November 1992

City of Cambridge

A Report

from

Ernst & Young

A Comprehensive Evaluation of the Services Provided by the Cambridge Fire Department and a Plan for the Provision of Fire Protection Services

ERNST & YOUNG

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November 18, 1992

PRIVATE AND CONFIDENTIAL

Ms. Lisa Peterson
Assistant to the City Manager
City of Cambridge
City Hall
795 Massachusetts Avenue
Cambridge, MA 02139
USA

Dear Ms. Peterson:

Re: A Plan for the Provision of Fire Protection Services

We are pleased to submit our final report pertaining to our review of the fire protection delivery system of the City of Cambridge and the development of a master plan for the provision of fire protection services to the citizens of Cambridge.

We wish to thank you, the members of the Steering Committee, the members of the municipal administration, and the Cambridge Fire Department for the assistance we received in completing this work.

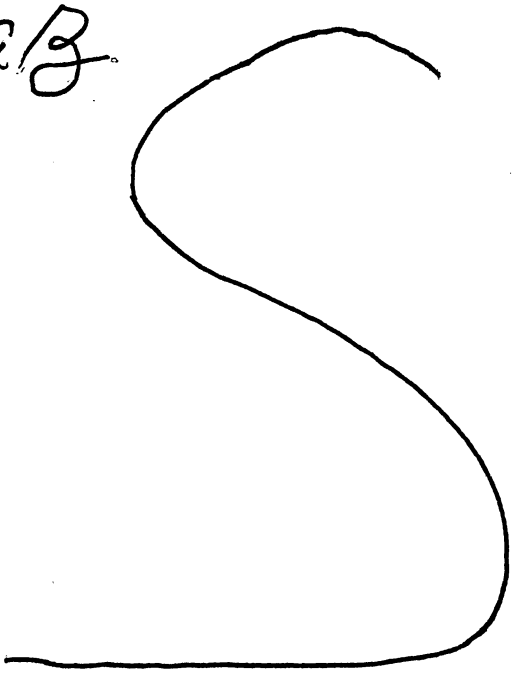
Yours very truly,

Ernst & Young

Ernst & Young

Fire Study

TAB



SUMMARY OF RECOMMENDATIONS

1. It is recommended that the Cambridge Fire Department adopt the following response capability objectives:

   A. The initial apparatus shall arrive at the scene of the alarm within four minutes of receipt of the alarm in at least 90% of all occurrences;

   AND/OR

   The full initial response complement shall arrive at the scene of the alarm within eight minutes of receipt of the alarm in at least 90% of all occurrences;

   AND

   B. The initial response complement shall be comprised of the manpower and equipment necessary to control and extinguish a structural fire in an occupancy of up to 5,000 square feet, and, at the same time, rescue and remove any endangered occupants from the structure;

   AND

   C. These response time objectives shall meet the four minute recommendations of the American Heart Association for response to medical emergencies in at least 90% of all occurrences.

   These recommended objectives were agreed upon by the Steering Committee at the meeting on March 10, 1992, were confirmed at the Steering Committee meeting on May 12, 1992 and were used as the basis for assessing the existing deployment and developing the recommended deployment.

2. It is recommended that the City of Cambridge replace the existing cardex system with computer aided dispatch as soon as practicable. It is estimated that the reduction in dispatch time that would result would range between 20 and 40 seconds. A somewhat larger reduction in the 90th percentile should be realized because a CAD reduces the variance in the time required to dispatch apparatus and makes it easier to dispatch multiple apparatus.

   The introduction of computer aided dispatch is the most far-reaching and equitable improvement that can be made in a fire protection service in that it reduces the response times to almost all citizens by the same amount. It is also the best way to significantly reduce the number of citizens in west Cambridge who reside in areas within which the RCOs are not achieved.

   The time spent passing information, or transferring a caller requesting service, from the 911 Center at the Police Department to the Electric Department Communications Center should be eliminated by establishing one, and only one, Communications Center to service all emergency response organizations in the City.

   A CFD supervisory presence would be required in an integrated 911 communications center to ensure effective communications since fire department communications and dispatch procedures differ significantly from police or ambulance dispatch and communications.

3. At present, there are only three firefighters on duty on a pump and on a ladder. A smaller number of pump and ladder companies, each staffed with four firefighters, is strongly recommended for the following reasons:

   - a four firefighter company is over 150% more effective than a three firefighter unit;
   - firefighters frequently work in pairs, particularly when inside a structure since working as a single firefighter is not considered a safe operation;
   - NFPA Standard 1500 addresses fire department occupational health and safety and in its appendix recommends four firefighter staffing as a minimum acceptable level; and
   - four-firefighter companies are more effectively managed on the fireground to insure prompt execution of critical tasks and more prompt accomplishment of critical functions of fire control.

   A more detailed discussion pertaining to on duty staffing per apparatus is set forth in Section 5.4.2

4. Increase the service level and broaden the scope of the first responder service by introducing automatic external defibrillators (AEDs) in each engine company.

   The AHA recommendation regarding response time to incidents requiring the use of an AED is four minutes. The Rescue Company is the only company currently equipped and trained to provide AED. Only 27,235 citizens, or 28.4 % of the population resides within a 2 1/2 minute travel time (four minute response) of Station One, where the Rescue Company is housed.

   If two firefighters on each engine were qualified to use AEDs and the CAD were implemented, then the CFD could respond to incidents requiring AED within a four minute period in more than 86 percent of the incidents using any of the deployment alternatives discussed in this report.

5. If the City of Cambridge decides to improve the service levels with respect to life support at the EMT level and emergency medical transportation, then it is recommended that the City adopt Alternative Two with the three combination Engine - EMT engine company configuration. The key elements of this alternative include:

   - establish three combination Engine - EMT companies at Station One, the relocated Station Two (Binney & Fulkerson) and Station Eight, each staffed with six firefighters.
   - eliminate the Rescue Company and transfer the firefighters to staff the combination Engine - EMT companies.
   - deploy five engine companies at Stations Three, Four, Five Six and Nine, each staffed with four firefighters.

- deploy three ladder companies at Stations One, Two and Eight each staffed with four firefighters.

- discontinue the two - apparatus wagon engine company concept.

6. If the City of Cambridge decides to introduce AED's, but opts not to improve the service levels with respect to life support at the EMT level and emergency medical transportation, then it is recommended that the CFD maintain the existing Rescue Company staffed with four firefighters and deploy eight, four fire fighter engine companies in the locations set forth in Alternative Two. All the other elements of Alternative two should be implemented.

It should be noted that:

- 89,639, or 93.6%, of the population reside at addresses at which the response capability objectives would have been achieved given the Alternative Two deployment with or without the enhanced emergency medical response option; and

- 741, or 91.4%, of the 811 code 11 structure fires that occurred during the four year period 1988 to 1991, occurred at addresses at which the response capability objectives would have been achieved given the Alternative Two deployment with or without the enhanced emergency medical response option.

Therefore Alternative Two, with or without the emergency medical response enhancement option, exceeds the response capability objectives agreed upon by the Steering Committee.

7. Adopt the following staffing recommendations:

- six firefighters per combination Engine- EMT company
- four firefighters per engine
- four firefighters per aerial apparatus

8. Reduce the number Deputy Chiefs on duty at any given time in the Suppression Division from two to one.

9. Relocate the repair facility to the new station at Binney & Fulkerson or to Station 3.

November 1992

City of Cambridge

A Comprehensive Evaluation of the Services Provided by the Cambridge Fire Department and a Plan for the Provision of Fire Protection Services

Fire Study

TAB 1

CAMBRIDGE FIRE DEPARTMENT

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Fire Study

TAB 1

1.0 INTRODUCTION

The Cambridge Fire Department (CFD) provides fire protection services to a population of approximately 95,800 residents, who inhabit an area of roughly 6.27 square miles. The City of Cambridge's Fire Department has an establishment of 283 uniformed positions and four non-uniformed positions. There were 246 positions filled in the Suppression Division on December 31, 1991. The CFD has an annual operating budget of approximately $17 million.

In January 1992, the City retained Ernst & Young to conduct a review of the fire protection delivery system of the City of Cambridge and to develop a plan through which the Cambridge Fire Department would provide fire protection and emergency medical response services to the citizens of Cambridge.

The goal of this project is to provide a review and analysis of the City's current fire and emergency medical response services, and to provide innovative recommendations addressing future fire protection and emergency medical service needs.

Specifically, this evaluation includes:

- an assessment of fire station locations, crew sizes, response time and pieces of fire apparatus at each engine company and ladder company as well as of the rescue/ hazardous material unit;
- an assessment of the existing fire station locations to determine if they should remain in place, relocate to a more appropriate location, or merge with an existing fire station;and
- an evaluation of staffing patterns in the Suppression Division.

This report addresses the following items:

a. apparatus and station deployment configuration;
b. apparatus staffing levels;
c. apparatus suitability;
d. response time:

    1. from time of dispatch centre receiving notification to time of dispatch to fire companies;

    2. from time of dispatch to arrival of the first apparatus;

e. dispatch and radio communications;

f. fireground management, command structure and operation;

g. personnel staffing patterns including, but not limited to, shift duration, sequence and crew sizes;

h. department management and command structure for the Suppression Division; and

i. efficiency and effectiveness of emergency medical response.

