City of Billings Fire Department

Fire Station Location and Staffing Study

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EXECUTIVE SUMMARY

This study focused on the fire department's ability to achieve a prompt and effective response to emergencies. Detailed analysis of historical response activity was conducted to determine factors contributing to current levels of performance. In addition, population growth and response activity was forecast to identify how workload will likely change in the future. Several conclusions were reached.

1. Population, almost exclusively, drives emergency response activity.
2. Billing's population has grown steadily and will continue to do so.
3. The Billings Fire Department's staffing has not grown at the pace of population. The fire department's staffing levels are significantly less than comparable communities.
4. The city does not have adopted service level performance objectives.
5. National benchmarks recommend a response time objective of 5 minutes or less, 90% of the time. The fire department's current response time performance exceeds this target by as much as double depending on the type of emergency.
6. Three factors are impacting the department's ability to meet its current response time objective:
    a. Response units are frequently out of their primary service areas for training, administrative, and other duties.
    b. Fire stations are not adequately distributed throughout the entire service area
    c. Turnout time exceeds what reasonably can be achieved

The study concluded with a variety of recommendations to improve fire and emergency services to varying degrees. These include modifications to shift management practices, staffing of the ladder truck, alternative work schedules for shift personnel, fire station location and staffing changes, use of technology and others. The cost of these options as well as the degree of benefit to be expected has been evaluated.

Of the recommendations offered, the most significant are:

- Adopt regulations requiring the installation of fire sprinkler systems in all new buildings and any building that undergoes a significant remodel or addition.
- Reduce the resistance of key response routes to improve response time.
- Increase the fire department's emergency medical service level of care so that advanced life support service can be provided from each fire department response unit (staffed engines and ladder truck).
- Improve the city's ability to serve a growing population and service area by relocating three existing fire stations and adding two new fire stations at or near the locations recommended.

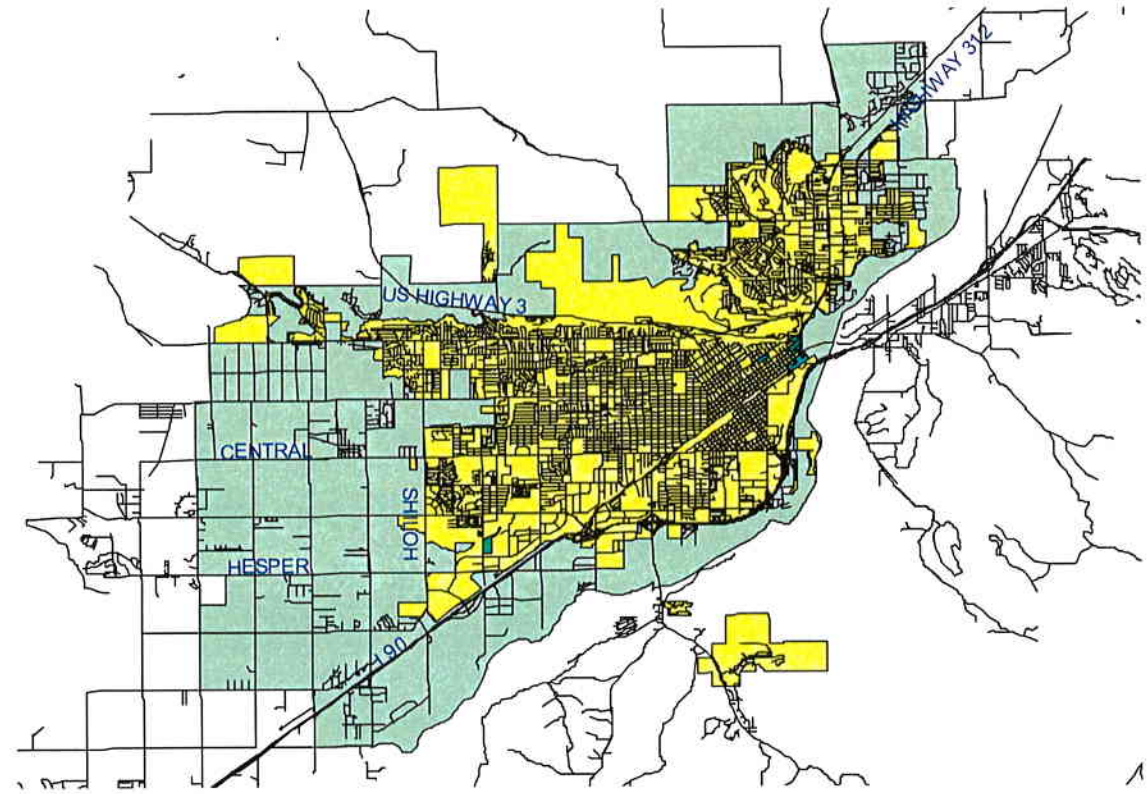
This report offers the city council of the City of Billings the tools to make choices on the level of service to be provided by its fire department. These choices will be based both on the desires of the community, and its ability to pay for services.

GENERAL COMMUNITY CONDITIONS

Background

The city of Billings is located in south-central Montana. It is the largest city in the state with a population of 91,000. Billings is a relatively vibrant community that has been steadily growing over time.

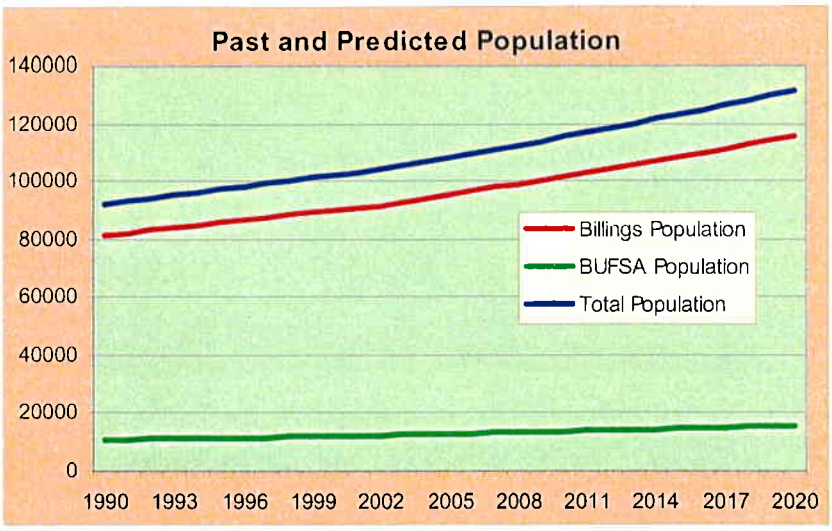
The city covers an area of approximately 38 square miles. The Billings Fire Department serves that, and an additional 46 square miles of unincorporated Yellowstone County called the Billings Urban Fire Service Area (BUFSA). The population of the BUFSA is estimated at approximately 12,000.



	City of Billings
	BUFSA

Population

The total population of the Billings Fire Department service area is 104,000. Population growth has been steady at about 2% per year for some time. This trend is expected to continue as the community develops. The chart below shows past and predicted population growth.



If growth continues as forecast the population of the service area will be 131,000 by the year 2020

Community Development

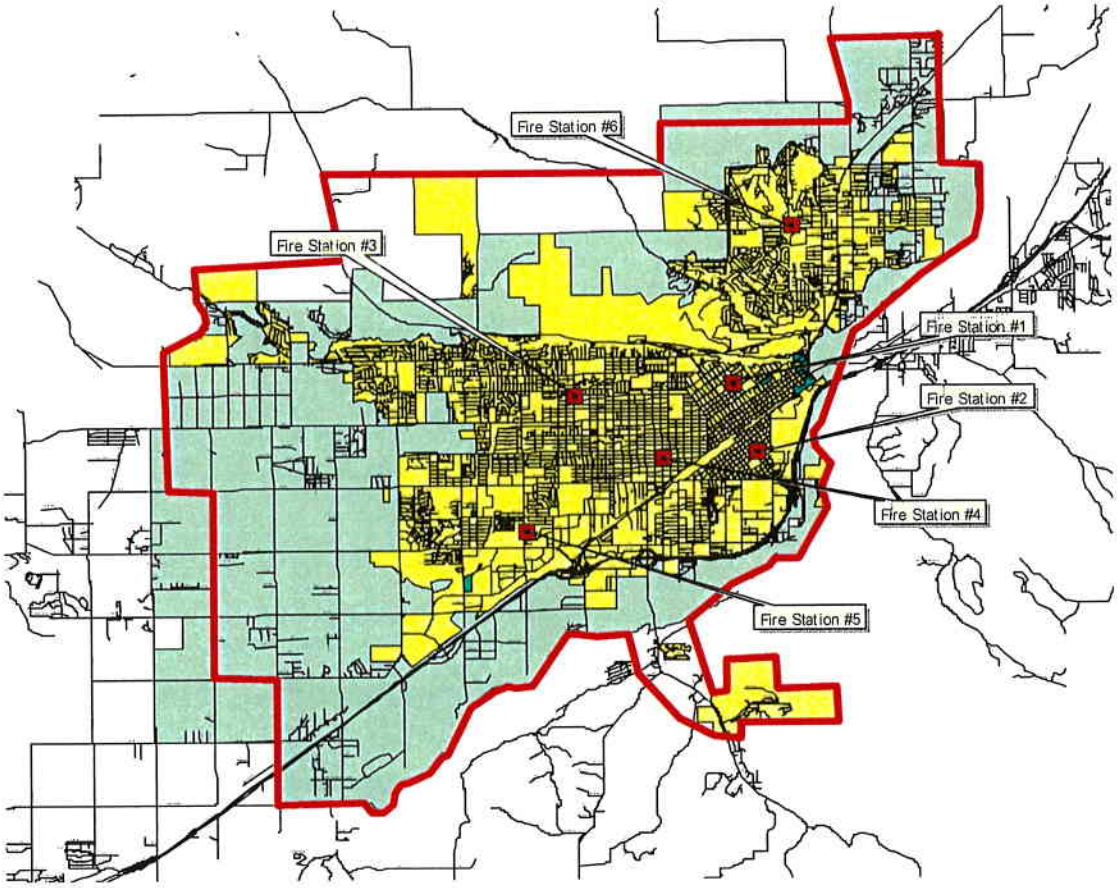
The city and surrounding area contain a mix of residential, commercial, and some industrial properties. Development density is focused in the central portion of the city. Residential properties exist around the city central core and within the BUFSA.

Commercial development is somewhat scattered throughout the entire area. Several high-rise buildings are present in the city center. A number of medium sized to large malls exist on major thoroughfares. Two hospitals are located just north of the city center. The Billings airport hosts several carriers providing scheduled air service.

Industrial properties are primarily located south, and south west of the city center. A number of new industrial properties are under development.

New residential development is occurring primarily west of the city center, and out into the BUFSA area. In addition, there is a large new residential development under construction north of Highway 3 and west of the Billings airport.

The city is expected to continue growing, not only in population but in size. The map below shows the boundaries of the city as they might exist by the year 2020. This is important for the station location effort as the city will want to ensure its investment in fire stations will make sense for the long-term.



	City of Billings
	BUFSA
	Future city boundary

BILLINGS FIRE DEPARTMENT

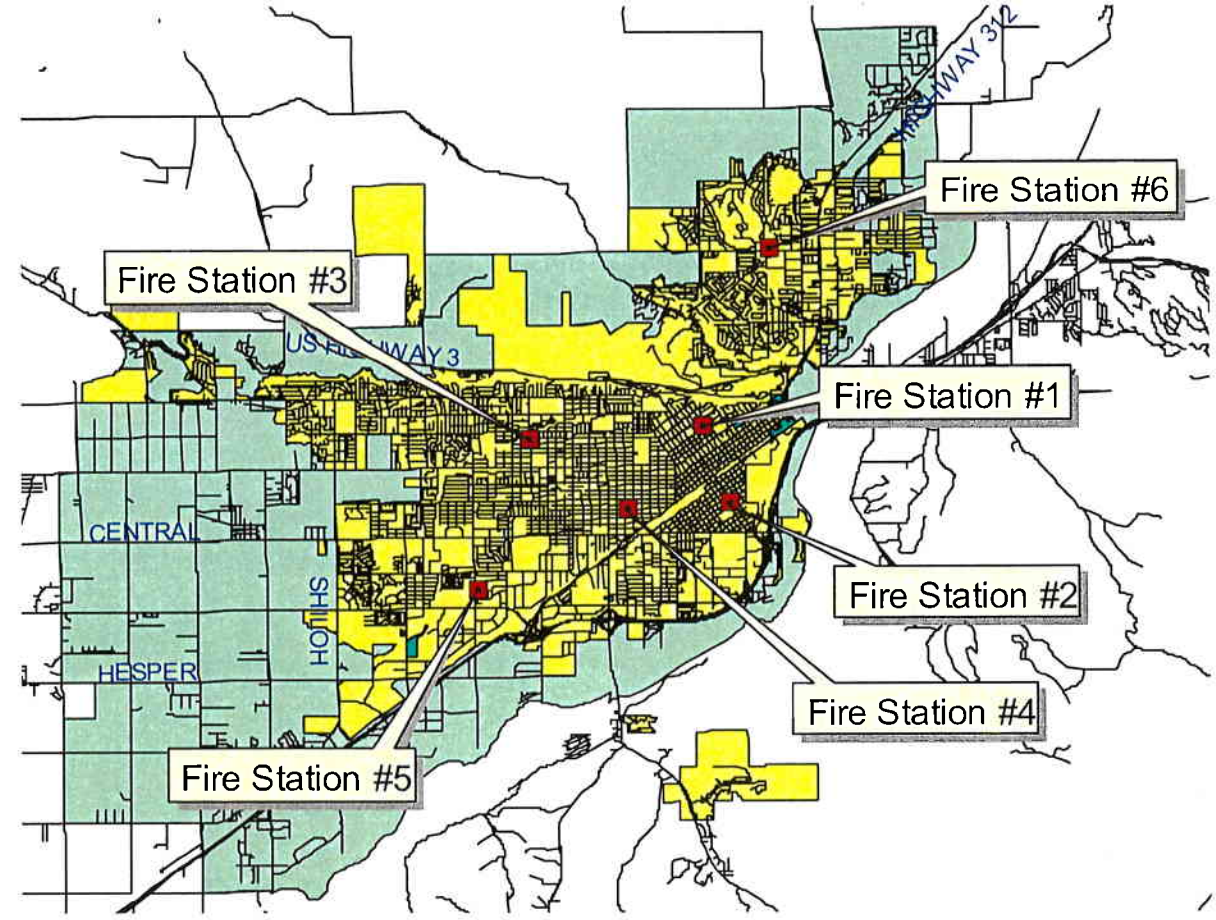
The Billings Fire Department is a well-managed, full service, public safety agency. The organization's personnel are enthusiastic about their work, and provide a full range of emergency services including:

- Fire suppression
- Emergency medical service (basic life support)
- Rescue
- Hazardous materials emergency response
- Review and inspection of new construction
- Public fire and life safety education
- Fire investigation
- Commercial and residential fire safety inspections

Resources

Facilities

The Billings Fire Department operates from six fire stations located throughout the city. Administration, fire prevention, and communications personnel work from the central fire station (Station 1). Five other stations house emergency response personnel. A maintenance facility is located adjacent to Station 5. The department has a training facility located at the Billings airport.



Staffing

Department staffing includes:

- Management – 2
- Support Services – 4
- Fire Prevention – 5
- Communications – 31
- Emergency Operations – 97

  Total staffing – 139

All six fire stations are staffed on a full-time basis. The table below lists the stations, and the response apparatus and personnel assigned to them.

Station	Apparatus		Staffing	
	Unit	Type	Minimum	Maximum
Station 1 2305 8th Ave N	4055	Battalion Chief	1	1
	4059	Engine	3	4
	4053	Truck	1	3
	4057	Brush truck	Cross staffed with personnel above	
	4088	Water tender		
	4084	Reserve quint	0	0
Station 2 501 S 28th St	4090	Engine	3	3
	4072	Rescue	Cross staffed	
Station 3 1928 17th St W	4067	Engine	3	3
	4069	Reserve engine	0	0
Station 4 475 6th St W	4066	Engine	3	3
	4085	Haz Mat unit	Cross staffed	
	4095	Haz Mat decon trailer		
	4073	Haz Mat equipment trailer		
Station 5 605 S 24th St W	4058	Engine	3	4
	4074	Brush truck	Cross staffed	
	4087	Water tender		
	4060	Reserve engine	0	0
Station 6 1601 St Andrews Dr	4091	Engine	3	3
	4083	Brush truck	Cross staffed	
	4075	Air unit		
TOTAL STAFFING PER SHIFT			**20**	**25**

Facilities and apparatus are in good to very good condition. A comprehensive facilities analysis has been conducted of all fire stations, and capital improvement needs identified. Apparatus are also on a scheduled replacement program.

Financial

The Billings Fire Department's Fiscal Year 2003 budget for services is $9,646,880. Contained within this amount is the full cost for operating the combined emergency communications center. Only approximately 10% of the $1,603,179 cost of operating this center is attributable to the fire department. When this adjustment is made, the cost of fire services becomes $8,204,018.

The department's budget is supported by revenue from city sources and from the BUFSA. The BUFSA's contribution during the current fiscal year is $717,566. Thus, the city's contribution to fire services is $7,486,452[1].

The chart below illustrates various value measures for both entities.

Jurisdiction	Market Value	Cost of service	Population	Responses	Cost per response	Cost per $1000 Market Value	Cost per capita
City	$3,549,987,586	$7,486,452	91,639	8,300	$901.98	$2.11	$81.70
BUFSA	$1,135,843,509	$717,566	12,397	582	$1,232.93	$0.63	$57.88
Total	$4,685,831,095	$8,204,018	$104,036	8,882	$923.67	$1.75	$78.86

Workload Evaluation

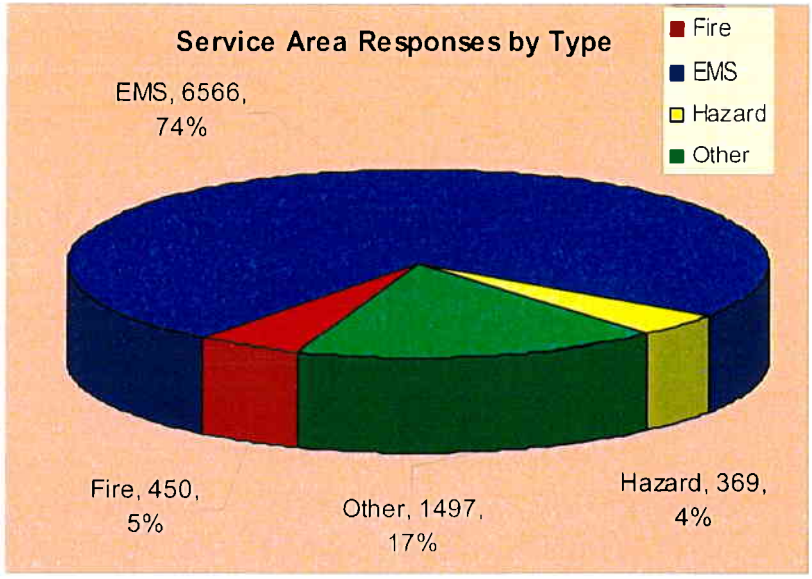
Much can be learned from a detailed review of the fire department's workload. Patterns of activity appear that, when considered in the deployment of resources, can lead to improvements in both service and efficiency.

It is fortunate that the Billings Fire Department maintains good records of its responses, in a format that allows for detailed analysis of workload and effectiveness.

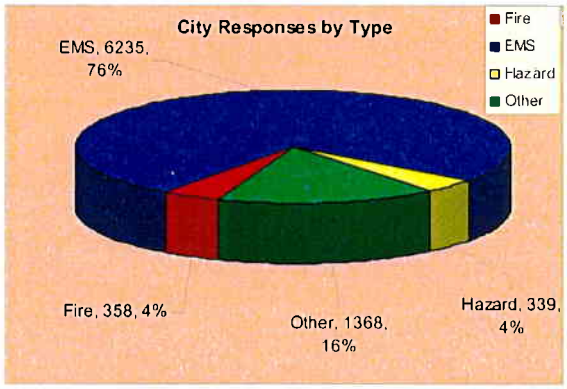
Emergency Response History

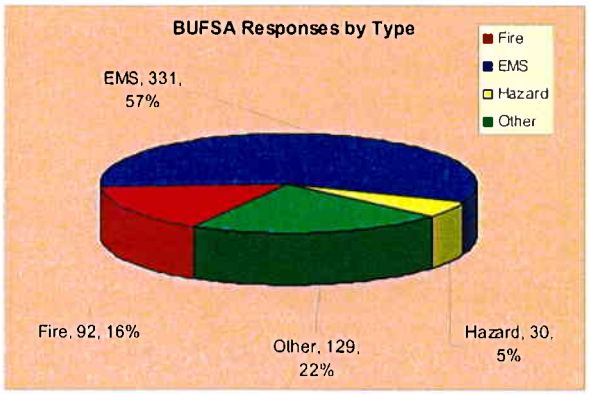
Emergency response activity has grown over the past 10 years at a rate greater than growth in population. In the time period December 1, 2001 through November 30, 2002 (referred to in this report as 2002) the department responded to 8,882 calls for service. The following chart shows the distribution of responses during this time period by type of response.

[1] The revenue for dispatch service from Yellowstone County Sheriff's Office is not included. The cost of services provided to them has been excluded from the fire department cost of service calculation.



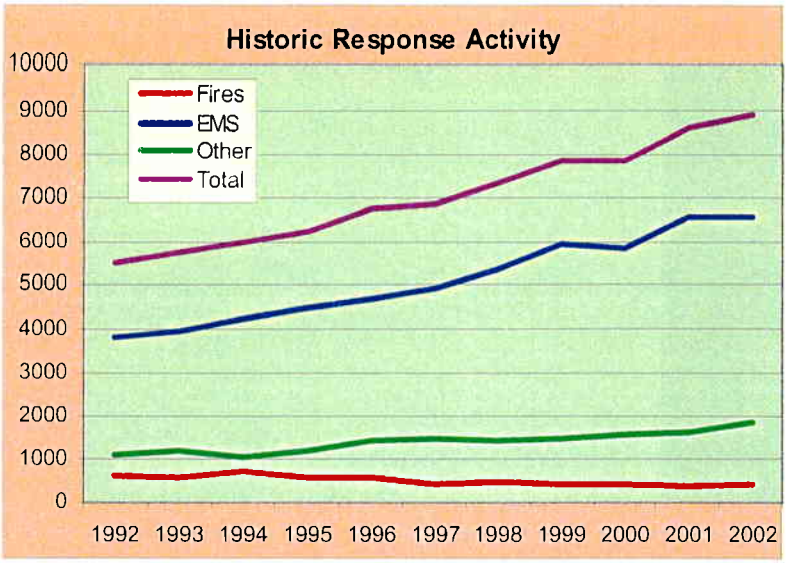
Response activity is substantially greater in the city (8,300) than in the BUFSA (582). Population drives emergency response workload, thus the city's larger population should generate greater response volume.





