

# Boulder Fire Department

## Master Plan

November 12, 1996

Prepared for the City of Boulder

By

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## **ACKNOWLEDGMENTS**

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### **Boulder City Council**

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### **Approval Process:**

The Boulder Fire Department Master Plan was reviewed by the City Manager's Office, and other City departments and was available for public review. The revised plan was recommended for adoption by the Planning Board on October 17, 1996. The City Council formally adopted this Master Plan following a public hearing on November 12, 1996.

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Throughout this planning effort, the Fire Department's management staff worked with committees formed by others within the Department, other City departments, and County agencies. Many of the issues and recommendations in this draft plan are the product of these committees. The Department would like to thank the following for their assistance:

<i>Brad Baker</i>	American Medical Response Ambulance
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The Department also acknowledges fire service consultant, Kevin Klein, for his work in preparing this document and translating fire department technobabble into a readable format.

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## EXECUTIVE SUMMARY

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This Master Plan was created through the cooperative efforts of Fire Department members, staff from other City departments, and officials from emergency response agencies with which the Fire Department works. The Master Plan Committee identified several issues concerning service delivery. These issues were then assigned to working groups for further analysis and recommendations. The plan was also presented to the Boulder City Council and the City of Boulder Planning Board for review and direction, which was incorporated into this document.

*The working groups and the Master Plan Committee identified the following existing deficiencies in the Department's services:*

- Response times for emergencies exceed the Boulder Valley Comprehensive Plan standards and exceed those of peer cities.
- Two of the City's six fire stations are over capacity.
- The Fire Department's public education activities are inadequate.
- The Fire Department's ability to protect lives, property and sensitive ecosystems threatened by wildland fires occurring in the wildland/urban interface is limited.
- Demands on the Fire Department's Training Division exceed the Division's capacity.
- The Fire Department's ability to prevent hazardous materials releases is limited.

Each working group was then asked to develop goals and objectives related to the group's area of expertise. The groups were charged with developing measurable objectives to be used as performance standards for future evaluation of the Department's effectiveness. These goals, objectives and performance measures were then examined in relation to the Department's history and future capabilities, and to the experience of peer cities and comparable Western cities. Using performance standards to evaluate the Department's services represents a significant improvement in program management. The Department's goals are to:

1. Minimize death and injuries due to fire.
2. Minimize direct and indirect losses due to fire.
3. Minimize death and suffering for people experiencing sudden illness, accidents, or injury.
4. Minimize the number and adverse impact of hazardous materials releases.
5. Minimize deaths, injuries, and property loss due to natural and technological disasters.
6. Provide cost effective fire protection and emergency services.
7. Protect local ecosystems.
8. Maximize citizen satisfaction.

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Guided by these goals and their associated objectives, the Committee evaluated service trends and growth projections to develop recommendations. *These recommendations allow the Department to maintain existing services and generally do not involve expanding service levels or adding new services. These recommendations, if approved, will also allow the Department to meet previous service levels in areas where increased demands for service have resulted in a decline in service levels.*

The Boulder Fire Department's primary recommendations include:

- Augmenting response resources in the City's core with a rescue squad during peak periods of demand.
- Decreasing service demand and risks through the prevention and enforcement activities of a new Public Safety Educator and a new Hazardous Materials Inspector.
- Constructing a new fire station on 55th Street south of Arapahoe Avenue to reduce response times and redistribute work loads.
- Adopting automatic external defibrillation technology to resuscitate cardiac arrest victims.
- Working with the Transportation Department to decrease negative impacts of traffic mitigation programs on response times.
- Enhancing the City's wildland fire response and mitigation capabilities by forming a Wildland Fire Mitigation and Response Crew.
- Constructing a new wildland fire mobilization and response facility (Fire Cache).
- Modifying the Department's dispatching and response to wildland fires.
- Enhancing the Department's management capabilities by promoting an Operations Chief.
- Participating in regular disaster preparedness exercises.
- Extending the Department's training capability by hiring a Training Assistant.
- Constructing a new training facility.

The Department proposes implementing these recommendations using a five-year phased approach. The annual cost of the implementation is \$2.25 million. At the end of the five years, the annual operating costs of the improvements are estimated to be \$1.4 million.

Finally, this Master Plan is an integral part of the Department's strategic planning process. The Master Plan allows the Department to anticipate and respond to changes in its environment before the changes adversely impact service delivery. In order to ensure that a contemporary strategy is used in the future, the Master Plan will be evaluated and revised on an annual basis.

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## INTRODUCTION/BACKGROUND

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### Why We Are Here

*The images cross our consciousness every now and then. The firestorm that destroys everything in its path while forcing people and animals to flee their homes. The elderly neighbor who suffers a heart attack. A historic building reduced to smoking rubble. Dead fish floating in a creek. A teenager who overdoses on drugs.*

*Sometimes the stories have happy endings. The elderly neighbor and the teenager recover. The firestorm is stopped. A spill is kept from the water's edge and fish don't die.*

*These happy endings are dependent upon the Fire Department.*

This fire and emergency services Master Plan is about increasing the number of happy endings. The Department believes the time to plan for an emergency is before it occurs, when people have time to think and reflect.

In many communities, the fire department waits for problems to surface and then reacts to the symptoms, rather than the root causes, of the problems. This philosophy has led to emergency service systems where large standby forces are maintained to protect people from hazards that may have been prevented. These reactive emergency services are ineffective as well as costly.

Boulder has chosen a different path. With the adoption and enforcement of more effective building, fire, and housing codes, Boulder has reduced the potential for large scale emergencies. This approach has allowed Boulder to minimize the loss of lives and property with a relatively small number of firefighters.

However, as Boulder matures, it is time to re-examine and broaden the Fire Department's proactive approach. The Department has inventoried and analyzed its resources so that it can adjust its service to better meet the community's future needs.

Specifically, this Master Plan:

- Profiles the current fire protection and emergency services system, including the capabilities and limitations of the system.
- Identifies the nature and extent of the risks faced by people and the environment in Boulder.
- Establishes goals and performance measures to evaluate the effectiveness of the fire and emergency services system in future years.

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Fire and its aftermath cost the citizens of Boulder in both human and financial terms. The Boulder Fire Department will respond to over 7,000 calls for service this year. Of these calls, 1,800 are for fire calls – resulting in 420 actual fires. Fires in Boulder kill an average of one person per year. The old and the young are most often victims of fire. Fifty percent of Colorado’s fire fatalities are over sixty or under five years of age. Sixty percent of these deaths occur in the victim’s home.<sup>1</sup>

Fire and fire protection cost Boulder citizens approximately \$38.4 million (\$400/person) annually<sup>2</sup>. Fire destroys an average of \$1.8 million worth of Boulder property each year. The remaining costs include insurance overhead, medical costs of fire injuries, costs for built-in fire protection systems, and the costs of fire suppression services.

Fire creates additional economic burdens for citizens. Following a fire in a commercial or industrial occupancy, the business’s clientele simply seek goods and services from another supplier. If that supplier is outside the City, Boulder loses economic benefits. In addition, Boulder loses the circulation of displaced employees’ payroll and the State suffers an increased burden from unemployment and welfare claims. Finally, a devastating fire in the City or in the Backdrop could have a negative impact on Boulder’s tourist trade.

What these economic costs fail to include is the human toll related to a fire loss. The loss of a loved one, the suffering of the burn victim, the emotional trauma experienced by a displaced family, and the emotional damage suffered by rescuers are all costs which are difficult to quantify. Simply put, how much would you pay to avoid being a fire victim or losing a loved one to fire?

## **The Boulder Fire Department**

### ***Mission***

The Department’s history and current activities are consistent with its mission, which is:

*The Boulder Fire Department strives to make Boulder a safe place to live and work. We reduce the human suffering caused by fires, accidents, sudden illness, hazardous material releases, or other disasters.*

### ***The Past***

The Boulder Fire Department has a long and proud history. The “Boulder Hook and Ladder Company” was organized February 15, 1875. By the spring of 1876, Boulder had 2,180 feet of water main on Pearl Street with four fireplugs. Fire equipment was pulled by hand during this era. Horses were introduced to the Department’s four hose companies in 1898. That same year, Boulder’s first paid firefighters were hired. By 1913 all equipment was mechanized and in 1915 the last of the volunteer fire companies in the City disbanded.

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The post-World War II era saw a dramatic increase in the population of Boulder, and with this increase came increased demands for municipal fire services. In 1965, a third fire station was dedicated. This station, located at 30th and Arapahoe Streets, remains an active station today. In June 1978, for the first time in Boulder, three women joined the Fire Department. By 1982, the Boulder Fire Department employed five percent of the paid women firefighters in the nation. Today, the Boulder Fire Department continues to be a nationally known leader in fire service diversity. Currently, women and minorities represent 37.5 percent of the Department's line personnel and approximately 50 percent of prevention and administrative personnel.

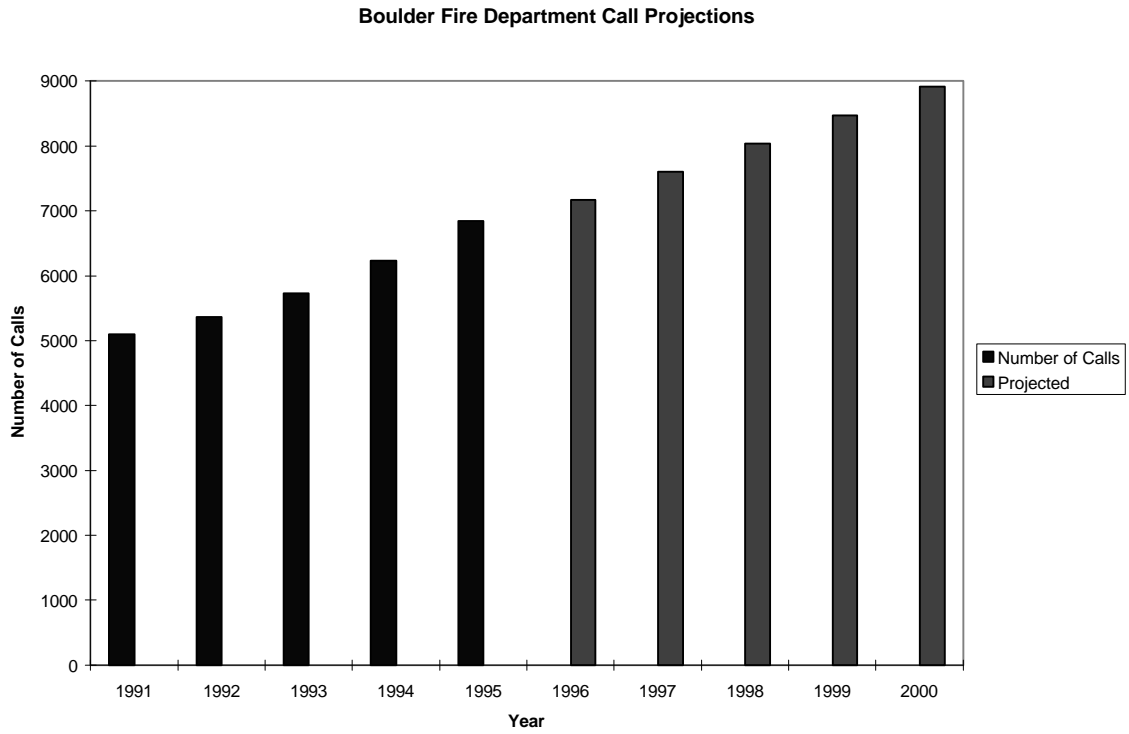
The decade of the 1980s saw the Fire Department extend its responsibilities into additional emergency response and prevention areas. Prevention efforts were increased with an emphasis on fire codes. Additionally, in a cooperative effort with the Boulder Fire Department, the University of Colorado spent \$1.5 million over five years to make fire safety improvements in residence halls.

### ***The Present***

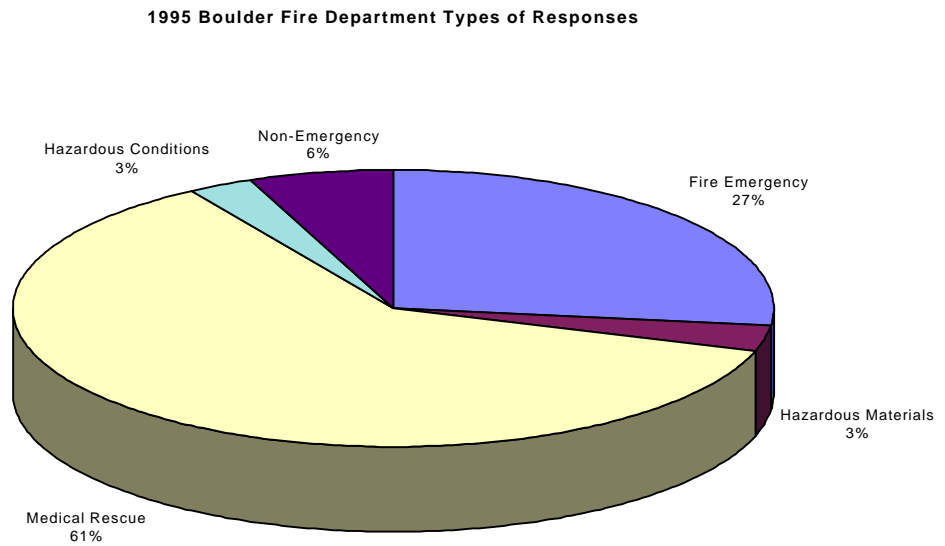
The Boulder Fire Department is meeting increasing demands for its services. It will respond to over 7,000 emergency calls this year, Figure 1. In addition to combating structure and wildland fires, firefighters provide basic life support for Boulder's emergency medical system, rescue people trapped as a result of accidents, and respond to hazardous material releases (see Figure 2 for a distribution of types of responses). The Department also provides non-emergency services such as inspection services for businesses, plan checks, counseling for children who misuse fire, arson investigations, and limited public education programs.

The Fire Department operates seven engine companies out of six fire stations. These stations are staffed 24 hours per day, seven days a week. At any given time there are at least 22 firefighters on-duty. The Department employs 87 uniformed and seven civilian personnel, see Figure 3. The Department's current annual budget is \$7 million.

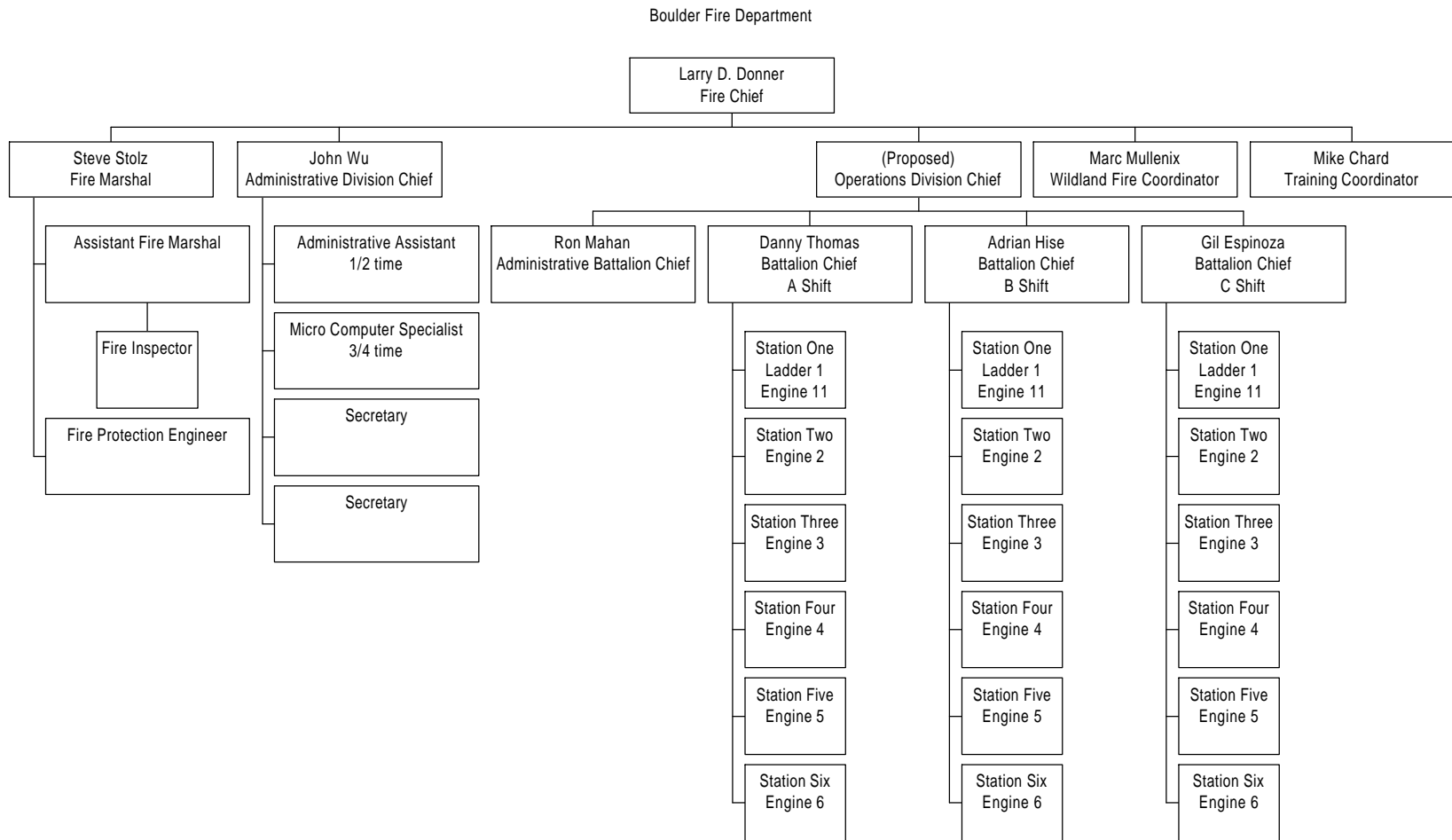
**Figure 1, Calls for Service**



**Figure 2, Types of Responses**



**Figure 3, Organization Chart**



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## The Community

### *Population*

Boulder's current population estimate is 95,442. A significant portion of this population is attributed to the 25,000 students attending the University of Colorado. In the decade between 1980 and 1990, Boulder experienced an annual growth rate just less than one percent. Since 1990, Boulder has experienced a significant increase in the annual growth rate to 2.29 percent annually, see Table 1. The recent population increase is mostly attributed to annexation and net migration rather than natural increase.<sup>3</sup>

**Table 1, Population Estimates**

<b>Year</b>	<b>Population</b>
1980	76,685
1990	83,312
1995	95,665
1996	95,442

### **Age**

The age structure of Boulder's population is changing in a manner with significant implications for the Fire Department. The median age of Boulder residents is approximately 29 years old. This is an increase from 25.9 in 1980. The newborn to five year olds group has increased 125 percent as percent of population. The percent population of persons 85 and older has increased 20 percent. These changes occurred while the total population experienced 8.6 percent increase.<sup>4</sup> Because the primary users of the Department's services are the youngest and oldest segments of the population, higher growth rates in these age groups have a greater impact on the Department's total calls for service.

## **Land and Real Estate Characteristics**

As of May 1995, the City of Boulder encompassed 25 square miles of land (enclaves of unannexed land are not included in this figure). In addition, the City owns 52 square miles of open space or park area. Boulder has a natural border to the west consisting of foothill mountains that are primarily City Mountain Parks and National Forest. To the north, south and east, the City is buffered by open space lands. This planned perimeter serves to protect Boulder's quality of life.<sup>5</sup>

The Boulder Fire Department protects \$7.89 billion dollars worth of real property within the municipality, see Table 2. The majority of the real property value is residential. Residential property is also associated with the largest fire and life losses in the City. In addition to the real property, the Department protects an additional \$750 million in personal property.<sup>6</sup>

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**Table 2, City of Boulder Real Property Values<sup>7</sup>**

Type	Sum of Assessed Value	Sum of Actual Value
Agricultural	53,000	289,850
Commercial	336,766,840	1,165,260,400
Industrial	124,927,030	430,782,000
Mineral	240	840
Residential	598,109,300	5,736,285,800
State Assessed	25,666,130	88,503,800
Tax Exempt	125,902,890	472,871,800
<i>Grand Total</i>	<i>\$1,211,425,430</i>	<i>\$7,893,994,490</i>

### ***Economic Characteristics***

At present, there are approximately 84,000 jobs in the City. Even with the adoption of the Commercial Growth Management Ordinance, projections show that jobs will increase to between 107,000 and 119,000 at Area I build-out.

