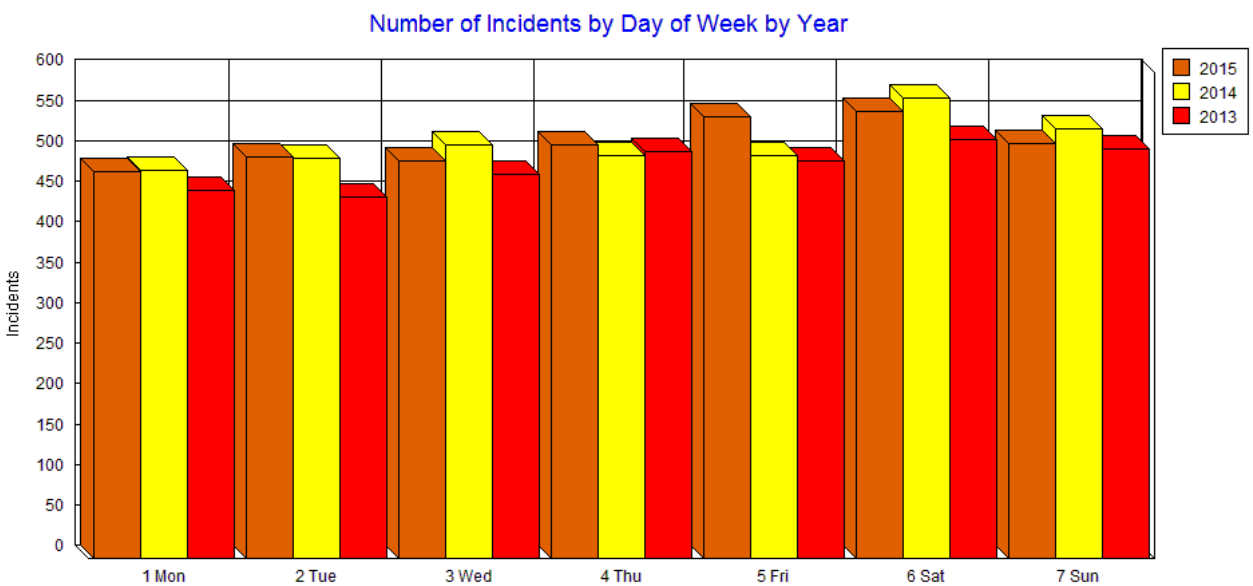
The number of incidents by month modulates year to year with consistent peak activity during the mid-summer months:

Figure 11—Number of Incidents by Month by Year



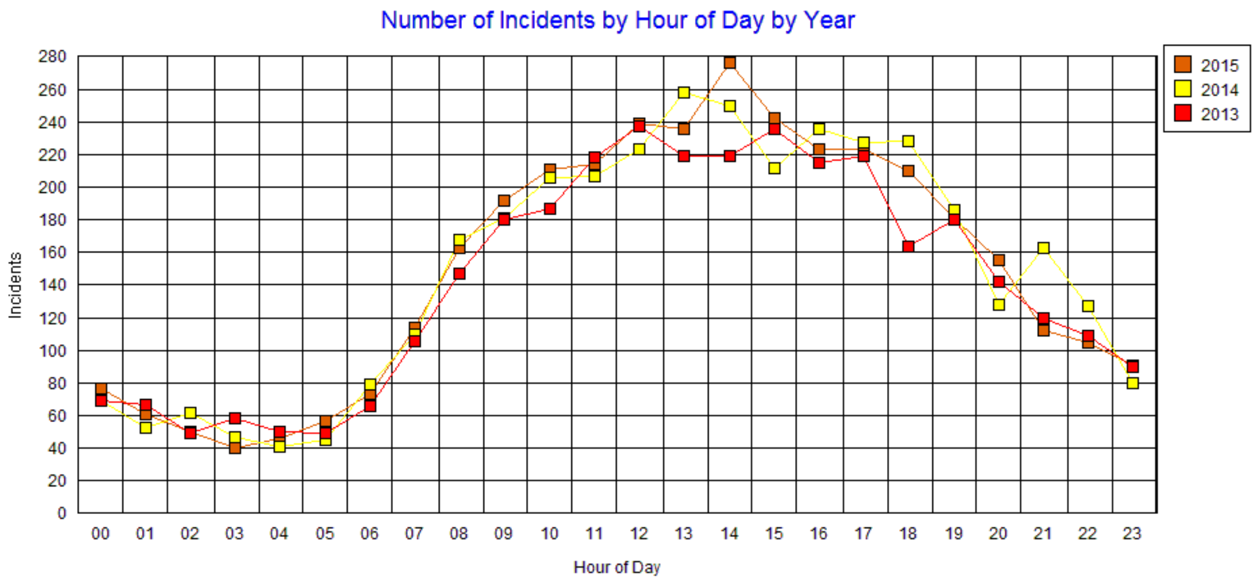
When broken down by day of week incident activity tends to build during the work week and a slight peak on weekends:

Figure 12—Number of Incidents by Day of Week by Year



The following chart shows the breakdown of incidents by hour of the day by year. Activity is consistent by hour of day with the exception of volatility in the afternoon and early evening hours:

Figure 13—Number of Incidents by Hour of Day by Year



Finding #6:	The District's time-of-day, day-of-week, and month-of-year calls for service demands are very consistent. This means the District needs to operate a fairly consistent 24/7/365 response system.

5.2.2 Breakdown of Incident Demand by Type

The following table shows the activity rankings of incidents by incident quantity in 2015 where there were five or more such occurrences. Notice the strong ranking for EMS incidents and incidents that are cancelled before the apparatus reaches the scene. Building fires ranked 22nd place by volume. There were 10 building fires in 2015.

There are 1,867 incident records being analyzed.