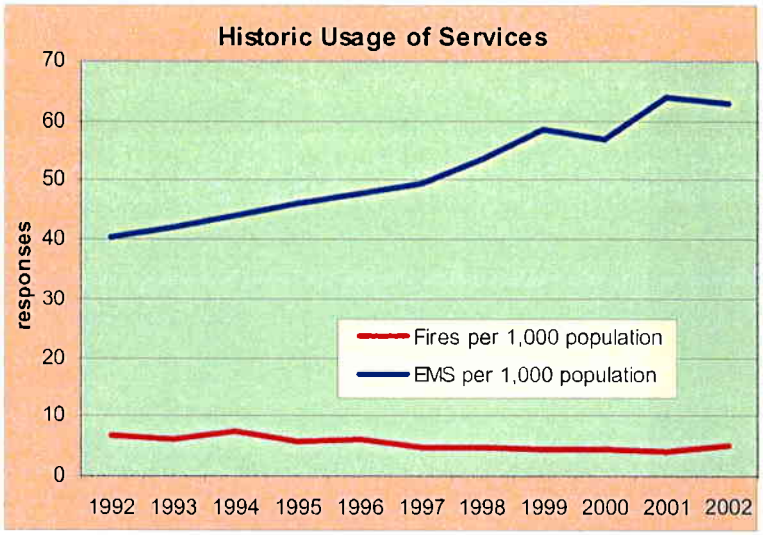
The predominance of the fire department's workload is for emergency medical services. This is very typical of departments providing this type of service across the nation.

The next chart shows how response activity (fire department workload) has increased over the past ten years. While fire responses have not increased, emergency medical service responses have increased substantially. Again, this is typical of the experience of other fire departments.



Activity	1992	2002	% Change
Fire responses	618	450	-27%
Emergency medical responses	3816	6566	+72%
Other responses	1091	1866	+71%

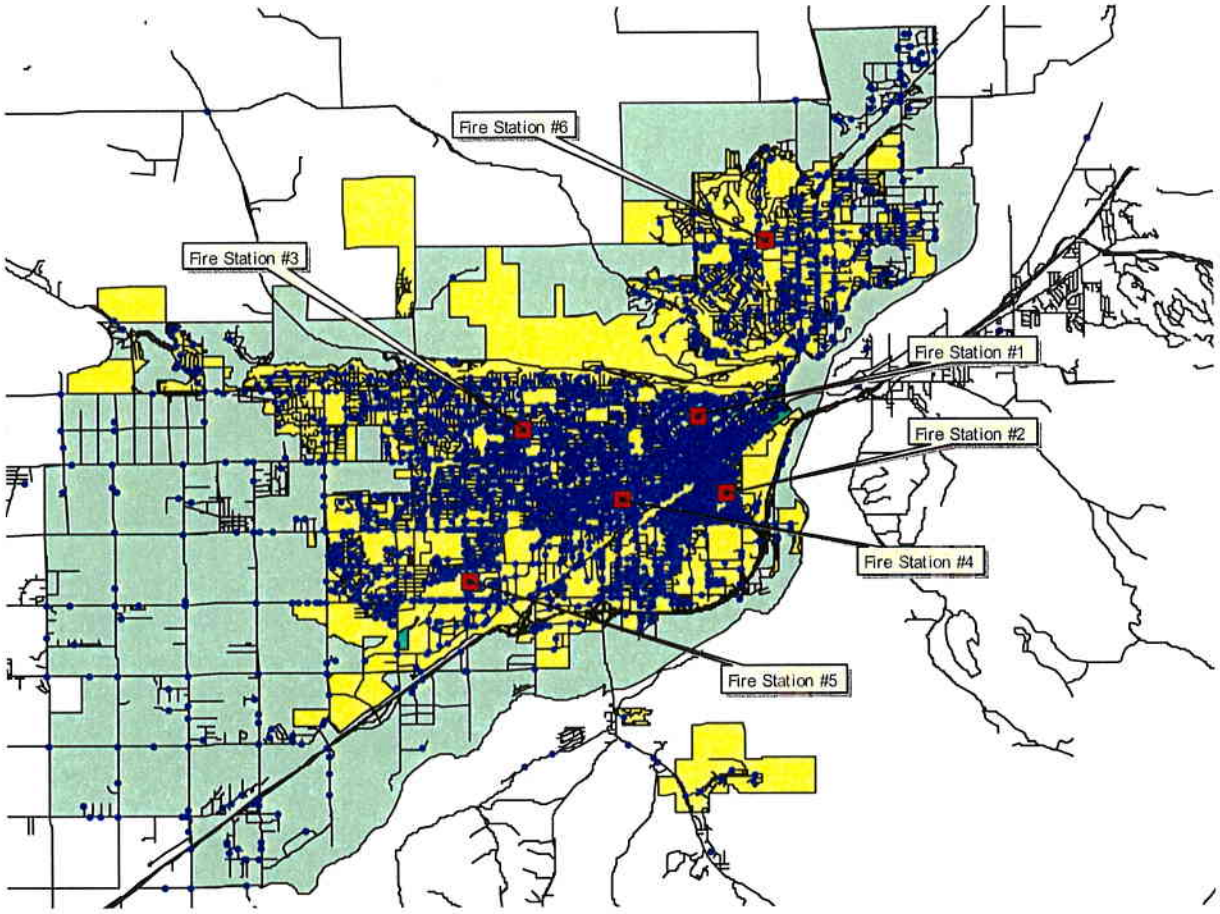
The use of the fire department's emergency response services have also increased over time. This is measured by the number of responses per 1,000 population, and is illustrated in the chart below. While fire responses have dropped on a per 1,000 population basis, use of emergency medical services has increased significantly.



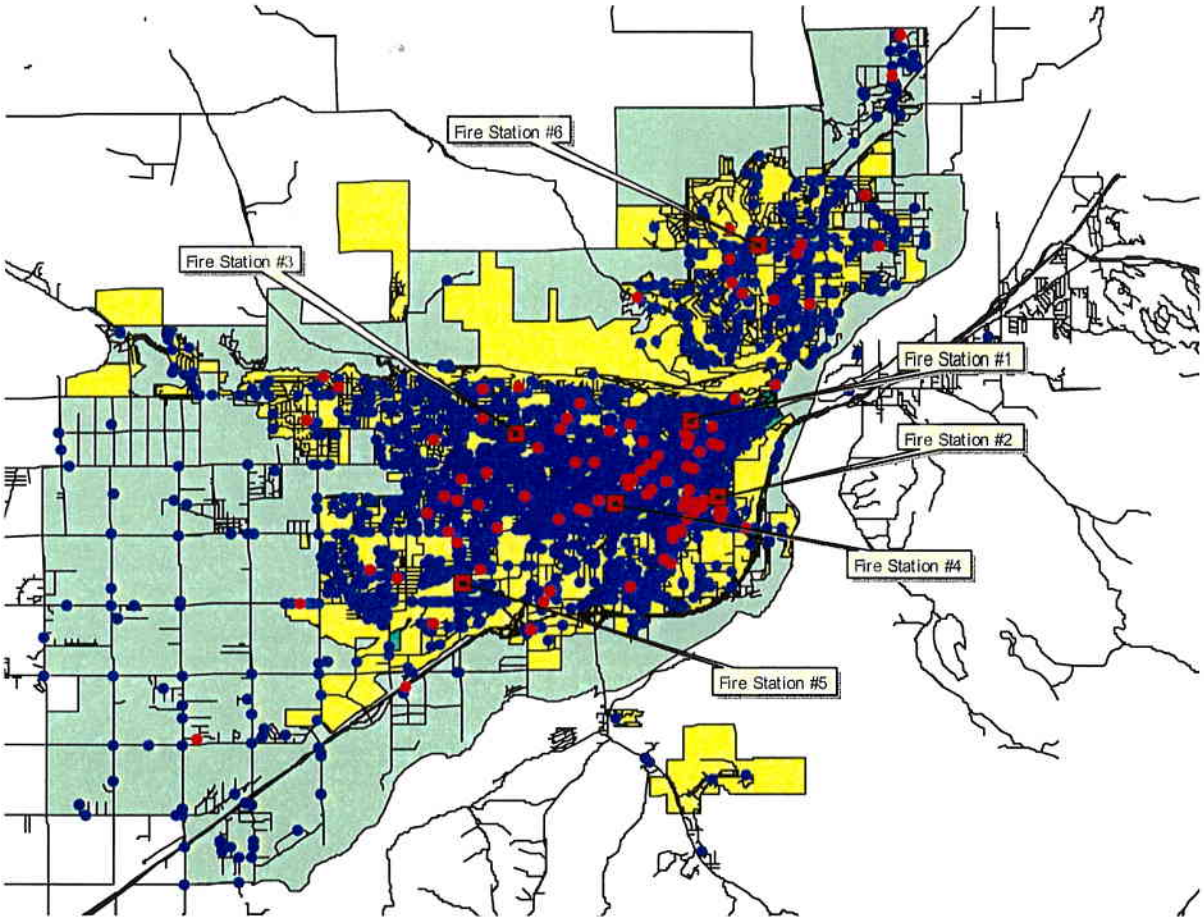
Activity	1992	2002	% Change
Fire responses per 1,000 population	6.6	4.3	-35%
Emergency medical responses per 1,000 population	40.5	63.3	+56%

Response Distribution

As indicated by the previous charts, response activity is focused in the more densely populated areas. The maps below show where incidents occurred during the 2002 study period. The first shows all incidents to which the department responded. The next shows only emergency medical service responses and structure fires. This depiction clearly shows that activity follows population density as is typical in most communities.



	City of Billings
	BUFSA
•	Incident location

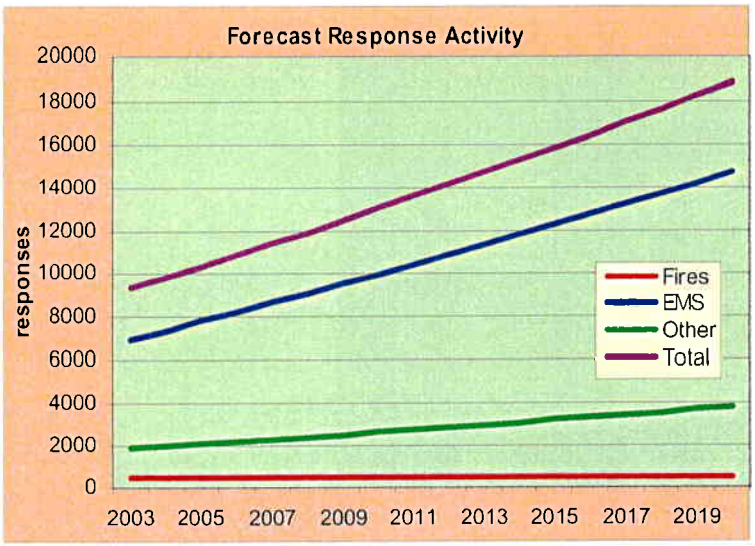


	City of Billings
	BUFSA
•	EMS incident
•	Structure fire

Predicted Emergency Response Activity

Community planners predict that population will continue to increase at a rate of approximately 2% per year for the next one to two decades, absent any unique influence. Given that projection, the population of the Billings Fire Department service area should reach 131,267 by the year 2020.

Historic changes in emergency response activity are likely to continue into the future. Fire activity should remain flat or decrease slightly over time. Emergency medical service responses will likely increase due to the aging of the population and increased need for this type of service. Other responses should also continue to increase based on growth in population in particular. The following chart shows how emergency response activity should change during the next 18 years.



If historic activity continues its trend, the Billings Fire Department should expect to respond to 18,875 incidents in the year 2020 (450 fires, 14,690 emergency medical responses, 3,735 other responses).

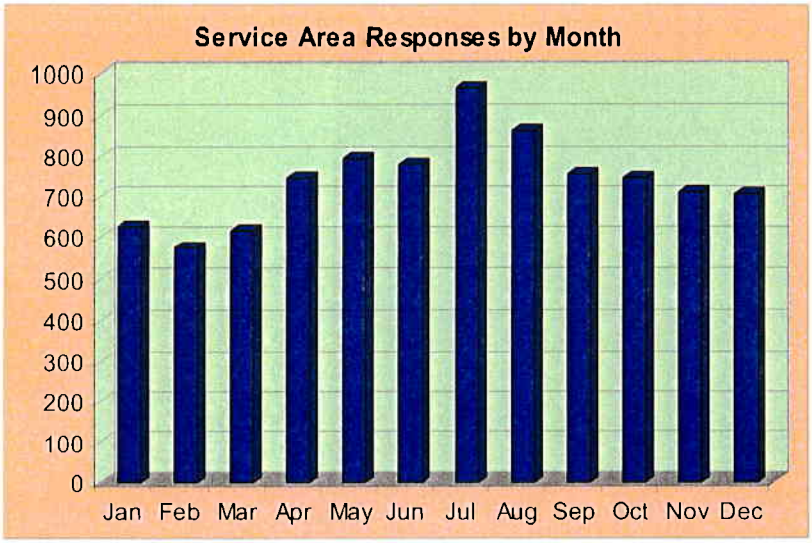
This will be a significant workload, unmanageable with current resources. The department will need to grow to keep pace with workload, develop programs and practices to reduce demand for services, or a combination of the two, in order to preserve service levels and effectiveness.

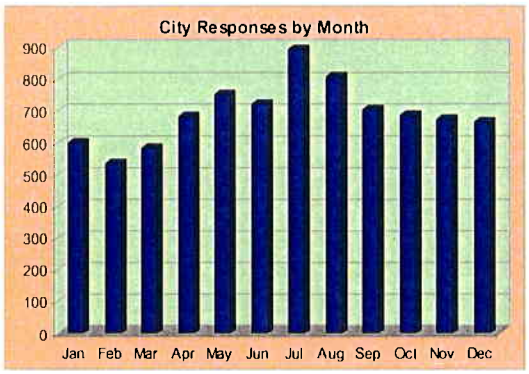
Temporal Analysis

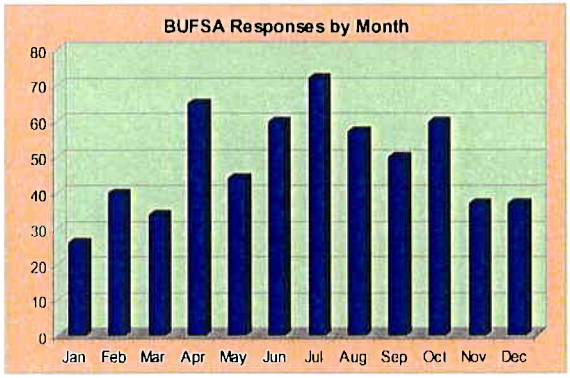
Emergency response workload can be highly variable over the course of a day, week, or year. Understanding when peak activity periods occur can assist in determining the deployment of resources.

For example, the department may choose to provide higher staffing levels during peak periods when concurrent responses are frequent. Or it may choose to conduct non-response activities, like training, during periods of lower activity to avoid response delays.

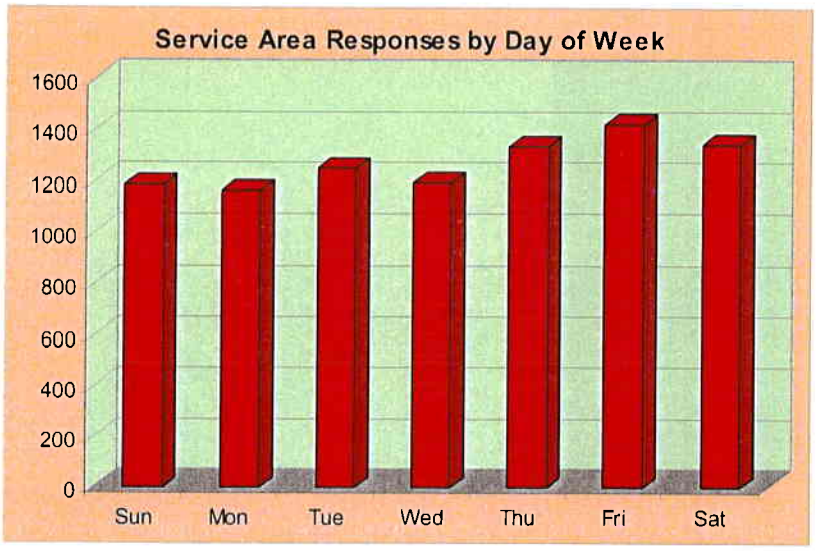
The following charts illustrate the variability of workload for the Billings Fire Department. The first shows response activity by month for December 1, 2001, through November 30, 2002 (2002). Summer months are the busiest for the department.

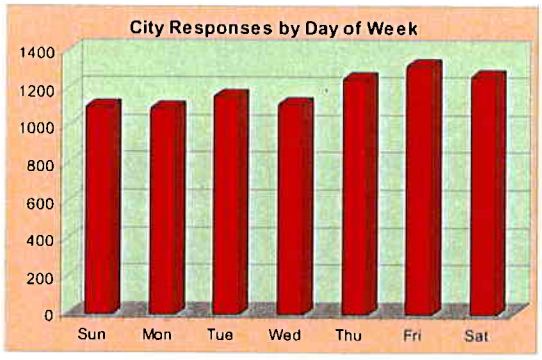


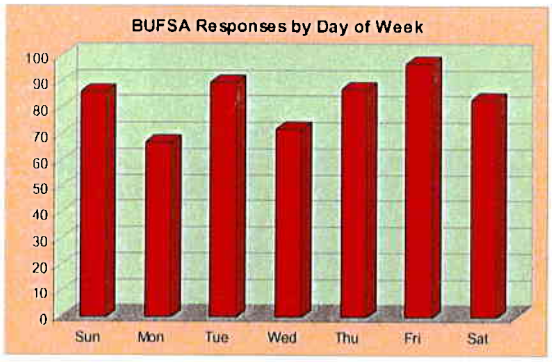




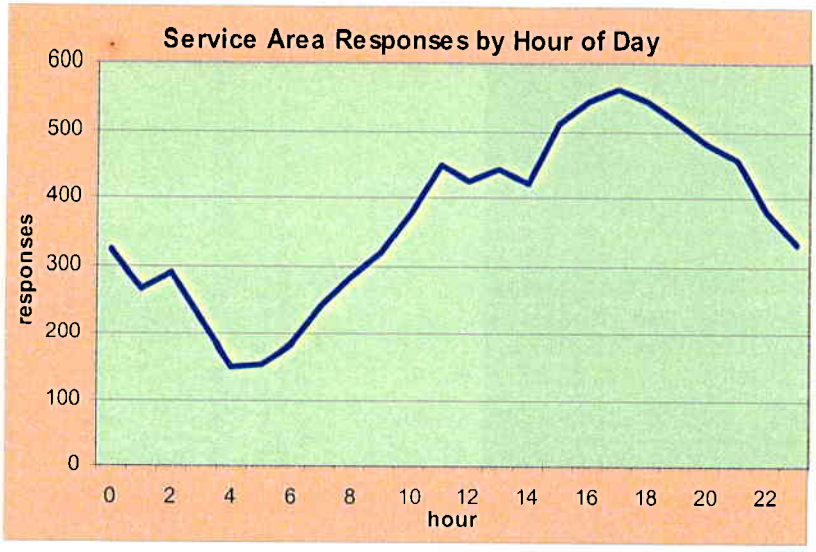
The next charts show response activity by day of week. These show little variability. In communities that lose daytime population to neighboring employment centers, activity usually decreases during the weekday. In communities that are employment centers, weekday activity usually increases. Since Billings is both the home, and employment center, response activity should be, and is relatively stable through the week.

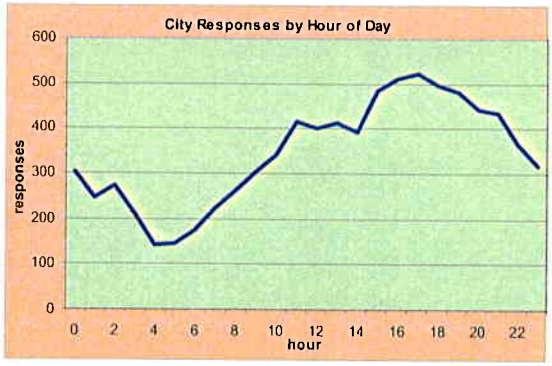


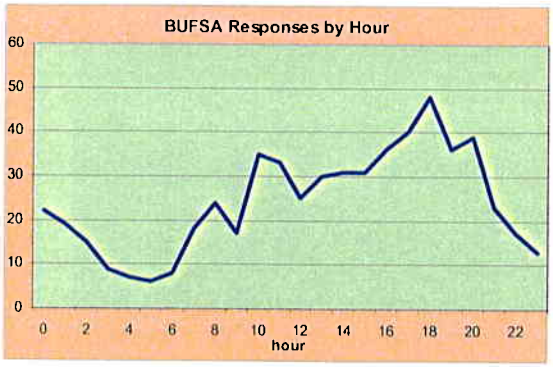




Response activity tends to increase during the daytime and evening hours and decreases during the night. People are more active during the day and evening creating more opportunity for accidents that result in a fire department response. Billings is no exception as illustrated in the charts that follow. Response workload is at its highest between 3:00 pm and 8:00 pm.



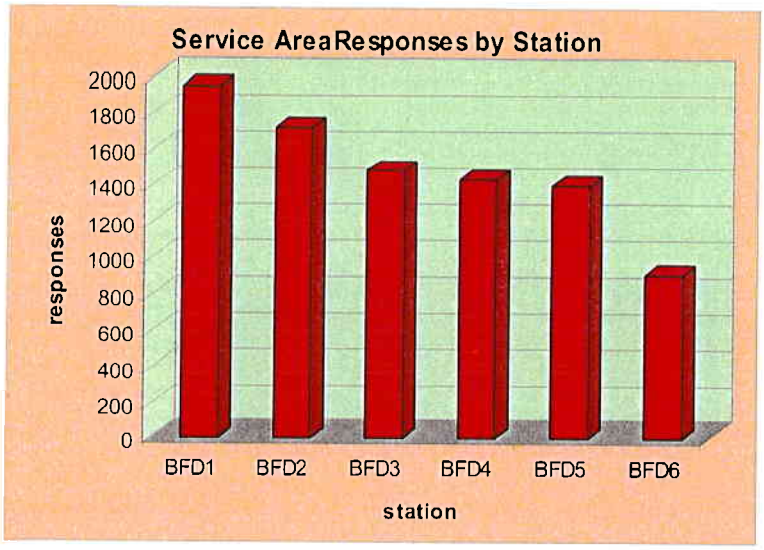


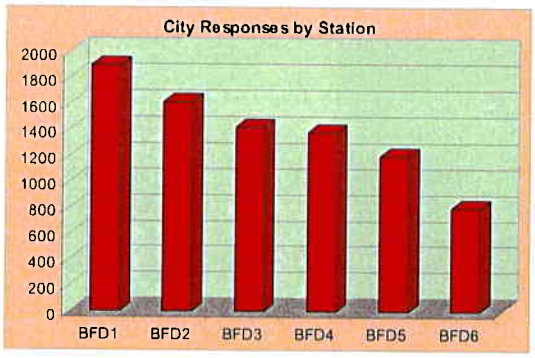


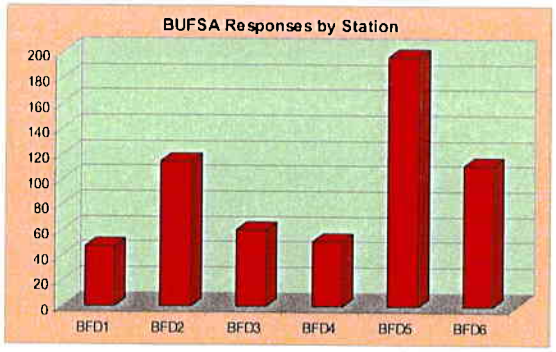
Resource Workload

The workload on emergency response units is a large factor in response time performance. The busier a given unit the less available it is for the next emergency. If a unit is unavailable then a unit from a more distant station must respond, increasing overall response time. Unlike production line operations, maintaining a degree of surplus capacity helps ensure prompt response to emergencies.