Fire Study

TAB 2

2.0 BACKGROUND

2.1 CITY AND REGION PROFILE

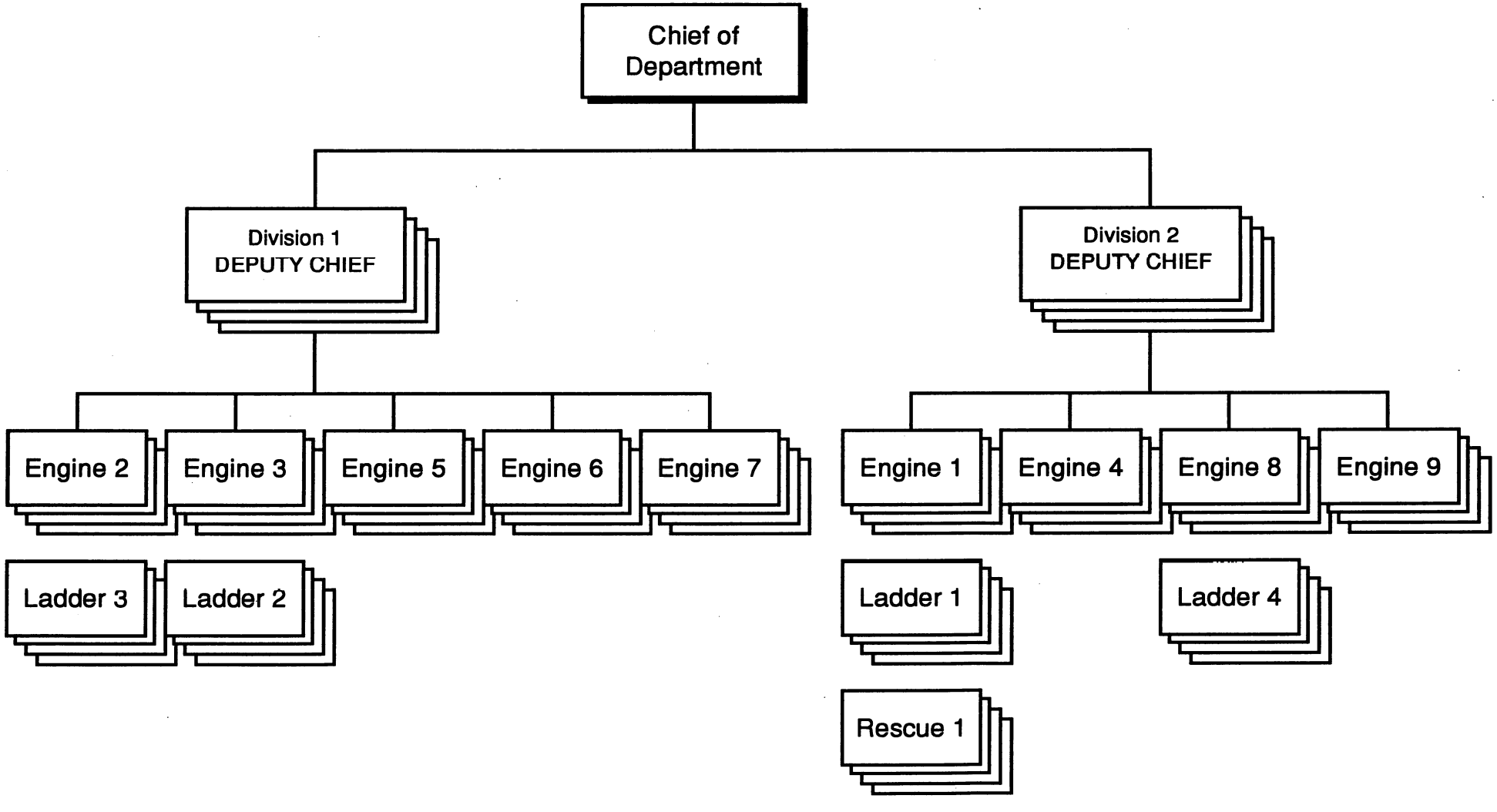
There are several characteristics of the City of Cambridge which are noteworthy from the viewpoint of providing fire protection services:

- The City has a population of approximately 95,800 people and a land area of only 6.25 square miles;
- The resulting average population density of over 15,300 persons per square mile makes Cambridge the sixth most densely populated city in the U.S. (among cities with a population greater than 75,000);
- The City's population peaked in the 1950's and has been in decline since then. During the ten year period between 1993 and 2000, the City's population is projected to decrease by 1,828 to 93,972 or by about 1.91%[1]. This is equivalent to an annual decrease of 0.24% per year;
- The number of residential dwelling units in the City is stable and for 1990 is estimated at 41,979;
- 36,110 or 86% of the residential dwelling units in Cambridge are located in multiple family dwellings;
- The majority of single and multiple family residential dwellings were built before 1945 and are of predominantly wood frame, balloon type construction;
- Narrow streets, traffic congestion and two house lots, common in many neighborhoods, make fire suppression in Cambridge more difficult than in a typical city of 95,000;
- The City has an established policy for preservation of existing housing stock. This program does not provide for retrofitted automatic fire detection and suppression systems. Consequently, the need for fire response by staffed units will remain undiminished;
- There are numerous non-dwelling occupancies in the City which include offices, laboratories, universities, hospitals, historic buildings, government buildings, and similar occupancies. Historically, the City's economy has been closely linked to manufacturing and high tech industries. In recent years, the City's educational, research and development, and service sectors have expanded at unprecedented rates;

1. Source: Metropolitan Area Planning Commission, 1992.

Exhibit 1

Establishment of the Suppression Division of the Cambridge Fire Department



- Some of the institutional occupancies include:

  - Harvard University;
  - Massachusetts Institute of Technology;
  - Radcliffe College;
  - three hospitals and other health care facilities; and
  - one penal institution.

- There are approximately 100 buildings in Cambridge which exceed six stories in height of which the majority are along Massachusetts Avenue ;

- There are 176 miles of water pipe in the City of Cambridge. The City has an established policy whereby, eventually, all water supply pipe will be at least 8 inches in diameter. However , at present, there are 4.4 miles of 4 inch pipe and 81 miles of 6 inch pipe. A study is underway to set priorities for the replacement of pipe below the 8 inch policy; but it is recognized that water pipe replacement is a costly, long term project; and

- Two railway lines traverse the city. In the east, the Boston & Albany line divides East Cambridge and MIT from the rest of the city. In the north and west, the Boston & Maine railway separates North Cambridge and the Alewife area from the rest of the city.

2.2 THE EXISTING ORGANIZATION OF THE SUPPRESSION DIVISION OF THE CAMBRIDGE FIRE DEPARTMENT

Exhibit 1 sets forth the existing organization of the Suppression Division of the Cambridge Fire Department as at December 31, 1991. Approximately 246 of the 283, or 93%, of the established uniformed positions are assigned to the Suppression Division. Ten of the 283 uniformed personnel have been unavailable for duty due to long term illness or disability.

The Suppression Division is organized into four groups, or platoons, each comprising approximately 62 positions. The City is partitioned into two districts, or Divisions. One platoon is on duty during each tour under the command of two Deputy Chiefs - one Deputy Chief for each district. The two Deputy Chiefs are on duty for each shift and are in command for management and response to working fires or emergencies throughout their respective districts.

Each firefighter in the Suppression Division works the equivalent of a 42 hour work week alternating between four, 10 hour day shifts and four, 14 hour night shifts once every eight days.

Demographics and Fire Data For Cambridge And Comparable Jurisdictions

Jurisdiction	Square Mileage	1990 Jurisdiction Population	Number of Housing Units	Percentage Pre-1939	Percentage 5 Plus Units	Housing Density*	Resident Population Density*	Total Personnel	Uniformed Personnel	Personnel on Duty	Number of Stations	Number of Engine Companies	Number of Ladder Companies	Number of Rescue Companies	On Duty Strength per 1000	Engines and Ladders per 1000	Engines and Ladders per square mile
Boston	47.0	574,283	241,444	63.0	42.8	5,137.11	12,218.79	1771	1614	300	34	33	21	2	0.52	0.09	1.15
Madison	55.7	191,262	68,949	23.6	32.4	1,237.86	3,433.79	276	263	54	10	8	3	1	0.28	0.06	0.20
Providence	18.9	160,728	67,495	66.1	22.3	3,571.16	8,504.13	565	548	110	14	16	8	6	0.68	0.14	1.22
New Haven	18.9	130,474	50,612	52.6	33.2	2,677.88	6,903.39	404	385	66	10	10	6	5	0.51	0.11	0.79
Lowell	13.0	103,439	34,883	59.2	29.9	2,683.31	7,956.85	227	224	42	11	11	4	1	0.41	0.15	1.15
Berkley	10.9	102,724	46,319	52.5	34.6	4,249.45	9,424.22	158	130	34	7	7	2	3	0.33	0.09	0.83
Brockton	21.5	92,788	34,270	45.1	24.2	1,614.88	4,315.72	172	158	30	6	5	2	0	0.32	0.08	0.33
Fall River	33.7	92,701	37,021	67.7	28.5	1,098.55	2,750.77	274	250	41	6	8	4	1	0.44	0.13	0.36
Quincy	17.0	84,985	34,352	55.5	25.8	2,020.71	4,860.59	218	209	39	8	8	3	1	0.46	0.13	0.65
Lynn	10.0	81,425	32,617	68.5	27.8	3,261.70	7,856.00	217	203	43	8	7	3	0	0.53	0.12	1.00
Somerville	3.9	76,210	30,942	77.9	23.2	7,933.85	19,541.03	167	165	27	5	5	3	0	0.36	0.10	2.05
Average	20.9	140,903	56,613	52.6	27.1	2,957.21	7,313.77	403	376	71	11	11	6	2	0.44	0.11	0.88
Median								227	224	42	8	8	3	1	0.44	0.10	0.83
Cambridge	6.0	95,802	41,300	67.7	51.5	6,883.33	15,210.00	267	263	46	9	9	4	1	0.48	0.14	2.20

*: per square mile

A COMPARATIVE ANALYSIS OF CAMBRIDGE AND COMPARABLE JURISDICTIONS

A. Demographic Information

Comparison Parameter	Cambridge	Rank	Other Jurisdictions (11) Range	Average
Square miles	6.0	11	3.9 - 55.7	20.9
1990 population (000's)	95,802	7	76,210 - 574,283	140,903
Housing units	41,300	6	30,942 - 241,444	56,613
% Pre-1939 units	67.7%	Tied 3	23.6% - 77.9%	52.6%
% 5 plus units	51.5%	1	23.2% - 42.8%	27.1%
Housing density *	6,883	2	1,098 - 7,933	2,957
Residential Population density *	15,210	2	2,750 - 19,541	7,313

NOTE: * : per square mile

B. Fire Protection Resource Comparison

Comparison Parameter	Cambridge	Rank	Other Jurisdictions (11) Range	Median
Total Personnel	267	6	157 - 1771	227
Uniformed Personel	263	Tied 4	155 - 1614	224
Personnel on duty	46	5	27 - 300	42
Number of Stations	9	6	5 - 34	8
Engine companies	9	5	5 - 33	8
Ladder companies	4	Tied 4	2 - 21	3
Rescue companies	1	Tied 5	0 - 5	1
On duty strength / 1,000	0.48	5	0.28 - 0.68	0.44
Engines and ladders / 1,000	0.14	Tied 2	0.06 - 0.14	0.10
Engines and ladders / sq. mile	2.20	1	0.33 - 2.05	0.83

2.3 A COMPARATIVE ANALYSIS

Ernst & Young compiled 17 statistics from 11 similarly situated American cities to develop a comparative assessment of the demand and supply of fire protection in the City of Cambridge relative to these municipalities. These are cities in the United States with which Cambridge has been compared in other fact finding work.