Table 19—Incident Demand by Incident Type in 2015

NFIRS Code # and Description	Quantity
321 EMS call, excluding vehicle accident with injury	1,041
611 Dispatched & canceled en route	169
322 Vehicle accident with injuries	66
700 False alarm or false call, other	60
300 Rescue, emergency medical call (EMS) call, other	60
324 Motor vehicle accident no injuries	48
400 Hazardous condition, other	29
510 Person in distress, other	28
554 Assist invalid	24
550 Public service assistance, other	20
500 Service call, other	19
444 Power line down	19
323 Motor vehicle/pedestrian accident (MV Ped)	15
600 Good intent call, other	13
531 Smoke or odor removal	13
412 Gas leak (natural gas or LPG)	13
561 Unauthorized burning	12
745 Alarm system sounded, no fire - unintentional	11
733 Smoke detector activation due to malfunction	11
553 Public service	11
311 Medical assist, assist EMS crew	10
111 Building fire	**10**
735 Alarm system sounded due to malfunction	9
100 Fire, other	9
551 Assist police or other governmental agency	8
520 Water problem, other	8
364 Surf rescue	8

NFIRS Code # and Description	Quantity
140 Natural vegetation fire, other	8
154 Dumpster or other outside trash receptacle fire	7
740 Unintentional transmission of alarm, other	6
650 Steam, other gas mistaken for smoke, other	5
411 Gasoline or other flammable liquid spill	5
151 Outside rubbish, trash or waste fire	5

5.2.3 Simultaneous Analysis

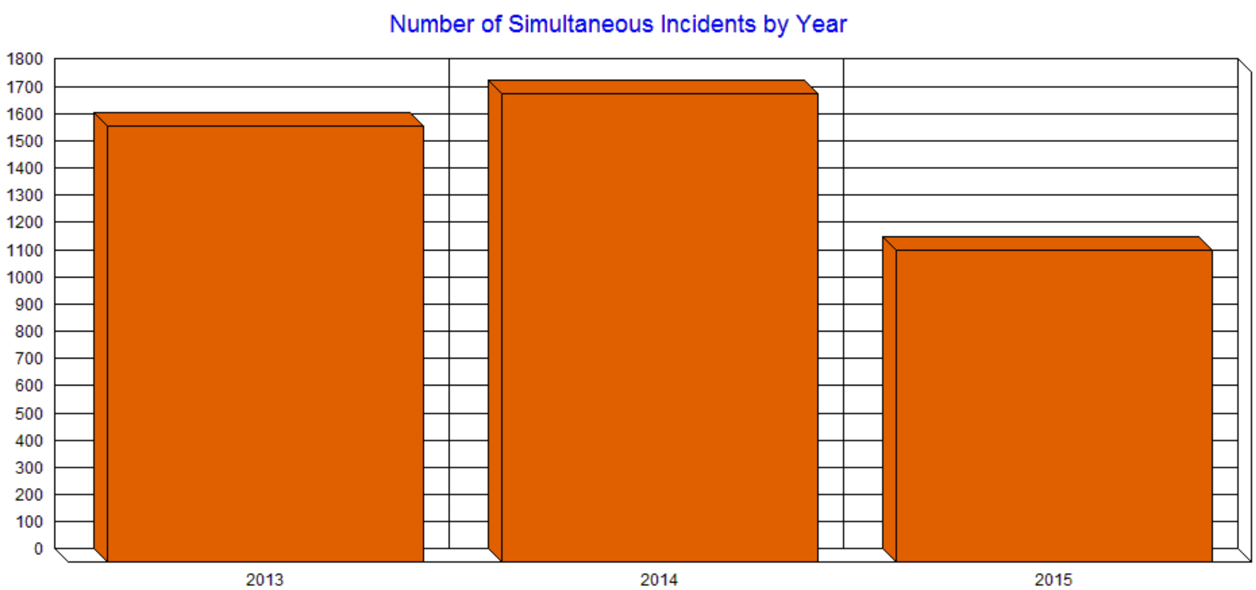
Simultaneous incidents are incidents that begin when other incidents are already underway. In 2015, 21.42% of incidents occurred while one or more other incidents were underway. The following table shows the percentage of simultaneous incidents broken-down by the number of simultaneous incidents.

Table 20—Simultaneous Incident Occurrences in 2015

Simultaneous Incidents	Percentage of Occurrences
1 or more simultaneous incidents	21.42%
2 or more simultaneous incidents	00.69%

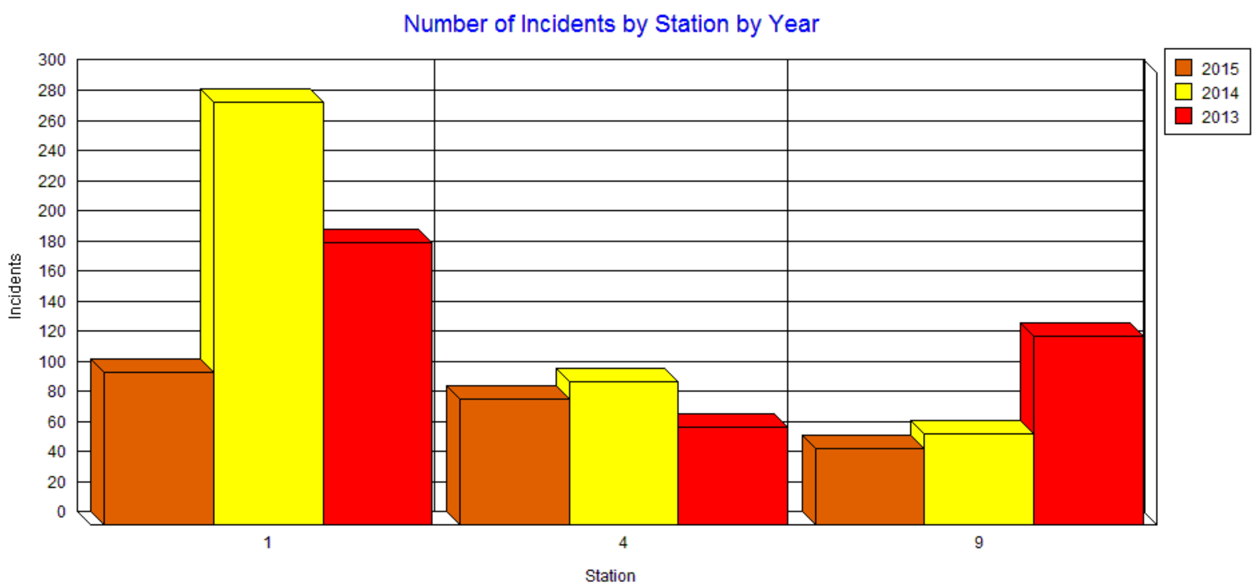
The following graph shows that the number of simultaneous incidents peaked in 2014 and dropped in 2015.