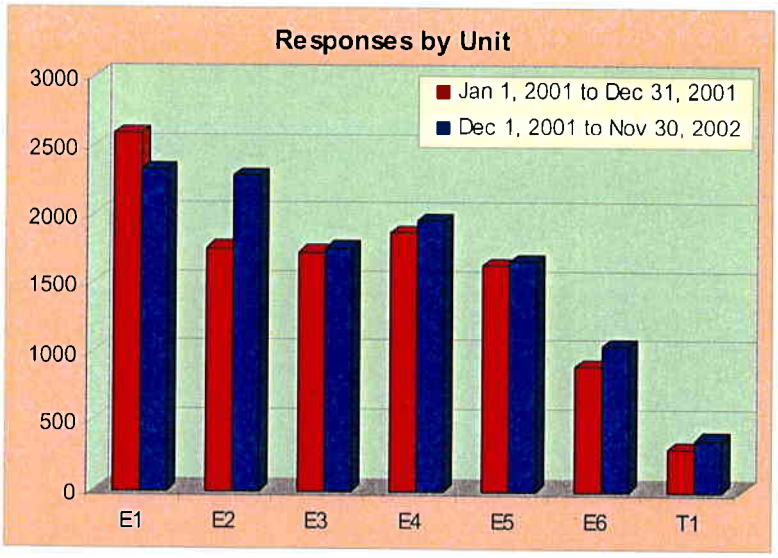
The next charts show response activity by station. Response activity within the individual station service areas is not excessive at this time.







The next chart shows response activity by unit. On many calls, more than one unit responds. Depending on response practices, this can lead to units being at or near an excessive response load. Engines 1 and 2 are approaching capacity.



Geographic Community Risk Analysis

Fire Protection Risk Factors

While there are many considerations that can be assessed when evaluating a community's fire protection risks, the issues can be narrowed into two major categories. How likely is it that a fire will occur within a given area and how bad will the fire be if it does occur? The geographic community risk analysis involves the answers to both of these questions.

The first phase of the fire protection risk analysis involves statistical analysis of the risk of fire occurrence. The second involves an analysis of the consequences, or the impact to the community, if a fire does occur.

The risk of fire occurrence can be attributed to various factors, some physical and some cultural. For instance, the physical proximity of a structure to highly combustible vegetation increases the risk of the structure being involved in fire as a result of a nearby wildland fire incident. This factor, commonly called urban-wildland interface, is why insurance costs are often higher for structures so exposed in comparison with other similar structures. It's a good example of a physical factor contributing to the risk of fire occurrence.

Cultural or demographic issues can play just as significant a role as physical issues. It has long been documented that the rate of structure fires per capita is highest in the southeastern United States. Not surprisingly, it can also be seen that the acceptance and use of newer, more aggressive fire and building codes was slower to develop in this same geographical area. Likewise, a higher rate of fire incidents per capita is typically observed when the density of population in a given geographic area increases. Densely populated urban settings, areas with less owner-occupancy, and communities with economic blight often trend toward higher fire incident rates.

In a community with stable growth, the likelihood of fire occurrence is reasonably tracked through an analysis of fire incident experience. In the absence of significant physical or cultural change, such as major factory closings or civil unrest, the analysis of fire experience yields a fair insight into the likelihood that a fire will occur within a given time period and within a given area. This fire incident experience analysis has been provided, both statistically and graphically, in other areas of this report.

The impact a fire is likely to have on a community if it does occur is a conclusion involving more prediction than experience. Fire instance, a fire in a vacant garage has little overall impact on the economic welfare of a community while a fire in the primary facility of a city's major employer can be devastating. Even if an analysis of fire experience shows both are equally likely to occur, one fire carries far more dire consequences than the other. A complete community fire protection risk analysis must involve some process of identifying the areas within the community where a fire will have greatest negative impact.

Consequence Factors

The consequence evaluation in this community fire risk analysis takes into account several major factors in an effort to geographically identify those areas of the community where fire is likely to have greatest impact. During the community evaluation, these consequence factors were assessed and utilized in placing structures into risk categories that carry numerical weight in the overall risk analysis formula.

Life Risk

Structures within a given community that present a significant risk for large loss of life are assessed a higher risk score, even if they are not large buildings. As an example, even a relatively small apartment structure with multiple families will assess at a higher risk than a comparatively large single-family dwelling. Hotels or high-rise occupancies will assess as higher risks than a commercial or light industrial occupancy. Structures used to house or assemble high-risk populations, such as elderly or disabled persons, will also assess at high risk. In general, the consequences of fire incidents in such structures can be a significant loss of life and is weighted accordingly in the risk analysis.

Economic Impact

Even though the destruction of a particular property may not result in any loss of life, the impact on a community can be devastating if it has a strong effect on the economy. Loss of employment, decreased taxable value, and reduction or losses to associated service companies, are all examples of the negative economic impact that fire can have on a community.

The economic impact of a fire depends on the type, use, and size of the structure involved. The total destruction of a single-family dwelling will have little overall impact on a community's economy, no matter how large the house. Likewise, loss of a single commercial entity, such as a restaurant or auto repair shop, may have an economic impact that is both temporary and limited to the local neighborhood. Loss of significant industrial facility or manufacturer, however, can cripple an entire community's economy for months or even years. The predictable economic impact, therefore, is also considered when placing structures into risk categories in the analysis.

Resource Demand

The outcome of a fire incident in comparison with the resources available is somewhat predictable. A study by the National Fire Protection Association on residential structure fires from 1994 to 1998 indicated that fatalities and dollar loss were over 85% lower in those incidents where the fire was contained to the room of origin.

Accomplishing this early control of a fire requires the proper number of firefighters and resources to arrive on the incident quickly enough to effectively deploy and contain the fire in its early stages. An ineffective number of resources or a later arrival would permit the fire to spread beyond the room of origin with predictable results.

The approximate number of firefighters and engine companies necessary to rapidly and effectively contain a fire within a given structure is evaluated. The structures are generally categorized within the medium, high, or maximum range for needed resources in accordance with the resource table utilized in the International Fire Service Accreditation Congress (IFSAC) model. The quantity and density of each category within given geographical areas (in this case using zoning classes) are utilized within the overall risk formula.

Risk Analysis Methodology

The geographic community risk analysis begins with a basic review of the zoning classifications for the area studied. Zoning classifications are utilized because they are an existing regulated classification that typically involves the type, use, size, and density of structures within a given geographical boundary. As indicated earlier, these factors weigh

heavily in the evaluation of both the likelihood of fire occurrence and the anticipated impact of a fire incident. By utilizing the zoning classes, advantage is taken of existing classifications that already exist and involve these factors.

Each community, however, differs slightly in the specifications for structure size, use, and density from zoning class to zoning class. Therefore, a basic review of each zoning classification in existence was conducted for purposes of establishing a standard risk-density factor that is based on true counts of structures within each zoning class. This process was conducted by actually driving through, street-by-street, representative areas of the various zoning classes and conducting a "windshield assessment" of structure type, use, and risk category.

These physical counts were compared to the actual geographic size of the study area using geographic information systems software (GIS). The result is an averaged risk-density number that is averaged across a particular zoning classification. Finally, a mathematical formula was utilized that considers the number and density of structures as categorized by potential community impact, consequence factors, and resource demand.

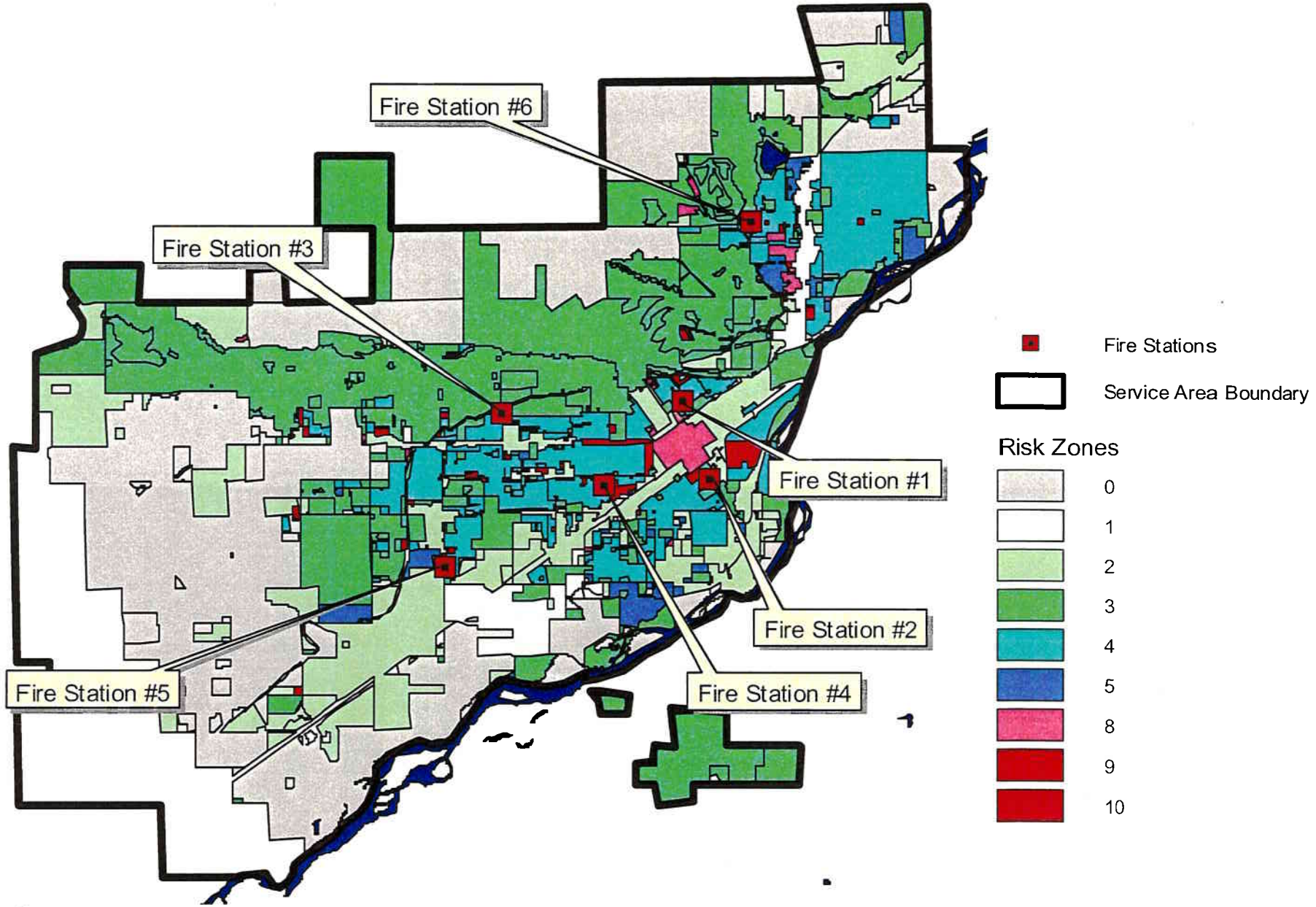
A resource factor was assigned to structures based on a relative comparison of resources (response companies and firefighters) that would be needed to effectively manage a fire incident. Medium risk occupancies receive a baseline resource factor of 1, high risk occupancies receive 1.3, and maximum risk occupancies receive 3.5. Next, multiplying the number of structures within each risk category by the resource factor derives a total risk score for the representative sample area.

In the next step, geographic information systems (GIS) software is used to determine the precise size of the sample areas evaluated. The total risk score of each area is divided by the size of the sample area in acres to arrive at the risk density factor. In most cases, several sample areas of each zoning class are used and then averaged to increase dependability of the results. This risk density factor can be used for comparison purposes when evaluating the overall fire risk within the community, zoning class by zoning class.

The following table lists the numerical risk factor derived from this formula for the study area of Billings, Montana.

Zoning Class	Risk Factor
Residential Multi-Family Restricted	2606
Neighborhood Commercial	2417
Residential Multi-Family	2000
Central Business District	1951
Residential 5000	1394
Residential Manufactured Home	1394
Residential 6000	1162
Residential 7000	996
Heavy Industrial	972
Residential 8000	871
Residential Professional	833
Planned Unit Development	743
Residential 9600	726
Controlled Industrial	608
Entryway Light Industrial	608
Medical Corridor Permit District	601
Community Commercial	490
Residential 15000	465
Entryway Mixed Use	357
Highway Commercial	257
South 27th Street Permit District	257
Entryway Light Commercial	257
Entryway General Commercial	257
Agricultural Suburban	5
Agricultural Open	0

A graphical representation of this risk analysis can also be derived from the numerical risk factor. The figure below shows each zoning classification within the map area by shading that corresponds to the relative fire risk in comparison with the overall community. A risk factor number assigned to each reflects the relative degree of risk on a scale from zero (little if any risk) to ten (maximum risk).


Fire Station #6
Fire Station #3
Fire Station #1
Fire Station #2
Fire Station #4
Fire Station #5
Fire Stations
Service Area Boundary
Risk Zones
0
1
2
3
4
5
8
9
10

Effective deployment planning concentrates more resources in areas of higher risk. This accomplishes two important results. First, it increases the likelihood that a response unit will be within a reasonable distance of the higher risk emergency. Second, it reduces the time required to get additional resources to the scene. The higher the risk, the more firefighters and apparatus will be needed to provide effective control of the emergency.

Billings fire stations are located in proximity to the higher risk portions of the service area. Discussed later in this report is the adequacy of available resources (personnel and apparatus) in relation to the area's risk.

Performance and Outcomes

The ultimate goal of any emergency service delivery system is to provide sufficient resources (personnel, apparatus, and equipment) to the scene of an emergency in time to take effective action to minimize the impacts of the emergency. This need applies to fires, medical emergencies, and any other emergency situation to which the fire department responds.

Before discussing the department's current performance, it is important to gain an understanding of the dynamics of fire and medical emergencies.

Dynamics of Fire in Buildings

Most fires within buildings develop in a predictable fashion, unless influenced by highly flammable material. Ignition, or the beginning of a fire, starts the sequence of events. It may take some minutes or even hours from the time of ignition until flame is visible. This smoldering stage is very dangerous, especially during times when people are sleeping, since large amounts of highly toxic smoke may be generated during early phases.

Once flames do appear, the sequence continues rapidly. Combustible material adjacent to the flame heats and ignites, which in turn heats and ignites other adjacent materials if sufficient oxygen is present. As the objects burn, heated gases accumulate at the ceiling of the room. Some of the gases are flammable and are highly toxic.

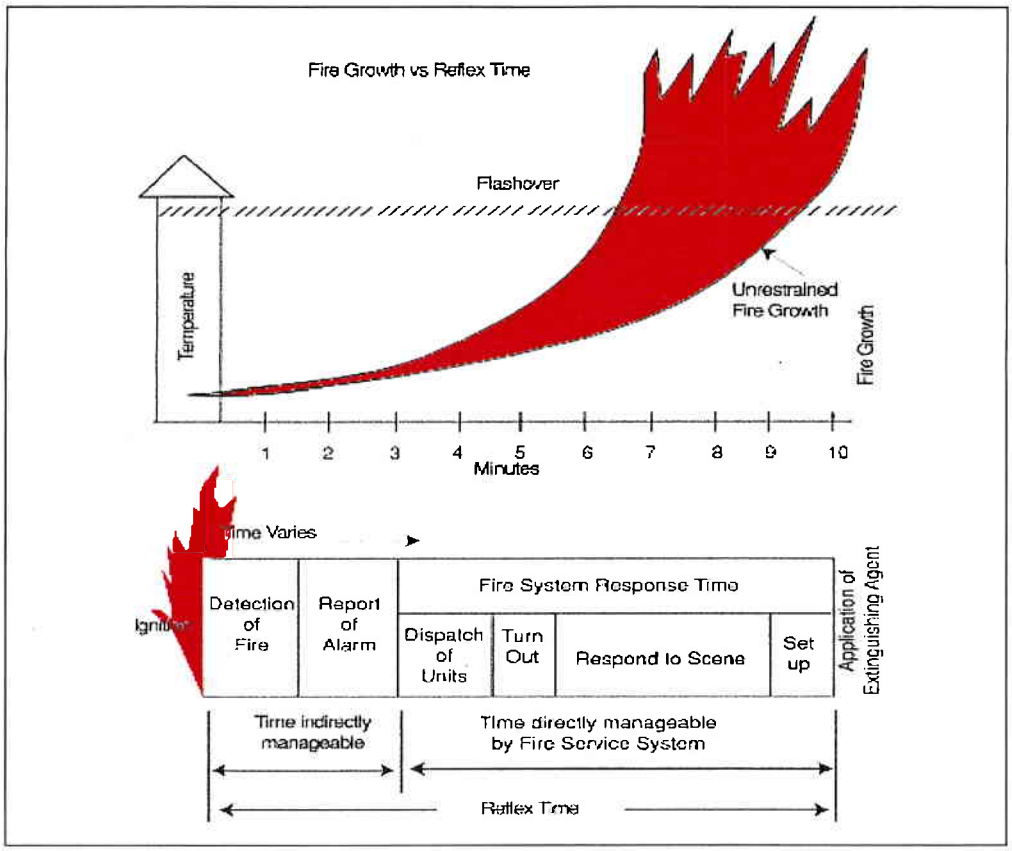
The spread of the fire continues quickly. Soon the flammable gases at the ceiling reach ignition temperature. At that point, an event termed "flashover" takes place; the gases ignite, which in turn ignites everything in the room. Once flashover occurs, damage caused by the fire is significant and the environment within the room can no longer support human life.

Flashover usually happens about five to eight minutes from the appearance of flame in typically furnished and ventilated buildings. Since flashover has such a dramatic influence on the outcome of a fire event, the goal of any fire agency is to apply water to a fire before flashover takes place.

Perhaps as important as preventing flashover is the need to control a fire before it does damage to the structural framing of a building. Materials used to construct buildings today are often less fire resistive than the heavy structural skeletons of older frame buildings. Roof trusses and floor joists are commonly made with lighter materials more easily weakened by the effects of fire. "Light weight" roof trusses fail after five to seven minutes of direct flame impingement. Plywood I-beam joists can fail after as little as three minutes of flame contact. This creates a very dangerous environment for firefighters.

In addition, the contents of buildings today have a much greater potential for heat production than in the past. The widespread use of plastics in furnishings and other building contents rapidly accelerate fire spread and increase the amount of water needed to effectively control a fire. All of these factors make the need for early application of water essential to a successful fire outcome.

A number of things must happen quickly to make it possible to achieve fire suppression prior to flashover. The following figure illustrates the sequence of events.



The reflex time continuum consists of six steps, beginning with ignition and concluding with the application of (usually) water. The time required for each of the six components varies. The policies and practices of the fire department directly influence four of the steps, but two are only indirectly manageable. The six parts of the continuum are:

1. **Detection**: The detection of a fire may occur immediately if someone happens to be present or if an automatic system is functioning. Otherwise, detection may be delayed, sometimes for a considerable period.
2. **Report**: Today most fires are reported by telephone to the 9-1-1 center. Call takers must quickly elicit accurate information about the nature and location of the fire from persons who are apt to be excited. A citizen well trained in how to report emergencies can reduce the time required for this phase.
3. **Dispatch**: The dispatcher must identify the correct fire units, subsequently dispatch them to the emergency, and continue to update information about the emergency while the units respond. This step offers a number of technological opportunities to speed the process including computer aided dispatch and global positioning systems.

4. **Turnout**: Firefighters must don firefighting equipment, assemble on the response vehicle, and begin travel to the fire. Good training and proper fire station design can minimize the time required for this step.
5. **Response**: This is potentially the longest phase of the continuum. The distance between the fire station and the location of the emergency influences reflex time the most. The quality and connectivity of streets, traffic, driver training, geography, and environmental conditions are also a factor.
6. **Set up**: Last, once firefighters arrive on the scene of a fire emergency, fire apparatus are positioned, hose lines stretched out, additional equipment assembled, and certain preliminary tasks performed (such as rescue) before entry is made to the structure and water is applied to the fire.

As is apparent by this description of the sequence of events, application of water in time to prevent flashover is a serious challenge for any fire department. It is reasonable though, to use the continuum as a tool for designing the emergency response system.

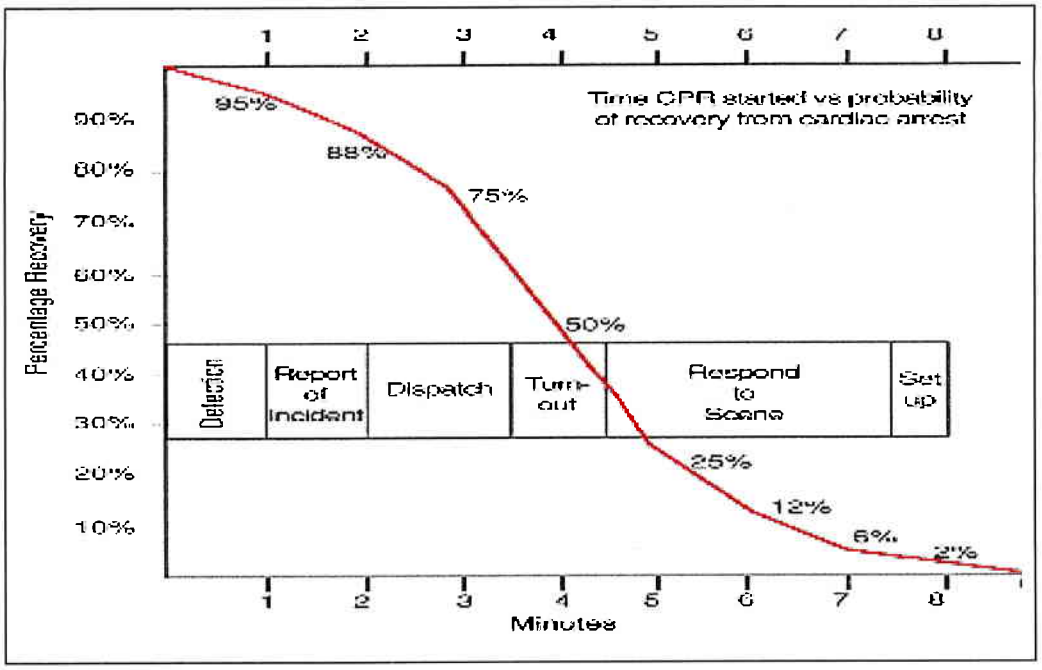
Emergency Medical Event Sequence

Cardiac arrest is the most significant life threatening medical event. A victim of cardiac arrest has mere minutes in which to receive definitive lifesaving care if there is to be any hope for resuscitation.