Boulder is somewhat insulated from major fluctuations in its economy by the presence of four major institutions: The National Oceanic and Atmospheric Administration, the National Institute of Standards and Technology, the Center for Atmospheric Research, and the University of Colorado. The net result of these institutions is a very well educated work force. Fifty-nine percent of the population, age 25 and older, hold a bachelor degree or better compared to a national average of 20 percent. This characteristic makes Boulder an attractive place for high-technology industry to locate (e.g. IBM and US West). The two highest employment categories in the City are services, with 41.9 percent of the workers, and government, with 15.4 percent of the workers.<sup>8</sup>

### ***Community Risk***

When compared to other cities, Boulder has a normal to low risk for fires occurring within the city limits. However, it has a high risk for wildland fires in the urban/wildland interface. Health risks in Boulder are also considered normal.

The absolute number of lives lost and dollar value of property loss is highest when the City looks at the cumulative impact of routine emergencies. While a major wildland fire has potential for great damage and life loss, *the Department believes the community's greatest current risk comes from deteriorating response times for the day-to-day emergencies.* A complete discussion of this is found in the Emergency Response chapter.

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## Overall Planning Assumptions

All planning documents are based on a series of assumptions. The assumptions used in this Plan are highlighted where appropriate. In addition to assumptions specific to a particular section, this Master Plan is developed under the following broad assumptions:

- The Master Plan considered Area I and Area II as the urban service area. However, this plan does not provide for services in new annexations. It primarily addresses deficiencies in Area I. New annexations should be addressed on a case-by-case basis.\*
- For wildland fires, the service area is all City-owned open areas.
- At build-out, the population of Boulder will be between 104,000 and 108,000 people, and the population is aging.
- The Fire Department will continue to experience increases in calls beyond build-out due to in-commuting, continued job growth, tourism growth and increased citizen expectations.
- The City has limited resources available to maintain public safety.
- Boulder will experience major urban/wildland interface fires given the intermix of buildings and natural vegetation on the perimeter of the City.
- Relative to other cities, Boulder's current codes have minimized fire risk in commercial and multifamily structures. Through the use of codes, Boulder is able to exert a significant amount of control over the types of fires experienced in the community.
- The Master Plan does not allocate resources for future unfunded mandates from State or Federal governments.

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\* See enclosed map for Area I and Area II boundaries and for response time deficiencies in Area I.

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## WHERE THE DEPARTMENT WANTS TO BE — GOALS AND OBJECTIVES

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This Master Plan contains eight goals under which the Department's fire protection and emergency services systems operate. Because of increasing demands for service and related increases in the Department's response times, these goals reflect the Department's desire to maintain its current levels of service and, in some areas, return to previously higher levels of service.

Each goal has associated objectives. Under these objectives are *performance measures* which are quantified in order to provide comparisons for existing and future service. These measures become benchmarks for comparisons with five-year averages, with previous years, and to other jurisdictions. Comparative data help establish reasonable community expectations, assess efficiency and effectiveness of Department services and identify practices that lead to superior service. The Department's use of performance measures represents a significant improvement in the Department's ability to perform quality management.

The performance measures were developed after reviewing Boulder's past experience against data from other cities with similar characteristics. The Department used comparisons from *peer cities* and *comparable cities*. Peer cities are those cities which the City of Boulder has identified as having similar characteristics and has exchanged data with for a variety of purposes.<sup>9</sup> Peer cities have similar demographics and have major educational institutions within their boundaries.\* Comparable cities are cities in the western United States with populations between 50,000 and 99,999 in 1994. Comparable cities are used by the United States Fire Administration for making comparisons.

*Important note: All cost and loss figures are reported in constant 1996 dollars.*

### **Goal One — Minimize death and injuries due to fire.**

The most tragic consequences of uncontrolled fires are human casualties. Therefore, the Department and its firefighters make every effort to keep deaths and injuries at the lowest level possible.

#### **Objective 1: Limit fire-related fatalities and injuries in the community.**

Unfortunately, Boulder's fire-related fatality and injury rates are higher than those of its peer cities. The Department is striving to lower these rates.

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\* Peer cities include selected Front Range cities for Colorado comparisons.

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Performance Measures:

1. *Limit the community to one fatal fire per 100,000 population on a five-year average.*

Over the past five years, Boulder has experienced three fatal fires, giving the City an average fire death rate of 0.7 per 100,000. Peer cities have experienced a slightly lower average fatality rate of 0.5 per 100,000. Comparable cities experienced a death rate of 1.0, while nation wide the rate is 1.7 per 100,000. It is important to understand that a single fire can produce multiple fatalities, thereby dramatically changing the annual fatality rate for a given year. Therefore, the Department is using a five-year average rate as being more representative of its experience.

2. *Limit fire-caused civilian injuries to 10 per 100,000 population per year.*  
Boulder's average fire-related civilian injury rate is 13.9 per 100,000. Unfortunately, Boulder is above its peer cities' average (8), comparable cities (8.7) and the national average (12).

**Objective 2: Limit fireground injuries to firefighters.**

Because firefighter injuries are closely tied to the number and severity of fires encountered in a given year, reducing the number and severity of fires helps lower the Department's injury rate. Similarly, when an insufficient number of firefighters are available to fight a fire, the likelihood of injuries increase.

Performance Measure:

1. *Limit fireground injuries to firefighters to five per year.*

Over the past five years, Boulder has averaged 9.4 firefighter injuries per year at fires.

**Objective 3: Provide timely responses to fire calls.**

While this objective is part of the Boulder Valley Comprehensive Plan, it also represents one of the Department's most difficult challenges. The Department's response times have steadily degraded and have exceeded reasonable standards. Currently, the Department meets the Boulder Valley Comprehensive Plan response time goal of six minutes or less for only 75 percent of its calls. This is substantially worse than the peer cities average of 4.6 minutes for 75 percent of the calls

Performance Measures:

1. *Provide fire response within six minutes in 90 percent of calls.*

A recent citizen survey indicates that 77 percent of Boulder citizens expect firefighters to arrive in five minutes or less from the time they dial 911 with an emergency.<sup>10</sup>

- 
2. *Intercede before flashover occurs in 90 percent of all structure fires.\**  
This is a new measure for the Boulder Fire Department. Because fires that flashover are responsible for a disproportionate number of fire deaths and large loss fires, this measure is critical to maintaining a reasonable level of risk in Boulder. Because most other fire departments do not track this information, this measure will be used to compare Boulder's current experience against past experience. This measure is very closely related to built-in fire protection and response time.

## **Goal Two — Minimize direct and indirect losses due to fire.**

Direct fire losses include damage to buildings and their contents. Indirect losses include the cost of medical treatment resulting from fire-related injuries, the loss of personal income and business revenues, loss of property and sales taxes, opportunity costs of lost productivity, and other economic losses to a community. Often the indirect costs dwarf the direct costs of fire. Because indirect losses are generally proportional to direct losses, the Department uses measures of direct losses as performance standards for both direct and indirect losses.

### **Objective 4: Limit the number of fires occurring in the community.**

By limiting the number of fires, the Department is able to limit fire loss.

#### Performance Measure:

1. *Limit fire starts to 400 per 100,000 population per year.*

The City of Boulder experienced an average of 431 fires per 100,000 population. Comparable cities averaged 580 and the national average is 1,000 fires per 100,000.

### **Objective 5: Limit fire losses in the community.**

Various measures of fire loss are used to gauge losses in terms of population, value of property protected and losses per fire.

#### Performance Measures:

1. *Limit direct community fire loss to \$20 per capita.*

Fire loss per capita varies from year to year because one or two large losses have a dramatic impact on the calculations. However, this measure serves as a good benchmark for five-year averages and for comparison to other cities. Boulder's average fire loss per capita is \$19.29, which is less than comparable cities (\$23.70) but not as good as peer cities (\$14.37).

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\* See Emergency Response chapter for more information on flashover.

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2. *Limit direct fire loss to \$0.30 per \$1,000 actual value protected.*

As a result of the TABOR Amendment, the County Assessor now supplies the City with actual value information. These data provide the Department with the ability to compare Boulder to other Colorado jurisdictions. Boulder's average loss per \$1,000 actual value protected is \$0.26.

3. *Limit direct fire loss to \$4,000 per fire.*

Boulder does relatively well in this category. Boulder's average loss per fire is \$4,538. Comparable cities averaged \$9,534 and peer cities averaged \$8,590 loss per fire.<sup>11</sup>

### **Goal Three — Minimize death and suffering for people experiencing sudden illness, accidents, or injury.**

When people suffer from a sudden severe illness, have an accident, or are injured in any way, the emergency medical services (EMS) system attempts to intercede before further injury or death results. A timely and appropriate EMS response reduces deaths, pain and suffering, hospital stays, and medical costs.

#### **Objective 6: Provide timely emergency medical and rescue services.**

The Boulder Valley Comprehensive Plan calls for the Department to provide a basic life support (BLS) response in four minutes or less. The four minute objective is based on a national standard developed for the response, care and treatment of cardiac arrest victims. The standard was developed by the American Heart Association and is the standard response time target for most municipal fire departments. Unfortunately, the Department cannot currently meet this target.

##### Performance Measures:

1. *Provide basic life support and automatic external defibrillation within six minutes for 90 percent of calls requiring emergency medical assistance.*  
This is a substantial departure from the objectives in the Boulder Valley Comprehensive Plan, but reflects a more realistic view of the Department's capabilities in light of increasing response times. Again, the Department can get to a call in less than six minutes only 75 percent of the time. This response time is substantially worse than the peer cities. In addition, a recent citizen survey indicates that 73 percent of Boulder citizens expect EMS in five minutes or less from the time they dial 911.<sup>12</sup>

2. *Provide advanced life support within eight minutes in 90 percent of calls requiring emergency medical assistance.*

This objective is based on national standards developed by the American Heart Association and is consistent with the Boulder Valley Comprehensive Plan. Advanced life support (ALS) is currently provided by a private ambulance service. Because the community has a vested interest in their response times, the Department intends to continue tracking and auditing the private ambulance services' response times. Renewal of the ALS contract should be closely connected to response time measures in order to ensure responsiveness

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and accountability. If ALS response times deteriorate, the Department will evaluate alternatives to deliver ALS services to emergency scenes.

3. *Provide rescue services within eight minutes to 90 percent of all rescue calls.* The purpose of rescue is to remove victims from a dangerous situations. Because rescue activities often require multiple engine companies, the response time goal is higher than a one engine company response. The eight minute objective is based on estimates of current multiple company rescue response times and will be tracked in the future.

**Objective 7: Provide automatic external defibrillation with the basic life support response.**

Automatic external defibrillation (AED) is one way to help offset the impact of delayed ALS response times. AED is a relatively new technology that allows BLS providers to defibrillate cardiac arrest victims prior to the arrival of advance life support personnel. Rapid defibrillation is the most effective means of resuscitating cardiac arrest victims in the field. Adoption of this technology provides an effective solution for the most time critical emergencies.\*

**Objective 8: Improve the community’s ability to provide emergency medical assistance to its own members.**

Citizen CPR is an effective means of delivering limited BLS service. Because the Department cannot guarantee BLS within the four minute target response time, an increased frequency of citizen CPR classes will create additional safeguards by encouraging early bystander intervention.

Performance Measure:

1. *Provide 12 CPR training classes per year within the Community.*

**Goal Four — Minimize the number and adverse impact of hazardous materials releases.**

Hazardous material releases threaten the lives and health of Boulder’s citizens. These releases are also a threat to air and water quality, private and public lands, wildlife habitats, commerce, and tax revenue.

**Objective 9: Limit the frequency and scope of hazardous materials releases.**

By limiting the number and effects of hazardous materials releases, the Department is better able to protect the community and the environment from the consequences of chemical releases.

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\* See EMS chapter for a detailed discussion.

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Performance Measures:

1. *Limit the average number of significant hazardous materials releases to 240 per 100,000 population per year.*

This is a new performance measurement. It is based upon the current five-year average of 246 releases per 100,000 in the City. As more data are collected, this performance measure may require modification.

2. *Confine the effects of hazardous materials releases to the immediate incident area in 75 percent of reported cases.*

This is another new performance measurement which the Department intends to track. As of this writing, no reliable historical data exist; therefore, this measurement may also require modification.

## **Goal Five — Minimize deaths, injuries, and property loss due to natural and technological disasters.**

By definition, a disaster is a large scale event that exceeds the resources normally available to cope with an emergency. Planning, preparedness, and public education are key factors in minimizing a community's risk.

### **Objective 10: Maintain a current disaster plan for the City of Boulder and practice using the plan.**

Because disasters are not routine and come in different types and sizes, an effective all-risk plan of action is important to maintain. This plan should cover: methods to reduce the risk of a disaster, resource acquisition and allocation contingencies to be used during a disaster, and plans for a prompt recovery following a disaster.

Performance Measure:

1. *Provide four disaster drills for emergency responders in Boulder each year.*

A major part of preparedness is acquired through disaster drills. Drills built around different types of disasters allow emergency response teams to improve plans and to sharpen their skills. Implementation of this objective will require substantial investment in training resources.

## **Goal Six — Provide cost effective fire protection and emergency services.**

The Boulder Fire Department believes in the prudent use of public funds. The Department will continue to evaluate its services in order to establish the best cost-benefit ratio possible. This is particularly important as demands for service are growing faster than the Department's financial resources.

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**Objective 11: Maintain cost effective services in terms of population and value of property protected.**

Boulder's Fire Department has been relatively underfunded for many years. The increases recommended in this Master Plan will keep the Department's expenses below comparable cities while allowing the Department to catch-up on needed improvements.

Performance Measures:

1. *Keep fire department costs under \$90 per capita, at buildout.*

Boulder has kept its adjusted average cost per capita relatively low at \$69.86 in 1996. Comparable cities' fire departments operate at \$96.16 per capita.<sup>13</sup> While the Department's recommendations increase the cost to \$89.33 per capita for 100,000 population, it will still be below comparable cities.

2. *Keep fire department costs under \$1.35 per \$1,000 value protected.*

As with the loss per actual value protected, the data for this performance measure are relatively new to jurisdictions in Colorado. Again, this measure will provide the Department with the ability to compare costs to other Colorado jurisdictions. It should be noted that this figure will have to be adjusted based upon potential changes in how actual values are calculated by the Assessor. Boulder's current average cost per \$1,000 actual value protected is \$0.95. With the proposed improvements to the Department's operations, the price per value increases to \$1.33.

**Goal Seven — Protect local ecosystems.**

The Department believes that Boulder's unique and sometimes fragile ecosystems should be protected. Boulder's unrivaled ecosystems add to the quality of life in the community and also provide economic opportunities for the City. For example, the Backdrop brings tourists from all over the world and has been identified as a key component in the quality of life for Boulder citizens. This is an asset which requires continual investment and guardianship. Objectives for protecting local ecosystems overlap objectives in other goals. For instance, limiting the number and scope of hazardous materials releases is also consistent with this goal.

**Objective 12: Protect the Backdrop and other sensitive ecosystems from devastating fires through appropriate resource management.**

The Department wishes to institute enhanced fire mitigation programs through sensitive and planned resource management. The Department will coordinate with Open Space and Mountain Parks to develop an appropriate performance measures.

**Objective 13: Limit the size of unwanted wildland fires.**

Losses from wildland fires are directly proportional to the size and intensity of the fire. By limiting the size of unwanted wildland fires, the department is better able to protect sensitive ecosystems.

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Performance Measure:

1. *Limit the size of unwanted wildland fires to one acre or less 95 percent of the time.*

This is another new performance measurement for the Department and most fire departments do not currently track these data; therefore, the measure will be examined over time for relevance. If a better measure is found, it will be substituted in the future.

**Objective 14: Provide a clean air burn building.**

The existing burn building at the training center is not designed to use clean air fuels. Even though training fires are exempt from burning regulations, the Department does not burn during high air pollution days. The Department would like to have a burn building that uses clean burning fuels. The Master Plan also calls for moving the training center away from the residential area in north Boulder to limit noise, air, and other environmental impacts associated with training activities.

**Goal Eight — Maximize citizen satisfaction.**

The Department is customer-focused and realizes the importance of citizen satisfaction. Therefore, the Department intends to maximize citizen satisfaction.

**Objective 15: Maintain a high approval rating by Boulder's citizens.**

Citizen surveys provide valuable information about public expectations and experiences. By being able to deliver quality services in a timely manner, the Department believes it will maintain a high satisfaction rating. In addition, the Department will take proactive measures such as public education and victim support to maintain a high citizen satisfaction rating.

Performance Measure:

1. *Maintain a 90 percent approval rating by citizens contacted in the annual City survey.*

Preliminary indications from a survey recently completed by the Center for Policy and Program Analysis shows 93 percent of the citizens surveyed rate the Department's service as "Good" or "Very Good."

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## EMERGENCY RESPONSE — RESPONSE TIMES

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The Boulder Fire Department delivers services to citizens in distress by responding directly to the scene of the request for help. To be effective, firefighters must:

- Arrive at the scene of the emergency quickly.
- Be well trained.
- Be well equipped.

These three factors are critical for successful outcomes in emergency response. Fulfillment of one of these conditions without both of the others renders the emergency response system ineffective. It is insufficient to simply arrive at the scene quickly, if the firefighters are not properly trained or equipped. Likewise, Boulder's highly trained and motivated firefighters' efforts are futile if they arrive too late.

### The Importance of Time

Decisions concerning fire and emergency medical services often center around the location and number of fire stations in a community. These discussions usually involve the distance between fire stations, the population each serves, and the hazards associated with particular locations.<sup>14</sup> The Department looked at several different approaches used to locate fire stations and found a common thread — the importance of time in fire suppression and emergency medical responses.

### *Fires*

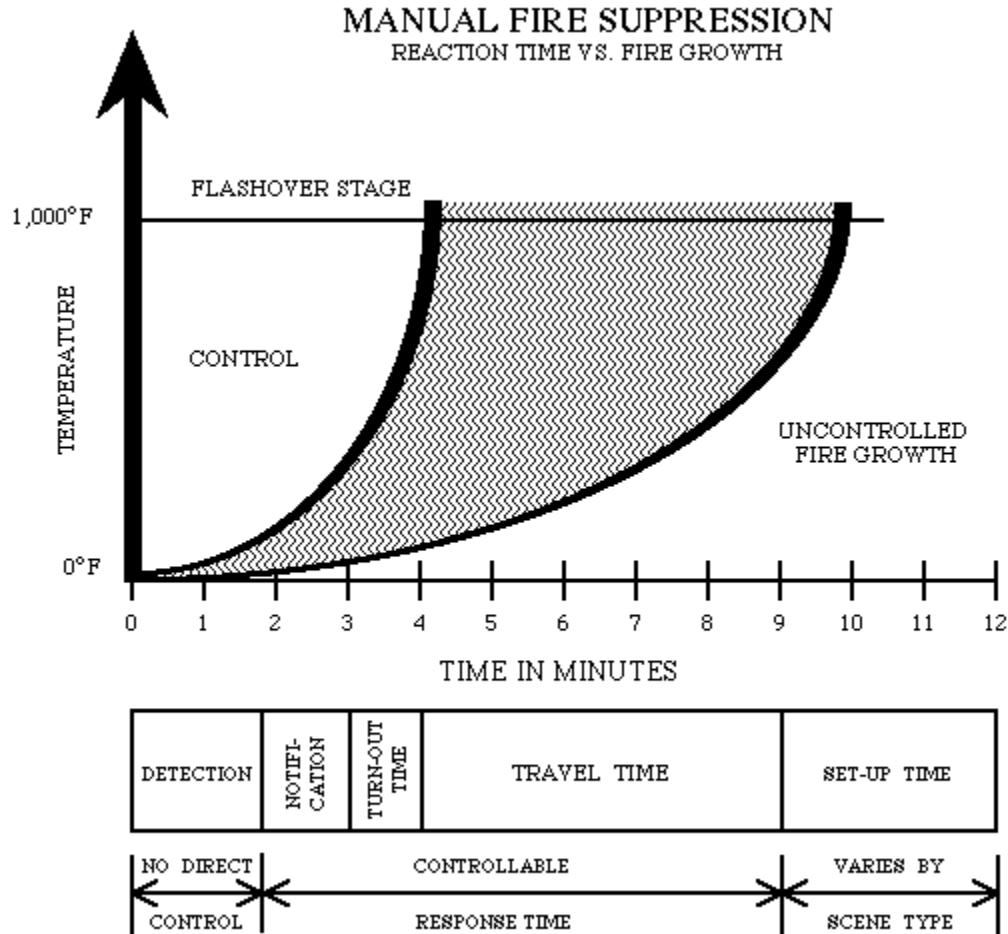
Saving lives during a fire requires keeping people away from the heat and toxic smoke released by fire. Limiting exposure can be done in two ways, by controlling the fire or by separating endangered people through evacuation or shielding.<sup>15</sup>

Fire grows exponentially until the entire surface area of the burning item is involved in fire, or until one of the elements needed to sustain combustion, such as oxygen or heat, is removed, as seen in Figure 4. As a typical fire involving a room and its contents grows, the fire approaches the critical point known as flashover. As the fire preheats the room's contents, the heated contents produce flammable vapors. These vapors build to the point where everything in the room ignites simultaneously. This phenomenon is known as *flashover*. At the point of flashover, fire totally engulfs the room and temperatures can exceed 2,000 degrees F. Flashover generally occurs six to nine minutes after the start of a fire.