Exhibit 2 lists the 11 cities and the data values for each of the 17 statistics. Exhibit 3 sets forth the statistics for the City of Cambridge, the city's rank relative to the other 11 cities and the range and median for the 12 cities. The statistics indicate that:

- Cambridge ranked between fifth and eighth, or in the middle third of the group, with respect to most statistics including:
  - population protected
  - housing units protected
  - uniformed personnel
  - personnel on duty
  - number of stations
  - number of engine companies
  - number of rescue companies
  - number of aerial companies
  - on duty suppression strength per 1,000 population; and
- the City of Cambridge ranked between first and fourth, or at the top one-third of the group, with respect to:
  - percentage of housing built prior to 1939
  - percentage of housing with five or more units
  - housing density per square mile
  - resident population per square mile
  - uniformed personnel
  - on duty strength per 1,000 population
  - engine and ladder companies per 1,000 population
  - engine and ladder companies per square mile; and
- the City of Cambridge ranked 11th with respect to square miles covered.

A COMPARATIVE ANALYSIS OF CAMBRIDGE AND BOSTON

A. Demographic Information

Comparison Parameter	Cambridge	Boston
Square miles	6.0	47
1990 population (000's)	95,802	574,283
Housing units	41,300	241,444
% Pre-1939 units	67.7%	63.0%
% 5 plus units	51.5%	42.8%
Housing density *	6,883	5,137
Residential Population density *	15,210	12,219

NOTE: * : per square mile

B. Fire Protection Resource Comparison

Comparison Parameter	Cambridge	Boston
Total Personnel	267	1771
Uniformed Personel	263	1614
Personnel on duty	46	300
Number of Stations	9	34
Engine companies	9	33
Ladder companies	4	21
Rescue companies	1	2

C. Fire Protection Resource Comparison

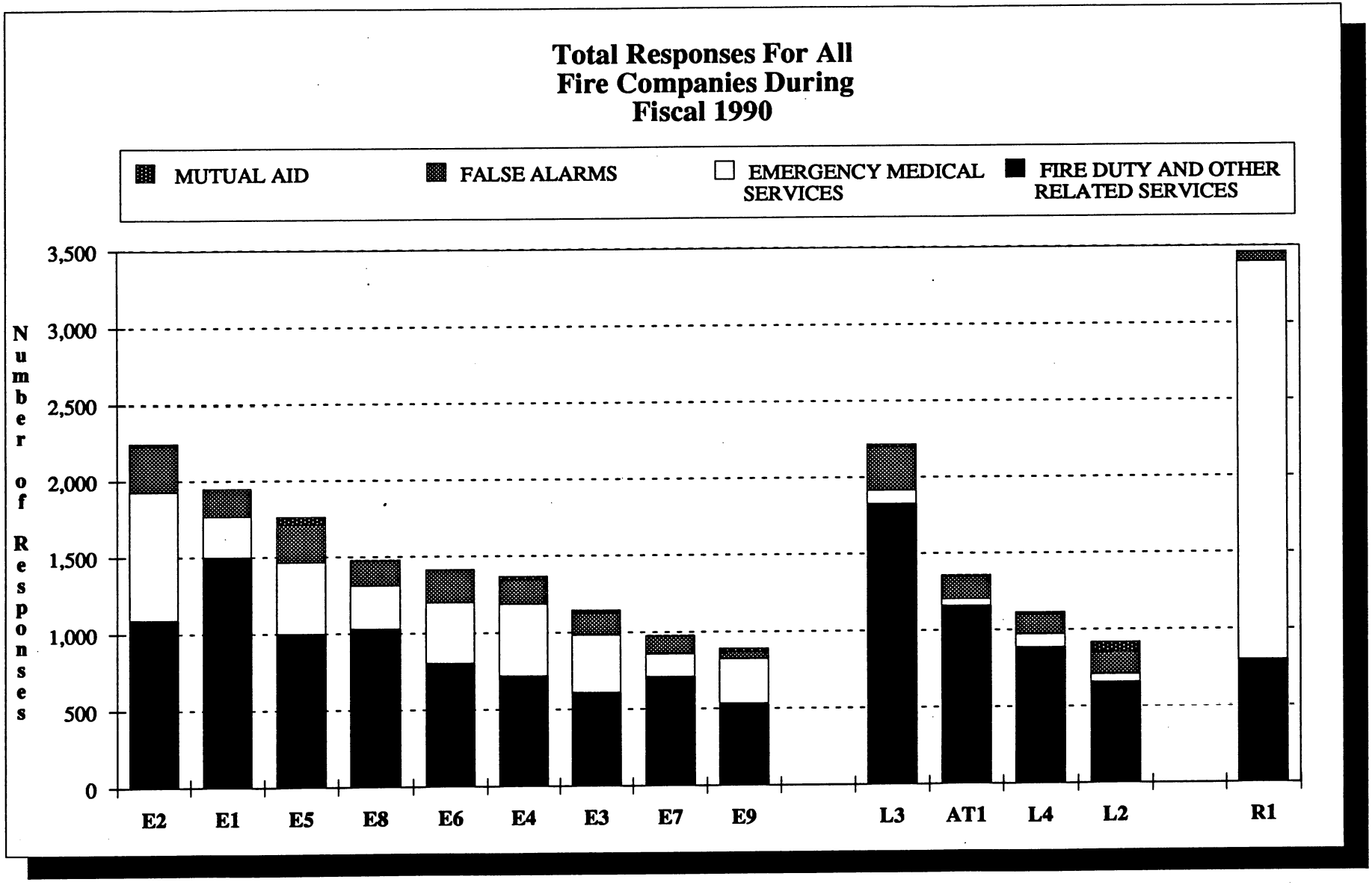
Comparison Parameter	Cambridge	Boston
On duty strength / 1,000	0.48	0.52
Engines and ladders / 1,000	0.140	0.090
Engines and ladders / sq. mile	2.200	1.150
Engines / 1,000	0.094	0.057
Ladders / 1,000	0.042	0.037
Engines / sq. mile	1.500	0.700
Ladders / sq. mile	0.670	0.450
On duty strength per 1000 at 50 FF	0.52	0.52
Engines and ladders per 1,000 at 11 E&L	0.115	0.090
Engines and ladders per sq. mi. at 11 E&L	1.830	1.150
Engines and ladders per 1,000 at 10 E&L	0.104	0.090
Engines and ladders per sq. mi. at 10 E&L	1.666	1.150

Exhibit 4 presents comparative statistics for the Cities of Boston and Cambridge. It can be seen that:

- approximately the same proportion of the housing stock in each city was built prior to 1939;
- approximately the same proportion of the residential structures in each city contain five dwelling units or more;
- Cambridge has housing and population densities that are somewhat higher than Boston, albeit there are sectors of Boston which are as densely built and populated as Cambridge;
- the on duty strength per capita is somewhat higher in Boston than in Cambridge (0.52 firefighters in Boston verses 0.48 in Cambridge);
- there are far fewer engines and ladders deployed both per square mile and per capita in Boston than in Cambridge;
- the on duty strength in Cambridge would have to be increased from approximately 46 firefighters to 50 firefighters to bring the per capita on duty staffing into line with that of Boston; and
- even if the number of engines and ladders in Cambridge were decreased from 13 to 10, there would still be more apparatus deployed both per capita and per square mile in Cambridge than in Boston.

The following general inferences can be made from these comparisons:

- the Cambridge Bureau of Fire has a significantly higher number of stations and apparatus per square mile than the other cities in the sample;
- the total strength and the on-duty strength per square mile and per capita is not out of line with the other cities in the sample;
- the CFD deploys far more apparatus both per square mile and per capita than does Boston, yet the on duty strength per capita is somewhat higher in Boston; and
- there is room for improvement in on-duty suppression strength per unit of response in the City of Cambridge.


Total Responses For All Fire Companies During Fiscal 1990
MUTUAL AID
FALSE ALARMS
EMERGENCY MEDICAL SERVICES
FIRE DUTY AND OTHER RELATED SERVICES
Number of Responses
3,500
3,000
2,500
2,000
1,500
1,000
500
0
E2
E1
E5
E8
E6
E4
E3
E7
E9
L3
AT1
L4
L2
R1

2.4 THE DEMAND FOR SERVICE

The following activities were carried out in order to develop an understanding of the demand for fire suppression services in the City of Cambridge:

- interviewed senior management;
- interviewed the on-duty station captains in all stations;
- analyzed the calls for service that occurred during 1990 by type and by response area;
- analyzed the 40,200 calls for service that occurred during the four year period 1988 to 1991 with respect to simultaneity of demand;
- plotted and analyzed the distribution of code 11 structure fires and code 30 calls for service that occurred during the four year period 1988 to 1991;
- travelled the primary routes of advance between selected stations and measured the distances;
- visited all nine stations in the Cambridge Fire Department; and
- reviewed the existing agreement between the City of Cambridge and the International Association of Fire Fighters.

Exhibit 5 sets forth the classification of the total responses for each and every company during 1990. There were 22,303 company responses to calls for service. This equates to approximately 61 responses per 24 hour period or 30 responses per shift. The percentage breakdown of these responses is as follows:

- alarms of fire comprised 60%;
- emergency medical responses 29%;
- mutual aid responses 1%; and
- false alarms another 10%.

During the four year period 1998 through 1991, there were approximately 45,265 calls for service. Of these, 919, or 2.0% were code 11 structure fires and 17,574, or 38.9% were emergency medical response calls.

These distributions by type of response and call for service are atypical of most large American cities, such as Cambridge, in which the number of EMS or first responder calls for service is usually twice that of all other calls for service.