Recently, the American Heart Association (AHA) issued a new set of cardiopulmonary resuscitation guidelines designed to streamline emergency procedures for heart attack victims, and to increase the likelihood of survival. The AHA guidelines include new goals for the application of cardiac defibrillation to cardiac arrest victims.

Heart attack survival chances fall by seven to ten percent for every minute between collapse and defibrillation. Consequently, the AHA now recommends the administration of "clot-busting" drugs as soon as professional medical care is available and cardiac defibrillation within five minutes of cardiac arrest.

As with fires, the sequence of events that lead to emergency cardiac care can be visually shown, as in the following figure.



The percentage of opportunity for recovery from cardiac arrest drops quickly as time progresses. The stages of medical response are very similar to the components described for a fire response. Recent research stresses the importance of rapid cardiac defibrillation and administration of certain drugs as a means of improving the opportunity for successful resuscitation and survival. An Oregon fire department recently studied the effect of time on cardiac arrest resuscitation and found that nearly all of their "saves" were within one and one-half miles of a fire station, underscoring the importance of quick response.

People, Tools and Time

Time matters a great deal in the achievement of an effective outcome to an emergency event. Time, however, isn't the only factor. Delivering sufficient numbers of properly trained, appropriately equipped, personnel within the critical time period completes the equation.

For medical emergencies this can vary based on the nature of the emergency. Most medical emergencies are not time critical. However, for serious trauma, cardiac arrest, or conditions that may lead to cardiac arrest, response time is very critical.

Equally critical is delivering enough personnel to the scene to perform all of the concurrent tasks required to deliver quality emergency care. For a cardiac arrest this can be up to six personnel; two to perform CPR, two to set up and operate advanced medical equipment, one to record the actions taken by emergency care workers, and one to direct patient care.

Thus, for a medical emergency the real test of performance is the time it takes to provide the personnel and equipment needed to deal effectively with the patient's condition, not necessarily the time it takes for the first person to arrive.

Fire emergencies are even more resource critical. Again, the true test of performance is the time it takes to deliver sufficient personnel to initiate application of water on the fire. This is the only practical method to reverse the continuing internal temperature increases and ultimately prevent flashover. The arrival of one person with a portable radio does not provide fire intervention capability and should not be counted as "arrival" by the fire department.

In order to legally enter a building to conduct interior firefighting operations at least four personnel must be on scene. The initial arrival of effective resources should be measured at the point in time when at least four personnel, properly trained and equipped, have assembled at the fire.

Effective operations at the scene of fire emergencies also depend on the arrival of enough trained personnel to perform all of the duties and tasks required to control a fire event. Tasks that must be performed can be broken down into two key components, life safety and fire flow. Life safety tasks are based on the number of building occupants, their location, status, and ability to take self-preservation action. Life safety tasks involve the search, rescue, and evacuation of victims. The fire flow component involves delivering sufficient quantities of water to extinguish the fire, and creating an environment within the building that allows entry by firefighters.

The number and types of tasks needing simultaneous action will dictate the minimum number of firefighters required to combat different types of fires. In the absence of adequate personnel to perform concurrent action, the command officer must prioritize the tasks, completing some in chronological order rather than at the same time, reducing overall fire emergency effectiveness. These tasks include:

command	scene safety	search and rescue
fire attack	water supply	pump operation
ventilation	back-up	

The following chart illustrates the fire ground staffing recommendations of the Commission on Fire Accreditation, International.

The following definitions apply to the chart:

Low Risk – Fires involving small sheds and other outbuildings, larger vehicles and similar. Characterized by sustained attack fire flows typically less than 250 gallons per minute.

Moderate Risk – Fires involving single-family dwellings and equivalently sized commercial office properties. Sustained attack fire flows range between 250 gallons per minute to 1,000 gallons per minute.

High Risk – Fires involving larger commercial properties with sustained attack fire flows between 1,000 gallons per minute and 2,500 gallons per minute

Maximum Risk – Fires in buildings with unusual hazards such as high-rise buildings, hazardous materials facilities, very large buildings, and high life risk properties (nursing homes, hospitals, etc.). Though they may not require large sustained attack fire flows they do require more personnel to perform tasks required for effective control.

Minimum Firefighting Personnel Needed Based Upon Level of Risk

Task	Maximum Risk	High Risk	Moderate Risk	Low Risk
Attack Line	4	4	2	2
Search and Rescue	4	2	2	
Ventilation	4	2	2	
Back-Up Line/Rapid Intervention	8	6	4	2
Pump Operator	1	1	1	1
Water Supply	1	1	1	
Utilities Support	1	1	1	
Command/Safety	2	2	2	1#
Forcible Entry	*			
Salvage	*			
Overhaul	*			
Communication	1*			
Operations Section Chief	1			
Logistics	1			
Planning	1*			
Staging	1*			
Rehabilitation	1			
Division/Group Supervisors	2*			
High Rise Evacuation	10*			
Stairwell Support	10*			
Totals:	53	19	15	6

Can often be handled by the first due officer.
* At maximum and high-risk fires, additional personnel may be needed.
See the definitions on the previous page

NFPA 1710

The National Fire Protection Association (NFPA) has issued a new standard for fire departments. This standard, among other things, identifies a target response time performance objective for career fire departments and a target staffing standard for structure fires. Though not a legal mandate, NFPA 1710 does provide a useful benchmark against which to measure fire department performance.

NFPA 1710 contains time performance standards for structure fire response as well as emergency medical response. Each will be discussed individually.

Structure Fire Response

NFPA 1710 recommends that the first company arrive at the scene of a structure fire within five minutes or less, 90% of the time. The standard establishes that a response "company" consists of four personnel. The standard does not require that all four be on the same vehicle, but does expect that the four will operate as a single functioning unit once on scene.

There is another reason the arrival of four personnel is critical for structure fires. As mentioned earlier, current safety regulations require that before personnel can enter a building to extinguish a fire at least two personnel must be on scene and assigned to conduct search and rescue in case the fire attack crew becomes trapped. This is referred to as the "two-in, two out" rule. The only exception to this regulation is if it is known that victims trapped are inside the building.

Thus, given the fire department's typical staffing of engines, the time it takes for the second unit to arrive becomes very important. If additional help is a considerable amount of time away the fire will continue to grow rapidly contributing to significantly more damage to the property.

Finally, the NFPA standard calls for the arrival of the entire initial assignment (three or four engines, a ladder company and a chief officer) within eight minutes, 90 % of the time. This is to ensure that enough people and equipment arrive soon enough to be effective in controlling a fire before substantial damage occurs.[2]

NFPA 1710 describes the following performance as meeting the structure fire response criteria of the standard:

- *Turnout time within one minute, 90% of the time*
- *Arrival of the first "company" (travel time) within four minutes, 90% of the time, or*
- *Arrival of the entire initial response assignment (all units assigned to the call) within eight minutes, 90% of the time*

Emergency Medical Response

There are three time standards for emergency medical responses. They are:

- *Turnout time within one minute, 90% of the time*
- *Arrival of a unit with first responder or higher level of capability (basic life support) within four minutes, 90% of the time*
- *Arrival of an advanced life support unit, where this service is provided by the fire department, within eight minutes or less, 90% of the time*

Billings Fire Department provides the basic life support component of emergency medical response. American Medical Response provides the advanced life support component.

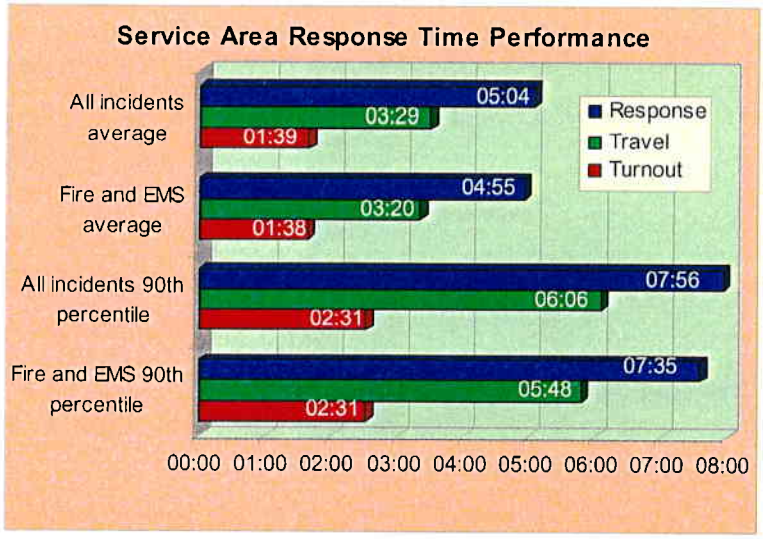
Billings Fire Department Performance

The discussion of response performance starts with first unit response time. Recall that the benchmark response time performance, as described by NFPA 1710, is five minutes, 90% of the time.

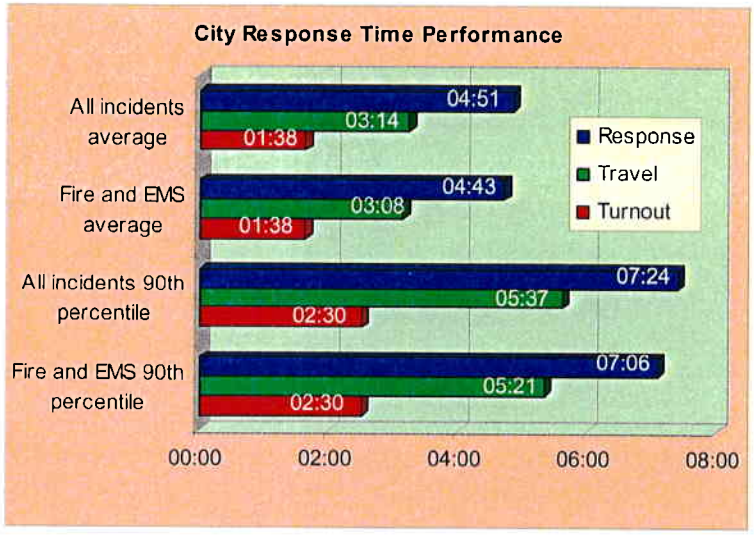
[2] See previous discussion about the "time/temperature curve" and the effects of flashover.

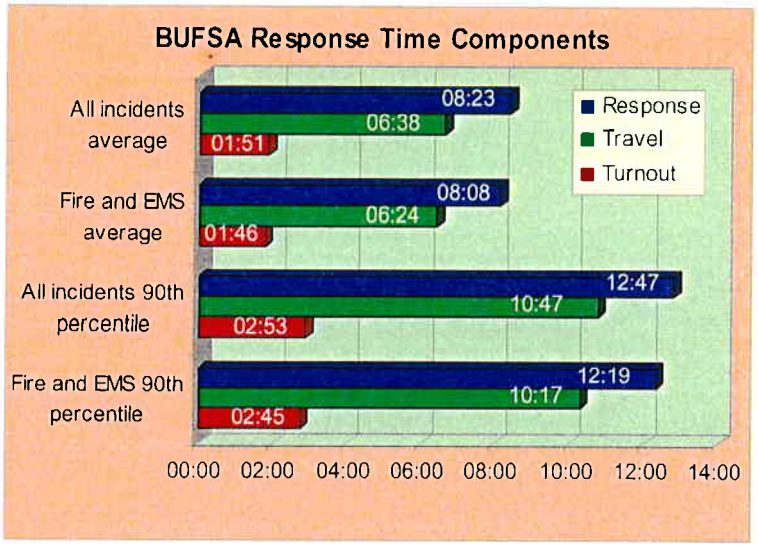
First Unit Response Time Performance

The chart below shows response time performance for the first arriving unit for the entire service area (city and BUFSA). Current performance is 7 minutes 56 seconds, 90% of the time, nearly three minutes longer than the benchmark.



The next charts show the difference between response time performance in the city and the BUFSA. Response time is significantly longer (nearly double) in the BUFSA primarily because of longer travel times.



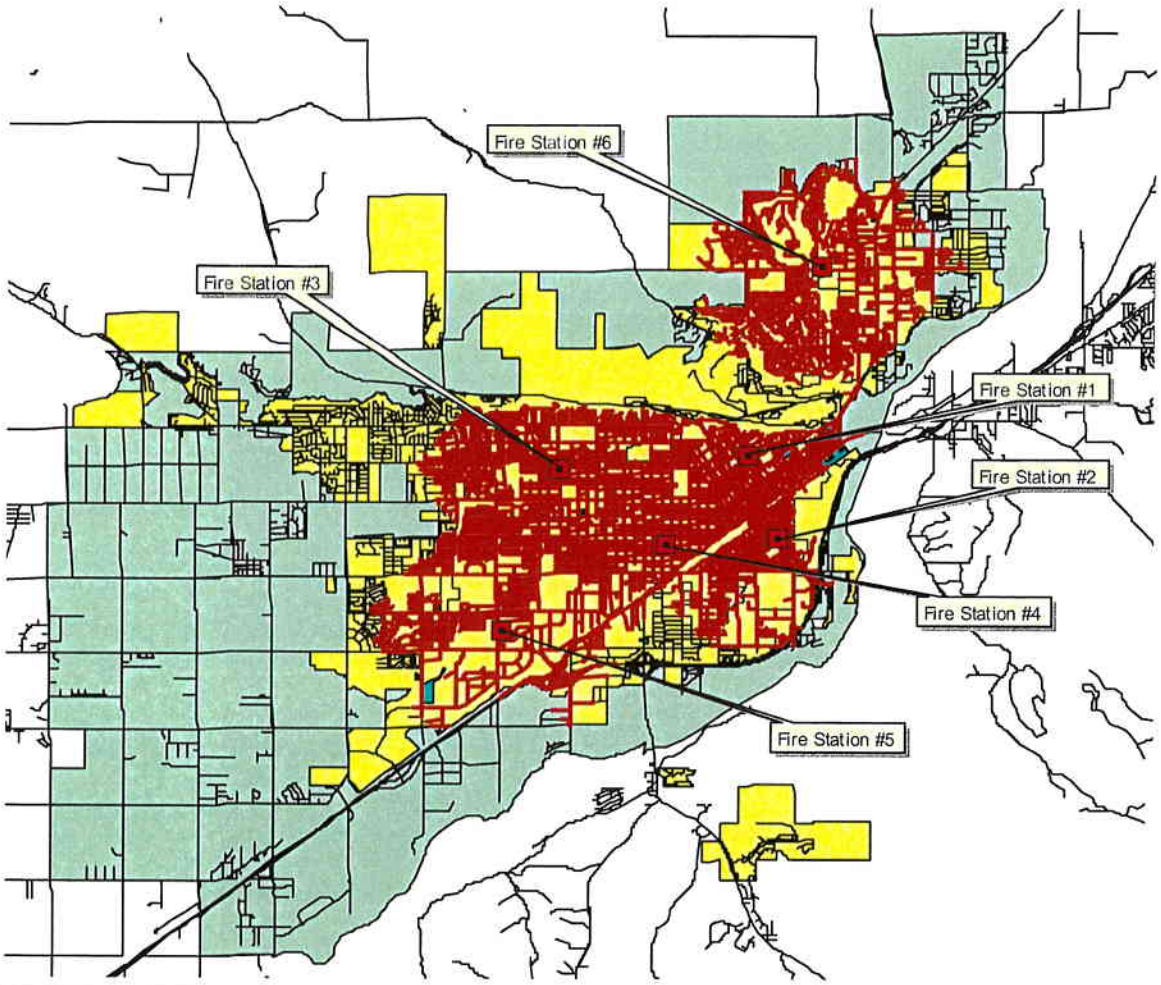


Turnout time appears to be overstated in the charts. These are the times recorded by the computer aided dispatch system used to select response units, alert response personnel, and track incident progress. However, in a review of randomly chosen incidents it appears turnout time is up to 40 seconds less. This is due to the method by which crew notification occurs and the how status change times are captured by the computer aided dispatch system.

The sample showed that actual turnout time was 60 seconds or less 58% of the time, short of the NFPA 1710 benchmark of 60 seconds or less 90% of the time[3]. Also, the time from the receipt of the first phone call at the dispatch center until the first response unit reported as enroute was three minutes or less 90% of the time.

The following map shows the location of fire stations, and the area that can be covered within a five minute response time around each station. It assumes a 60 second turnout time (as defined in NFPA 1710) and a four minute travel time (assumed average travel speed of 30 MPH).

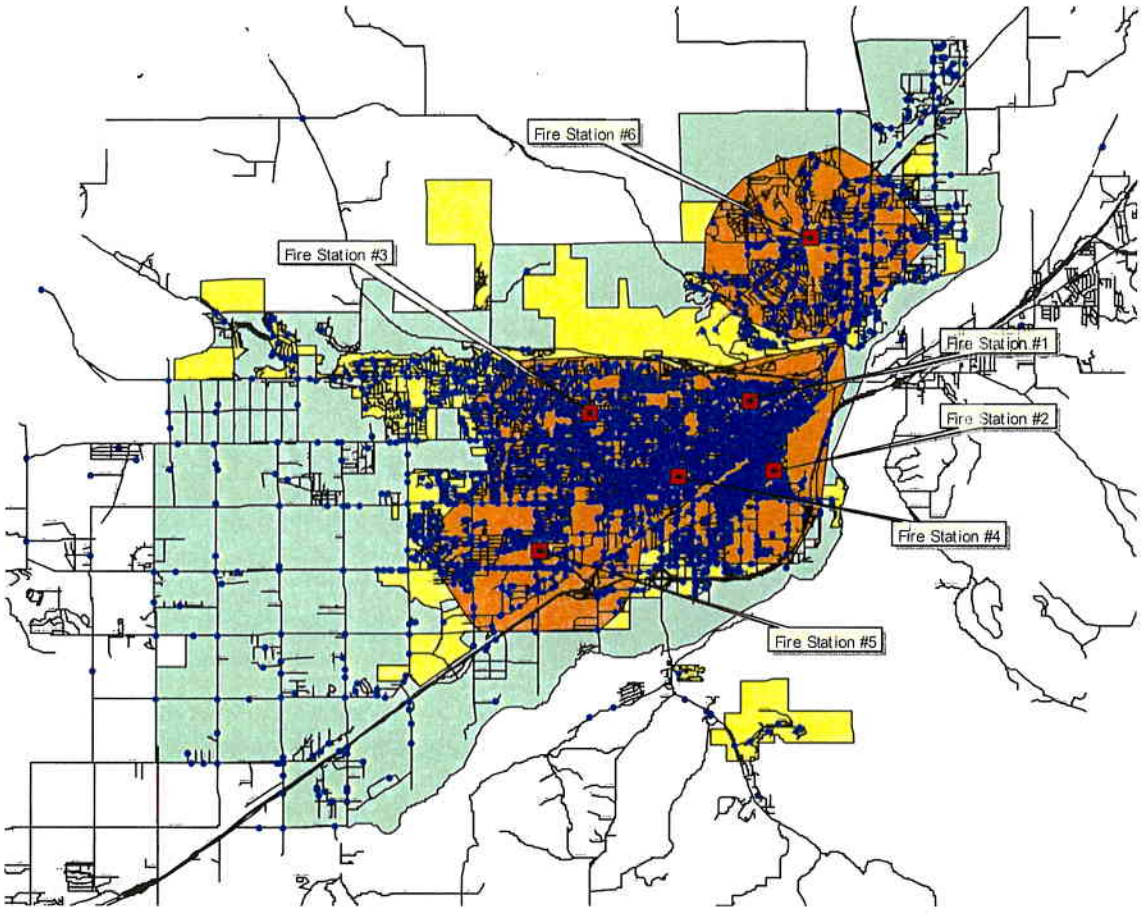
[3] At the 90th percentile, turnout time was 1 minute 41 seconds



	City of Billings
	BUFSA
	Streets inside the 5 minute response time area

A significant amount of the Billings Fire Department service area lies outside the five minute response coverage currently provided by existing fire stations. Response time performance cannot be improved without relocating or adding fire stations, apparatus, and personnel.

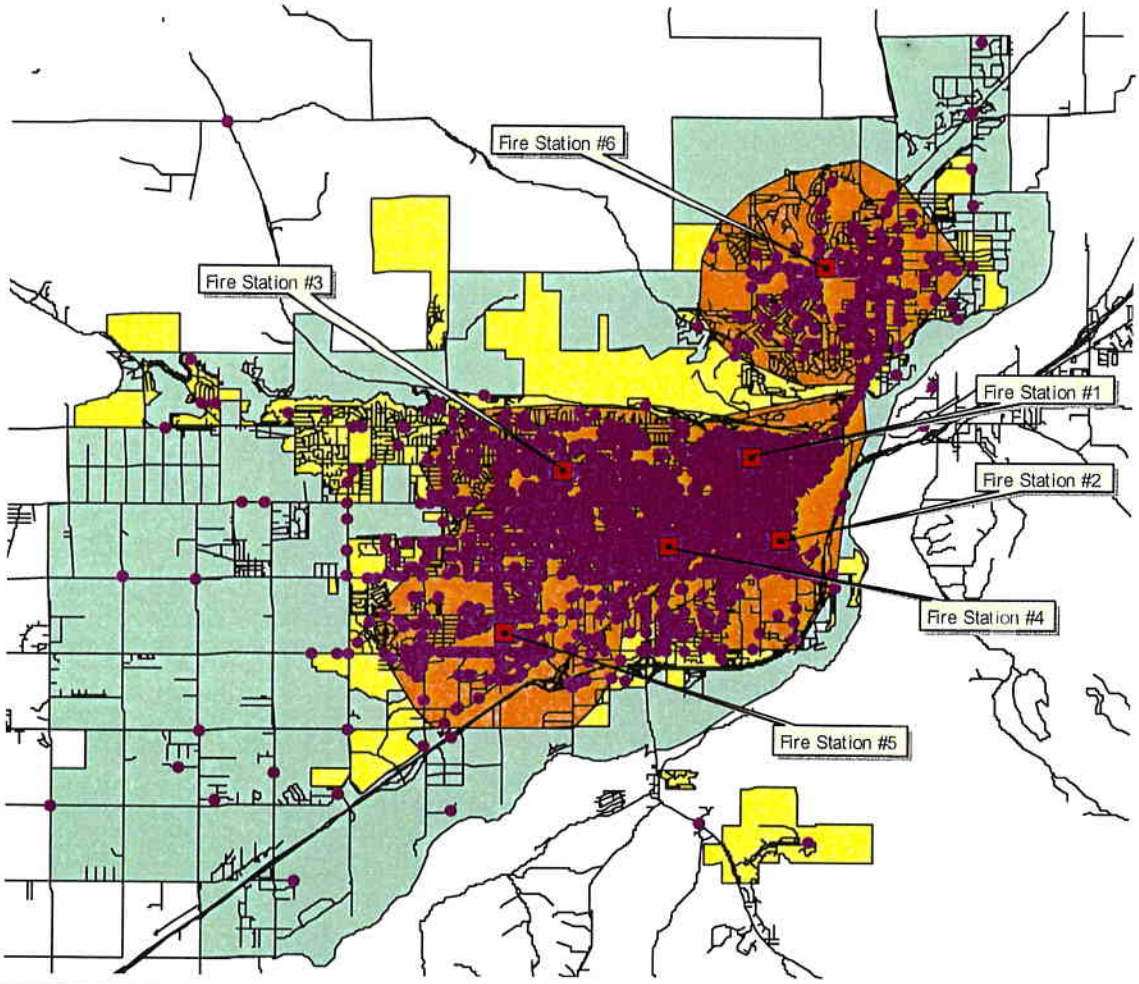
The following map shows the current five minute response coverage from the existing stations as polygons and all fire and emergency medical incidents during 2002. 88% of all these incidents occurred inside the five minute response coverage area.