Figure 14—Number of Simultaneous Incidents by Year



The following graph illustrates the number of single-station simultaneous incidents by station area by year. Station 1 experiences the greatest number of simultaneous incidents.

Figure 15—Number of In-Station Area Simultaneous Incidents by Station



5.2.4 Unit-Hour Utilization

The utilization percentage for apparatus is calculated by two primary factors: the number of responses and duration of responses. The following chart is a 2015 Unit Utilization Summary for District engines.

In the graph below the busiest engine is listed first:

Table 21—District Engine Unit-Hour Utilization in 2015

Hour	E1	E4	E9
00:00	2.13%	1.69%	1.29%
01:00	1.91%	0.84%	0.92%
02:00	1.46%	1.06%	1.24%
03:00	2.37%	0.93%	0.67%
04:00	2.19%	1.18%	0.82%
05:00	2.21%	1.72%	1.62%
06:00	3.86%	1.67%	1.38%
07:00	3.79%	1.58%	1.43%
08:00	5.44%	2.51%	2.39%
09:00	5.83%	2.75%	2.43%
10:00	6.78%	2.77%	2.83%
11:00	6.45%	3.11%	2.82%
12:00	6.84%	4.52%	4.36%
13:00	8.06%	5.06%	3.48%
14:00	8.05%	3.60%	4.97%
15:00	7.92%	5.73%	4.13%
16:00	7.71%	4.62%	3.21%
17:00	6.28%	5.57%	3.61%
18:00	14.70%	3.58%	3.71%
19:00	6.07%	2.73%	2.76%
20:00	5.13%	2.55%	2.99%
21:00	4.67%	1.67%	3.25%
22:00	2.78%	1.89%	1.95%
23:00	2.82%	2.51%	1.86%
Overall	**5.23%**	**2.74%**	**2.51%**
Runs	**1,138**	**563**	**595**

The chart below illustrates the Unit Hour Utilization for medic company responses into the District in 2015.

Table 22—District Medic Company Unit-Hour Utilization in 2015

Hour	MED1	MED4	R9
00:00	5.32%	4.55%	2.15%
01:00	5.59%	2.42%	1.47%
02:00	3.11%	2.38%	1.67%
03:00	4.32%	1.43%	1.31%
04:00	4.46%	2.74%	2.47%
05:00	5.40%	2.72%	1.85%
06:00	8.49%	2.34%	1.01%
07:00	8.19%	4.12%	1.88%
08:00	16.18%	8.06%	5.73%
09:00	12.90%	7.04%	3.51%
10:00	15.20%	9.76%	5.73%
11:00	15.65%	11.55%	4.09%
12:00	16.41%	12.32%	3.70%
13:00	19.43%	16.52%	5.02%
14:00	20.60%	12.05%	5.69%
15:00	15.25%	12.97%	4.19%
16:00	17.01%	12.79%	5.73%
17:00	14.34%	9.63%	6.57%
18:00	13.42%	9.28%	4.97%
19:00	9.43%	8.81%	3.71%
20:00	11.62%	5.48%	4.16%
21:00	10.22%	4.16%	3.30%
22:00	8.11%	2.91%	2.65%
23:00	6.37%	2.98%	3.03%
Overall	**11.12%**	**7.04%**	**3.57%**
Runs	**1,113**	**707**	**755**

What should be the maximum utilization percentage on a firefighting unit? During the 9-hour daytime work period, when crews on a 24-hour shift need to also pay attention to apparatus checkout, station duties, training, public education, and paperwork, plus required physical training and meal breaks, Citygate believes the maximum commitment UHU per hour should not exceed 30%. Beyond that, the most important element to suffer will be training hours.

For a dedicated unit, such as an ambulance or low acuity squad working less than a 24-hour shift, then UHU can rise to 40-50% at a maximum. At that UHU level, peak hour squad crews must then have additional duty days for training only, and not responding to incidents, to meet their annual continuing education and training hours requirements.

In the District's case, the modest incident volume per hour is not yet taxing the units to the point of needing another unit *solely* for peak-hour workload. The units have the capacity for more incident load per hour *if there are not simultaneous* incidents. However, at this time the actual rate of simultaneous occurrences at 21% is still relatively low as compared to other suburban areas.

5.2.4 Aid Activity with Other Jurisdictions

The following table shows aid activity for the three reporting years. These numbers report data collected in the Mutual Aid section of NFIRS 5 data.

There are 10,573 Incident records being analyzed.

Table 23—2015 Incidents: Quantity – Aid Type

Aid Type	2013	2014	2015	Totals
1 Mutual Aid Received	8	7	7	**22**
2 Automatic Aid Received	234	301	460	**995**
3 Mutual Aid Given	53	26	25	**104**
4 Automatic Aid Given	588	472	653	**1,713**
5 Other Aid Given			2	**2**

The District is just under twice as likely to give aid as to receive aid. While aid given or received is measurable, it is involved in only 8.4% of District incidents. However, most of the "aid" is given to the Mill Valley and Sausalito areas, given the way the national incident system measures by defined City names separate from District areas. As such, the in and out mutual aid use in the District is very modest and not of concern from a balancing perspective.

5.3 Response Time Analysis

Once the types of incidents are quantified, incident analysis shifts to the time required to respond to those incidents. Fractile breakdowns track the percentage (and count the number) of incidents meeting defined criteria, such as the first apparatus to reach the scene within progressive time segments.

5.3.1 District-wide Response Time Performance

A resident or visitor of the District measures the speed of fire department response from the time assistance is requested until the assistance arrives. This measurement is called "Call to 1st Apparatus Arrival" (or "Call to Arrival"). Police and sheriff's departments, under state law, act as a Public Safety Answering Point (PSAP) for 9-1-1 calls. All 9-1-1 calls for fire service in the District are received and dispatched under contract by the County Sheriff's Communications Center.

Based on national recommendations, Citygate's response time test goal is for the 90% Call to Arrival to be 7 minutes (or 420 seconds). This is comprised of three component parts:

Call Processing Time: 1 minute (receive, determine need, alert crew)

Turnout Time: 2 minutes (notify, don required protective gear, get moving)

Travel Time: 4 minutes (travel time)

Following is the breakdown of fire dispatch call received to first apparatus arrival for the overall District and by station area by year *for fire and emergency medical* incidents:

Table 24—Call to Arrival Response Time (Minutes/Seconds) – 90% Performance

Area	Overall	2013	2014	2015
District-Wide	09:34	09:12	09:42	09:37
Station 1	09:52	09:27	09:44	10:12
Station 4	10:51	11:00	11:14	10:04
Station 9	08:08	08:12	08:00	08:20

While all of the call to arrival times to 90% of the emergent incidents in the table above are past a Citygate recommended 7 minutes. The next set of tables will present the individual segments of total response time—dispatch time, crew turnout time, and travel time—to understand which measure(s) are responsible for the total time being longer than 7 minutes.