Exhibit 6

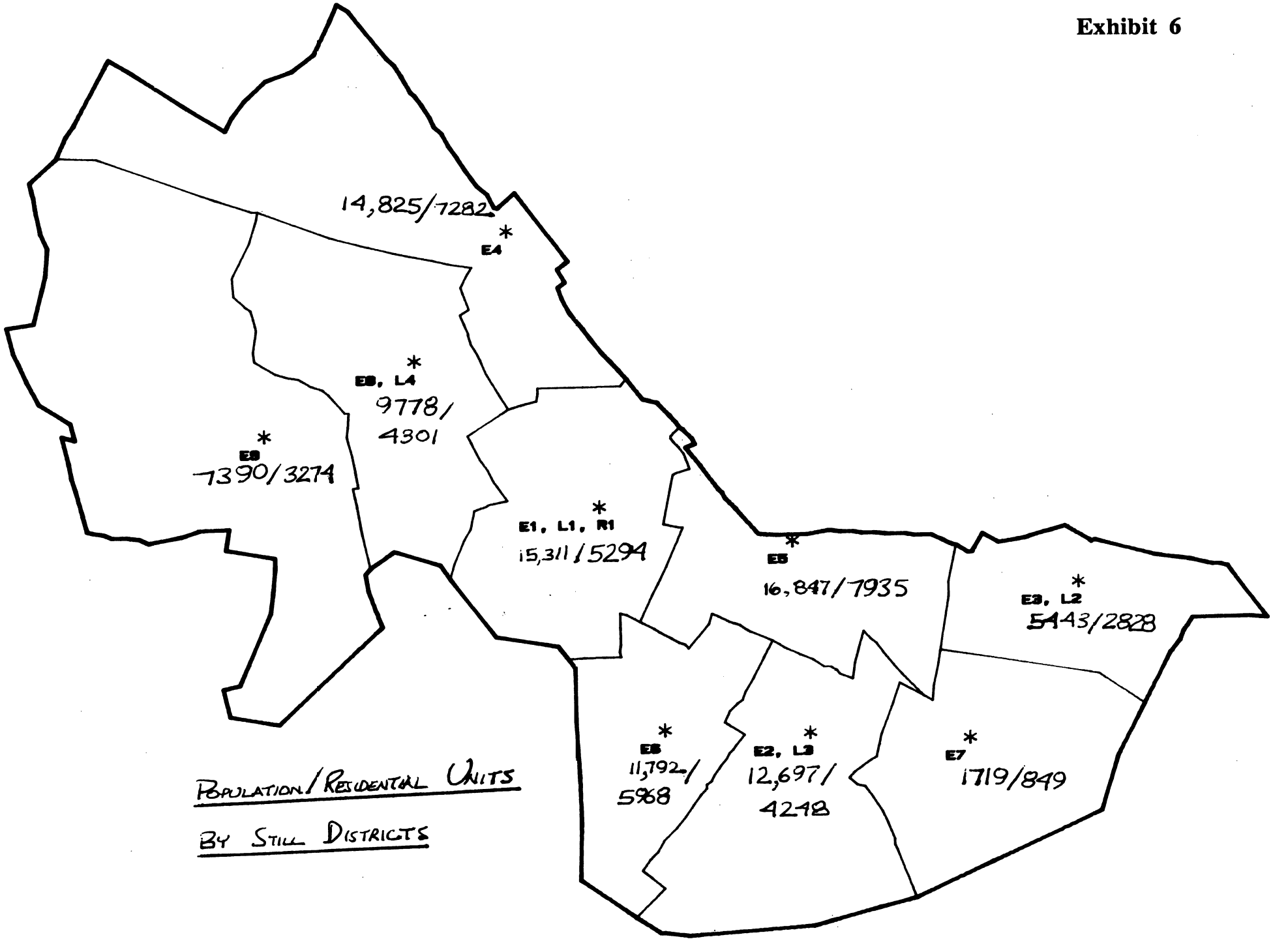

14,825/7282
E4
E8, L4
9778/
4301
E8
7390/3274
E1, L1, R1
15,311/5294
E5
16,847/7935
E3, L2
5443/2828
E6
11,792/
5968
E2, L3
12,697/
4248
E7
1719/849
POPULATION/RESIDENTIAL UNITS
BY STILL DISTRICTS

Exhibit 5 also indicates that there are large variances in the number of responses from one company to another. For example, Engines 1 and 2 each responded to more than twice the number of calls than did either Engine 7 or Engine 9. Each of the latter responded to fewer than 1000 calls during 1990, or fewer than 2.8 calls per day. On average, this equated to fewer than 1.5 responses per shift for each of these engines.

Finally, Exhibit 5 depicts how active the Rescue unit is relative to the other companies. At present, for all medical emergencies not considered life threatening, the CFD dispatches the nearest engine company. The Rescue Company is only dispatched to those EMS situations normally considered to be potentially life threatening and has responsibility for city - wide response. In addition, the Rescue Company responds to all structure fires and calls for service where hazardous materials are known to be involved. The Rescue unit responded to almost 3500 calls for service during 1990, or to approximately 9.5 calls for service per day. On average this equated to about five calls for service per shift. At this level of activity there is a significant probability that this company could be busy on a call for service when another call occurs.

If recent trends in other municipalities are realized in the City of Cambridge, the Cambridge Fire Department will experience an increase in emergency medical response calls over the next five years while at the same time the number of fire related responses will remain stable or diminish slightly. The projected declining population base and aging population will accentuate this disparity in the types of calls for service received. It is conceivable that the frequency of medical calls for service could double in a five year period.

For fire protection services purposes, the City is partitioned into nine still districts, or demand zones, as illustrated in Exhibit 6. Each demand zone is named after the engine deployed within the demand zone. (There is a one-to-one correspondence between engines and demand zones.) The exhibit also depicts the number of dwelling units and inhabitants in each demand zone.

Selected Demographic Statistics By Fire Demand Zone (Still District)

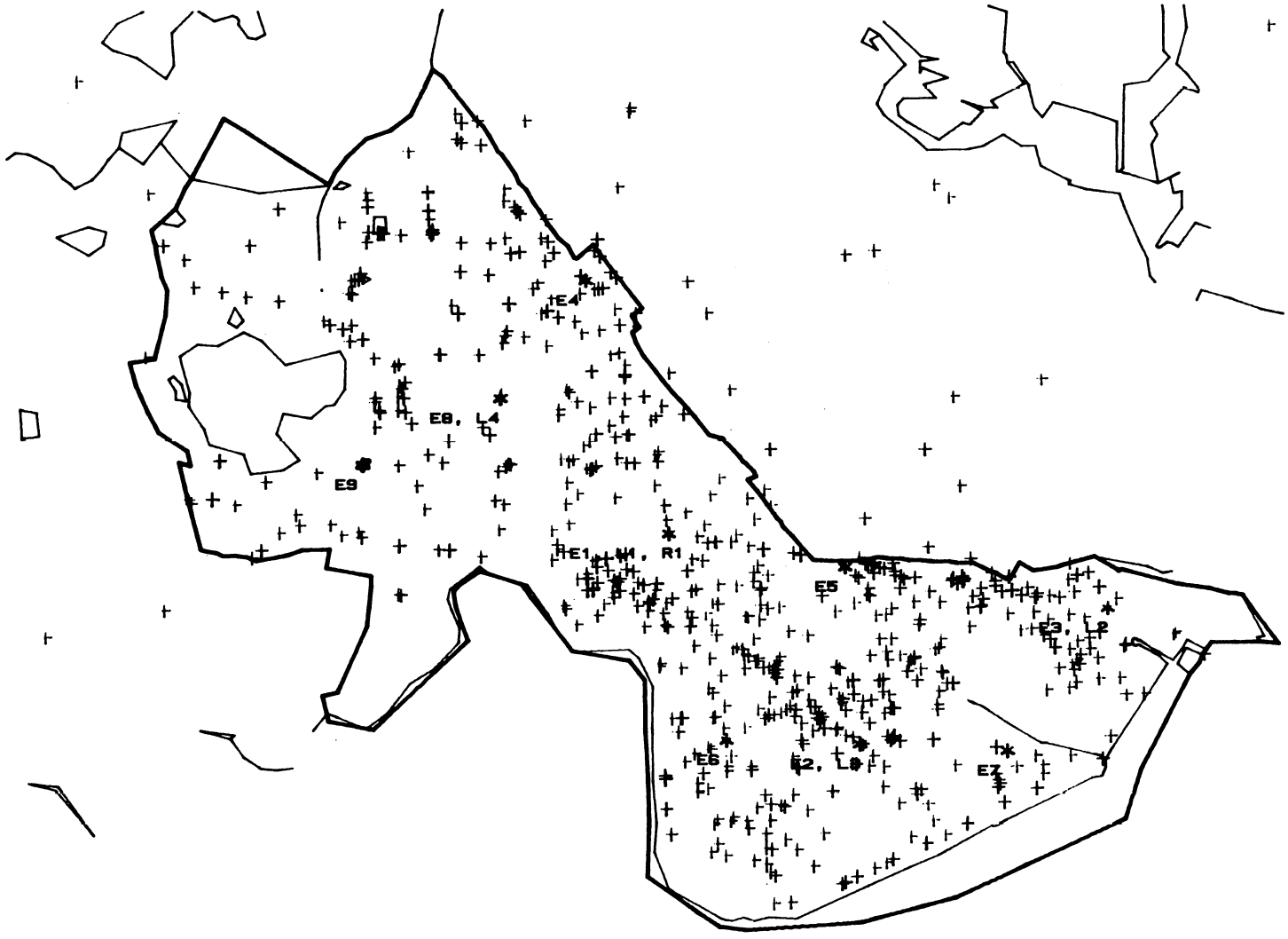
Ranked by Population per Demand Zone

Demand Zone (Still)	Est Area *(Sq. Mi)*	1990 Pop'n	No. of Dwellings	Pop'n per Sq. Mile	Dwellings per Sq. Mile	Cambridge Pop'n Within 2.0 Min	Cambridge Pop'n Within 2.5 Min	Difference between 2.0 and 2.5	Code 11 by Demand Zone	Code 11 Within 2.0 Min	Code 11 Within 2.5 Min	Difference between 2.0 and 2.5
1	0.70	15,311	5,294	21,873	7,563	18,936	27,235	8,299	126	151	208	57
2	0.76	12,697	4,248	16,707	5,589	15,229	25,057	9,828	138	186	242	56
3	0.49	5,443	2,828	11,108	5,771	6,680	9,923	3,243	66	83	121	38
4	1.07	14,825	7,282	13,855	6,806	7,081	11,245	4,164	120	66	93	27
5	0.56	16,847	7,935	30,084	14,170	16,513	24,771	8,258	124	149	245	96
6	0.52	11,792	5,968	22,677	11,477	16,723	22,694	5,971	86	142	197	55
7	0.64	1,719	849	2,686	1,327	7,551	13,815	6,264	41	108	170	62
8	0.80	9,778	4,301	12,223	5,376	13,737	19,695	5,958	56	75	121	46
9	1.57	7,390	3,274	4,707	2,085	6,023	9,686	3,663	54	40	77	37
	7.11	95,802	41,979	13,474	5,904	108,473	164,121	55,648	811	1,000	1,474	474

Note: Population is defined as the number of people residing in Cambridge as determined by the 1990 Census.

