COMMUNITY RISK ASSESSMENT FOR BRISTOL FIRE OPERATIONS

FIRE AND RISK ANALYSIS FOR BRISTOL FIRE DEPARTMENT

August 2014

City of Bristol,
Connecticut
111 N. Main St.
Bristol, CT 06010

Submitted by:

www.manitouinc.com
1008 Main Street
Peekskill, NY 10566

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Executive Summary

Manitou, Inc. was awarded a contract to perform a community risk analysis for the City of Bristol, (City) Connecticut in early 2014. This report presents findings of this risk analysis. The analysis was intended to be comprehensive of fires, rescue, and natural and technological hazards that the City might experience and therefore require a response from the fire service.

This analysis uses a research-driven methodology, and was designed to be consistent with prevailing industry practice in the fire service. In particular, this analysis was intended to meet the requirements for a community risk analysis as defined by the Federal Emergency Management Agency (FEMA) for purposes of the Assistance to Firefighters Grant program.

The City of Bristol and the Bristol Fire Department have done a good job matching resources to the risks faced by the community. Although the risks of a large-scale fire in the City are limited, there are numerous large structures with hazardous processes and significant property and life at risk. The fact that the City enjoys a favorable fire loss record is a tribute to the sound management of these risks.

We believe that the risk picture is aided by several factors:

1. The City's Code Enforcement Committee takes action to maintain minimum property maintenance standards, and targets inspectional resources where they will have the greatest impact. The literature has shown that vacant buildings have a significant fire problem, and the fact that Bristol does not have a major concern in this area is evidence of this program's success.
2. The Bristol Fire Department has a significant fire prevention inspection program, which has resulted in good code compliance, and installation of fire suppression systems such as sprinklers in many of the City's larger structures.
3. The mix of specialized services provided by the Department is reasonable, and we make our recommendations to better target these activities based on analysis of risk.

Findings

The Bristol Fire Department's (BFD) resources are generally well matched to the risks within the community. Based on existing development patterns and trends, we do not foresee a need for additional personnel resources in the near future. The existing system of personnel and equipment should be able to absorb future development in the coming years.

The BFD provides a number of specialty services, which are appropriate given the broad range of risks and activities within the City. For several of these key services, such as hazardous materials and high angle rescue, the department uses regional approaches to collaborate with nearby departments and entities to provide these specialized functions. This is a reasonable approach given the relatively small number of calls for service among these special capabilities. Requirements, particularly the need to maintain training and to assure a minimum complement of qualified personnel on duty, are a significant challenge to mid-sized organizations. Using regional resources for specialized capabilities is a sensible and effective way to mitigate these low frequency, moderate-to-high risk scenarios.

Based on our analysis of flood, water rescue, and swift-water rescue in the City, we believe that additional training or equipment may be needed to maintain or improve the capability of the BFD to respond to these emergent events.

With regard to fire prevention, the BFD has an active program of fire inspections that appears to be showing positive results in terms of overall community losses. Traditional code enforcement programs give most attention to commercial buildings, where the code requirements are more far ranging, and complex. To further reduce losses, the BFD needs to target their public fire education efforts at high-risk populations and buildings within the City. This approach is receiving renewed attention from progressive fire departments nationally, and can be effective at further reducing fire losses in residential structures.

A key component of designing and implementing such a program is to assure a solid base of data that can be centrally accessed and monitored. Completion of incident

reports for all incidents, and especially for fires, is important to be able to measure impact in the future.

Because the City has a number of large commercial properties representing employment and high property value, the City's Insurance Services Office of Public Protection Classification (PPC) is important, as it directly influences rates for property insurance for commercial structures.[1] The grading schedule used to assess the fire department has recently undergone significant change, and could influence the City's future rating. Based on a three to four-year schedule, the City would not likely be re-rated until 2015-2016.

Acknowledgments

We would like to thank the personnel who we interacted with on this project for their support and their evident commitment to the well being of the City and its residents. We would particularly like to thank Fire Marshal Grimaldi, who served as our liaison throughout the study, and assisted in our site visits and provided ample information to support the project.

Jon Pose, Fire Chief
Robert Grimaldi, Fire Marshal
Lee Adams, GIS/CAD Technician, Department of Public Works
Thomas DeNoto, Assessor
Robert Flanagan, Assistant City Planner, Department of Public Works
Dawn Leger, PhD, Grants Administrator, Bristol Development Authority

Project Staff

Manitou, Inc. would like to acknowledge the staff who performed this analysis and contributed to the report.

Charles Jennings, PhD, FIFireE, Project Manager
Robert McNally, MS, Geographic Information System and Data Analyst
John Cochran, MIFireE, Insurance Rating Analysis and General Support

[1] The PPC is also important, but less so, for residential properties.

Introduction

Each community engages in risk management, consciously or otherwise, by applying resources to activities designed to reduce the likelihood or consequence of loss arising from various events. These events may range from deliberate human behavior to natural hazards such as extreme weather. Events may also involve threats to human health, such as acute illness or chronic disease, and phenomena such as fires.

Indeed, fire is historically among the greatest threats facing urbanized areas, as these events ravaged city centers and large industrial buildings throughout America's early urban history.

The purpose of a community risk analysis is to identify risks facing a community, and to assess them in terms of the threat they pose to a community's wellbeing. The risk analysis can then be used to identify the adequacy of resources and strategies used to reduce these risks, as well as to inform the need for future strategies to address gaps identified between risk and preventive or protective resources.

This risk analysis is broad, but is focused on those risks for which the fire services are primarily responsible, or for which they provide a significant response. The risk analysis is also limited to acute events and hazards, not long-term economic or social trends.

Background

The City of Bristol issued a Request for Proposals for a community risk analysis based upon receipt of a Federal Emergency Management Agency Fire Prevention and Safety grant. The purpose of the grant was to fund a community risk analysis. The risk analysis was designed to identify the types of fires occurring in the community, their characteristics, and other hazards facing the local fire service.

After a competitive bidding process, the contract was awarded to Manitou, Inc., of Peekskill, New York. Manitou is a firm specializing in fire and emergency service management, deployment, and risk consulting. The contract was awarded in fall 2013, and the work began in early 2014.

Terms and Scope

The City of Bristol prepared the following scope for this study:

1. Objectives for Project Period: Identify the BFD's newest risks. These include all risks for which the BFD is responsible, including fire, hazardous materials, natural disasters, etc. The consultant shall study recent and impending demographic and infrastructure changes and their effects on fire and other emergency risks. To accomplish this objective, the consultant will be expected to meet with the downtown developer to obtain details of planned buildings, number of residential and commercial inhabitants, new parking plans, and more.

In addition, the consultant will research Census 2010 demographic data and identify the City's concentrations of certain high risk groups – the elderly, English language learners, disabled individuals, young children, including detailed information on the structures accommodating these high risk citizens.

2. Firefighter Training and Equipment Objectives: Based on the conclusions of the risk assessment, the BFD will implement appropriate risk mitigation action plans, including the purchase of necessary equipment and implementation of new firefighter training programs. Such projects will be prioritized based on the level of severity of each risk and/or timing considerations identified by the project consultant. To accomplish this objective, the BFD will rely on the detailed risk assessment as justification when seeking public funds to support such projects.

3. Public Outreach Objectives: Based on the risk assessment conclusions, the BFD will implement appropriate public outreach and other projects that may be eligible for future grant initiatives. The consultant shall be charged with identifying specific outreach initiatives, such as those geared toward families where English is not the primarily language.

4. Regional Risk Mitigation Objectives: Based on the risk assessment, the BFD will identify potential regional risk mitigation initiatives to pursue with neighboring municipalities. In order to accomplish this objective, the BFD will charge the risk assessment consultant with

studying fire and other emergency risks near the City's perimeter, which could be mitigated by working in tandem with nearby fire departments.

Definitions of Risk and Its Analysis

There are numerous definitions and approaches to risk analysis – some are specific to a particular type of risk, while others may be geared to specific industries or services. In the general field of fire safety, there are three major approaches. The first and oldest is the property protection approach, which grew out of insurance industry involvement in curbing highly destructive mass fires known as conflagrations. Conflagrations were common as cities began developing in the US in the late 1800s and early 1900s. This emphasis on property protection and avoiding major fire losses has continued and remains a major area of concern for fire services. More recently, the risk to people in a community, and the implication that risk is related to characteristics of the population and economy, has gained influence. This conclusion was largely informed by social science research on fire risk and initially funded by the federal government. Most recently, a series of fire service driven efforts, including accreditation, have sought to define risk analysis in the context of deployment of resources. There are several variations on this approach, and they vary in the degree to which they balance life and property risk. However, these approaches are generally narrower in the range of solutions that they entertain to address or mitigate risks in the community.

Manitou advocates a social science approach that emphasizes population-based risk, and considers property risk and conflagration avoidance as secondary. This is appropriate for a community such as Bristol, as we will discuss. It is also consistent with the approach advocated by the US Fire Administration as a means of managing community fire risk.

Methodology

The US Fire Administration defines community fire risk analysis as "the process of quantifying the probability of a fire happening involving individuals or populations due to certain activities." [2] This definition originates in part from previous research work done by Manitou principals. The objective of the analysis is to identify who, what, where, when, and how fire and other risks are causing losses in a community. This project would be defined as a formal risk analysis, in that it is performed by an outside expert and uses quantitative data to develop the risk profile.

The results of this risk analysis are designed to fulfill much of the initial work in the five-step public fire education planning process.[3]

Other methodologies include the Insurance industry's Fire Suppression Rating Schedule, which is designed as a property insurance rating tool and not as a management document for fire services. The other methods or standards considered or implied in our analysis include the National Fire Protection Association's (NFPA) standard 1710, which is designed to assess response time and staffing performance of fire services.

[2] US Fire Administration. *Community Risk Assessment and Fire Prevention and Safety Grants*. (Video).http://www.fema.gov/media-library/assets/videos/79499.
[3] US Fire Administration. *Public Fire Education Planning: A Five Step Process*. FA-219, June 2008.

The process used in our methodology conforms with the process advocated by major risk analysis methodologies in use nationally. As an example, the steps in the NFPA's deployment-intensive risk assessment methodology are shown below.

NFPA's Deployment-Based Assessment Risk Process

STEP 1 Assess Fire Hazards and Associated Risks in the Community

Examine and analyze the relevant risk factors that characterize their community. The assessment should include an analysis of the probability of risk events occurring and their subsequent consequences.

STEP 2 Collect Response Data

Collect and summarize detailed deployment data, including individual apparatus and overall alarm staffing data from actual emergency response calls to reported (working) structure fires and EMS responses.

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STEP 3 Analyze Response Data

The purpose of this analysis is to determine actual source deployment capabilities and capacity and identify response deficiencies.

STEP 4 Summarize Emergency Response System Status

The purpose of a status report is to provide detailed information about the current state of fire department capability, availability, capacity, and overall operations. The report should also include options for changes and recommendations that link resource allocations to the anticipated outcomes.

STEP 5 Report to Decision Makers

Prepare a report to decision makers identifying the current fire suppression capability and capacity as well as an assessment of vulnerability based on any proposed resource cuts. [1]

Manitou uses a very geographic data-intensive approach to developing community risk assessments. This is important for three reasons – first, using geographic information systems (GIS) enables manipulation and display of large quantities of data; second, fire and other risks are seldom uniformly distributed in a community; and third, risks can be tied directly to fire service deployment information such as station response (first-due) areas, and compared with response times and other information on fire service outputs.

In addition, Manitou uses both census data and assessor's data to provide unparalleled insight into the underlying characteristics of risk facing the community. Additionally, we match assessor's data with fire incident data, which permits a greater understanding of how risk within the building stock is realized.

This approach is informed by international research, and represents the most sophisticated approach to community risk analysis being practiced today.

Overall Description of Community

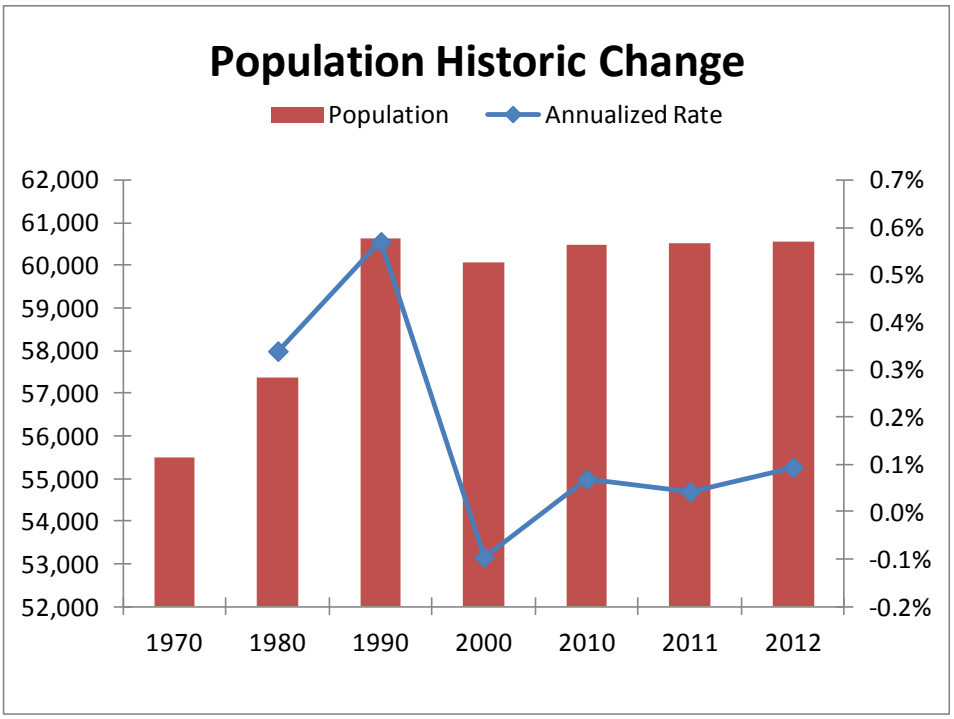
Bristol is the 10th largest city in the State of Connecticut. Located in the central region about 20 miles southwest of the capital, Bristol is a 26.4 square mile area located along the Pequabuck River. Incorporated in 1785, the Town was known for clock making and a museum in the city testifies to its history. Lake Compounce, located on the south side of the generally square-shaped town, is the oldest continuingly operated amusement park in the nation, having been founded in 1846. Today, Bristol is home to the ESPN, the cable television channel along with other industries such as, Otis Elevator, Associated Spring, and Eastern Plastics to name a few. A redevelopment of the downtown area has in part prompted the city leaders to review the local and regional risks to the community that the fire department is charged to handle.

Demographics

The population of Bristol is approximately 60,560 residents according to the 2012 U.S. Census Bureau estimates[4]. This is an increase of less than 1 percent from over a decade earlier when the 2000 decennial census reported residential population was 60,062. Historically, the City population had been almost unchanged since 1970, growing less than 1 percent annually (see Figure 1).

[4] US Census American Community Survey 2012 5yr Estimates

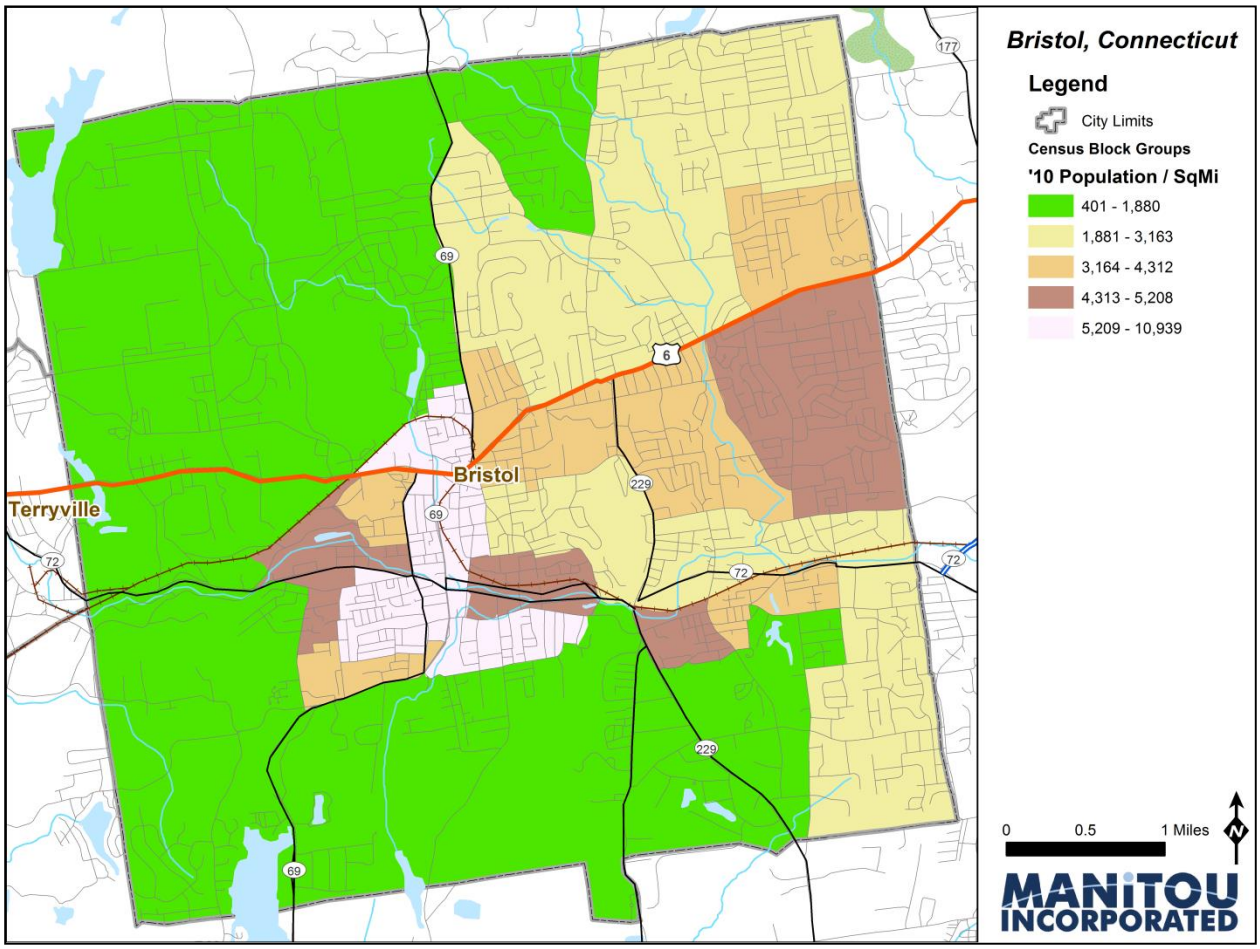
Figure 1: Bristol Population Change 1970-present



These figures represent residential population and do not account for the variation during the daytime hours for commuters, shoppers, and out of area employees. It is estimated (using census data) that Bristol decreases approximately 11.6 percent in population as people commute elsewhere for work[5]. Once again, this does not factor flow-through traffic, shoppers, and tourists. The residential population is also not evenly distributed. It is well understood that demand for emergency services correlate with areas of higher population. The following map shows the concentration of residential population by census block group areas (see Figure 2).

[5] ACS 5yr 06-10 Estimated Daytime Population

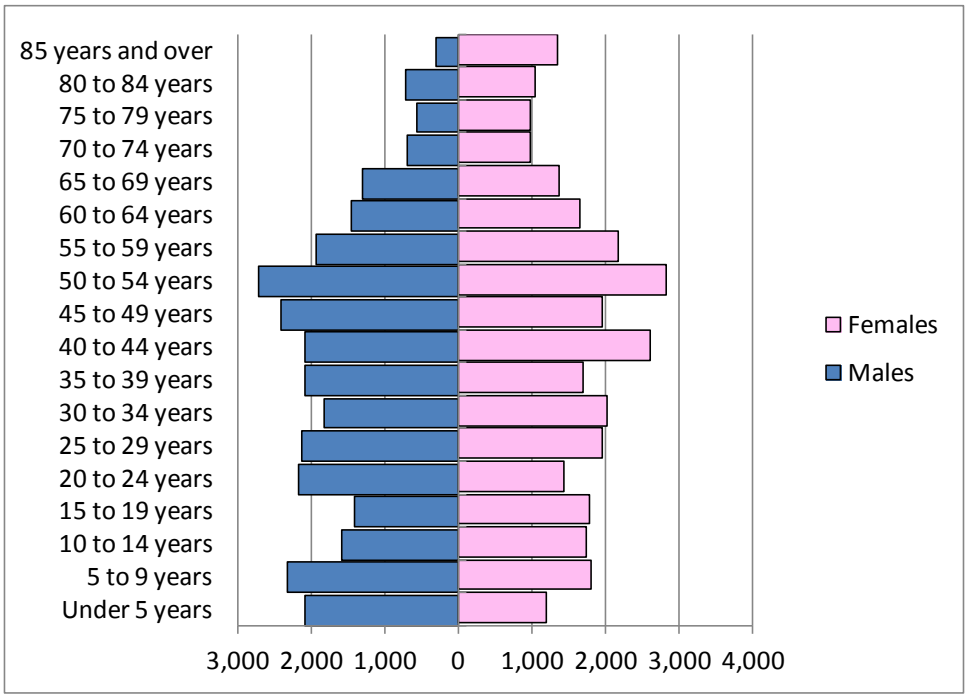
Figure 2: Population Density



Age Composition

Although general population levels play a role in the geographic distribution of demand for fire and medical services, it is important to examine the composition of the population because the aged and pediatric populations are more prone to serious medical emergencies and to succumb to smoke and fire due to their behavioral tendencies during a fire. Children often hide making an interior search by firefighters more difficult, while mobility issues limit the ability of the aged to escape. Figure 3 illustrates the levels of population by age group in Bristol.

Figure 3: Age and Gender Breakdown, City of Bristol



Six percent of the City's population is less than five years of age, while 12.3 percent is younger school aged (under age 15). An additional 16 percent is over age 65. Fire prevention efforts and fire escape procedures should be emphasized with these groups. The population in Bristol is becoming more elderly in general. The following table details the change in age cohort levels over the previous two census tabulations of residential population. Notice the decrease in population composition in the less than 44 age cohorts compared to the older generations still residing in the City (Table 1).

Table 1: Population Age Distribution 2000-2012

	Total	Age <5	5 to 24	25 to 44	45 to 54	55 to 64	65 to 74	75+
2012	60,560	3,331	14,232	16,351	9,932	7,267	4,360	5,026
2000	60,062	3,761	14,505	19,527	8,087	5,257	4,374	4,551
change	1%	-11%	-2%	-16%	23%	38%	0%	10%

The older age cohorts (45+) have significant increases in population numbers. It should be noted that within the next ten years the bulk of this 'baby boomer' population (those born between 1946 and 1964) is poised to enter the ranks of the 'senior citizen' (generally those above the age of 65). It is expected that demand for medical emergencies will rise

significantly and the threat of fatal fire death may also increase based upon the age progression of the population. Figures 4 and 5 map the older and young population of the City.

Figure 4: Concentration of Population Greater Than 64

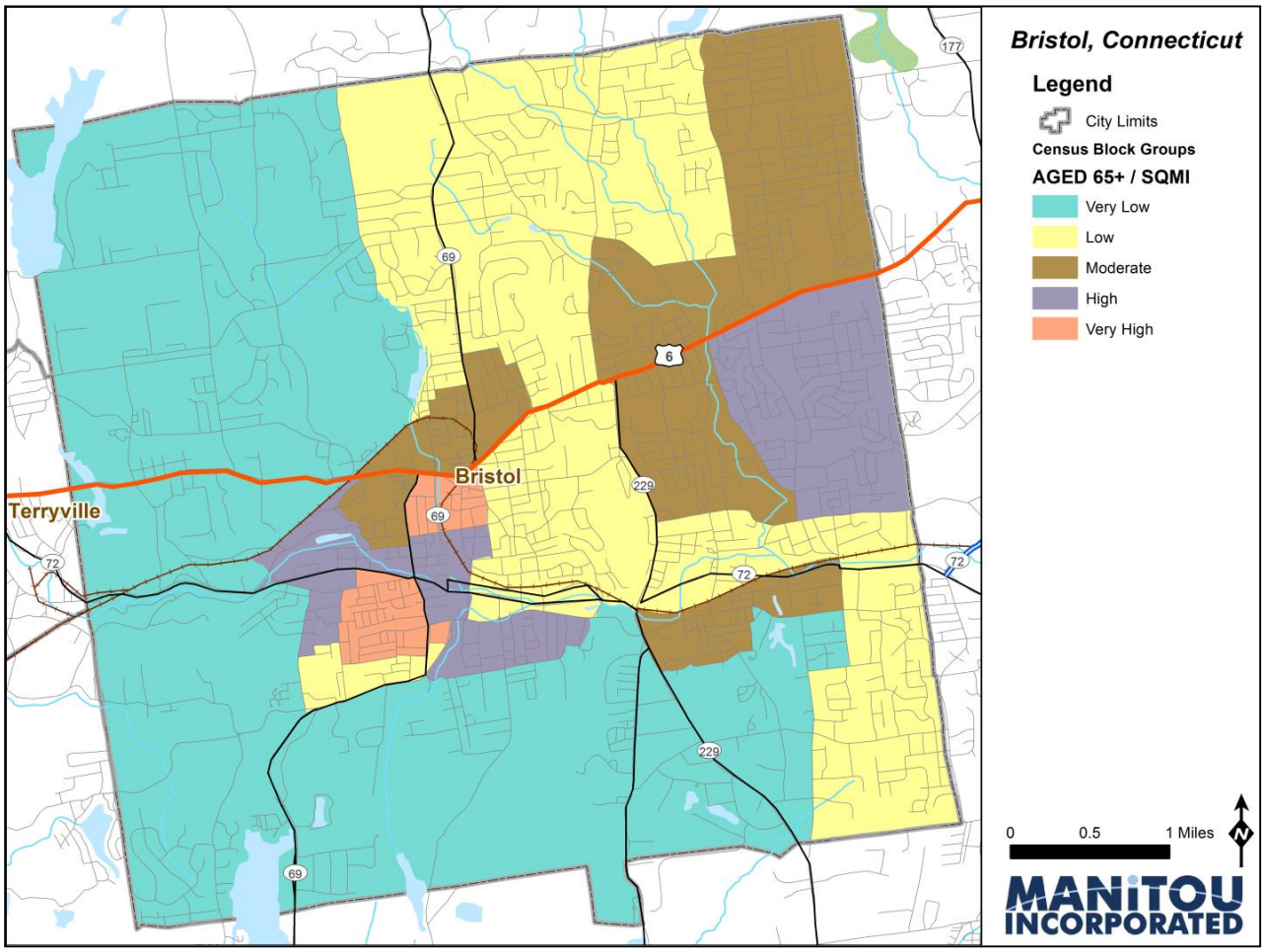
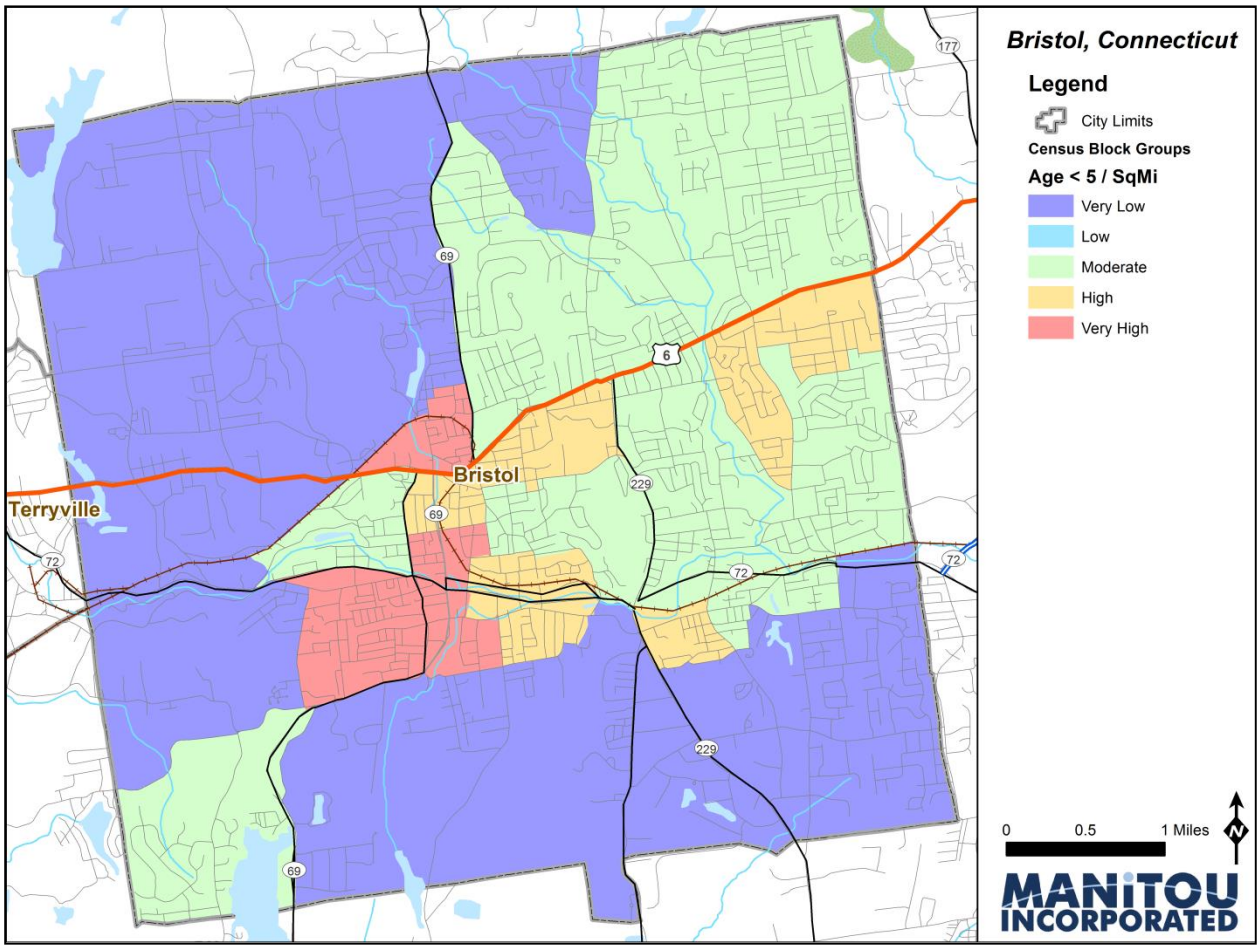


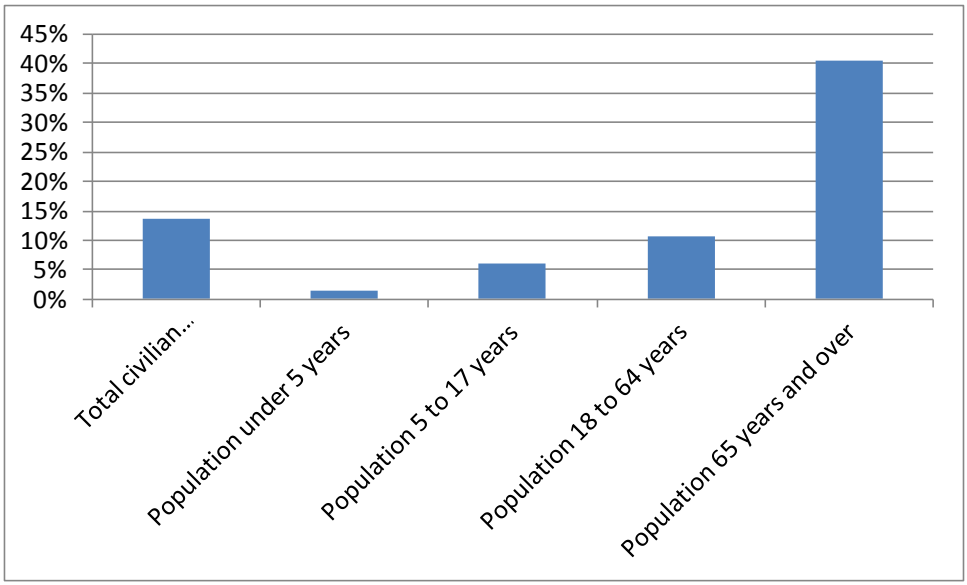
Figure 5: Concentration of Population Less Than or Equal to Five Years of Age



Disabled/Group Homes

Individuals who have some sort of disability or are institutionalized in a group quarters, nursing home, hospital, jail or dormitory are important groups to be aware of in the case of an emergency or declared disaster. These people will require extra assistance to remain safe or to be rescued in such an event. In 2012, the US Census Bureau estimates that 756 persons were in-group quarters. However, it also estimates that 13.8 percent of the non-institutionalized civilian residential population has some sort of disability; be it a hearing difficulty, vision impairment, cognitive or mobility issue, or needing assistance with daily care. Proportionally, the aged are more afflicted as exhibited in the Figure 6.

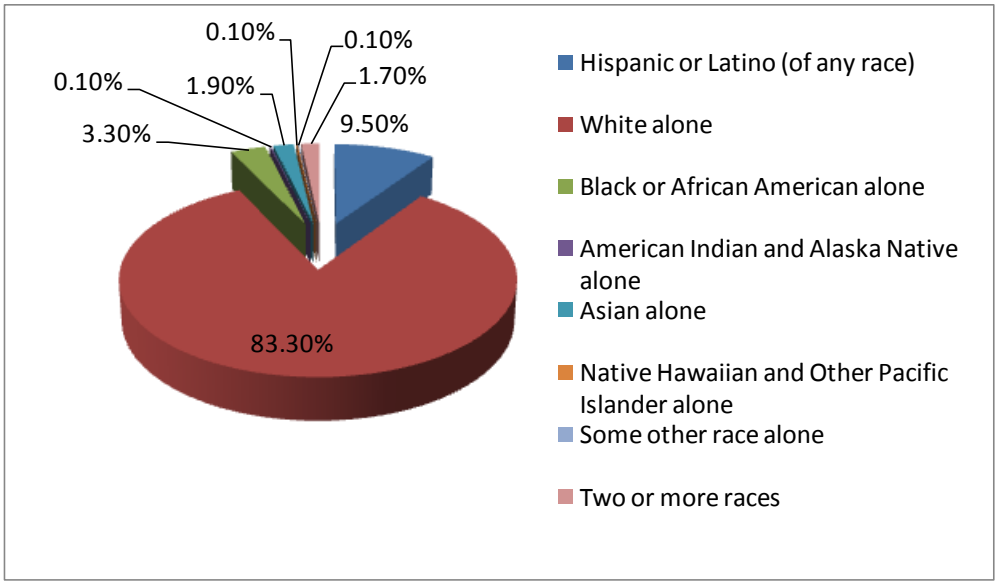
Figure 6: Percentage of Population with Disabilities by Age Group



Ethnicity

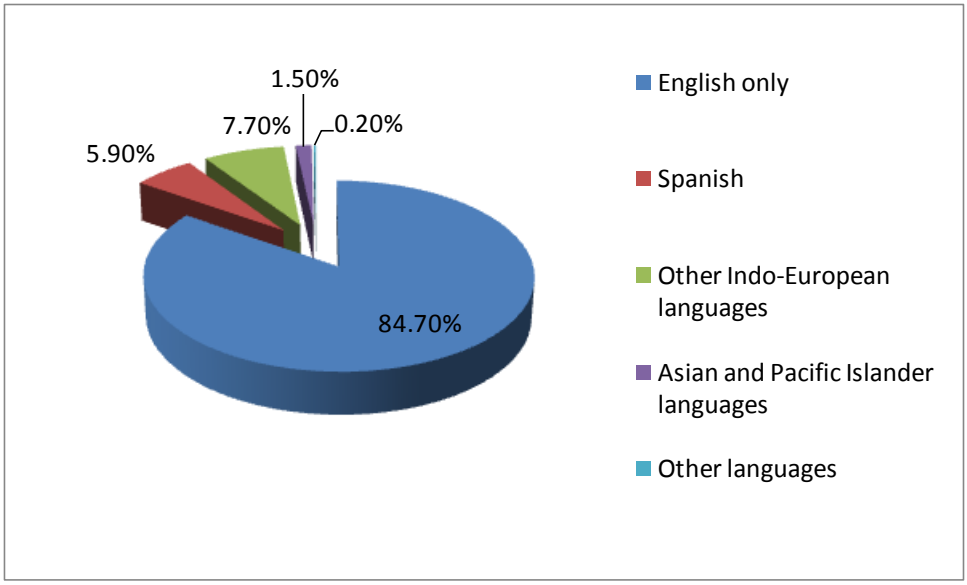
The following chart (Figure 7) illustrates Bristol's racial and ethnic composition of the population. It can be seen that the majority of Bristol residents are Caucasian (white). The largest minority population is the Hispanic or Latino person.