5.3.2 Call Processing Time

Dispatch time: This measure is the time it takes to answer the 9-1-1 call received at the Marin County Sheriff's Office Communications Center, to when the notification is sent to the District, determine the emergency, enter information into the computer-aided-dispatch system, and alert the closest crew. NFPA 1710's advice is for 90% of the calls to be dispatched in 90 seconds. Where language barriers exist, or medical self-help instructions are needed, these calls should be dispatched within 120 seconds. The performance of the Marin County Sheriff's Office Communications Center is shown below:

Table 25—Call Process Time (Minutes/Seconds) – 90% Performance

Area	Overall	2013	2014	2015
District-Wide	02:08	01:46	02:19	02:15
Station 1	01:55	01:32	01:54	02:02
Station 4	02:07	01:41	02:16	02:10
Station 9	02:40	01:59	02:59	02:45

Finding #7: The Fire District is not in control of the Sheriff's Office Communications Center performance; however, for time-sensitive fire and EMS events, the Center's performance is not to best practices and the time lost in dispatch processing cannot be made up by driving faster.

5.3.3 Turnout Time

Turnout time: This measure is the time it takes for all crews to hear the dispatch message, don safety clothing, and begin moving the assigned apparatus.

Table 26—Turnout Time (Minutes/Seconds) – 90% Performance

Area	Overall	2013	2014	2015
District-Wide	02:25	02:28	02:21	02:24
Station 1	02:25	02:20	02:25	02:28
Station 4	02:36	02:42	02:32	02:33
Station 9	02:15	02:28	02:11	02:07

While the NFPA and CFAI recommends 60-80 seconds for turnout time, it has long been recognized as a standard rarely met in practical experience. Crews must not just hear the dispatch message; they must also don the personal protective clothing mandated by the Occupational Safety and Health Administration (OSHA) for the type of emergency. Citygate has long recommended that, due to this and the floor plan design of some stations, agencies can reasonably make a 2-minute crew turnout time to 90% of the emergency incidents.

Finding #8: The District's turnout times need improvement and need to fall consistently below 2 minutes.

5.3.4 Travel Time

Travel time – The District-wide travel time measures to all emergency incidents are shown hereafter. Travel time is defined as the time element between when the Communications Center is notified, either verbally or electronically, that the unit is en-route to the call, and when it arrives at the address or location street front (not the patient's side).

Table 27—Travel Time (Minutes/Seconds) – 90% Performance

Area	Overall	2013	2014	2015
District-Wide	06:17	06:28	05:59	06:21
Station 1	07:11	07:27	06:59	07:08
Station 4	06:12	06:27	05:56	06:14
Station 9	04:57	05:09	04:28	05:01

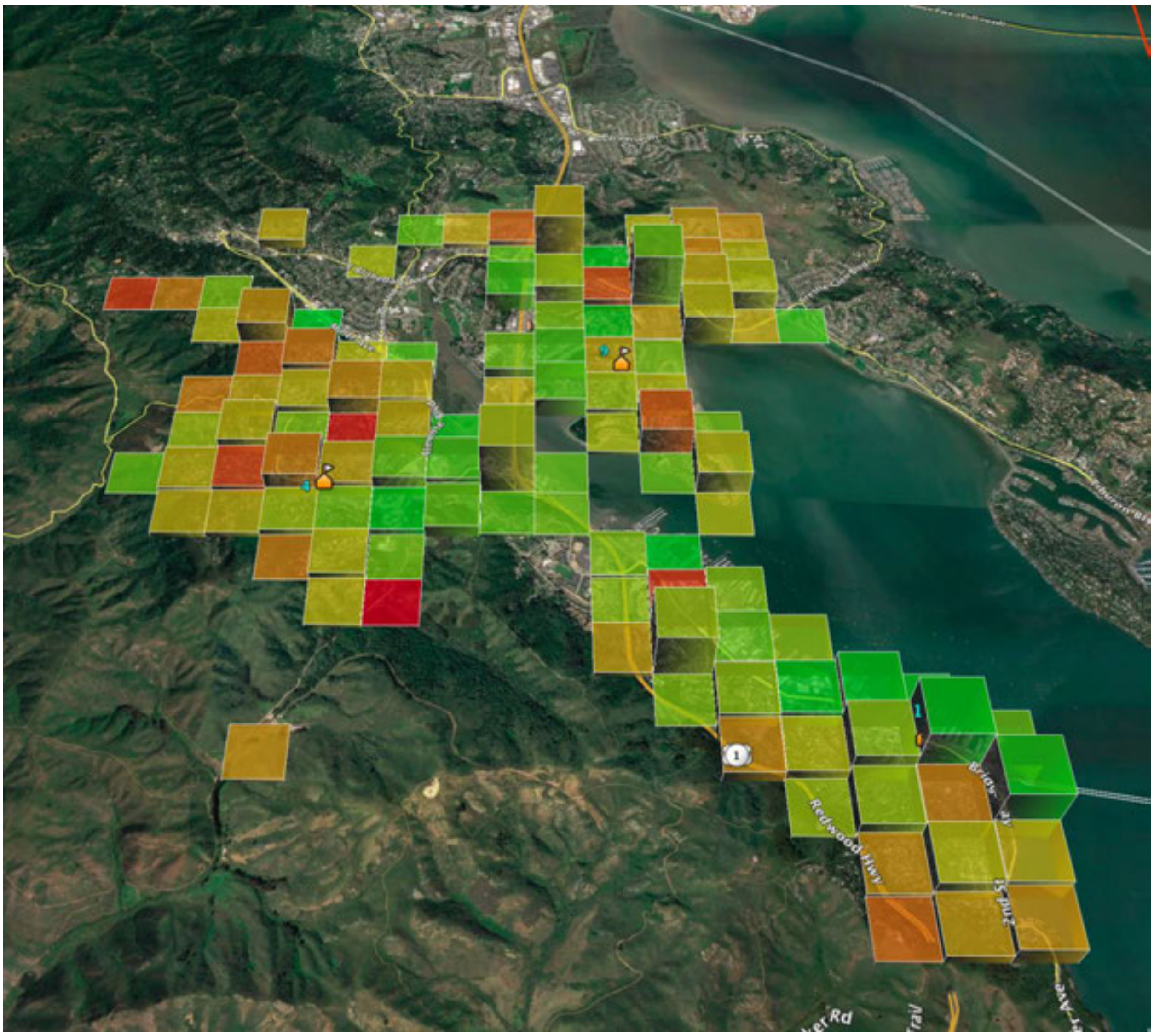
NFPA Standard 1710 recommends a 4-minute travel time goal in urban and suburban areas. As seen in Table 27, all travel times are higher than this goal. There are several reasons for slower travel time, not all of which can be cost-effectively improved. Traffic congestion variation, non-grid road network areas, open spaces, and limited cross access boulevards all affect travel time.