Source: Bureau of the Census and the City of Cambridge

Exhibit 8



0 0.51 miles

843 CODE 11 INCIDENTS

PLOTTED

This represents 91.5% of the 921 Code 11 Calls responded to during the period 1988-1991.

816 of the 921 Code 11 Calls occurred within the Cambridge City Boundary. Of the 816 Calls 811 were successfully loaded by the GIS.

INCIDENTS

Code 11 INCIDENTs

AREA/FEATURE

CITY

There were 10,050 calls for service, on average, per year during the four year period. Exhibit 7 sets forth selected demographic data and code 11 structure fire statistics for each of the City's nine fire demand zones. The demand zones are sequenced by population. Based on a sample of 40,200 calls for service during the four year period 1988 to 1991, the following observations are noteworthy:

- There were 921 code 11 structure fires (for which complete records were provided) to which the CFD responded during the four period. This equates to an average of 230 structure fires per annum, or about two structure fires every three days.

- 816 of the 921 code 11 structure fires , or 89%, of these occurred within the boundaries of the City of Cambridge. This amounts to about 174 structure fires per annum in Cambridge, or about one structure fire every second day.

- Demand Zones 1,2,4, 5 and 6 are the most populated and the most densely populated demand zones. Approximately 74.6% of the population resides in these five demand zones and 73.2% of the code 11 structure fires that occurred during the four year period occurred in these five demand zones. This indicates that, as expected, the number of structure fires in a demand zone varies directly as the population and as the population density.

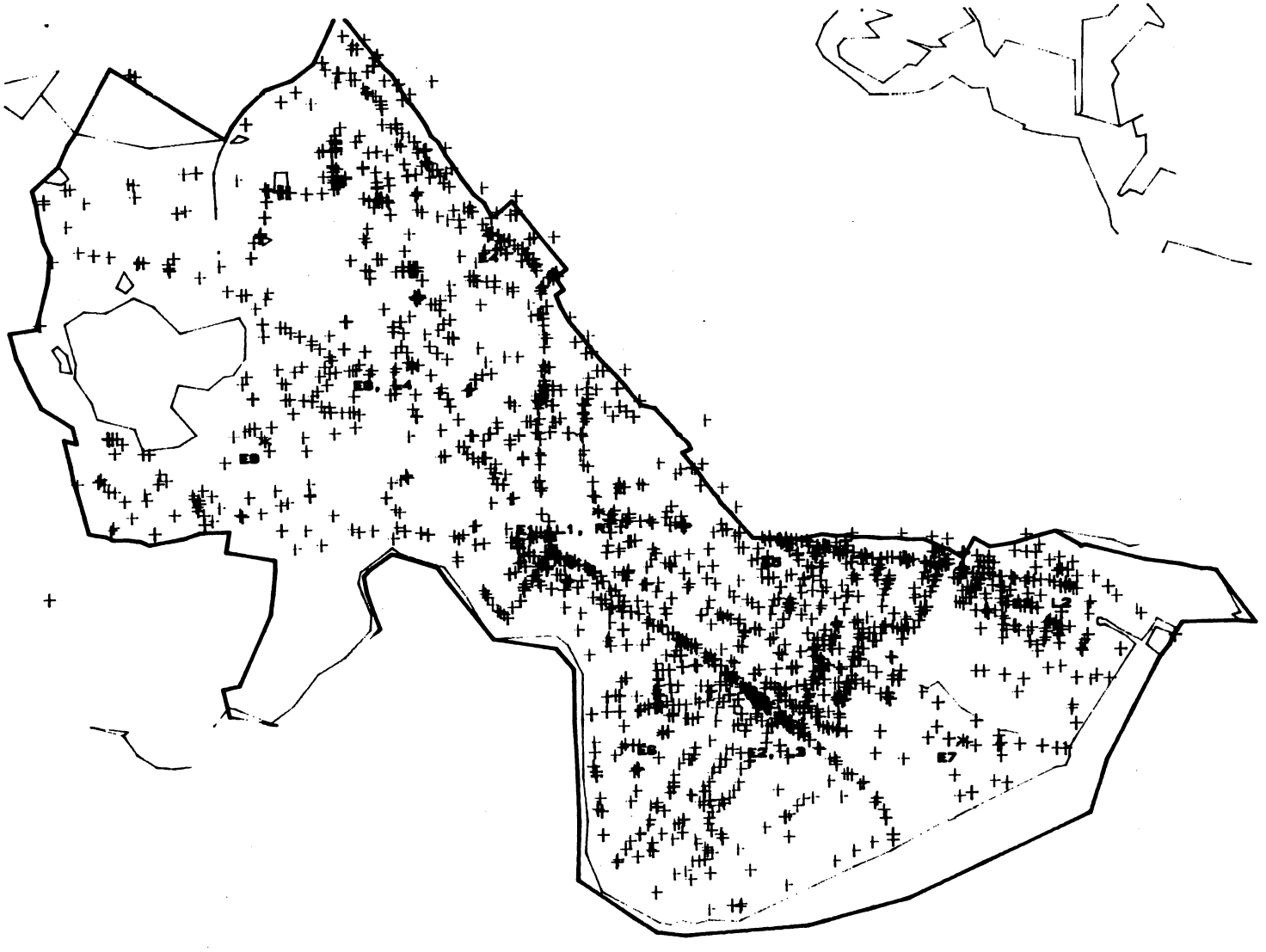
- Given the current deployment, with the exception of Station 4, an engine responding at an average speed of 15 miles per hour can, within two minutes travel time after dispatch, reach a population approximately equal to or greater than the population that resides within its demand zone or still district.

- Given the current deployment, with the exception of Station 4, an engine responding at an average speed of 15 miles per hour can, within 2.5 minutes travel time after dispatch, reach a population significantly greater than the population that resides within its demand zone or still district.

- Four hundred and seventy four (474), or 47%, more structure fires occurred at sites that were within a 2.5 minute travel time of a station than occurred within a 2.0 minute travel time. This clearly indicates the importance of reducing the time between the recognition of a fire by a citizen and the dispatch of the appropriate apparatus.

Exhibit 8 is a geographic information system (GIS) plot of 843 of the 921 code 11 structural fires to which the CFD responded during the four year period 1988 to 1991. Of these 843, there were 816 code 11 structure fires which occurred within the City of Cambridge and GIS address matches were found for 811 of these. The exhibit vividly depicts the concentrations of structure fire occurrences, especially in certain segments of demand zones 1,2,3,5 and 6.

Exhibit 9



3201 CODE 32 INCIDENTS PLOTTED

This represents 88% of the 3624 Code 32 Calls responded to by the department during 1991.

CODE32 CALLS

| ALL CODE32 CALLSs

AREA/FEATURE

CITY

* STATIONS

0 0.46 miles

These observations reflect the experience expected in the more densely developed sections of the city where older structures with multiple dwelling occupancies and perhaps non-resident ownership are more prevalent.

In summary, the areas where the demand for service occur have a combination of factors: the absolute number of residential housing units, the densely built, older, wood frame structures and the relative age and condition of the housing stock. The west third of the City is less densely built and is more recently built. These are some of the factors that create the pattern of structural fires shown in Exhibit 8.

Exhibit 9 is a GIS plot of 3201 of the 3624 code 32 emergency medical response calls for service to which the CFD responded during the four year period 1988 to 1991. Again, the exhibit vividly depicts the concentrations of code 32 occurrences, especially along major traffic arterials. This is due in part to the number of responses that are traffic accident related. It should also be noted that , while there again appears to be a higher number of calls for service in demand zones 1,2,3 and 5, there are a significant number of code 32 calls for service in all areas of the City.

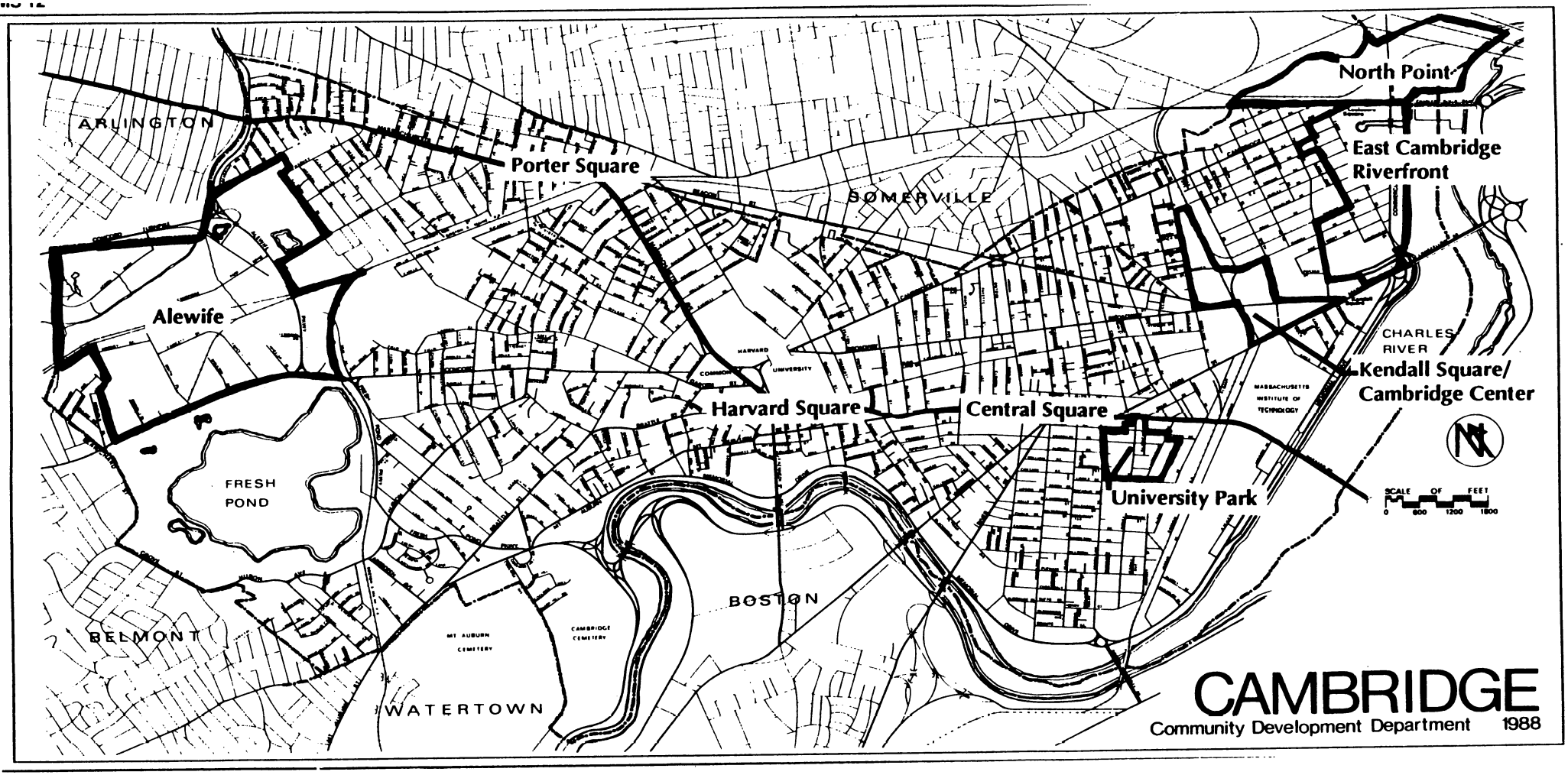
2.5 SELECTED DEMOGRAPHIC AND PLANNING INFORMATION

The following persons provided the information necessary to identify planning and demographic issues affecting the deployment and response of fire protection resources in the City of Cambridge:

- The City Manager;
- Assistant City Manager for Community Development;
- Planning Data Manager;
- Director and Deputy Director, Traffic and Planning; and
- Fire Department Management.

The following are the salient points pertaining to the population and housing stock as they relate to the deployment of fire protection resources over a ten year planning horizon:

- The City of Cambridge experienced a net decrease in population of about 5% over the past two decades. This downward trend is expected to continue, albeit at a slower rate, during the 1990's. The Metropolitan Area Planning Commission is projecting the


North Point
ARLINGTON
Porter Square
SOMERVILLE
East Cambridge
Riverfront
Alewife
CHARLES
RIVER
Kendall Square/
Cambridge Center
Harvard Square
Central Square
FRESH
POND
University Park
BOSTON
BELMONT
WATERTOWN
CAMBRIDGE
Community Development Department 1988

population to decrease from 95,802 in 1990 to 93,972 in 2000, a 1.91% decrease over ten years;

- During the 1980's, the number of residential dwelling units in the entire city increased less than 2%, from 41,300 to 41,979. The Community Development Department anticipates a modest increase in the housing stock during the 1990's.
- 3295, or 7.8%, of residential dwelling units are single detached.
- 15,433 or 37% of residential dwelling units are situated in structures comprising 10 or more family dwelling units; and
- At present, little new development is occurring, vacancy rates are high and the City's priority is to retain existing business. Until the economy recovers, only limited commercial or residential construction is expected.

Management in the Community Development Department described the manner in which the City is partitioned into residential neighbourhoods, provided an overview of the current situation and plans for each area and some planning documents. This information was reviewed and our understanding of the City's plans, together with proposed planning assumptions for the purposes of deploying fire protection resources over a ten year horizon, was presented to the Steering Committee on May 12, 1992. Exhibit 10 depicts the five areas discussed with the Steering Committee and the estimates of the timing for the development of these areas.

The following paragraphs describe briefly, for each of these five areas, the proposed development, the type of occupancies proposed, and the Steering Committee's consensus regarding the timing of the proposed developments over the next ten year period.

1. East Cambridge Riverfront

This area began to be redeveloped during the 1980's during which approximately $630 million was invested. The area is considered to be about 90% developed. Past developments included 3.0 million square feet of office space, the Lechmere Canal Park, the Cambridge Side Galleria (retail mall), a 400 room hotel and some 700 condominium units. It is expected that office, retail and housing developments will continue during the 1990's. This would include an 80-unit residential structure already approved.

2. Kendall Square Urban Renewal Project

The Kendall Square/Cambridge Center developments were first planned in the early 1980's with the intent of transforming a 42 acre dilapidated manufacturing area into a major commercial focal point for the city. In the last ten years, approximately 10 acres have been redeveloped as part of the Cambridge Center Development. Construction to date has occurred primarily in a triangle bounded by Broadway, Main Street and Fulkerson Street. Thus far, 11 buildings have been constructed including a 431 room hotel. The Cambridge Center project, when completed, calls for 2.7 million square feet of new development in 20 buildings. The development is primarily office, retail, and R&D. The western part of the development not yet completed, however, would also include an unspecified amount of residential development. Over the next decade, the Cambridge Redevelopment Authority projects an additional 1.2 million square feet of development for Cambridge Center.

3. University Park

The University Park urban renewal project was planned during the mid 1980's. As shown in Exhibit 10, it encompasses a 27 acre site bounded by Massachusetts Avenue, Pacific Street, Brookline Street and Purrington Street in the city's Cambridge Port Industrial District. The Community Development Department has stated that when the economy improves, University Park will be one of the first areas to be developed.

The project is comprehensively planned and permitted to encompass 1,900,000 square feet of research and development, office, light industrial, and retail space. An additional 400,000 square feet is designated for residential use. Thus far, 150 apartment units have been leased and 350,000 square feet of industrial space has been rehabilitated for research and development. Future development plans call for a 300 room hotel, 100,000 square feet of retail space and, possibly, a 125,000 square foot office/R&D building.

4. Alewife

Alewife is the largest potential development area in Cambridge. As shown in Exhibit 10, it is bounded approximately by Concord Avenue, Alewife Parkway, Concord Turnpike, and the western boundary. The Community Development Department is currently working on a master plan for the area. The area historically has been industrial. During the 1970's and 1980's, the character of the area began to change. The MBTA red line Alewife station was built, along with a large commuter garage. This caused some commercial development. During the 1980's 1 million square feet of commercial and industrial space was permitted. Of this total, 150,000 square feet comprised the Alewife Center retail development located east of the Alewife Parkway and north of Rindge Avenue. Outside of these developments, future development of Alewife is likely not to begin within the next five to ten years.

5. Northpoint

As shown in Exhibit 10, the Northpoint area is a 70 acre site in the extreme eastern section of Cambridge and is currently railway yards. A plan exists to develop this area as a mixed use district. The development of this area, however, is dependent on the construction of a new MBTA station and the building of the central artery. For these reasons and the poor economy, it will likely be ten years or more before Northpoint goes ahead.

Summary

The above areas development mix will determine the future population density in these areas, and, as a result, the future demand for fire protection services. Fire protection can be provided to new developments in the East Cambridge Riverfront, Kendall Square/Cambridge

Center, and University Park areas by the existing deployment of fire protection resources or by any of the deployment alternatives discussed later in this report.

A significant portion of the Alewife area is outside the one pump four minute response time of the existing station configuration. The two trucks - three engine, eight minute response coverage is better and includes the Alewife Center, but a significant area of Alewife along the city boundary between the Concord Turnpike and Concord Avenue is outside the existing eight minute coverage. The solution to providing better coverage to Alewife should be examined in three stages. First, if a CAD system is implemented, then the dispatch time should improve by at least 30 seconds. If this occurs, fire suppression apparatus would be able to travel further into the Alewife area within the four minute response time, significantly improving coverage. Second, the current road network into and inside Alewife is not well developed. This road network is expected to undergo significant improvements as the area develops. For this reason, analyzing the current response capability may not accurately reflect the improved response as a result of network improvements. Finally, even with dispatch time and the road network improvements, fire suppression apparatus may not be able to respond to all of Alewife within the agreed upon response capability objectives. If this is the case, the City may need to consider deploying additional apparatus in existing stations to improve the eight minute response by the initial response team into this area. The annual cost of deploying one four firefighter apparatus around the clock 365 days a year in Cambridge is approximately $1,100,000.

In summary, the decision of whether to build, relocate, or continue with the existing deployment will depend on the CAD system and the planned road network into and inside the Alewife area. It would be inappropriate to speculate about the need for such a station at this time.

The Northpoint area is located to the north and east of East Cambridge. If the Northpoint area is developed, Engine 3 at Cambridge and Second Streets would be ideally located to respond to this area within four minutes. It is the only station in the existing deployment that could provide a one pump, four minute coverage to the area. Engine 5 is well within an eight minute response. With improvements in dispatch times, eight minute coverages could be provided by both engines and aerials responding from Stations 1 and 2. However this area is not expected to be developed within the ten year planning horizon.

Fire Study

TAB 3

3.0 RECOMMENDED RESPONSE CAPABILITY OBJECTIVES

The goals and service level objectives for a fire department should be set by the City Council to which a department reports. The service level objectives for the suppression force should be developed by the City Council after consultation with the Chief of the Fire Department and other knowledgeable sources, and translated into measurable response capability objectives.

There are two important components to the response capability objectives:

- the amount of time that elapses between the receipt of the alarm and the arrival of the initial response complement; and
- the capabilities provided by the manpower and equipment that comprise the initial response complement.

When establishing the response capability objectives, it is important to take into account the nature of the fire risks that need to be addressed, the level of service desired and the costs of various levels of service.

Ernst & Young carried out a review of hazards and target risks. The Ernst & Young team:

- discussed target risks existing in the response area with station captains during the station captain interviews; and
- toured the City, usually accompanied by the CFD Management.

The interviews, station visits, and tours of the City confirm that target risks which present significant life safety risk, economic risk or challenging fire suppression risks are spread across almost every response area in the City of Cambridge. The nature of the target hazards may vary from one response area to another, but there is at least one target risk such as a hospital, nursing home, school, hazardous materials location, warehouse with a high fire load, railway marshalling yard, or high-rise structure in almost every response area.

Within the City of Cambridge, the vast majority of occupancies are wood frame or non-fireproof residential dwelling units that do not have automatic detection or suppression systems. In most municipalities, and Cambridge is no exception, almost all fire related fatalities and injuries occur in residential structures that do not have automatic detection and suppression systems. Therefore it is important to develop response capability objectives which will result in a ***distribution*** of stations that will address residential risk but not to the detriment of the other risks in the community.