Figure 7: Racial/Ethnic Breakdown of Population



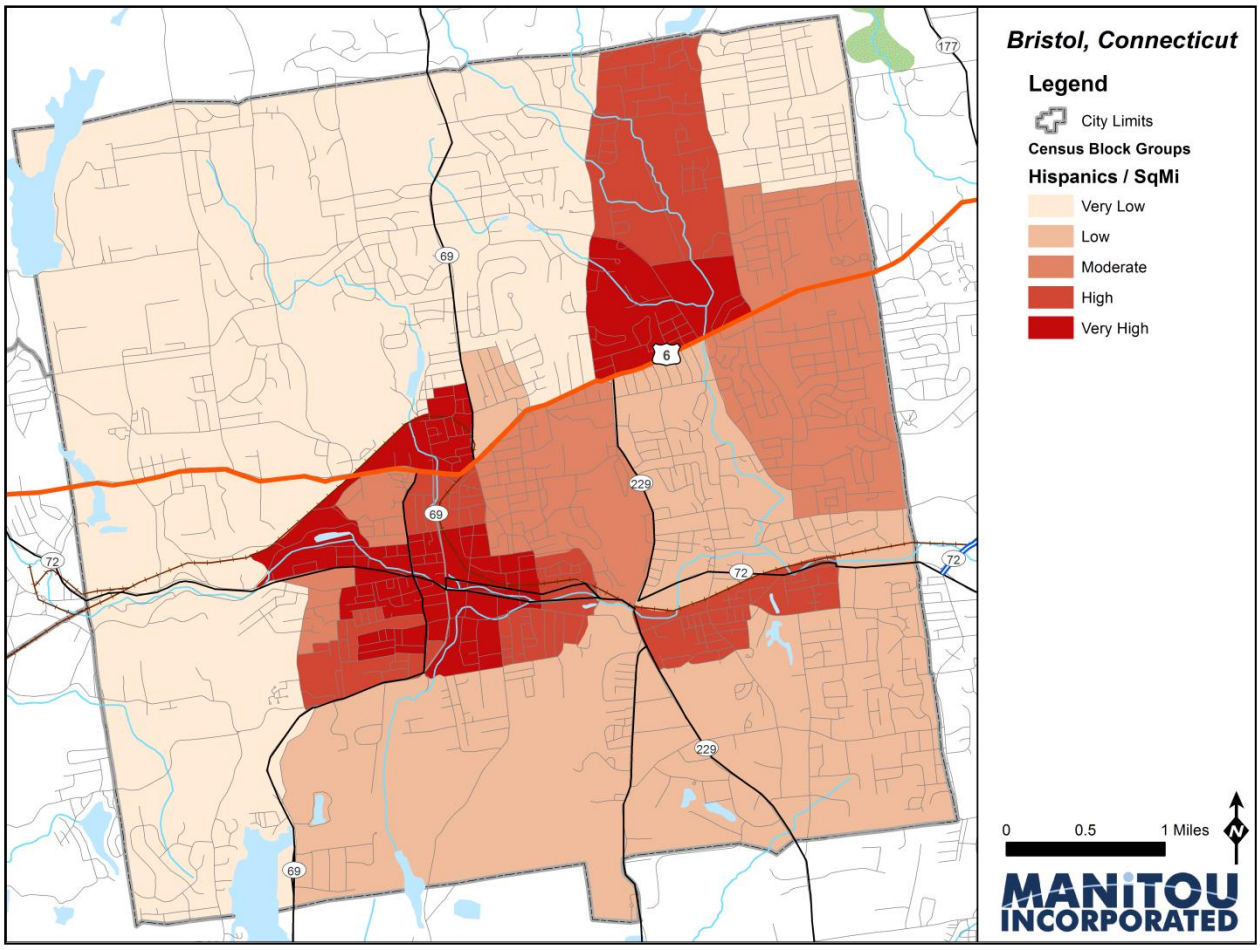
While race or ethnicity matters little for emergency services, the concern lies with those who may not be able to communicate with or understand English, the dominant language of the area. While some firefighters may speak other languages, a widespread multi-lingual capability is not the reality in emergency services. In an emergency situation or disaster, it is important to know where this community may reside as well as implement programs to increase the communicative capacity of the firefighters.

Figure 8: Language Spoken at Home



Just over 15 percent of the population in Bristol speaks another language, specifically, Spanish. Nearly 6 percent of these people report that they speak English less than "very well" according the US Census Bureau. This can create difficulties during an emergency, disaster, or an evacuation. The following map illustrates the Hispanic population in the City of Bristol as they have the highest percentage of persons where English is a second language (Figure 9).

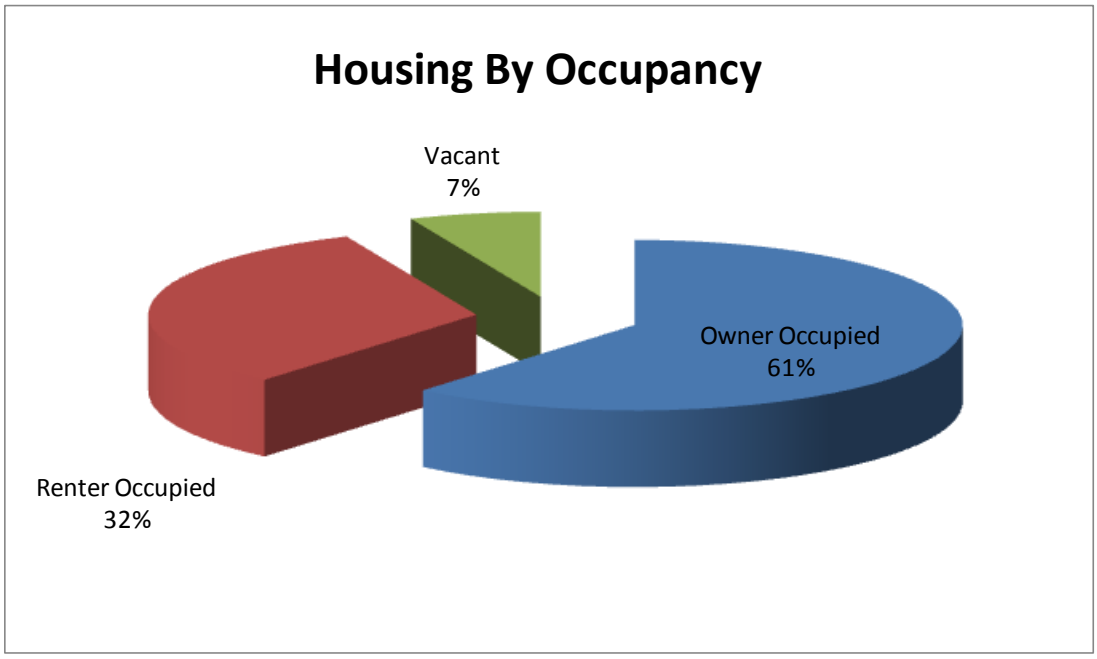
Figure 9: Hispanic Population Density by Census Tract



Housing

In the following graphic, housing is examined by occupancy types. It should be noted that a lower than average national and statewide rate of renter-occupied and vacant properties exists. This is important because areas of lower vacancy and rental properties are typically reflective of better economic means and that fact situation correlates with lower demand for emergency services.

Figure 10: Housing Tenure



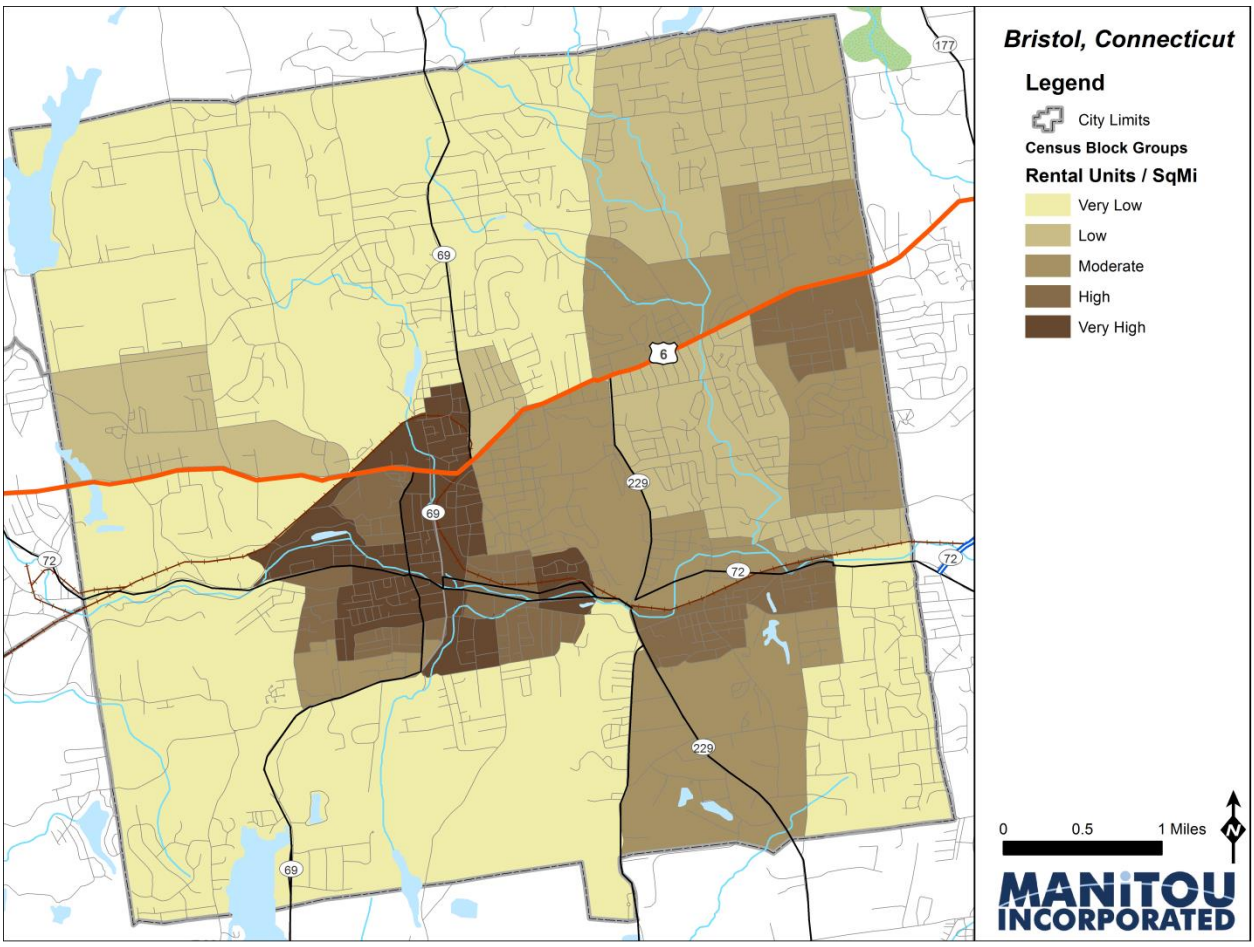
The following table illustrates that owner-occupied and vacant properties have increased modestly since the 2000 U.S. Census, while the rental occupied properties have declined slightly in proportion to the total housing stock.

Table 2: Housing Tenure, 2000-2012

	Total	Owner Occupied	Renter Occupied	Vacant
2012	26,829	16,405	8,682	1,742
2000	26,125	15,410	9,476	1,239
change	3%	2%	-4%	2%

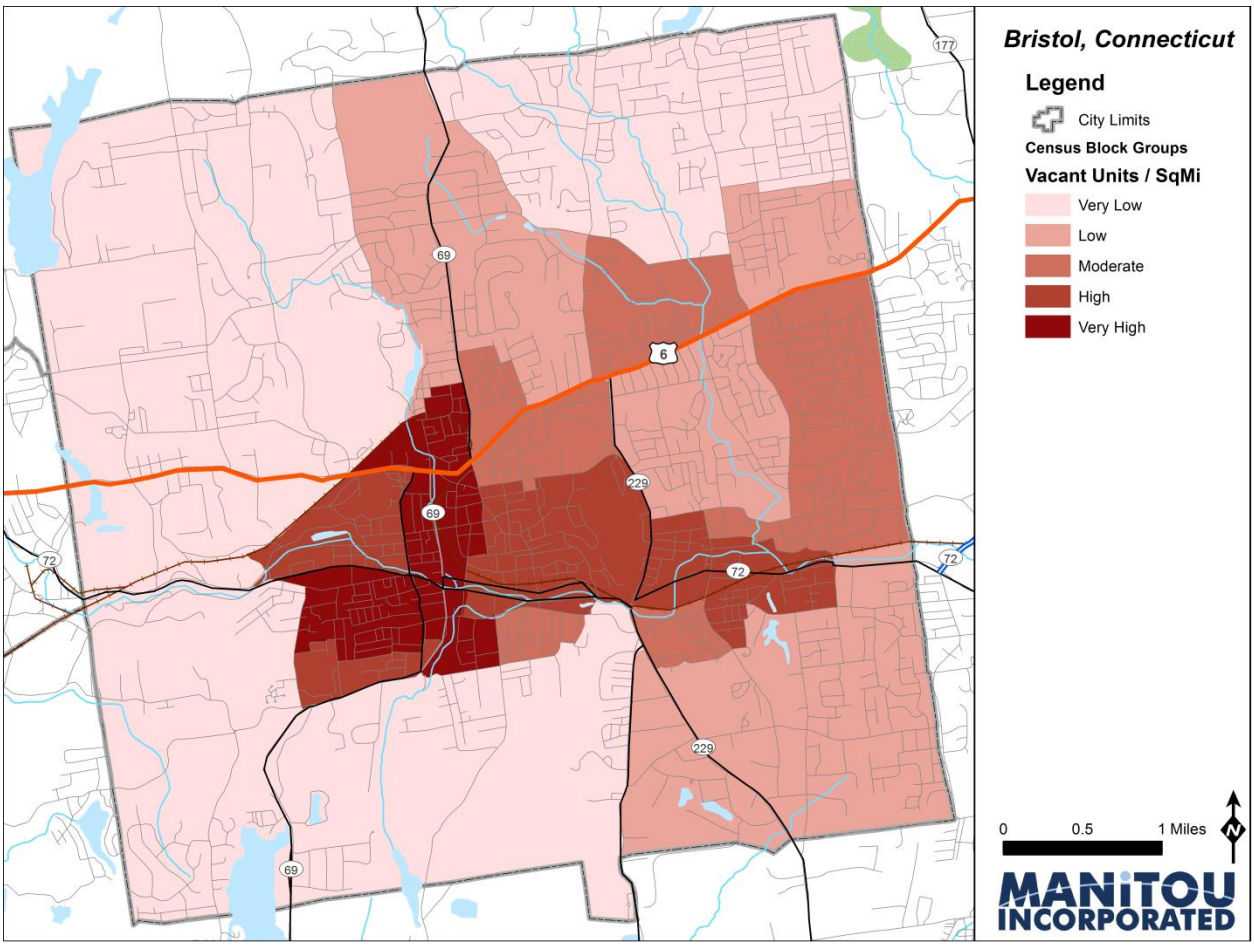
The following map (Figure 11) shows where the concentration of rental units is highest in the city. It can be seen that the city core and along highways have the highest proportion of rental housing.

Figure 11: Density of Rental Housing Units by Census Tract



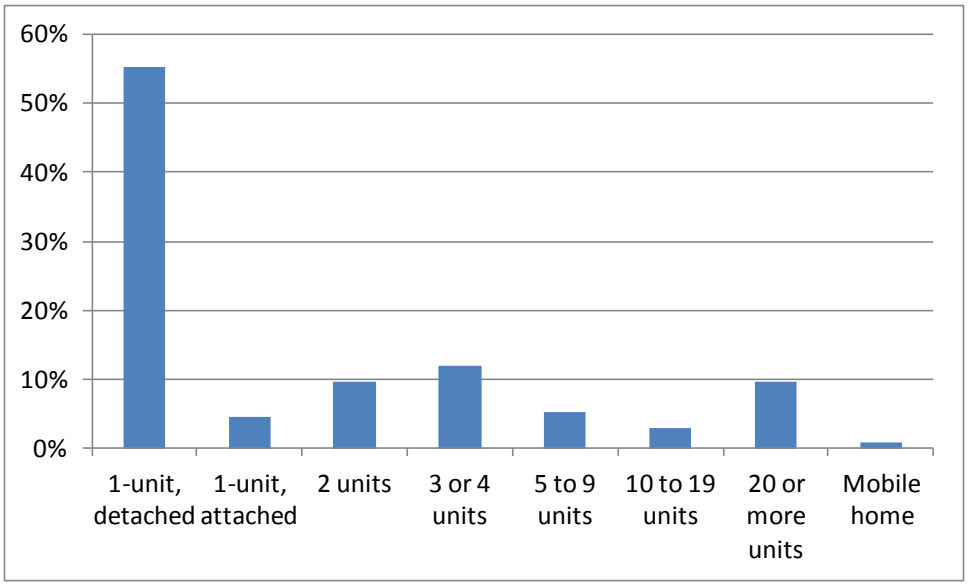
Vacant units can be an arson target or locations for squatters who may be in need of medical attention or located for evacuation purposes. Figure 12 reveals that higher proportions of vacant housing in Bristol are located in almost the same areas as rental units but in other areas as well.

Figure 12: Vacant Housing Units per Square Mile



While most of the housing is single unit detached, a significant minority is multi-unit housing or attached single unit structures. This increases the life and fire risk because more population is exposed to a fire or other threat. The following chart illustrates the housing types in Bristol, based on census data.

Figure 13: Housing by Number of Units

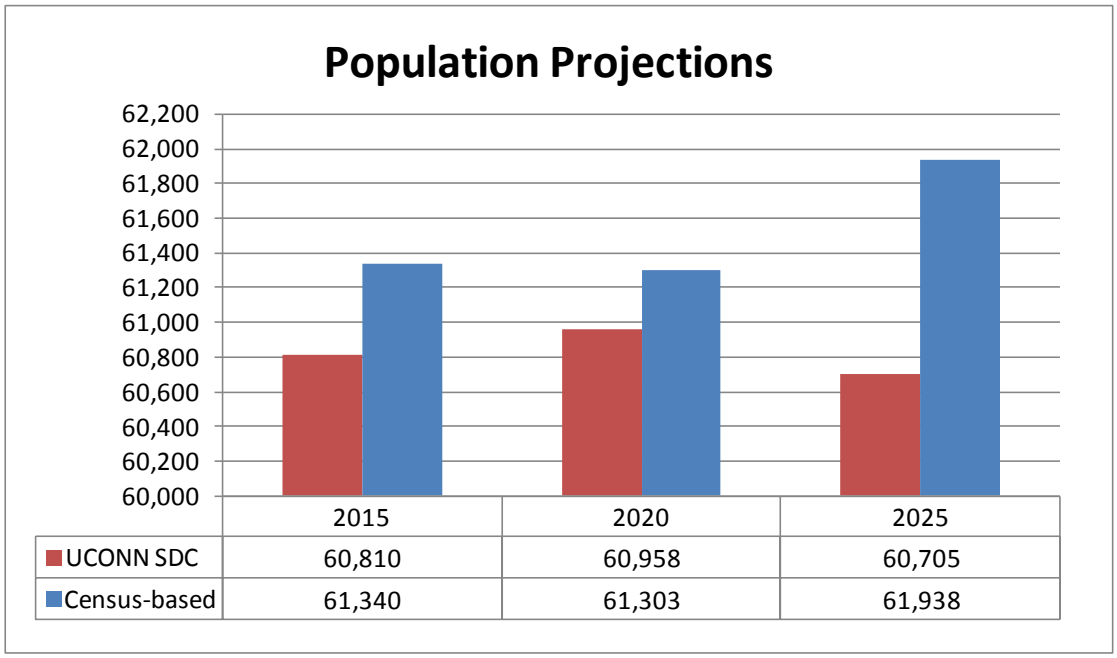


One method to project population growth is based on several decades of census experience. Decennial census figures and census estimates of population for 2011 - 2012 were used to extrapolate forecasted population figures through the year 2025.

This method, however, can fail to account for expected trends in the growth rate of an area. These changes often result from redevelopment, changes in employment capacity, or other socio-economic factors not taken into consideration in a linear projection from historic rates. Because of this, we also reviewed local population projections from agencies with differing methodology.

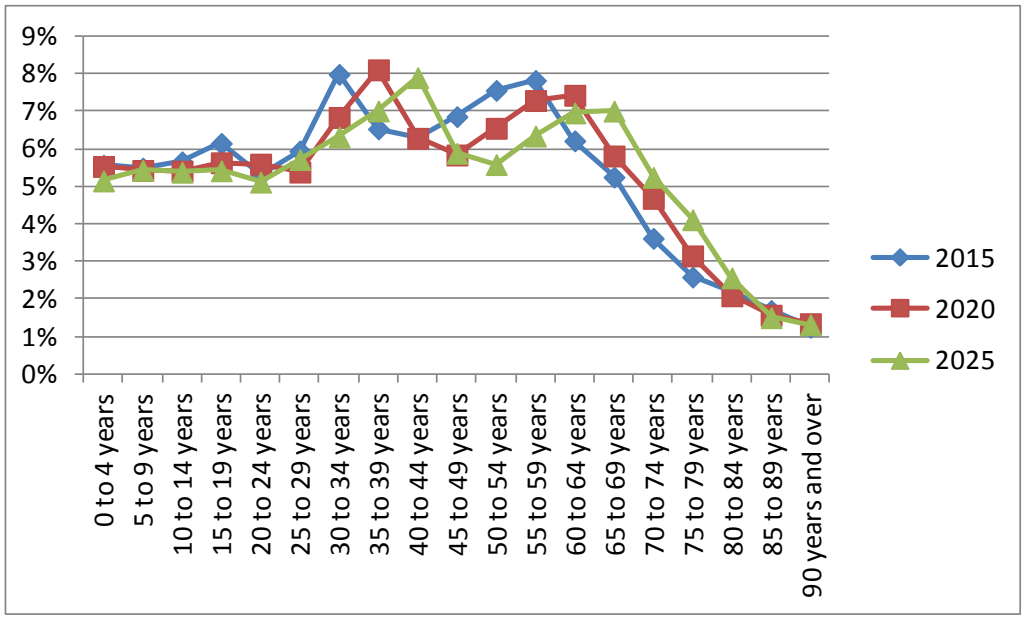
For Bristol, we also used information available from the State Data Center of the University of Connecticut. The following graph presents the results of the two methods of population growth for the City of Bristol.

Figure 14: Bristol Population Projections Through 2025



As the years progress, the census-based estimates forecast a slight decline in 2020 before resumed growth to a larger population in 2025. By contrast, the UCONN model predicts an uptick in 2020 followed by a decline. Because the UCONN model takes into account local factors, it may reflect growth restraints not factored into the census-based forecast method. While these projections are not the definitive authority of future population within Bristol, they provide a way to plan for changing populations. According to UCONN, the age composition of the Bristol population will become progressively older as illustrated in the rightward movement of the age percentages through the projected year ranges (see Figure 15).

Figure 15: Forecast of Population Distribution by Age Group



Risks Considered

This project is designed to identify and address risks from a community-wide perspective. The risks included in this project are intended to represent those events that would require a response for the fire services for which they would be a primary responding agency either by personnel commitment or by jurisdictional domain.

A broad series of hazards was considered, including fires, rescue, natural hazards such as floods, tornados, or severe storms, and technological hazards such as hazardous materials. In the next section of the report, we describe the risks in the City of Bristol.

Fire Risk

We consider fire risk using the following model of residential fire risk. This model accounts for the various factors that help explain fire risk. First, risk can be conceived as the product of frequency of occurrence (likelihood) and magnitude of loss (severity). However, we

need to understand the risk more completely, and to identify possible areas of intervention in the fire problem.[6]

To better understand risk, we separate fire initiation from fire loss. This distinction is important, because certain activities act to reduce the frequency of fires, while others do not reduce the incidence of fires, but reduce their severity once a fire occurs. An example of this is installation of sprinkler systems. Sprinkler systems do not act until a fire starts, but once they activate, they are effective at confining or extinguishing fires, thus reducing fire losses.

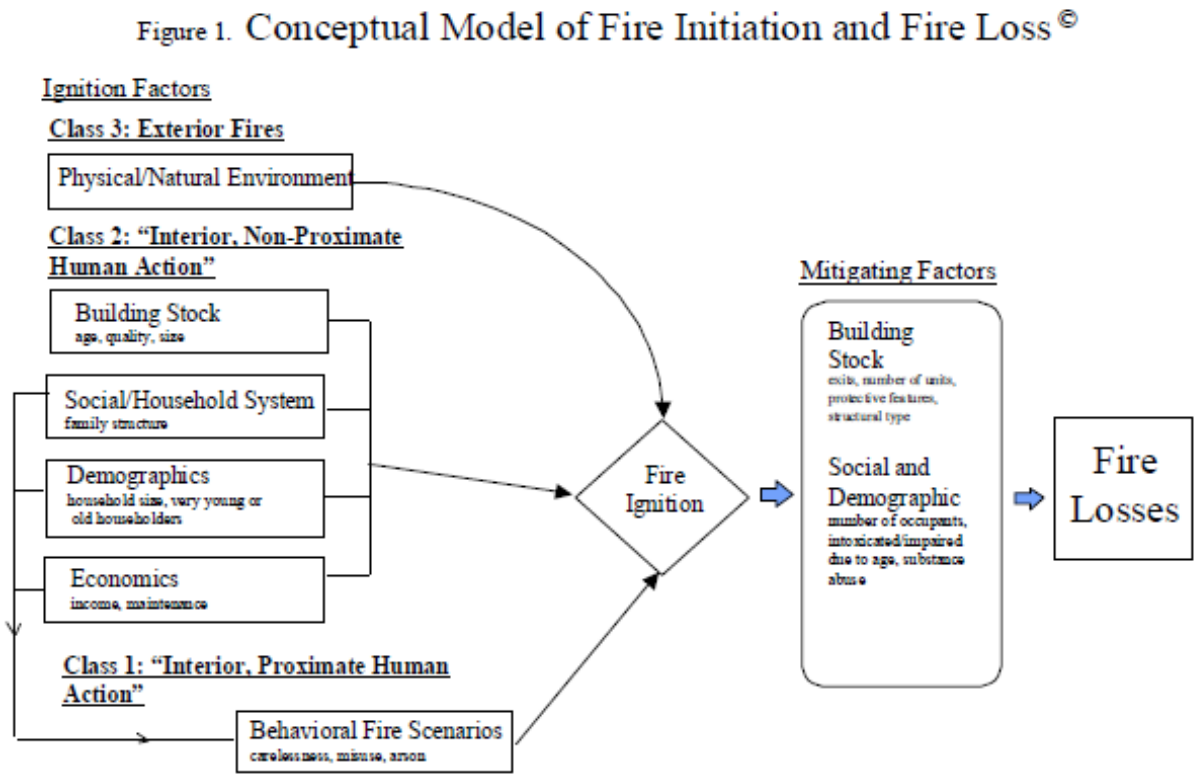
Many things can cause fires; but we can break them into two categories – fires that start on the exterior of structures; and fires that start within a structure. We can consider interior fires as those that arise without proximate human action (an electrical fault in a wall); and fires that arise from intentional human action such as careless smoking, or even arson.

As we see on the left side of the model (Figure 16), several demographic and environmental factors influence the likelihood of a fire starting. For example, an overcrowded housing unit might experience a higher incidence of fires merely because more people are cooking or placing demands on a building's systems. Some of these factors (social/household system, demographics, and economics) can influence the incidence of fires caused by both direct human action as well as fires considered "accidental."

Once a fire starts (fire initiation), the magnitude of the loss is influenced by building stock characteristics, as well as the occupants' demographic characteristics. Presence of a working smoke detector can give an early alarm, and allow occupants to safely evacuate from a fire. Demographic characteristics such as age of occupants, influence fire loss, because children or elderly residents may need assistance in evacuating during a fire, and may be unable to get out without assistance of others.

[6] Jennings, Charles. Urban Residential Fires: An Empirical Analysis Using Building Stock and Socioeconomic Characteristics for Memphis, Tennessee. Unpublished dissertation, Cornell University, Department of City and Regional Planning, 1996.

Figure 16: Model of Residential Fire Risk



To summarize, this model helps to organize our thinking about how fire risk may vary from community to community. As we will see, the determination of risk is more complicated than merely considering the building stock. Indeed, two communities with an identical building stock could have very different fire risks because of the other factors included in this model.

Natural Hazards

Next, we consider the risk of natural hazards. Natural hazards are defined as naturally occurring phenomena including drought, extreme heat, earthquakes, flood, hurricanes, tornados, wildfires, landslides, and extreme cold. We will consider the most common events that have occurred in the Bristol area.

According to the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center, 495 natural severe weather events[7] occurred in the Hartford County area since 1984 causing one death, 11 injuries, and nearly 26 million dollars in property damage.

Excessive Heat

Excessive heat (heat wave) is characterized by NOAA as time periods when high heat and humidity combine to produce a heat index that exceeds locally/regionally established heat-warning thresholds. This occurred three times over the 3 decades:

Table 3: Excessive Heat Events in Bristol

Date	Description
05/07-08/2000	The high temperature at Bradley International Airport in Windsor Locks reached 93 degrees, which tied the record high for the date set in 1930.
10/14/2000	The high temperature of 81 degrees at Bradley International Airport in Windsor Locks tied the record high for the date, which was set in 1954.
05/04/2001	The high temperature reached 91 degrees at Bradley International Airport in Windsor Locks, which broke the previous record high of 85 degrees set in 1965.
05/21/2001	The high temperature of 89 degrees at Bradley International Airport in Windsor Locks broke the record high for the date, which was 88 degrees set in 1991.
07/06/2011	A strong ridge built into Southern New England resulting in temperatures nearing 100 with high humidity. Heat index values ranged from 100 to 106 for most of Southern New England on the 6th and again on the 7th in a more limited area, generally the Connecticut River Valley.
07/21-22/2011	A strong upper level ridge brought very hot temperatures to Southern New England. A moist southwest low-level flow increased humidity levels such that heat index values rose above 105 degrees for a period of a few hours each day.

Severe Storms

Storm events that occur in warmer weather can produce significant rainfall, lightning, and wind that could cause damage to homes and businesses. They can also damage infrastructure such as utility lines. Driving in this type of weather can also be challenging

[7] ***Selected Event Types:*** *Blizzard, Excessive Heat, Extreme Cold/Wind Chill, Flash Flood, Flood, Hail, Hurricane (Typhoon), Ice Storm, Lightning, Thunderstorm Wind, Tornado, Winter Storm*. ***Date Range:*** *2/28/84-2/28/14. Events other than Tornado, Thunderstorm Wind, & Hail were recorded since 1996.*

leading to multiple occurrences of vehicular collisions that also must be tended to by the fire department. Thunderstorms usually produce the most wind damage and, on occasion, generate reports of various sizes of hail.

Table 4: Significant Storm Events in the Bristol Area

Date	Time	Wind Speed	Property Damage ($)	Description
7/8/1994	15:45	UnAvail.	50.00K	Numerous trees and power lines were reported down. In addition, there was extensive damage to a house, as reported by the local police.
10/28/1995	5:39	53 kts.	0.00K	
7/1/2001	15:30	50 kts.	0.00K	Severe thunderstorms downed trees in Bristol and Farmington.
8/2/2002	16:15	50 kts.	2.00K	Severe thunderstorms moved through much of northern Connecticut during the afternoon and evening. There were many reports of downed trees, large branches, and power lines, especially in Hartford County. Thunderstorm winds blew out windows from a building in West Suffield, according to amateur radio operators.
8/13/2003	13:30	50 kts.	25.00K	A severe thunderstorm downed power lines and caused minor flooding in southern Hartford County. Plainville was hardest hit, with nearly 3,600 customers left without power. Another 3,000 customers in Bristol and New Britain also lost power because of the storm. Some area roads also experienced minor flooding.
7/19/2007	14:44	50 kts.	0.00K	A quick-moving storm downed trees and wires
6/10/2008	21:20	50 kts.	0.00K	Trees on Mill Street were downed by thunderstorm winds
6/29/2008	14:12	50 kts.	3.00K	Trees and wires were downed by thunderstorm winds
6/26/2009	16:00	50 kts.	50.00K	Large trees, up to two feet in diameter, in the Elmwood section of Bristol were downed by thunderstorm winds.

Reports of hail in Bristol are detailed in the following table. Curiously, NOAA recorded no damage cost estimates. This is doubtful considering the size of hail falling on roofs and vehicles.

Table 5: Hail Events in Bristol

Date	Time	Size	Description
7/9/1997	15:03	0.75 in.	
5/23/2004	15:00	1.50 in.	Severe thunderstorms moved across north central Connecticut during the afternoon and evening. There were numerous reports of penny to nickel sized hail in Hartford and Tolland Counties, but hail as large as ping pong balls was observed in Farmington and Plainville. No damage was reported as a result of the large hail.
5/23/2004	17:21	0.75 in.	In addition, thunderstorm wind gusts estimated at nearly 60 mph downed small trees along Main Street in Manchester, and downed several trees onto power lines in Mansfield.
7/21/2006	16:55	1.00 in.	A spotter in Bristol reported quarter sized hail.
6/16/2007	13:51	0.75 in.	Cold temperatures aloft combined with a prefrontal trough aided in the development of scattered thunderstorms across Southern New England on the 16th of June. A few of the thunderstorms produced large hail.
5/31/2008	18:35	0.75 in.	A warm, moist air mass moved into southern New England providing enough instability for showers and thunderstorms to develop across the area. Several of these storms had very strong winds associated with them, evident in a 69 mph wind gust in Windsor Locks, CT and wind damage across much of western Massachusetts and northern Connecticut.

Tornado

While Central Connecticut is not as well known as the Midwest of the United States for tornado activity, they occasionally do form in the Bristol area. A review of the historic records[8] reveals that 19 tornadoes with 4 fatalities have occurred countywide since 1951 and two tornadoes have affected Bristol directly.

A tornado formed near the center of town during the afternoon on July 5th 1984. This F2[9] twister was 200 feet wide and traveled 3 miles northeast toward Farmington. Estimates of damage for this event are unavailable. The second less intense (F1) tornado moved nearly due east from Terryville through Bristol for a distance of 1.73 miles. This 25 foot wide

[8] NOAA data through TornadoHistoryProject.com

[9] Fujita Scale

twister happened in late July of 2010 at about 2 PM and caused over a half million dollars in damage.