Finding #9: The District is too difficult to serve within a best practice urban travel time of 4 minutes due to topography and the location of current fire stations in the centers of main population clusters. As such, it would not be possible to lower travel time without doubling the number of fire stations, clearly not a cost-effective solution given the modest quantity of incidents annually.

5.3.5 Travel Time Results on Geography

The following map shows, by small grid area, where the District's travel times varied across the topography from green (being the fastest) to red (being the slowest):

Figure 16—Travel Time for First-Due Units in 2015



5.3.6 First Alarm (Effective Response Force) Performance to Building Fires

First Alarm or Effective Response Force Performance to Building Fires: The District responds to building fires with one ladder truck, three engines (one of which is via mutual aid), one medic unit, one rescue squad, and one Battalion Chief.

This response force is needed to provide enough units when fires are very serious at the time of the 9-1-1 call. However, in a given year, there are few building fires in each station area where the entire force including mutual aid units is needed at the incident location. Therefore, the following multiple-unit response time sample size is very small.

The best representation for the First Alarm or Effective Response Force units is **travel** time across the District's street network. The NFPA 1710 recommendation is for all units to arrive within 8 minutes travel time. The reader is cautioned that some of these sample sizes are very small and can readily change year-to-year depending on the exact locations of serious fires and the various units' availability.

Table 28—Travel Time for Effective Response Force Incidents (Minutes/Seconds) – 90% Performance (2013-2015)

Station	Responses	1st Arrival Travel	2nd Arrival Travel	3rd Arrival Travel	4th Arrival Travel
1	9,608	08:42	09:19	09:42	09:08
4	4,942	07:58	08:28	08:54	08:48
9	7,584	06:44	06:35	07:59	07:39

Finding #10: The few building fires that do occur are typically in the most populated areas near fire stations. As such, the fourth-due unit at building fires can arrive in under 10 minutes, which is very good given the District's challenging topography.

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SECTION 6—SOC EVALUATION AND DEPLOYMENT RECOMMENDATION

6.1 OVERALL EVALUATION

SOC ELEMENT 8 OF 8
OVERALL EVALUATION

The Fire District serves a diverse, spaced out population pattern that, in some locations, is geographically challenged with open spaces, and limited cross access boulevards which limits quick response times. Population drives service demand, and development brings population. The District has historically funded the best fire services it can afford and, even post-recession, continues to do so. The incident volumes in the District are modest, and reflective of the strong socioeconomics of the area.

For the foreseeable future, the District will need both a first-due firefighting unit and Effective Response Force (First Alarm) coverage in all parts of the populated areas of the District, consistent with best practices, if the risk of fire is to be limited to only part of the inside of an affected building, or wildland fires are to be stopped when small. While residential fire sprinklers are now included in the state fire codes, it will be decades before the existing housing stock will be upgraded or replaced, even as these codes are applied to all new construction.

While the volume of and response times to EMS incidents consume much of the District's attention, all communities need a "stand-by and readily available" firefighting force for when fires break out. If the District wants to continue providing the elements below, and be *less dependent* on mutual aid for an immediate response ladder truck, the District can slightly increase its deployment plan by fielding a another firefighter per day at Station 4. Citygate suggests that the District provide equitable response times to all similar risk neighborhoods to:

- Provide for depth of response when multiple incidents occur.
- Provide for a concentration of response forces for high-risk properties.

For its current risks and likely desired outcomes, the District does have a sufficient quantity of fire engines spaced across the District's most populated areas. Given the low number of building fires annually, the District can continue to request mutual aid when needed.

While the District does not separately staff an aerial ladder truck, it does have the ladder truck at Station 4, which is cross-staffed by the station crew. If the daily crew were increased to five at Station 4, then three crewmembers could be assigned to the engine or the ladder truck while leaving the other unit staffed with two personnel. Or, to a serious verified building fire, four personnel could staff the ladder truck at a best practices-based level, still allowing one crewmember to drive the engine if needed.

The first deployment step for the District Board in the near-term is to adopt updated and complete performance measures from which to set forth service expectations and, on an annual budget basis, monitor and fund fire crew performance.

6.1.1 Deployment Recommendation

Based on the technical analysis and findings contained in this Standards of Coverage study, Citygate offers the following overall deployment recommendations:

Recommendation #3: **Adopt Deployment Measures Policies:** The District elected officials should adopt updated, complete performance measures to direct fire crew planning and to monitor the operation of the District. The measures of time should be designed to save patients where medically possible and to keep small but serious fires from becoming greater alarm fires. With this is mind, Citygate recommends the following measures:

3.1 Distribution of Fire Stations: To treat medical patients and control small fires, the first-due unit should arrive within 9:30 minutes/seconds, 90% of the time from the receipt of the call in the Sheriff's Office Communications Center. This equates to a 90-second dispatch time, a 2-minute company turnout time, and a 6-minute drive time in the most populated areas.

3.2 Multiple-Unit Effective Response Force for Serious Emergencies: To confine fires near the room of origin, to stop wildland fires to under three acres when noticed promptly, and to treat up to five medical patients at once, a multiple-unit response of a *minimum* of one ladder truck, four engines (two of which are via mutual aid), one medic unit, and one Battalion Chief totaling 17-18 personnel (based on unit staffing) should arrive within 11:30 minutes/seconds from the time of 9-1-1 call receipt in fire dispatch, 90% of the time. This equates to a 90-second dispatch time, 2-minute company turnout time, and 8-minute drive time spacing for multiple units in the most populated areas.