The next series of maps show fire and emergency medical incident locations[4] where the five minute performance benchmark was, and was not, achieved. It is apparent that more is at play in the department's current performance than simply station location.

The first map shows incident locations where the five minute response time target was met. Most (96%) fall inside the five minute response coverage of the existing fire stations.

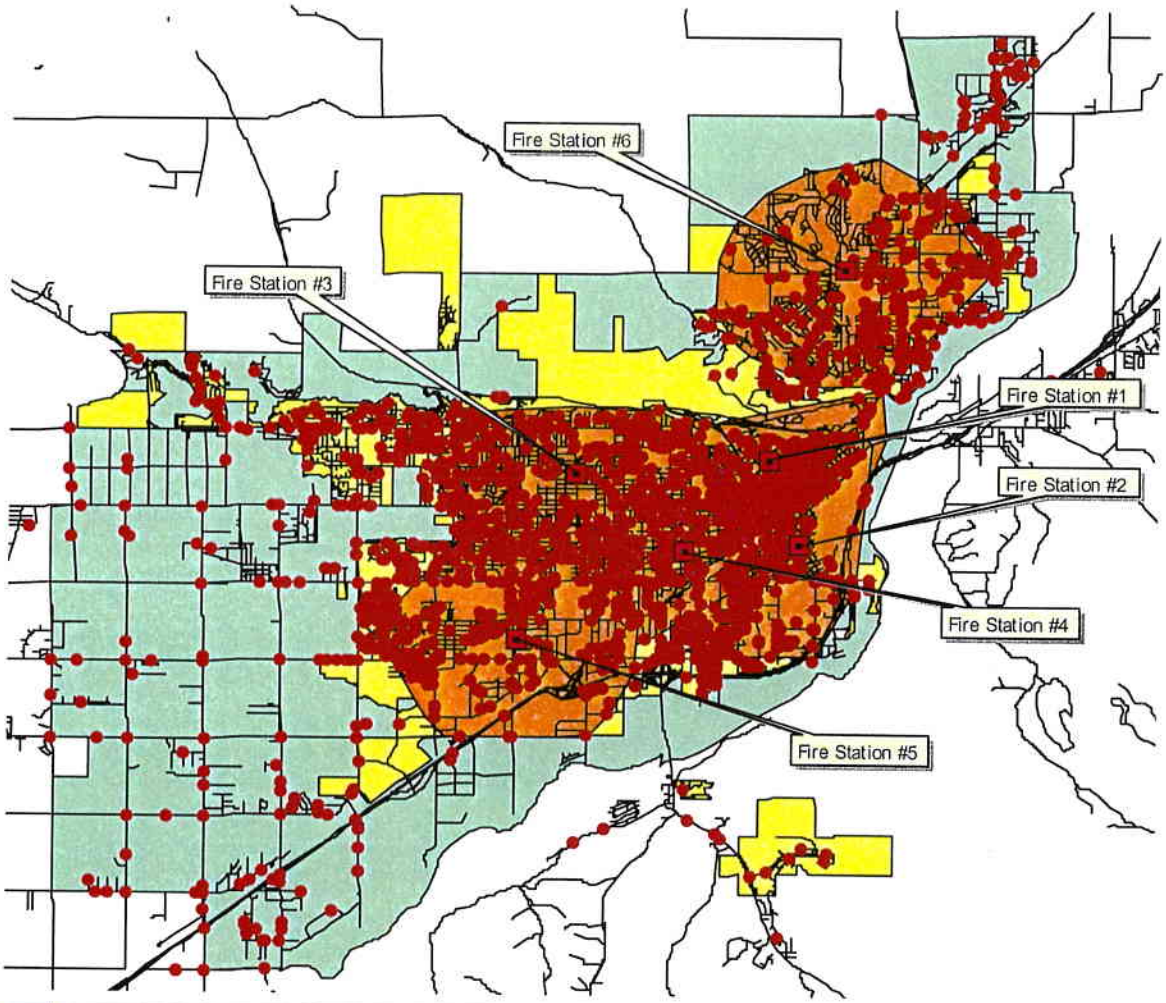
[4] Only fire and EMS calls are included to exclude any non-emergency responses.



	City of Billings
	BUFSA
	Five minute response area
•	Fire and EMS incidents with response times of five minutes or less

Proximately to a fire station provides a clear advantage to receiving a prompt response. Those that show outside the five minute coverage areas likely had a response unit returning from another incident, or on administrative duties, close by at the time of the alarm.

The next map shows locations of responses that did not meet the five minute target.



	City of Billings
	BUFSA
	Five minute response area
•	Fire and EMS incidents with response times of more than five minutes

A substantial number (73%) of the incidents with response times longer than five minutes fall within the five minute response time areas. This is due to a number of factors including:

- The primary response unit is already on another incident
- The primary response unit is out of its area for training or other duties
- Unusual traffic or weather conditions impede response
- Difficulty finding the incident due to invalid address, etc.
- Unusually long turnout time

NFPA 1710 Benchmark Analysis

The department's response performance was evaluated against the objectives described in NFPA 1710. These objectives call for the arrival of the first company (at least one engine and at least four personnel) within five minutes or less, 90% of the time. Or, the department should deliver the full initial assignment (three fire engines, ladder truck and battalion chief) including all personnel needed to handle the risk within eight minutes or less, 90% of the time. The chart on the following page shows how the Billings Fire Department compared to this benchmark.

Structure Fire Response Performance			
Service Area	1st unit arrival[5]	1st comp arrival[6]	Full assignment arrival[7]
Average	0:06:46	0:08:35	0:11:24
90th percentile	0:08:30	0:10:39	0:17:55
Average number of personnel on scene			14
90th percentile number of personnel on scene			21.0
22 of 91 incidents had first company arrival in 5 minutes or less			
38 of 91 incidents had full assignment arrive in 8 minutes or less			
43 of 91 incidents met NFPA 1710 response objectives[8]			
City	1st unit arrival[1]	1st comp arrival[2]	Full assignment arrival[3]
average	0:05:19	0:07:08	0:11:21
90th percentile	0:06:40	0:09:57	0:18:13
Average number of personnel on scene			14
90th percentile number of personnel on scene			21.0
22 of 83 incidents had first company arrival in 5 minutes or less			
36 of 83 incidents had full assignment arrival in 8 minutes or less			
41 of 83 incidents met NFPA 1710 response objectives[4]			
BUFSA	1st unit arrival[1]	1st comp arrival[2]	Full assignment arrival[3]
average	0:08:10	0:11:05	0:12:14
90th percentile	0:09:58	0:16:00	0:17:37
Average number of personnel on scene			14
90th percentile number of personnel on scene			21.8
0 of 7 incidents had first company arrival in 5 minutes or less			
1 of 7 incidents had full assignment arrival in 8 minutes or less			
1 of 7 incidents met NFPA 1710 response objectives[4]			

[5] First unit arrival is the total time for the first fire engine or aerial ladder to arrive on scene
[6] First company arrival is the total time required to assemble at least one engine and four personnel (other than the battalion chief or fire marshal) at the scene
[7] Full assignment is the total time required for three engines and one aerial ladder (or tender in rural areas) to arrive at the scene
[8] NFPA 1710 response objectives call for either first company arrival in five minutes or less, or the arrival of the full response assignment within eight minutes or less.

Throughout the service area the department's first company response time exceeds the NFPA 1710 benchmark by more than 100%. In the city, the performance is almost double. In the BUFSA, first company response times exceed the target by more than three times.

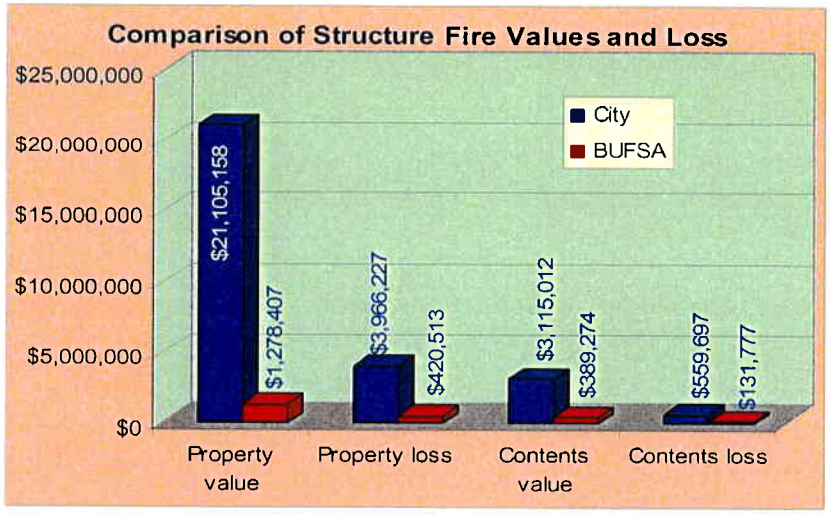
Providing a level of service equivalent to that described by NFPA 1710 will require greater resources, distributed in a manner to provide a more prompt response.

Analysis of Outcomes

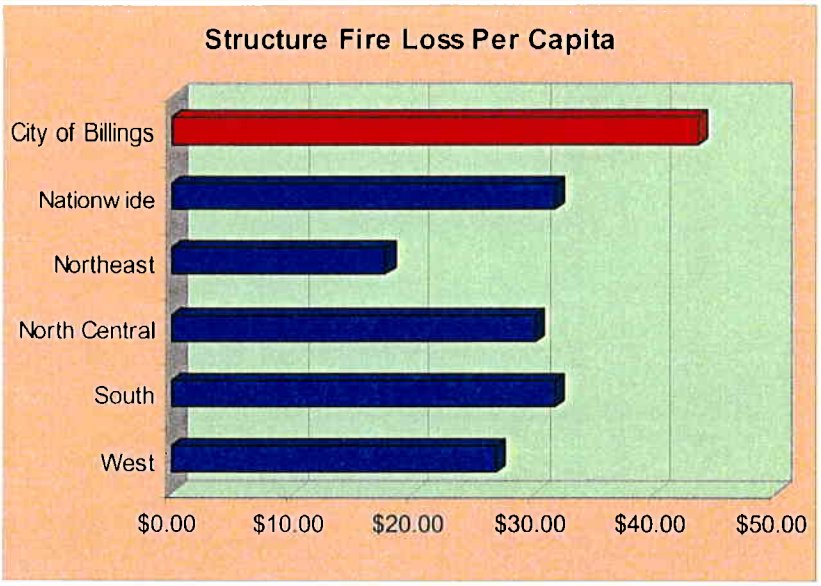
Fire departments respond to emergency events to control the emergency in progress in such a way that the damage to life and property is minimized. There are a variety of ways to measure this given complete and accurate data. Unfortunately, outcome data is largely unavailable. Fire loss information is available and provides a useful review of structure fire outcomes.

In the chart below, fire losses are compared between the city and the BUFSA. While the numbers are smaller for the BUFSA, (due to fewer structure fire incidents) the loss comparison is striking.

Within the city, the loss to structures involved in fire equaled **$188 per $1,000 of property value involved.** In the BUFSA, the loss to structures involved in fire equaled **$329 per $1,000 of property value involved.** This is likely due to the longer response times in the BUFSA, which allows fire to build to larger and more damaging levels.



The city's fire loss experience was compared with regional and national experience on a fire loss per capita basis. The chart below illustrates. The city's loss experience is quite a bit higher than the rest of the nation.



Other Standards and Comparisons

There are a number of other standards and comparisons that can be used to evaluate the capabilities of the Billings Fire Department.

Insurance Rating

The Insurance Services Office (ISO) evaluates the fire protection capabilities of communities across the country. The ISO uses a 1 – 10 rating scale with Class 1 being the best level of service (and lowest fire insurance premium cost) and Class 10 being no service at all. The ISO reviews fire protection in three major categories. These categories are shown below.

Communication (10%) – This evaluates the function and reliability of the dispatch service. The communications system received near maximum credit.

Water Supply (40%) – This evaluates the community's ability to deliver firefighting water in sufficient volumes to combat fires in buildings. The water system received 36.47 out of a possible 40 points, a relative classification of 1.

Fire Department – (50%) – This evaluates the capability of the fire department to effectively respond to and extinguish a fire. Items reviewed include apparatus, staffing, training, and station locations. The fire department received good credit for the number of front-line and reserve engine companies, and for pump capacity, but lost a substantial number of points in the area of ladder company service, station distribution, staffing, and availability and use of training facilities.

The ISO rating is important to a community. Many property insurance companies base the fire risk portion of property insurance premiums on the community's ISO rating. The chart below shows an example of how fire insurance rates for homes change based on the ISO rating assigned.

FIRE DEPARTMENT CLASS RATE VERSUS INSURANCE PREMIUM COSTS

Fire Rating	Annual Premiums based on home value (home values in thousand dollars) (source: Survey of insurance companies in southeast United States)							
	100	150	200	250	300	350	400	500
10	894	1358	1856	2341	2826	3311	3844	4918
9	806	1224	1674	2112	2549	2986	3468	4436
7	430	652	892	1125	1359	1592	1848	2365
6	399	607	829	1046	1262	1479	1717	2196
5	373	566	774	976	1179	1380	1603	2051
4	373	566	774	976	1179	1380	1603	2051
3	373	566	774	976	1179	1380	1603	2051

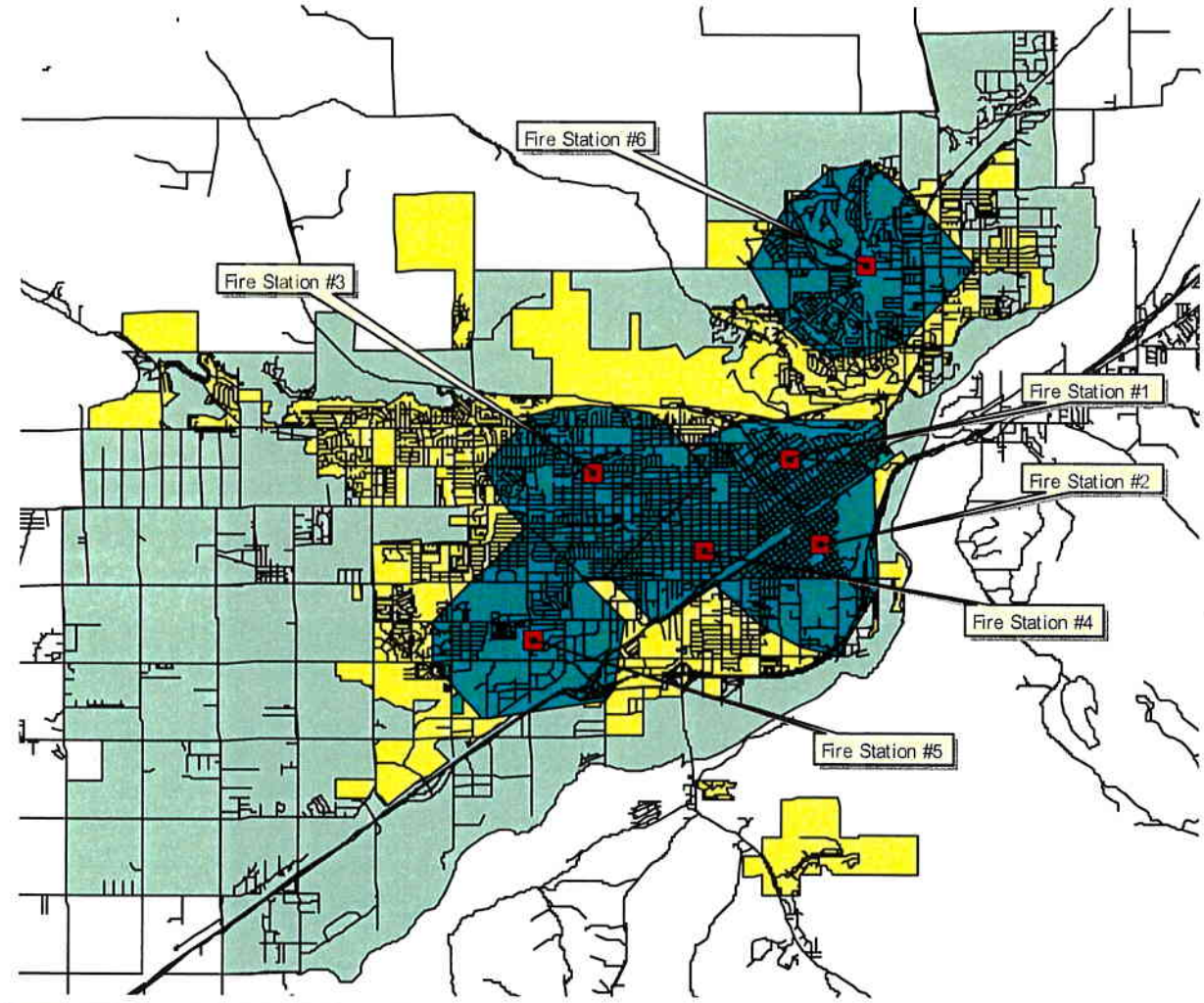
As the ISO class improves, fire insurance rates decrease dramatically until Class 5 for homes. Businesses generally benefit from further reductions down to Class 1[9].

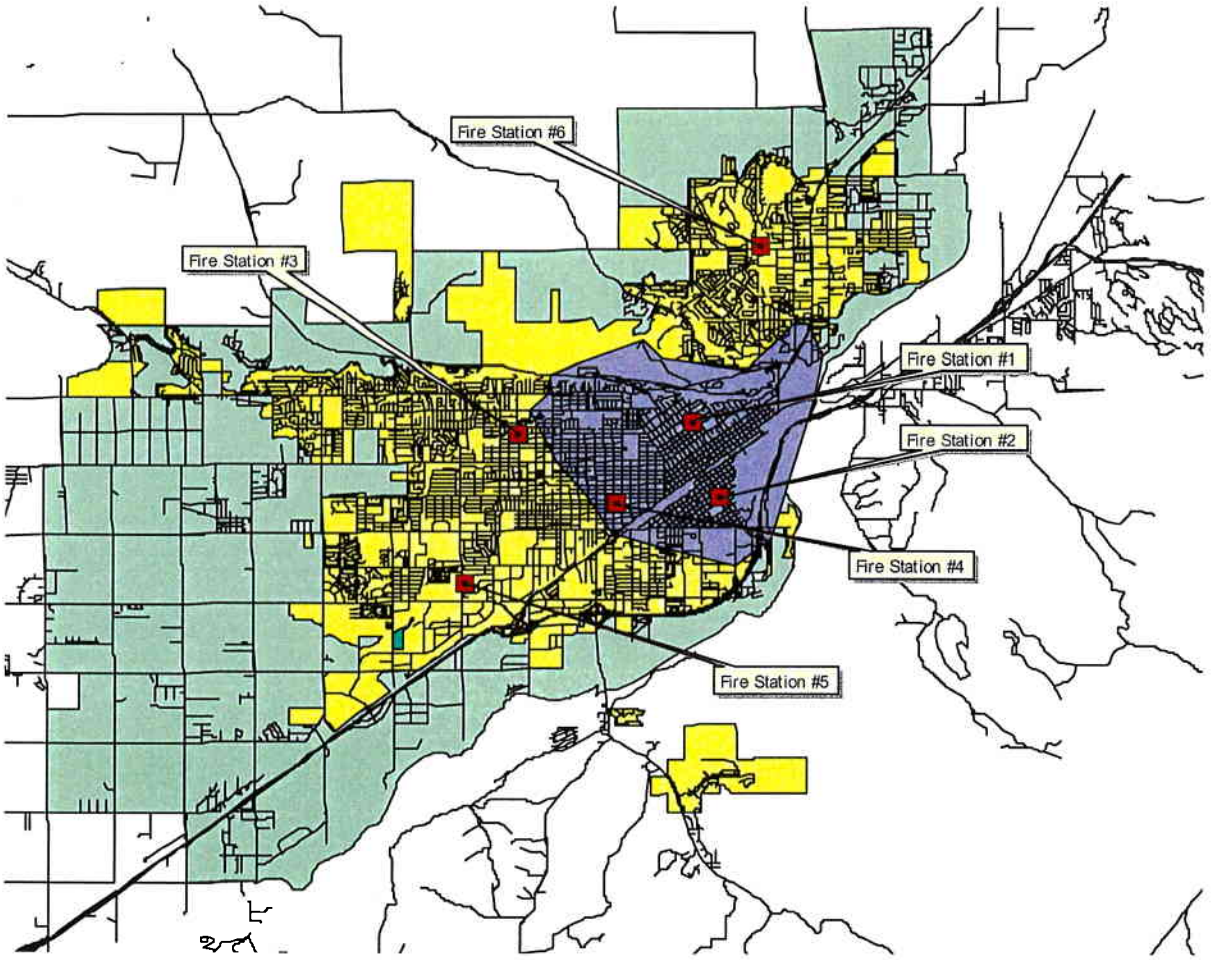
The Billings Fire Department service area is rated as Class 3 for all property within 1000 feet of a fire hydrant with acceptable volume, and Class 9 for all property more than 1000 feet from a fire hydrant. This rating applies to both the city and the BUFSA

[9] A similar chart is not available for commercial properties. Property use affects the premium and many are individually rated.

The ISO places a great emphasis in its rating on the location of fire stations, number of response apparatus, and the department's on-duty staffing levels. ISO standards call for a fire station within one and one-half miles of any built-upon property, sufficient numbers of fire engines to deliver the required fire flow, and sufficient staffing to respond to identified risks. In addition, there should be an adequately staffed ladder company within two and one-half miles of built-upon property.

The city has a sufficient number of engine companies to meet fire flow expectations. Staffing levels are less than those called for in the ISO's rating criteria for both engines and the ladder truck. The maps below show how the department's station locations compare to the ISO's distance expectations.





	City of Billings
	BUFSA
	Area within 2.5 miles of a ladder truck

National Benchmarks and Comparables

There are a variety of other standards and performance criteria developed by various organizations with an interest in fire and emergency services. The chart on the next page lists a number of these.