Winter Storms

While no extreme cold/wind chill events were recorded, several winter storms have affected the Bristol area. These storms make it very difficult for fire crews to travel to and manage incidents. We found one blizzard report in the database; the official description follows:

> *An historic winter storm deposited tremendous amounts of snow over all of southern New England, mainly from the mid-afternoon on Friday, February 8, 2013 and lasting into the daylight hours of Saturday, February 9, 2013. What made this an amazing storm was the widespread coverage of heavy snowfall. Most locations received 2 to 2.5 feet of snow! A stationary band of even heavier snowfall persisted from southwest NH through central MA and on to the southwest across central and western CT. In those areas, reports averaged closer to 2.5 to 3 feet! Isolated thunderstorms were common across the entire region during the height of the storm.*
>
> *A low-pressure system advancing from the Great Lakes region combined forces with a very moist low-pressure system moving northeast from the Gulf Coast states. Snowfall gained intensity during the afternoon, but during the night, 2 to 3 inches per hour were common throughout the region. The band of heaviest snowfall, with 3 to 5 inches per hour for several hours, extended from southwest NH to central and western CT. Snow ended in the morning in western and central MA, southwest NH, most of CT and RI, and in the early afternoon across eastern MA.*
>
> *The Connecticut Department of Agriculture reported that more than 140 agricultural structures were damaged or destroyed throughout the state because of the weight of the snow. Many of these were hoop houses, but a few greenhouses and barns were destroyed as well. Blizzard conditions were observed on the Automated Surface Observing System at Hartford-Brainard Airport (KHFD) for a total of three hours. The highest wind gust observed at Bradley International Airport (KBDL) was 60 mph.*

Impactful winter storms, albeit less severe than blizzards, have occurred in the Bristol region. The table that follows details the most severe events over the last 30 years.

Table 6: Winter Storms in Bristol

Date	Time	Property Damage ($)	Description
12/25/2002	13:00	15.00K	A major winter storm impacted southern New England on Christmas Day, bringing heavy, wet snow to north central Connecticut. Rain fell through the morning, and then by mid-afternoon had changed to sleet and snow as far east as the Interstate 84 corridor. The greatest snowfall accumulations were reported in Hartford County, where totals of 5 to 10 inches were common.
1/3/2003	14:00	0.00K	A powerful winter storm tracked south of New England and dumped heavy snow over northern Connecticut. Totals of 6 to 10 inches were common in Hartford, Tolland, and Windham Counties. Aside from scattered power outages and dozens of minor accidents, little significant impact occurred from the storm since most residents avoided travel. No injuries or damage was directly attributable to the storm.
2/7/2003	5:00	0.00K	A winter storm passing southeast of Nantucket brought heavy snow to northern Connecticut. Totals of 5 to 10 inches were common in Hartford, Tolland, and Windham counties with the greatest amounts reported in Windham County. No significant storm damage was reported, mainly due to the fluffy, light nature of the snow as temperatures dropped into the teens and 20s during the height of the storm. The main impact was on travel, as motorists failed to negotiate slick roadways. State police handled dozens of fender-benders on the highways but no injuries were reported.
2/17/2003	10:00	0.00K	A major winter storm impacted southern New England with heavy snow and strong winds as it tracked southeast of Nantucket. Snowfall totals of 12 to 20 inches were widely observed in Hartford, Tolland, and Windham counties. No significant damage was reported due to the storm, primarily since the snow was fluffy and light with temperatures in the teens and 20s. Impact on travel was minimal, since the storm affected the region on Presidents Day and most schools were closed that week. However, there were numerous reports of minor accidents as a result of slippery roads. No injuries were reported. Officially, the storm total at Bradley International Airport in Windsor Locks was 15.0 inches. This

			set a new daily snowfall record, breaking the previous record of 7.6 inches which fell on the same date in 1952.
3/6/2003	10:00	50.00K	A fast moving winter storm passing south of New England brought heavy snow to northern Connecticut, where totals of 6 to 12 inches were common. Officially, 8.0 inches of snow was reported at Bradley International Airport in Windsor Locks. Other snowfall totals as reported by trained spotters included 9 inches in Bristol.
12/5/2003	22:00	0.00K	In northern Connecticut, snowfall amounts averaged between 12 and 20 inches, and had a major disruption of transportation due to the combination of poor visibility and snow covered roads. Dozens of minor accidents were reported
1/27/2004	19:00	0.00K	In northern Connecticut, snowfall totals of 5 to 10 inches were widely observed with locally as much as one foot in the higher elevations.
1/5/2005	9:00	0.00K	Strengthening low pressure tracking southeast of Nantucket brought heavy snow to northern Connecticut and much of interior southern New England. Snowfall totals of 4 to 8 inches were widely observed throughout Hartford, Tolland, and Windham Counties. The official snowfall total at Bradley International Airport in Windsor Locks was 7.1 inches, which was a two-day total and included 2.4 inches from the day before. Other storm totals, as reported by trained spotters, included 9 inches in Bristol;
1/8/2005	7:00	50.00K	Low pressure quickly strengthened as it passed south of New England and brought a mix of snow, sleet, and freezing rain to much of interior southern New England. North central Connecticut was especially hard hit by freezing rain, where as much as one half inch of glaze brought down trees, tree limbs and power lines. There was no estimate of how many customers lost power, but dozens of accidents were reported as a result of icy roads.
1/22/2005	15:00	0.00K	In northern Connecticut, snowfall totals of 8 to 16 inches were widely observed in Hartford, Tolland, and Windham counties. Winds gusting as high as 45 mph created near blizzard conditions at times, making travel impossible during the height of the storm. Officially, the snowfall total at Bradley International Airport in Windsor Locks was 12.5 inches. Other snowfall totals, as reported by trained spotters, included 16 inches in Stafford Springs; 13 inches in Southington;

3/1/2005	0:00	0.00K	Heavy snow and gusty winds affected northern Connecticut and all of southern New England, as low pressure reformed off the mid-Atlantic coast and tracked southeast of the region. Snowfall totals of 4 to 8 inches were widely observed
3/8/2005	14:00	0.00K	Low pressure strengthened rapidly off the Delaware coast and tracked southeast of New England, bringing heavy snow and high winds to parts of northern Connecticut. Snowfall totals of 4 to 7 inches were widely observed in Hartford County. The snow and high winds made travel difficult. State police described several highways, including Interstate 84, as "barely passable" during the height of the storm. In Hartford, downtown streets were jammed with cars as many businesses and state offices closed early. Commuting times were doubled or tripled in many locations. A trained spotter in Bristol measured a wind gust to 58 mph, but no damage was reported.
2/12/2006	4:00	10.00K	Low pressure centered off the Virginia coast intensified into a strong Nor'easter as it tracked about 75 miles southeast of Nantucket Sunday afternoon, 12 February 2006. This strong Nor'easter produced heavy snow and windy conditions across Hartford, Tolland, and Windham counties in Connecticut. The accumulating snow began around 4 AM and tapered off around 4 PM. Snowfall amounts generally ranged between 13 and 20 inches, with some locations reporting up to 27 inches of snow. 21.9 inches of snow fell at Windsor Locks, which breaks the previous record for the greatest snow amount from a snowstorm as well as the record daily maximum snow amount for the date at Windsor Locks. No known injuries directly resulted from this winter storm.
2/13/2007	23:00	0.00K	Low pressure strengthened rapidly as it tracked from the mid-Atlantic coast to Cape Cod. Snow began in northern Connecticut late in the evening on the 13th, before changing to a wintry mix of snow, sleet, and freezing rain during the morning of the 14th. Although snowfall totals only averaged 2 to 5 inches, this was the season's first winter storm, and the combination of snow and ice resulted in hazardous travel conditions, especially for morning commuters
3/16/2007	11:00	0.00K	Low pressure over the Carolinas strengthened as it tracked over southeast Massachusetts and Cape Cod Bay. This winter storm brought heavy snow and sleet to

			northern Connecticut, with totals of 6 to 12 inches on average, before changing to sleet and freezing rain as the storm wound down.
12/26/2010	12:00	50.00K	A strengthening winter storm passed southeast of Nantucket and brought heavy snow and strong winds to northern Connecticut, resulting in near blizzard conditions at times. More than 2000 flights were cancelled along the east coast due to the storm and Amtrak service between New York and Boston was suspended during the storm. Despite numerous cancellations, Bradley International Airport remained open during the storm, except for a 1-2 hour period early Monday morning, which they used to clear snowfall from runways and taxiways. Snowfall totals of 6 to 12 inches were widely observed.
2/1/2011	6:00	2.500M	A series of significant heavy snow events occurred between December 26, 2010 and February 2, 2011. Snow for the winter season totaled 86.4 inches, most of which fell during this period. Across Connecticut, numerous roof collapses due to heavy snow load occurred following the February 2nd storm, including 75 structures in Hartford County, 28 structures in Windham County, and 31 structures in Tolland County. Damage amounts for this storm include these roof collapses. A total of 6-11 inches of snow fell across Hartford County over the two-day period, with upwards of a quarter inch of ice accumulation for isolated locations falling during the morning period on the 2nd. Damage amounts are for the roof collapses of some 75 structures that occurred following heavy snowfall that totaled 86.4 inches by the end of the snow season. Most of this snow fell from December 26 through February 2 and most roof collapses occurred during or shortly after the February 1 and 2 snow storms.

While the Bristol area may be accustomed to cold/wind chill during the winter months, severe and impactful winter storms are the norm and still provide a significant risk to the community.

Flooding

Significant flooding can occur due to hurricane-related rainfall. According to NOAA the most specific flooding event in Bristol was due to Hurricane Irene in August of 2011 causing one death and 8 million dollars in property damage. Forty-three significant rainfall events in the region over the last three decades also caused flooding as tributaries to the

Connecticut River swelled to handle the run-off (Table 6A). Fortunately a concrete conduit is designed to contain most heavy rainfall situations and prevents flooding into Bristol. Nonetheless, the Federal Emergency Management Agency has designated certain areas with Bristol as a potential flood zone.

Table 6A: Historic Record of Flood Events in Bristol

Date	Time	Type	Deaths	Injuries	Property Damage ($)
1/19/1996	18:00	Flash Flood	0	0	0.00K
1/20/1996	23:00	Flood	0	0	0.00K
1/27/1996	14:00	Flood	0	0	0.00K
1/27/1996	19:00	Flood	0	0	0.00K
1/28/1996	5:00	Flood	0	0	0.00K
1/28/1996	7:00	Flood	0	0	0.00K
4/16/1996	8:05	Flood	0	0	0.00K
4/16/1996	13:55	Flash Flood	0	0	0.00K
4/17/1996	0:45	Flood	0	0	0.00K
4/17/1996	4:15	Flood	0	0	0.00K
4/17/1996	13:30	Flood	0	0	0.00K
5/1/1996	0:00	Flood	0	0	0.00K
5/1/1996	6:00	Flood	0	0	0.00K
5/12/1996	23:00	Flood	0	0	0.00K
5/12/1996	23:00	Flood	0	0	0.00K
7/13/1996	17:20	Flood	0	0	0.00K
10/20/1996	9:00	Flood	0	0	0.00K
10/21/1996	3:00	Flood	0	0	0.00K
12/2/1996	5:40	Flash Flood	0	0	0.00K
12/2/1996	6:00	Flood	0	0	0.00K
12/3/1996	17:00	Flood	0	0	0.00K
4/8/1997	7:00	Flood	0	0	0.00K
4/20/1997	16:00	Flood	0	0	0.00K
8/29/1997	10:45	Flash Flood	0	0	500.00K
1/9/1998	22:00	Flood	0	0	0.00K
3/9/1998	13:00	Flash Flood	0	0	0.00K
3/11/1998	13:00	Flood	0	0	0.00K
3/30/1998	10:00	Flood	0	0	0.00K
4/1/1998	0:00	Flood	0	0	0.00K
5/11/1998	23:00	Flood	0	0	0.00K

6/16/1998	13:30	Flood	0	0	0.00K
6/30/1998	17:10	Flash Flood	0	0	0.00K
6/30/1998	20:45	Flash Flood	0	0	0.00K
7/1/1998	0:00	Flash Flood	0	0	0.00K
7/1/1998	0:00	Flash Flood	0	0	0.00K
1/24/1999	18:15	Flash Flood	0	0	0.00K
2/2/1999	21:00	Flood	0	0	0.00K
3/23/1999	20:00	Flood	0	0	0.00K
9/16/1999	3:13	Flood	0	0	0.00K
9/16/1999	16:40	Flash Flood	0	0	0.00K
9/16/1999	18:17	Flash Flood	0	0	0.00K
9/16/1999	20:00	Flash Flood	0	0	0.00K
9/17/1999	23:59	Flood	0	0	0.00K
4/6/2000	5:28	Flood	0	0	0.00K
4/12/2000	3:47	Flood	0	0	0.00K
4/22/2000	0:15	Flash Flood	0	0	0.00K
12/19/2000	5:00	Flood	0	0	0.00K
3/22/2001	4:30	Flash Flood	0	0	0.00K
3/30/2001	14:00	Flash Flood	0	0	0.00K
4/13/2001	3:11	Flood	0	0	0.00K
4/23/2001	10:15	Flood	0	0	0.00K
5/28/2003	16:30	Flash Flood	0	0	20.00K
9/28/2003	9:00	Flash Flood	0	0	25.00K
12/19/2003	18:15	Flood	0	0	0.00K
12/20/2003	19:00	Flood	0	0	0.00K
12/26/2003	10:00	Flood	0	0	0.00K
12/26/2003	15:10	Flood	0	0	0.00K
4/2/2004	6:25	Flood	0	0	0.00K
4/2/2004	7:00	Flood	0	0	0.00K
4/2/2004	8:54	Flood	0	0	0.00K
3/31/2005	2:30	Flood	0	0	0.00K

7/15/2005	20:36	Flash Flood	0	0	5.00K
7/27/2005	17:50	Flash Flood	0	0	20.00K
10/15/2005	6:00	Flood	0	0	4.200M
6/29/2006	11:30	Flood	0	0	5.00K
7/26/2006	15:15	Flash Flood	0	0	15.00K
4/16/2007	7:12	Flood	0	0	50.00K
2/13/2008	12:00	Flood	0	0	20.00K
3/5/2008	7:24	Flood	0	0	0.00K
3/8/2008	17:07	Flood	0	0	0.00K
3/8/2008	17:07	Flood	0	0	0.00K
9/28/2008	19:17	Flash Flood	0	0	40.00K
12/12/2008	5:12	Flood	0	0	0.00K
12/12/2008	11:10	Flood	0	0	3.00K
7/21/2010	15:45	Flood	0	0	0.00K
3/7/2011	0:48	Flood	0	0	50.00K
3/7/2011	0:48	Flood	0	0	100.00K
8/28/2011	7:43	Flood	0	0	0.00K
8/28/2011	8:03	Flood	1	0	8.000M
9/8/2011	5:45	Flash Flood	0	0	18.00K
9/8/2011	6:00	Flash Flood	0	0	100.00K
9/8/2011	7:58	Flood	0	0	0.00K
6/22/2012	15:14	Flood	0	0	0.00K
7/28/2012	14:34	Flood	0	0	10.00K
7/28/2012	15:02	Flood	0	0	0.00K
8/5/2012	16:43	Flood	0	0	0.00K
9/18/2012	20:46	Flood	0	0	0.00K
7/10/2013	16:06	Flash Flood	0	0	3.00K
8/9/2013	12:46	Flash Flood	0	0	30.00K
9/2/2013	11:10	Flood	0	0	5.00K
	Total		**1**	**0**	**13.219M**

Definitions of FEMA Flood Zones

Flood zones are geographic areas that FEMA has defined according to varying levels of flood risk and type of flooding. These zones are depicted on the published Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map (FHBM).

Special Flood Hazard Areas represent the area subject to inundation by 1-percent-annual chance flood. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply in these zones.

Table 7: FEMA Flood Zones

ZONE	DESCRIPTION
A	Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.
AE, A1-A30	Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. BFEs are shown within these zones. (Zone AE is used on new and revised maps in place of Zones A1–A30.)
AH	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are 1–3 feet. BFEs derived from detailed hydraulic analyses are shown in this zone.
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are 1–3 feet. Average flood depths derived from detailed hydraulic analyses are shown within this zone.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection.
A99	Areas subject to inundation by the 1-percent-annual-chance flood event, but which will ultimately be protected upon completion of an under-construction Federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may be used only when the flood protection system has reached specified statutory progress toward completion. No BFEs or flood depths are shown.

Coastal High Hazard Areas (CHHA) represent the area subject to inundation by 1-percent-annual chance flood, extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. Structures located within the CHHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory purchase requirements apply in these zones (see Table 8).

Table 8: FEMA Coastal Hazard Area Definitions

ZONE	DESCRIPTION
V	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves. Because detailed coastal analyses have not been performed, no BFEs or flood depths are shown.
VE, V1-V30	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic coastal analyses are shown within these zones. (Zone VE is used on new and revised maps in place of Zones V1–V30.)

Moderate and Minimal Risk Areas

Areas of moderate or minimal hazard are studied based upon the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Flood insurance is available in participating communities, but is not required by regulation in these zones. Nearly 25-percent of all flood claims filed are for structures located within these zones.

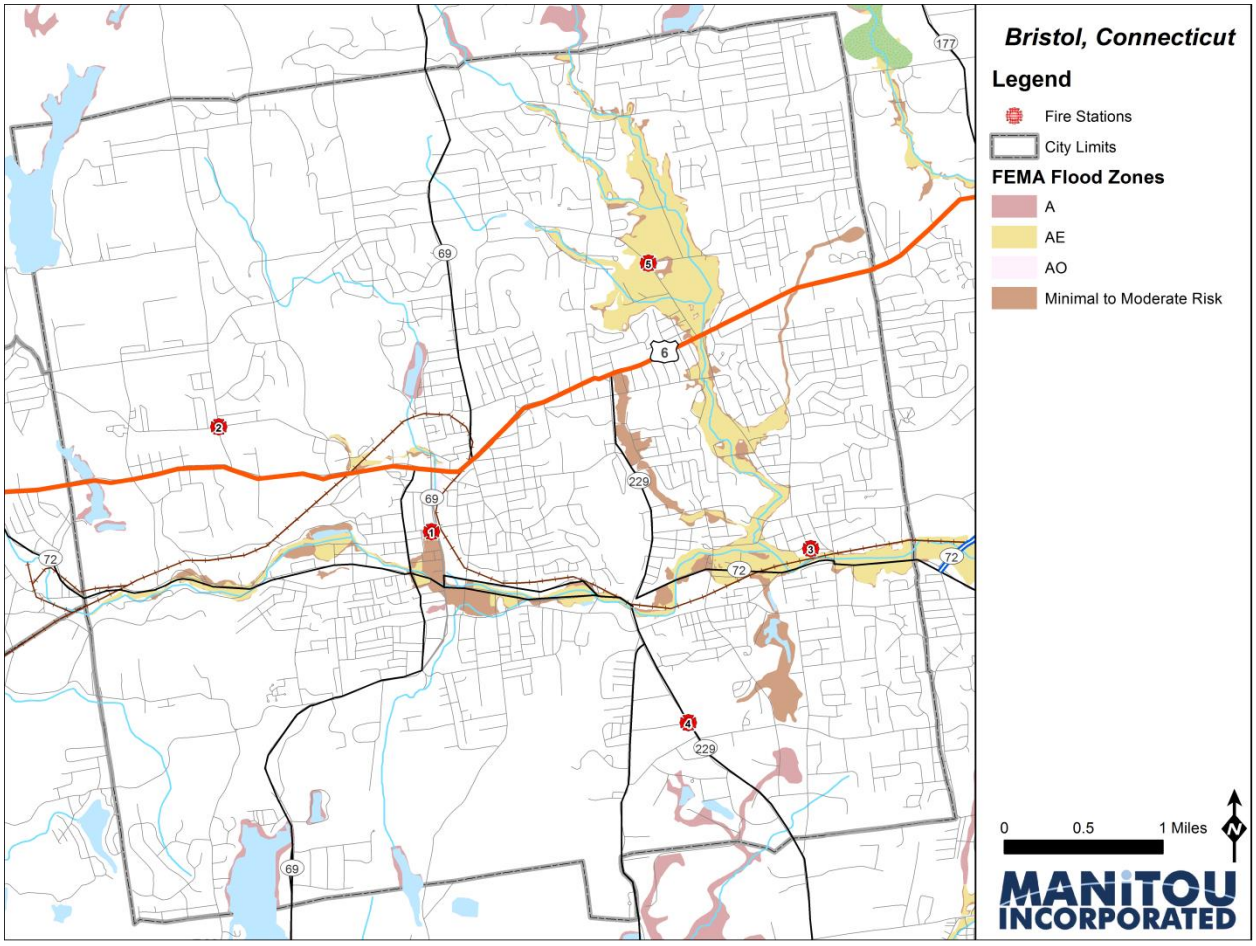
Table 9: FEMA Flood Risk Areas

ZONE	DESCRIPTION
B, X	Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (Zone X is used on new and revised maps in place of Zone B.)
C, X	Minimal risk areas outside the 1-percent and .2-percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones. (Zone X is used on new and revised maps in place of Zone C.)
D	Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply.

The following map details the FEMA designated flood zones within the City of Bristol. It appears that several fire stations are within designated flood zones. Specifically Station 1 within a minimal to moderate risk zone and Station 5 that appears to be within an AE zone. Station 3 is not within a flood zone though it appears close on the

map (Figure 17). Measures to mitigate flood damage to stations and apparatus must be established if not already done so.

Figure 17: FEMA Flood Zones



Aside from the threat to the fire stations, other infrastructures as well as population in Bristol are within the flood zones. The following table details some specific building types and estimated population affected by living within these FEMA designated flood zones.

Table 10: Properties in Flood Zones, Bristol

Flood Zone	A	AE	AO	Minimal to Moderate Risk
Population (Est.Census Block)	151	2643	0	1044
Housing Units	72	1219	0	446
Non-Specific Buildings	128	1247	14	1119
Hospitals	0	0	0	0
Senior Care Facilities	0	0	1	0
Schools	0	2	0	1
Houses of Worship	0	0	0	4
Institutions	1	1	0	1
Water Infrastructure	0	6	0	0
Sewer Infrastructure	0	6	0	1
Electric Infrastructure	153	0	0	0

The electric Infrastructure in Zone A is transmission towers, which are safe from the floodwaters. Access to them for repair would be impeded. The specific building types are areas of public assembly and may need evacuation during a flood event. These facilities should not be used for sheltering activities during a potential flood event. The fire department should be aware that hydrants in flood zones may be unreachable and therefore alternative methods of delivery in case of fire should be investigated. Road and rail access into these areas will also be compromised.

Drought

Conversely, the lack of precipitation can cause periods of droughts within the region. This can threaten the drinking supply levels as well as the use of water for essential processes whether commercial or medicinal. For the fire department, droughts can cause fires to burn more easily. The use of water for extinguishment must be readily available.

Table 11: Historic Droughts

Drought Periods	Duration	Lowest PDSI[10]
6/1911 - 7/1911	2 months	-3.53 in 7/1911
11/1914 - 12/1914	2 months	-3.11 in 11/1914
9/1930 - 2/1931	6 months	-3.47 in 11/1930
10/1949 - 1/1950	4 months	-3.74 in 12/1949
7/1957 - 11/1957	5 months	-3.88 in 9/1957
8/1964 - 11/1966	28 months	-5.01 in 12/1965
1/1967 - 2/1967	2 months	-3.38 in 1/1967
12/2001 - 4/2002	5 months	-3.94 in 2/2002

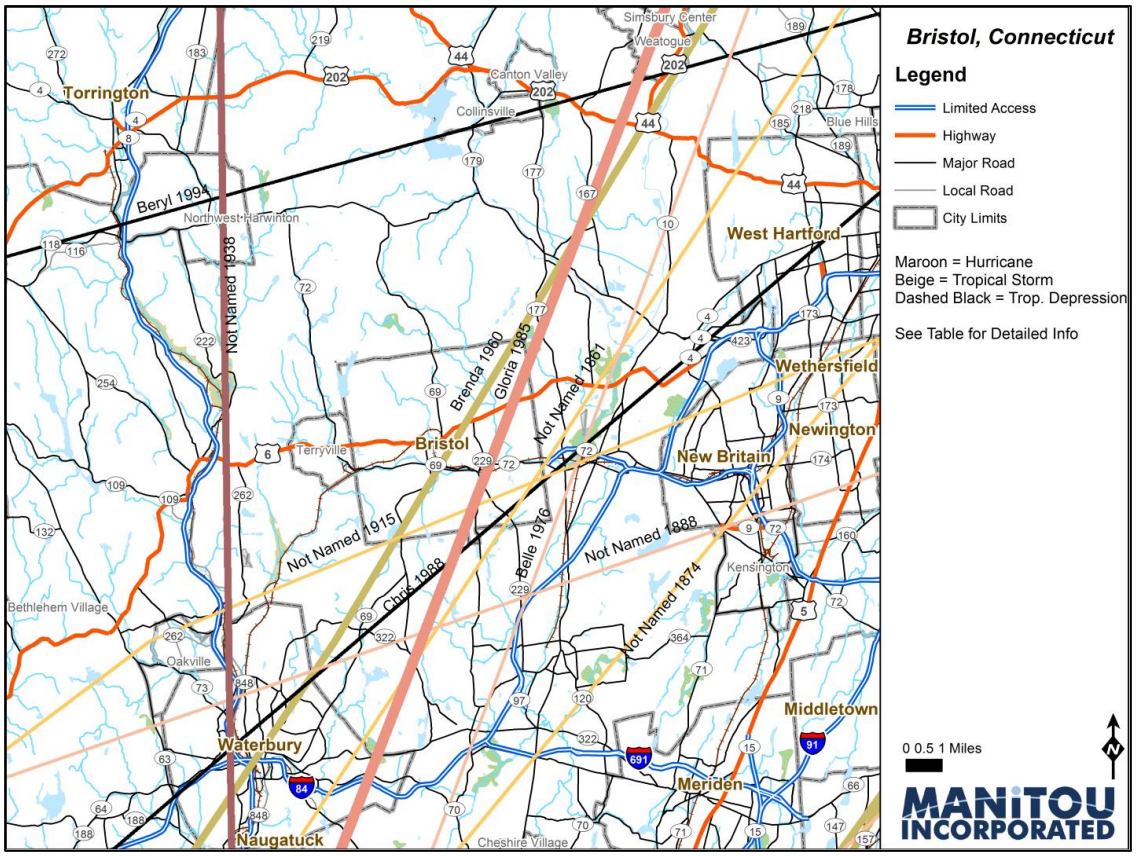
[10] Based on the monthly Palmer Drought Severity Index as computed by the National Climatic Data Center. Period of record: January 1895 through February 2014

The following table details the more serious drought periods. The last official drought recorded by NOAA was for two weeks in the spring of 2012. For more details refer to Table 11.

Hurricane

The City of Bristol is just 50 miles from the Long Island Sound. Atlantic Hurricanes often travel up the Atlantic seaboard making landfall along the way. Several times they do cross the Sound and into New England. The City is at high risk of being affected by Atlantic Hurricanes and should take mitigative measures to prevent damage and loss of life. The following map illustrates the historic hurricane tracks on record that have come within the immediate Bristol area. Although alluded to previously, even hurricanes that do not come as near can produce significant flooding (Irene 2011) (see Figure 18).

Figure 18: Historic Hurricane Tracks



The following table provides some detailed information when viewing the previous map.

Table 12: List of Historic Hurricanes in Bristol

Date	Name	MSW (kts)	Pressure (mb)	Status
9/28/1861	None	60	0	Tropical Storm
9/30/1874	None	60	0	Tropical Storm
8/22/1888	None	40	0	Tropical Storm
8/5/1915	None	45	0	Tropical Storm
9/21/1938	None	85	940	Hurricane Cat 2
7/30/1960	Brenda	45	0	Tropical Storm
8/10/1976	Belle	60	983	Tropical Storm
9/27/1985	Gloria	75	964	Hurricane Cat 1
8/26/1988	Chris	30	1008	Tropical Depression
8/18/1994	Beryl	15	1010	Tropical Depression

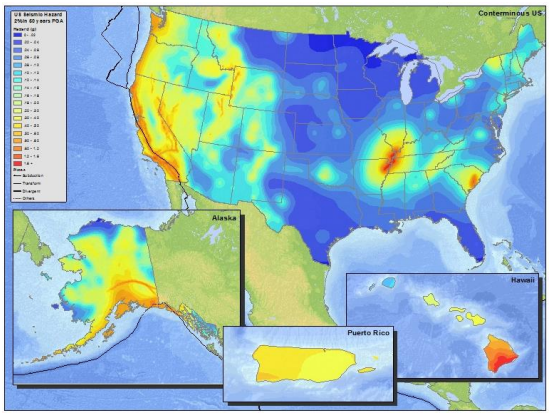
MSW=Maximum Sustained Winds in knots

Hurricanes that make landfall anywhere along the Connecticut shoreline will have a significant impact upon the city, its residents, and stress the resources of the fire department as it provides fire and rescue services (see Table 12).

Earthquake

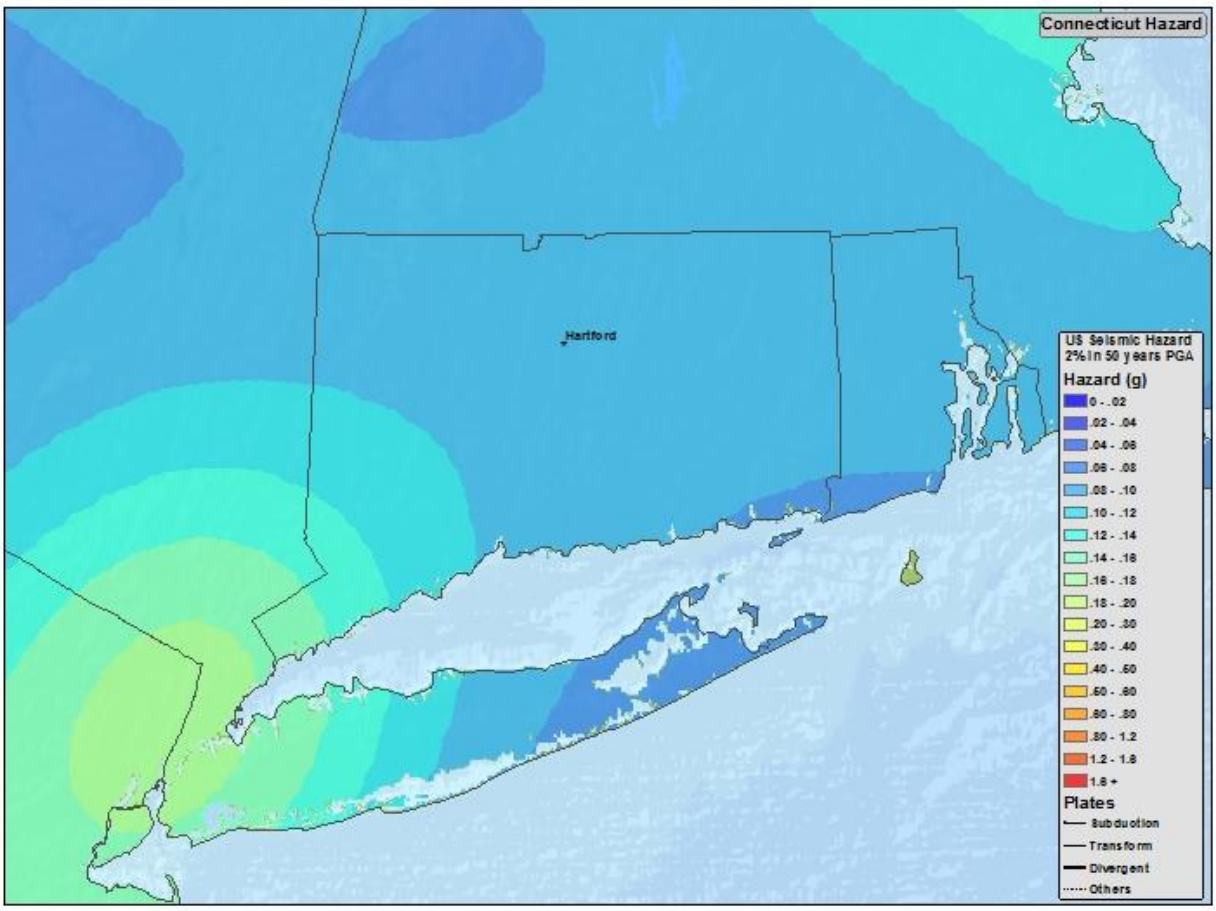
According to the United States Geological Survey (USGS) who monitors earthquake activity and hazards for the nation, the Bristol region is in an area of very minor seismic activity compared to other areas of the country. That is not to say earthquakes have not happened in the greater Bristol area but that any effects have been minimal without reported damage or loss of life. The following map shows the relative seismic hazard for the United States.

Figure 19: US Earthquake Risk



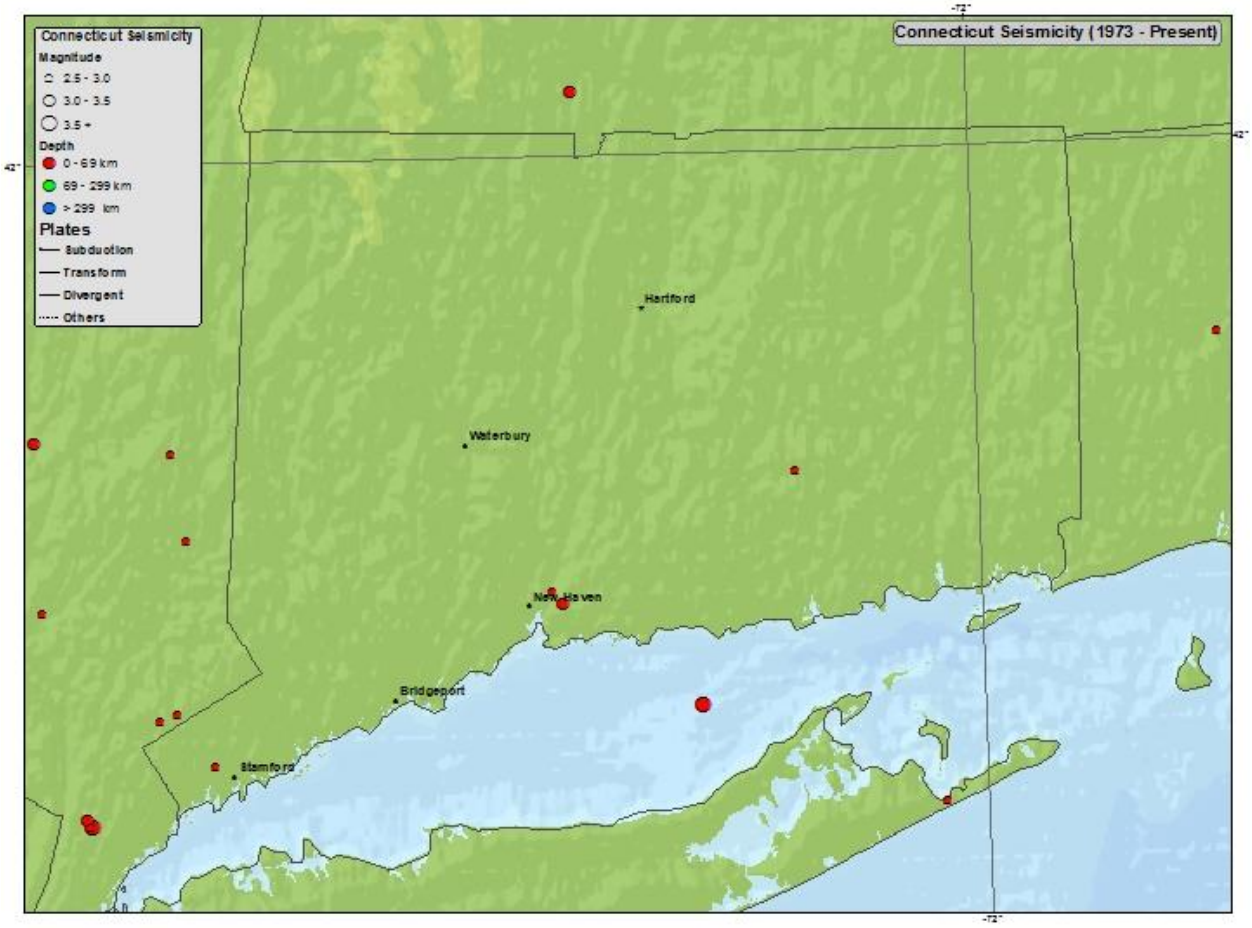
It is clear that other areas of the country are at much higher risk and that central Connecticut's main threat of earth shaking comes New Jersey (Ramapo Fault) (see Figure 20).