When firefighters arrive before flashover, they usually find a low-intensity blaze that requires very little water and little effort to extinguish. However, once flash-over occurs, ordinary fire suppression techniques have little impact on life and property loss in the immediate vicinity of the fire. After flashover, the smoke and heat generated by the fire dramatically reduce chances of safe evacuation in the remainder of the building. After

flashover, the blaze also presents much greater danger to firefighters. Therefore, the goal of fire suppression services is to intervene before flashover — six to nine minutes after ignition.

Figure 4\*

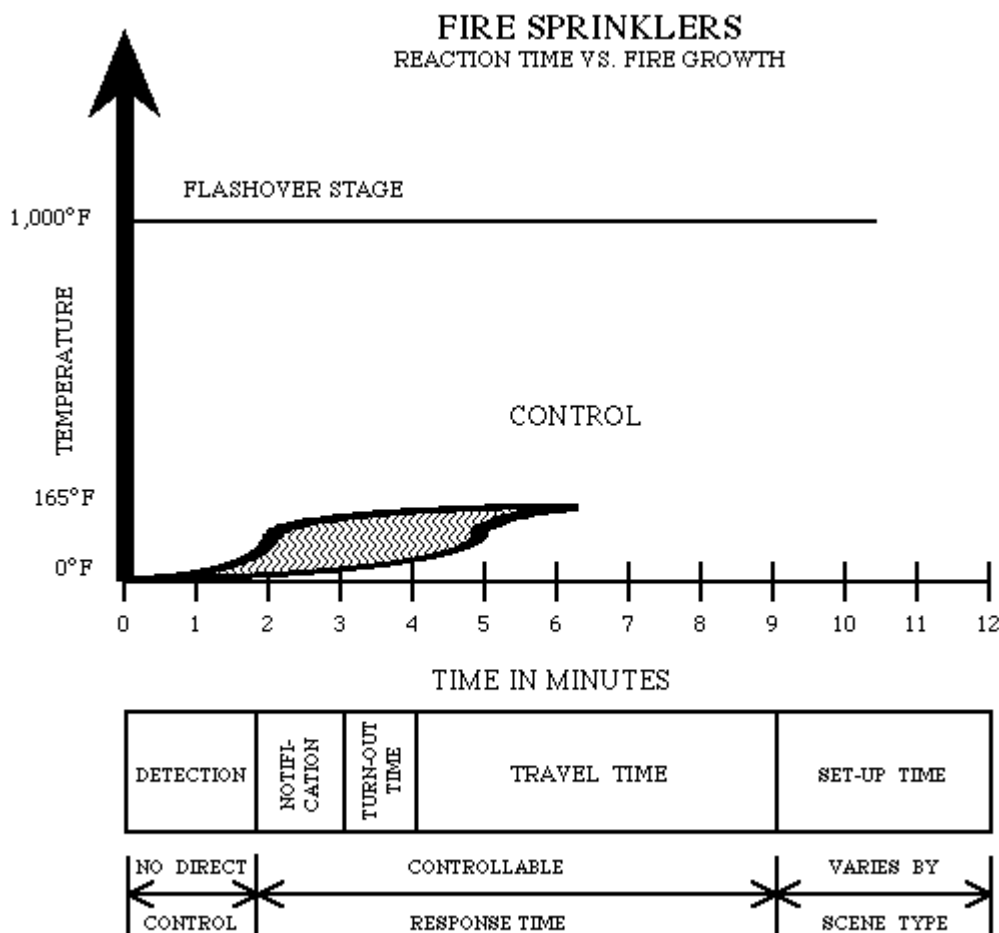


Early suppression is the most effective means of fire intervention. Fire detection and automatic suppression technology have allowed suppression and notification to occur simultaneously, as Figure 5 shows. The most common systems are found in occupancies equipped with fire sprinklers. Automatic fire sprinklers have been in existence for over a century; and in that time have come to be recognized as the single most effective fire protection method available. Their effectiveness in commercial and industrial buildings is well documented. Average losses in fully-sprinklered buildings are only a fraction of the average loss in non-sprinklered buildings; and in buildings with operational sprinkler systems, fire deaths are almost unknown.

\* Times do not represent Boulder's. Graph is for illustrative purposes only.

In communities where sprinkler systems are required in all occupancies, fewer firefighters and less equipment are required. Boulder has adopted ordinances that reflect this philosophy. In most new commercial and multi-family buildings, the adoption and enforcement of the sprinkler requirement has dramatically diminished the fire threat. Boulder's sprinkler ordinance allowed the Department to operate with fewer resources than comparable cities.

Figure 5\*



### Medical Emergencies

Approximately 60 percent of the Department's calls are medical calls, where time is also critical. The American Heart Association has established a standard response time of four minutes for basic life support and eight minutes for advanced life support to begin for victims of cardiac arrest.<sup>16</sup> These standards were established using the probability of survival curve, Figure 6. As the intervention time approaches four minutes, the slope of the probability of survival curve becomes more steep. This illustrates that without basic or

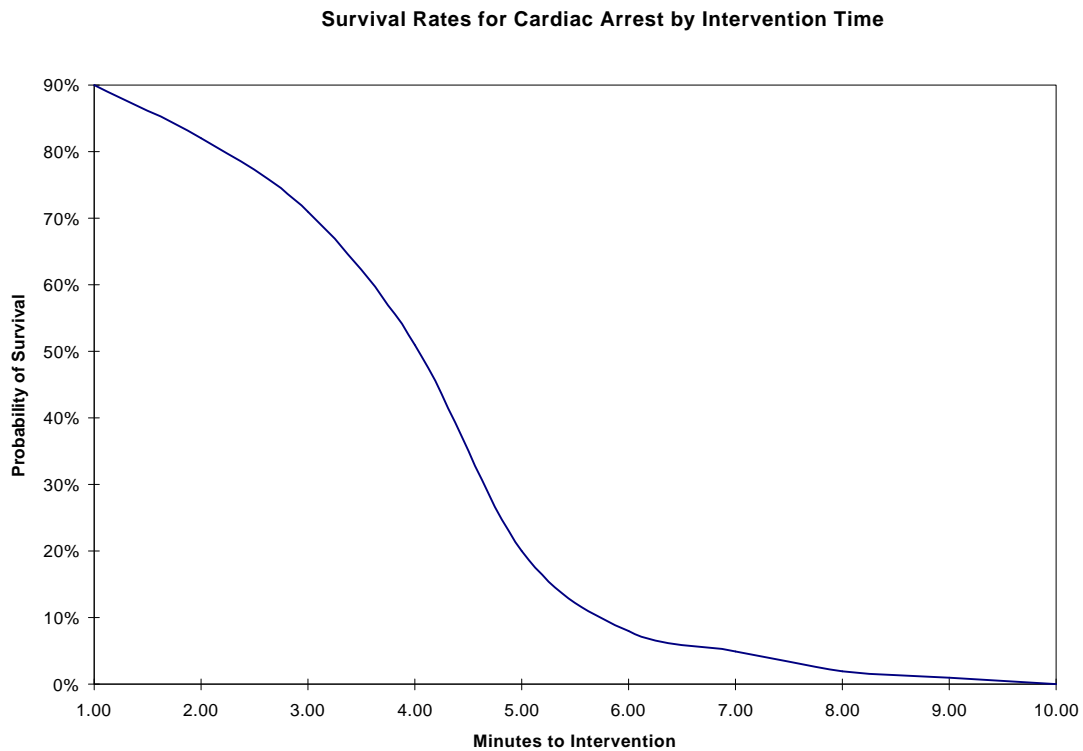
\* Times do not represent Boulder's. Graph is for illustrative purposes only.

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advanced life support, the chances of reviving a critical patient diminish quickly. The probability for survival curve also applies to drowning, electrocution, severe trauma, and choking victims. In all of these cases the victims' bodily systems are not able to supply the brain with sufficient oxygen. Without oxygen, the brain begins to die. Intervention after four minutes may still result in a "save," but the quality of life for the survivor is questionable.

Response times for trauma victims are also critical. Medical researchers have linked response times for EMS to survival of major trauma victims. In one study, survival of major trauma victims, who were expected not to survive, was linked to short response times (average 3.5 minutes), and trauma patients who were expected to survive but did not were linked to longer response times (average 5.9 minutes).<sup>17</sup> Again, shorter response times for EMS in Boulder will improve survival rates.

**Figure 6**<sup>18</sup>



### ***Response Time***

In one of their most successful advertisements, FedEx described waiting “[a]s frustrating, demoralizing, agonizing, aggravating, annoying, time consuming and incredibly expensive.”<sup>19</sup> If this is how it feels to wait for a package, imagine what it feels like to wait for firefighters when you are experiencing an emergency. In the most severe cases, it is literally like holding your breath the entire time you are waiting.

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## Components of Response Time

There are five key factors which influence the time interval between ignition and intervention in fires. Similar factors influence the response time for medical emergencies. The first is the *detection time* period. Early discovery through smoke detectors and other alarm systems increases the probability of the occupants escaping and results in earlier notification of the fire department. Without automatic detection in place, there is a variable period of time that passes before one detects or recognizes that there is a problem. The detection time can be minimized through appropriate detection and alarm methods, enforcement of fire codes related to fire detection equipment upkeep, and it can also be lowered through public education concerning smoke detectors and alarm systems.

The second period of time is the *notification time*. This is the amount of time it takes to notify the fire department that there is a call. The Boulder Regional Communications Center averages a 1 minute 16 second notification time for the top priority fire and rescue calls. Including this time is critical when looking at fire growth and probability of survival from cardiac arrest. It is also critical from a customer service point of view; the customer is only concerned with the time it takes for a fire truck to arrive after they have dialed 911, not how long it takes for the firefighters to be notified.

In Boulder, the notification time has significantly improved since the investment in computer-aided dispatching. However, the Boulder Regional Communication Center's dispatching times are 35 percent higher than the national average for similar size fire departments (57 seconds).<sup>20</sup> Further improvements can be gained through new dispatching technology and changes in dispatching protocols. An effective public education program also reduces dispatching times by decreasing the demands placed upon dispatchers through a decreased number of false calls.

The next time interval is *turn-out time*; the time between notification of the dispatch center and the first engine company going in route to the scene. Several factors influence turn-out time, including the time required for firefighters to don their protective clothing and equipment. Turn-out time is minimized through proper training and equipment.

The fourth time interval is *travel time*. Travel time is influenced by the distance between the emergency and the fire station, road conditions, traffic, weather, time of day, and how fast the fire apparatus can safely travel. For most departments, this is the most significant time interval. Boulder's fire department is no exception; in fact, travel time may have a larger impact on the Department's overall response time when compared to its peer cities. As Boulder becomes more congested, maintaining short travel times becomes more challenging. If traffic mitigation programs, which control and slow the flow of vehicles, narrow the choices for direct, uninterrupted travel, the travel time component will further deteriorate.

The final period of time to consider is *setup time*; the time between the arrival of the first engine company and the initial attack on the fire or the application of emergency medical treatment. Once on the scene, crews must find access, acquire information in order to plan and execute their mission, and conduct final preparations of themselves and their equipment before the actual rescue or fire attack occurs.

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While set-up time varies with the type of incident; training, staffing, equipment, and prior knowledge of response districts have a profound effect on set-up time. For example, most structure fires require 12 to 16 firefighters to perform efficiently without undue fatigue.<sup>21</sup> Fewer firefighters can extinguish smaller fires, but chances of firefighter injuries increase when fewer firefighters are used. Since effectiveness in fire suppression means lives and property saved or lost, it is important that adequate numbers of firefighters arrive on the scene simultaneously whenever possible. In Boulder, additional staffing must come from adjacent stations or from mutual aid departments. Therefore, the set-up time can be extended while crews wait for additional resources.

## **The Boulder Valley Comprehensive Plan's Response Time Requirements Are Not Being Met.**

In recognition of the importance of a timely response, the Boulder Valley Comprehensive Plan adopted urban response time standards for the community. These standards are:

1. Respond to fire emergencies within six minutes.
2. Respond with basic life support to 90 percent of medical emergencies within four minutes and to 100 percent within eight minutes.

Unfortunately, neither of these standards are being met by the Department. In addition, the Department's response times are substantially longer than its peer cities' average response times.

In order to better understand the significance of the Department's response times, the Department examined the distribution of its response times. The response time distribution is the rank ordering of response times by how often they occur. The Department's response time distribution is shown in Figure 7. As Figure 7 shows, over 25 percent of the Department's response times are longer than six minutes. In addition, only 25 percent occur in four minutes or less. The Department's peer cities averaged 4.6 minutes for 75 percent of the calls. Finally, as Figure 8 shows, the distributions of the Department's response times by year are moving toward slower response times. In other words, more and more of the calls have longer than average response times.

Figure 7

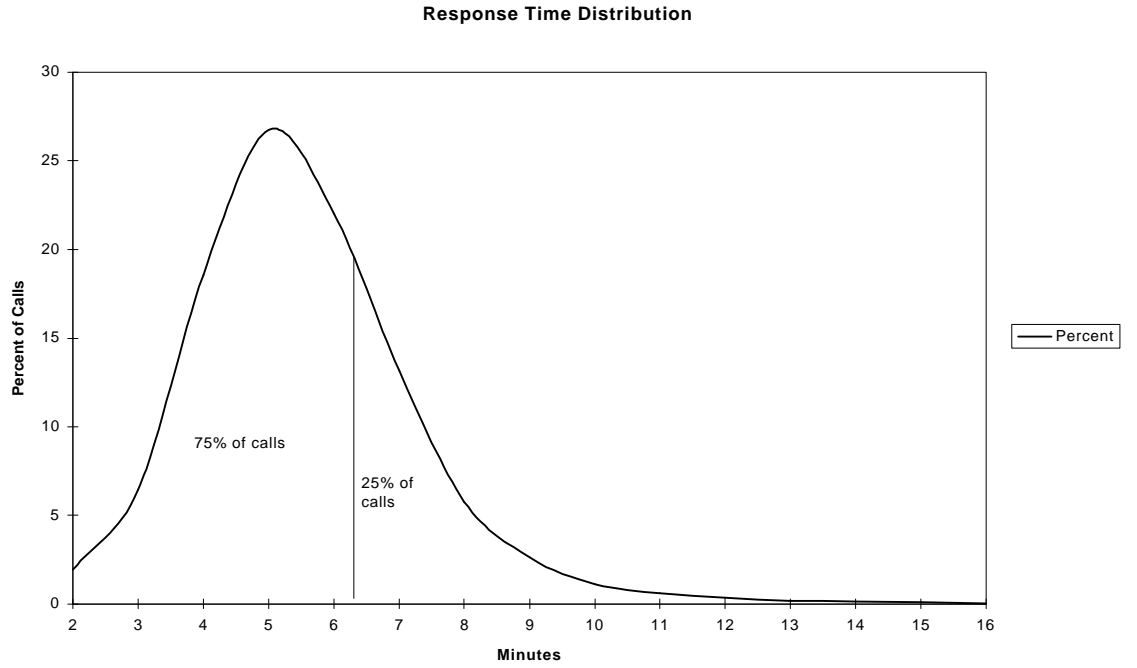
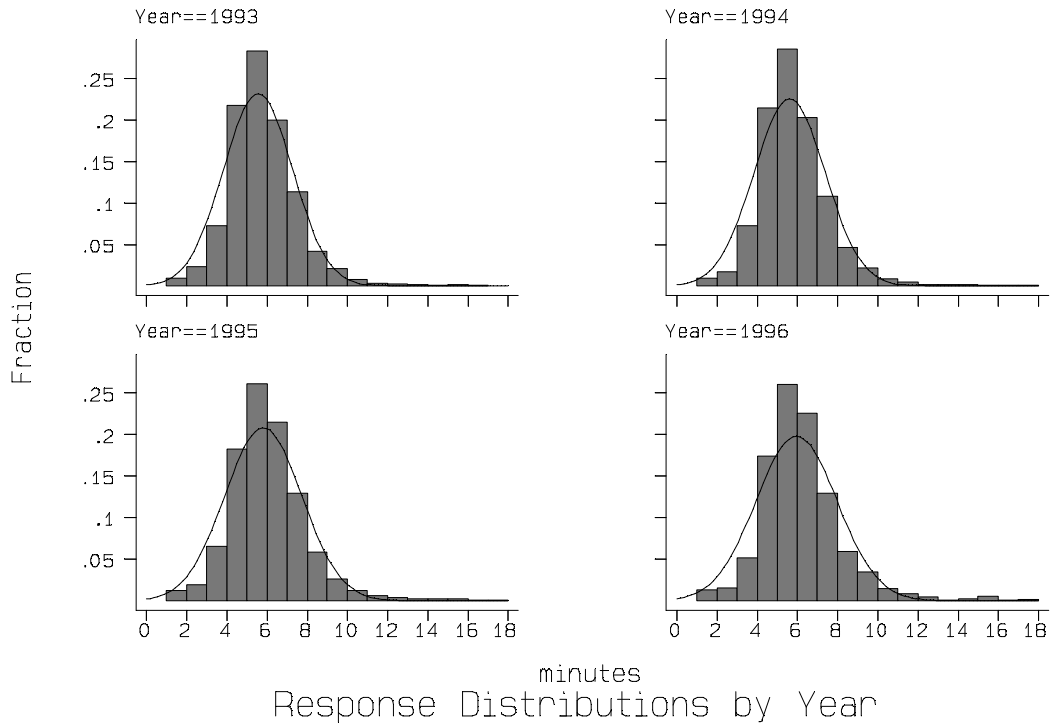
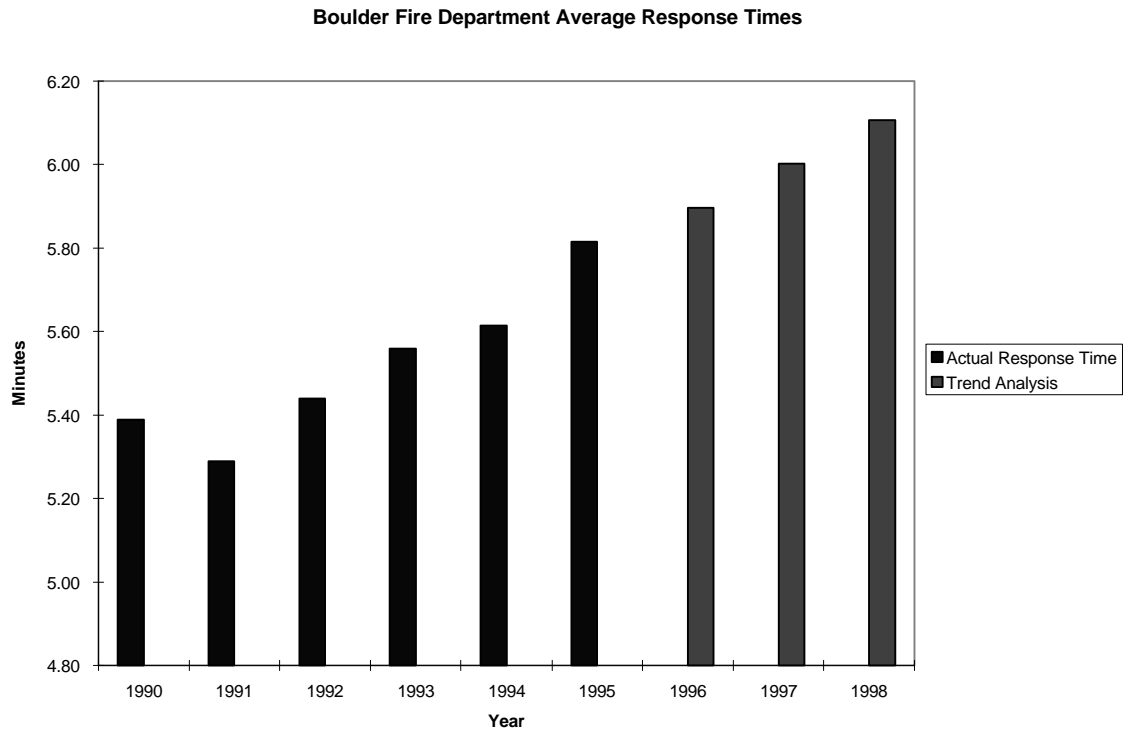


Figure 8



The Department's analysis of response times shows a steady decline in service. This decline is best illustrated by looking at how the average response times change over time. The Department's average response time increased from 5 minutes 23 seconds in 1990 to 5 minutes 58 seconds in 1996. A trend analysis of average response times (Figure 9) shows a strong and significant increase in average response times over the last several years and projects further increases if steps are not taken to remedy the situation.\* This negative trend affects responses from all of Boulder's fire stations.