National Standard or Comparison	*Organization*	*Current Billings Standard*
Minimum effective company staffing is 4 firefighters	Dallas Fire Dept. Study, Seattle Fire Dept. Study, NFPA Standards., Federal OSHA	Current staffing levels for engines is 3 firefighters
Engine co. within 1.5 miles of built upon areas	Insurance Services Office (ISO)	Not met
Ladder truck within 2.5 miles of built upon areas	Insurance Services Office (ISO)	Not met
Staffed ladder truck if 5 or more buildings exceed 35' high	Insurance Services Office (ISO)	Met, however staffing is below ISO standards
Average fireground staffing to be 15 firefighters (up to 53 at mall, high rise, etc.)	Commission on Fire Accreditation International (International Association of Fire Chiefs)	Met for low, moderate and high risk fires. Not met for maximum risk fires
National average of on-duty personnel = .48 per 1,000 population	International City/County Management Association (ICMA)	Current minimum staffing level is .19 per 1,000 population
National average total uniformed personnel = 1.59 per 1,000	International City/County Management Association (ICMA)	Current strength is .94 per 1,000 population
Arrive at structure fire prior to flashover (typically 5 to 7 minutes from ignition)	FEMA , National Fire Academy	First "company" arrival is 10:39 or less, 90% of the time
Arrive at EMS call within 4 to 6 minutes of cardiac or respiratory arrest	American Red Cross	First "BLS unit" arrival is 8:30 or less, 90% of the time

Other Comparables

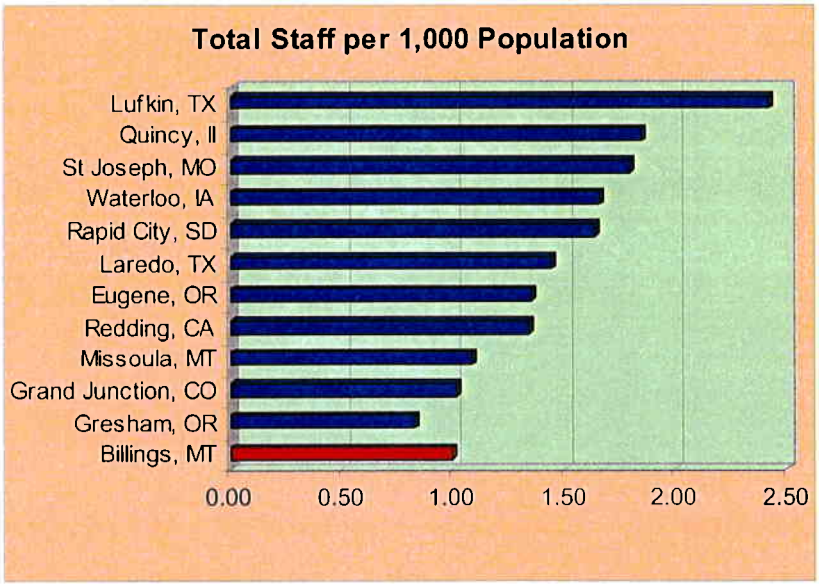
Demographic, resource and performance information from other similar jurisdictions was compared to the Billings Fire Department. The jurisdictions selected for this review were many of the same used in a previous comparison study conducted by the city. In addition, two others known to be very similar to the Billings Fire Department organization and service responsibility were included.

The table below shows the jurisdictions and key demographic information about them.

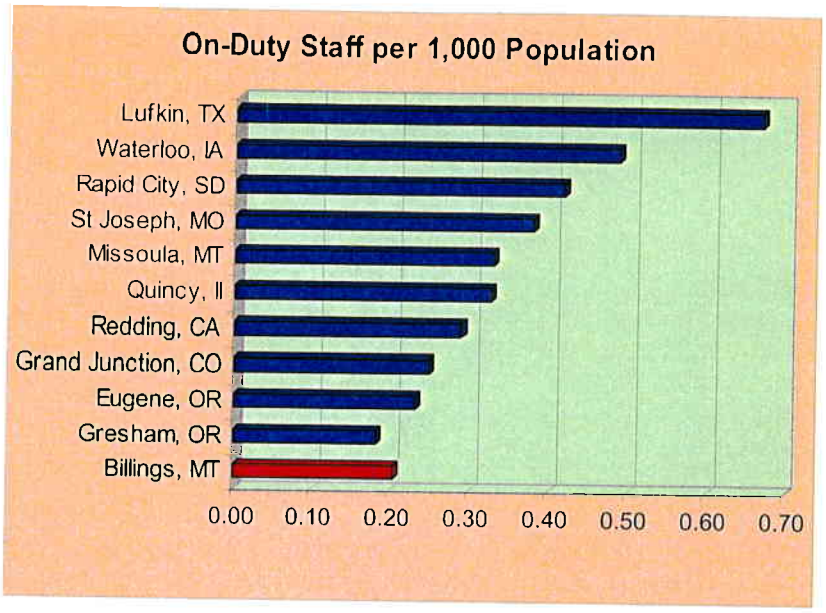
Jurisdiction	Population	Square Miles	Fire Department Budget	Total Department Staff	On-duty staff	2002 Responses	Stations
Billings, MT	104,000	84	$8,053,695	103	21	8882	6
Lufkin, TX	33,000	27	$4,272,000	80	22	8202	5
Quincy, Il	40,128	58	$5,500,000	74	13	5500	5
Missoula, MT	58,000	24	$5,295,379	63	19	4244	4
Rapid City, SD	60,000	42	$5,650,000	98	25	5100	6
Grand Junction, CO	68,850	93	$5,884,727	70	17	6929	4
Waterloo, IA	70,000	76	$7,800,000	116	34	10461	7
St Joseph, MO	74,000	54	$7,474,983	133	28	10288	9
Redding, CA	80,000	80	$8,000,000	107	23	8150	7
Gresham, OR	122,000	60	$13,030,954	100	22	10343	6
Eugene, OR	152,285	72	$21,606,709	205	35	17644	11

The charts below use this and other information to contrast the Billings Fire Department against the listed comparables.

The first chart compares each department based on total staff per 1,000 population. While not the lowest, the fire department's total staffing is much less than the average of the group.

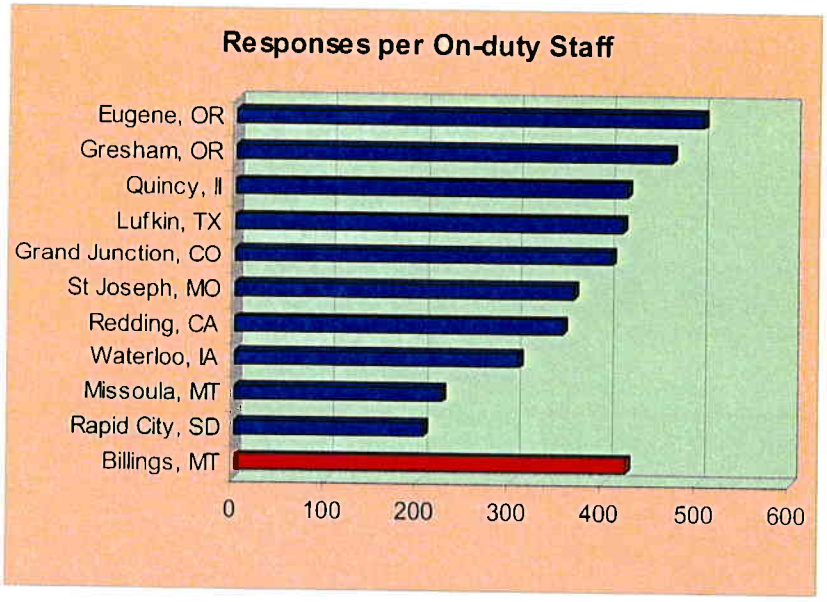


The next chart compares on-duty emergency response staffing per 1,000 population. This is an important comparison since a big part of the department's ability to deliver service is based on having personnel readily available to respond to emergencies.

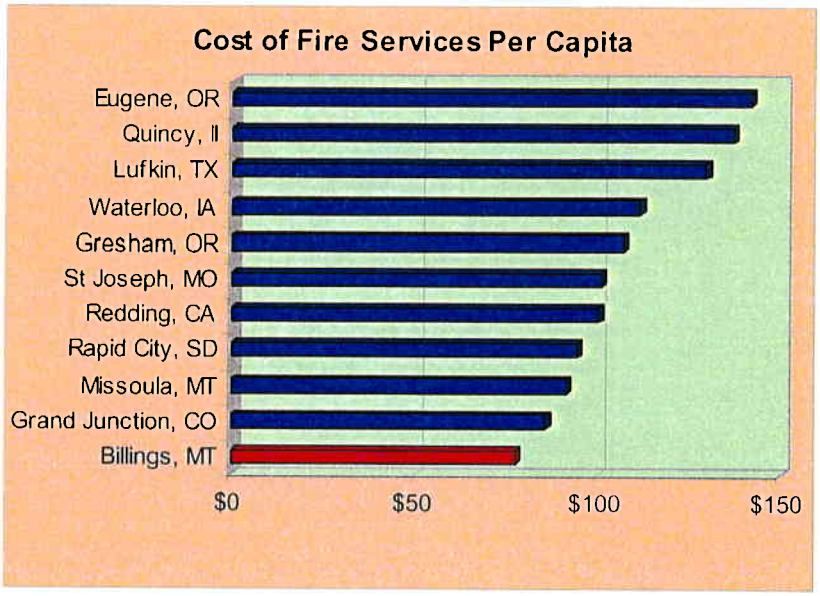


Again, Billings ranks at the low end in comparison to the other jurisdictions. As discussed previously, population drives emergency response workload. Having sufficient personnel available to respond to, and take action at, emergencies is essential to effective service.

Another important comparable is the workload on available on-duty response personnel. The next chart compares responses per on-duty personnel. Billings ranks just above the average of all jurisdictions listed.



The final chart compares the financial cost for fire services placed on the population. Billings is the least expensive, on a per capita basis, of the comparable jurisdictions.



LEVEL OF SERVICE

In order to determine the community's desired level of service the preceding information was presented to the Billings city council in a workshop held on February 18, 2003. The significance of this information was discussed, and the council asked a series of questions, to establish performance benchmarks for future planning purposes. These questions included:

1. Is the fire department is providing services now that are of little value to the community, or should be fire department begin delivering a service it does not now provide?
2. Should the fire department take on a more involved role in the delivery of emergency medical service? For example, should the department provide advanced life support (paramedic) level service as a first responder?
3. Should a stronger emphasis be placed on risk mitigation (such as requiring fire sprinkler protection in all new construction) as a means of controlling future fire service workload?
4. Should there be a greater integration of aircraft rescue and firefighting services provided by the airport and the urban fire protection services provided by the Billings Fire Department?
5. Would a greater regionalization of service delivery provide benefit?
6. What level of service should the Billings Fire Department provide for fire suppression and for emergency medical service?

Services

The fire department currently provides a full range of response services including:

- Fire suppression
- Emergency medical first response (basic life support)
- Technical rescue
- Hazardous materials emergency intervention
- Public assistance

The council determined that the services currently delivered are appropriate and should continue.

Emergency Medical Service

The Billings Fire Department provides first response (patient care and treatment) service at the basic life support level. American Medical Response provides ambulance transportation and advanced life support care.

The council noted that emergency medical response is the most commonly requested service. The value of the fire department's role in delivering patient care and treatment was recognized.

The fire department is planning to upgrade its capability to the "intermediate" level over the next several years.[10]

While there was a diversity of viewpoints from individual councilors, the consensus was to continue delivery of first responder emergency medical service and to move forward with the intermediate level upgrade as funding is available.

Risk Mitigation

Many communities encourage, or even require, the installation of fire sprinkler systems in buildings to provide a greater level of fire and life safety, and to help control future fire service costs as the communities grow. The council discussed the merits of this approach for the Billings community.

While stopping short of supporting the mandatory installation of fire sprinklers in all buildings, the council expressed interest in exploring options to require fire sprinklers in larger buildings and encourage their installation in other buildings.

ARFF/Fire Department Integration

The city operates two fire departments; one serving the aircraft rescue and firefighting needs of the airport and the other serving the fire and emergency service needs of the rest of the community. While the two departments have a close working relationship they still exist as two separate organizations.

[10] The intermediate level of care adds advanced airway management, intravenous administration and other skills above the basic care level

The differences of the two departments were identified, including their different missions, training requirements, bargaining units, personnel utilization and the like. However, the council was interested in seeing what possibilities might exist to capture economies and improved service delivery through increased coordination.

Regionalization

There are number of fire departments within Yellowstone County both public and private. The Billings Fire Department has formal mutual assistance agreements with the three refinery fire departments, and mutual assistance provisions with the other departments through the state-wide mutual assistance agreement.

The council expressed very little interest in exploring consolidation of area fire departments but did want to ensure that the various departments continue to be capable of working together effectively during major incidents and even improve that ability.

Level of Service

As noted in preceding sections, the Billings Fire Department is not meeting national recommendations for level of service, primarily in the area of structure fire suppression capability.

After significant discussion, the council's consensus was to not attempt to improve the current level of service. The cost of improvements (four person staffing being the primary concern) appears to not be within the city's ability to provide funding.

However, the council did recognize that as the city continues to grow expansion of fire department resources to serve this workload would be necessary. In addition, the council strongly encouraged the exploration of low cost service improvements, continued delivery of strong fire prevention programs, and the application of risk mitigation measures to newly developing areas

OPTIONS AND RECOMMENDATIONS

The balance of this report identifies and details a variety of options and recommendations for the city and its fire department. Included are short term recommendations to capture service delivery improvements through such things as adjustments to business practices, staffing, technology, and others. In addition, the implications of future community growth are addressed in long term recommendations for the relocation or addition of fire stations, apparatus, and personnel.

The Billings Fire Department is faced with a number of challenges that will make its job more and more difficult over time. These challenges include increasing regulation of its activities, growth in population and the community's utilization of fire department services, expanding service area boundaries, and geographic obstacles. The services delivered by the fire department are critical elements of public safety and contribute to the overall livability of the Billings community.

Risk Mitigation

Earlier in this report the dynamics of fire in a building were described as they relate to response time. While excellent response time performance by the fire department is vitally important, the most effective method to protect lives and property from fire is the fire sprinkler system. Fire service resources cannot be provided to match the level of protection provided by this technology. The cost would simply be too high.

The best opportunity to apply water to a fire prior to flashover is through the use of built-in fire sprinkler systems in homes, businesses and other buildings. Their advantage is that they not only detect the fire but also apply water well before flashover.

Recent innovations in residential fire sprinkler design have dramatically reduced their cost. Scottsdale Arizona, for example, reports that residential fire sprinkler installation costs are averaging $.59 per square foot ($885 for a 1500 square foot house). St. Helens Oregon is reporting costs of about $.75 per square foot ($1,125 for a 1500 square foot house) in a pilot project within their community.

Scottsdale, in 1985 passed a city ordinance requiring fire sprinklers in all new buildings including single family residential. This created a large market for sprinkler installers and is the primary reason for their lower cost experience.

Their ordinance, in addition to requiring fire sprinklers also allowed opportunities for "design freedoms" in new development. These include increased density in new subdivisions, narrower street widths, smaller water main sizes, increased spacing between fire hydrants and longer cul-de-sac lengths. These resulted in development and construction costs savings (1986 estimates) of $2,110 per unit. In a report by the California State Fire Marshal's Office, similar results were reported for design freedom programs in that state.

Scottsdale conducted a comprehensive evaluation of the effectiveness of their fire sprinkler ordinance. This evaluation covered a ten-year period following the implementation of the ordinance. Their findings indicated:

"The average fire loss per sprinklered incident was only $1,945, compared to a non-sprinklered loss of $17,067. Automatic protection had a direct role in saving eight lives. One or two heads controlled or extinguished the fire 92% of the time, with the majority of the exceptions a result of flammable liquid incidents."

The City of Billings has the ability to pass a local law requiring fire sprinklers as Scottsdale, and many other jurisdictions across the nation have done. Doing so will not only increase the level of fire and life safety within the community but will help control future fire service costs since new buildings constructed would have a significantly lower fire risk.

In addition, cost savings could be realized in the construction of water service facilities. Since fire sprinkler protected buildings have half the fire flow demand as non-sprinklered buildings, smaller water mains and reservoirs can be built as development continues.

The city should consider certain modifications to its system connection charges to encourage voluntary fire sprinkler installation. In most cases, the standard three quarter inch water meter is sufficient to supply both domestic and fire protection needs in a single family dwelling. In very large homes a one inch meter may be needed. There is a significant connection charge difference between the standard meter and larger meters (just

over $1,000 between a three quarter inch meter and a one inch meter). Though the larger meter may in fact provide additional domestic capacity the benefit in life safety and risk mitigation may offset this.

Additional incentives to voluntary installation of fire sprinkler systems can be achieved through water use charges. Much of the base rate is used to support the maintenance costs of the community water system. The system is designed to provide both domestic needs and fire protection needs. Since a building protected with fire sprinklers creates significantly less demand on the fire protection component of the water system, consideration should be given to charging that property a smaller base rate.

Recommendations:

- Adopt regulations requiring the installation of fire sprinkler systems in all new buildings and any building that undergoes a significant remodel or addition.
- Review and revise water system connection and use charges to encourage voluntary installation of fire sprinkler systems, for example a lower base water rate.

Management Information and Data Collection

Any organization must continually evaluate its activities in order to identify variations that affect performance. To do so, activity data needs to be collected and analyzed on a regular basis. This analysis can identify specific issues contributing to the relative effectiveness and efficiency of the organization and the services it provides.

The Billings Fire Department has a number of data collection and analysis tools in use. For the most part they produce useful information for analysis and decision making. However there are several issues that should be resolved to provide even better information in the future.

In order to help reduce response times the dispatch center's computer system "pre-alerts" response companies of an impending alarm. This pre-alert sends alarm information to printers in each station. This helps ensure the printed information is available to responding fire companies in time for it to be used on the responses.

Unfortunately the pre-alerting process "starts the clock" on turnout time[11]. The actual notification of response personnel comes up to a minute later. The consequence is that turnout time is overstated in the data. The analysis capability lost as a result is the ability to define the complete reason for response time performance that does not meet expectations.

Another example is in the reporting of the number of personnel who respond to a given call. The current system counts personnel on each unit as assigned in the scheduling system. At shift change this can mean that the number of personnel assigned to the response is double those actually assigned.

The city should consider acquiring data collection systems that resolve these and other issues. The systems should be fully integrated and compliant with the National Fire Incident Reporting System, version 5.0. In addition, data collected within these systems should be exportable to the city's geographic information system for more detailed geospatial analysis. In particular, addresses entered into the computer aided dispatch system and the fire departments incident record system must be consistent with the street address data base in the geographic information system.

Recommendations:

- Complete a comprehensive needs analysis to determine the fire department's data collection and evaluation requirements. Acquire appropriate software and associated hardware identified through the needs analysis.

Response Improvement Technology

The Billings Fire Department is dependent on manual systems to support some response preparation and data tracking activities. Information on the response is supplied on paper, travel routes are planned by reviewing paper maps, unit status changes are made over the radio and manually entered into the computer aided dispatch system. Hazard and pre-fire planning information about a particular location are maintained in notebooks.

[11] The time period between notification and initiation of response

Technology is available that can provided a great deal more information to emergency responders, reduce response preparation time and provide a greater degree of accuracy to data collected on each response. Mobile computing technology has become a common fire service application. The city should strongly consider making it available to its fire department.

With appropriately designed applications, the following response scenario is available.

A 9-1-1 call is answered at the dispatch center. The call taker questions the caller about the location and circumstances of the emergency and enters that information into the computer aided dispatch system. Once sufficient information is received the incident is forwarded to a dispatcher for processing. The dispatcher acknowledges the incident and directs the computer system to dispatch the call. Alert tones activate at each assigned fire station and the dispatcher gives a voice description of the incident. Simultaneously the computer transmits the incident information, via radio, to a computer on the assigned fire apparatus.

Fire crews don equipment and climb aboard the fire apparatus. Displayed on the computer in the cab of the unit is the location and description of the emergency. Also displayed is a map that shows the incident location and the best travel route to it. The travel route has been updated in real time for any road closures, known peak hour congestion, and the like that would make a different route faster.

The officer presses a single button to report that they are enroute to the emergency. This automatically updates the computer and displays a message to the dispatcher that the unit is enroute.

As the apparatus respond to the scene the computer, using GPS technology, provides voice directions indicating when and where to make turns. The fire officer is reviewing hazard and pre-incident information that has also been displayed for that particular location.

Once the unit reaches the incident the officer again presses a single button to report arrival at the scene. The officer gives an initial arrival "size-up" and begins directing operations.

The shift commander has been monitoring the incident on his computer and the status of other in-progress incidents. The current status of all fire department apparatus is available allowing the shift commander to adjust resources as needed.

Using this technology provides a number of benefits. Response data is captured far more accurately since data entry delays inherent in manual systems are eliminated. Turnout time is reduced since travel route planning is done automatically. Incident commanders are provided substantially more information to use to plan incident activities and better ensure the safety of their personnel. Shift commanders can provide better dynamic resource management improving response to the next occurring emergency.

This technology is not inexpensive. In addition to hardware and software costs are costs to train personnel in its use and the cost of maintaining the databases that make the system work. However, use of this technology can provide real response performance improvements and better management analysis capability.

Recommendation:

- Implement mobile computing technology to improve response performance, enhance resource management, and improve management analysis capabilities.

Response Route Improvements

There are a number of travel routes in the Billings community used by fire department responders that present significant resistance to prompt response. Three are noteworthy.

24th, between King and Central, is heavily congested during daytime hours, especially during rush hour periods. Fire station 5 must use this road to access every incident to which it responds. Improvement of the traffic carrying capacity of this road will make an appreciable difference in Fire station 5's response time performance. The alternative is to relocate the station to a less congested area.

There is only one means of access to the Billings Heights area in the northeast section of the city (6th Ave.). Fire department personnel report significant response delays through this part of the city during the rush hours. While there is a station in the Billings Heights area,

backup forces are often needed and must pass through this "bottleneck". Creating additional pathways to the Billings Heights from the downtown area would reduce the risk of delayed response of primary and backup response units.

The rail lines that traverse the southern portion of the city can create response delays as well. Most rail crossings are "at grade" and as such are blocked when a train is present. One of the underpass crossings does not provide the height necessary to allow passage of the department's ladder truck. Adding additional over or underpasses across the rail line will provide more reliable response to industrialized areas.

Recommendation:

- Improve the fire department's ability to respond quickly by reducing the resistance of key response routes.

Response Resource Location Management

Earlier in this report is a map showing the locations of responses that had response times longer than the planning target of five minutes. Many of these were within the plotted five minute response boundaries around existing fire stations.

Extended response times can occur when the response unit assigned to the incident is not within its primary response area is already on another incident, or simply not available, at the time of the call. This results in travel times that preclude the fire department from achieving target performance.

The daily activities of response personnel can require they be out of their primary service area for activities such as apparatus maintenance, picking up supplies, and training. While these are all necessary functions the fire department should, and to a degree does, have practices that minimize this "out of area" time.

The Billings Fire Department maintains a training facility at the airport. On-duty personnel train there regularly. The facility, however, is not ideally located to facilitate prompt return to primary service areas in the event an incident occurs during the training period.