Figure 20: Regional Earthquake Risk



Most recent events have been less than a five on the Richter scale (8 being most severe). According to the USGS the following map (Figure 21) shows the epicenter of some recent minor activity from 1973 through March 2012. Notice the magnitude remains less than 5 and the depth of the quake is shallow therefore resulting in minimal shaking that may not be noticeable to most residents.

Figure 21: Location of Historic Earthquakes, State of Connecticut



Greater magnitude earthquakes in the region that may have unnerved residents are listed in Table 13.

Table 13: Historic Earthquakes Greater Than 5.0 (Richter)

Place	Magnitude	Depth (mi)	Date
Northeast New Jersey	5.3	10	1783
New York City, NY	5.5	10	1884
Blue Mountain Lake, NY	5.3	7	1983
Cape Ann, MA	5.8	10	1755

While the risk of damage because of an earthquake is low, it is not implausible. The concern in Bristol is building collapse and loss of life in structures that were built centuries ago.

Volcano (Ash)

There are no active volcanoes on the east coast of the United States that directly threaten the City of Bristol. However, active volcanic mountains in the western part of the country, as well as the cauldron beneath Yellowstone could produce ash clouds that are carried by the prevailing winds as far as Connecticut. The fire department could be called to assist residents who suffer from respiratory diseases, distribute facemasks, or to simply wash down certain areas.

Meteorites/Space Junk/Solar Flares

Recent meteorite impacts in Russia remind us that the possibility looms over all of civilization. Connecticut has not been immune from such events. The first verified meteorite impact was in 1807 at Weston, Fairfield County. In more recent times, the community of Wethersfield, outside Hartford and just east of Bristol, suffered two meteorite impacts in just over a decade, both hitting homes that were occupied at the time.

Similarly, manmade space equipment has fallen to the earth. While most are destroyed reentering the atmosphere, some survive the fall. Skylab fell to Earth in June of 1979, spreading debris in the Australian Outback. In 2008, the US Government shot down one of its spy satellites, as it was apparent it would fall to Earth and might land in the wrong hands.

Solar flares are very common and can disrupt communication equipment vital for the fire department and other outlets as they communicate emergency information to Bristol Residents.

Landslides

The State Department of Energy and Environmental Protection (DEEP), in its 2014 Natural Hazards Mitigation Update, have determined that the Bristol region is not susceptible to significant landslides. Although falling rock from road cuts and erosion from heavy rain are to be expected.

Sinkholes

While sinkholes are a low-moderate risk according to the State DEEP, they can occur as evidenced by recent reports of a Bristol home threatened by collapse due to a sinkhole forming below it. Structural collapse and the loss of life are the greatest threat due to sinkhole formation. The fire department must have resources readily available in such cases.

Wildfires

Bristol has a combination of urban, suburban, commercial, industrial, and some rural areas. The most significant risk of a wildfire in wooded areas is when they threaten the building stock. Mitigation procedures should be reviewed and practiced to effectively combat a fire within the interface between woodland and development. The following table illustrates the last four-year history of woodland/grassland fires within the City of Bristol. There is no history of significant wildland fires that have threatened structures in the City.[11]

Technological Hazards

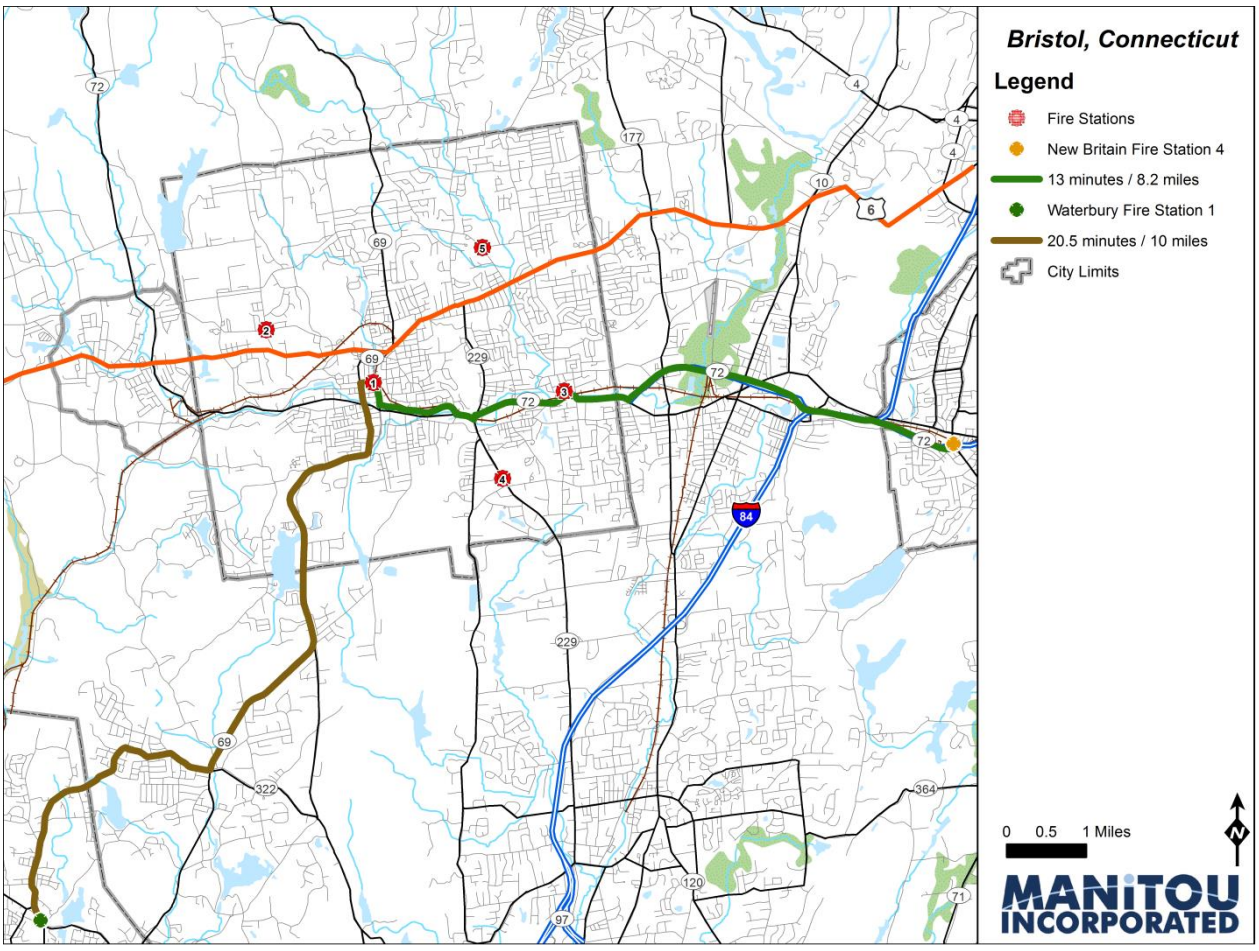
Technological hazards (also known as man-made hazards) include threats from industrial activity, transportation, chemicals, radiological materials, and the like.

Hazardous materials of all sorts are utilized by industry in their manufacturing processes. They are also sold to consumers in forms such as pesticides, fertilizers, and solvents. Most homes have a supply of hazardous materials, which makes residential fires in garages and sheds potentially toxic. This section's focus however, is on industrial hazardous materials and their risk to the community.

The Bristol Fire department is trained to handle a hazardous materials incident at the 'operational' level. This is the lowest level of knowledge of Hazmat firefighting; spill containment, evacuation, and mitigation that have been developed for the fire service. While the State Hazmat team can respond from Windsor Locks 30 miles away, closer career fire departments in Waterbury and New Britain have specialized Hazmat equipment that could aid the Bristol Fire Department in the event of an incident. One concern is how fast they could respond into Bristol. Given the breadth of sites across the City, the downtown center was used as an incident location for this scenario. The following map (Figure 22) shows the route of travel and the approximate time to help in the Bristol area for Waterbury Station 1 and New Britain Station 4, the closest stations in these career departments. These times exclude the time from dispatch to the time their Hazmat technicians and apparatus begin responding.

[11] Examples of educational and standards programs tailored to wildland hazards include NFPA's Firewise program, as well as their standard NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*. If significant development occurs in forested areas of the City, these should be considered but are not a priority at this time.

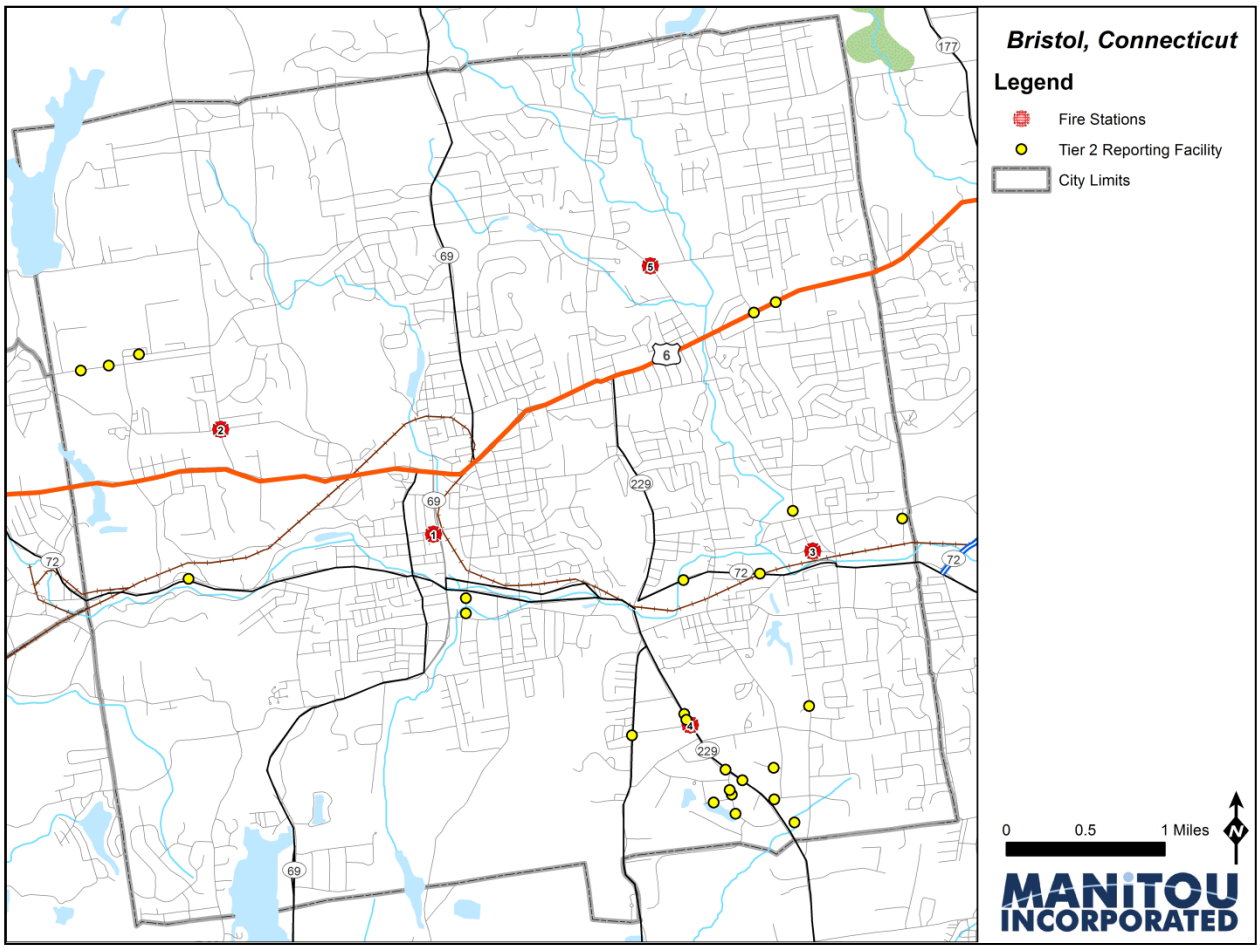
Figure 22: Mutual Aid Stations



The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 requires industry to report to federal, state, and local governments regarding the storage, use and release of hazardous chemicals. The fire department receives these reports from 32 different industries including the hospital and utility companies mapped previously. The following map shows the locations of industries required to submit a Tier 2 report in geographic relation to the fire stations.

A first responding apparatus can reach all of the facilities. The facilities near Station 2 and on the edge of town on the eastern border are outside the first alarm time objective. It can be seen that most of the facilities are near Station 4. It would be wise to place Hazmat assets at the planned new station. There are several Tier 2 reporting facilities in Plainville just to the east of Bristol and in Southington south of the Bristol City line.

Figure 23: EPA Tier 2 Reporting Facilities



Known Hazmat Sites

Despite careful processes, accidents and spills do occur occasionally. Before more stringent environmental laws, past industrial practices may have contributed to contamination of water, soil, or air. These may or may not threaten human health and groundwater supplies.

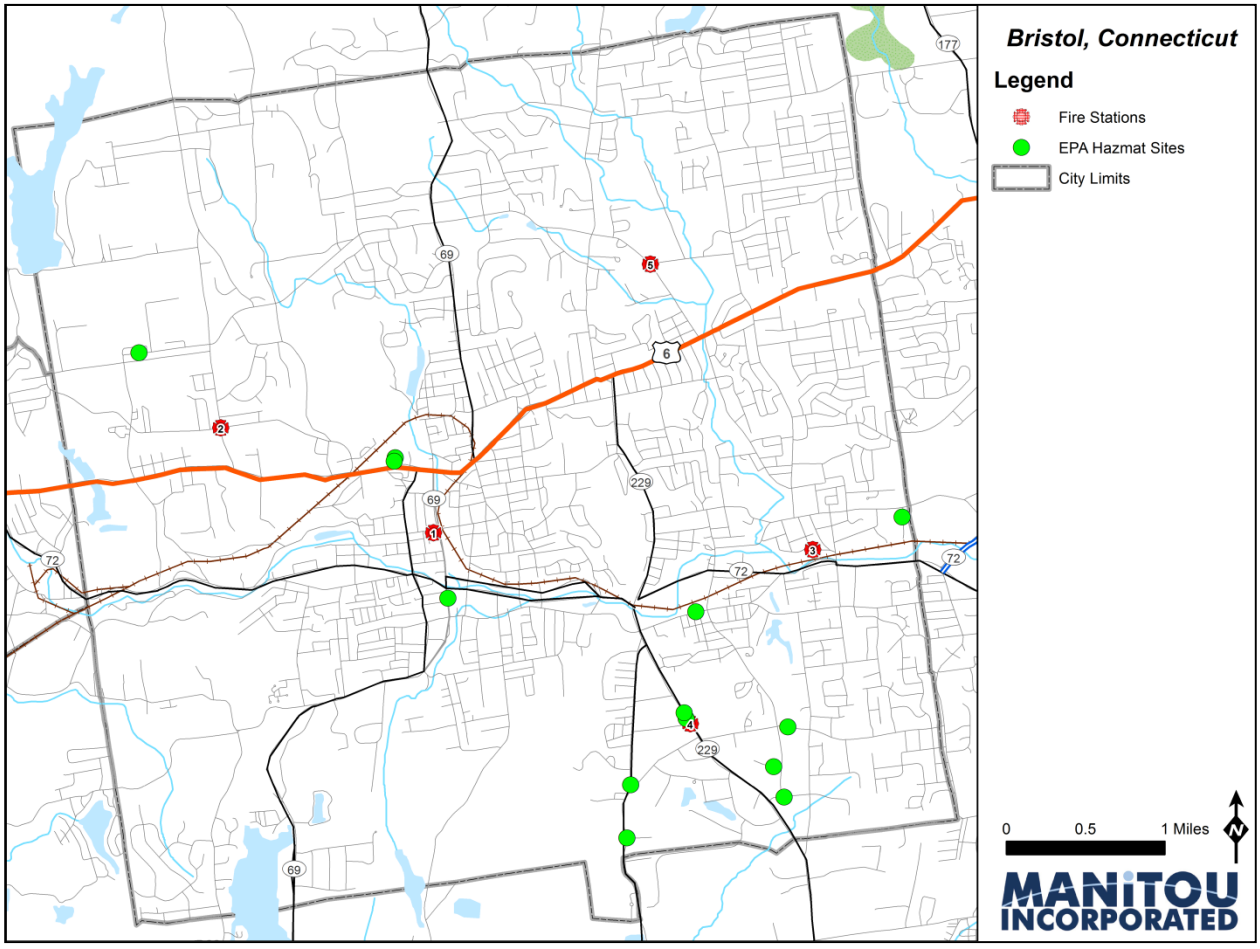
The Environmental Protection Agency (EPA) oversees these concerns. They work with the State Department of Energy and Environmental Protection. (CT DEEP). EPA's Superfund program was established in 1980 to locate, investigate, and clean up hazardous waste sites throughout the United States. EPA New England's Superfund program oversees long-term cleanups at National Priorities List (NPL) sites; short-term cleanups ("SHORT") and response to chemical and oil spill emergencies.

Brownfields are defined as real properties, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. EPA's Brownfields Program provides funds and technical assistance to states, communities, and other stakeholders in economic redevelopment to work together to assess, safely clean up, and sustainably reuse brownfields.

Under the Resource Conservation and Recovery Act (RCRA) program, facilities that treat, store, or dispose of hazardous wastes (TSDs) are required to clean up environmental contaminants at their sites. This cleanup at TSD facilities is termed RCRA Corrective Action.

According to the New England office of the EPA[12], the following map (Figure 24) illustrates where known hazmat sites are in Bristol.

Figure 24: EPA Contaminated Sites



[12] http://yosemite.epa.gov/r1/npl_pad.nsf/QuickByName?SearchView&Query=bristol,ct&count=10&start=1&SearchOrder=4

Once again, most of the known sites are near Station 4 but these are ongoing or closed sites according to the EPA. They report that most do not pose a human or groundwater threat.

While there are numerous industrial operations within the City that utilize reportable quantities of hazardous materials, two of Bristol's largest facilities that have hazardous materials stored on site will be discussed further here. One is the Bristol Industrial Complex on James P. Casey Road northwest of Station 2 and the second is the Clean Harbors facility to the east of Station 4. They occupy opposite ends of town but any inadvertent spill, release, or fire may have an impact upon the community.

Clean Harbors Environmental, 51 Broderick Rd.

Clean Harbors is a permitted hazardous waste manager and recycler by the State of Connecticut. The stated stored chemicals on site are oxidizers, acids, corrosives, and alkalizers used in the process of waste recycling and are not especially dangerous by themselves. They are used for the chemical treatment of inorganic-based non-hazardous wastes and other hazardous substances and the stabilization/fixation of sludge and solids intended for land disposal. Clean Harbors accepts hazardous wastes, including polychlorinated biphenyls (PCBs) from manufacturers of electronics, electroplaters, chemical facilities, plastics manufacturers, medical labs, utilities, and petroleum distributers. It also accepts scrap metals for removal of regulated materials before recycling.

What can be concerning is the type of hazardous waste that is being trucked into the facility and, in some cases, stored up to ten days. While no disposal of waste is conducted on-site, treated waste is again being transported out of the facility to its intended disposal site. Currently, Clean Harbors is permitted to accept, store, treat, and then truck away the following wastes[13]:

- 42 different types of wastes[14] that are ignitable, corrosive, or toxic
- Discarded commercial chemical products
- Sludge from the process of wood preservation that uses creosote or pentachlorophenol.
- Waste from the production of dithiocarbamate acids and their salts (pesticide).
- Used oils
- Pesticides
- Used electronics
- Mercury

[13] Clean Harbors Fact Sheet 7/17/2013 Waste Facility Renewal Permit
[14] http://www.epa.gov/waste/inforesources/data/br91/na_apb-p.pdf

- Asbestos & biomedical waste
- Freon

While this list may seem inclusive of all waste types generated, it is not. There are also certain wastes, for instance explosives and compressed gases, that Clean Harbors is prohibited from handling.

Because the chemicals present at Clean Harbors vary over time, the hazard of the facility can be thought of as varying with the range and quantity of materials accepted for processing. This uncertainty about materials of various types and in various stages of processing being moved into and out of the facility is a risk for which the fire service must be prepared. Fortunately, the frequency of significant events at the facility is low.

Bristol Industrial Complex, 780 James P. Casey Road

There are three tenants of note in this massive 1.2 million square foot building at the time of the report. They are Firestone Building Products, Arett Sales Corporation, and Clark/Dietrich Building systems. Clark/Dietrich produces metal studwork for wall frames, and does not present an unusual hazardous materials challenge.

Firestone Building Products primarily provides wall and roofing supplies to construction contractors and for sale at some retail outlets. The Bristol plant manufactures polyiso insulation, the foam boards installed between walls to insulate the building. Aside from various chemicals needed in the production process, other roofing material such as asphalt sheeting, cement, and flashing products are stored on the property. The most common chemical consumed at the plant is Methylene Diphenyl Diisocyanate, which is consumed in large quantities and shipped to the site via rail tank cars by the Pan Am Southern Railway. The EPA characterizes Methylene Diphenyl Diisocyanate as a moderate to low environmental risk in regard to plants and animals.[15] Workers applying the product must use respiratory protection and avoid skin contact, but from an emergency response standpoint, large spills require a 150-foot evacuation distance. The material does not readily ignite, but a tank car exposed to a large fire would require a half-mile evacuation.[16]

In addition, smaller quantities of flammable, corrosive, and water-reactive materials are used in the manufacturing process. Some of these are also shipped by rail.

[15] U.S. EPA. Methylene Diphenyl Diisocyanate (MDI) And Related Compounds Action Plan [RIN 2070-ZA15] April 2011.
[16] US Department of Transportation. Emergency Response Guidebook (2012). Guide number 171, p. 280-281.

Arett Sales Corporation is a major distributor of lawn and garden supplies to national retail outlets. Aside from goods such as tools, fencing, and hardware, they also distribute chemicals including fertilizers, pesticides, and insecticides. Several corrosive compounds can be naturally found with these types of products. There are also small amounts of flammable butane, propane, isopropyl alcohol, and ethanol. Although these are found in containers designed for end use by consumers, quantities of these goods could produce a heightened hazard. The fire risk is generally greater than any hazardous material concerns.

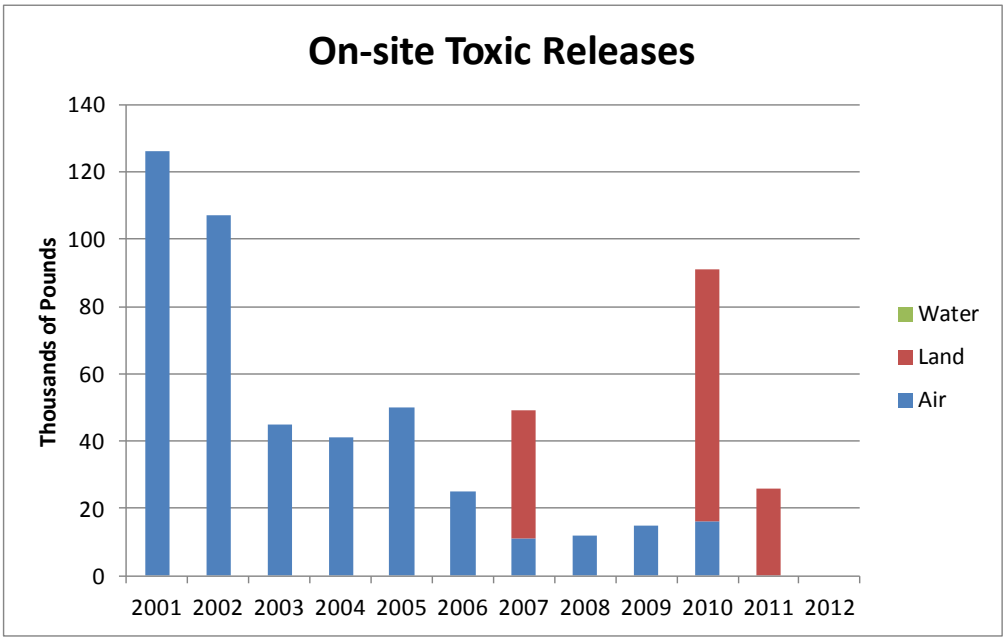
We did not inspect this facility, but it is protected by automatic extinguishing systems and firewalls.

Toxic Release Inventory

The EPA requires a Toxic Release Inventory (TRI) from industries that meet certain criteria. The most recent data release in March 2014 indicates that over 230,000 lbs. of toxic material was transferred to offsite transfer locations. Only 120 lbs. were released on-site.

Of the off-site transfers, nearly all came from Clean Harbors, which is a Hazardous Waste/Solvent recovery firm. This may mean that an equivalent amount was trucked in primarily from Interstate 84 into Bristol from the south end to be treated and then removed from the site. The primary chemical transferred was Ethylene Glycol (63%). A complete list of chemicals released in Bristol can be found at EPA TRI Chemical Report for Bristol.

Figure 25: On-Site Toxic Releases 2001-2011



The good news is that overall on-site releases have been decreasing for the past decade. In 2012, the releases to the air (107lbs), has been primarily lead. To water (10lbs), the release has been nearly equally split between lead, chromium compounds, manganese compounds, and nickel compounds. Toxic spills on land were limited to 2 lbs. of nitrate compounds.

Hazmat incidents can be high consequence/low frequency events. Nonetheless, a level of training and equipment must be maintained to enable the fire department to handle the initial incident until advanced responders can arrive. This section detailed the industry within Bristol that poses a potential hazard. What cannot be tabulated specifically are the amount of hazardous materials that traverse through Bristol by rail and by truck on the major thoroughfares and side streets leading to nearby industry and beyond Bristol.

Development Patterns/Building Stock

A critical component of risk is the building stock. In this section of the report, we will describe the Bristol building stock to better understand its relationship to risk. As a starting point, the Insurance Services Office (ISO), whose reports are a major determinant for many insurance companies' rating methodology, routinely examines commercial properties across the country. Their data are limited to commercial structures, but represent most of the high-value properties in the City. Information provided by the ISO include a Needed Fire Flow report that includes square footage, construction factors, number of stories, and other information used to calculate how much water flow would be needed in the event of a fire.

Aerial truck apparatus, with their long ladders are able to reach higher buildings and larger square footage structures such as 'big box stores'. Fire departments typically position them near an area that contains many such structures. The BFD has stationed its manned tower apparatus in the downtown area of Station 1. The following map (Figure26) details the buildings listed by ISO that have higher needed water flow rates. It is followed by higher storied buildings, and then finally by larger square footage structures.

Figure 26: ISO Needed Fire Flow (Commercial Buildings)

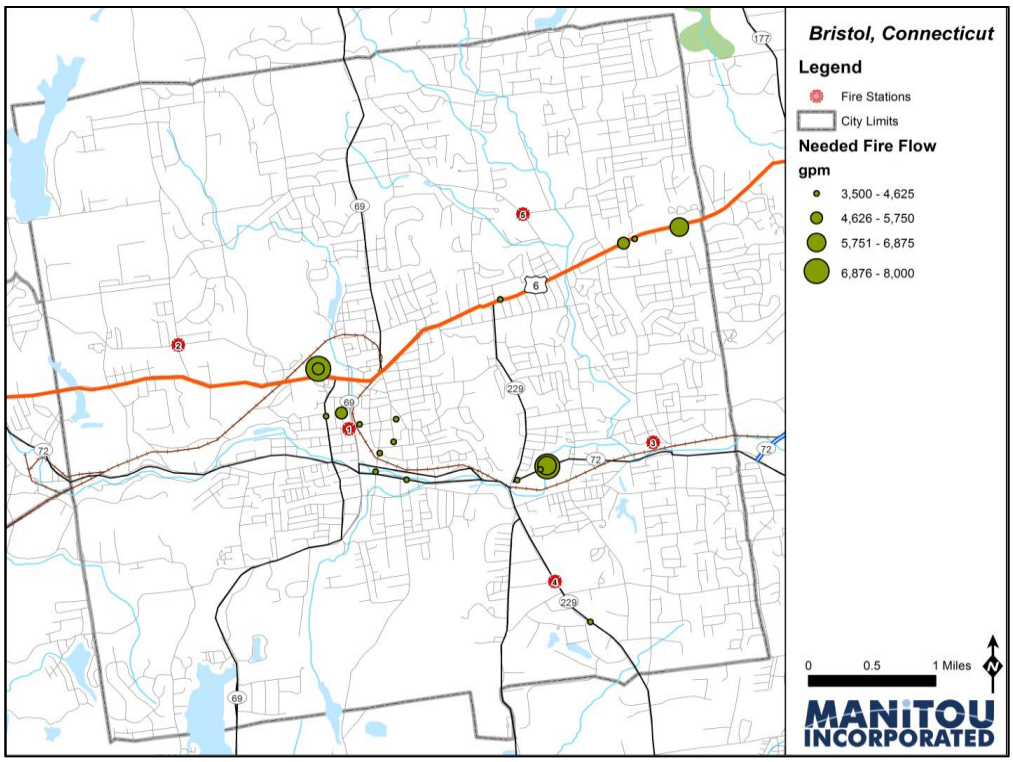


Figure 27: Number of Stories (Commercial Buildings)

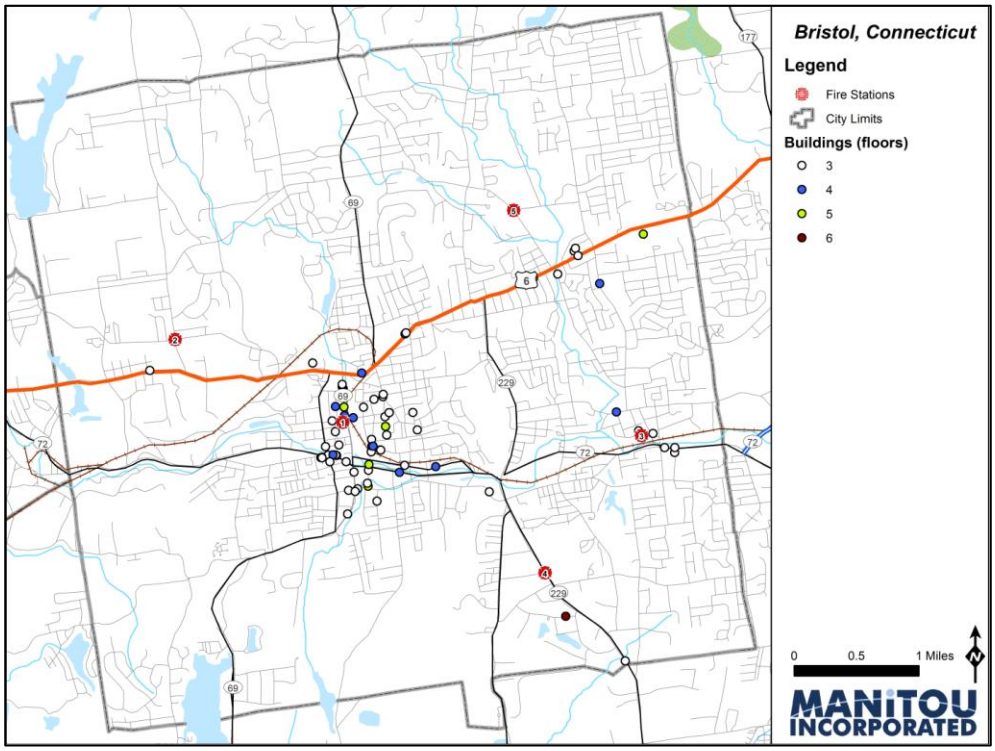
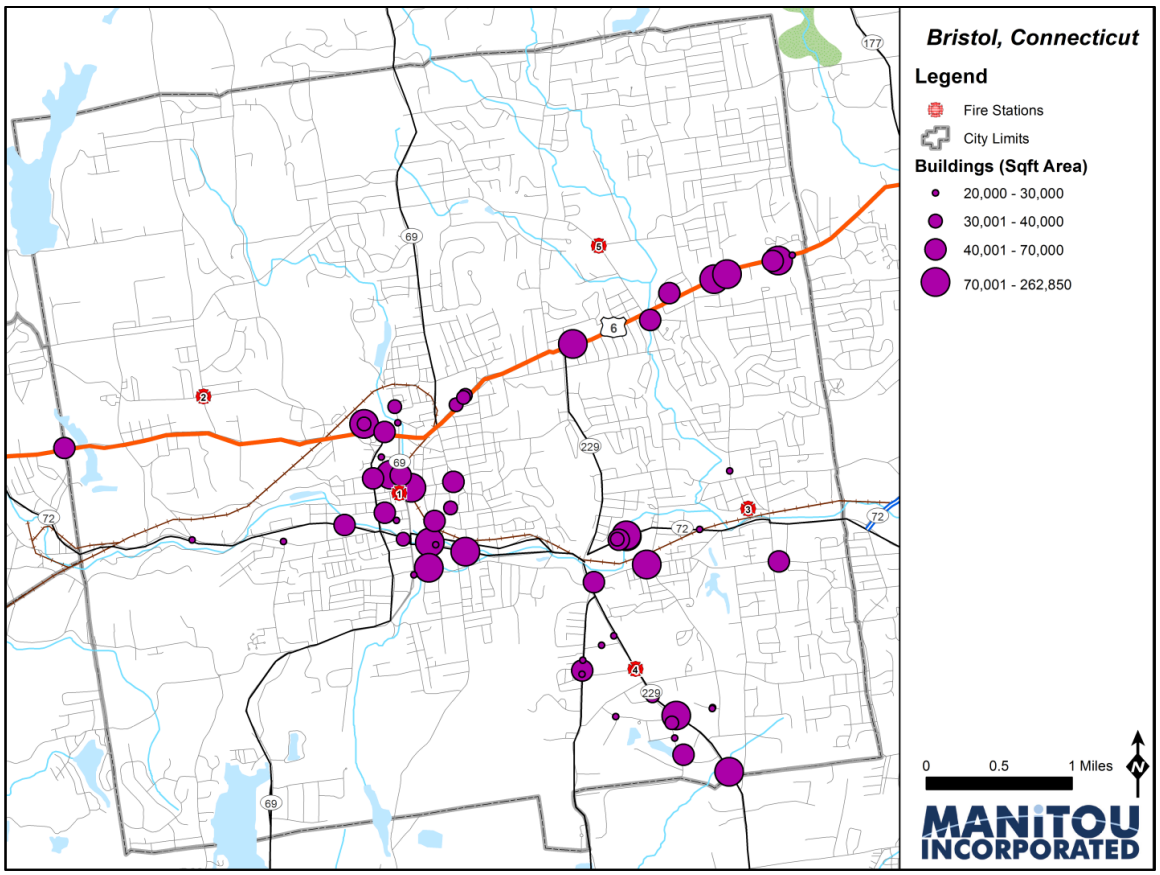


Figure 28: Square Footage of Building Ares (Commercial Buildings)

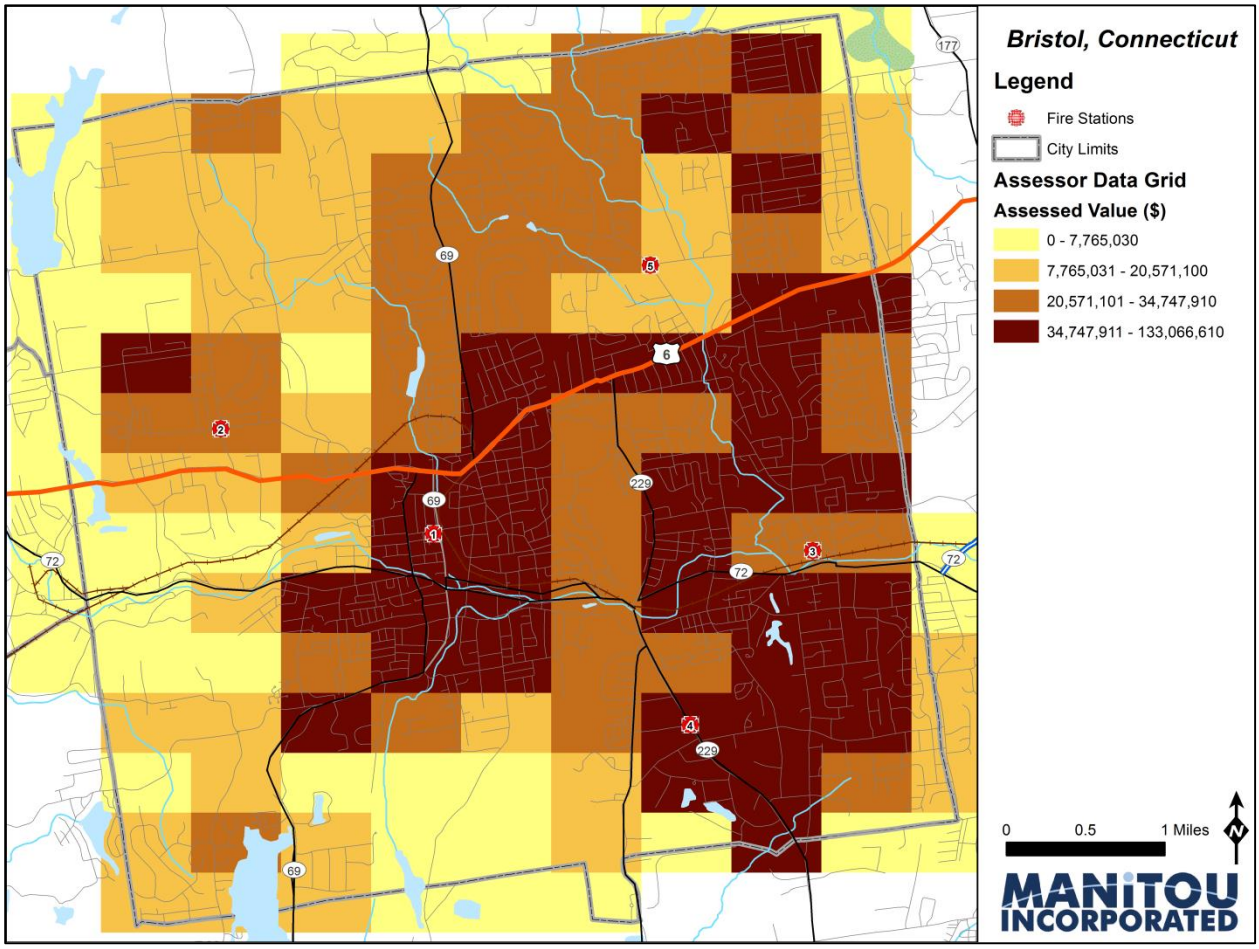


Ninety eight percent of the properties identified within Bristol by the ISO are within the first due apparatus travel time area. All of the properties, that are either 3 or more stories and/or greater than 20,000 square feet in space, are within the travel time model for a first due apparatus. The same holds true for the first alarm assembly area pictured in the preceding map. However, it appears that many properties are not listed, such as the Firestone complex north of station 2 and certain industrial complexes including some ESPN buildings.