3.3 Hazardous Materials Response: Provide hazardous materials response designed to protect the community from the hazards associated with uncontrolled release of hazardous and toxic materials. The fundamental mission of the District response is to minimize or halt the release of a hazardous substance so it has minimal impact on the community. It can achieve this with a travel time for the first company capable of investigating a HazMat release at the operations level within 6 minutes travel time or less, 90% of the time. After size-up and scene evaluation is completed, a determination will be made whether to request additional resources from the District's multiple-agency hazardous materials response partnership.

3.4 Technical Rescue: Respond to technical rescue emergencies as efficiently and effectively as possible with enough trained personnel to facilitate a successful rescue. Achieve a travel time for the first company in for size-up of the rescue within 8 minutes travel time or less, 90% of the time. Assemble additional resources for technical rescue capable of initiating a rescue within a total response time of 11:30 minutes/seconds, 90% of the time. Safely complete rescue/extrication to ensure delivery of patient to a definitive care facility.

Recommendation #4: The District needs to slightly lower fire crew turnout times.

Recommendation #5: The District should consider adding a fifth crewmember per day to Station 4 to enhance engine and ladder truck deployment options.

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SECTION 7—SUMMARY LEVEL HEADQUARTERS AND SUPPORT FUNCTIONS STAFFING ADEQUACY REVIEW

7.1 INTRODUCTION

As part of our deployment assessment Citygate conducted a high-level review of key District headquarters programs and staffing necessary to support the field crew deployment in the fire stations. It is considered a good practice to corroborate that the headquarters and support functions are in alignment with the response operations. This ensures that not only are responses timely, but that the personnel are well trained, properly supported, and that enough prevention activities have been performed to reduce calls for service.

7.2 MANAGEMENT ORGANIZATION

National Fire Protection Agency (NFPA) 1201[8] states in part, "the [department] shall have a leader and organizational structure that facilitates efficient and effective management of its resources to carry out its mandate as required [in its mission statement]."

A fire department needs a management organization that is properly sized, adequately trained, and appropriately supported. There are increasing regulations to comply with in operating fire services, and the proper hiring, training, and supervision of response employees requires an equally serious commitment to leadership and general management functions.

The District's management organization consists of 1 Fire Chief, 1 Battalion Chief Training and Operations, 1 Deputy Fire Marshal, 1 Prevention Officer, 1 Finance Manager, 1 Project Manager, and 1 Administrative Services Manager as shown in Figure 17, totaling 6 total administration personnel.

[8] NFPA 1201 – Standard for Providing Emergency Services to the Public (2015 Edition)

Figure 17—District Management Organization

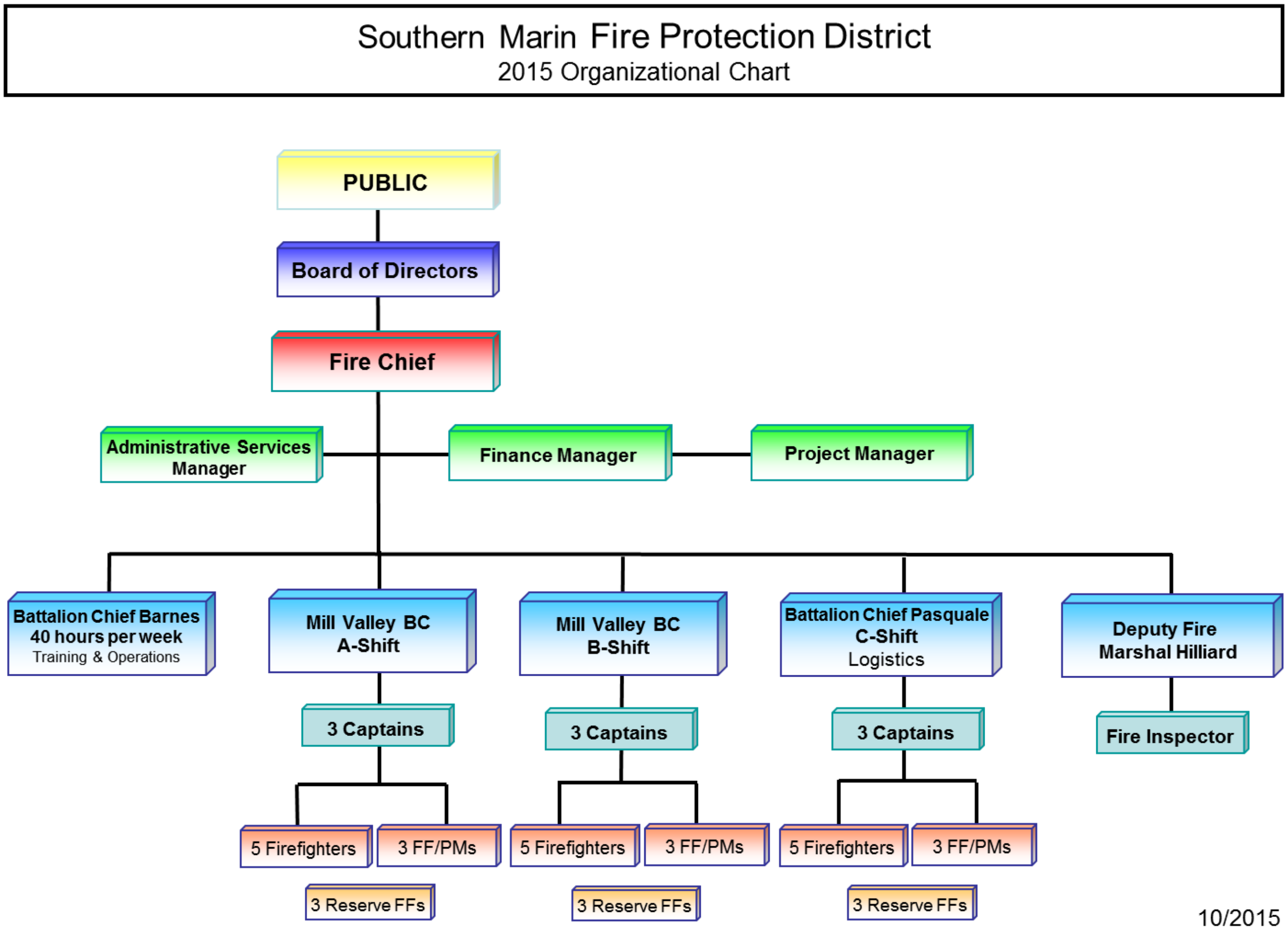

Figure 17 depicts the minimal management structure appropriate to meet the operational and support needs of a three-station fire protection district, including an effective chain of command and manageable span of control.