The fire department should explore ways to minimize "out of area" time as much as possible. A number of options are available:

- Relocate the training facility to a location more central to the department's service area
- Schedule training during periods of predicted low activity (see the previous graph illustrating response activity by hour of day)
- Install two-way video conferencing equipment in all stations so response units can stay in their primary area during classroom-based training, meetings, and other suitable group activities
- Staff an additional engine company to cover stations left vacant for training activities

Recommendation:

- Identify and implement methods to minimize the time response units are out of their primary service areas

Emergency Medical Service Level

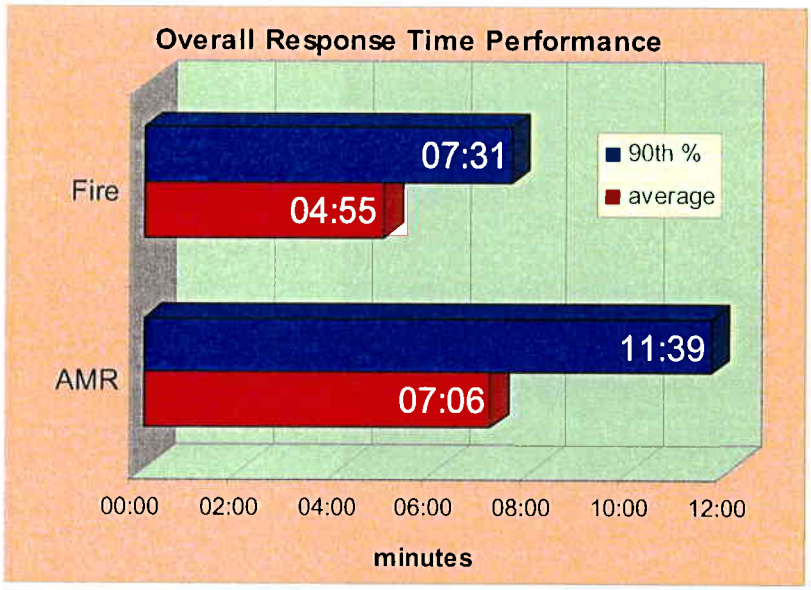
74% of the responses made by the Billings Fire Department are to medical emergencies. This is typical of most departments who provide this service. The fire department delivers basic life support care. American Medical Response (AMR), a private company, provides advanced life support care and transportation to a medical facility.

The fire department is considering increasing their level of care capability to the "intermediate" level. This would allow properly trained and equipped personnel to administer intravenous solutions, provide advanced airway management, and other skills. The fire department's plan is to institute this higher capability on two or three engine companies initially and the balance at a later date when sufficient personnel have received the necessary training.

To determine whether the investment in this service level upgrade has value to the community a comparison of ambulance response performance to fire department response performance was conducted. The results clearly indicate that the service level upgrade should be fully supported, and even enhanced.

Response data for 5,668 emergency medical incidents occurring between December 1, 2001 and October 31, 2002 were evaluated to determine which agency arrived first, and by how long. Only incidents in which both the fire department and ambulance company responded and arrived were reviewed. Unknown from the analysis is how response times may be impacted when the first arriving unit slows the subsequent unit to non-emergency response. The department's data systems should be modified to capture that information.

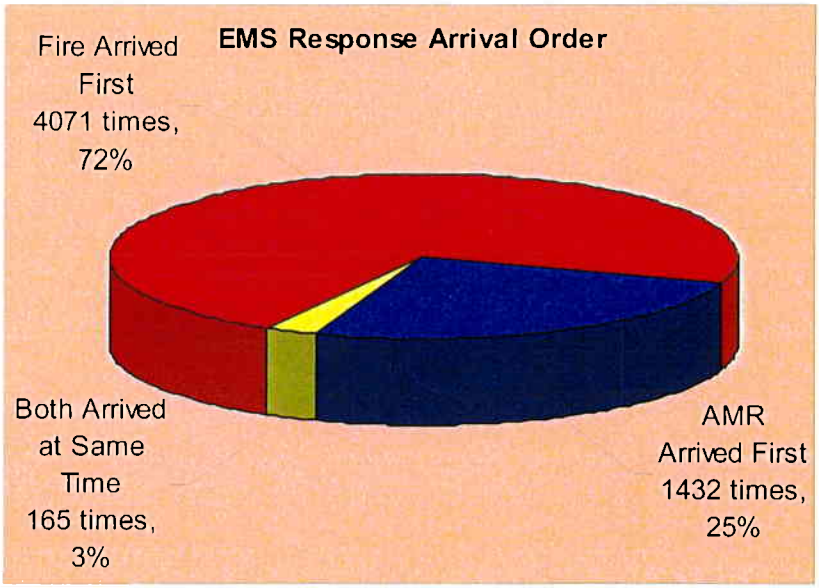
The chart below shows overall response time performance for AMR and the fire department. Recall that the NFPA 1710 benchmark for arrival of advanced life support service is eight minutes or less, 90% of the time.



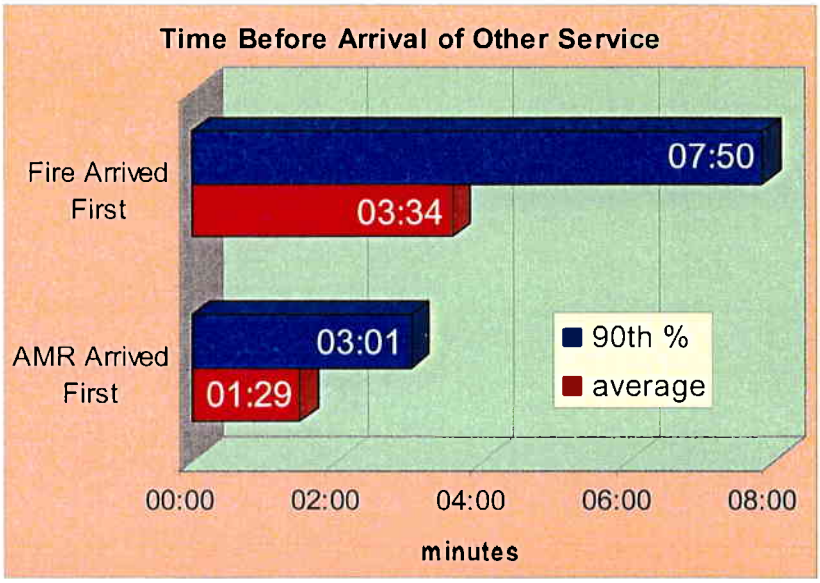
The fire department arrives at emergency medical responses within 7 minutes, 31 seconds 90% of the time. AMR arrives within 11 minutes, 39 seconds 90% of the time. Since AMR is providing the advanced life support service the NFPA 1710 benchmark is currently exceeded by 3 minutes, 39 seconds.

It's important to note that AMR reports its response time performance differently than shown above for the purposes of contract compliance review. The difference is when the response time clock starts. AMR starts the clock at the time they dispatch their ambulance. This can be up to several minutes after the fire department is dispatched. From the customer's point of view the clock should start when emergency services are notified of the incident. For the purpose of this review the response time clock starts for both units at the time of initial dispatch by the city's emergency communication center.

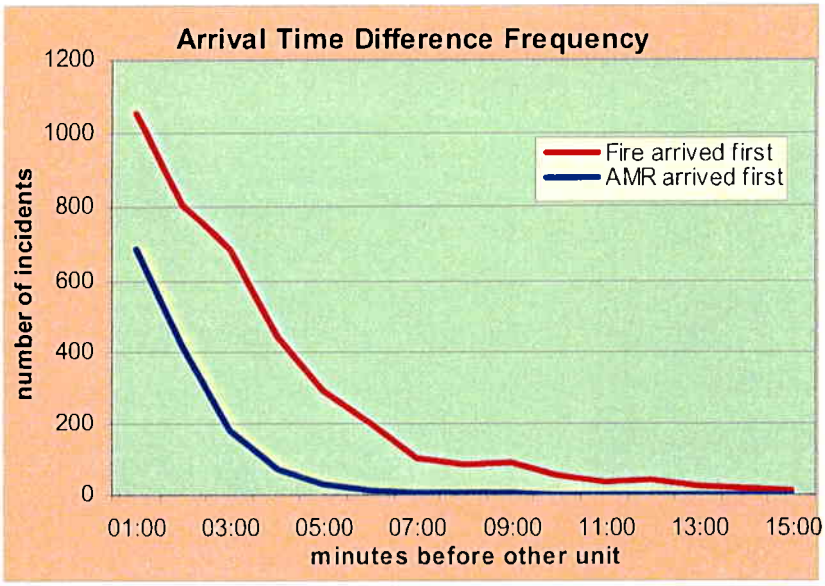
The next chart shows how often the fire department reaches an emergency medical incident first. As can be seen the fire department arrives first 72% of the time.



Reviewed also was how long either the fire department, or AMR had to wait before the other arrived. The next chart shows that on average the fire department arrived 3 minutes, 34 seconds ahead of the ambulance. When AMR arrived first they did so only 1 minute, 29 seconds ahead of the fire department, on the average. This clearly indicates that the fire department would have ample opportunity to use the upgraded skills prior to the arrival of advanced life support service from AMR. It also means the patient would benefit from the earlier, and more skilled, medical care provided by an upgraded fire department capability.



The chart below shows that the fire department very frequently is on scene well ahead of the ambulance, and often for extended periods of time.



Advanced life support care is well proven to make a difference in critical medical emergencies. Delivery of that level of care in the shortest possible time is valuable. The city has two providers of emergency medical services. Either are capable of delivering advanced life support care within the NFPA 1710 benchmark.

Given the results of this analysis the city should either:

1. Redefine the response performance standards for the ambulance company to achieve an 8 minute or less, 90% of the time response time performance from ***the time of initial dispatch,*** or
2. Upgrade the level of service capability of the fire department to advanced life support (paramedic) on all response units.

Choice number two is recommended. Upgrading the fire department's capability offers a number of advantages.

- Emergency medical patients will receive advanced life support care 35% earlier than is currently provided.
- Mass casualty and disaster events will have greater numbers of advanced life support personnel available to provide care and treatment.

- Fire department personnel are able to enter hazardous areas while ambulance personnel are not. Fire department paramedics would be able to deliver advanced life support care while the patient is still inside a hazardous area.
- Should the private ambulance provider discontinue its service the fire department would have advanced life support trained personnel it could use to provide ambulance service.

Another concern related to the ambulance notification process should also be addressed. Currently ambulance dispatchers monitor a radio tuned to the fire department's dispatch frequency. When they hear an emergency medical incident dispatched by the fire department they, in turn, select and dispatch an ambulance.

While there are no recorded instances of this process resulting in a missed incident, the risk of such is present. A more direct and verifiable system should be put in place. There are a variety of options available ranging from telephone follow-up to ambulance dispatcher by the fire department dispatcher, to having ambulances dispatched from the fire dispatch center. The option that may be most practical in this situation is to provide the ambulance dispatch a direct link to the fire department's computer aided dispatch system. When the call taker sends the incident to the fire dispatcher it would be simultaneously sent to the ambulance dispatcher.

This should accomplish to benefits. First, it will reduce the opportunity for an incident to be missed by the ambulance dispatcher. Second, it should help shorten the response time of the ambulance since both dispatchers will receive notice of the call at the same time. The ambulance dispatcher will receive notice much earlier in the process than they do currently.

Recommendation:

- Increase the fire department's emergency medical service level of care so that advanced life support service can be provided from each fire department response unit (staffed engines and ladder truck).
- Modify the manner in which ambulance dispatchers are notified of emergency medical incidents to reduce the chance of missed calls and to shorten the ambulance call processing time.

Work Schedule Alternative

The city of Billings and International Association of Firefighters Local 521 have contractually agreed to a 43.5 hour work schedule for shift personnel. During each 27 day period a shift employee will work 168 hours. The schedule is 24 hours on duty followed by 48 hours off duty for seven cycles. Then each employee is off for an additional six days.

Federal law limits a firefighter's work hours to 204 during the same 27 day period. Hours worked in excess of 204 are subject to overtime compensation. The city and Local 521 have agreed to a work schedule 36 hours per 27 day cycle less than the federal limit.

ESCi, in this report, does not intend to interject itself into the city's collective bargaining process. The contract is what it is and will remain so absent negotiated changes. This discussion will focus on those benefits and consequences that might present as a result of a change in the current work hour limitation.

Firefighter work hours vary significantly across the nation. In the western states, a work schedule that produces a 53 hour work week (204 hours in the 27 day cycle) is common. There is a high degree of variation, though, even in the western states.

The hours worked by each firefighter impacts the total number of personnel needed to fill each 24 hour shift position. Currently, as discussed earlier, 4.35 employees are needed to ensure each 24 hour shift position is staffed. On a 53 hour per week schedule the number of employees required per 24 hour shift position drops to 3.53.

ESCi assumes, for the purposes of this discussion, that the hourly rate paid to fire department shift personnel would remain constant if work week hours were to increase. There are potential costs savings to the city that can be realized if the work week hours were to be increased. For example, benefits costs, training, uniforms, and personnel protective equipment cost the same whether an employee works 43.5 hours per week or 53 hours per week.

Based on these assumptions, the current cost of fire service would be slightly reduced if shift personnel worked a 53 hour work week. The table below shows the comparison.

Comparison of Staffing and Cost for Current Deployment

Classification	Number of personnel needed at 43.5 hours per week	Cost of personnel at 43.5 hours per week[12]	Number of personnel needed at 53 hours per week	Cost of personnel at 53 hours per week	Potential savings
Firefighter (all classifications)	39	$1,752,851	31.7	$1,676,533	$76,318
Engineer	27	$1,353,882	22	$1,302,978	$50,904
Captain	27	$1,619,264	22	$1,566,121	$53,143
Battalion Chief	4	$273,013	3.53	$286,898	-$13,885
TOTAL	**97**	**$4,999,010**	**78.43**	**$4,832,531**	**$166,479**

In each of the following deployment and staffing sections the cost for additional personnel needed to implement the various options will be shown for both the current 43.5 hour work week and a 53 hour work week.

Aerial Ladder Company Staffing

The Billings Fire Department staffs fire engines and an aerial ladder unit (ladder truck) as its primary response resources. In certain situations, personnel assigned to these units are moved to other more suitable types of response units, such as wildland firefighting vehicles.

Ladder truck staffing varies from a maximum of three personnel to a minimum of one person. Shift vacancies created by vacation, work hour reduction, sick leave, and other factors force ladder truck staffing to levels less than three 66% of the time, two personnel 52% of the time, and one person 14% of the time[13].

One or two personnel are not sufficient to properly staff a ladder truck given the complexity of tasks it typically performs. Ladder trucks are responsible for a variety of activities:

- Forcible entry into the building as needed
- Opening the roof to allow heat to escape prior to fire attack
- Salvage and property conservation activities
- Setting up exhaust fans, scene lighting, and other incident support

[12] Includes wages, benefits and support costs (uniforms, training, personal protective equipment)

[13] Based on staffing data for 2002

National standards recommend four or five personnel be constantly assigned to ladder trucks. This number provides the personnel needed to perform the tasks usually assigned to these units. Since Billings does not staff with this number of personnel, firefighters from engine companies must divert from their primary tasks to perform the tasks normally assigned to ladder truck personnel. This leads to delays in fire attack, rescue and other engine company activities.

The National Fire Protection Association discussed this issue in its Fire Protection Handbook:

> *It is frequently impossible for small cities to fully staff all of the fire companies they need to handle working fires throughout the community. In many cases, the population density and the values protected per square mile are relatively low. In such communities, some engine companies may respond with only three persons on duty, and ladder trucks with only two. Such low levels of staffing should be backed up promptly to ensure adequate personnel by off-shift or call personnel or by multiple-alarm response.*[14]

The fire department does attempt to call back personnel for significant emergencies. However, it is not able to do so quickly enough in the early stages of an incident to provide effective staffing levels.

The city needs to make a choice about its ladder truck resource. It should either staff it with no less than three personnel (four ideally) or discontinue operating the unit. Discontinuing its operation is not recommended. There will be a negative impact on the city's insurance rating if a ladder truck is not staffed and operated as part of the initial response to a structure fire.

[14] National Fire Protection Handbook, 18th edition, National Fire Protection Association

The cost of improving ladder truck staffing is not insignificant. An additional two personnel per shift must be assigned to assure at least three personnel are on the ladder truck and to provide four-person staffing the majority of the time (86%). Based on the current work schedule (43.5 hours per week), the annual cost of the additional staffing to provide a minimum of three and normally four personnel on the truck would be approximately $445,680[15].

Based on a 53 hour work week, total shift staffing required to staff engines at their current level and the ladder truck at the recommended level would be 86.5 rather than the current 97 personnel. The cost of this staffing improvement is reduced to $219,599, a savings of $226,081. Incurring the cost of ladder truck staffing improvements will provide the Billings community with an important increase in fire suppression effectiveness.

Recommendation:

- Increase the minimum staffing for the ladder truck to at least three, and if possible four, personnel.

Resource Deployment Options

The city council determined in its discussion that the current level of service, as defined by staffing and response time, is adequate for the community. Given this position, the focus of these options and recommendations will be on maintaining the current level of service as the community expands and population increases.

Certain assumptions were made to develop the options that follow. These include:

- The city will continue to expand through annexations to the boundaries described earlier in this report (page 5).
- The service area population will grow as described in this report. It assumes a year 2020 population of 131,000.

[15] This amount includes wages, benefits, estimated costs for uniforms, personal protective equipment, training and other support costs for nine firefighters. The figure shown is the first year cost. Annual increases will occur in accordance with the labor agreement.

- The community's land use patterns will not change radically. Current land use designations will remain fairly consistent over time although some land currently designated as agricultural may be rezoned to residential and neighborhood commercial uses.
- The fire department's mission and services will not be significantly altered.

Two deployment options have been developed for consideration. Each is graphically presented to show improvements in response coverage. The estimated additional costs to implement the options are provided based on the department's current operating costs. The costs are shown for both the current 43.5 hour per week schedule and a 53 hour per week schedule for shift personnel.

Each option is intended to improve geographic coverage of the department's service area. Significant gaps exist currently. Other areas will need improved coverage as development continues. Suggested timing for implementation of various components of each option is also provided.

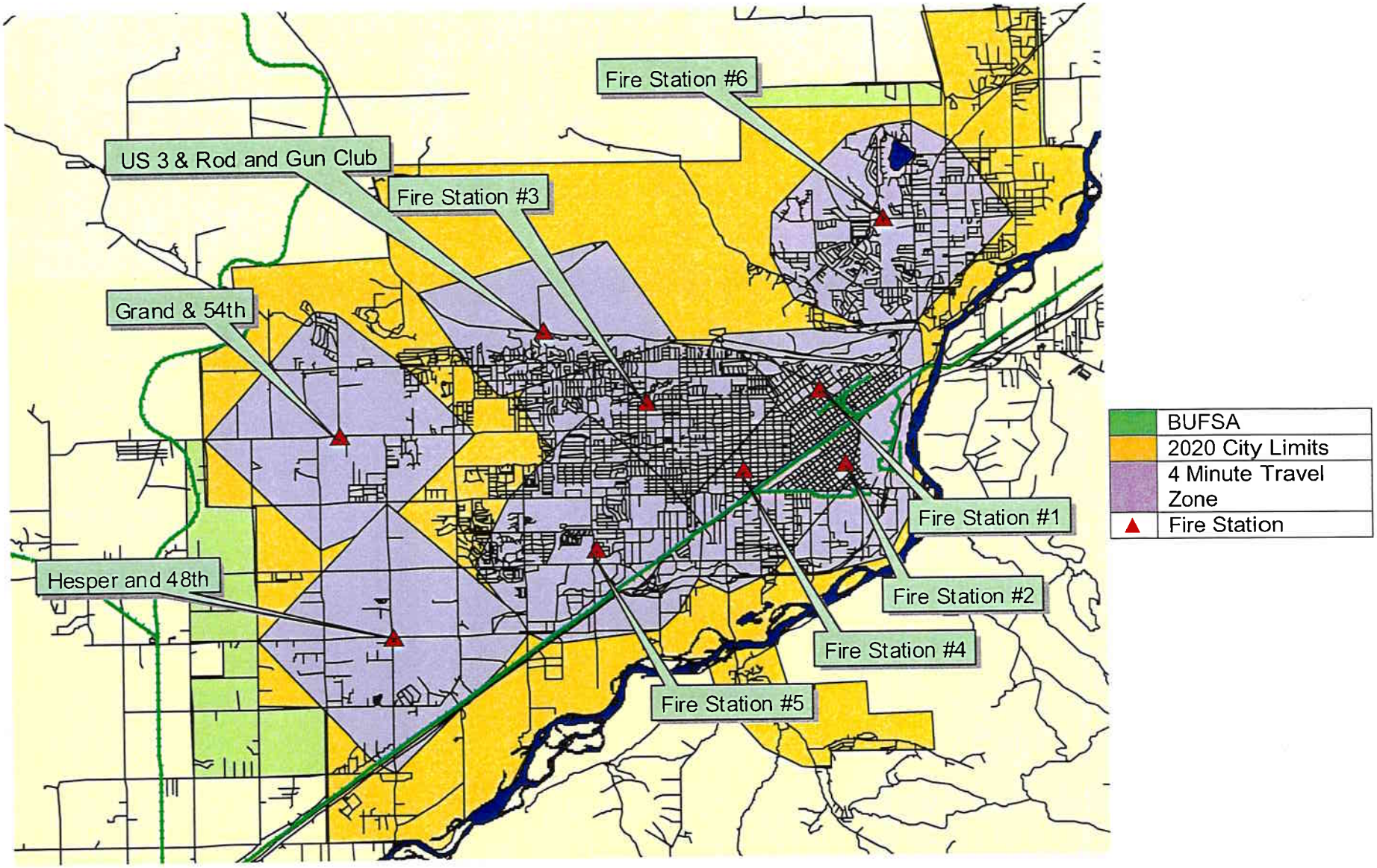
Deployment Option One

The first option attempts to utilize all existing fire stations in the response coverage plan. The community has already invested in these facilities, and to the degree they can continue providing service they should.