Given the omission of known data in the ISO Needed Fire Flow Report, city data was acquired in the expectation that it would offer a more accurate representation of building stock. While the city has building footprint geographic data, it neglects critical attribute information such as use and number of floors (which determines total square footage). It can provide for the number of buildings but little else. Later in the report we will discuss the ISO Fire Suppression Rating Schedule as it relates to the Fire Department.

More detailed information was found in the Assessor property tabular database. The database addresses[17] were plotted on a map and then the information was placed into a previously empty database of the geographically represented assessor's grid provided by the Town. A property's assessed value is an important element in examining the general fiscal risk of an area and in relation to fire station coverage. Figure 29 represents the total assessed value of properties by individual assessor grid cell.

Figure 29: Assessed Value by Grid Area

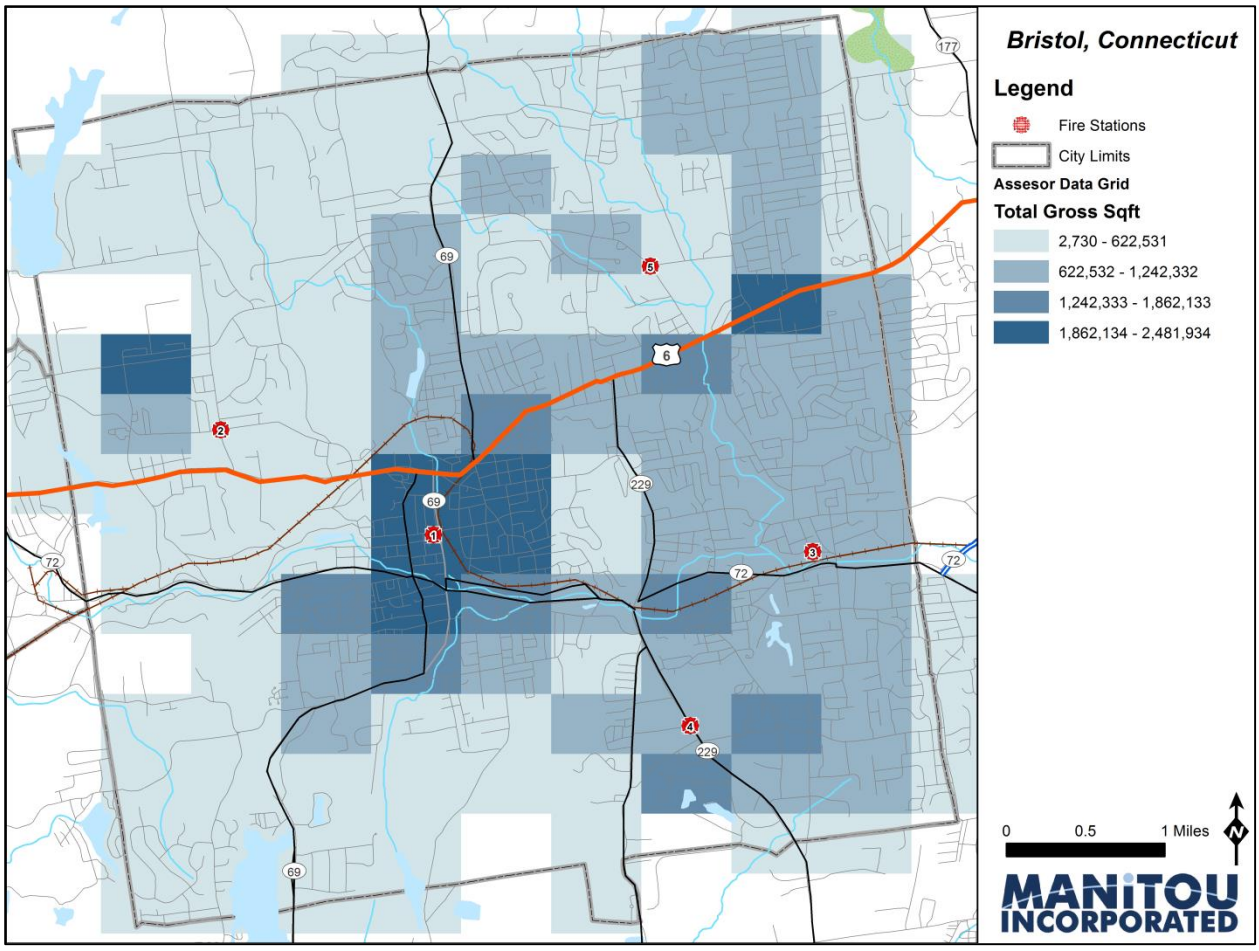


It can be seen that the fire stations are located in areas that have the highest assessed valuation. Specifically, first due engine apparatus can reach 72 percent of the total assessed value plotted, while 60 percent can be reached with a currently manned first alarm assembly force.

[17] If address is complete and matched street data, 92 percent were plotted.

The next illustration shows the location of areas (grid cells) and the amount of gross square footage according to assessor data. It can be seen that the largest amount of square footage is concentrated downtown and along the east side and southeast side of Town. The industrial complex and a new school near Station 2 provide a discontinuous area of higher square footage.

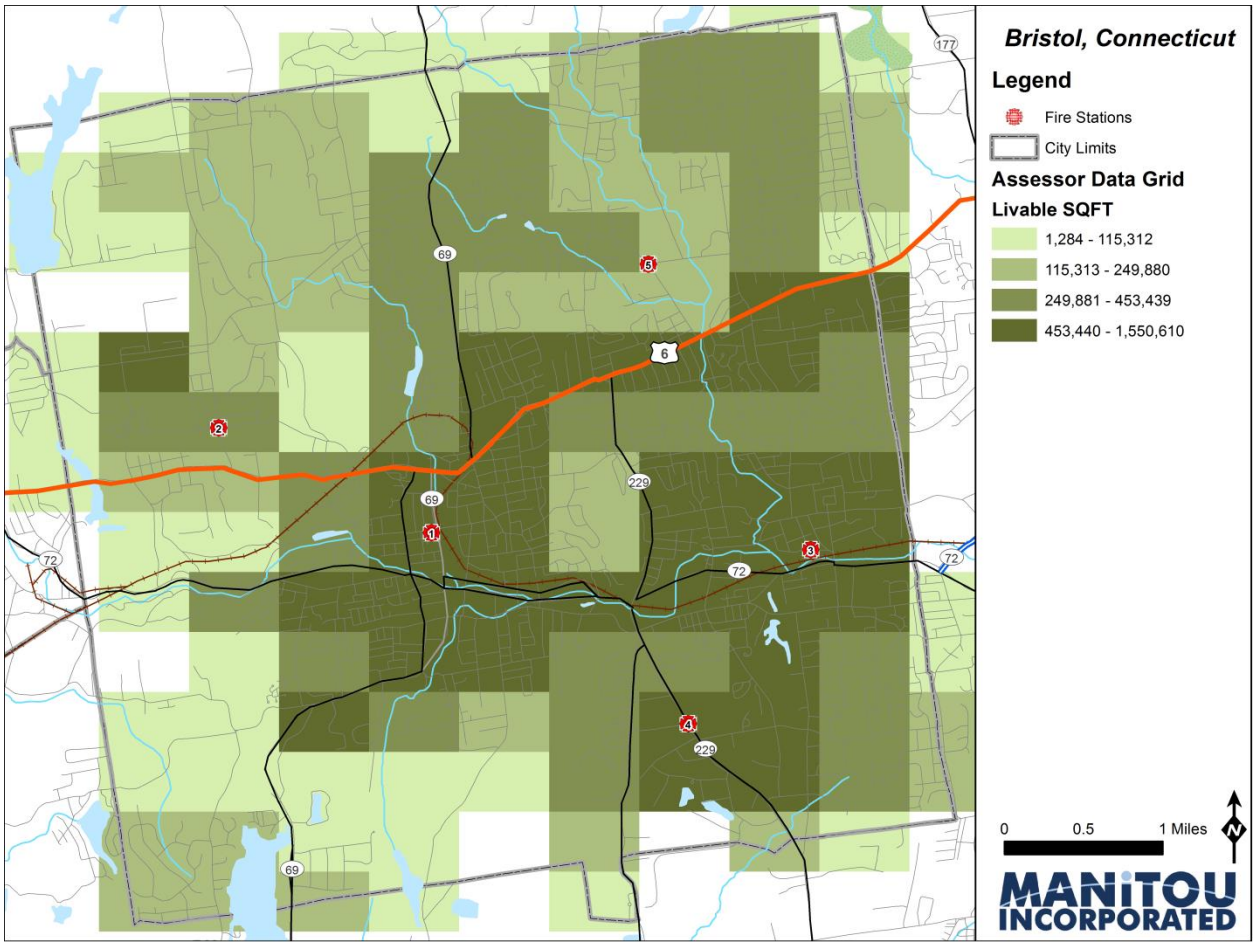
Figure 30: Total Square Footage of Built Area, Assessor's Data



The first responding engine can reach 73 percent of the buildings with gross square footage recorded in the assessor data within the travel time goal. For a first alarm assignment, 60 percent of the gross square footage can be reached within the time criteria.

Gross square footage includes many areas of a property that is not deemed "livable" such as attics, crawlspaces, sheds, overhangs, and garages. The following map limits the square footage totals to livable square feet total by assessor grid area.

Figure 31: Livable Square Footage, Assessor's Data



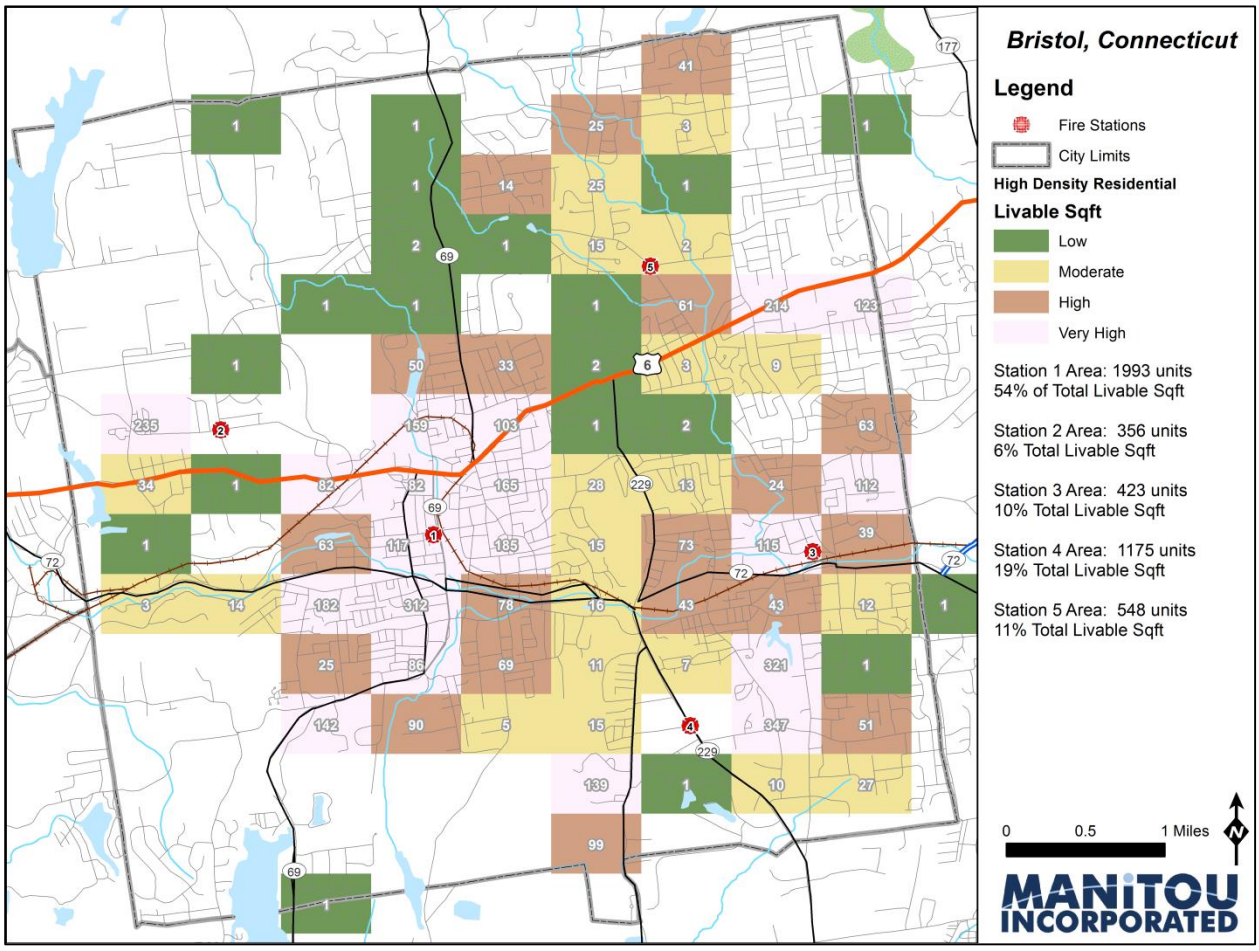
The first responding apparatus can reach 77 percent of the livable square footage. A full first alarm assembly can reach 60 percent of the livable square footage in the recommended time parameter.

Certain properties pose a higher risk for the loss of life, property, and commerce to a community. Certain properties deserve special attention, such as a major employer, large multi-family or multi-unit structures, and whose commerce is vital to the city,.

Like most communities, single family residential represents the greatest number of properties in the assessor database. Higher Density Housing, such as multi-family,

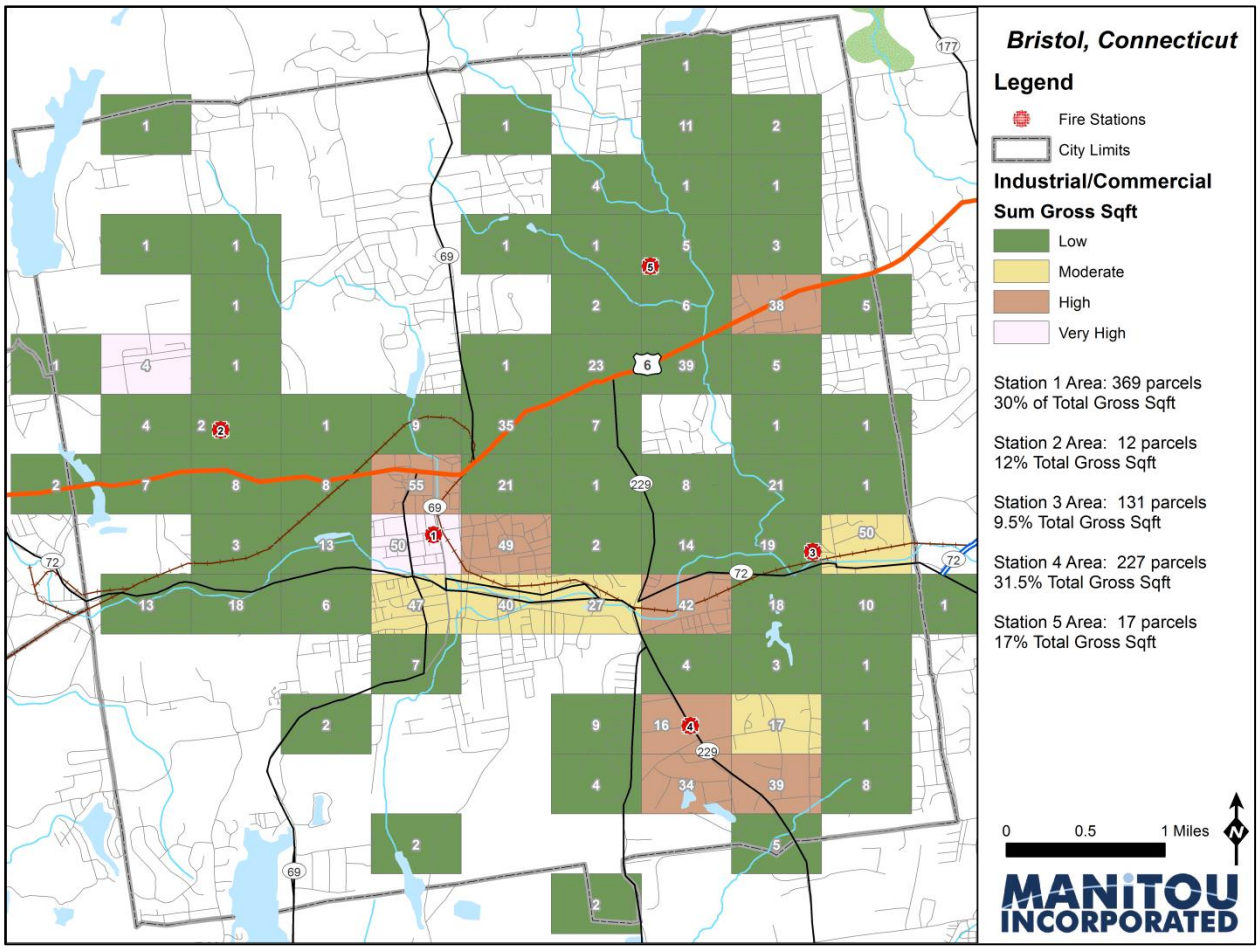
apartments, and condominums, pose a higher life and property loss risk than a single family home. The following map illustrates the amount of high density housing and livable square footage by assesor grid area.

Figure 32: Housing Density by Assessor Grid



The first responding apparatus can reach 91 percent of high-density housing within time goals. A first alarm assembly reaches 83 percent within nine minutes from dispatch. While it's not surprising that high-density housing is concentrated downtown, it is interesting that pockets of higher amounts of square footage dot the other station areas. Station 4 has a large share of high-density housing located in an area that has high industrial/commercial content much like Station 1 shown in Figure 33.

Figure 33: Industrial and Commercial Buildings by Assessor's Grid

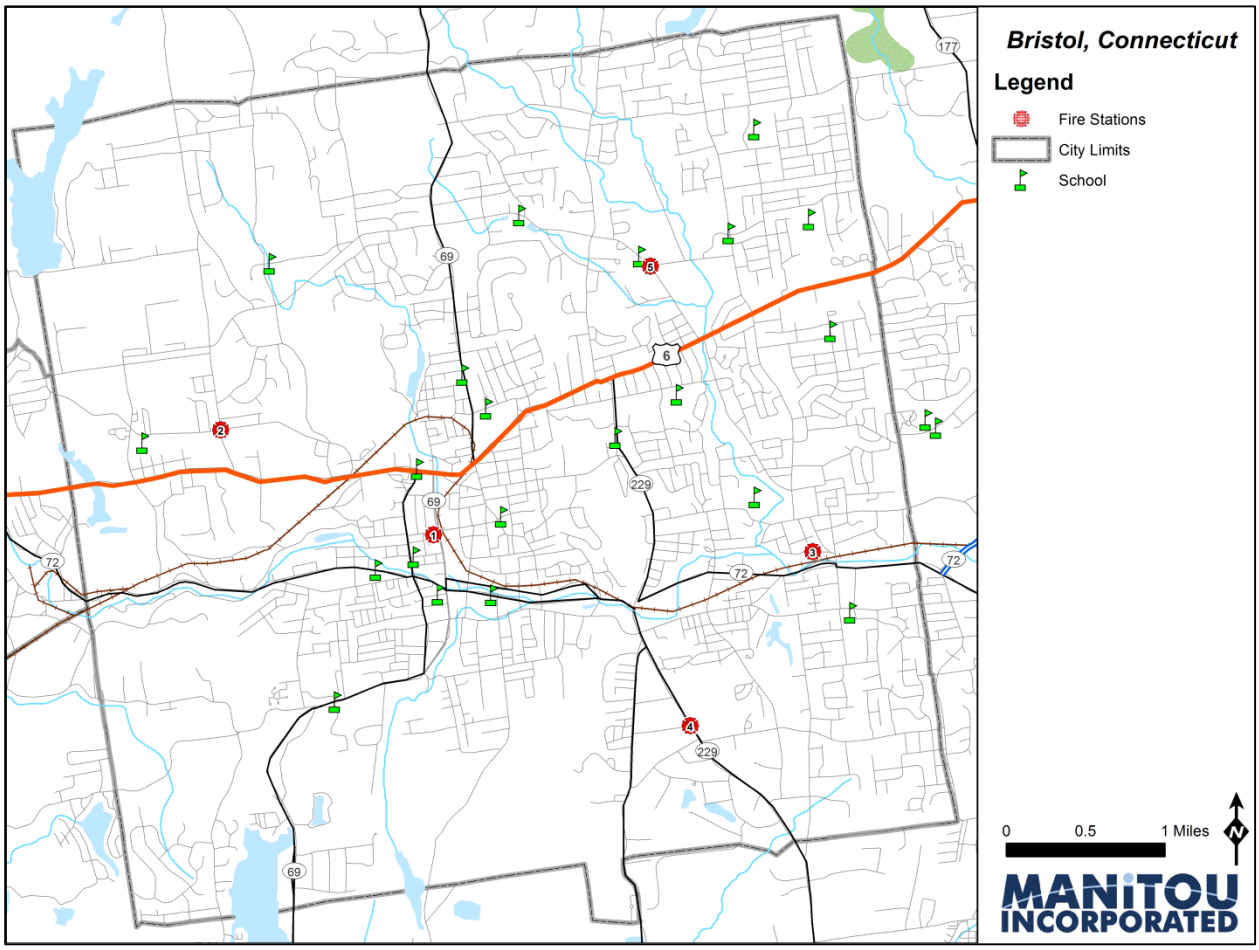


Note the high amount of square footage of industrial/Commercial complex just northeast of Station 2 matching the range for the downtown area. Note as well the higher concentration of industrial commercial properties near Station 4. Fortunately, over 90 percent of these properties can be reached by first responding and first alarm assembly apparatus within time objectives.

Schools

Certain institutions create micro-communities that bind a town together. A school building is an example, where the children of Bristol spend much of their day. Many parents converge at these centers for performances and sub-regional civic meetings. None of the Bristol schools are outside the time objective for the fire department travel time.

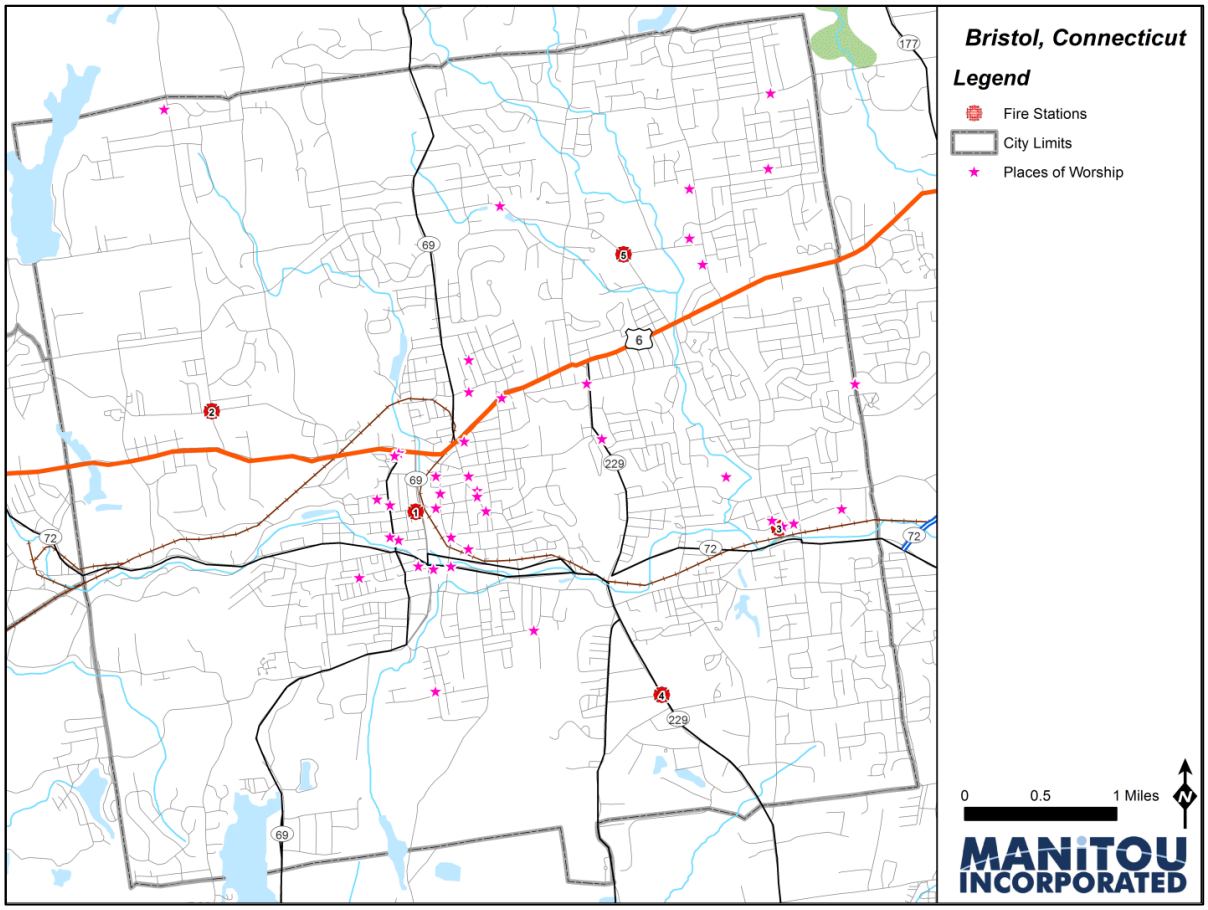
Figure 34: Schools Locations



Houses of Worship

Houses of Worship are also crucial community centers that forge relationships for City residents. Of the 40 religious buildings located in Bristol, only 4 were outside the fire department travel time goal reach. Religious buildings have special significance for the community, and often may be older and larger than other structures.

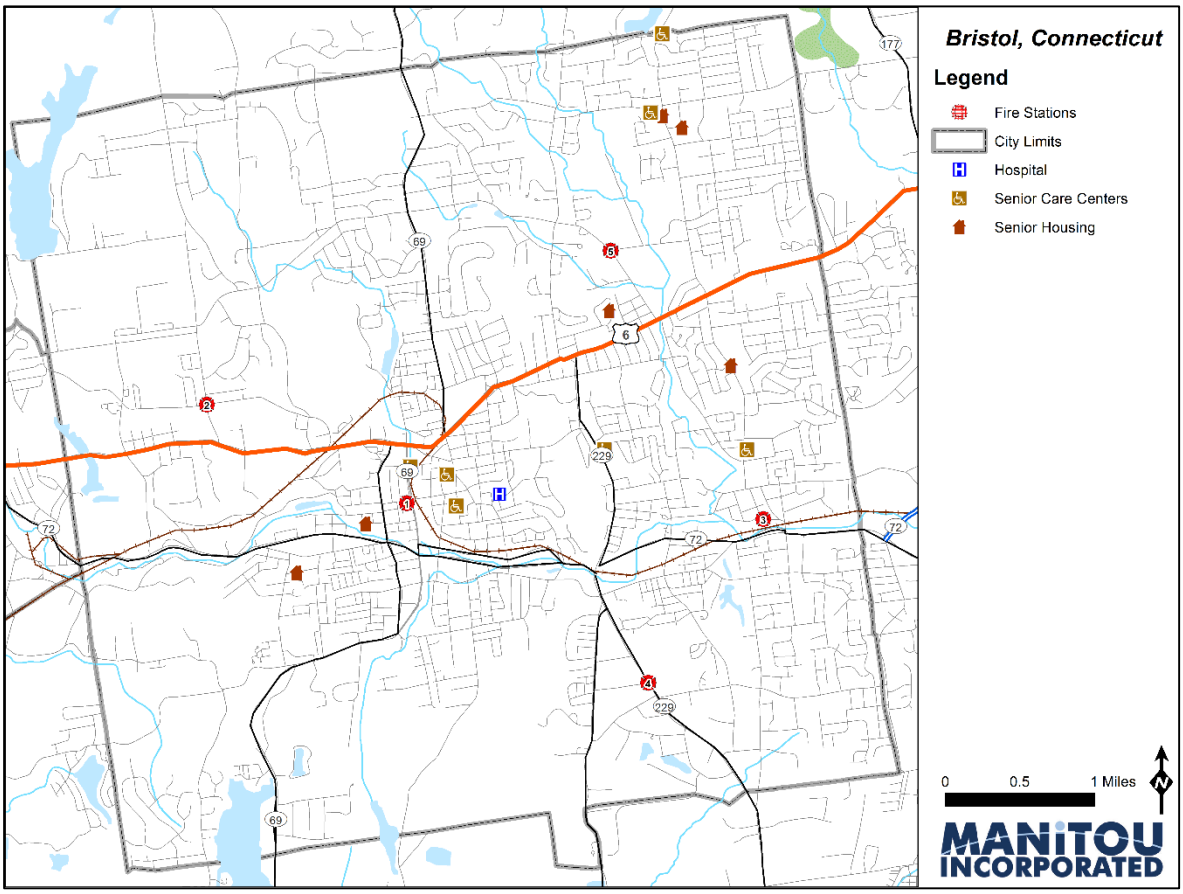
Figure 35: Houses of Worship



Senior Living & Medical Care Facilities

Those who are infirmed are especially vulnerable in the case of a fire; the same concerns can hold true for Senior and Age Restricted Housing. While living independently, some seniors can have mobility issues and not be able to move as quickly in the case of an emergency. This should be top of mind when firefighters are dispatched to these addresses. The assisted living facility north of Station 5 on the town border is outside the travel time goals for the fire department. The two age restricted developments, also north of Station 5, are reachable by the first response engine from that station. A full first alarm force will take slightly longer than the travel time criteria models given the current staffing of apparatus.