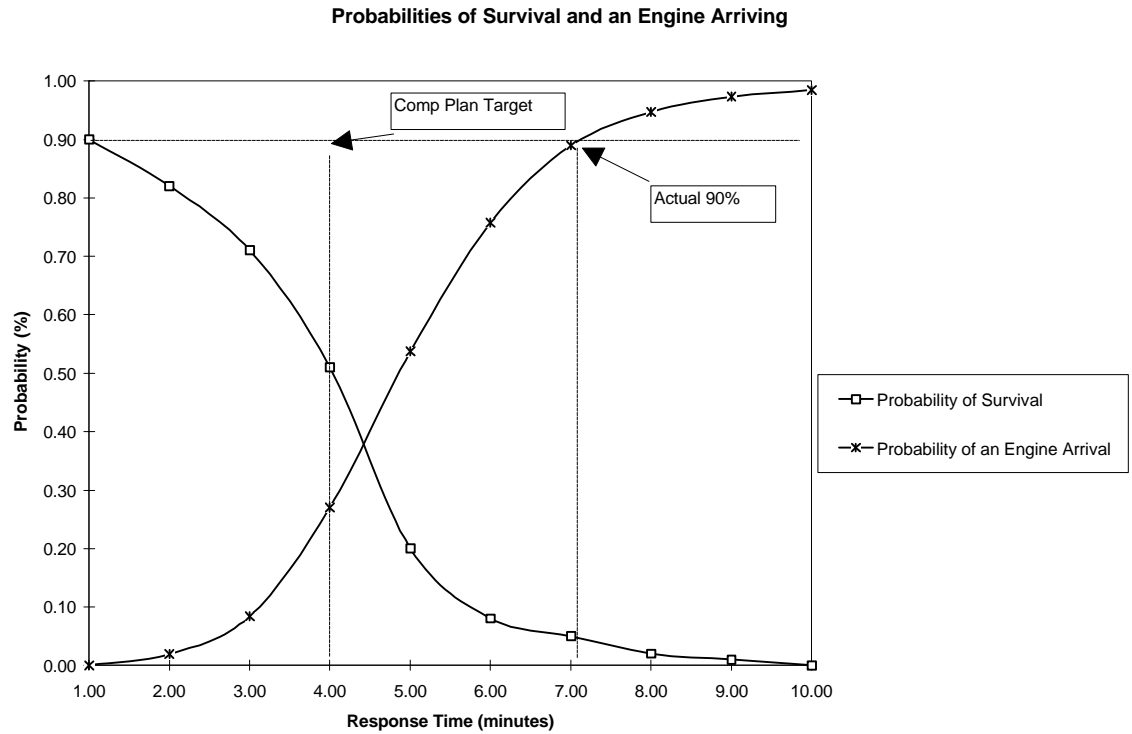
**Figure 9, Response Time History**



While this 11 percent worsening of response times may seem insignificant at first glance, it is not. For example, in a Mayo Clinic study of early defibrillation (please see EMS section for a complete description), survivors of ventricular fibrillation, on average, received care in the field only one minute sooner than non-survivors.<sup>22</sup> As Figure 10 illustrates, increasing response times dramatically reduces the probability of survival for cardiac arrest victims. A similar situation exists for fire suppression.

\* The Department's mean response time increased significantly ( $p < 0.0000$  for each year) A trend analysis of response the times shows a strong ( $r^2 > 0.9$ ) and significant ( $p < 0.001$ ) increase of average response times

Figure 10



### ***Why Are The Response Times Increasing?***

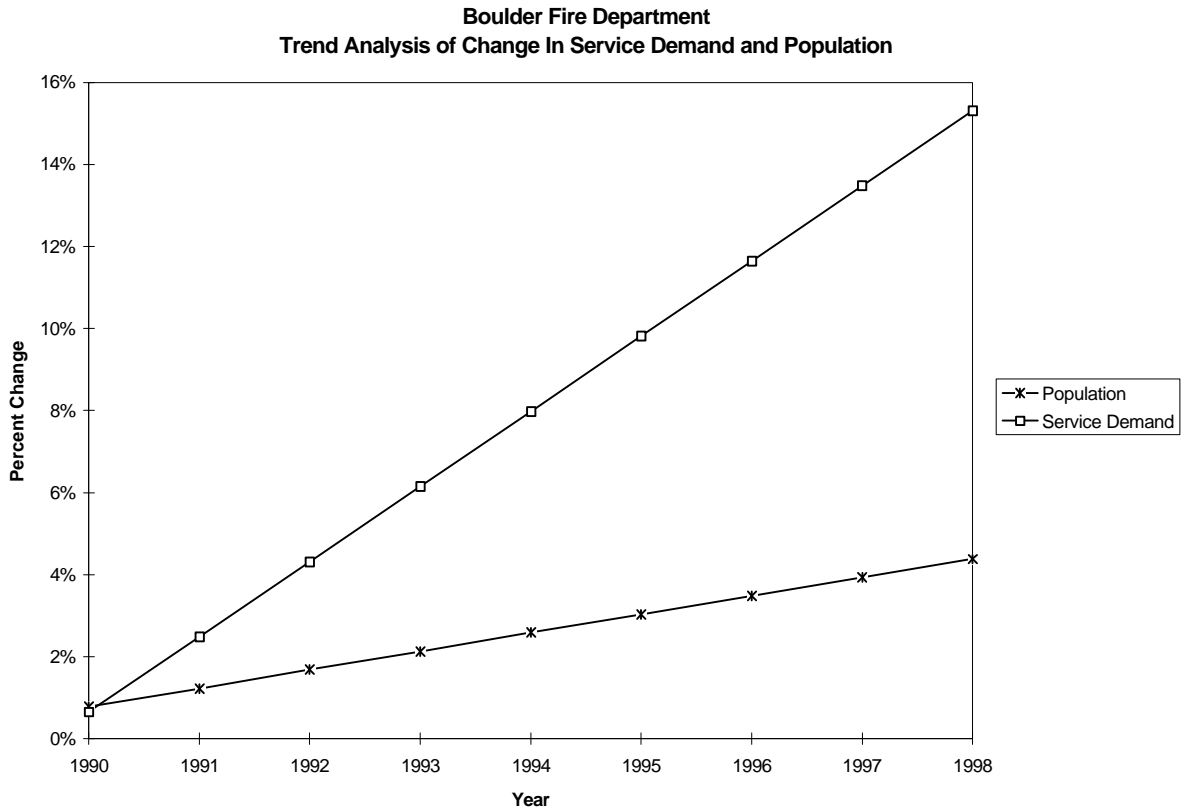
Boulder currently delivers emergency services with six engine companies and a ladder company based out of six fire stations located throughout the city. This configuration of stations and apparatus was developed in response to Resolution 208, Report of the Joint Fire Study Committee in 1976. Since the 1976 adoption of Resolution 208, Boulder has changed dramatically. The population has increased, the geographic boundaries have expanded due to annexation, the density of the City has increased due to in-fill, and Boulder has evolved into a regional business and retail center. Today, in-commuting far exceeds out-commuting resulting in a large daytime population.

These changes in Boulder's character and size impacted three major factors related to response time: 1) demand and capacity related issues; 2) travel distance; and 3) traffic congestion and mitigation.

### **Demand and Capacity Issues — Two Boulder Fire Stations Are Beyond Their Capacity**

Over the last twenty years, Boulder's population increased approximately 25 percent, while fire department calls increased approximately 425 percent. Most of this increase in calls for service is attributed to the advent of emergency medical responses in 1976. However, a recent trend analysis of the rate of change in service demand and population shows the rate of change in demand dramatically exceeding the rate of change in population, Figure 11 (also see Figure 1).

**Figure 11**

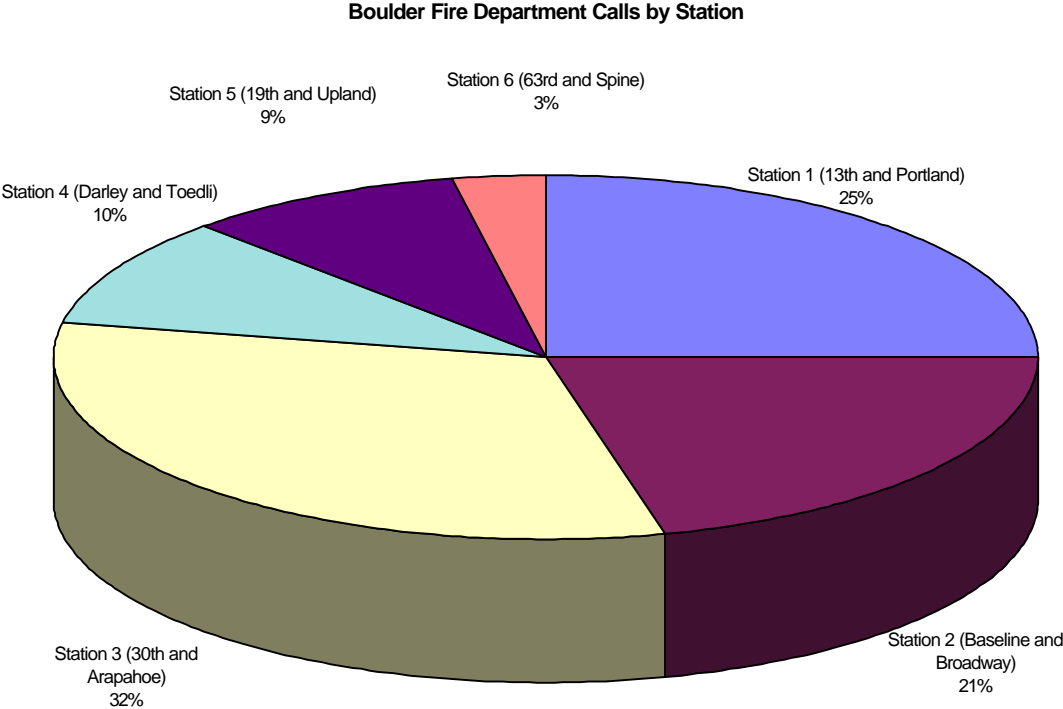


The increased demand for services has exceeded the capacity of stations Two and Three. Here, capacity is simply defined as the ability of the engine company to respond to its emergency calls, participate in training and perform fire prevention activities. As Figure 12 shows, stations Two and Three are covering 53 percent of the City's calls.\* This increased demand for service, particularly in stations Two and Three's districts results in a substantial number of simultaneous calls for service. When the station that serves a particular district is committed to an emergency at the time that another call for service in the same district is received, the next closest station responds to the call. Because the next closest station is generally located further away from the incident than the original station, there is a longer travel distance and travel time – exceeding capacity results in longer response times.

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\* While Station One runs more calls than Station Two, it does so with two companies unlike the other stations.

Figure 12



Every fire department has some acceptable level of delay resulting from simultaneous calls. To avoid all delays associated with simultaneous calls would cost too much. However, at some time simultaneous calls push a station beyond capacity and drain the system to the point where the service delivery is inadequate. An all too common example: when Station Three (30th and Arapahoe) is committed to a call and a simultaneous 911 request is received in its district, Station Two (Baseline and Broadway) covers the second call. While Station Two is committed to Station Three’s call, an emergency is reported in Station Two or Station Three’s district. Now Station Four (Darley and Toedli) takes this call. Unfortunately, not one piece of apparatus is available for calls south of 13th and Portland – over half of Boulder is uncovered. In this scenario, any address south of the CU campus or east of Folsom is unprotected.

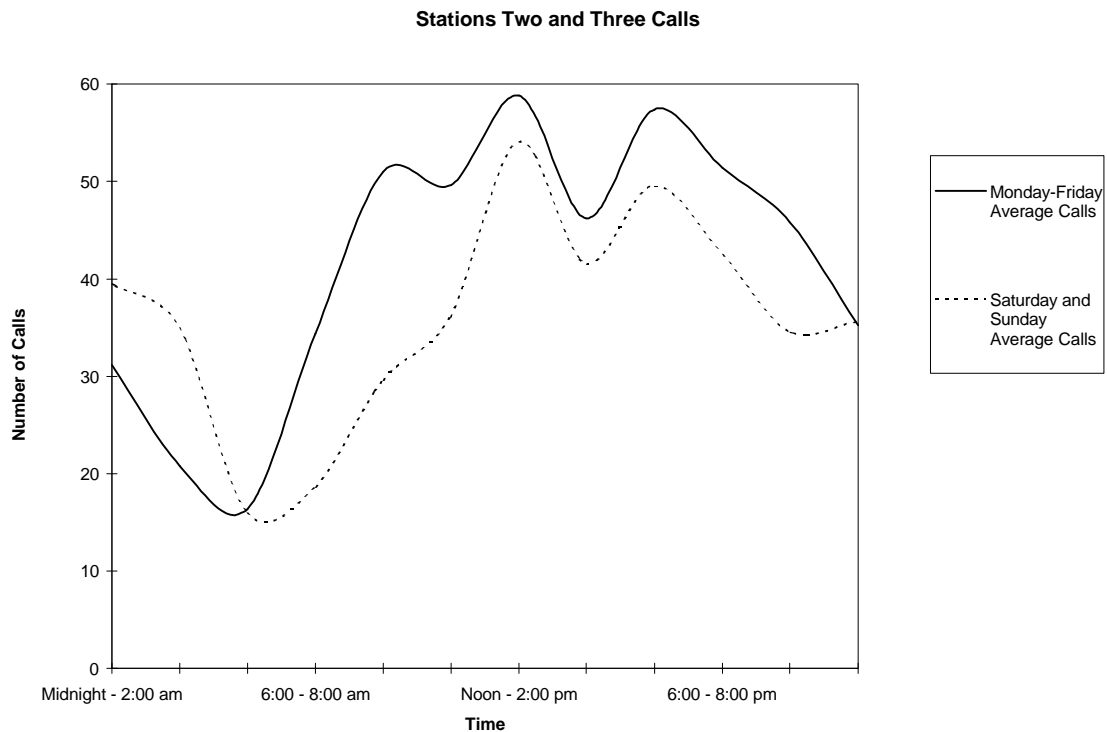
Scenarios such as the one above become much more likely once 10 percent of a station’s calls are being covered by the next closest engine. Currently, 16.6 percent of Engine Three’s and 9.7 percent of Engine Two’s calls occur while the engines are busy. In addition to emergency calls, other regular activities take an engine company out of service requiring another station to cover its calls. Routine training, maintenance and administrative activities all take engines temporarily out of service.

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### *Capacity by Time of Day and Day of Week*

Stations Two and Three's capacity problems are aggravated by peak demands during the normal workday. These stations respond to 69 percent of their calls between 8:00 AM and 8:00 PM, Monday through Friday, which is only 36 percent of the week, Figure 13. These peak demands prevent engine crews from accomplishing other important duties. In Boulder, the hours when businesses are open and can be inspected, and the hours when businesses and schools request public education programs, coincide with hours of highest call demand. While smaller peaks still occur during Saturday and Sunday, fire inspection and public education programs are not generally scheduled during those periods; therefore, the crews have a higher capacity for responses on Saturday and Sunday.

**Figure 13, Stations 2 and 3 Calls by Time of Day and Day of Week**



### *Related Work Load Issues*

Responding to emergencies is the firefighters' primary mission. Implicit in this mission is the fact that firefighters stop what ever else they are doing in order to respond to an emergency. This practice ensures that the Department maximizes its availability to its citizens. The increasing demand for emergency services has consequences other than a simple increase in the number of calls. The primary consequence of a station being over capacity is a backlog of non-emergency work. Of greatest concern are fire inspections and public education programs. These proactive programs are jeopardized when a station is at or over capacity. As these proactive programs become more compromised, the number and severity of emergencies increase. This pattern creates a downward spiral that can lead

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to a totally reactive provision of service, similar to the provision of service in decaying urban settings across the country.

Workload has significant stress-related effects on firefighters. Since calls are increasing at all times, the frequency of non-peak demand is also increasing. Fatigue associated with responding to calls during non-peak times can be compared to the fatigue felt by new parents, who must get up at night with a newborn baby, sometimes two to three times each night. When firefighters are fatigued, they can make poor decisions. Not only does firefighter stress result in a lower quality service, fatigued firefighters are also at higher risk for injury. The Department's expectations of continual productivity improvement should be tempered by these concerns.

### **Longer Travel Distances Increase Response Time**

Fire and emergency service delivery systems are geographically based. Living close to a fire station ensures prompt service. In these limited areas, the existing system is performing sufficiently. However, as the distance from fire stations increases, or as access to an area is restricted, response times worsen. Over the years, annexations in East Boulder have increased travel distances.

In late 1994, the Department analyzed a computer model of projected response times and actual response times in order to identify areas with excessive response times. The results of the analysis indicated that the most significant response time problems occurred along the eastern flank of Boulder in the East Boulder and Southeast Boulder subcommunities. A subsequent analysis confirmed these findings in Boulder's eastern areas.

The subsequent analysis also demonstrated the potential to substantially reduce response times in the affected areas and in the City as a whole by adding a fire station in East Boulder and adding a rescue squad during peak demand periods in the core of the City.

### **Traffic Congestion and Traffic Mitigation Increase Response Times**

Because of increased traffic congestion, the Department has a reduced ability to provide services within reasonable response times. The Department tried to relieve the impact of traffic congestion with an OptiCom™ system. This system turns traffic lights green for emergency vehicles as they approach the intersections. While the OptiCom™ system has helped slow the degradation in response times, it has not reversed the trend. The installation of OptiCom™ does not influence travel distances nor the adverse impacts of traffic mitigation efforts.

The proposed traffic mitigation projects on primary response routes will substantially worsen already long response times. Physical barriers used to slow automobile traffic also slow fire apparatus. Many cities avoid this problem by carrying the through traffic on existing arterial grid systems. Others, like Portland, Oregon, limit traffic mitigation efforts to streets that carry fewer than 10,000 car trips per day. In the long-run, it does not matter whether emergency responders are slowed by traffic congestion or traffic mitigation; the result is the same — longer response times and a reduction in service to the public.

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## Improving Response Times

### *Rescue Squad — Increasing Capacity*

A two-person rescue squad, put into service to answer medical calls during peak demand periods, will decrease response times by increasing the Department's capacity. This additional resource will immediately begin to decrease response times in the core of the City. An analysis of projected response times indicated a decrease of the average response time by a minimum of ten seconds for the city as a whole by adding a rescue squad. With the addition of a rescue squad, response time reductions for central areas of the City are expected to be approximately 48 seconds. Because the rescue squad is a smaller, more maneuverable vehicle, it is hoped that travel times will be lower for rescue squad responses in comparison to engines traveling the same distance. The Department will monitor the response times of the smaller rescue squad in order to evaluate the use of smaller vehicles in other applications.

The rescue squad will carry tools necessary for specialized rescue assignments. These assignments include search and rescue, assisting in hazardous chemical spills and extricating automobile accident victims. The rescue squad can also assist engine companies on fire calls. The added capacity will help the Department redistribute the workload in order to take better advantage of proactive functions such as fire inspections and public education programs.

In order to keep capital costs down, the squad truck and crew should initially be housed at Station Three. This location will optimize the ability of the rescue squad to answer the capacity problems at stations Two and Three.