A separated area of 5,000 square feet is generally recognized as the maximum area within which a fire can be controlled and extinguished by an initial alarm assignment by manual means without the assistance of automatic suppression systems. The response capability objectives for the City of Cambridge should be tailored to address manual extinguishment of a structural fire in an occupancy of up to 5,000 square feet in area because the City is predominantly comprised of non-fireproof residential occupancies and is not likely to change significantly. Accordingly, it is recommended that the Department adopt the following response capability objectives:

1. The initial apparatus shall arrive at the scene of the alarm within four minutes of receipt of the alarm in at least 90% of all occurrences;

   AND/OR

   The full initial response complement shall arrive at the scene of the alarm within eight minutes of receipt of the alarm in at least 90% of all occurrences;

   AND

2. The initial response complement shall be comprised of the manpower and equipment necessary to control and extinguish a structural fire in an occupancy of up to 5,000 square feet, and, at the same time, rescue and remove any endangered occupants from the structure;

   AND

3. These response time objectives shall meet the four minute recommendations of the American Heart Association for response to medical emergencies in at least 90% of all occurrences.

These recommended objectives were agreed upon by the Steering Committee at the meeting on March 10, 1992, were confirmed at the Steering Committee meeting on May 12, 1992 and were used as the basis for assessing the existing deployment and developing the recommended deployment.

It would be a financial and physical impracticality for any municipality to expect either the initial apparatus to arrive within four minutes or the entire initial response complement to arrive within eight minutes 100% of the time. However, to do so 90% of the time is both achievable and practical. Nevertheless, it should be recognized that there will still be some areas of the City of Cambridge at or beyond the response capability objectives given the influence of such variable factors as weather, driving conditions, transportation barriers, distance or competing demands for service.

It is the responsibility of the CFD to identify those areas of the City within which the response capability objectives are not being achieved, on an ongoing basis, and to implement strategies to deal with these situations.

The response capability objectives are meant to apply not only to residential occupancies but also to the commercial, industrial and institutional occupancies in Cambridge. The demand presented by these occupancies need not affect the ***distribution*** of stations, because the target risks are distributed across most of the urban areas of the City and alarms in these occupancies can be addressed by dispatching a pre-determined, larger initial response complement that is tailored to the nature of the occupancy. Computer aided dispatch information systems and the development of pre-plans are important in this respect. The installation of automatic detection and suppression systems is more generally available in commercial, industrial and institutional occupancies. The increased risk in these occupancies is addressed by heavier reliance on pre-engineered systems and by dispatching a significantly larger response complement.

In developing our recommendations we addressed a range of considerations for developing an equitable distribution of fire department resources to the residential, commercial, industrial and institutional occupancies within the City.

Some of these considerations included:

- travel time to selected locations
- road and traffic conditions
- the many at-grade railway crossings
- traffic density at varying times of day
- weather restrictions at different times of year
- building density and construction
- life safety hazards
- business and economic risks
- height and area of building construction
- combustibility of exposures
- available water supply
- limitations of building occupants
- insurance risks and costs
- conflagration potential
- topography of area
- availability of land with respect to possible station locations
- type and size of apparatus required
- population density served
- land area served
- frequency and severity of fire history; and
- costs to the city budget.

Fire Study

TAB 4

4.0 BACKGROUND INFORMATION ON APPARATUS CAPABILITIES AND COMPANY DUTIES

This section is organized as follows in order to provide the background required to understand the rationale underlying the findings and recommendations regarding initial response capability and the deployment of suppression resources:

- a discussion of the duties of pumper, aerial and rescue companies; and
- a discussion of the relationships between companies.

4.1 FIRE COMPANY DUTIES AT THE FIREGROUND (ENGINE - LADDER - RESCUE UNITS)

Fire suppression forces in any city are comprised of two basic units:

- pumper companies; and
- aerial companies.

Pumper company personnel focus on the actual extinguishment of the blaze, while aerial company personnel are assigned the roles of rescue, removal of occupants and execution of specific functions necessary to timely extinguishment.

To accomplish their principal assignment, engine or pumper company personnel must advance in close proximity to the fire to apply hose streams on the fire using a variety of nozzles, connections and different diameter hose lines that must be placed and operated manually. A 1-3/4 inch hose line is the standard interior line used, and can weigh hundreds of pounds when charged with water and has a nozzle stream reaction exceeding 100 psi. A minimum of three (3) firefighters often is required to place, extend and operate such a hose stream, while a fourth firefighter remains at the pumper to operate the pump and control pressure, etc.

The other basic unit of fire suppression is the aerial (ladder) or truck company. Firefighters assigned to ladder companies respond with a vehicle equipped with ladders and other tools. Unlike the engine company personnel concerned with extinguishment, their primary mission is to search for, remove and rescue endangered occupants; force entry to the building; position ladders as required; provide access to the fire building for advancing hose lines; provide routes of egress

from the building; ventilate to permit escape of heat and gases and execute a range of other tasks necessary for the prompt control and extinguishment of the fire. These personnel employ a variety of tools - axes, portable ladders, power saws - and work in close co-ordination with the engine company under the overall command of a Deputy Chief.

4.2 RELATIONSHIPS BETWEEN COMPANIES

Heavy duty rescue companies can play a vital role in fire ground operations, enhancing the capability of the pumper and truck company operations to control and extinguish fires. Often, the effectiveness of the rescue company determines the overall efficiency of the entire operation.

The objective of a team responding on a rescue vehicle is to provide rapid response, flexibility and versatility at the fire scene while ensuring that traditional truck or engine company tasks are executed. It is essential that a rescue vehicle be properly staffed at a minimum of four firefighters per vehicle. Generally, the rescue company will split into 2 two-man teams. One team is assigned the fire floor and the floor above the fire. The other team takes the rear of the building and the roof. Without two-man teams, an individual firefighter would have to work alone which is both ineffective and unsafe. Often, the rescue unit will also be assigned the task of relieving a pump company in advancing a hose line since these men can arrive properly outfitted with protective breathing apparatus and equipment.

Given the appropriate equipment, the firefighters responding on a rescue apparatus can carry out all the aerial company tasks or function as an engine company.

The CFD Rescue Company is equipped for light and heavy duty rescue operations , victim extrication from vehicular accidents and for performing emergency medical services including transportation. While response of this company to fires is valuable, its principal role for the City of Cambridge remains as an emergency response unit and, we understand that this is the fundamental reason for the establishment of this company.

Fire Study

TAB 5

5.0 DEPLOYMENT ANALYSIS

5.1 OUR APPROACH

Our approach for assessing existing fire risks and fire suppression operations is commonly known throughout North America as deployment, or risk, analysis.

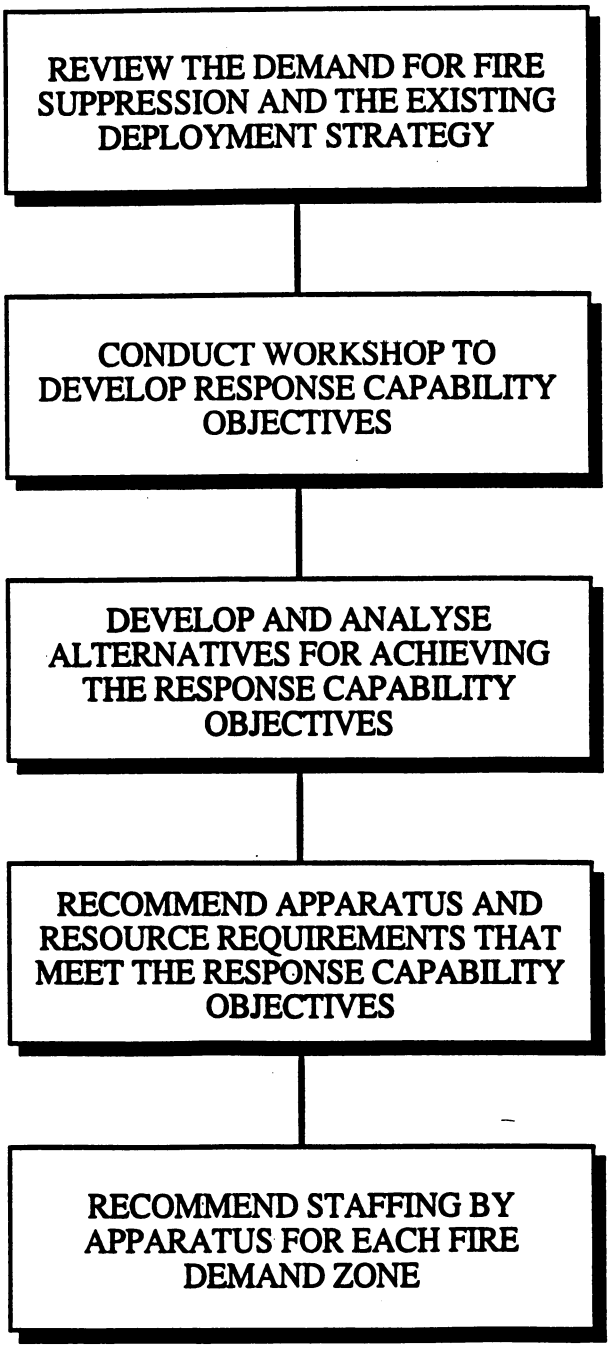
The concept of the Deployment Analysis Process is depicted in Exhibit 11 and comprises five major steps:

- review the demand for fire protection services within the City of Cambridge (the frequency and type of calls for service and the fire risks) and the existing deployment strategy;
- conduct a workshop to present our understanding of the demand and the rationale underlying the existing deployment strategy, and to develop agreed-upon response capability objectives;
- develop and analyze alternatives for achieving the response capability objectives;
- recommend a deployment that meets, but does not exceed, the response capability objectives; and
- recommend staffing levels by apparatus for each fire response area in the City of Cambridge.

Section 2.4 provided a summary of the demand for fire protection services in the City of Cambridge. The recommended response capability objectives, which were agreed upon by the Steering Committee on March 10, 1992, were discussed and set forth in Section 3.0. The purposes of Section 5 are to assess the existing deployment and to present the process through which deployment alternatives were developed that meet, but do not exceed, the agreed-upon response capability objectives.

Briefly, the generation of deployment alternatives and the development of the recommended deployment of suppression resources comprised the following activities. The Ernst & Young team:

THE DEPLOYMENT ANALYSIS PROCESS



- visited all nine stations;
- interviewed the station captains at all stations;
- studied the demand statistics by type and frequency of occurrence and location;
- used a geographic information system (GIS), together with the 1991 U.S.Census Bureau TIGER file for the City of Cambridge, to assist with the generation and analysis of deployment alternatives;
- analyzed the deployment alternatives by touring selected response areas, visiting selected stations and measuring distances along likely routes of advance between selected stations;
- refined the deployment alternatives;
- presented the draft deployment alternatives to the Steering Committee on May 12, 1992 to demonstrate our approach, to discuss the outputs from the GIS and to obtain feedback; and
- further refined the alternatives and finalized the recommended deployment strategy.