Figure 36: Senior Living and Medical Facilities



Cultural Assets

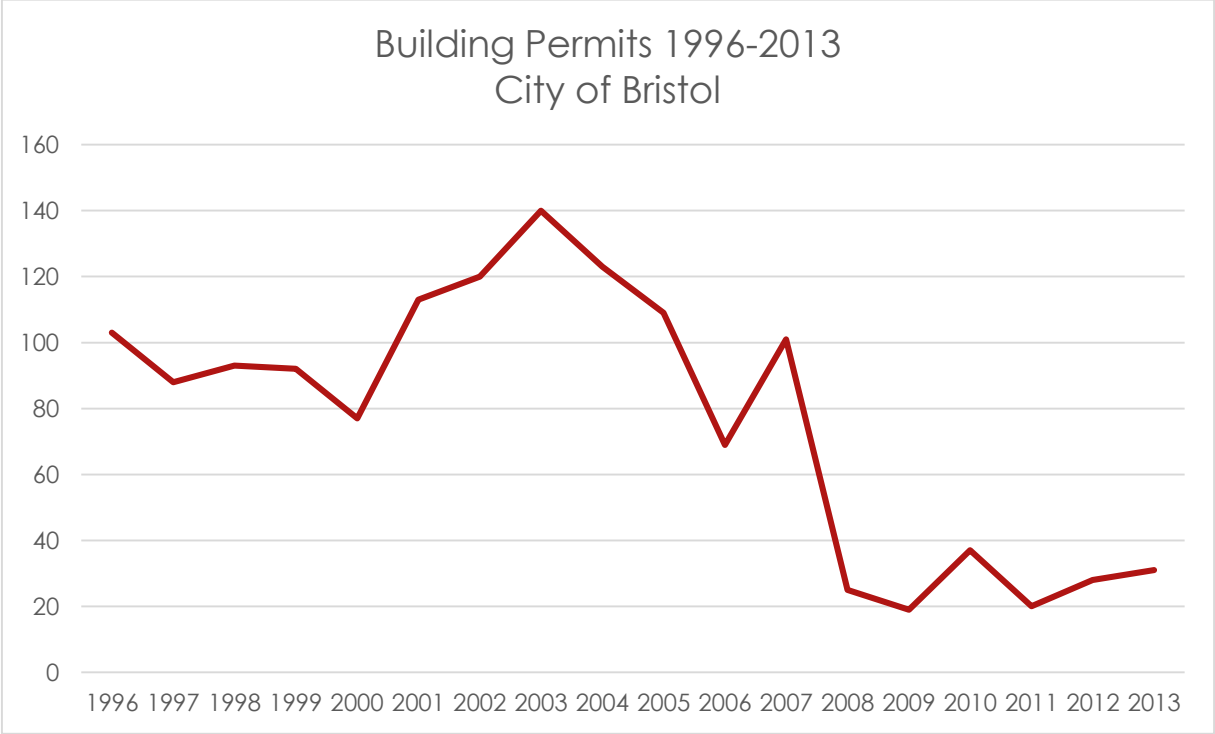
In any community, certain buildings, areas, and venues provide a source of civic pride as they help set it apart from other regional centers. These are often valued with protective historic status or promoted for tourism. These are important resources that, if lost, would shake the core of the community. In Bristol, its past in the manufacture of timepieces is preserved in the American Clock & Watch Museum, located in a wooden historic structure very near downtown. Also nearby is the New England Carousel museum, located in a former factory building. Restored carousels, that provided joy to many in yesteryear, share space with the Bristol Fire History museum and the Greek Culture museum. Other ethnic civic clubs are located near downtown. The older areas of Federal Hill and Forestville contain stately homes with distinctive architecture. On the south side of town in the outcropping of the town limits, the oldest continually operated amusement

park, Lake Compounce, provides an enjoyable respite to many in the region. Fortunately, all of these are within the travel time goals of responding fire apparatus.

Planned Development

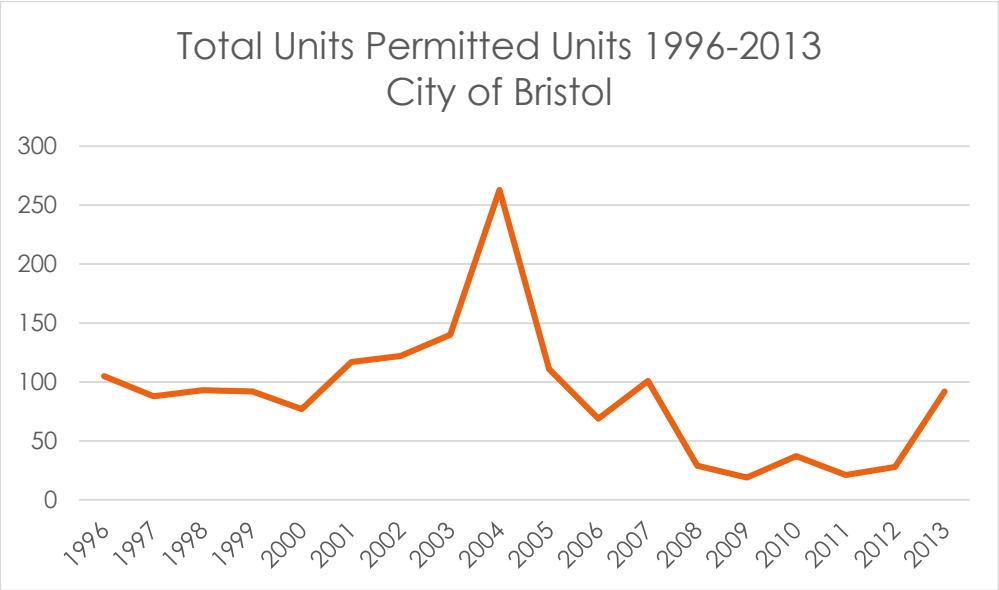
We reviewed building permit data to gain an understanding of patterns in new construction within the City. Figure 37 below shows census data on the number of building permits issued from 1996-2013. The effect of the national economic slowdown in 2008 is apparent. The number of permits is slowly rising since 2011, but still well below earlier numbers. The number of permits does not indicate the number of housing units being constructed, as a permit can be for a single-family dwelling or an apartment complex.

Figure 37: Building Permits 1996-2013



In Figure 38, we show the total number of housing units covered by permits. Although the pattern tracks with the number of permits, we see that in the last few years, the number of permits for multi-unit developments has increased as a share of the total permits.

Figure 38: Number of Housing Units Proposed, 1996-2013



A meeting with the Bristol Planning Department yielded the following perspective. Little change in new residential and commercial development is expected in the Town, with one exception, the downtown Depot Square development. The Depot Square plan may spur nearby infill development including former commercial and academic building conversions to residential projects. The depot development is downtown across from City Hall as well as the Police and Fire Headquarters. It is slated to have 1,000 residential units, over 73,000 sq. ft. of retail space, a 9 story office building, and a 125 room, 9 story hotel. While phase one, including the office and hotel towers, has been approved, new tenants aren't expected until 2016 or later.

A critical aspect for this project is the return of commuter rail service to Bristol after a 50-year hiatus. This would provide an attractive amenity for commuting residents to the project given that it is located on the tracks across from Main Street. The fire department needs to carefully evaluate the street width and access to all building exposures when approving further phases of the project. Narrow streets and underpasses as planned should accommodate large fire apparatus and their turning radii.

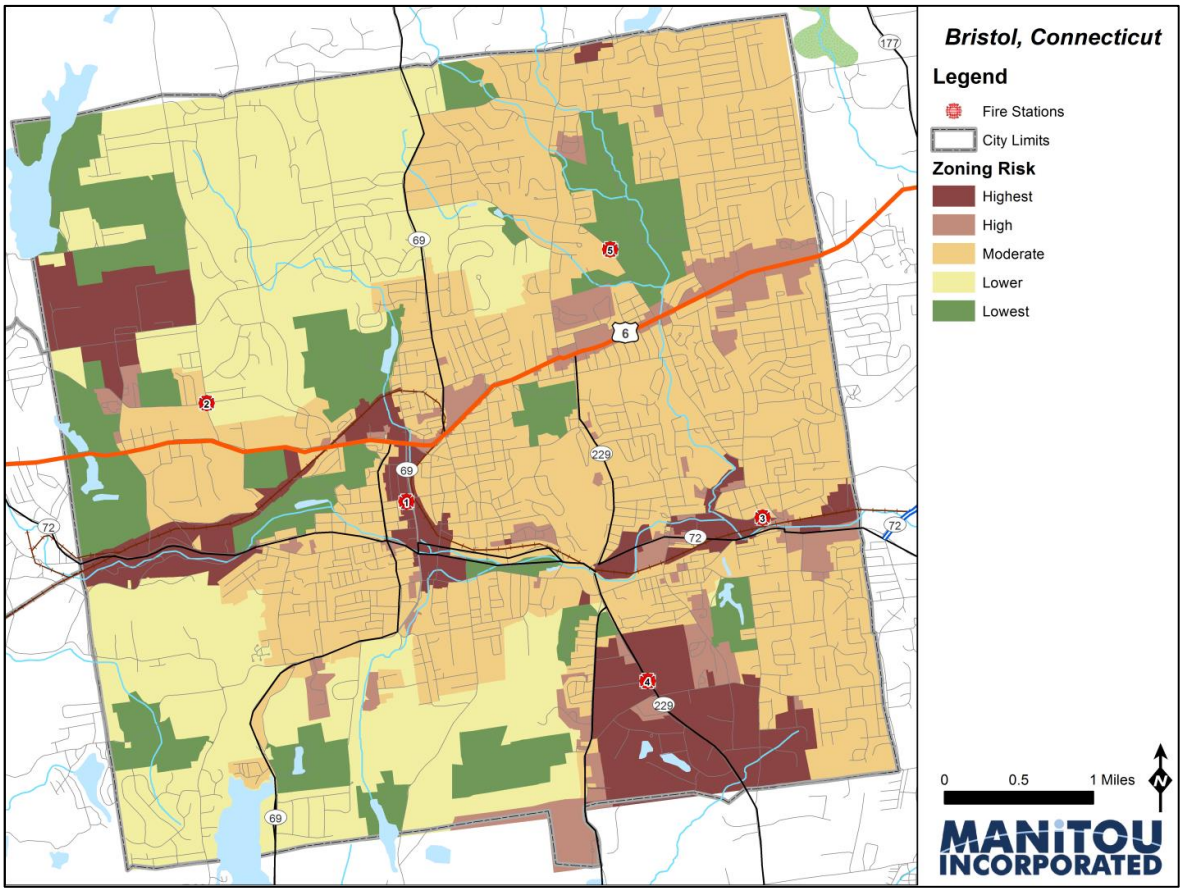
No new streets or bridge replacement were communicated during the meeting with planning officials. Route 6 is being widened on the east end and this should aid the fire apparatus getting around traffic and turning left from Stafford Avenue. On the southeast

side of town, ESPN is renovating an existing building and constructing a new dining facility on its sprawling campus. The Bristol Hospital, located for decades on Federal Hill, continues to expand its facility to serve the region.

Without much on the "radar" this may not last forever. The City has adopted a general zoning ordinance that describes not only current development but also permissible types in an area. These adopted general zoning types have been categorized in relative risk to the community using the following guidelines

1. Highest - Refineries, large industry, hospitals, school dormitories, lumber yards, and propane storage facilities without built-in suppression or detection systems;
2. High - High-rise hotels and residential buildings, large shopping centers, and industrial complexes;
3. Medium - Commercial and industrial facilities with sprinkler systems, small shopping centers, and high-density, medium density residential buildings;
4. Low – Lower density Single-family dwellings
5. Minimum - Wide separation of single-family dwellings and farm land.

Figure 39: Zoning versus Risk



As seen in the previous maps, there are exceptions to the general zoning permitted in an area. A good example is the hospital located in a primarily zoned residential area. Again, these approximations are very crude, and do not account for the full range of factors that determine risk, and are weighted toward needed fire flows and occupancy.

Summary

The building risk within Bristol is widespread. Fortunately, the placement of the fire stations provides for a quick first response by an engine company and reasonable coverage by a first alarm assembly given the current staffing structure. In addition, in most of the community outside the downtown, buildings are spaced sufficiently that risk of fire spread between structures is not a major concern.

The Bristol Fire Service

The Bristol Fire Department (BFD), a career (paid), municipally supported operation, services the City of Bristol. The Fire Department's operations consist of five (5) districts, covered by five (5) firehouses.

The Fire Department responds to emergency and non-emergency incidents via calls made to a civilian dispatch center, which serves the needs of police, fire, and EMS operations.

Firehouse software licensed by ACS is used for assignment of staffing, tracking of training activities for certification of fire fighters, reporting of incident responses consistent with NFIRS standards, storage of building-specific data (e.g. egress, hazmat, etc.), and fire inspection activities. The Firehouse software is integrated with the dispatch software for incident responses.

Fire vehicles communicate via a Motorola 800 MHz trunked system, which includes microwave signaling via designated microwave broadcast locations. Each fire vehicle is equipped with a ruggedized laptop, communicating to network applications via VPN connection for building, MSDS, and NFIRS data.

All fire fighters are certified in accordance with standards set forth by the National Incident Management System ("NIMS"). All are certified in CPR and all attend an annual blood-borne pathogen class. Eighty percent are certified Medical Response Technicians, 12 percent are certified as Emergency Response Technicians or paramedics, and 8 percent are certified in First Aid. A full-time training officer is maintained within the department and operates the training center, stationed at Engine 4.

The Bristol Fire Department does not handle emergency medical services treatment or transport, which is provided by a separate service. They do provide rescue assistance and support for the emergency medical services, but not as a primary responding agency.

The Bristol Fire Service has an organizational statement which formalizes its:

- Reasons for Existence
- Identifies basic organization
- Identifies type, amount, and frequency of training provided
- Identifies the number of fire department members
- Identifies the functions that the fire department performs.

This is a well-executed document, known as the *Bristol Fire Department Organizational Statement,* which is included in the Appendices.

The Department's mission statement is:

> The Bristol Fire Department is a full service fire service organization providing leadership in the community, continually striving to exceed expectations, valued by the citizens it protects and by its employees.
>
> The mission of the Bristol Fire Department is to protect the lives and property of the citizens of Bristol by immediate response to all emergencies, rapid mitigation of all fires, protection from hazardous materials, competent application of life saving techniques, and to provide fire prevention and public education programs to improve the quality of life of the citizens we serve.

Station 1 / Headquarters / Maintenance (Figure 40)

Figure 40

This four bay drive-through station was built in 1961 and sits centrally downtown. An unmanned rescue truck with extrication equipment also shares the bay space. A pontoon rescue boat is also stored here. The maintenance bay is very narrow and does not have a lift for more extensive work. Administrative and watch offices are on the lower floor adjacent to the bays while the crew quarters occupies the upper level.

In this area, downtown commercial and high-density residential areas are nestled with the hospital, museums, and industrial buildings. The 9 and 7 story Gaylord and Kennedy Housing Buildings are located several blocks from this station. The Main Street railroad trestle does not permit access by the Tower apparatus, but street connectivity allows for alternate routing without a time issue.

Station 2 (Figure 41)

Figure 41

This two bay drive through station was built in 1968. Located at Hill and Matthews Streets, it is expandable by virtue of city owned property next door. However, it could be considered an historic property, which could block expansion plans. It is located in the northwest part of town near a large industrial complex and a new school.

Station 3 (Figure 42)

Figure 42

Built in 1961, its design is copied by the rest of the stations. It sits on a parcel with no room for expansion except to add floors. This type of fire station is not drive through so backing in impedes traffic. Exiting the station has good site lines despite being on a slight curve. A small johnboat for occasional flooding is stored within this station. The Thiess Tower is a multi-story industrial structure along the Pequabuck River nearby.

Station 4 / Training (Figure 43)

Figure 43

Mimicking Station 3's design, this 1964 structure lies in the industrial southeast part of town that also has high-density housing.

Nearby are the ESPN Headquarters, the amusement Park, a 6-story hotel, and the sprawling public works facility. Emerging from the landscape is the Otis Elevator test tower and the exhaust tower for the refuse incinerator. Located on a side street accessing the busy Middle Street, this station could benefit from a dedicated traffic control signal.

The training division has one small classroom and limited training grounds that need updating. Due to space limitations, rescue trailers are kept outside the station. Fortunately many of the station's deficiencies will be rectified by plans to expand the station.

Station 5 (Figure 44)

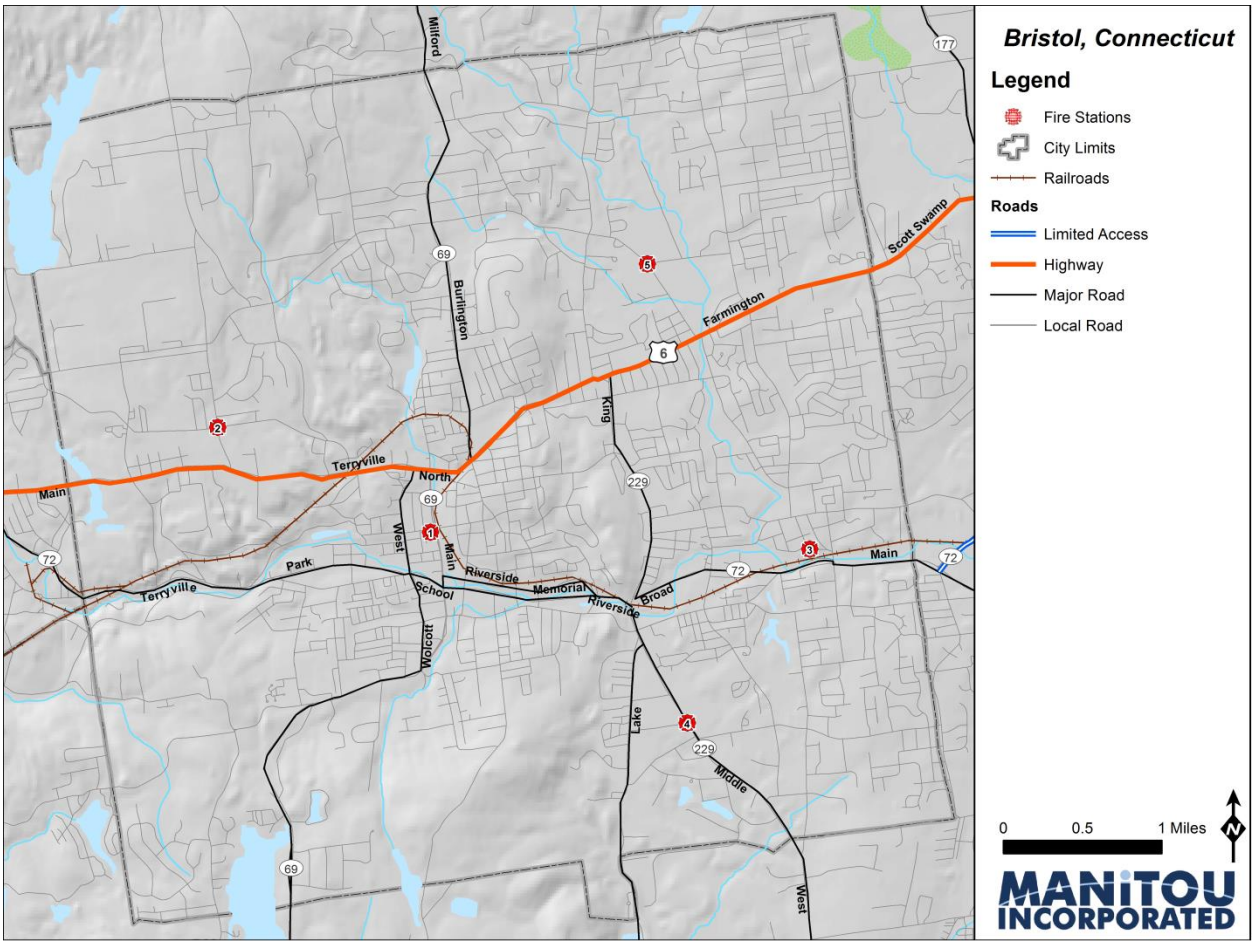
Figure 44

This station, built in 1964, is located in the Town's northeast area on Mix Street near the ball field complex. While there is slight room to expand southward, it could also be expanded by adding a floor above. They experience some difficulty turning right from the station due to the three way stop that stacks traffic near the front of the station. During large public events, this traffic worsens especially as patrons park along roadways. While there is occasional flooding in the area, this station does not have room for a boat.

Staffing Configuration

This section will examine the Bristol Fire Department's deployment, risks, and performance in delivering emergency services within the city through its five fire stations. The following map displays the locations of the fire stations relative to the City area and roadway network (Figure 45).

Figure 45: BFD Fire Station Locations



All of the fire stations have 3 person crews to operate an Engine-type apparatus. Station 1 has a 4-man crew that is assigned to aerial ladder truck type apparatus. The Deputy Chief on duty also responds from Station 1 which doubles as Fire Headquarters. It can also be seen in the previous map that terrain of the city involves ridges near waterways and along the east side of Route 229. Throughout the city, steep slopes along the street network can create a slower response when climbing and treacherous conditions in either direction during winter weather.

Response Time Capability

The response time of fire and EMS apparatus to the scene of an emergency incident is an essential factor that determines the magnitude of the fire or medical emergency. It

has been proven that the shorter the response time, the smaller the fire that must be extinguished and the better opportunity for paramedics to save critical patients.

The National Fire Protection Association's (NFPA) 1710 is a guideline that serves as a benchmark for the deployment of services offered by firefighters. It is a widely accepted goal for paid/career fire departments and describes the requirements for delivery of services, response capabilities, incident management, and strategy.

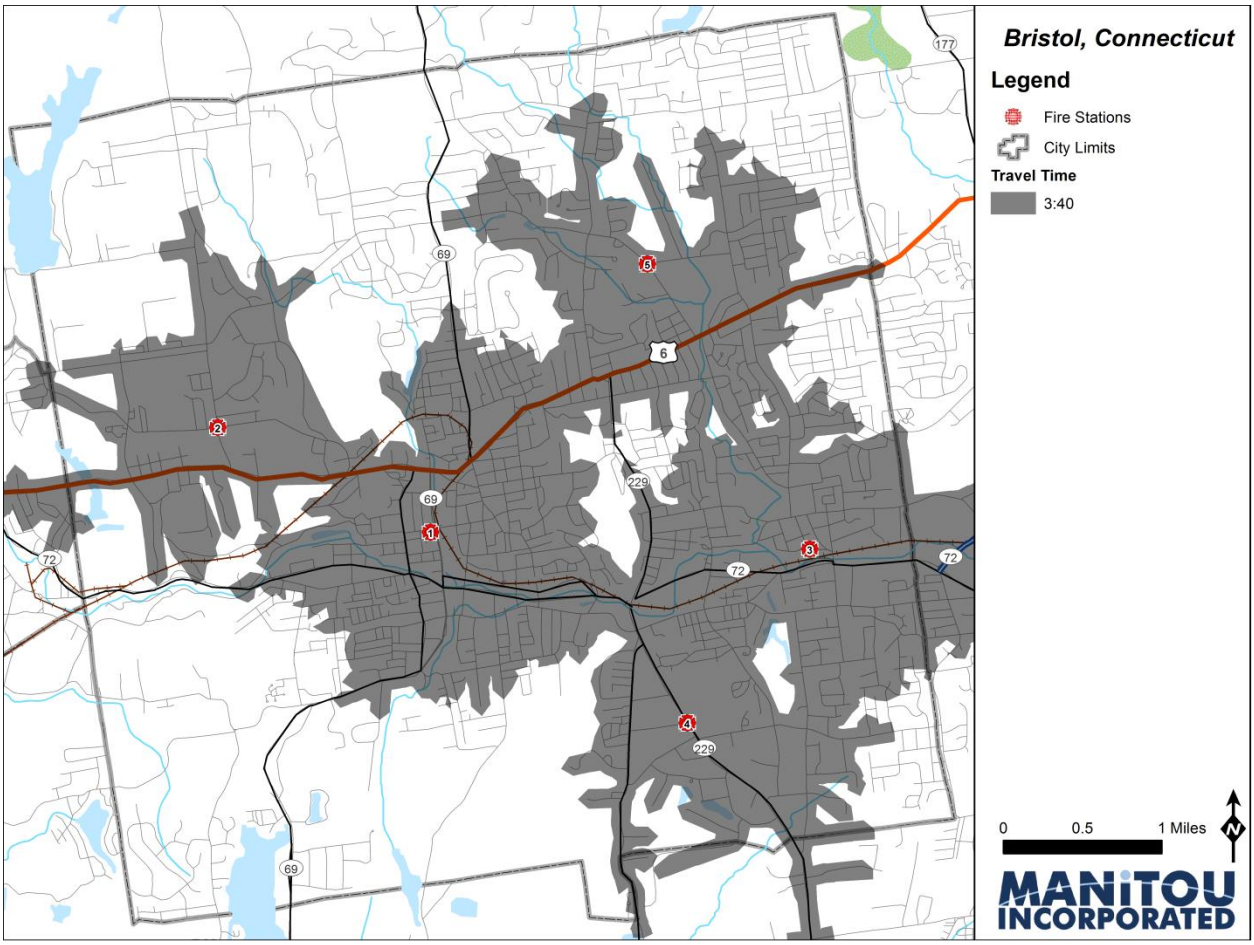
It includes the following benchmarks related to call receipt and processing time, turnout time, and response (travel) time:

- Turnout time of eighty seconds on fire suppression calls and sixty seconds for EMS calls.
- The fire department's fire suppression resources deployed to provide for the arrival of an engine company within a four-minute travel time and/or the initial full alarm assignment within an eight-minute response time to 90 percent of the incidents.
- A fire department's EMS basic life support (BLS) resources with automatic defibrillator equipment deployed to provide for the arrival of a BLS unit (EMS first responder or transport unit) within a four-minute travel time; and,
- A fire department's EMS resources providing advanced life support (ALS) service deployed to provide for the arrival of an ALS company within an eight-minute travel time to 90 percent of the incidents. BFD does not provide BLS or ALS services. Bristol Fire Department does not provide either BLS or ALS services, nor does it routinely respond as medical first responders.

Not all requests for services to the fire department ought to be construed as requiring apparatus to respond emergently or within the short time constraints. These should be limited to the critical emergencies in which they were designed.

The following map models the travel time of apparatus from each of the current fire stations. The model utilizes the street network of the City and surrounding areas calculating the travel time extent via distance and speed capability of streets. Actual posted speed limits were utilized and time penalties were assessed for negotiating turns and intersections. This model assumes departure from the fire stations, which may not always be the case. It also does not take into account weather conditions, traffic congestion, construction, or detours. It does respect the one-way restrictions as they are in place.

Figure 46: BFD First-Due Travel Times 3:40

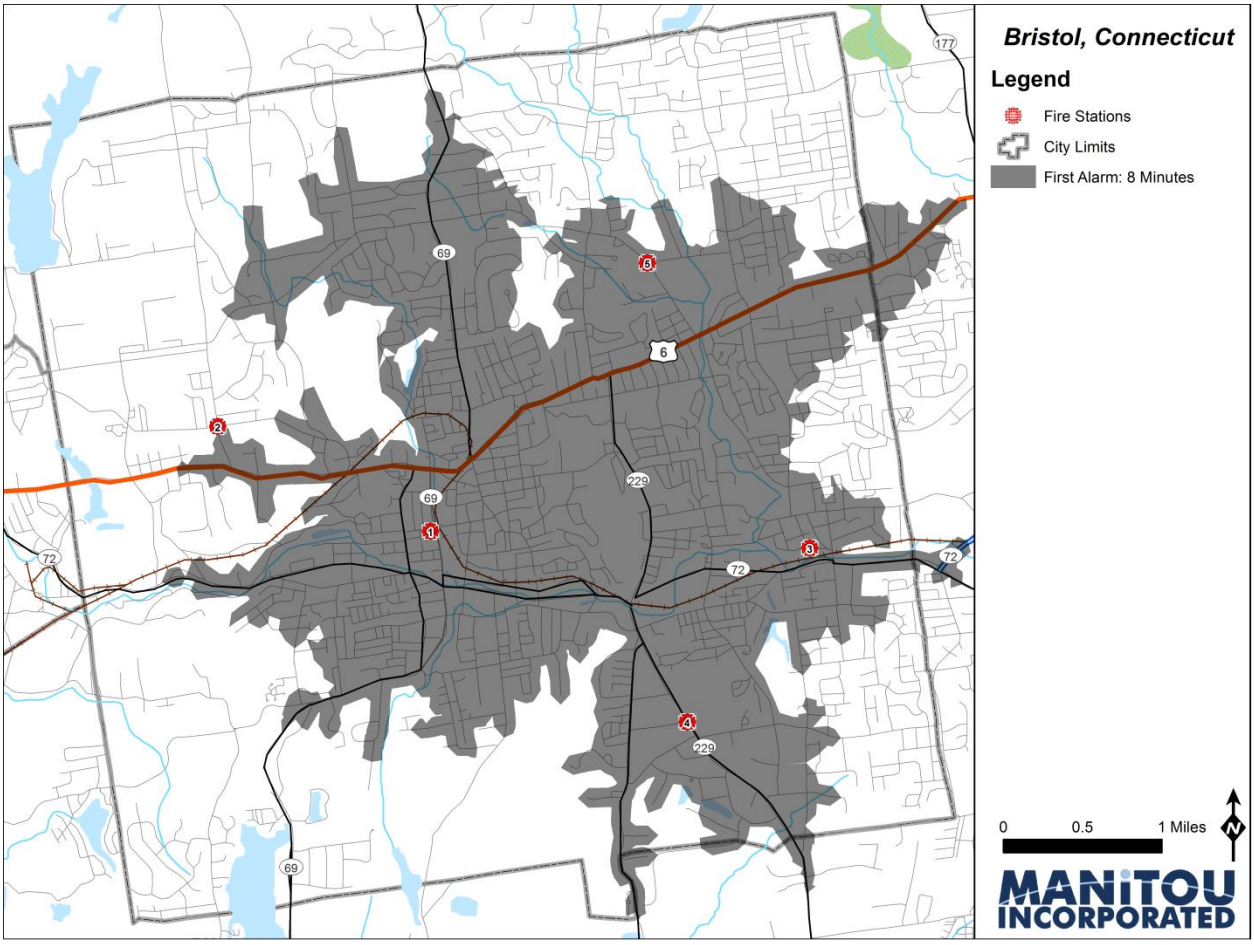


The preceding figure (Figure 46) represents the capability and geographic extent when responding to the most critical of incidents. Certain areas of town will require slightly more time to reach than those areas that are naturally closer and roadway accessible to the existing fire stations.

It can also be seen that there could be some coverage overlap of the travel time between the stations. While this may seem wasteful, it has to be taken into consideration that fire calls usually do not typically require a single apparatus response. Multiple apparatus from many stations are standard firefighting procedure. It calls for the arrival of the entire initial assignment (sufficient apparatus and personnel to effectively combat a fire based on its level of risk) within a certain amount of time. The Bristol Fire Department has established a first alarm for structure fires as a collective initial response of the on-duty deputy chief, three engines, and one ladder truck for the *initial* report of a structure fire.

This provides 14 firefighters given the current staffing. It is recommended by the NFPA that a force of 12 to 15 firefighters be assembled for a first alarm attack of a structure fire.[18] The following map illustrates the geographic extent of first alarm coverage by the BFD within a collective response time of 8 minutes (Figure 47).

Figure 47: BFD Full Complement within 8 Minutes



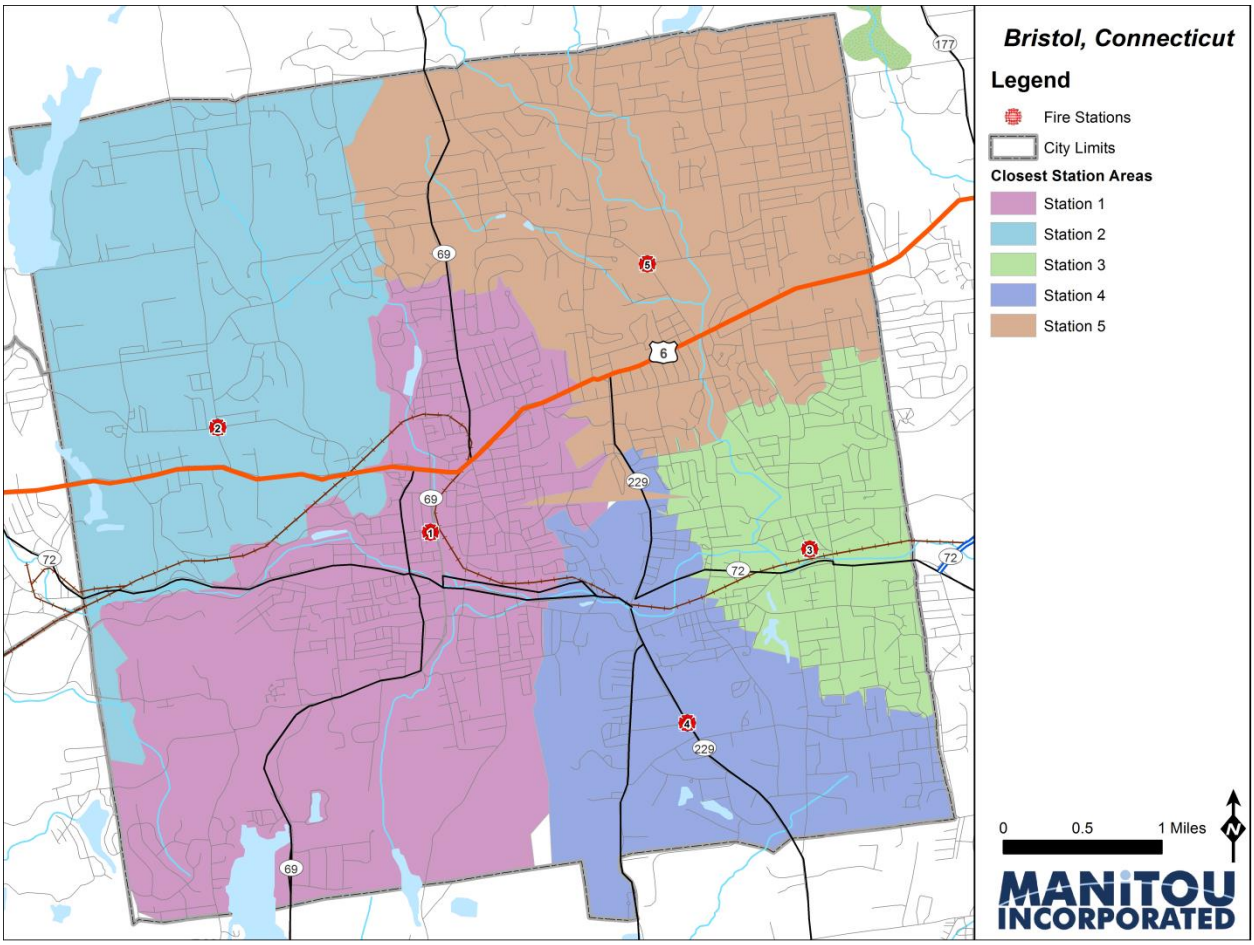
While much of the City's developed core is covered within the effective fire force time parameters, including the industrialized area of Station 4, the Firestone complex north of Station 2 is outside the coverage area.

Because help closest to an incident has more time to mitigate the situation, the fire department has a dispatch order based upon certain streets. It is not clear how the order methodology was developed. Nonetheless, the following map illustrates the closest

[18] The Insurance Services Office (ISO) and NFPA differ on whether the chief officer is counted as part of initial staffing. The NFPA includes the on-duty chief, while the ISO does not.

station areas based upon a modeled "race" pitting one station's apparatus against another. Where they meet on a roadway becomes part of the division line that ought to separate the first due apparatus assignments (Figure 48).