While the organization is currently able to meet mandated responsibilities, it lacks sufficient capacity and depth to conduct organizational performance benchmarking / ongoing evaluation, long-term strategic planning, risk analysis, and more effective community engagement. Many daily and periodic support service needs are handled by the on-duty personnel as "program specialists" under the overall guidance of one of the three Battalion Chiefs.

While the headquarters team is the smallest possible, it cannot do everything effectively, including developing future chief officers. The District has no clear second-in-command in the Fire Chief's absence, and no back-up for a chief officer who might need long-term illness or injury leave. Stated this way, the team only functions when everyone is available and able to work long hours to make ends meet.

The Fire Chief is the executive officer that has final authority for supervision and planning for all of the District's business functions, from fiscal to human resources, to legal services, multiple-agency partnerships, and the Board of Directors. They must spend considerable time on these activities as there is no city manager or executive officer to handle these items. As such, the Fire Chief does not have enough time to completely handle the internal supervision and coordination of the three line shifts and the headquarters staff. The result is that something suffers based on the priority of the week due to internal or external issues.

7.3 Training Division

The Training Division is responsible for all departmental education and training, except fire prevention training, which is handled by the Fire Prevention Bureau.

The training program is led by a Battalion Chief. The District has an annual training plan and tracks the subject hours, by employee, annually for mandated classes and certifications.

7.4 Emergency Medical Services Program

The District operates a paramedic transport program. One shift Battalion Chief oversees emergency medical training, patient care quality assurance, and certification records. Assistance is received from line personnel in handling all of the functions of the District's EMS plan within State and County EMS Agency regulations.

While the goal is always to deliver the best patient care, in many instances it is not up to the District to determine the method for providing care. Unlike other aspects of firefighting, EMS care is heavily regulated and burdened with mandated oversight requirements. All of these requirements, while medically necessary, add to the District's overhead cost to provide EMS. The District has no choice but to follow laws and regulations related to training, clinical oversight, data for tracking trends in care and paramedic skills, shelf-life of medical supplies, biomedical equipment certification, controlled drug tracking, etc.

The concept of providing focus and emphasis on Continuous Quality Improvement (CQI) in patient care delivery became a top priority in EMS in the early 1990s. EMS providers and EMS oversight agencies across the United States developed systems that guaranteed objective feedback about performance both internally (to support CQI efforts) and externally (to demonstrate accountability to partners and oversight agencies).

An effective CQI program must be consistent and systematic, based on evidence, and free of any perceived or real punitive involvement. It will include a fact-based decision-making process that involves industry-accepted performance measures and comparison of treatment to standard protocols for patient conditions. It will foster learning and knowledge sharing, and will motivate care providers to be the best possible clinicians with each and every patient contact.

Clinical training, oversight, and command staff in the EMS program supports the field personnel. In turn, these technical positions must have office support professionals to *support them.* Functions such as recordkeeping, notifications, filing, internal communications, budgeting, purchase requests, telephone inquiries, scheduling, and a multitude of other assignments must be provided by the EMS oversight team.

The EMS Battalion Chief also directs EMS education within the District via the overall Training Division team. Each EMT and paramedic is trained regarding policy and protocol updates/changes, infrequently-used skills, CPR skills, etc. each year.

7.5 Fire Apparatus and Equipment

Fire apparatus need to be properly maintained to ensure response readiness, safe arrival, effective operation, and return to readiness for the next assignment. Considering that a fire apparatus driver is entrusted to drive a vehicle weighing up to 17 tons or more at speeds up to 65 miles per hour, often against prevailing traffic at controlled intersections, officials should ensure that the maintenance, as well as the training program, meets all applicable legal and best-practice standards.

The fire service generally groups fire apparatus into two categories: (1) engine companies, which are primarily responsible for pumping and delivering water and performing basic firefighting functions, including search and rescue; and (2) truck companies, which are primarily responsible for forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul, and salvage work. Other types of apparatus include water tenders, which are primarily responsible for carrying large quantities of water; squads or rescue companies, which carry a variety of rescue and emergency medical equipment; medic units or ambulances; command vehicles; and other auxiliary or specialized response apparatus. To be effective, fire apparatus must be properly designed and well equipped with the proper hose, appliances, tools, ladders, and other equipment necessary to perform the complex work of firefighting, rescue, emergency medical, and public service tasks.

Two basic NFPA standards apply to fire apparatus:

- NFPA 1901 *Standard for Automotive Fire Apparatus* defines the requirements for new fire apparatus designed to be used under emergency conditions to transport personnel and equipment and to support the suppression of fire and mitigation of other hazardous situations.

- NFPA 1906 *Standard for Wildland Fire Apparatus* defines the requirements for new fire apparatus designed primarily to support wildland fire suppression operations.

In addition to these standards having application for the development of purchase specifications, there are additional performance standards useful for evaluating in-service apparatus:

- NFPA 1911 *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus.* This standard defines the minimum requirements for establishing an inspection, maintenance, and testing program for in-service fire apparatus. This standard also includes guidelines for fire apparatus refurbishment and retirement; it identifies the systems and items on a fire apparatus that are to be inspected and maintained, the frequency of such inspections and maintenance, and the requirements and procedures for conducting performance tests on components; it also provides sample forms for collecting inspection and test data.

- There should also be a system of testing, maintenance, and repair, which ensures a high state of readiness of apparatus and critical equipment. In 2000, the NFPA issued NFPA 1915 *Standard for Fire Apparatus Preventative Maintenance Program*, which defines the minimum requirements for a fire department preventative maintenance program. Under this standard, the personnel who conduct the preventative maintenance program should meet NFPA 1071 *Standard for Emergency Vehicle Technician Professional Qualifications*. This standard defines the minimum job requirements an emergency vehicle technician should possess. These include the ability to diagnose, maintain, repair, and test the functions of the apparatus.

The Federal Department of Transportation also has motor vehicle safety standards that are applicable to fire apparatus. The District's fire apparatus and vehicle fleet inventory is summarized in Table 29 below.