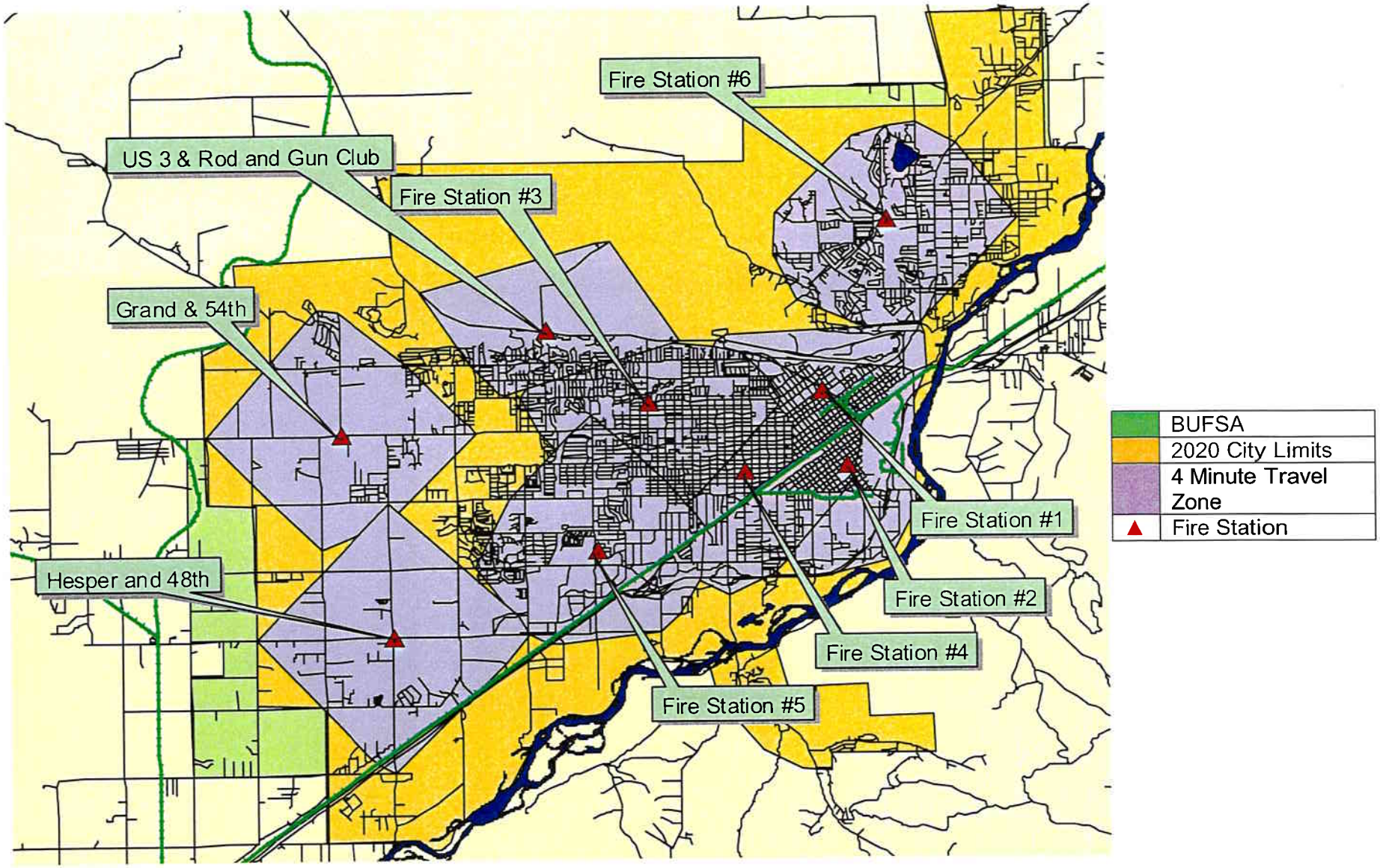
This option proposes three new fire stations (as shown on the map on the following page). Two are located in the west Billings area, and one west of the airport off US Highway 3. Each new station is proposed to house a single response company staffing a fire engine. Additional apparatus can be located at these stations, such as brush units, providing additional response flexibility.

The total number of fire stations in this plan is nine housing nine fire engines, one ladder truck, and a battalion chief. This option provides minimum on-duty staffing based on current staffing practices of 29 personnel and maximum staffing of 34 personnel. 39 additional personnel would be required to provide needed staffing based on the 43.5 hour work week. 32 additional personnel are needed based on the 53 hour work week.

Fire Station Location Option A



Fire Station Location Option A



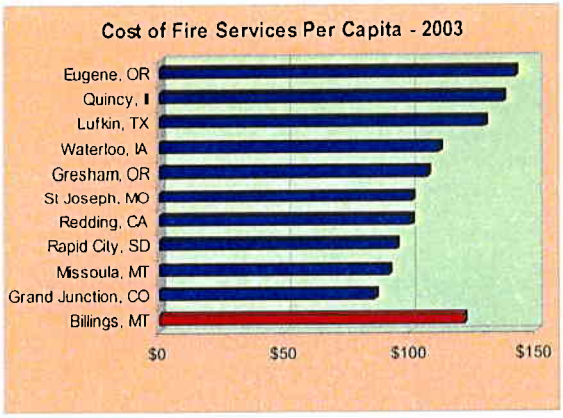
This option provides a more dense coverage of the more intensely developed, higher risk areas and continues less dense coverage of residential areas. However, even with the addition of three more fire stations, apparatus, and personnel, a substantial amount of the service area still lies outside the four-minute travel coverage.

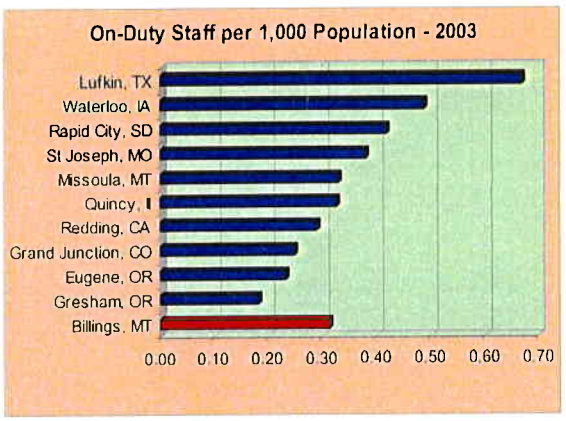
The estimated additional costs to implement this option are shown below.

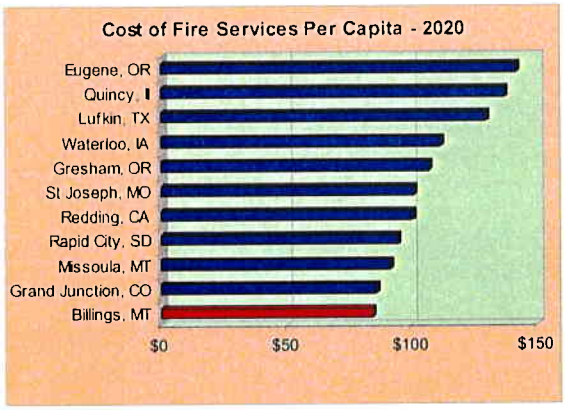
Capital Construction	**43.5 Hour Week**	**53 Hour Week**
Three Fire Stations – 2 bays and living quarters. (8,746 square feet each at an estimated $140 per square foot construction and furnishing cost. See the space analysis in the Appendix)	$3,673,320	$3,673,320
Land Acquisition and Site Engineering		
Three sites total (estimated at an average cost of $200,000)	$600,000	$600,000
Capital Equipment Acquisition		
Three fire engines at a fully equipped cost of $350,000	$1,050,000	$1,050,000
Total Capital Costs	**$5,323,320**	**$5,323,320**
Ongoing Expenses	**43.5 Hour Week**	**53 Hour Week**
Staffing	$2,011,568	$1,772,306
Operations and maintenance (estimated at $200,000 per station)	$600,000	$600,000
Financing of one-time costs – 20 year note at 5% interest	$427,157	$427,157
Total Additional Ongoing Costs	**$3,038,725**	**$2,799,463**

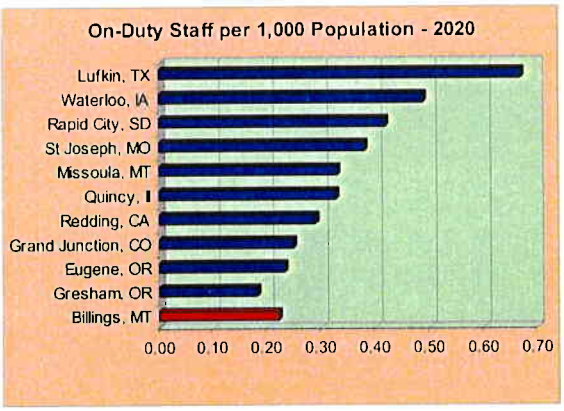
If this option is selected, the city should plan for the addition of two of the three stations in the near term. The US Highway 3 and Rod and Gun Club Rd., and the Grand and 54th stations will provide substantially improve service to areas inside the city that are currently underserved.

The new costs (based on the 43.5 hour work week) for all three stations were applied to the fire department and contrasted with the similar communities used in the comparison shown earlier in this report. The results are shown in the charts below for both the current year and projected to the year 2020 assuming the forecasted population.







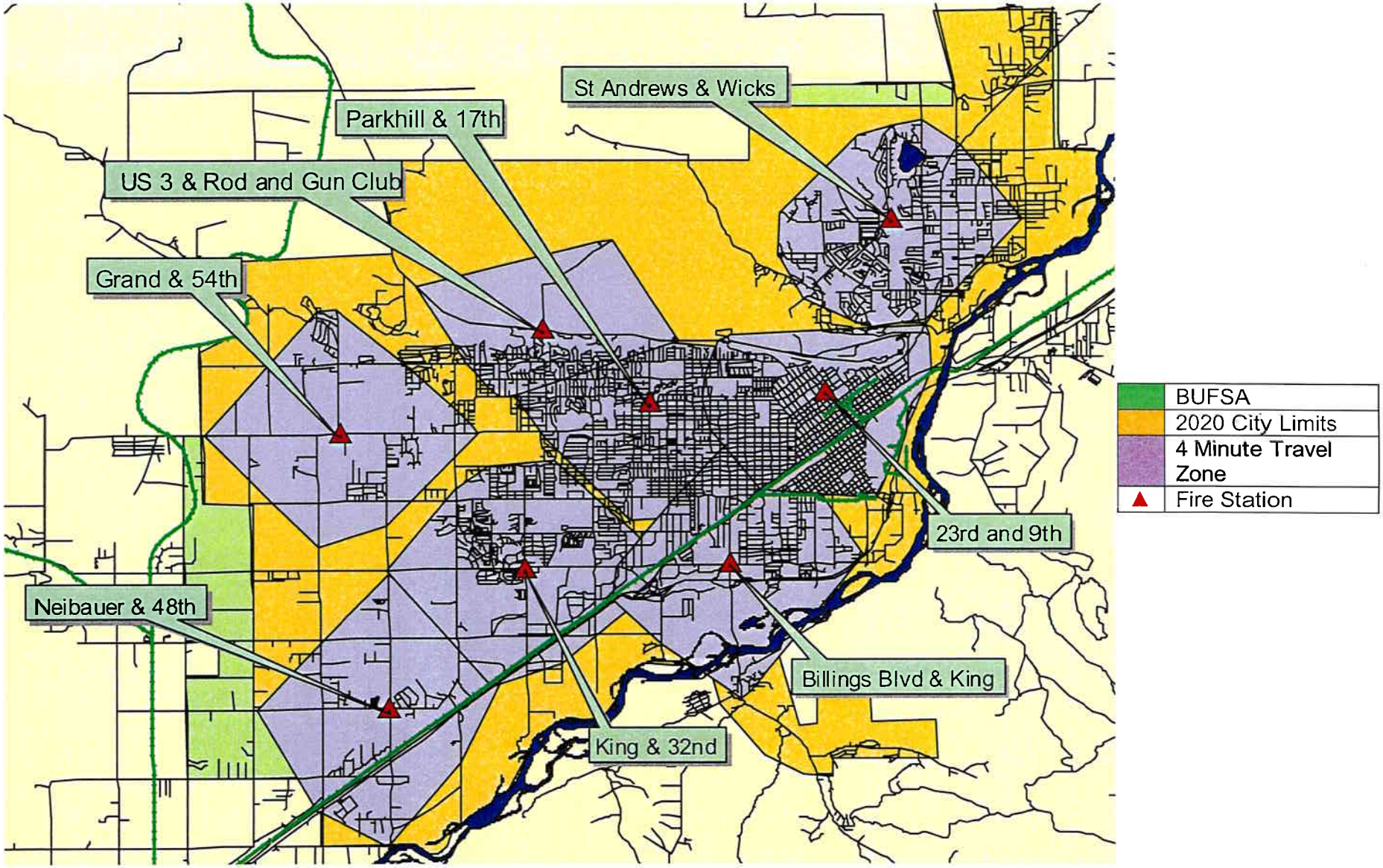


Full implementation of this option now increases per capita costs to just over the average of the other comparable jurisdictions. However by the year 2020 per capita costs reduce to once again make Billings Fire Department the most affordable of the listed comparables.

Deployment Option Two

This option assumes that all current fire station locations are subject to relocation in order to provide the greatest amount of coverage at the least cost. The map on the following page shows how eight fire stations, properly located, can provide better coverage than the nine used in Deployment Option One.

Fire Station Location Option B



In this option stations 1, 3 and 6 remain where they currently sit. Stations 2, 4 and 5 are relocated and two new stations are added.

Each new station is proposed as a single response company station staffing a fire engine. Additional apparatus can be located at these stations, such as brush units, providing additional response flexibility.

The total number of fire stations in this plan is eight housing eight fire engines, one ladder truck, and a battalion chief. This option provides minimum on-duty staffing based on current staffing practices of 26 personnel and maximum staffing of 31 personnel. 26 additional personnel would be required to provide needed staffing based on the 43.5 hour work week. 21 additional personnel are needed based on the 53 hour work week.

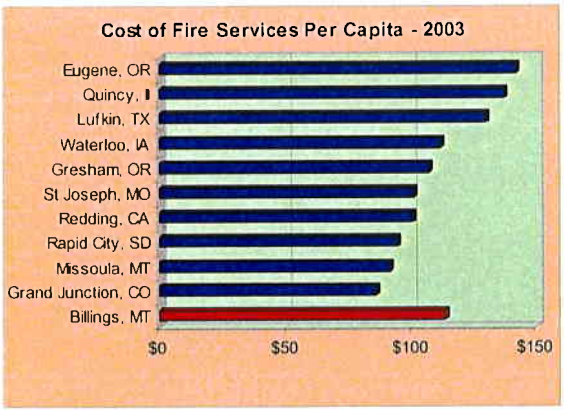
This option provides good coverage of the more intensely developed, higher risk areas and continues less dense coverage of residential areas.

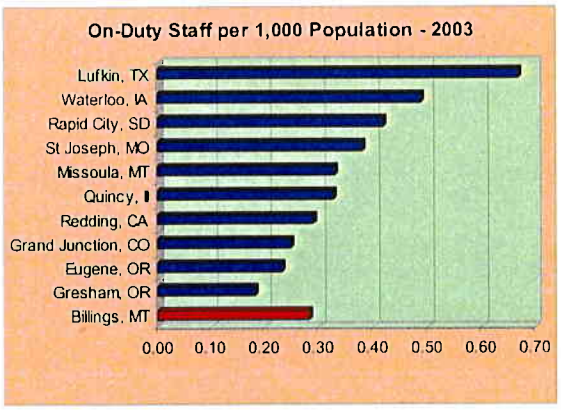
The estimated additional costs to implement this option are shown below.

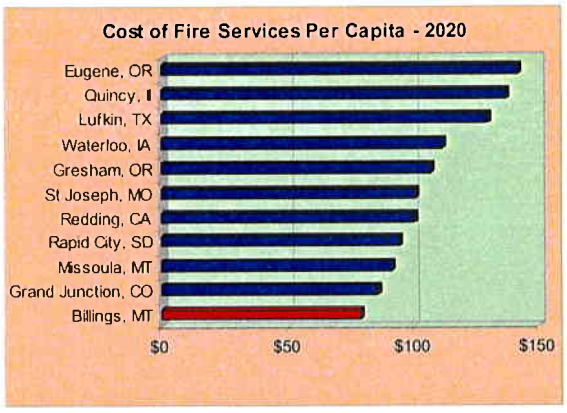
Capital Construction	**43.5 Hour Week**	**53 Hour Week**
Five Fire Stations – 2 bays and living quarters. (8,746 square feet each at an estimated $140 per square foot construction and furnishing cost. See the space analysis in the Appendix)	$6,122,200	$6,122,200
Land Acquisition and Site Engineering		
Five sites total (estimated at an average cost of $200,000)	$1,000,000	$1,000,000
Capital Equipment Acquisition		
Two fire engines at a fully equipped cost of $350,000	$700,000	$700,000
Total Capital Costs	**$7,822,200**	**$7,822,200**
Ongoing Expenses	**43.5 Hour Week**	**53 Hour Week**
Staffing	$1,341,087	$1,132,494
Operations and maintenance (estimated at $200,000 per station)	$400,000	$600,000
Financing of one-time costs – 20 year note at 5% interest	$627,674	$427,157
Total Additional Ongoing Costs	**$2,368,761**	**$2,159,651**

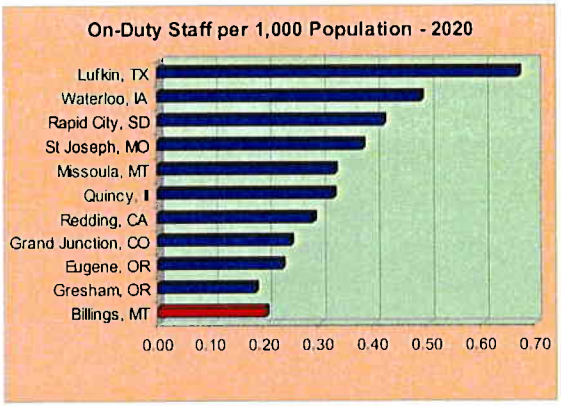
If this option is selected, the city should plan for the relocation of 2, 4 and 5 as well as the addition of the station at Grand and 54th concurrently and in the near-term. Construction and staffing of the station at Neibauer and 48th can be deferred until additional development occurs. The US Highway 3 and Rod and Gun Club Rd., and the Grand and 54th stations will substantially improve service to currently underserved areas inside the city.

The new costs for this option were applied to the fire department and contrasted with the similar communities used in the comparison shown earlier in this report. The results are shown in the charts below for both the current year and projected to the year 2020 assuming the forecasted population.









Full implementation of this option now increases per capita costs to the average of the other comparable jurisdictions. By the year 2020 per capita costs reduce to once again make Billings Fire Department the most affordable of the listed comparables.

Comparison of Options

The degree of benefit received from each option is important to review. This can be measured by reviewing the amount of land and the percentage of historic incidents that fall within two travel miles of a fire station. As this is a forward looking study, the land area used in the comparisons is the presumed city boundaries in the year 2020. The coverage benefits of each option are described in the table below.

Benchmark	Current Coverage	Option A Coverage	Option B Coverage
Number of fire stations	6	9	8
Land area within two travel miles of a fire station	28 square miles	50 square miles	54 square miles
Percentage of incidents within two travel miles of a fire station	88%	91%	94%
Annual additional cost of option	$0	$3,038,725 (43.5 hour week) $2,799,463 (53 hour week)	$2,368,761 (43.5 hour week) $2,159,651 (53 hour week)

Option B provides the most cost effective means of improving coverage of the service area. Resources are focused on areas that are either currently developed, or likely to develop in the next decade.

Recommendation:

- Improve the city's ability to serve a growing population and service area by relocating three existing fire stations and adding two new fire stations as recommended in Deployment Option B.

TIMING OF STATION ADDITIONS AND RELOCATIONS

The Billings Fire Department will need to continually monitor its performance, using a variety of criteria, in order to ensure it continues to meet is objectives. The department's data collection, with previously recommended modifications, will provide the information needed to conduct ongoing review of performance against the following performance indicators defining the current level of service.

- Initiate response to an emergency within 2 minutes from the time of dispatch, 90% of the time.
- Provide for the arrival of sufficient resources to initiate interior attack on a structure fire within 10 minutes from the time of dispatch, 90% of the time.
- Provide for the arrival of the full initial assignment to a structure fire within 18 minutes from the time of dispatch, 90% of the time.
- Provide for the arrival of basic life support services to an emergency medical incident within 7.5 minutes from the time of dispatch, 90% of the time.

Other performance indicators that should be monitored include:

- Response time performance by time of day – This will reveal the impacts of growing workload. If response times begin to increase during peak demand time periods this will suggest the need to add additional response units during those more active periods.
- Response time performance by station area – As workload increases individual response companies more frequently will not be available to cover calls in their primary area. Consequently response units from adjacent stations will be dispatched creating longer travel times. Increases in a given station area's response times can also indicate the need for an additional response company during peak activity periods to manage demand.

The addition and relocation of fire stations should be predicated on maintenance of these performance objectives. Over the next several years, as response activity continues to increase, it is expected that response performance will begin to diminish. Areas experiencing more vigorous growth will show the effects first.

The city should consider the following implementation plan and develop the necessary funding to accomplish it.

1. Construct equip and staff the proposed fire station at U.S. Highway 3 and Rod and Gun Club Rd. Anticipate this will be needed within the next two to three years.
2. Relocate fire stations 2, 4 and 5. These will need to be done concurrently to ensure no gaps in coverage. Anticipate this will be needed within the next five to ten years.
3. Construct, equip and staff the proposed fire station at Neibauer and 48th. The timing of this addition will be highly dependent on the rate of development within its response region.

The future is not easily predicted. Adjustments may be needed based on the city's future planning, development, and growth. Continual measurement of the impacts of change on the fire department's service delivery will allow opportunity to make resource deployment adjustments and allow the fire department to continue the good services it provides at levels desired by the community.

Appendix

1. Single company fire station space analysis
2. Summary of recommendations
3. Current service area map

Single Company Fire Station Space Analysis

Space Description	Size	Square Feet
Administration		
Entry Vestibule	5x8	40
Communications/watch room	10x10	100
Storage	6x8	48
Living Quarters		
Dayroom/classroom	20x15	300
Kitchen	12x15	180
Dining area	12x15	180
Sleeping rooms	8 @ 10x12	960
Washroom – men's	12x15	225
Washroom – women's	12x12	144
Locker room – men's	10x15	150
Locker room – women's	10x15	150
Utility storage	8x12	96
Supply storage	8x8	64
Laundry room	10x10	100
Physical fitness room	15x20	300
Apparatus Room		
Apparatus bays (4)	50x90	4,500
Tools and parts storage	8x10	80
Equipment decontamination room	8x12	96
Hose tower	8x12	96
Hose storage	8x10	80
Turnout storage	8x15	150
Site maintenance storage	10x10	100
Subtotal of room/space sizes		**8,139**
Plus 20% of office/quarters for circulation		**607**
Total Recommended Square Feet of Space		**8,746**

Summary of Recommendations

- Adopt regulations requiring the installation of fire sprinkler systems in all new buildings and any building that undergoes a significant remodel or addition.
- Review and revise water system connection and use charges to encourage voluntary installation of fire sprinkler systems, for example a lower base water rate.
- Complete a comprehensive needs analysis to determine the fire department's data collection and evaluation requirements. Acquire appropriate software and associated hardware identified through the needs analysis.
- Implement mobile computing technology to improve response performance, enhance resource management, and improve management analysis capabilities.
- Identify and implement methods to minimize the time response units are out of their primary service areas
- Improve the fire department's ability to respond quickly by reducing the resistance of key response routes.
- Increase the minimum staffing for the ladder truck to at least three, and if possible four, personnel.
- Increase the fire department's emergency medical service level of care so that advanced life support service can be provided from each fire department response unit (staffed engines and ladder truck).
- Modify the manner in which ambulance dispatchers are notified of emergency medical incidents to reduce the chance of missed calls and to shorten the ambulance call processing time.
- Improve the city's ability to serve a growing population and service area by relocating three existing fire stations and adding two new fire stations as recommended in Deployment Option B.