Figure 48: Engine Company First-Due Areas (by Drive Time)

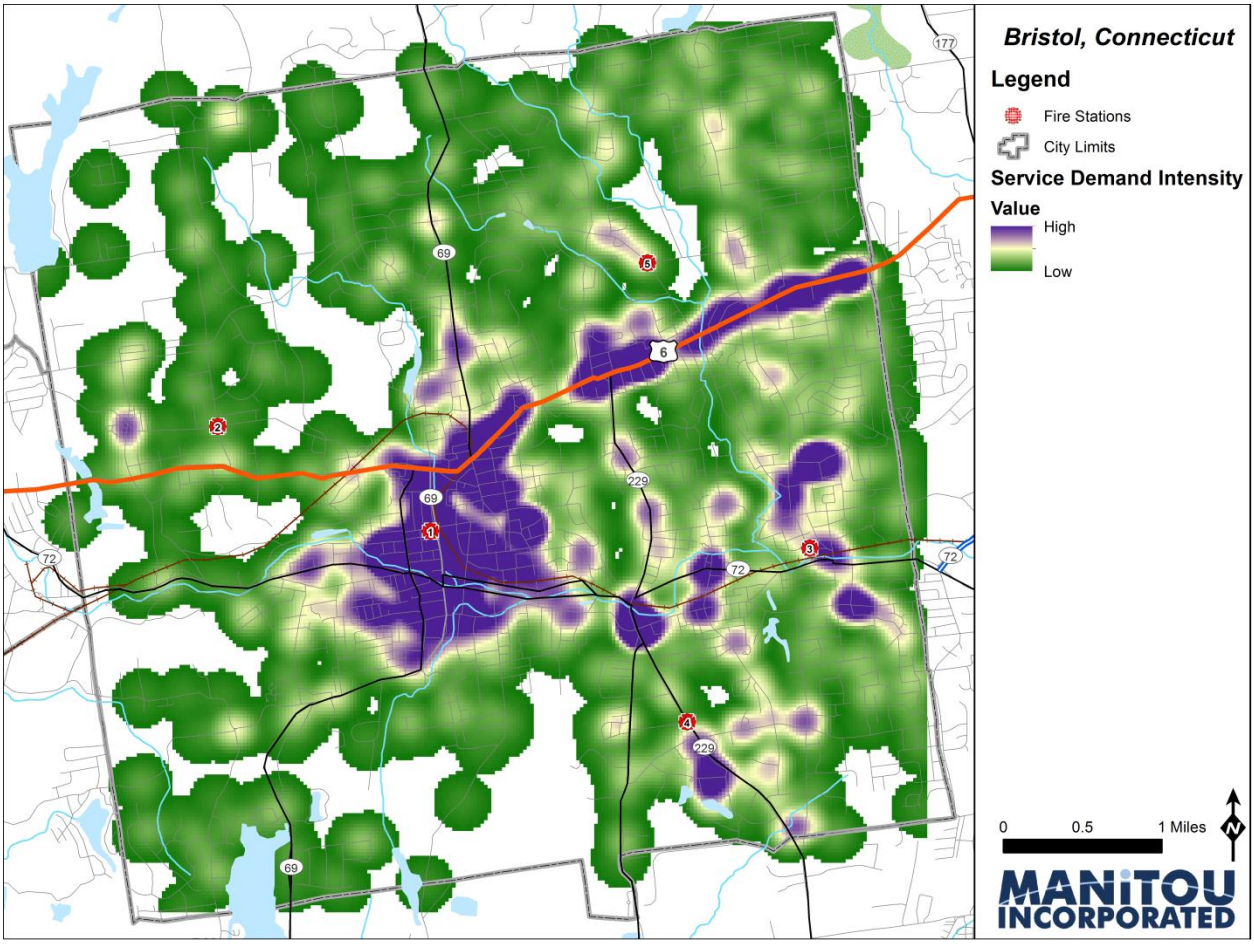


Current Workload Risk

Demand for the services of the fire department range from medical incidents, to rescues, to trees down on wires, to calls for trapped people or animals. Demand is not typically distributed evenly within an area. There are areas where incident calls occur frequently and near each other as well as other places where demand is less intense and the occurrence is further from each other. Service demand is typically higher in areas of higher population, not just residential but as offices and shopping centers fill with people.

The following map (Figure 49) illustrates the level of demand for Bristol Fire Department services over the last year and into March of 2014.

Figure 49: Intensity of Calls for Service



The amount of demand that can be reached within travel time parameters is of vital importance in evaluating the current station locations. Comparing the travel time model capability against the demand for services, it was found that 85 percent of all calls were within a recommended drive time. The most critical dispatch for fire apparatus is that of a reported fire. Isolating these reported fire dispatches (NFIRS [19] Code 100 series) compared to the modeled travel time reveals that 87 percent of reported fires are reached within the first alarm travel model. One measure was to look at the calls that had an amount of property or content dollar loss identified and whether there was an

[19] National Fire Incident Reporting System

actual fire when dispatched. Over 85 percent of these calls were within the current first alarm travel model.

Records of incidents within the City of Bristol were acquired from the fire department's records management system. The following graph illustrates the change in volume over the past four years for categories of reported fire, medical and all other categories of incidents (alarm, hazard, spill, etc.). Although data was provided back to 2004, an examination revealed missing data prior to 2010 and therefore excluded. Otherwise, it was assumed complete as provided by the City.

Table 14: BFD Calls for Service by Type, 2010-2013

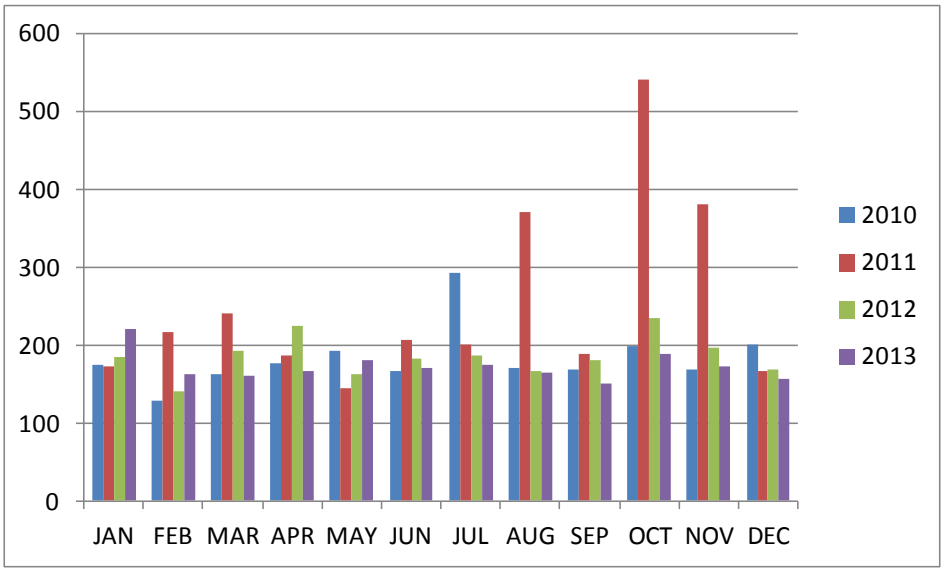
	2010	2011	2012	2013
Fire	242	245	271	218
Overpressure	4	5	3	6
Rescue, Medical	79	105	97	46
Haz.Cond.	874	868	715	672
Service	418	672	480	459
Good Intent	217	311	263	247
False Alarm	365	446	389	414
Weather	3	360	3	1
Special/Other		1	1	2

The terminology used in the NFIRS database will be summarized briefly here. Fire is self-explanatory; overpressure rupture and explosion are incidents such as a breach of a tank or other vessel or other emergency caused by a release of pressure, usually from a gas under pressure. Rescue and emergency medical service incidents include ambulance calls as well as technical rescues of persons trapped, searches, or removal of people injured from automobile or other accidents. Hazardous conditions are those circumstances in which the fire service responds to secure a situation, typically downed power wires, or a gas leak in a building. Service calls represent assistance, often of a non-emergency nature, to the public or other agencies including lockouts, or assistance with specialized equipment. Good intent calls are reports of emergency, made in good faith, which are found to be false or not as initially reported. An example of this would include condensation from a clothes dryer vent being mistaken for smoke. False alarm and false

call include both activation of automatic alarm systems, as well as malicious or intentional reports of fire or other emergencies made to the fire service. Severe weather, self-explanatory, and special incident types are reserved for incidents not classified above.

It can be seen that most calls do not involve actual firefighting but mitigating a wide variety of emergencies, less serious incidents, and citizen concerns. Fire calls are approximately 10 percent while Hazardous Condition calls account on average for just over 32 percent. Examining the data more closely, changes in demand can be seen on a monthly basis. The next graph (Figure 50) illustrates that service demand for all types of calls is slightly higher in the summer months.

Figure 50: Incidents per Month, 2010-2013

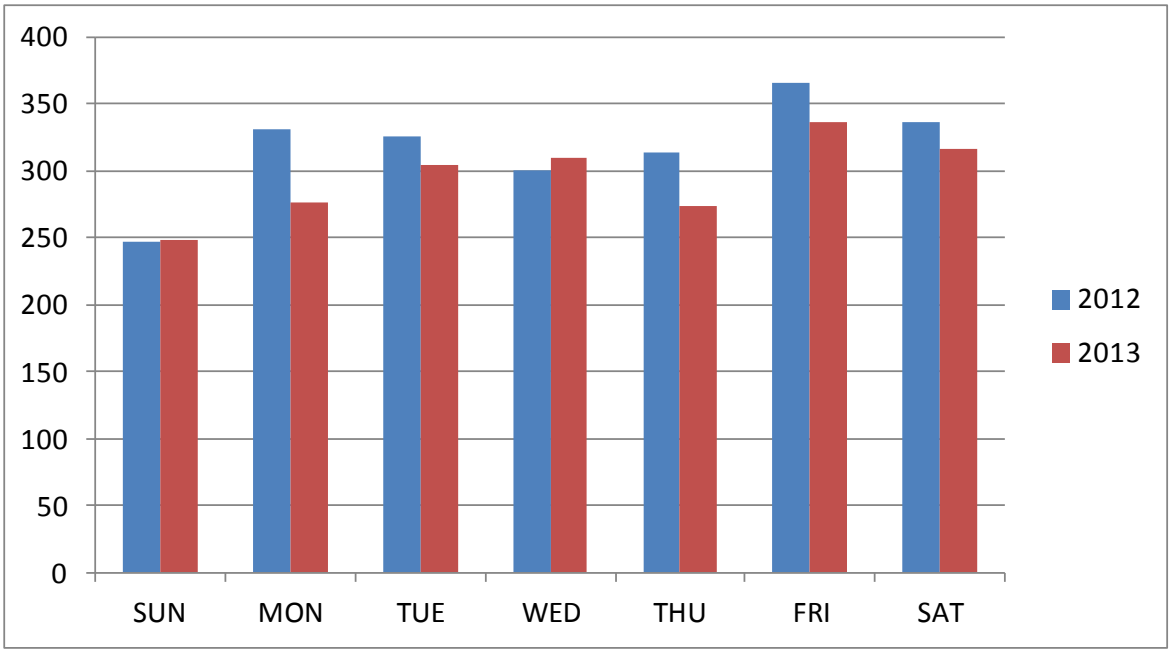


It can be discerned from the previous two charts that anomalous events had occurred to increase the demand upon the Fire Department in 2010 and in 2011. In July of 2010, Bristol experienced a tornado event. In August of 2011, Hurricane Irene's path went south to north, west of the Bristol area. Later in the fall, on Halloween, a nor'easter produced record snowfall and winds in excess of 60 mph that caused numerous power outages. A year later, Hurricane Sandy had less effect as it veered east into the Jersey Shore, sparing Connecticut the worst of its damage. These events serve as a reminder that resources

not utilized on a day-to-day operation will be employed, and at times, overwhelmed in a disaster situation.

Examining the department service demand by the day of the week reveals that Fridays and Saturdays are the busiest days of the week for the fire department over the last two full years[20]. Demand for services are least numerous on Sundays as observed in the following chart (Figure 51).

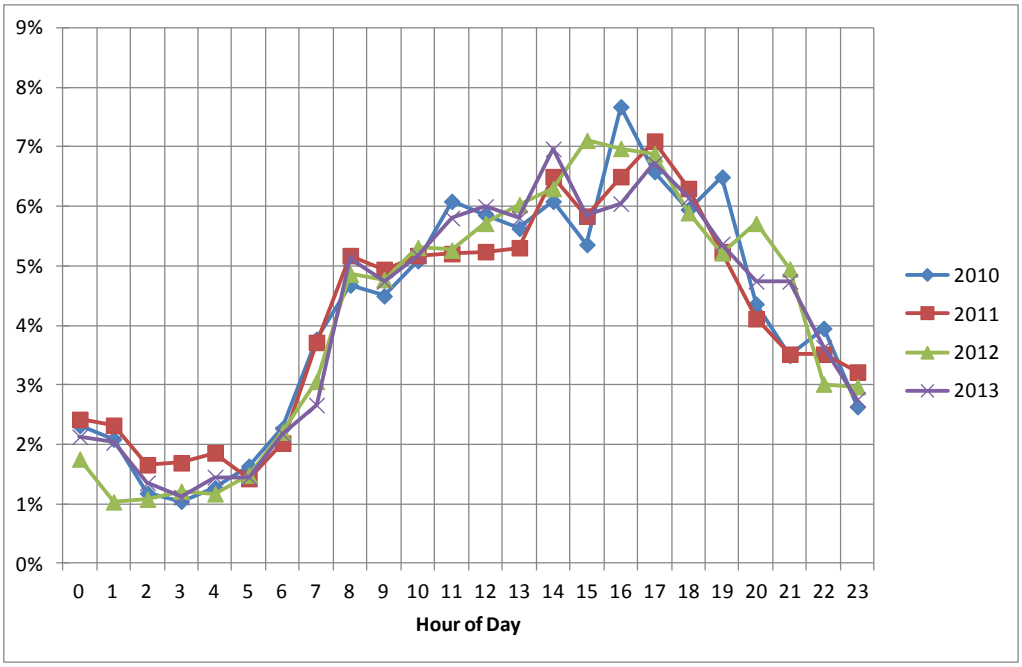
Figure 51: Demand for Service by Day of Week



Next, the workload is examined on an hourly basis displayed as a *percentage of total volume* because of the weather events in the previous figures. It can be seen in the following graph that service demand for the fire department increases with daytime human activity. Not surprisingly therefore, demand volume surges beginning at 5 AM and remains high until after 5 PM, when it steadily declines.

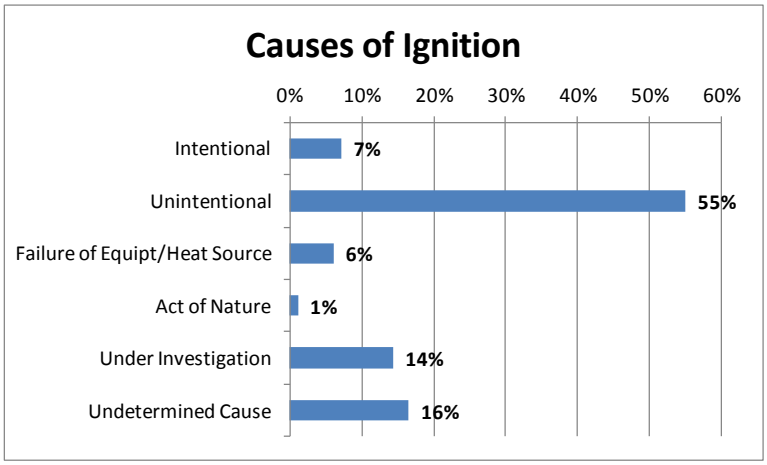
[20] 2010 and 2011 removed due to skewed results from weather events described earlier

Figure 52: Demand for Service by Hour of Day



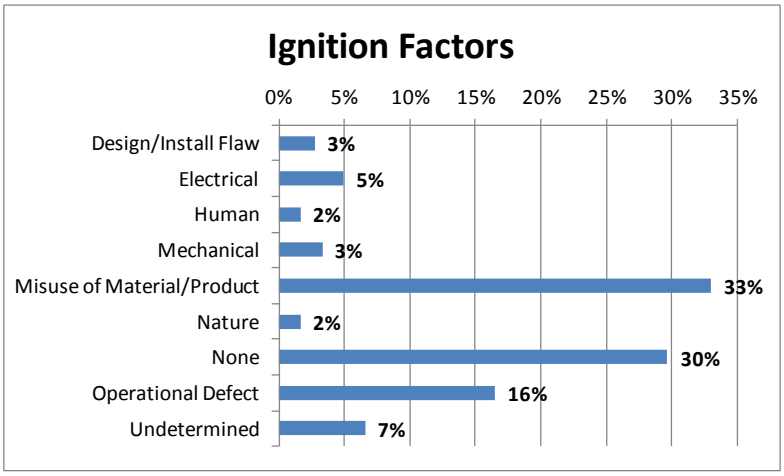
Records from the Bristol Fire Departments submissions to the National Fire Incident Reporting System (NFIRS), that are also sent to the State Fire Marshal, were analyzed for building fire causes for the years 2010-2013. Certain codes are entered by the fire department software user (fire captain, etc.) that detail the causes of fire, in this case of structure fires, which cause the largest property and content loss. Approximately 65 percent of the database did not have codes entered. The first graph that follows expresses the general cause of the fire.

Figure 53: Cause of Ignition of Structure Fires



The vast majority of structure fires that have occurred in Bristol have been deemed unintentional. Twenty percent are either undeterminable or continue under investigation. The resources and staff of the Fire Marshal should be adequate to reduce these cases to a much smaller percentage as insurance repayments depend upon their investigative results. In cases where more are found intentional, increased criminal prosecution and prevention of arson can be achieved. Based upon the codes entered in the database, the next figure details the contributing factors that allowed the heat source and combustible material to combine to ignite the fire.

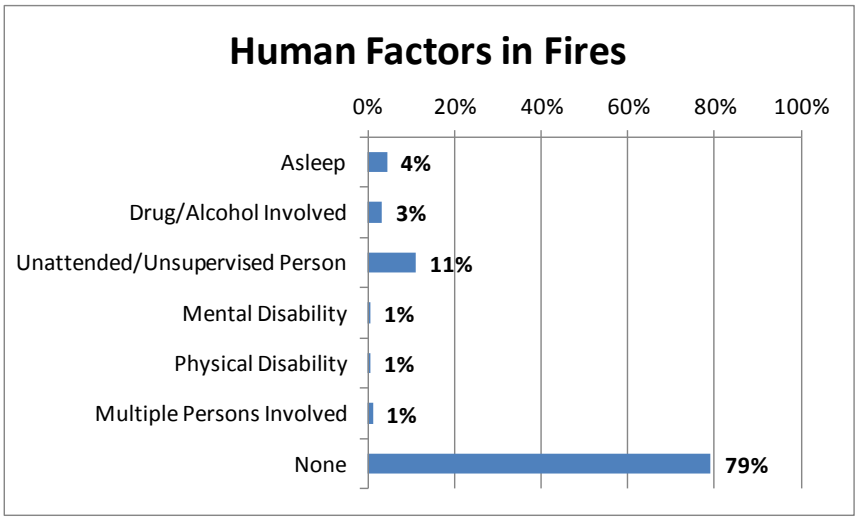
Figure 54: Ignition Factors for Structure Fires



When there was a contributing factor, overwhelmingly it was the misuse of a material or a product (such as a cigarette, frying pan, or candle to name a few) that contributed to the cause of a fire. Usually this is caused by human activity (or inactivity) that allows the

contributing factors to ignite. The next chart indicates the type of human activity that the fire department has coded as responsible for a fire condition.

Figure 55: Human Factors in Structure Fires

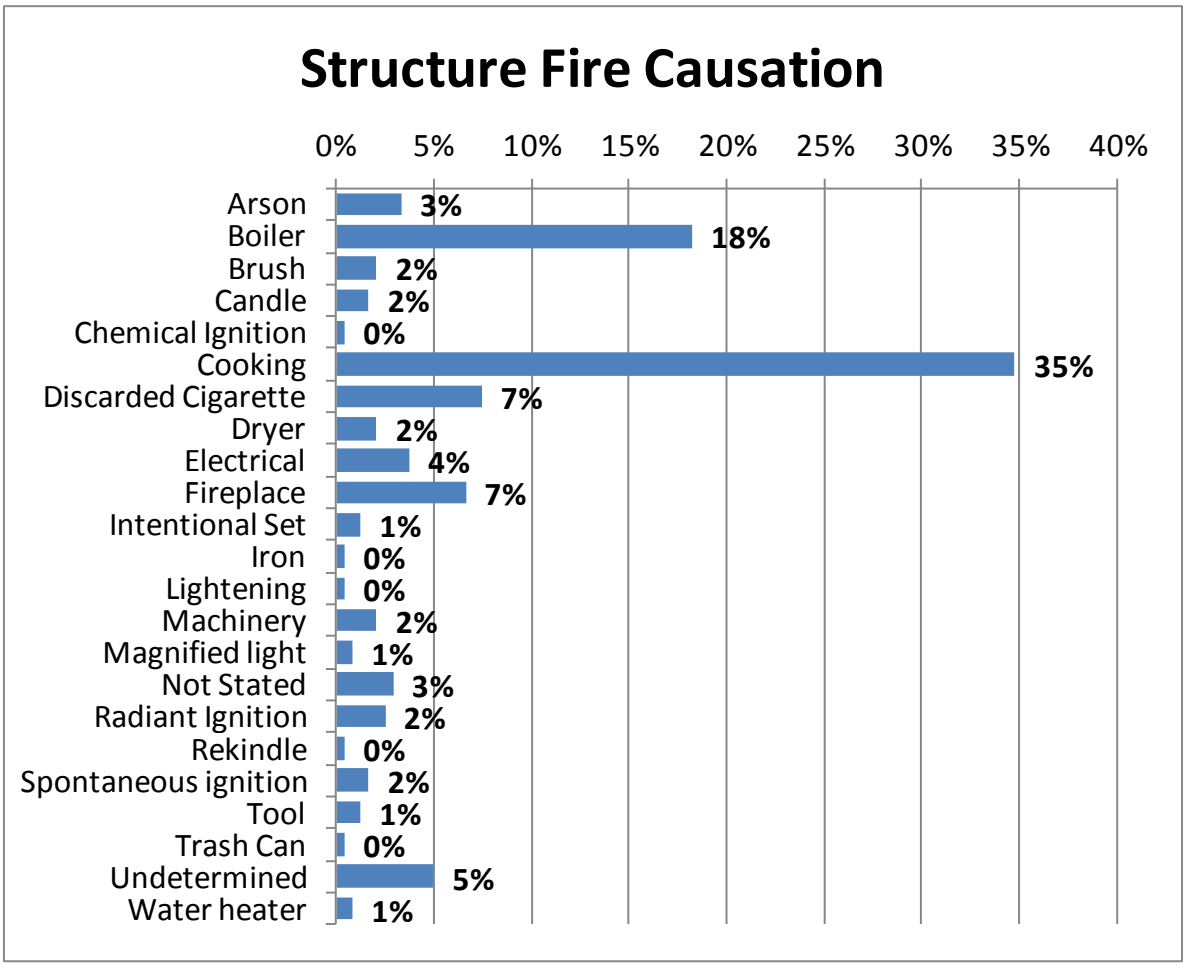


Most of the time, the Bristol Fire department has not designated a human factor in the event of a fire. However, discussion with the Department suggests that inattentiveness is behind most fire causes.

The narrative descriptions of the scene were examined to shed more light on causation of Bristol structure fires because so many of the structure fires lacked a code input by the fire department software user. Only 46 percent of the records had narrative description that could be used in an effort to identify causation. The cause, if documented, was simplified into categories because the narratives are variable depending upon the report writer. Figure 56 shows these simplified categories and the quantity identified in records with narrative descriptions.

It can be seen that public education efforts need to be focused on preventing unattended cooking practices, safe disposal of smoking products, fireplace/woodstove safety, boiler maintenance, and chimney care.

Figure 56: Detailed Fire Causes



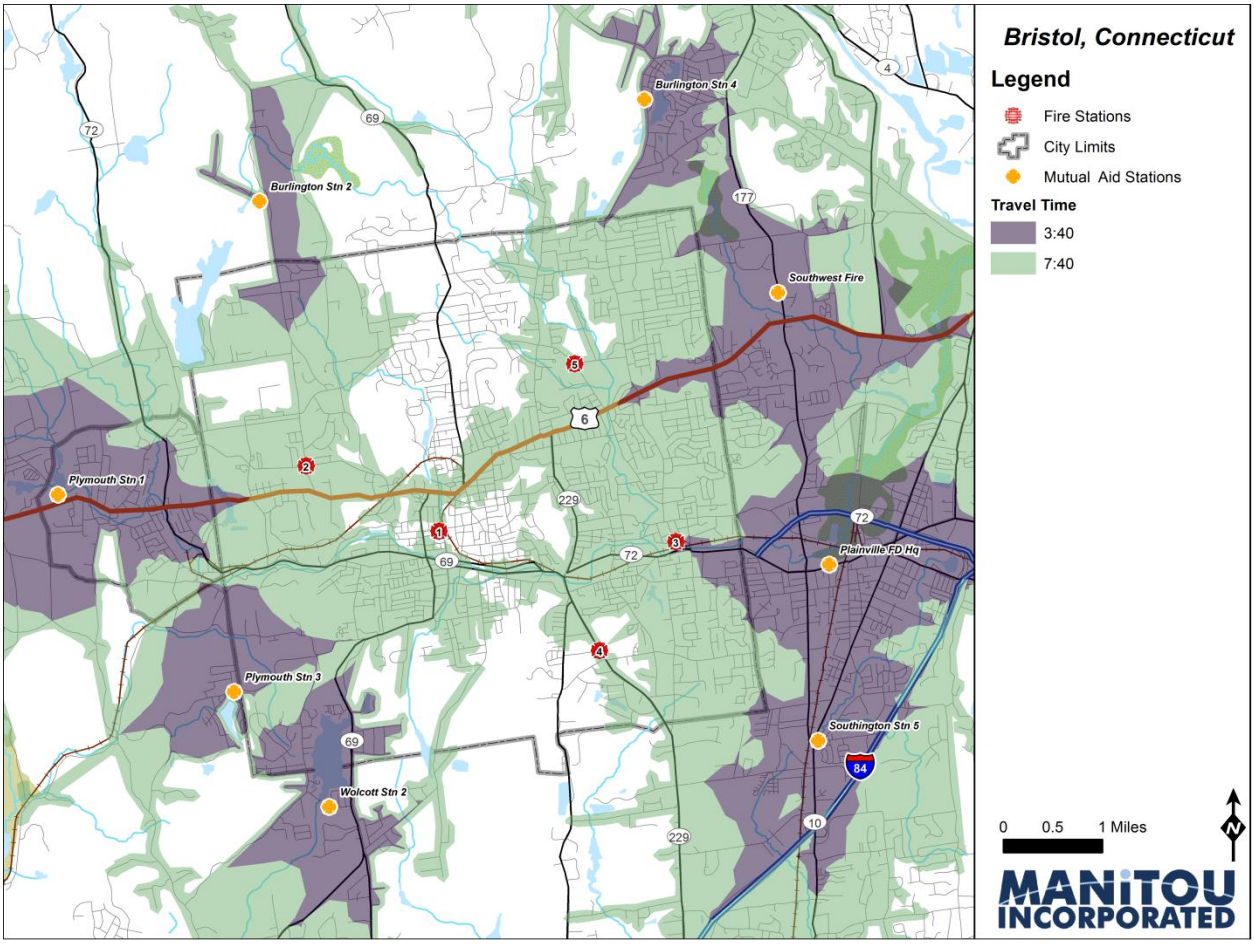
While determination of origin and causation is standard procedure for the fire department in any incident involving smoke or fire, persons responsible for determining this information should be required to submit this information in the NFIRS reports, which ultimately form state and federal fire statistics.

Mutual Aid

Mutual Aid refers to agreements that neighboring fire departments have that they will respond into each other's jurisdiction when either requested by the host department or automatically upon dispatch for certain events. These are critical agreements to ensure timely response by neighboring units when additional resources are needed due to a

large fire or multiple simultaneous calls. The following map (Figure 57) models the travel time of apparatus leaving neighboring fire department stations.

Figure 57: Mutual Aid Stations



Due to their geographic proximity, some neighboring departments are capable of reaching the outskirts of Bristol within a first due response time. All of them can provide additional resources in the event of a structure fire or other large-scale event within the first due assembly time. However, it will take longer to reach the downtown core of Bristol.

Excessive mutual aid received can signal an under-resourced or understaffed department. The same is true for a neighboring department whereby Bristol Fire Department finds itself aiding on a regular basis. An analysis of the incident record indicates mutual aid is not burdensome either way. The following table details mutual aid given versus received.

Table 15: Mutual Aid Analysis

Mutual Aid Analysis	2010	2011	2012	2013	2014	Grand Total
Aid Received by Neighboring Fire Dept		2	1	1	2	6
Automatic Aid Received					1	1
Aid Given to neighboring fire department	1	3		2		6
Other Aid Given (ex: to police, EMS)	1	3	1			5
No Aid Required	2200	3007	2220	2062	353	9842
Grand Total	**2202**	**3015**	**2222**	**2065**	**356**	**9860**

Three jurisdictions were named in the incident record, Burlington, Meriden, and Terryville. There were events listed in Bristol but this may reflect either postal address or input error.

It appears that mutual aid to other jurisdictions or by the Bristol Fire Department is not currently a troubling issue. The low numbers suggest that there is capacity to accommodate more intensive use of mutual aid should it be needed.

Insurance Services Office

The Insurance Services Office (ISO) is an independent organization that serves the insurance industry with a wide range of data collection and analysis. In turn, insurance companies apply the data when setting rates for a variety of insured properties. One type of data and related information provided to companies is the rating of communities based on the capabilities of a public fire defense system with regard to its ability to suppress fires in small to average sized structure and similar properties. In doing so, the company maintains surveys of over 48,000 cities, towns, and similar public fire jurisdictions throughout the country. Structures requiring extreme quantities of water to suppress (fire flows in excess of 3500 gpm) are surveyed separately from a community's fire defenses. Fire defenses are usually defined as facilities, equipment, and personnel of the fire and water departments and the receiving of emergency calls and dispatching of fire department resources to structure fires.

The Fire Suppression Rating Schedule. Generally, ISO conducts onsite surveys of community fire defenses by applying the Fire Suppression Rating Schedule (FSRS), the organization's guidebook for evaluating the various components of fire defense

capabilities. Upon completion of a survey a community is then assigned a Public Protection Classification (PPC) rating number. The classification assigned includes a rating number from 1 through 10. Class 1 represents the best attainable class for fire defenses while a Class 10 indicates that fire defenses do not meet the minimum criteria of the schedule. Once a PPC is established, a community is then subject to a resurvey if changes have occurred in the community or its fire defenses. Examples of changes include annexation, population growth, or changes in the fire or water department capabilities that could impact the overall effectiveness of the fire defense system to control fire losses.

Scope of the FSRS. As mentioned, the guidelines of the FSRS apply to fire protection capabilities that mitigate potential losses due to fires within structures. Further, it is important to note that ISO does not evaluate the fire department's capabilities related to the rescuing of civilian victims who may be trapped in burning structures. More specifically, the schedule focuses on capabilities of fire suppression forces for the initial call to structure fires and does not evaluate resource capabilities where multiple alarm fires or simultaneous calls may occur. It is important to point out that structure fire protection is only one service provided by the modern fire department. Other services provided often include fire suppression of other types of fires including wildland/brush, vehicle, and aircraft. In addition, many departments provide some level of response to emergency medical calls, motor vehicle accidents requiring the extrication of victims, and a wide variety of emergencies including hazardous material incidents.

Since 1915 the FSRS has been used as one of the primary measuring sticks to determine the effectiveness of municipal fire defenses. Over the years the schedule has been revised to reflect changes in the make-up and development of our nation's communities and associated fire risks and the technological changes in the delivery of public fire protection. The most recent and significant revision to the schedule was in 2012-13. A community's investment in fire protection upgrades is a proven and reliable predictor of reducing future fire losses. Historic loss data bears out the relationship between effective fire protection as measured by a community's PPC and reduced fire losses. It is due to

this relationship that the insurance industry reference PPC information for marketing, underwriting, and to help establish fair premiums for property owners. In general, the price of fire insurance in a community with a good PPC is often much lower than a community with a poor PPC, assuming all other factors are equal.

The guidelines of the FSRS evaluate fire defenses according to a uniform set of criteria, which in part incorporates its own standards, and those of the National Fire Protection Association (NFPA) and the American Water Works Association (AWWA). The guidelines address:

The 2013 Revised Schedule. In 2013 ISO issued a revised version of the Schedule. The revisions include changes in credit values for some criteria in the fire department and water supply system. In addition, community fire risk reduction was also added to the list of areas that are now being evaluated. Most notably, a community's fire prevention programs are now included in the schedule. Below is a comparison of the 1980 and the 2013 editions (Table 16). The 1980 schedule is included here because it was the basis for the 2011 rating.

Findings of the ISO survey reflect conditions found by ISO's staff during the observation, and may not necessarily reflect practice or local policies in effect. If they were not challenged at the time of the observation, they cannot effectively be refuted.

Needed Fire Flows. Which are representative of insured property locations used to determine the community's specific amount of water needed for fire suppression.

Dispatching of the Fire Department. This includes telephone and related communication systems, telephone system infrastructure, dispatch center staffing and facilities. This section of the schedule is 10 percent of credits a community may earn under the PPC. The credits are broken into the following areas:

- Telephone Service 2 credits
- Number of Needed Dispatchers 3 credits
- Dispatch Circuits 5 credits

Table 16: Comparison of 1980 v. 2013 Editions of Schedule

	Credits	
	1980 Edition	Revised Edition
Dispatch/Communication		
Telephone service	2	3
Number of needed dispatchers	3	4
Dispatch circuits	5	3
Total	10	10
Fire Department		
Number of engine (pumper) companies	10	6
Number of reserve pumpers	1	0.5
Pumper capacity	5	3
Aerial Ladder/service companies	5	4
Reserve ladder/service trucks	1	0.5
Distribution of companies/deployment	4	10
Company staffing levels	15	15
Training	9	9
Operational considerations		2
Total	50	50
Water Supply System		
Pumps and reservoir infrastructure	35	30
Hydrant specifications	2	3
Hydrant inspection and condition	3	7
Total	40	40
Community Risk Reduction		
Fire prevention code adoption and enforcement		2.2
Public fire safety education		2.2
Fire investigation		1.1
Total		6
Total Credits	**100**	**100**

Fire Department. This includes personnel, apparatus, training, geographic location of fire stations. The fire department accounts for 50 percent of a classification. Areas include:

- Number of Engine (Pumper) Companies 10 credits
- Number of Reserve Pumpers 1 credit
- Pumper Capacity 5 credits
- Ladder/Service Companies * 5 credits
- Reserve Ladder/Service Trucks 1 credit
- Distribution of Companies 4 credits
- Company Staffing Levels 15 credits
- Training 9 credits

* ISO recommends ladder trucks equipped with aerial ladders or equivalent in areas of the community where there exist five or more buildings of three stories or higher or where there is a needed fire flow of 3500 gpm or greater. Ladder trucks should be equipped with a complete inventory of ground ladders, forcible entry, overhaul, and salvage equipment. Other areas should be served with service trucks equipped with all the above except an aerial device.

Water Supply. Criteria includes the capabilities of fire hydrants, mains, pump stations and reservoirs. Relevant components of the water system account for 40 percent of a classification which include:

- Pumps and Reservoir Infrastructure 35 credits
- Hydrant Specifications 2 credits
- Hydrant Inspection and Condition 3 credits

A community's PPC includes a divergence factor that considers the rating difference of the above three areas. The factor recognizes disparity between the effectiveness of fire and water departments. By doing so, each of the three areas receives a sub-classification under the overall community PPC.