### *Additional Fire Stations*

While the Squad will help alleviate capacity-related response time problems in the core of the City, it will not alleviate problems associated with travel time to portions of the East Boulder and Southeast Boulder subcommunities. Therefore, the Department performed a station location analysis. The analysis indicated the need for a new fire station and associated engine company on the eastern flank of Boulder. It also identified the potential for an additional station in Northeast Boulder if further development in that area takes place.

### **When To Build A New Station**

As part of the station location analysis, the Department examined when other departments chose to add a station. The following is typical of what others use as criteria for adding a station:<sup>23</sup>

1. The community expands either in population or in area.
2. The community's land uses are changing.
  - a. Residential to commercial
  - b. Vacant to residential
  - c. Single family residential to multifamily
1. A station becomes obsolete or too old to house modern fire equipment.
2. The numbers of calls to an area increases.

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Some departments use thresholds that trigger the need for a new fire station. For example, the City of Aurora has the following requirements for station additions:

1. Construct a “Rural Station” when:
  - More than 100 calls for service are received for a given area, and
  - The number of housing units is greater than 100
2. Construct an “Urban Station” when:
  - More than 400 calls for service and,
  - More than 500 housing units are in place, or
  - More than 4 million square feet of commercial area are in a given area.

The Boulder Fire Department proposes a different approach, using call volumes and response times as criteria for adding a fire station. The station location analysis indicated Department’s threshold criteria should be:

1. Call volume – More than 400 calls for service annually to a given area.
2. Response time – More than 50 percent of a given area’s calls are more than 1 standard deviation (currently 1.9 minute) above the Department’s average response time.

## **Where To Build New Stations**

### *How Do Others Determine Fire Station Location?*

The Department’s research indicated three typical approaches to locating fire stations: 1) a purely political approach, 2) utilizing national standards, or 3) approaches using local data and experience. For the purposes of this discussion, the purely political approach will not be examined.

Departments which use national standards for fire station location use the National Fire Protection Association’s (NFPA) or the Insurance Services Organization’s (ISO) standards. The NFPA recommends that first due engines be located within 2 miles of residential areas, one and one-half miles of commercial, and within one mile of buildings that require a 5,000 gallon per minute flow of water to control anticipated fires.<sup>24</sup> The NFPA also recommends that fire station location activities include an assessment of the relative risk of various areas of the City and that fire companies be concentrated in those areas of risk.<sup>25</sup> Typical fire hazard classifications are shown in Table 3.

**Table 3, Fire Hazard Classifications<sup>26</sup>**

Risk	Description
Maximum Risk	Hospitals, senior citizen homes, lumber yards, downtown commercial areas, industrial operations that constitute a critical hazard.
High Risk	Regional shopping centers and other residential, industrial, and commercial areas that warrant a high risk priority.
Normal Risk	Low, medium, and high density residential development with normal occupancy, small neighborhood and convenience shopping centers, standard industrial centers with sprinkler systems.
Low Risk	Rural development and new rural settlements, freeways.
Minimum Risk	Scattered residential farmland and rural open spaces.

The Department further investigated communities who select station location based upon relative risk and response time. Although the peer cities did not have similar data, other communities using risk and response times were found during a literature search, Table 4 (1987 data).

**Table 4, Response Times by Risk<sup>27</sup>**

	Risk				
	Maximum Risk	High Risk	Normal Risk	Low Risk	Minimum Risk
<b>Community</b>					
San Antonio, TX	2.20	3.00	3.50	4.00	6.00
Lynchburg, VA	3.00	4.00	5.00	6.00	7.00
Ardmore, PA	3.00	3.50	4.00	5.00	6.00
Memphis, TN	2.30	2.70	3.30	4.30	5.80
Davenport, IA	3.00	3.50	4.00	4.50	5.00

The ISO rates individual properties based on distance from a fire station. The ISO's typical distance thresholds are two and one half and five driving miles from a fire station for commercial and residential occupancies respectively. The 1995 response time and station location study found that significant portions of east and southeast Boulder not only fall outside the ISO criteria, but fail to meet the urban response time goals of the Boulder Valley Comprehensive Plan even under ideal response circumstances.

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### *Types of Fire Stations*

To some extent the location of the station is dependent upon what type of station is being constructed. The department has identified three main types of fire stations: 1) Temporary, 2) Residential, and 3) Permanent-Full Service. Each of these have advantages and disadvantages which will be briefly explored.

#### *Temporary*

Temporary fire stations are used by many departments which are experiencing rapid growth. The stations are designed to be inexpensive and often mobile (mobile home/Butler Building combinations are frequently used). They are most often used to provide service while a permanent fire station is being built. They are sometimes used when the fire department is unsure of the direction growth will take and therefore, hesitant to make a large capital investment.

Temporary fire stations have some serious limitations. Primarily, the ability to have the appropriate apparatus is limited. Other fire department activities are also limited when temporary stations are used. Space for training and administrative functions is practically nonexistent. Neighborhood concerns also limit the use of temporary fire stations. Temporary fire stations may not be compatible with the ambiance of a residential community.

#### *Residential*

Residential fire stations are frequently used in suburban residential areas. These fire stations are designed to look like a home in the neighborhood, similar to the existing stations Four and Five. Many are model homes with modifications to the living room and garage areas. The living room and garage are combined to make bay space. They are most often used as a temporary station with the belief that the station can be remodeled and sold as a single family dwelling.

Residential and temporary stations share similar drawbacks. Space available for appropriate apparatus and equipment storage is limited. Neighborhood concerns are also a factor — noise and parking complaints are frequent with residential stations. Access problems are also associated with residential stations. They are rarely located near major arterials and pedestrian safety can become a concern.

Finally, residential stations that are thought of as temporary are rarely that way. The history of residential stations is that they become permanent and the problems associated with them also become permanent. The resale value of residential stations is also suspect.

#### *Permanent Full-Service*

These types of stations are designed to house the appropriate apparatus, have facilities for training and administration, store necessary equipment, house fire fighters, provide plenty of parking and driveway area, and serve as a community meeting place. These stations are generally located outside of residential areas, along major arterials. The drawback to this type of station is its cost, because it is a large building on a large lot.

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### ***Political Concerns***

Political concerns regarding fire station location are complex. This is best described by California State Fire Marshal Ron Coleman who said, “There are a few hard and fast rules we live by in the fire service. First, you cannot put a new fire station in an existing neighborhood. Second, you cannot take a fire station out of an existing neighborhood.”<sup>28</sup> While choosing fire station locations and choosing the number of fire stations in the Department must be addressed in technical terms, the final decision is usually a political one in which key players—elected officials, citizens and fire department staff—play a significant role.<sup>29</sup>

### **Proposed Station Seven**

The Department is recommending that a full-service permanent station be constructed south of the intersection of 55th Street and Arapahoe Avenue — Station Seven.

A response time analysis was conducted utilizing a hypothetical station (Station Seven) located on Boulder’s eastern flank. Two significant, and somewhat surprising findings came from this study. First, had the station been in service in 1995, it would have responded to 416 calls for service. Second, without the new station, the eastern district showed response times for more than 50 percent of the calls to be two minutes longer than the Department’s average. These findings exceed the recommended criteria for the addition of a new fire station.

A new station on Boulder’s eastern flank will reduce Station Three’s call volume by 15 percent and Station Two’s call volume by seven percent. A statistical analysis indicates that average response times for the portions of the East Boulder and Southeast Boulder subcommunities served by the new station will decrease (on average) by 1 minute and 37 seconds. In addition, average response times in Boulder’s core will decrease by a minimum of ten seconds due to fewer out of district responses for existing stations.

Other sites on Boulder’s eastern flank were examined as potential locations for a new fire station. The Department identified response time deficiencies in Northeast Boulder that could be served by another new station. However, the volume of calls in this area does not meet the Department’s threshold criteria and is not expected to in the near future unless further development occurs in that area.

### ***Other Response Time Reduction Strategies***

#### **Reduce Demand for Services**

Another strategy the Department should pursue to reduce response times is to reduce the demand for services — thereby, reducing simultaneous calls for service. Proactive fire and injury public education programs have long been recognized as a very cost effective long-term solution in reducing emergency service demand. Not only can the Department educate people about when to call for help, these programs are ideal opportunities to teach citizens about injury prevention, home safety and general wellness. Additionally, fire code enforcement efforts should be augmented so that businesses and industrial users continue to provide safe work environments.

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### **Work With Traffic Mitigation Programs**

At this time the Traffic Mitigation Plan is still under development. The Fire Department has serious concerns about the impact of traffic mitigation devices on response routes. The Fire Department will continue to work closely with the Transportation Department in developing traffic mitigation strategies which are compatible with emergency response.

### **Decrease Notification Time**

The Department believes that response times can be lowered by improving its dispatching services. The Department intends to explore the use of new dispatching technology to reduce response times. For example, automatic vehicle locator dispatching utilizes the global positioning system (GPS) and geographic information systems (GIS) to dispatch the closest apparatus to emergency calls. The current system does not always dispatch the closest units because apparatus may be involved in administrative or training functions, or be returning from a call in an outlying area.

In addition to pursuing new dispatching technology, the Department is working with the Communications Center to change dispatching protocols in order to decrease notification time.

### **Restructure Response Time Goals**

While the Boulder Valley Comprehensive Plan recognizes the importance of keeping emergency medical response times short, the distinction between the two response times is artificial, there is no statistical difference between response times for fire and EMS calls. The Department recommends that a single response time target of under six minutes for 90 percent of all emergency calls be used for future comparisons. The Department believes the reduced standard for medical response times can be offset by the use of new technology, which will be discussed in the EMS section. The Department also believes that attainable response time goals have more meaning and are more carefully considered than goals which are unattainable.

## **Summary of Emergency Response Recommendations**

- 1) Augment responses during peak periods with a two-person rescue squad.**
- 2) Add a new fire station in East Boulder to reduce response times.**
- 3) Work closely with the Transportation Department to minimize impacts of traffic mitigation plans on emergency response.**
- 4) Reduce demand for services through proactive programs such as public education and fire prevention services.**
- 5) Work with the Communications Center to decrease notification time.**
- 6) Consolidate fire and EMS response times into one realistic goal.**

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## EMERGENCY MEDICAL SERVICES

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### Responding To Emergency Medical Incidents In Boulder

Emergency medical responses account for over 60 percent of the Boulder Fire Department's total responses. Most victims of a medical emergency in the City of Boulder receive their first assistance from the Boulder Fire Department. Medical response is an integral part of the job of a Boulder Firefighter and Boulder's firefighters are an integral part of the health care system.

#### *Tiered Response*

Boulder citizens who suffer from a sudden illness or are victims of an accident receive aid according to a five-tier response system. The tiered responses are:

1. *Bystanders* —The bystander's ability to provide care is a function of his/her level of training, if any, and the intrinsic desire to help. While the quality of aid from bystanders varies greatly, it can be enhanced through public education programs. Citizen CPR classes and public education can decrease death and injury in a community. As the Department's response times increase, so does the importance of bystander intervention.
2. *Emergency Medical Dispatching (EMD)* — EMD is a critical component of the City's 911 system. Under Boulder's EMD program, specially trained dispatchers provide emergency medical instructions to victims and/or bystanders that are instrumental in providing for the best outcome for the patient. EMD personnel can actually "talk" an untrained person through CPR while the Fire Department is still responding to the call. Again, as the Department's response times increase, the importance of EMD also increases.
3. *Boulder Fire Department* — In the absence of trained bystanders, Boulder Fire Department personnel are generally the first care givers to make contact with the patient. The Department's distributed station locations ensure consistently faster responses than the existing private ambulance company's.

Basic life support (BLS) services in Boulder are provided by the Boulder Fire Department. Every line firefighter of the Boulder Fire Department maintains qualifications as an Emergency Medical Technician (EMT). This way, any responding apparatus has the trained personnel necessary to provide medical assistance. BLS services include checking for injuries, monitoring pulses and blood pressure, spinal immobilization, stopping bleeding, bandaging, administering oxygen and a variety of other functions that assess and stabilize the patient until definitive care can begin.

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4. *Private Ambulance* — Advanced life support (ALS) is provided by a private ambulance company, American Medical Response of Boulder County (AMR). ALS procedures include advanced airway management, pharmaceutical interventions, and manual defibrillation. These advanced procedures must be performed by paramedics. AMR's response goal is to deliver paramedics to the patient in less than eight minutes. In addition to paramedic care, AMR also provides transportation of the patient to the appropriate medical facility, when needed.
  5. *Local Hospitals* — The patient may be transported to a local hospital for definitive care once the patient has received emergency treatment in the field. Once in the hospital, the emergency department conducts more evaluation and treatment of the patient. If necessary, local hospitals provide other specialty care which may include cardiac care, surgery, neurosurgery, intensive care, rehabilitation, and many others services.

### ***Alternatives To The Tiered Response System***

EMS response can be managed in a variety of ways in a community. Some communities delegate this responsibility by contracting with private ambulance companies for all levels of prehospital care. Other communities provide EMS solely through the fire department. Finally, some communities provide EMS through an independent governmental agency. While there is no one perfect way, there are advantages and disadvantages to each alternative.

Communities with all privately provided care sometime struggle to maintain consistency and quality. While private, for profit ambulances can often provide some level of care at low initial cost, it is not clear that low cost translates to highest value for patients and citizens over the long-term. Alternatives where all care and transport of patients are provided by the fire department have high cost of entry and high operating and maintenance costs. However, these systems have the advantage of being able to collect offsetting charges from their patients.

Privatizing all EMS has been suggested in Boulder. However, the private ambulance company would need to place additional ambulances into the system in order to provide the same level of service now provided through the public/private partnership. If these additional costs are not be covered through third party payers, the private ambulance company may seek subsidies from the City. In addition, the monopolistic nature of contracted EMS service reduces the Community's ability to influence decisions related to care of those less able to pay. Should changes in the EMS market occur due to changes in demographics or as a result of health care reform, the ability for ambulance companies to recover their costs may be adversely impacted, resulting in less willingness to offer a high level of care.

Even without further privatization of EMS, the Department is concerned about service levels. A private provider's long-term viability depends upon earning an adequate return for its shareholders. Although ultimately the company must also satisfy its customers, its short term goals are less altruistic because of shareholder demands. Therefore, it is critical for the City to continuously monitor the performance of any private EMS provider. By

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being actively involved in the provision of EMS, the Department is well equipped to monitor the service being delivered by a private provider.

Because of the limitations of privatization, the Department recommends that the tiered system remain the foundation of the community's EMS delivery structure. The Department will continue to monitor the performance of AMR to assure that this partnership continues to meet the City's goals and objectives for EMS. As part of this monitoring, the Department will explore performance standards for private EMS providers in the City of Boulder.

## **Saving Lives With New Technology — Early Defibrillation**

As noted above, emergency medical service delivery is time dependent. However, rapid response is only one of the necessary components of the Department's health care delivery system. Once medical responders arrive on the scene, they must have at their disposal the proper training and equipment to render care. Unfortunately, there are technological advancements in BLS which the Department has not had the opportunity to utilize — specifically, early defibrillation.

Early defibrillation in the BLS setting relies upon automatic external defibrillators (AED). These units incorporate an automatic heart monitor that can detect (and discriminate from other electrical activity) the erratic heart activity of a patient in ventricular fibrillation. If the unit detects the presence of ventricular fibrillation, it delivers an electrical shock to the patient's heart. This electrical shock stops the heart's chaotic electrical activity and allows it to resume beating with a normal electrical activity. This is exactly what the ALS units do when they arrive. However, with AEDs the patient does not have to wait for a paramedic to arrive, interpret the heart rhythm and defibrillate the patient — evaluation and treatment are automatic and initiated by the first arriving BLS units.

Early defibrillation is the most effective therapy in cases of cardiac arrest (ventricular fibrillation).<sup>30</sup> In a Mayo Clinic study of 84 patients with ventricular fibrillation, 41 of the patients receiving early defibrillation survived to be released from the hospital. Of the survivors, the average time from call to defibrillation was 5.7 minutes, but the average time was 6.7 minutes for the nonsurvivor group.<sup>31</sup> Again, the importance of a short response time is evident.

The Department's EMS Committee reviewed emergency responses for cardiac arrest victims and believes that defibrillation, applied within six minutes, will save an additional two to three people per year in Boulder. As the average age in Boulder increases, the number of people who can be saved by early defibrillation will also increase. With AEDs, Boulder firefighters can provide defibrillation on average four minutes earlier than in the current tiered system. The Department recommends implementing early defibrillation technology. For a relatively minor investment, this technology has the potential to save lives.

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## **Enhanced Citizen Involvement in the EMS System**

As noted previously, rapid response to medical emergencies is a critical component of the EMS system. In light of the Department's increasing response times, the Department recommends that citizen CPR classes be regularly provided by the Department in conjunction with groups such as the Red Cross and the American Heart Association. In addition, the Department recommends public education programs that emphasize community responsibility – people helping people in distress.

## **Summary of EMS Recommendations**

- 1. Improve response times to meet six minute goal.**
- 2. Provide early defibrillation through the Fire Department.**
- 3. Provide public education programs that enhance the initial care given to victims of sudden illness or injury.**
- 4. Maintain the tiered response system.**
- 5. Establish and monitor performance standards for the private ambulance company.**

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## **WILDLAND FIRE RESPONSE AND MANAGEMENT**

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### **Wildland Fire and the City of Boulder**

The recent Buffalo Creek Fire in Jefferson County is a graphic reminder of the constant fire threat Boulder faces. Unfortunately, given the existing intermix of buildings and natural vegetation on the perimeter of the City, Boulder will experience a major urban/wildland interface fire. Neighborhoods at particular risk include Chautauqua, Devil's Thumb, Shanahan Ridge and Wonderland Hills.

The City Council has taken a major step in controlling the wildland fire problem with the wood shingle ordinance. Banning the use of wood shingles will have a dramatic and long lasting impact on limiting the spread of wildfire in the urban interface. Passage of this ordinance was a critical piece in the Department's wildland mitigation strategy.

In Boulder, wildland fire management is a cooperative effort among the Open Space, Fire, and Parks and Recreation Departments. The Wildland Fire Program was formally created in the late 1980s with the hiring of the Wildland Fire Coordinator. The Coordinator works not only with the staffs of the three City departments but with other special districts, cities, county, state, and federal agencies as well. The purpose of this interagency coordination is to provide mechanisms to manage wildland fire and its consequences through preparedness, mitigation, emergency response, and recovery efforts. The Coordinator helps assure that these efforts are carried out in an integrated manner throughout the mountain Backdrop and the Boulder Valley.

The Wildland Fire Program concentrates efforts in two broad areas. First, the program ensures that the various agencies within the City and the fire protection districts are prepared to respond to wildland fires on City-owned land outside of the City limits (such as Open Space and Mountain Parks land). The second area is that of mitigation, where strategy is to reduce the probability and limit the aftermath of undesired wildland fires.

Mitigation can go a long way toward reducing the risk and consequences of wildland fires. However, because of the geography and urban design of Boulder, the risk will never be eliminated. Therefore, response to wildland fires will always be a critical aspect of the Program.

### **Wildland Fire Emergency Response**

Under moderate weather conditions, the City of Boulder Fire Department, Mountain Parks, and Open Space units together, with contracted assistance from fire protection districts, can generally control and extinguish small wildland fires within 60 minutes. However, in dry and windy weather, large conflagrations are possible in Boulder's foothills, regardless of the time of year. For the purposes of this document, wildland fire responses are considered to be for wildland fires where no structures are initially threatened. When structures are threatened, the response is modified to include structural firefighting resources.

Response times to wildland fires in the Boulder area generally range from ten minutes to one hour. Two factors enter into this extended time frame:

1. Wildland fires often occur in areas of limited access where personnel must leave their vehicles on access roads and hike to the fire.
2. Rangers and contracted fire district firefighters must pick up their vehicles before responding. Rangers pick up the wildland fire apparatus from strategically located storage facilities and volunteer firefighters pick up apparatus from fire stations.

Small wildland fires are usually controlled on the initial attack. An *initial attack* fire has a duration less than one hour. Initial attack fires typically have three to four wildland engines (brush trucks) and nine to twelve people responding, Table 5. Wildland fires with a duration greater than two hours are referred to as *extended attack* fires. Extended attack fires typically have six wildland engines and a local wildland fire crew for a total of 22 to 25 people responding, Table 6.