Table 29—District Fire Apparatus and Vehicles

Radio Number	Fire Unit Equipment Number	Chassis Make	Build-up Make	In-Service Year	Capacity	NIMS Type	Status	Current Replacement Cost
E1	07-01E	Dash	Pierce	2007	1500	1	Front	600,000
E2	06-01E	Dash	Pierce	2006	1500	1	Reserve	600,000
E4	15-01E	Arrow XT	Pierce	2015	1500	1	Front	600,000
E6	N/A	Dash	Pierce	2007	1250	1	Front	500,000
E7	N/A	Spartan	Rosenbauer	2013	1250	1	Front	500,000
E8	N/A	Saber	Pierce	2001	1250	1	Reserve	500,000
E604	99-01E	International	West Mark	1999	500	3	Front	450,000
E607	N/A	International	West Mark	1998	500	3	Front	450,000
R9	03-01R	Dash	Pierce	2003	0	2	Front	600,000
T4	94-01T	Lance	Pierce	1994	1500	N/A	Front	1,300,000
M1	13-01A	Ford E-350	Horton	2013	N/A	N/A	Front	170,000
M4	13-02A	Ford E-350	Horton	2013	N/A	N/A	Front	170,000
M6	N/A	Ford E-350	Horton	2014	N/A	N/A	Front	170,000
B1	07-01U	Ford	Expedition	2007	N/A	N/A	Front	70,000
B2	11-01U	Chevy	Tahoe	2011	N/A	N/A	Front	70,000
U1	95-04U	Ford F-150	F-150	1995	N/A	N/A	Utility	45,000
U4	11-02U	Ford	F-250	2011	N/A	N/A	Utility	45,000
U6	N/A	Ford	F-150	1998	N/A	N/A	Utility	45,000
U7/B8	N/A	Ford	F-150	2008	N/A	N/A	Front	48,000
U9	08-01U	Ford	F-250	2008	N/A	N/A	Utility	48,000
U9A	03-01U	Ford	Explorer	2003	N/A	N/A	Utility	40,000

Finding #11: The District operates the needed fire apparatus and support vehicles to respond to expected risks.

7.5.1 Apparatus/Vehicle Replacement Program

The District's Fire Protection Master Plan includes a fire apparatus/vehicle replacement schedule as summarized in Table 30.

Table 30—Apparatus/Vehicle Replacement Schedule*

Unit Number	Shop Number	Chassis Make	Make	Year	Pump	Status	Miles	Replacement Cost
E1	07-01E	Dash	Pierce	2007	1500	Front	64,763	600,000
E2	06-01E	Dash	Pierce	2006	1500	Reserve	64,921	600,000
E4	15-01E	Arrow XT	Pierce	2015	1500	Front	4,681	600,000
E6	4237	Dash	Pierce	2007	1250	Front	50,570	500,000
E7	4244	Spartan	Rosenbauer	2013	1250	Front	13,887	500,000
E8	4235	Saber	Pierce	2001	1250	Reserve	79,299	500,000
E9	09-01E	Arrow XT	Pierce	2009	1500	Front	43,027	600,000
E604	99-01E	International	West Mark	1999	500	Front	51,795	450,000
E607	4234	International	West Mark	1998	500	Front	49,280	450,000
R9	03-01R	Dash	Pierce	2003	0	Front	114,125	600,000
T4	94-01T	Lance	Pierce	1994	1500	Front	115,991	1,300,000
M1	13-01A	Ford E-350	Horton	2013	N/A	Front	56,018	170,000
M4	13-02A	Ford E-350	Horton	2013	N/A	Front	44,675	170,000
M6		Ford E-350	Horton	2014	N/A	Front	23,970	170,000
B1	07-01U	Ford	Expedition	2007	N/A	Front	100,682	70,000
B2	11-01U	Chevy	Tahoe	2011	N/A	Front	31,970	70,000
U1	95-04U	Ford F-150	F-150	1995	N/A	Utility	75,564	45,000
U4	11-02U	Ford	F-250	2011	N/A	Utility	28,361	45,000
U6	4232	Ford	F-150	1998	N/A	Utility	80,745	45,000
U7/B8	4236	Ford	F-150	2008	N/A	Front	30,822	48,000
U9	08-01U	Ford	F-250	2008	N/A	Utility	57,016	48,000
U9A	03-01U	Ford	Explorer	2003	N/A	Utility	162,322	40,000
DT-1	14-01U	Ford	F-250	2014	N/A	Front / Dive Tender	2,167	N/A
Prev-1	03-02U	Chevy	Tahoe	2003	N/A	Front	N/A	N/A
U8	N/A	Ford	F-150	N/A	N/A	N/A	30,823	N/A
B5	4239	Ford	F-150	N/A	N/A	Front	46,535	N/A
B7	4242	Ford	F-150	N/A	N/A	Front	48,949	N/A
C7	4241	Ford	Explorer	N/A	N/A	Front	23,970	N/A
C1	10-01U	Ford	Explorer	2010	N/A	Front	69,500	N/A
Fire Boat Liberty	N/A	Metalcraft	Firestorm 30	2004	N/A	Front	482 hours	800,000

* Mill Valley units are highlighted in grey.

Finding #12:	The District has a plan for the replacement of capital fire apparatus and support vehicles.

SECTION 8—NEXT STEPS

8.1 NEXT STEPS

The purpose of this assessment is to compare the District's current performance against the local risks to be protected, as well as to compare against nationally recognized best practices. This analysis of performance forms the base from which to make recommendations for changes, if any, in fire station locations, equipment types, staffing, and headquarters programs.

As one step, the District Board of Directors should adopt updated and best practices-based response time goals for the District and provide accountability for the District personnel to meet those standards. The goals identified in Recommendation #3 meet national best practices. Measurement and planning as the District continues to evolve will be necessary for the District to meet these goals. Citygate recommends that the District's next steps be to work through the issues identified in this study over the following time lines:

8.1.1 Short-Term Steps

- Absorb the policy recommendations of this fire services study and adopt updated District performance measures to drive the deployment of firefighting and emergency medical resources.
- Identify funding and timing for an added crew member per day at Fire Station 4.

8.1.2 Ongoing Steps

- Monitor the headquarters staff workload and, as capacity is exceeded, use part-time or contract employees to support services during economic upswings.