The PPC classification assigned to a community is based on a 100-point scale:

Public Protection Classification

	Credits
1	90.00 or more
2	80.00 to 89.00
3	70.00 to 79.00
4	60.00 to 69.00
5	50.00 to 59.00
6	40.00 to 49.00
7	30.00 to 39.00
8	20.00 to 29.00
9	10.00 to 19.00
10	0.00 to 9.99

PPC numbers can be further broken down as follows:

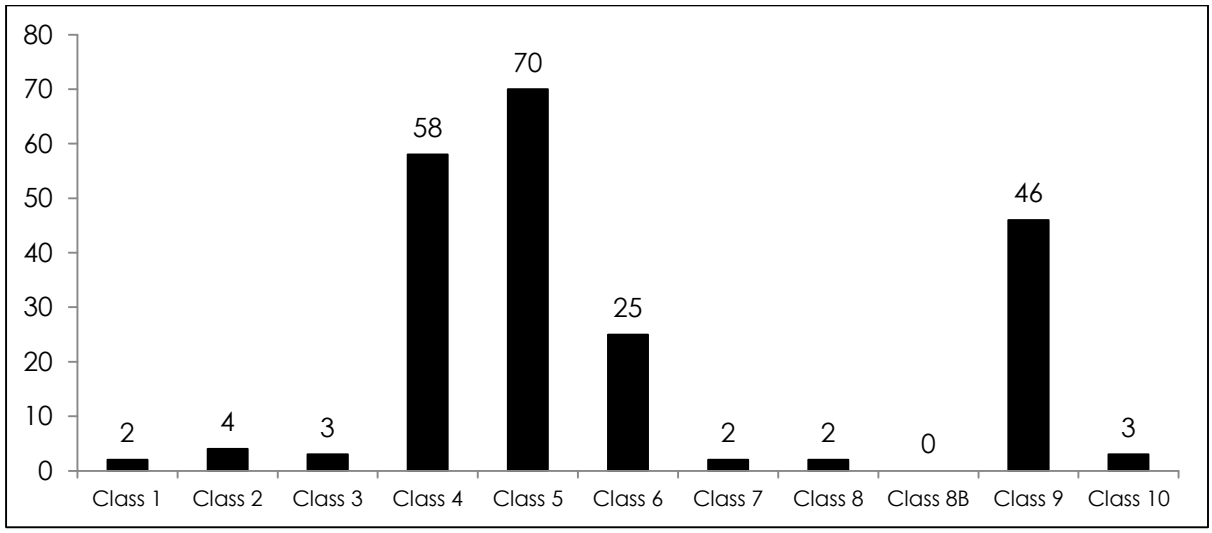
- Class 1 through Class 8 represents a fire defense system that incorporates a creditable dispatch center, fire department, and water supplies.

- Class 8B is a special classification that recognizes a superior level of fire protection in otherwise Class 9 communities. The special rating is designed to represent a fire defense system that is superior to a Class 9 except for a lack of a water supply system capable of flowing 250 gpm for 2 hours.

- Class 9 is a fire defense system that includes a creditable dispatch center, fire department but no creditable water supply per the FSRS.

- Class 10 does not meet the criteria of the FSRS.

Figure 58: Comparison of Connecticut Communities and their Public Protection Classifications



Split Public Protection Classifications. In some communities, a community's PPC is subject to receive a split classification. This is due to the following:

- The first class (e.g. "6" in a Class 6/9 PPC) applies to properties within 5 road miles of a recognized fire station and within 1,000 feet of an approved water supply system and fire hydrant or alternate water supply.

- Class 8B or class 9 applies to properties beyond 1,000 feet of an approved water supply and hydrant but within 5 road miles of a recognized fire station.

- Alternate Water Supply: The first class (e.g. "6" in a 6/10) applies to properties with 5 road miles of a recognized fire station with no recognized water supply and hydrant distance requirement.

- Class 10 applies to properties over 5 road miles of a recognized fire station.

Applying the FSRS as an Integral Component to Future Planning

The FSRS is not intended to be the sole guide for fire department long range planning. However, the schedule can serve as a useful resource when developing effective and efficient public fire services. It should be remembered that the Schedule is intended to determine if local fire suppression forces are in place to mitigate the effects of fires within structures. However, when developing a long-range plan for fire and rescue operations, other services provided must be considered including non-structure fire responses, EMS, special operations, and hazardous materials. These are not addressed within the FSRS but provided by the fire department and must be considered.

Bristol's May 2011 PPC Survey Report

The City of Bristol was surveyed by ISO in April of 2011. A summary report was submitted to the City, which stated that a total of 74.39 out of 100 credits were awarded as a result of the survey. The credit was sufficient for the City to receive a Class 3 PPC rating which took effect on October 1 of that year. ISO Field representatives applied the 1980 edition of the Schedule during the survey. It must be noted the revised Schedule (2014 edition), if applied today may present different findings and subsequent credit, thus resulting in a different PPC/Rating. The credits earned are itemized in the table below. Before any changes are contemplated for improving or maintaining the City's rating, the City should consult with the ISO on implications of the new schedule, which could be significant.

Credits for Fire Department

Number of needed front line pumpers (Engine Companies)
The number of front line pumpers needed is based on the City's flow demand (see water supply), response area covered, and the method of operation. The number of pumpers needed is five (5). Partial credit 0f 9.34 out of 10 was awarded due to the following:

- 3 front line pumpers needed to support a Basic Fire Flow of 3,000.

- 5 pumpers needed to provide fire service to areas with a reasonable population of properties without a responding station within 1-½ miles.
- 5 front line pumpers based on the department's method of operation to provide a minimum of two (2) pumpers responding to all initial response to reported structure fires.

Note: In certain cases credit may be awarded where neighboring fire departments provided the automatic pumper response (under the provisions of "Automatic Aid"). Currently this need does not exist within the City from surrounding departments.

Table 17: City of Bristol FSRS 2011 Survey – Credits Earned

FSRS Item	Earned	Credit Available
Receiving and Handling Alarms		
Telephone Service	2.00	2.00
Operators/Dispatchers	2.76	3.00
Dispatch Circuits	1.65	5.00
Total for Reviving & Handling Alarms	6.41	10.00
Fire Department		
Engine Companies	9.34	10.00
Reserve Pumpers	0.92	1.00
Pumper Capacity	5.00	5.00
Ladder Service	3.00	5.00
Reserve Ladder/Service Trucks	0.58	1.00
Company Distribution	2.15	4.00
Company Personnel/Staffing	7.14	15.00
Training	7.22	9.00
Total Credit for Fire Department	35.35	50.00
Water Supply		
Supply System	33.95	35.00
Hydrants	2.00	2.00
Inspection and Condition	1.03	3.00
Total for Water Supply	36.98	40.00
Divergence	- 4.35	–
Total Credit	74.39	100.00

Annual testing of pump(s) and hose

Pump and hose test should be conducted on all pumper apparatus per NFPA 1911 and NFPA 1962 respectively. Credit earned was not indicated within the ISO report.

Mutual-aid and automatic-aid agreements
Credit for sharing of resources with neighboring fire departments including the dispatching of fire apparatus pumper on all initial responses to structure fires are considered by ISO. Credit earned was not found within the ISO report.

Reserve pumpers
Partial credit of 0.92 of 1.0 was awarded for a reserve pumper.

Recommendation: At the time of the survey the department received partial credit for one reserve pumper. Reserve pumpers anticipated for credit should meet all the criteria of a front line pumper including pump capacity and equipment carried. If no reserve pumper is in service the department should secure a reserve pumper by entering into a written agreement for reserve pumper availability with an adjoining fire district.

Pumper capacity
Pump capacity is based on the "rated" capacity of the apparatus pump per the speciation of the apparatus at the time of delivery. ISO will only provide a maximum of 80 percent of the pump's rated capacity if no annual pump tests are conducted. Maximum credit of 5.0 was awarded for pumper capacity.

Aerial ladder truck service.
To maximize credit, ISO suggests that two ladder trucks are needed due to fire flow and/or the number of multi-story structures within areas of the City where there exist five or more buildings of 3 or more stories in height. The City has one in-service aerial ladder truck. Partial credit of 3.00 was awarded for aerial ladder truck service. The partial credit may be due to the lack of complete ISO/NFPA equipment and/or aerial device testing.

Reserve ladder/service trucks.
Credit of 0.58 of 1.0 was awarded for the City's one reserve aerial ladder/service truck. Partial credit of 3.00 was awarded for aerial ladder truck service. The partial credit may be due to the lack of complete ISO/NFPA equipment and/or aerial device testing.

Distribution of engine and ladder/service trucks.

In order to receive credit for company distribution, all built upon areas of the City need to be within 1.5 miles travel distance from the closest engine company and 2.5 miles from the closest aerial ladder truck. Bristol received 2.15 out of 4.00 credits.[21]

Firefighting personnel

The department is staffed by an all-career system. A credit of 7.14 out of 15.0 was awarded for personnel. This is due to the fact that an average of 20 firefighters and officers are available to respond on alarms to structure fires. In the future, additional credit may be given if on-duty company staffing levels are increased from their current levels. Note: Chief Officers who respond as part of the initial response to structure fires are not considered under this item for staffing of engine and ladder companies. Additional chief officers who respond to the initial alarm may be credited, but only if they perform company level firefighting duties.

Fire Department Training

The department received a total of 7.22 out of 9 possible credits for training.

	Credit	Credit Available
Drill Tower	8.00	8.00
Fire Building	4.00	8.00
Combustible Liquid Pit	5.00	5.00
Training Library	2.00	2.00
Multi-Media Training Aids	2.00	2.00
Training Grounds (Area)	10.00	10.00
Half-day company drills	0.40	0.40
Half-day multi-company drills	0.40	0.40
Night drills	0.00	0.20
Company Training	25.00	25.00
Officer	13.13	15.00
Driver/Operator	2.00	2.00
New Driver/Operator	2.00	2.00
Hazardous Materials	1.00	1.00
Recruit training	5.00	5.00
Pre-fire planning	7.32	15.00
Total	7.22	9.00

[21] One approach to improving the aerial ladder company credit deficiency is to convert at least one of the outlying engine companies into a "quint-pumper" unit (pumper chassis with 75 foot aerial). That way the City may receive full credit as an engine company and half credit for a ladder company. Alternatively, a more costly way would be to staff up an additional ladder company. There are likely to be other areas in the schedule where more cost-effective improvements could be made.

Drill Tower.

For maximum credit a 4-story drill tower is needed. The Department has access to a 4-story tower.

Fire Building.

To receive maximum credit, a fire resistive smoke room that is separated from the drill tower is needed. The Department does not have access to a fire building.

Combustible Liquids Pit

A 1,500 square foot combustible liquid pit or equivalent video instructing effective fire suppression of Class B fires should be used.

Library and Training Manuals

Appropriate NFPA, IFSTA, and related training materials should be provided. A complete set of training manuals was provided.

Fire Engine Pump and Fire Hydrant Training Props

Three-dimensional training props should be provided. Both prop types were provided.

Training Area (Grounds).

To receive credit, at least 2 acres should be dedicated to drill grounds. Ideally, the grounds should be an integral part of an overall training facility. Bristol maintains 2.2 acres for training, and improvements are planned.

Half-day company and multi-company and night drills.

Credit is given for the following drill schedule:

Table *: Drill Credits	Needed Per Year
Single company drills	8 half-day drills per year
Multi-company drills	4 half-day drills per year
Night drills	2 3-hour drills per year

All company personnel must attend the above schedule.

Training for probationary, driver, and company officers

A maximum score for training, in addition to company drills, is 55 credits. Bristol received 48 credits for training, a very good score for the Fire department.

Pre-Fire Planning Inspections.

The Fire Department should pre-inspect all commercial, industrial, and institutional facilities at least twice per year to receive full credit. The Department received credit for inspecting 61 percent of recognized properties within the City.

Table 18: Credit Summary for Apparatus

Fire Department		
Engine Companies	9.34	10.00
Reserve Pumpers	0.92	1.00
Pumper Capacity	5.00	5.00
Ladder Service	3.00	5.00
Reserve Ladder/Service Trucks	0.58	1.00
Company Distribution	2.15	4.00
Company Personnel/Staffing	7.14	15.00
Training *	7.22	9.00
Total Credit for Fire Department	35.35	50.00

Credits for Water Supply System

Needed Fire Flow. Bristol's needed fire flow was calculated as 3,500 gpm. Thirty-one locations of the water system were tested during the survey. Of those surveyed, at least five were deficient in needed flows:

East Main Street and Lincoln Avenue

King Street and 2nd Street

Terryville Avenue and Franklin Street

Farmington and Stafford Avenues

Vera Road and Beths Avenue

Water Pressure and Volume and Hydrant Distribution.

The water pressure and volume is based on the system's ability to flow the City's needed fire flow demand for a specified period of time. Credit for hydrant distribution is based on distance from properties to the nearest hydrants up to 1,000 feet. The City received 36.98 out of 40 available credits.

Recommendation: Ensure all fire hydrants meet the design and installation credit per the guidelines of the American Water Works Association and NFPA.

Fire hydrant size, type and installation.

Maximum credit for fire hydrants is 2.00. Full credit was awarded for hydrants. Hydrants on six-inch or larger branch lines and consisting of pumper outlets with two 2.5 inch auxiliary outlets receive maximum credit.

Fire hydrant inspection and condition.

Full credit was not awarded due infrequent inspection of hydrants. Records indicate that two years lapsed, between 2008 and 2010, where no recorded formal hydrant inspections occurred. This resulted in receiving only 35 percent of credit for hydrant inspections.

Table 19: Credit Summary for Water Supply

Water Supply System	33.95	35.00
Fire Hydrants	2.00	2.00
Fire Hydrant Inspection	1.03	3.00
Total for Water Supply	36.98	40.00

Dispatch Center

The Bristol Communications Department received 6.41 credits out of 10. The dispatch center receives and processes emergency calls.

The following provides a detailed review of credit earned by the Department.

Number of needed designated "fire" lines.

For maximum credit, there should be 4 incoming telephone lines reserved for receiving notification of fires. Maximum credit of 25.00 was awarded.

Number of needed fire, business, and private alarm lines.

For maximum credit there should be sufficient lines awarded for incoming fire, business, and private lines. Maximum credit of 25.00 was awarded.

Progression of emergency calls to business lines.

For maximum credit for fire lines all fire lines should roll over to business lines. Maximum credit of 10.00 was awarded.

Emergency number on the inside front cover or the front-page local directory.

Maximum credit of 10.00 was awarded.

Emergency number and business number listed under "Fire Department."

Maximum credit of 5.0 was awarded.

Emergency number and business number listed under the name of the city.

A maximum credit of 5.0 was awarded.

Use of recording device.

Maximum credit of 20.0 was awarded.

Number of on-duty dispatchers needed.

Partial credit of 73.40 of 80.00 was awarded.

Number of on-duty dispatchers awake at all times.

Partial credit of 18.35 of 20.00 was awarded.

Dispatch circuits provided.

Credit of 20.00 of 40.00 was awarded.

Monitory for integrity of circuits.

No credit was awarded out of 30.00.

Recommendation: ensure all fire dispatch circuits are monitored at all times per NFPA 1221.

Dispatch recording facilities at communication center.

Five out of a maximum credit of 10.00 was awarded.

Dispatch center emergency power supply.

Partial credit of 8.00 of 20.00 was awarded.

Recommendation: Ensure the providing dispatch center has in place an emergency power back up per NFPA 1221.

Table 20: Credit Summary for Dispatch

FSRS Item	Earned	Credit Available
414. Telephone Service	2.00	2.00
422. Dispatcher/Operator	2.76	3.00
432. Dispatch Circuits	1.65	5
Total Credit	6.41	10

Again, because of significant changes in the ISO rating schedule, any changes should be reevaluated in consultation with ISO either by special request or in anticipation of the City's next rating.

Using Assessor Data to Connect Fire Risk to the Building Stock

One important measure of risk is the building stock. The building stock represents a critical component of a community's wealth, and serves to facilitate economic and household life. One important distinction is between the building itself, and the uses or activities that

take place within that building. As we discussed previously, risk can vary greatly between identical buildings based upon the nature of the activities housed, as well as the characteristics of the population using those buildings.

Traditional fire risk analysis treats the risk of buildings and activities as fixed, based upon single measures of risk such as the amount of water and application rate necessary to extinguish a fully involved fire. The insurance industry's rating schedule emphasizes only property protection, and thus forms a single but incomplete measure of fire risk. This risk is usually expressed in rough classes such as high, medium, or low.

A more incisive approach to understanding fire risk is to evaluate the building stock against its *actual* fire experience. This risk, referred to as "realized risk" represents the actual incidence of fires based on the type or use of a building.

We used the Bristol Assessor's records to determine a count of buildings and their square footage. The Bristol Assessor's database consists of nearly 21,800 records. Each record does not correspond exactly to a structure; as some records cover undeveloped land, and still others represent parcels that may have multiple structures.

There are numerous categories of building uses and types in the database. We will discuss some of the most common and interesting in regard to the risk analysis. Not surprisingly, residential buildings dominate the count of structures in the City. We see in Table 21 that singe family dwellings are the most common structure, with an average of 1,505 livable square feet.

Table 21: Top Five Building Types by Number and Square footage

Building Type	Number of records	Average Square Footage
Single Family	14,082	1505
Condo Residential	2,382	1099
Two Family	1,253	2021
Three Family	733	2881
Mobile Home	163	806

Next, we matched the assessor's records on building stock to the Fire Department's incident records on a citywide basis. Although it is possible to match each incident to a specific record in the Assessor's database, this would be very labor intensive. However,

performing a match at the citywide level allows us to compare risks of fire across types of buildings, both in terms of risk per building or structure, as well as by the square footage of built area by type of building.[22]

Table 22: Fire Risk by Building Count and Type

Property Type (National Fire Incident System)	Number of Properties	2010	2011	2012	2013	Average Fires 2010-2013	Average Fires/100 Structures/ Year
1 – Assembly	115	2	1	3	2	2	1.74
2 – Education	28	0	0	0	1	0.25	0.89
3 – Health Care, Detention	6	0	1	1	0	0.5	8.33
4 – Residential	18773	43	24	40	33	35	0.19
5 – Mercantile, Business	540	3	6	2	7	4.5	0.83
6 – Industrial, Utility, Defense, Agriculture	160	1	2	1	6	2.5	1.56
7 – Manufacturing	3	0	0	0	0	0	0.00
8 – Storage	256	1	0	1	1	0.75	0.29

We can see from this analysis that fire risk varies depending on whether we consider the structure as the unit of measurement, or we consider square footage of built area. When we adjust for the number of fires in each use type based on the number of buildings, we see that health care and detention occupancies have the highest rate of fires per building annually, over four times as high as the next use group, assembly. Industrial buildings are slightly lower, followed by business and mercantile occupancies. The lowest rate of fires per structure is in residential properties. However, if we consider the larger number of residential properties, we see that they are the most common sites for fires, in spite of their lower risk on a per-structure basis.

The following table (Table 23) details the fire risk experience per capita and by square footage for each fire station's first-due response area. The highest rates of fires per 1,000 residents are in Station 3 and 4's area. However, Station 3 has the highest rate of fires per million square feet of built area in its response district.

[22] Jennings, Charles. "Urban Fire Risk: Using GIS to Connect Fire, Census, and Assessor's Data." *Regional Science Review*. Vol. 17 (1998) pp. 105-112.

Table 23: Fires/Person and Per Square Foot of Built Area

Station	Fires per 1M sqft	Fires per capita (1K)
1	2	2.3
2	1	1.4
3	3	3.7
4	2	3.6
5	2	2.3

Possible Building and Fire Code Interventions

The State of Connecticut Department does not permit localities to enact more stringent code requirements than those adopted by the State. This limits the interventions possible in this realm. Fortunately, the Connecticut State codes have increased safety levels in new construction, and the Bristol Fire Department has been effective in working with schools and other institutions to promote installation of sprinkler systems.

Code Enforcement Committee

The City of Bristol's Code Enforcement Committee is a collaborative entity consisting of multiple City agencies working together to address issues of chronic code enforcement. The Committee includes representatives of the Mayor and City Council, Building Department, Zoning, Public Works, Tax Assessor, Police, Fire, and the City's Corporation Counsel.

Properties with multiple or ongoing code enforcement violations, particularly those that threaten the structural integrity or present quality of life or blighting influences on neighboring properties, are identified for enhanced enforcement action. The Code Enforcement Committee has been successful in causing rehabilitation of several major properties, and in cases where repairs cannot be made, demolition of the troubled structure.

Working through entities such as the Bristol Development Authority, targeted funding programs are used to help offset costs of repairs and renovations in areas of the City

considered at-risk for decline. This effort dates back to the 1990s, with the formation of the "Blight Committee", the forerunner of the current Committee.

The effect of this effort appears to be very positive, as the general condition of buildings in the city is good, and vacant or underused buildings appear to be in decent repair and secure from trespassers. Vacant or dilapidated buildings experience a heightened risk of fires, and these activities have largely allowed the City to avoid this destructive problem.

Depot Square Project

The proposed development at Depot Square is a potential major construction project that is planned as a mixed-use office/retail/residential development. Planned for a large parcel in the heart of downtown along Main Street, the project would potentially include several high-rise buildings and parking garages. Such downtown development projects have been recognized as positive for communities by encouraging greater density and reinforcing the pedestrian orientation of downtown.

The project is still in proposal stages as of this report, but we can make some preliminary statements that will apply to the range of alternatives being considered for the development. The project would be built according to the latest building codes, which would require sprinkler and fire alarm systems, among other safety features. Sprinkler systems are well over 95 percent effective at controlling or extinguishing fires.

The Bristol Fire Department, through its Fire Marshal's Office, has the authority to review planned development and approve fire safety and operating features such as fire lanes, site plans, and operating features such as fire alarm activation procedures. Using these powers, we believe that the development can be accommodated without undue impact on the City's fire risk.

High-rise developments such as the proposed Depot Square will require additional emphasis on training and exercises, particularly utilization of mutual or automatic aid resources, for response to a significant fire. Multi-agency drills and training should be planned to make sure that agencies who would likely respond to a significant event are

familiar with equipment, procedures, and practices used in the City of Bristol. Additional discussion in this area is included under "Regional Approaches."

We must remember that the likelihood of a serious fire is very small, and the emphasis of activity from the fire department should be to assure that protection systems are operational, and that property management maintains and operates in accordance with good practice. Staffing in anticipation of a major fire is simply not practical, nor effective.

Fire Inspections

The fire prevention staff of the BFD does not perform annual fire inspections due to resource constraints. Instead, the staff focuses on complaints, and inspections related to the City's Code Enforcement committee.

A formal fire company pre-fire planning program should be initiated for selected large or hazardous properties in the City. Such properties are commonly referred to as "target hazards." The BFD's records management software has the capacity to store and retrieve this information.

Public Fire Education/Outreach

Four personnel – the Fire Marshal and three inspectors, staff the BFD Fire Marshal's Office. The Fire Marshal's Office handles new construction inspections, maintenance inspections of existing buildings, fire investigation, and public fire education.

Fire Inspections

The State of Connecticut sets inspectional frequency of certain occupancies. These requirements are spelled out in Section 29-292-7e (c) of the Fire Code.

(c) The minimum requirements for the frequency of inspections as prescribed in section 29-305 of the Connecticut General Statutes shall be as follows:

1. (1) Annual inspections for the occupancy classifications -- All Residential, Assembly (Theaters, Restaurants, Bars Nightclubs); Education (including Day Care with >6 children); Explosives or explosive chemicals, and Institutional including board and care homes, halfway houses, or locations where occupants are unable to care for themselves. (R, A-1, A-2, E, H-1, I-1).
2. (2) Inspections every two years for the occupancy classifications – Assembly occupancies such as houses of worship, museums, lecture halls; buildings with materials that support combustion; hospitals and nursing homes; jails; day care, adult care; Colleges; Medical clinics and outpatient care, (A-3, H-2, I-2, I-3, I-4, B-Medical, B-College)).
3. (3) Inspections every three years for occupancy classifications – Business, High Hazard Storage (materials that support combustion); Stores and gas stations; moderate hazard storage; indoor arenas, and outdoor stadiums or bleachers; B, H-3, M, S-1, A-4, A-5.
4. (4) Inspections every four years for the occupancy classifications. (Factories, Corrosives or toxic materials use; low hazard storage; and barns, carports, garages, and other accessory structures. (F-1, F-2, H-4, H-5, S-2, U)).

Inspection staffing does not permit inspection of all properties according to the State's guidance. In reality, the inspectional workload is driven by complaints, targeted enforcement on troubled properties, new construction or permit-related inspections, and then routine maintenance inspections.

Public Fire Education

The BFD maintains an active public fire education program. This program is geared to children, with annual presentations made to day care centers (pre-K), and third and fourth graders. All schools participate in this program. Most day care centers are covered annually. Line company personnel assigned to the fire stations also assist in making these presentations. Occasional programs are presented to seniors or other community groups, usually driven by requests.

Research has shown that public fire education programs, when properly targeted and designed, can produce reductions in fires and losses.[23] Other initiatives, such as Vision 2020 (strategicfire.org) provide guidance on developing such programs.

[23] Clare, Joseph, Len Garis, Charles Jennings, Darryl Plecas, and Karin Mark. "Safe and sound: A Canadian fire department uses a home-visitation program to drive down house fires." *Fire Chief*. Vo. 56, no. 11. November 2012. pp. 38-43.

Table 24: Top Five Property Types Experiencing Fires, Bristol

Property Type	Percentage
One and Two-Family Dwellings	44.2
Multifamily Dwellings	37.4
Heath Care/Developmental Boarding Facility	2.6
Restaurant/Cafeteria	2.1
Nursing Home	1.3
Manufacturing Plant	1.3

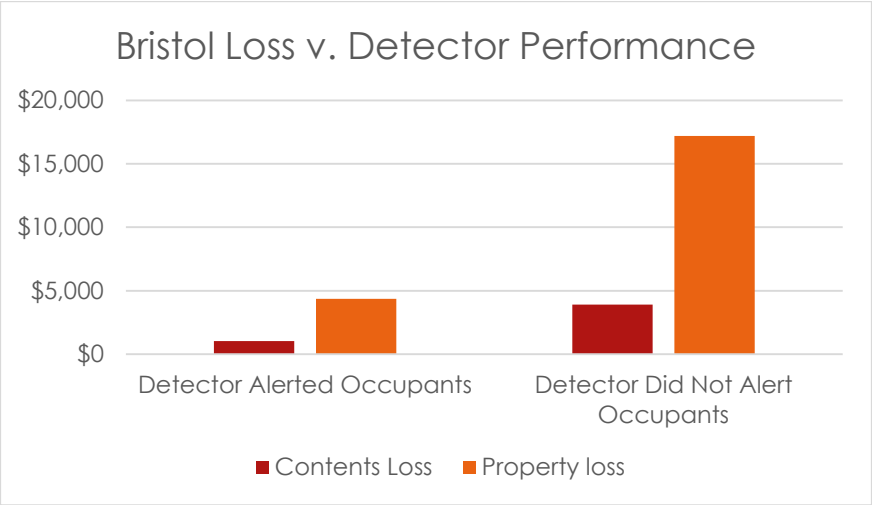
Using the BFD's incident reports, we examined the scope and potential impact of an enhanced fire prevention education program. We see (Table 24) that, as in most communities, over 81 percent of structure fires are in residential occupancies. Interestingly, less than half of fires are in single-family dwellings.

Smoke detectors are an important tool for improving life safety and reducing fire loss. As we see in Figure 59, smoke detectors are clearly shown to be associated with lower property loss in fires.

The overall performance of smoke detectors appears to be good within the City. However, 12.5 percent of fires in one and two-family dwellings occurred where the smoke detectors failed to operate. In apartments, it was slightly lower, at just over 10 percent. This indicates that targeting those residences where smoke detectors are not working is a worthwhile activity. There were no cases reported of detectors failing to operate in non-residential properties. These findings speak to the effectiveness of fire prevention programs in the City. The overall smoke detector compliance figures should be viewed cautiously, since in most cases, data on the presence of smoke detectors in structure fire reports was not recorded.

With regard to casualties, we see that fires caused injuries to civilians in roughly 3.6 percent of all fires, while 2.4 percent of fires resulted in a firefighter injury. These statistics were calculated using incident types of structure fire, including cases where no dollar loss was reported. If zero-loss fires were included, these percentages would increase by a factor of 2.

Figure 59: Detector Performance v. Fire Loss



It is recommended that a more detailed analysis be conducted in the future to identify those properties where smoke detectors are not working. Given the information on fire risk from the literature, we recommend targeting areas of the City where low-income populations reside, particularly in apartments.

Such interventions may include smoke detector installation and maintenance programs or cooking safety (35 percent of structure fires). Interestingly, the second most common cause of structure fires was boiler issues, suggesting that this may be an area for additional attention by fire prevention.

Based on our analysis in this report, we would recommend that public fire education programs be targeted at low-income, renter, and Spanish-speaking populations. At present, the BFD has little capacity to develop materials in Spanish. A translator should be included in any plans for development or adaptation of educational materials targeted at this population. In addition, any national or regional dialects should be considered, and messages tested before production of final materials.[24]

A smoke detector giveaway and installation program, accompanied by voluntary home/apartment inspections by the BFD should be pursued. The costs of purchasing smoke detectors and other program costs could be funded in part through grants and

[24] The Fire Marshal staff could benefit from conversational Spanish for first responders training, which would be helpful in relating to this element of the community.

donations. The targeting of these programs is very important to their success. Those households at highest risk should be emphasized in the program. Such a program is useful to help firefighters become more familiar with the buildings in the community, and can provide benefits in terms of community relations, and identification of code enforcement or other problems in their early stages.

The five-step planning process cited previously should guide any program that is developed.

Regional Approaches to Risk

The Bristol Fire Department currently uses regional assets in several ways. For the most part, these relationships appear to be strong, but built primarily on relationships and informal agreement. We recommend that these relationships be further formalized through creation of procedures that explicitly spell out when mutual aid or regional resources should be called. The resources required may vary depending on the location of the emergency within the City and the specialized equipment or personnel required.

"Normal" Mutual Aid – The Bristol Fire Department enjoys a good working relationship with its neighboring fire departments. Assistance is requested routinely for incidents near the border, as well as for large events such as flooding, which may simultaneously affect multiple jurisdictions.

One way to manage risks in large or complex properties is to consider automatic aid. Under automatic aid, a neighboring agency is dispatched simultaneously, which effectively increases the initial response force. The Department should make an ongoing evaluation of the balance between mutual and automatic aid.

Specialized Services

The City of Bristol also faces some specialized fire service risks. The most significant of these are in three areas: hazardous materials; high-angle/confined space rescue, and swift water rescue.

Hazardous Materials – The City of Bristol Fire Department currently operates at the Operations level for hazardous materials incidents. This level of training is recognized according to federal Occupational Safety and Health Administration (OSHA) standards. The operations level means that personnel are trained to be able to respond to a hazardous materials emergency. While these personnel are trained in self-protection, identification, and basic remediation of incidents, they are not equipped to handle complex operations such as may be required with highly hazardous or toxic substances, large quantities of material, or complex industrial settings. For more complex incidents, a hazardous materials team with personnel trained to the higher *technician* level will respond. The applicable industry training standard is NFPA 472 *Standard for Competence of Responder to Hazardous Materials/Weapons of Mass Destruction Incidents*.

The City of Bristol has two alternatives for technician-level hazardous materials response. Teams are available from the City of Waterbury, and the State of Connecticut Capital Region response team. The resources available to the City are adequate to support their needs, but these linkages should be strengthened in partnership with local industry.

High-Angle/Confined Space Rescue – The Bristol Fire Department maintains a limited capability for confined space rescue. Confined spaces can include sewers, storage tanks, boilers, and industrial process equipment. Owners of such facilities are required to maintain agreements for rescue services. Local facilities should be contacted to verify the validity of these arrangements, and determine that appropriate staff and equipment are available, or that outside resources to provide these services can be readily procured.

High-angle rescue, which involves use of ropes to move personnel from heights, is a specialized capability. Although there are not numerous facilities that would potentially call for such rescues, Lake Compounce, the amusement park, is such a locale. The BFD, in conjunction with the Southington Fire Department, responds to such rescues at the Park. Our understanding is that periodic training maintains readiness for this capability. While the number of incidents is small, the availability of this expertise should be maintained and certification pursued, in conjunction with Southington. The existing arrangements are satisfactory, and training and drills should be continued to maintain this capacity.

Swift Water Rescue -- The City of Bristol has a history of flooding. The FD has several boats and provides limited services to evacuate residents who may be stranded during periods of flooding. The Bristol Fire Department should consider developing a minimum capability for swift-water rescue certification among its personnel. Such training is commonly available through contractors.

Conclusion and Recommendations

The City of Bristol has a fairly benign community risk profile. The City's stable population, diverse employment base, and sound management policies have maintained a favorable set of conditions for fire risk in particular. A number of major properties have built-in fire protection systems, and corporate clients such as ESPN, which control major properties, are credited with well-managed safety programs.

The Bristol Fire Department is appropriately staffed to address the risks faced by the community. While future development may create additional needs, there is sufficient capacity in the existing system to support additional calls for service.

Natural hazards, namely flooding, will continue to be a challenge. Prioritizing mitigation initiatives should continue to be studied.

Actions to Pursue

From a strategic standpoint, the City and BFD should adopt a more preventive stance, moving into the realm of public education. Traditional code enforcement should be maintained, but in order to reduce residential fires, the bulk of the BFD workload, targeted prevention programs should be developed.

The specialized services provided by the BFD are generally appropriate, but additional swift water training may be necessary, and agreements and working relationships for specialized services such as hazmat or heavy specialized rescue should be strengthened.

The City of Bristol is doing a good job overall of balancing community risks and protective resources. This process should continue.

Summary Risks Chart

Table 25 summarizes community risks based on our analysis and review of the literature on national fire experience and disaster loss. In this chart, we summarize the credible risks facing the City.

The existing allocation of resources within the BFD appears to be very reasonable. The relatively high incidence of flooding and the need for water rescue or swiftwater rescue suggests that this capability be strengthened within the City. In the area of hazardous materials, we believe that the BFD should formalize its policies on utilization of hazardous materials teams. The frequency of hazardous materials incidents does not justify the training time and expense of developing its own hazardous materials team. The support from existing teams is sufficient. The BFD should implement regular training and exercises with their hazardous materials partners so that the utilization of these resources is well rehearsed.

Table 25: Summary of Credible Risks

Event type	Occurrence Frequency			Severity or Consequence			Activity
	Low (<0.5/year)	Medium (< 2/year)	High (> 2/year)	Low	Medium	High	
Content loss due to fire (>85/year)			X		X		Maintain Capability
Property loss due to Fire (>85/year)			X		X		Maintain Capability
Life loss due to fire (0.3)	X					X	Maintain Capability
Hazmat[25] (1.3)		X			X		Strengthen Relationships
Earthquake[26] (0.13)	X				X		
Flood (1.4)	X				X		
Tornado (<.0.1)	X					X	
Hurricane (0.1)	X				X		
Heat wave (0.2)	X			X			
Severe Storm (0.3)	X				X		
Hail (0.2)	X				X		
Winter storm/Snow (>1)		X		X			
Drought (0.03)	X			X			
Wildfire/Brush fire		X		X			
High Angle Rescue (1)		X		X			Maintain capability.
Swift Water Rescue (4)			X		X		Strengthen Capability
Trench Rescue (0.3)	X				X		
Reliance on Mutual Aid		X		X			
Resource Draw to Mutual Aid (<1)	X			X			

Fires remain by far the highest risk in terms of both frequency and severity. Existing firefighting capabilities should be maintained. To further reduce fire risk, we suggest a targeted campaign to improve smoke detector installation and maintenance. In

[25] Hazmat incidents here are limited to those involving a spill of more than 55 gallons or requiring special action.

[26] Earthquake risk was defined as a 3.0 magnitude or greater earthquake within 90 miles of Bristol.

particular, the Department should strive to complete and enter all structural fire data into the records system to permit analysis of this type in the future, and to better understand the characteristics of residences that may not have working smoke detectors, as well as other trends in fire loss.