**Table 5, Boulder’s Initial Attack Resources Typically Available**

<b>Initial Attack</b>	
<b>Apparatus</b>	<b>Personnel</b>
1 Engine-Boulder Mountain Parks and /or	3 Rangers and/or
1 Engine-Boulder Open Space	3 Rangers
1 Engine-Boulder Fire Department	3 Firefighters
1 Engine-Contracted Fire District	3 Firefighters
Total	9-12 Personnel

**Table 6, Boulder’s Extended Attack Resources Typically Available**

<b>Extended Attack</b>	
<b>Apparatus</b>	<b>Personnel</b>
1 Water Tender* -Boulder Mountain Parks	1 Ranger
1 Water Tender-Boulder Fire Dept.	2 Firefighters
1 Water Tender-Contracted Fire Department	1 Firefighter
1 Engine-Boulder Mountain Parks	3 Rangers
1 Engine-Boulder Open Space	3 Rangers
1 Engine-Contracted Fire District	3 Firefighters
Fire Crew	13 Personnel
Total	22-25 Personnel

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\* A “tender” is a water hauling truck.

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Small wildland fires, under moderate weather conditions, are easily handled with these local resources. However, larger fires or fires occurring under adverse weather conditions, may require resources that are beyond the local capability. For these situations, the City has agreements with state and federal agencies that will provide equipment and personnel at the City's expense. It is important to note that these state and federal resources take hours and sometimes days to arrive.

### ***Existing Problems***

A swift and effective initial attack on wildland fires often precludes the necessity for an extended attack; therefore, the consistency of response on initial attack is imperative. Unfortunately, the response to wildland fires in and around Boulder is inconsistent and, to some extent, out of the control of the Department. Inconsistencies arise from any or all of the following factors:

- *Long response times.* Resources which are not from the Boulder Fire Department generally have longer response times. This is due to a variety of factors. Contracted fire protection districts rely primarily upon volunteers who must respond to their respective fire stations prior to responding to fire calls. This is also true of Open Space and Mountain Parks rangers who are on-call and not on-duty.
- *Emergency response personnel arriving without appropriate equipment.* Resources responding from other jurisdictions may not always have the appropriate apparatus or wildland firefighting tools.
- *Emergency response personnel without appropriate training.* Personnel responding from other jurisdictions may not always have the appropriate training for wildland firefighting and wildland fire incident management. Because of the nature of some of the fire departments with which the City contracts, volunteers with appropriate levels of training may not always be available to respond to incidents in and around City property.
- *Variations in the strength of the response depending on time of the day, day of week or time of year.* The availability of volunteers from contracted fire protection districts varies with time of day and day of week. Seasonal employees on the City's wildland fire crew cause variations in availability associated with time of year. The County's wildland fire crew relies heavily upon college students, and therefore, is also susceptible to seasonal variations.

### ***Improving the Initial Attack on Wildland Fires***

The Fire Department examined several alternatives to address inconsistencies in initial attack. The Department believes that criteria-based dispatching and a modification of the Fire Department's initial response to wildland fires should be instituted.

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## **Criteria-Based Dispatching**

Under criteria-based dispatch, specific groups of apparatus and personnel are sent to wildland fire incidents based upon precise criteria related to relative fire risk. When the fire danger is reported to be high or extreme, more resources would automatically be sent than when the fire danger is moderate to low. Currently, resources are dispatched and requested only by the responsible fire district, and not by designated apparatus and personnel. In the most extreme cases, a fire which can be extinguished by a small hand crew of six could draw twenty or more firefighters, and at the opposite extreme, a large wildfire may only receive a response by six people.

Criteria-based dispatching alleviates uncertainty by ensuring an appropriate and consistent response. This approach increases the Department's ability to plan for responses to wildland fires. This also has the effect of minimizing ecological damage associated with inappropriately large wildland fire responses. Conversely, when conditions dictate a response which is larger than a typical response, criteria-based dispatching ensures that additional resources are sent out on the initial attack. By tailoring the response to the severity of the fire, topography, weather, and moisture, efficiency and effectiveness are improved.

## **Modify the Department's Initial Wildland Fire Response**

The Department should modify its initial response to wildland fires occurring on City-owned property outside the City limits during high and extreme fire danger periods. During these periods, a Boulder Fire Department wildland fire engine and wildland fire personnel should respond on initial attack along with the appropriate fire protection district. As with criteria-based dispatching, this modification in the City's response to wildland fires more effectively matches response to risk and reduces the danger of a wildland fire burning out of control. This modification guarantees a City presence at high risk wildland fires affecting City-owned property. Also, this modification is less expensive than the Department assuming full responsibility for all initial responses.

## **Capital Resources for Wildland Fire Response**

Capital resources also play a role in the Department's preparedness to respond to wildland fires. There are facility and fleet concerns which influence the Department's ability to respond to wildland fires.

### ***Wildland Fire Facilities — The Fire Cache***

In an effort to facilitate coordination of wildland fire planning and training activities, the Open Space Department opened a wildland fire mobilization and response facility (Fire Cache) in an old farm house northwest of Boulder Reservoir in 1992. The Cache serves as a place to assemble personnel and equipment for fires, monitor weather conditions, store equipment, and perform light equipment maintenance. The Cache also serves as a location where wildland fire management agencies meet and perform integrated planning for fires. Since 1992, the Cache has served as the headquarters of the Wildland Fire Program.

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Not only does the Cache serve as integrated planning and coordination center for emergency response, it also houses a wildland fire library. Videos, books, and other resources are available for participating agencies and citizens to use for reference, public education, and training. Finally, much of the wildland fire equipment is stored and reconditioned after use at the Cache.

Unfortunately, the existing Cache does not meet the current requirements of the Wildland Fire Program. As the Program has grown, so have space requirements. Currently, storage space is inadequate. In addition, the Cache lacks indoor facilities to store wildland fire apparatus and large equipment, which poses two serious weather-related problems. First, with exposure to the elements, equipment and apparatus rapidly deteriorate. Second and, more important, pumpers and water tenders need to be drained whenever the temperature drops below 40 degrees F in order to ensure that nothing freezes. Refilling these tanks takes 30 minutes to one hour with the limited water supply at the existing Cache. In the event of a winter fire, this delay in response could be the difference between a small and a large fire.

### **A New Fire Cache**

The Fire Department recommends a new Cache be co-located with the existing Station Six. Because the Cache is not primarily used for initial response, locating it near wildland areas is not critical. The relocation of the Cache to Station Six will allow personnel assigned to Station Six to assist with the maintenance of wildland firefighting equipment. Since the City already owns the land adjacent to Station Six (63rd and Spine), the cost of the relocation would be only the cost of constructing the building and installing necessary utilities. The facility should be large enough to accommodate apparatus, large equipment, and the administrative offices for the Wildland Fire Management Group.

### ***Wildland Fleet***

The Wildland Fire Program is jointly funded through the Fire Department, the Mountain Parks Division of Parks and Recreation, and Open Space. As such, apparatus and equipment are jointly funded. The current wildland fire fleet evolved over the past five years as funds were available for purchases or lease agreements. Unfortunately, there is no plan for the replacement of much of this capital. This is a critical vulnerability in the area of vehicles and apparatus as larger purchases are not easily absorbed into a department or division's annual operating budget—a fully equipped, wildland firefighting vehicle costs \$45,000 in 1996.

The current Wildland fleet varies in age and condition from units believed to have been purchased in the 1950s to those purchased in 1995. A detailed listing of the current wildland fire fleet is displayed in Table 7.

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*Table 7, Wildland Fire Fleet*

<b>VEHICLE</b>	<b>MODEL YEAR</b>	<b>OWNER</b>
Brush Truck	1990 GMC	Mountain Parks
Brush Truck	1990 GMC	Mountain Parks
Brush Truck	1990 GMC	Open Space
Brush Truck	1990 GMC	Open Space
Brush Truck	1991 Ford F350	Fire Department
Water Tender	1950s GMC Jimmy	Mountain Parks
Water Tender	1964 Kaiser 6x6	Mountain Parks
Water Tender	1950s Military 6x6	Open Space
Water Tender	Newly reconditioned in 1995	Fire Department
Patrol	1993 GMC Sierra	Fire Department
Patrol	Unknown	Mountain Parks
Patrol	Unknown	Open Space

### **Funding the Future Wildland Fleet**

Over the years, the departments of Fire, Open Space, and Parks and Recreation (Mountain Parks Division) have acquired apparatus that have not been incorporated into the fleet replacement fund. As such, there is not currently an adequate accrual for replacement for some apparatus.

In the future, the Department recommends that all purchases and replacements of wildland fire vehicles be made through the fleet fund, in accordance with City policy. This practice will ensure that the proper replacement accruals are being made and that replacement criteria are developed. For vehicles and apparatus that do not require immediate replacement, the Master Plan recommendation is to place those vehicles into the fleet fund and to accelerate accrual for replacement if necessary. All vehicles for which a replacement accrual is not established should be phased out of service.

### **Decreasing the Number and Severity of Wildland Fires, While Protecting Sensitive Ecosystems**

Given Boulder's weather patterns, terrain, vegetation, and limited access to homes at the base of the foothills, the City can expect a major wildland/urban interface fire. Recent experience with these types of fires in other parts of the country, as well as past experience in Boulder County with the Old Stage and Black Tiger fires, suggests there will be extensive damage before sufficient resources are assembled to extinguish the fire. However, the City can take measures to mitigate wildland fire risk for areas that lie within the wildland/urban interface.

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## ***Ecosystem Management and Protection — Mitigation***

The fire service has traditionally thought of wildland fires as being harmful, something to be extinguished as soon as possible. Only recently has the fire service begun to realize that fire plays an important role in maintaining a healthy ecosystem. Fire is one of nature's tools for cleansing wildlands of debris and unhealthy vegetation. Naturally-occurring fires ensured healthy habitat for a wide variety of plant and animal species. Early photographs of Chautauqua and the surrounding foothills illustrate the less fuel dense natural plant species prior to the intervention of well-intentioned fire suppression efforts.

Boulder's backdrop supports a ponderosa pine and grass ecosystem. Historically, this environment has adapted to frequent low intensity wildland fires. Wildland fires cleansed the forest an average of every five to twenty-five years. Denied regular naturally occurring fires, these forests become susceptible to destruction by high intensity fires. In the grasslands, wildland fires were more frequent, occurring every one to five years. Here, healthy prairie grasses grow from buds located just below the soil surface following a fire. Unfortunately, firefighting efforts have interrupted nature's cycle. Over the past 80 years, foothills vegetation has accumulated to unnatural extremes.

By inadvertently increasing the fuel loads, the fire service has dramatically increased the intensity of undesired wildland fires. These intense wildland fires are a threat to lives and property in Boulder. They are also a threat to the very ecosystems that are being protected. High intensity fires can sterilize sensitive ecosystems, further increasing the need for mitigating fuel loads.

### ***Developing Mitigation Plans***

Although mitigation efforts cannot reduce the risk of undesired wildland fires to zero, aggressive mitigation programs can substantially reduce the risk. While different City departments are currently employing some mitigation techniques, a truly effective and coordinated wildland fire mitigation program does not yet exist.

Prevention of major wildland fires is not a simple problem with a singular solution. There are a variety of mitigation techniques available, and each has positive and negative effects on the ecosystems to which they are applied. Because of this, the Fire Department's Staff has been working closely with the staffs of Mountain Parks and Open Space to develop integrated recommendations for managing the wildland fire problem in the most ecologically sound manner. These planning efforts are listed in Table 8.

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**Table 8, City of Boulder Fire Mitigation Plans**

<b>Plan</b>	<b>Department</b>	<b>Completion</b>
Ecosystem Management Plan	Open Space and Mountain Parks	Projected completion in 1996
Forest Ecosystem Management Plan	Open Space and Mountain Parks	Projected completion in 1997
Eldorado Mountain Area Management Plan	Open Space	Projected completion in December 1996
Boulder Mountain Parks Resource Management Plan	Mountain Parks	Projected completion in 1998
Shanahan Area Management Plan	Open Space	Projected completion in 1998

Although final recommendations for an integrated program of fuel reduction will come with the completion of the management plans being developed, the Fire Department, together with Mountain Parks and Open Space, has taken some measures to begin to manage the fuel load in the wildland areas surrounding Boulder. These departments have implemented a series of prescription burns. Prescription burning is the intentional use of fire to maintain a healthy ecosystem. Boulder's use of these burns not only reduced extreme fuel loads, but also provided data necessary to evaluate the effectiveness of prescription burns as a mitigation tool. These data also support outside research sponsored by Open Space and Mountain Parks to explore fire's role in ecosystem health.

### **Fire Department Wildland Fire Mitigation Program**

The Fire Department believes ecosystem management projects, including mitigation, are critical to the safety of Boulder's citizens and to the health of sensitive ecosystems. Therefore, the Fire Department recommends that a more aggressive wildland fire hazard mitigation program be adopted by the City. The program recommendations include:

- Work in conjunction with Mountain Parks and Open Space staffs to more aggressively identify wildland fire hazard areas and implement appropriate ecosystem management strategies.
- Establish and maintain healthy ecosystems throughout Mountain Parks and Open Space utilizing fuel reduction techniques where appropriate.
- Use a variety of methods to treat a minimum of 50 to 100 acres on Mountain Parks and Open Space land annually.
- Establish a Fire Department Wildland Fire Mitigation and Response Crew dedicated to vegetation management on Mountain Parks and Open Space land. The crew would also have seasonal workers available to respond to undesired wildland fires.

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## **FIRMIT - Fire Mitigation Program**

Jurisdictions that have experienced major fires often adopt strategies to reduce their risk. Most often these cities:

- Implement vegetation management programs.
- Improve access to neighborhoods adjacent to open spaces.
- Encourage home owners in high risk areas to landscape using native fire-resistive plants.
- Discourage the use of wood building materials for homes along the interface through special code adoption.
- Strategically locate equipment to facilitate a quick response to wildland fires.

In 1994, Boulder began working on the Fire Mitigation Program (FIRMIT). The FIRMIT Program utilizes wildland fire specialists to assess the wildland fire hazards within neighborhoods and on public lands in and around Boulder. The Program identifies the wildland fire hazards that exist within wildland/urban interface areas and provides information to homeowners on available mitigation techniques. It is hoped that the information given to homeowners will increase the number of homes that are protected through fire resistive vegetation and landscaping. The City departments of Fire and Open Space, and Mountain Parks Division work closely and cooperate with the Boulder County Land Use and Sheriff's departments, local fire protection districts, the Colorado State Forest Service, and the U.S. Forest Service in coordinating the FIRMIT Program.

The initial FIRMIT area lies west of Broadway bounded by Baseline Road to the north, Shanahan Ridge to the south, and the foothills ridge line to the west. The eastern boundary has been determined by following lines created by a neighborhood's proximity to natural vegetation and home density. While FIRMIT is an ongoing program, the ultimate goal is to continue the process until all development which is contiguous to City owned wildlands is included.

Although FIRMIT represents an important step towards decreasing the risk of uncontrolled wildland fires, there is still a significant amount of work to be done in order to mitigate the wildland fire hazard.

## **Fuel Reduction Techniques**

All mitigation techniques have positive and negative impacts on the ecosystem. Ecosystem impacts may be acceptable in some areas but unacceptable in others. Before recommending any technique for a specific area, it is necessary to understand the effects of the particular technique on the following areas:

- Air quality
- Water quality
- Aesthetics

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- Relationship between topography and the effectiveness/feasibility of the technique
  - Public perceptions
  - Sensitivity of the environment to the particular technique
  - The extent government pursues restoring the environment to its “natural state”
  - The level of risk of a large wildland fire that the City is willing to accept

In order to further understand the specific impacts of particular mitigation techniques, the Wildland Fire Master Planning Group evaluated the benefits and costs of the various techniques. For the purposes of this evaluation, the Group considered two major mitigation strategies as well as the option of maintaining the status quo. The status quo option was discarded because of the risks to the community and sensitive ecosystems. The recommended mitigation strategies are mechanical thinning and prescription burning.

### ***Mechanical Thinning***

Mechanical thinning includes a wide range of thinning options which range from selective cutting of tree limbs to removal of trees. Mechanical thinning lessens the severity of fire effects by restoring the forest to a more natural state when compared to the state that exists as a result of intervention on natural fires. Mechanical thinning has a lower impact on air quality than prescription burning and is beneficial for some plant and animal species. It has a final advantage in that it is seasonally adaptable and can be performed year round.

### ***Prescription Burning***

As discussed earlier, prescription fires are used to treat unhealthy ecosystems and prevent catastrophic fires. In Boulder and “In the West there is an urgency, ‘We only have a 15 to 30 year window to recover from over protection,’ one forester said. ‘Otherwise, we will have killing crown fires over virtually the whole ponderosa forest.’”<sup>32</sup> Prescription burning includes planned and purposely ignited fires as well as prescription natural fires. Prescription natural fires are naturally ignited fires that are allowed to burn as long as weather, fuel and fire conditions remain within predetermined parameters established to prevent an unacceptably large and destructive fire. These fires are allowed to continue when they occur in an area predetermined to be safe and able to be benefited by the burn. In either type of prescription burn, firefighting forces must be available to extinguish the fire if necessary. Prescribed fires are carefully planned and implemented by the Wildland Fire Coordinator along with resource specialists from the departments of Open Space and Parks and Recreation. Prescribed fire provides a holistic, cost-effective way to manage ecosystems and simultaneously achieve the goals of reducing non-native species, thinning downed and dead vegetation, stimulating growth of native species, returning valuable nutrients to the soil, and reducing fuel load. The City has successfully used prescription fires on numerous occasions.

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## **Summary of Wildland Recommendations**

- 1. Adopt criteria based dispatching and a modified initial response for wildland fires.**
- 2. Adopt a fire mitigation plan and hire personnel to perform wildland fire mitigation and response activities.**
- 3. Construct a Fire Cache at Station Six.**
- 4. Place all wildland firefighting vehicles into the City's fleet replacement program.**
- 5. Continue the FIRMIT Program.**

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## STRUCTURAL FIRE SUPPRESSION

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### Suppression Efforts

The Department's strategy in responding to structure fires is simple — get there fast and extinguish the fire while it is still small. In the 1970s and 1980s the Department used a combination of small mini-pumpers staffed with two firefighters and standard full-size engines staffed with three firefighters to attack fires. In theory, the mini-pumper's location and maneuverability would provide a more timely response and faster attack on fires. While there were merits to the theory, in practice it did not work. The mini-pumpers were susceptible to longer response times and when they did arrive, they did not have the personnel or equipment necessary to extinguish the fires. As additional personnel and equipment trickled into the scene, the fire grew beyond the capacity of the first responding crews. This type of approach also presented a greater danger to the Department's firefighters; as they were faced with fighting larger fires with insufficient resources. As the nature of the City changed, problems with the old approach became more evident. Simply put, the frequency of larger fires increased, putting initial responding crews at greater danger and increasing property losses.

The Department changed its approach. It now delivers two full-size engine companies, a ladder company, and a Battalion Chief on an initial alarm. This response puts nine firefighters on the fire and provides for coordination of fire suppression efforts. The engine companies are responsible for rescuing occupants, advancing fire hoses and extinguishing the fire, while the ladder company performs specialized rescue and fire suppression activities. With these resources, the Boulder Fire Department can extinguish a fully involved fire in 750 to 1,000 square feet of single story space.\* This is approximately the size of a two-bedroom condo entirely engulfed in flames. Because these measurements assume that two fire hoses are attacking the fire, this extinguishing potential is not reached until the second engine company arrives and is set-up. However, the first arriving firefighters are expected to immediately begin rescue and extinguishing activities to the best of their ability in a safe manner. When this first crew begins to put water on the fire, the fire's growth slows. This buys some time while the second engine arrives and sets up. Once the second engine company joins in the firefight, full extinguishing potential occurs.

### *Transition Fires — A Second Alarm*

Because fire continues to grow in size and intensity until it's overwhelmed by the water spray applied to it, second engine response times are critical in determining whether a fire can be successfully extinguished in its early stages. In Boulder, second engine response times average eight minutes and 32 seconds. Even with early detection and notification, the Department's theoretical potential to extinguish the fire approaches the predicted flashover time limit. If the first engine crew is unable to slow the fire's growth sufficiently, both crews will likely be caught in a transition fire. A transition fire occurs

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\* According to the National Fire Academy and Kimball formulas for extinguishing capacity, and following National Fire Protection Association's recommendations for effective fire attack.

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following flashover and when the fire becomes larger than the first arriving firefighters' extinguishing potential.

Transition fires present additional dangers to firefighters. They can become exhausted and more susceptible to injury due to fatigue. The building around them may collapse leading to an entrapment. Because of this potential for collapse, firefighting efforts may switch from a direct attack in the fire building to protecting adjacent properties exposed to the fire. Instead of working on the inside, they are forced by the intense heat and instability of the structure to retreat outside.

Transition fires tend to spread to adjacent units or buildings, becoming uncontrollable by the first two engine companies and the ladder company. Therefore, additional resources are called for. These resources are an additional three engine companies, also known as a second alarm assignment.

Once a second alarm is called, the City has only one remaining engine company; therefore, mutual aid from surrounding fire departments is called to assist until additional Boulder firefighters can be called in on overtime or the fire is extinguished and engine companies are returned to service. Even with overtime coverage from off-duty personnel, transition fires often require additional resources only available through mutual aid.

### **Automatic Mutual Aid and Call-Backs**

The Department is very motivated to pursue alternatives that put additional firefighters at the scene quickly so that transitional firefighting can be more effective. The Department has very good mutual aid agreements with neighboring departments and will continue to work toward automatic mutual aid for transition fires. Automatic mutual aid is a reciprocal agreement which allows for predetermined personnel and equipment to be dispatched automatically when certain criteria are met. For example, firefighters from a neighboring agency may be called automatically on a second alarm freeing some of Boulder's fire suppression resources to respond to additional calls for service. This differs from the Department's current system where neighboring fire departments respond only to specific requests. The automatic response allows for a more timely response and decreases the number of decisions Fire Department commanders need to make; thereby allowing them to focus on the task at hand. In addition, recent experience indicates that the Department will receive more mutual aid than it gives.

In conjunction with automatic mutual aid, the Department will continue to call-back off-duty personnel. This strategy helps address the coverage problem encountered whenever the Department responds with more than four engines. In 1995, there were only 35 incidents where four or more engines were needed to control structure fires in the City. Therefore, implementation of automatic mutual aid and call-back of off-duty personnel should not place an undue burden on current resources or adversely impact neighboring departments.

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## **Coordination of Transition Fires**

Transition fires require very high levels of coordination. A command staff of over ten people is common on large fires. However, the Department can only routinely bring four to five command staff members to any one emergency incident. Therefore, the Department believes the addition of an Operations Chief is a crucial step toward having adequate command resources.

### *Operations Chief*

In 1995, a vacancy due to retirement occurred in position of Operations Chief. Instead of filling the vacancy, the position was exchanged for additional firefighters needed to bring staffing on engines up to three. The duties and responsibilities for supervision and support of the Emergency Services Division were added to the existing responsibilities of remaining staff members. In addition to command functions for an Operations Chief, the Master Plan has components that require thorough management, planning, review, and oversight. Among these are the planning, hiring, and support functions related to wildland fire management, training issues and the Training Center, and the construction of Station Seven.

## **Fire Prevention Through Codes**

### *Fire Codes — The First Line of Defense*

Modern fire protection is provided through a systematic combination of public education, fire suppression and fire prevention activities. Fire codes are a critical component in Boulder's current fire prevention activities. The codes help prevent fires from starting and minimize the size and impacts of fires which cannot be prevented. They protect the occupants of buildings and the firefighters who assist the occupants during an emergency. Codes act as the first line of defense in fire protection. However, fire codes do not eliminate the risk of fire and fire-related losses. Instead, they are based upon the concept of acceptable risk — balancing fire safety with economic growth and personal liberties.

The design, construction, contents, and use of every occupancy have fire safety consequences. The design and construction of a building can contain or accelerate a fire. The placement of walls and exits affect the ability of people to exit a building. The contents of a building can slow or expedite flame spread. Finally, the use of a building impacts the probability of a fire occurring and influences the result of a fire. For example, hazardous processes in a manufacturing building can increase the probability of a fire starting, or a small fire in a crowded theater can have a devastating impact on the occupants.

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## **Economic Advantages of Fire Codes**

Fire codes decrease direct and indirect costs of fire by reducing the number of fires and decreasing the damage caused by fires that cannot be prevented. Because resources lost to fire cannot be replaced without obtaining new resources from other activities, reducing fire losses provides an economic benefit.

The costs associated with providing fire suppression services are significant and ongoing and can be reduced through the proper application of fire codes. Codes which prevent fires decrease the number of firefighters and equipment necessary to protect a community from the possibility of multiple fires occurring simultaneously. Codes which minimize the impact of fires, and allow for the safe escape of building occupants, also allow jurisdictions to have fewer firefighters and less equipment. Therefore, fire codes reduce the cost of fire suppression services.

Fire codes shift some of the burden of fire protection from the taxpayer onto the building's owner, internalizing the cost based upon the building's design, construction and use. However, the building owner also realizes benefits in the form of enhanced safety and lower insurance premiums when the building is in compliance with the codes.

### ***Fire Codes in Boulder — Progress and Limits***

Relative to other cities, Boulder's fire codes are very progressive. The current codes have minimized fire risk in commercial and multi-family structures. Through the use of codes, Boulder has exerted a significant amount of control over the types of fires experienced in the community. Boulder's codes are more stringent than many other cities in Colorado. For example, multi-family housing of over four units and commercial buildings over 2,000 square feet are required to have automatic sprinkler systems. Boulder also had the foresight to adopt landmark fire codes concerning combustible roofing materials. While Boulder's building and fire codes recognize the capabilities of the Fire Department and the limitations of manual fire suppression efforts, fire codes in general have limitations. In addition, fire codes in Colorado have statutory restrictions which make it more difficult for municipalities like Boulder to take full advantage of fire codes.

### **Residential Occupancies**

Fire codes generally do not apply to residential property. Unfortunately, most of Boulder's structure fires, and associated fatalities and injuries, occur in residential occupancies. Therefore, a different strategy needs to be used to prevent fires, and minimize the effects of fires which cannot be prevented, in the home. The most effective strategy for existing residential occupancies, other than automatic fire sprinkler systems, is public education, which is addressed in another section of this document.

### **Commercial and Industrial Occupancies**

As noted above, the fire code is quite effective in commercial and industrial occupancies. Boulder's firefighters do an excellent job inspecting these properties when they are available. In addition, Boulder's business community is generally interested in, and

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responsive to, fire code violations when they are discovered. However, the capacity problems at stations Two and Three limit the Department's ability to perform inspections. If workload trends continue, the City is in danger of having fire code violations go undetected and uncorrected.

### **State-Owned or Licensed Occupancies — The University of Colorado**

Another fire code issue which plagues Colorado as a whole is the application (or lack thereof) of fire codes in State-owned or licensed facilities. With the exception of fire protection in Eisenhower and Hanging Lakes tunnels, local jurisdictions are responsible for providing fire protection to State-owned or licensed facilities. However, the local jurisdictions do not have the authority to enforce their fire codes in these facilities. While fire safety standards do exist for these facilities; the standards are often not enforced, enforced using a code which is different from Boulder's code or are developed and implemented without respect to the Department's capabilities.

The University of Colorado is a prime example of challenges presented by State-owned and licensed facilities. While the Department must respond to incidents in the University's facilities, it is not allowed to enforce its codes within the University. This inability to enforce codes places students at risk and forces the Department to prepare for emergency incidents on the University's grounds which are larger than would occur if appropriate fire codes were in place.

The Department works closely with the University on fire prevention issues. The University has been generally cooperative and has attempted to bring its facilities up to the Department's standards. However, University personnel responsible for fire safety do not have much discretion or power when it comes to enforcing fire safety standards. The Department realizes this and does the best it can given its limitations.

## **Summary of Recommendations for Structural Fire Suppression**

- 1. Improve response times.**
- 2. Explore greater use of automatic mutual aid on transition fires.**
- 3. Hire an Operations Chief.**
- 4. Continue to prevent fires through the application of codes.**
- 5. Enhance public safety education programs.**
- 6. Maintain the existing positive relationship with the University of Colorado.**

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## HAZARDOUS MATERIALS

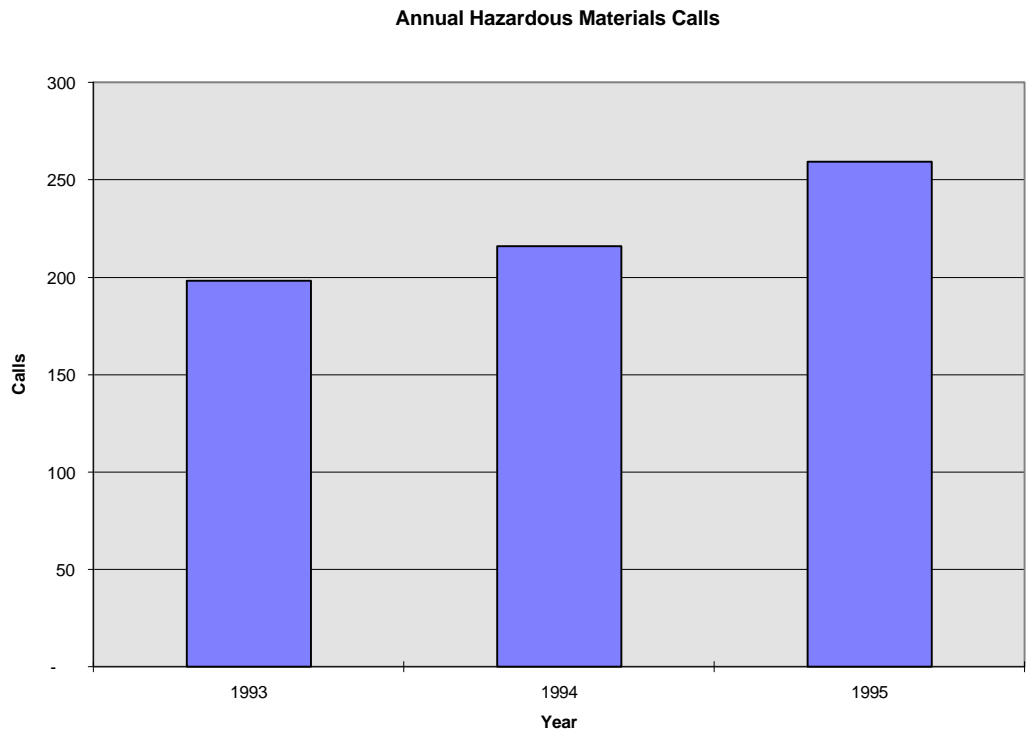
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### Responding to Hazardous Materials Incidents

#### *Nature and Scope*

Because a significant portion of Boulder's economy is associated with advanced technology, research, and chemical manufacturing, large quantities of hazardous materials are transported through and used in the City of Boulder. These chemicals, when either accidentally or intentionally released from their containers, threaten the lives and health of Boulder's citizens.\* These chemical releases also threaten air and water quality, private and public lands, and the economy. Finally, hazardous material incidents pose a serious threat to the health and safety of the Department's firefighters who must respond to these releases. Because of this, the Boulder Fire Department takes its responsibilities towards preventing and controlling hazardous materials releases very seriously.

**Figure 14**



Hazardous materials responses are increasing in the City of Boulder. From 1993 through 1995, the number of hazardous materials emergencies has increased 31 percent, from 198 to 259 incidents, Figure 14. Growth in demand for this type of service is consistent with

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\* Intentional releases in Boulder have included illegal dumping and acts of sabotage.

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trends seen throughout the region and the nation. The current and projected growth in calls for hazardous materials incidents can be attributed to three factors. First, successful public education campaigns have heightened awareness about hazardous substances and the need to protect the environment. Today, citizens are calling for help with the disposal of chemicals that they would have washed down their sinks just a few years ago. Second, the increased demand for hazardous materials responses is related to changes in manufacturing and technological processes in industry — more and more companies are using hazardous chemicals in their production processes. This is resulting in a proportionate increase in spills and other chemical emergencies. Finally, increased costs for legally disposing of hazardous wastes have resulted in more illegal dumping of hazardous materials.

### ***Response to hazardous materials calls***

In Colorado, hazardous materials response became a locally provided service by statute. Federal law required the state to develop hazardous materials response systems. In Colorado, the responsibility was delegated to local jurisdictions by statute. The statute requires local governing bodies to appoint a Designated Emergency Response Authority (DERA) for the purpose of responding to hazardous materials emergencies within their jurisdictions. In the City of Boulder, the Boulder Fire Department is the DERA. In unincorporated Boulder County, the Commissioners appointed the Sheriff as the DERA. In order to provide the citizens with the best possible and most cost effective response, many jurisdictions in the County, including the Boulder Fire Department, work together on the Boulder County HazMat Team. Personnel with advanced training in hazardous materials incidents and specialized equipment are pooled within the Team. This allows Team members to support each other when assistance is needed to contain hazardous material releases.

Initial response to hazardous materials spills within the City is handled by the Department. If needed, this response can be supplemented by regional or even national resources. By statute, all expenses associated with the response to a hazardous materials incident can be recovered from the party responsible for the event. The Boulder Fire Department currently bills to recover extraordinary costs associated with hazardous materials incidents within the City of Boulder.

Responses to hazardous materials incidents in Boulder and unincorporated Boulder County follow a mode system. The sequence of modes associated with responses to hazardous material emergencies in the City of Boulder is:

*Mode I* — When the Fire Department first receives a call to respond to a hazardous materials incident, the Department responds in Mode I. Engine companies and the Battalion Chief respond to the scene and assess the situation. If the incident is within the capabilities of the first responding units, they handle the containment and arrange for disposal themselves. If the first responding personnel cannot handle the incident alone, they call for additional assistance. At the point additional assistance is requested, the incident enters Mode II.

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*Mode II* — When the first responding engine company cannot handle the incident alone, they call for additional assistance from the Department’s on-duty HazMat Team members. Once this happens, the incident enters Mode II. If there are no on-duty Team members available, assistance comes from on-call members of the Team. In Mode II, control of the incident remains with the City.

*Mode III* — If the incident is too large to be handled by the Department and its members of the County HazMat Team, the incident commander requests additional assistance from the County. At this point, the incident becomes a Mode III incident and receives a full HazMat Team response. In Mode III command of the incident is either transferred to the County or a joint command is established.

*Mode IV* — In Mode IV, Federal and/or State assistance is requested and command of the incident is turned over to the appropriate state or federal agency. An incident would reach Mode IV only after all local resources are exhausted.

While hazardous materials incidents are not currently an excessive burden on the Department’s response resources, they are still a threat to Boulder’s citizens, firefighters and the environment. Therefore, the Department recommends taking a more active role in preventing hazardous materials releases and gaining information on hazardous materials storage and use which is critical to firefighter safety.

## **Preventing Hazardous Materials Emergencies — Public Education and Enforcement**

### ***Preventing Releases — Hazardous Materials Public Education***

Although public education programs are more thoroughly discussed in subsequent sections of this Master Plan, they deserve a mention here. The first efforts towards decreasing the number and severity of hazardous materials incidents involves public education. Through public education efforts, the Department will be able to increase the awareness of options such as the Household Hazardous Waste Disposal program, thereby decreasing unnecessary storage and inappropriate or illegal disposal of hazardous substances by citizens. Public education programs for business and industry will also help decrease the number and severity of hazardous materials releases.

### ***Preventing Releases — Enforcement***

Another essential aspect of decreasing the number and severity of hazardous materials incidents is the enforcement of complex local, state and federal laws concerning the storage, transportation and handling of hazardous materials. Areas of the fire code which pertain to hazardous materials have become quite complex. This complexity, combined with the Department’s already limited ability to deal with routine code enforcement issues, has left a void in the Department’s ability to prevent hazardous materials releases.

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## **Hazardous Materials Inspector**

To cope in this complex regulatory environment, the Department recommends hiring a Hazardous Materials Inspector. Not only would this inspector help enforce complex aspects of state, federal and local laws regarding hazardous materials, he or she would also collect information about the storage and handling of hazardous materials. While this information is already collected by law in Boulder County, its use for pre-planning incidents, reacting to incidents and providing firefighters with information concerning their personal safety is very limited. The current system is a paper collection of information stored at Norlin Library.

In addition to enforcing hazardous materials laws and regulations in industry and business, the Hazardous Materials Inspector can assist the Fire Department and other City Departments to remain compliant with hazardous materials laws and regulations.

## **Summary of Hazardous Materials Recommendations**

- 1. Carefully monitor trends in hazardous materials incidents.**
- 2. Prevent hazardous materials incidents through public education.**
- 3. Hire a Hazardous Materials Inspector to enforce appropriate laws and regulations concerning hazardous materials.**
- 4. Monitor types and quantities of hazardous materials and their locations so that firefighters know what their potential for exposure is.**

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## **DECREASING DEMAND AND RISK THROUGH THE COMMUNITY — PUBLIC SAFETY EDUCATION**

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While no one believes fires and medical emergencies can be completely eliminated, there are many proactive actions the Fire Department can take to reduce the number of incidents and severity of fires and medical emergencies in the community. Boulder has been a leader in adopting fire codes which reduce the probability of and impacts from unwanted fires. However, there are several areas where Boulder can be more proactive in decreasing the number and severity of emergency incidents. Improving every individual's ability to avoid emergencies and his or her ability to react appropriately during an emergency is one such area.

### **Educating to Decrease Demand**

Public education efforts of the fire service have traditionally been directed towards fire prevention. Slogans such as "People can learn not to burn" and "Stop, drop and roll," have become cornerstones of fire department public education efforts. However, the Fire Department has an obligation to protect lives, property and the environment from a variety of threats — not just fires. Therefore, the Department wishes to expand its approach to public education to encompass all risks.

### ***Current Public Education Efforts Are Sporadic***

The engine companies and the Fire Prevention Bureau shoulder most of the public education responsibilities. As previously discussed, both the engine companies and the Fire Prevention Bureau have work loads which preclude some public education efforts. Currently, the Fire Prevention Bureau and engine companies provide educational programs as personnel are available. Unfortunately, a vicious cycle exists; the increased call load diminishes the Department's ability to provide the very services which may stem the increase in demand.

Currently, public education efforts are limited to community events such as the Fall Festival, the Boulder Creek Festival and Fire Prevention Week. When the Department is able, it also presents organization-specific safety programs in response to requests from schools, nursing homes, child care facilities, industry, neighborhoods, and citizen groups.

### ***Public Education for Emergency Medical Services***

Many progressive fire departments, such as the Phoenix and Fort Collins fire departments, already incorporate EMS-related activities in their public education programs. The EMS Master Plan Group, embraced the idea of nontraditional fire department public education programs and identified three public education efforts that would have a significant impact on the overall health of the community. The Group developed the following recommendations for public education efforts:

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1. *Appropriate 911 Use* — Firefighters and paramedics are frequently called to situations which do not require emergency treatment. The Group believes that public education programs which highlight the appropriate use of emergency resources could help stem the rate of increase in service demands.
  2. *Accident Prevention* — The Group recommended that the Department participate in accident prevention programs. Home safety and helmet awareness programs for bicyclists are examples of accident prevention programs the Group recommended for the Department to provide.
  3. *Citizen CPR Classes* — The EMS Master Planning Group believes that citizen CPR classes should be a high priority for the Department.

### ***Other Public Education Issues***

The Department identified several other public education issues which will be briefly discussed here.

#### **Wildland Fires**

As previously discussed, public education is an important aspect of preventing undesired wildland fires. The Department believes the public education aspects of FIRMIT should be expanded upon. The Department also needs to communicate the benefits of mitigation programs in order to gain public acceptance.

#### **Hazardous Materials Public Education**

Public education in the hazardous materials arena includes working with business and industry, and individual citizens. By providing public education concerning hazardous materials, both the Department and City businesses are better able to inventory and assess the hazards, develop strategies to improve safety when working with hazardous chemicals, and provide better information to the public about what to do in case of a chemical emergency. Public education efforts will also increase awareness of options available to citizens for proper handling and disposal of hazardous materials. For example, the Household Hazardous Waste Disposal program has decreased inappropriate and illegal disposal of hazardous substances by citizens. This issue is further addressed in the Hazardous Materials section of this document.

#### **Community Involvement — The Neighborhood Program**

The Fire Department would like to become more active in the programs developed by the City's Neighborhood Liaison. The Department believes that neighborhood meetings provide an excellent opportunity to provide public education programs. The Department also hopes to incorporate health and safety information in neighborhood newsletters.

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### **Consistent Elementary School Programs**

Studies have shown that fire safety programs are very effective when given consistently to kindergarten through fourth grade students. Therefore, the Department is recommending that a consistent safety program be implemented for these students.

### **Disaster Preparedness**

The educational needs in disaster preparedness are largely informational. Much of the information concerning evacuation routes, shelters, emergency alert sirens, and basic survival tips can be shared with the citizens through the Neighborhood Liaison. The Fire Department should work with the City's Neighborhood Liaison to incorporate basic disaster survival information into neighborhood presentations.

### **Citizen Academies**

Citizen Academies are programs where community leaders are invited to participate in a specially designed course which demonstrates the roles and responsibilities of firefighters in a dynamic, hands-on training environment. Participants are given the opportunity to fight fire, climb ladders, rappel from a training tower and a variety of other activities. The Academy allows participants to experience (in a safe and controlled environment) some of challenges of being a firefighter.

## **Summary of Public Safety Educator**

In order to provide these public education programs, the Department must increase its public education resources. The Department is recommending that a Public Safety Educator be hired. The Public Safety Educator will be responsible for developing, coordinating and presenting a regular schedule of public education programs in conjunction with the engine companies and members of the Fire Prevention Bureau. Finally, the Boulder Fire Department is one of the few professional fire departments on the Front Range without a full-time Public Safety Educator.

## **Summary of Public Safety Education Recommendations**

- 1. Expand the Department's current fire safety message to include the appropriate use of 911, CPR, accident prevention, hazardous materials awareness, and disaster preparedness.**
- 2. Hire a Public Safety Educator.**

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## TRAINING

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### Why Emphasize Training and Development?

Today's firefighters operate in a complex, dangerous and dynamic environment. Firefighter training is the single most important factor in determining if firefighters are prepared to meet the challenges of the environments in which they work. Proper training means the difference between success and failure during emergency operations. The need for improved firefighter and officer training within the Department is substantial.

Firefighter safety and survival is the first and foremost reason for improved training in the Department. As the City matures, firefighters are faced with new challenges and hazards. Changing construction techniques and new manufacturing processes require specialized knowledge in order for firefighters to respond safely to emergency incidents. With Boulder's growth of high technology enterprises, the furniture store has been replaced by the biotechnology lab as the Department's more dangerous occupancy.

Citizen expectations also increase the need for improved firefighter training. The Department provides a variety of services previously unheard of in the fire service—services such as hazardous materials response, emergency medical services, automobile rescue, dive and swift water rescue, wild-land/urban interface fire suppression, and a variety of other services such as diversion programs for juvenile fire starters.

The demands for increased efficiency and effectiveness also drive the need for enhanced training. As the service demands increase, the Department attempts to do more with limited resources by looking at new technologies and procedures to make its operations more efficient and effective. The use of new technologies (such as automatic external defibrillators) and procedures (such as dive and swift water rescue) require training.

Increased training requirements are also driven by the "Paradox of Firefighter Training." This paradox simply states: As the Fire Department does a better job in preventing fires and other emergencies, the less proficient firefighters become — basic skills must be practiced and refreshed. This paradox accelerates the need for training in order to provide superior services to the community.

Finally, the Boulder Fire Department is a relatively small department, which means that its personnel do not have the depth of experience that larger departments enjoy. In order to maintain expertise and provide promotional opportunities from within, the Department must provide adequate development opportunities for its personnel. By promoting from within, the Department is able to take advantage of existing employees' knowledge of the community. By being able to take advantage of local expertise, the Department is able to deliver better services to the citizens it protects.

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## **Training Standards**

Various laws and professional standards influence the activities of the Training Division. The Division utilizes these existing laws and standards for conduct and development of training programs.

## **Training Delivery Needs**

Boulder Firefighters continually strive to enhance the delivery of service. The current training program takes advantage of these qualities and continually integrates these innovations into its training program.

The Training Division is responsible for the coordination, development and implementation of all training within the Department. However, the Division is a one person operation. The lack of people in the Division results in deficiencies in providing adequate training and development for firefighters and officers.

The Training Division has established annual training targets for firefighters, shown in Table 9. These targets include basic training as well as specialty training for individuals who specialize in functions such as dive rescue, wildland fire, and hazardous materials responses. As

Table 10 shows, the department has significantly increased the number of training hours its firefighters participate in over the last three years. However, the number of training hours falls short of the targets.

**Table 9, Training Targets**

<b>Topic</b>	<b>Hours per Firefighter</b>
EMS	24
Fire Suppression	24
Hazardous Materials Technician	24
Specialty Training	24
Incident Command	12
Fire Prevention	8
Hazardous Materials Ops.	8
Driver Education	3
Public Education	2
<b>Total</b>	<b>129</b>

**Table 10, Actual Delivery of Training Programs**

<b>Year</b>	<b>Average Annual Training Hours Per Firefighter</b>
1993	56.5
1994	98.0
1995	118.6

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In addition to falling short of its training targets, other deficiencies exist. These specific deficiencies include:

*Staff and Officer Development* — The Training Division is unable to provide Staff and Officer development courses. Any Staff and Officer development classes in which members participate in are provided outside the department. The Department considers this to be a critical shortcoming in its training program. As stated earlier, the department wishes to promote from within; therefore, Staff and Officer training is crucial to developing future leaders from within the Department.

*EMS Quality Assurance Program* — Beginning in 1997, the Training Division will be responsible for the Department's EMS Quality Assurance Program. This program was previously supplied by Boulder Community Hospital. Unfortunately, the hospital has decided to discontinue its quality assurance program for Boulder County EMS agencies. A quality assurance program is essential in providing high caliber EMS. It is also essential for liability reasons.

*Curriculum Development* – The Training Division does not have the resources necessary to develop new curricula. This primarily impacts the training of the Department's specialty teams. The various specialty teams need training programs developed for activities within each team.

*Scheduling* – Department training is very difficult to coordinate. Scheduling is dependent upon various teams and shifts working together in order to develop training opportunities while maintaining adequate protection in a station's home district. As the Department works with more outside agencies on specialty teams, the complexity of scheduling increases. Scheduling occupies a significant portion of the Training Division's time, detracting from other activities.

*Instructor Availability* – The expansion of the Department's training program requires more specialized instructors. Presently, the Department is short on adjunct instructors and specialty team instructors. This situation has overloaded existing personnel involved with training and limited new program development.

*Increased Overtime Costs* — In order to meet minimum safety requirements during live fire training, two instructors are necessary. Because the Department only has one full-time instructor, off-duty firefighters must be called in on overtime to assist with live fire training exercises.

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### ***Training Assistant***

In order to meet the existing training needs, the Department recommends that a Training Assistant be hired. The Training Assistant will help the Training Officer with his duties including scheduling, instructing, developing new curricula, and performing quality assurance activities for EMS calls.

### **Training Center**

The Department utilizes the Boulder Regional Fire Training Center for much of its training activities. The Training Center was constructed in 1974 under a cooperative agreement between the City of Boulder and Boulder County and is currently operated under intergovernmental agreement between the City and County. The Training Center is located on three acres of land south Lee Hill Drive and West of Broadway.

The Training Center has a training tower, a burn building and classrooms. However, there are several drawbacks associated with the existing training facility. The existing burn building utilizes wooden pallets as fuel to provide heat, smoke and flames for live fire training. As with any fire utilizing wood as a fuel, smoke is released into the atmosphere. Because of the Department's sensitivity to air pollution, the Department does not train with live fire during the winter high air pollution season. In addition to the air pollution, operations at the training center cause noise and light pollution. Fire trucks with their engines running at high speed in order to pump water during training exercises create noise pollution. Training activities during the night require lighting which causes light pollution.

Air, noise and light pollution were not of great concern until recent annexations and development surrounding the facility resulted in homes being built in the vicinity of the Training Center. This recent development has caused conflict between the local residents and the Department. The Department has incorporated changes into the training program to reduce negative impacts of training on the neighborhood. However, the negative impacts cannot be completely eliminated.

In addition to the neighborhood concerns, the existing Training Center is also lacking adequate props to simulate various rescue, fire suppression and hazardous materials release scenarios. Finally the existing training center does not have the space necessary to conduct fire apparatus driver training programs. Currently, driving skills must be learned on the public roadways or in private or public parking lots.

### ***A New Training Center***

The Department recommends that a new training center be constructed in an area that is removed from residential occupancies and readily accessible to Boulder Fire personnel and apparatus. The Department further recommends that the center utilize technology which minimizes atmospheric releases of smoke and other toxic substances.

The new facility should have adequate classroom, office and storage space, and props to simulate different emergency scenarios. Among these props are a building for live fire training (which utilizes clean burning fuels), a tower to simulate multiple story firefighting

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and rescue scenarios, a hazardous materials pit to simulate spills and hydrocarbon fires, and enough paved area for a driving course. The Department believes approximately five to ten acres of space will be necessary for the new facility. The size of the site is not only important in terms of providing sufficient work and training areas, but also to provide a buffer between the facility and neighboring businesses or residences.

Finally, the Department would like to pursue joint funding of a new training facility with neighboring fire departments and County law enforcement agencies. The Department believes it is important to train with mutual aid agencies in order to function more effectively on large incidents where mutual aid is utilized. The Department also believes it is in the City's interest to have well trained firefighters in neighboring fire departments. Joint funding and utilization of a fire training provides mutual benefits to the City and the surrounding communities.

## **Summary of Training Recommendations**

- 1. Hire a Training Assistant.**
- 2. Relocate the Training Center and pursue joint funding with neighboring departments.**

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## DISASTER PREPAREDNESS

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Disasters are a fact of life in Colorado. The 1994 South Canyon Fire resulted in 14 firefighter deaths. The 1992 visit of Pope John Paul II resulted in a mass casualty incident of unprecedented scale — over 20,000 people required emergency medical treatment during the two-day event. The Black Tiger fire of 1989 destroyed 44 homes in Boulder County, required over 500 firefighters, and resulted in \$10 million in property loss. In 1976, the Big Thompson Flood killed 130 people. With increasing growth and urbanization, Colorado is becoming more and more vulnerable to similar large scale emergencies.

Emergencies are routine for the fire service and generally there is no community-wide impact or need for extraordinary resources to bring conditions back to normal. It is the scale of an emergency which defines a disaster. By definition, when the scope of an emergency exceeds the local jurisdiction's resources, it becomes a disaster.

There are three types of disasters: natural, technological and civil. Natural disasters include, but are not limited to, forest fires, floods and tornadoes. Technological disasters include chemical and biological releases, fires and radioactive material releases. Civil disasters include civil unrest, terrorist attacks and incidents where no unrest is present but conditions lead to large numbers of people being injured, such as the Papal visit.

In Boulder, the Office of Emergency Management (OEM) coordinates disaster planning. An intergovernmental agreement between the City of Boulder and Boulder County created the OEM. Under the joint funding structure, funds from all levels of government (City, County, State, and Federal) are funneled through the Federal Emergency Management Agency (FEMA). State statutes require each county to maintain an emergency management and preparedness office. The joint operation between the City of Boulder and Boulder County is the only such partnership in Colorado.

Disasters have a very low probability of occurring but very high potential for catastrophic losses. Because the risk at any given time is relatively low, jurisdictions, including Boulder, never staff for the "big one." It can take days, even weeks, to amass the resources necessary to combat and recover from a catastrophic event. In many cases, it may take up to 72 hours to deliver assistance to all but the most severely affected citizens. Therefore, Boulder residents should be encouraged to devise plans to care for themselves for up to 72 hours.

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## **Practice Makes Perfect**

Because disasters occur so infrequently, it is difficult for emergency response officials to remain proficient in all aspects of disaster response. Disasters require response from several agencies, from both inside and outside of the City. These agencies may not work together on a regular basis, so it is essential to practice the skills and develop a working knowledge of other agencies' capabilities before a disaster strikes. The Department recommends that Boulder continue to run disaster plan exercises at least four times each year.

## **Public Education for Disaster Preparedness**

As noted above, disaster assistance may take up to 72 hours to reach all but the most critical victims. In many cases, those that best survive a disaster are those that can assist themselves. Therefore, basic survival education for citizens is a critical component of disaster preparedness. Basic disaster survival education should include an assessment of the relative risks, general survival tips, and information specific to particular disaster situations. In addition, citizens should learn evacuation routes, emergency shelter locations, and how to interpret and respond to the tones and messages from the emergency alert sirens.

## **Summary of Disaster Preparedness Recommendations**

- 1. Disaster plans should be exercised at least four times a year in Boulder.**
- 2. Citizens should be educated on the need to care for themselves for up to three days following a disaster.**

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## SUMMARY AND COST OF RECOMMENDATIONS

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The Fire and Emergency Services Master Plan has eight goals designed to enhance the safety and sense of well-being for the citizens of Boulder. Each of those goals has specific performance objectives associated with them. The Plan weighs safety and economic security against the cost to the taxpayers. The Department believes the Plan is both reasonable and cost-effective.

The Plan, if adopted, carries a significant price tag. Because the Department is asking for capital improvements of over \$6.5 million coupled with a \$1.4 million annual increase in its operational budget, the Department is recommending a five-year, phase-in of the Plan. If funded at the same level for the first five years, this strategy will cost the City \$2.25 million and then drop to \$1.4 million annually at the conclusion of capital expenditures. The cost analysis does not include costs associated with future unfunded federal mandates or building replacement allocations.\*

The recommended phase-in for costs and implementation of recommendations is:

### Year One

#### **Wildland Fire Recommendations:**

- Fire Cache Relocation — One-time construction cost, \$650,000.
- Wildland Fire Response Group — Start-up costs, \$237,500. (Includes two additional full-time employees and six seasonal crew members, a vehicle and equipment.)

\* Annual costs after the first year are \$196,000.

#### **Public Safety Education Program:**

- Start-up costs, \$96,000. (Includes vehicle, one full-time employee, training, and equipment.)

\* Annual costs after the first year are \$75,000.

#### **Rescue Squad:**

- Start-up costs, \$322,500. (Includes personnel, vehicle, and equipment.)

\* Annual costs after the first year are \$155,000.

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\* An example of a potential unfunded federal mandate is the proposed FCC's spectrum reallocation. While it is not anticipated to occur during the life of this plan, it will require a substantial investment in new radio equipment when it becomes law.

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## Year Two

### Fire Station Seven:

- One-time land purchase and station design, \$300,000.

### Training Center Relocation:

- One-time land purchase and center design, \$1,000,000.

### Operations Chief:

- Start-up costs, \$61,000. (Includes vehicle, equipment, and overtime for existing personnel — no FTE required.)

\* Annual costs after the start-up year are \$57,000.

### Hazardous Materials Inspector:

- Start-up costs, \$96,000. (Includes vehicle, one full-time inspector, training, and equipment.)

\* Annual costs after the start-up year are \$79,000.

## Year Three

### Fire Station Seven:

- One-time construction costs, \$340,000.

### Training Center Relocation:

- One-time costs for roads and utilities, \$1,000,000.

### Training Assistant:

- Start-up costs, \$82,000. (Includes one full-time instructor, training, and equipment.)

\* Annual costs after the start-up year are \$60,000.

## Year Four

### Fire Station Seven:

- New fire apparatus and station furnishings, \$405,000.

\* Annual costs after station opens \$793,000. (Includes 12 firefighters and operating expenses).

### Training Center Relocation:

- Beginning construction costs, \$510,000. (Includes classrooms, storage, offices, burn building, burn props, and training tower.)

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## **Year Five**

### **Training Center Relocation:**

- Completion of construction, \$2,073,000.

## **Beyond This Plan**

This Master Plan is an integral part of the Department's strategic planning process, allowing the Department to anticipate and respond to changes in its environment before the changes adversely impact service delivery. In order to ensure that a contemporary strategy is used in the future, the Master Plan will be evaluated and revised on an annual basis.

## **Final Observation**

The Department recognizes that the price of public safety is not inexpensive. However, despite the Department's best efforts, both the quantity and quality of the Department's services have eroded in the face of growing demands. The status quo no longer serves the needs of Boulder's citizens; therefore, the time has come to acknowledge that the Department's resources are stretched as far as possible. This proposal is a solid investment for the citizens of Boulder.

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## END NOTES

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- <sup>1</sup> Colorado State Fire Chiefs' Association, "A Five Point Plan for A Fire Safe Colorado," 1996.
- <sup>2</sup> USFA Fire in the United States data placed in per capita figures against Boulder's population in 1994 dollars.
- <sup>3</sup> Boulder Police Department, "Master Plan", 1996.
- <sup>4</sup> US Census data.
- <sup>5</sup> Boulder Police Department, "Master Plan", 1996.
- <sup>6</sup> Estimate from 1995 Boulder County Assessor's personal property abstract.
- <sup>7</sup> August 1996 Boulder County Assessor's data.
- <sup>8</sup> Boulder Police Department, "Master Plan", 1996.
- <sup>9</sup> Peer Cities include: Eugene, OR; Santa Barbara, CA; Tempe, AZ; Provo, UT; Fort Collins, CO; Madison, WI; North Metro Fire Rescue -- Thornton, Broomfield and Northglenn, CO; and Aurora, CO.
- <sup>10</sup> CPPA preliminary survey results, 1996 unpublished as of this date.
- <sup>11</sup> Adjusted to 1996 from 1994 NFPA data.
- <sup>12</sup> CPPA preliminary survey results, 1996 unpublished as of this date.
- <sup>13</sup> ICMA report 1992, adjusted to 1996 dollars.
- <sup>14</sup> William Gay & Alan Siegel, "Fire Station Location Analysis: A Comprehensive Planning Approach," *ICMA MIS Report* (July 1987).
- <sup>15</sup> John Watts, "Assessing Life Safety in Buildings," The Fire Protection Handbook, 17th Edition, (Boston: NFPA 1991).
- <sup>16</sup> Kevin McIntyre and James Lewis, Text Book of Advanced Cardiac Life Support, (Dallas: American Heart Association 1991).
- <sup>17</sup> Stan Feero, et al., "Does Out-of-Hospital EMS Time Affect Trauma Survival?", American Journal of Emergency Medicine, 13:2, March 1994, pp. 133-135.
- <sup>18</sup> Kevin McIntyre and James Lewis, Text Book of Advanced Cardiac Life Support, (Dallas: American Heart Association 1991).
- <sup>19</sup> Harvard Business School, The psychology of waiting lines, 1984.
- <sup>20</sup> Charles Rule, IAFC "Accreditation Committee Surveys Fire Departments, Charts Response Times", IAFC On Scene, September 1, 1991, p. 7 & 8.
- <sup>21</sup> Joseph Bachtler, Thomas Brennan, Fire Chiefs' Handbook 5th edition , p. 623, 1995.
- <sup>22</sup> White, R., Asplin B., Bugliosi T., Hankins D., "High Release Survival From Out-of-Hospital Ventricular Fibrillation with Rapid Defibrillation by Both Police and Paramedics". *Academic Emergency Medicine*, 1996;3(5):422.
- <sup>23</sup> Jim Gallager, "From the Ground Up: The Expansion of a Fire Department Starts with the Site Selection," *Fire Command* (November 1989).
- <sup>24</sup> Gordon McKinnon, Fire Protection Handbook, 14th Edition, (Boston: NFPA, 1976).
- <sup>25</sup> Emmanuel Mesagna & John Raroni, "Fire Department Facilities and Fire Training Facilities," The Fire Protection Handbook, 17th Edition, (Boston: NFPA 1991).
- <sup>26</sup> Susan Benton & Neil Carpenter, "A Computerized Approach To Fire Station Location," *ICMA MIS Report* (July 1987).
- <sup>27</sup> William Gay & Alan Siegel, "Fire Station Location Analysis: A Comprehensive Planning Approach," *ICMA MIS Report* (July 1987).
- <sup>28</sup> Ronny J. Coleman, "New Directions for IAFC Publications," *The International Fire Chief* (January 1987), p. 16.
- <sup>29</sup> William Gay & Alan Siegel, "Fire Station Location Analysis: A Comprehensive Planning Approach," *ICMA MIS Report* (July 1987).
- <sup>30</sup> Kevin McIntyre and James Lewis, Text Book of Advanced Cardiac Life Support, (Dallas: American Heart Association 1991).
- <sup>31</sup> White, R., Asplin B., Bugliosi T., Hankins D., "High Release Survival From Out-of-Hospital Ventricular Fibrillation with Rapid Defibrillation by Both Police and Paramedics". *Academic Emergency Medicine*, 1996;3(5):422.
- <sup>32</sup> Michael Parfit, "The Essential Element of Fire," *National Geographic*, September 1996, p131, 132. (190:3).