It is important to think of the deployment of fire suppression resources as a system comprising a variety of types of apparatus, that each type of apparatus plays an important role, and that there are a number of ways to configure the system to provide a response to a call for service at a particular location. In addition, the various types of apparatus required in a response will emanate from two or three locations. For these reasons, when considering deployment alternatives for an area within the City, one must consider all of the possible locations from which an appropriate mix of apparatus could effectively respond simultaneously. Ultimately, each and every apparatus deployed throughout Cambridge, regardless of its type and location, is interrelated. This is why a systemic approach and an interactive geographic information decision support tool are so well suited to assisting in the development of the recommended deployment alternative.

Accordingly, Section 5 is organized as follows:

- Developing the Geographic Decision Support System Application
- Establishing Assumptions to be Used Throughout the Analysis
- Assessing the Existing Deployment and Coverage
- Developing and Describing the Recommended Deployment Strategy.

5.2 DEVELOPING THE GEOGRAPHIC INFORMATION DECISION SUPPORT SYSTEM APPLICATION

5.2.1 Introduction

Geographic information software uses computer readable map data bases to model street networks, station and apparatus locations by type of apparatus, and locations of calls for service.

The following activities were carried out to establish the GIS model of the existing deployment strategy and to generate deployment alternatives:

- obtained a computer readable map data base of the City of Cambridge from the U.S. Census Bureau;
- carried out selected updates on the data base to make it sufficiently accurate to assist with the generation and analysis of deployment alternatives;
- plotted all existing fire response areas and apparatus locations;
- plotted the locations of 4,545 calls for service that occurred between January 1, 1988 and December 31, 1991 for which complete records were provided; and
- developed assumptions for using the GIS to assist with the generation of alternatives.

5.2.2 Establishing the Computer Readable Map Data Base

A computer readable map data base defines the complete street network, address ranges, rivers, bridges, railway tracks, and other physical features which one would normally find on a detailed municipal map. During the 1980's, the U.S. Census Bureau, in cooperation with the U.S. Geological Survey (USGS), developed a major new computer-readable map data base. The primary sources of the data base were the USGS 1:100,000-scale maps, the U.S. Census Bureau's 1980 GBF/DIME Files. The accuracy of the USGS 1:100,000-scale maps meet national map accuracy standards and use coordinates defined by the North American Datum, 1927 (see reference McKenzie and LaMacchia, 1987). These geographic/cartographic files are excellent as a base for a geographic information system (GIS). The U.S. Census Bureau's TIGER System automates the mapping and related geographic activities required to support the census and sample survey programs of the Census Bureau, starting with the 1990 Decennial Census.

Selected Distances Between GIS Files, and Odometer Readings

From Station/Address	To Station/Address	Odometer Miles	GIS File Miles
Concord Ave/Fresh Pond Pkwy	Concord Ave./Huron Ave	0.6	0.60
Concord Ave/Blanchard Rd	Concord Ave/Alewife Brook Pkwy	0.9	0.82
Huron Ave/Lexington Ave	Blanchard Rd/Concord Ave	1.9	1.67
Massachusetts Ave/Ringe Ave	Alewife Brook Pkwy/Massachusetts Ave	0.8	0.84
E8, L4	Garden St/Concord Ave	0.5	0.48
Garden St/Concord Ave	Headquarters	0.7	0.72
Headquarters	E5, (Inman Square)	0.8	0.76
E5, (Inman Square)	Cardinal Medeiros Ave/Cambridge St	0.7	0.64
E3, L2	First St/Commercial Ave	0.7	0.59
Putnam Ave/Waverly St	Putnam Ave/River St	0.7	0.62

NOTE:
1. The measurement error of the odometer is ±0.2 miles.

There are two measures of accuracy for a GIS file:

- spatial, or positional, accuracy; and
- relative accuracy.

Spatial accuracy refers to whether the GIS file positions the area (the City of Cambridge) covered by the file correctly, relative to the other jurisdictions in the area. This type of accuracy is not important for the kinds of analysis that were carried out in the study. Relative accuracy refers to whether one point in the City of Cambridge (e.g. an intersection) is positioned accurately, relative to another point (e.g. another intersection), within a certain radius, say three miles. Relative accuracy is important to the analysis.

It was reasonable to expect that, given a modest amount of updating in carefully selected areas, the relative accuracy of the TIGER file would be sufficient to develop and analyze deployment alternatives. The relative accuracy of the TIGER file can be discussed with regard to precision and up-to-dateness. The output level of precision is influenced by a number of factors, such as the quality of the source base map and the processes involved in creating and/or updating the TIGER. In general, the TIGER precision average is + or - 33 feet from ground value. Ernst & Young carried out the following preliminary work on a copy of the U.S. Census Bureau's Cambridge 1986 census TIGER file to ensure that the **relative** accuracy was sufficient to use the file for fire protection services deployment analysis:

- compared point to point distances provided by the TIGER file to those on hard copy maps provided by the City of Cambridge. It was found that when there were differences, the differences were so small that they were less than the measurement error in the device used to measure distances on the hard copy map (see Exhibit 12);

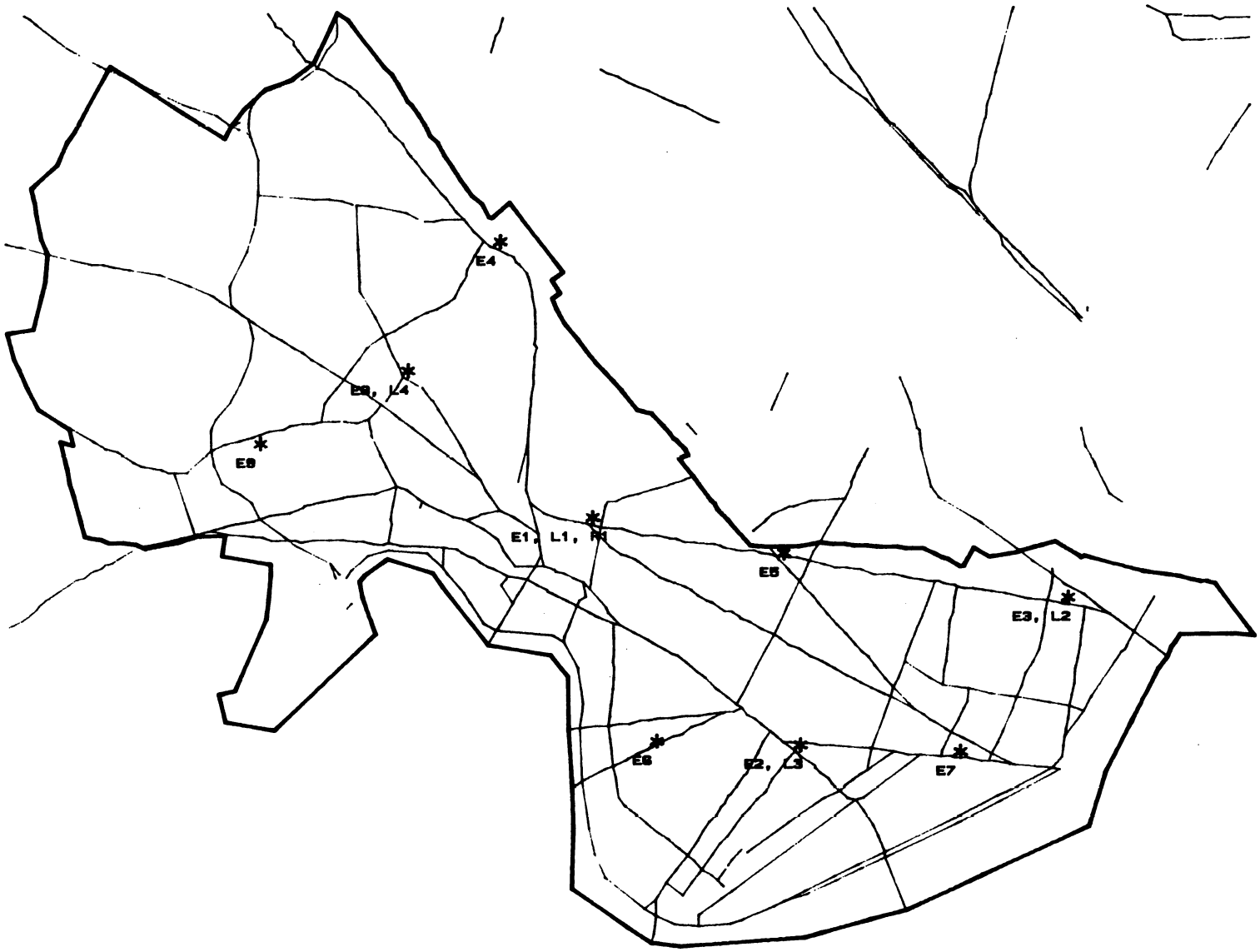
- measured distances in selected areas of the City using an odometer and compared these distances to those on the TIGER file. Again any differences were within 10% of the distance travelled (see Exhibit 12);

- removed any nodes in the TIGER file that the GIS would read as intersections (e.g. crossings which are not level, such as in a clover leaf);

- updated streets and intersections in selected areas of the City; and

Exhibit 13

City of Cambridge



Arterial Roadways assigned a speed of 20 miles/hour.

Source:
City of Cambridge
Department of Traffic

AREA/FEATURE
— CITY
* STATIONS

0 0.46 miles

- vetted the address match against the TIGER file on more than 88% of the 4545 code 11 code and 32 calls for service to which the CFD responded during the four year period 1988 to 1991.

Appendix B sets forth the digitized street network of the City of Cambridge after selected updates were carried out on the TIGER file.

5.3 ASSUMPTIONS USED THROUGHOUT THE ANALYSIS

The GIS software will generate the coverage areas which can be provided by an apparatus within a specified time interval given the following information:

- the location of the apparatus;
- the average speed with which the apparatus will respond on normal streets;
- the average speed with which the apparatus will respond on the designated throughways; and
- any road network characteristics which restrict or impede the travel of fire suppression apparatus.

Apparatus were restricted from advancing across the railway bridges because of weight restrictions at the following locations:

- Alewife Brook Parkway at the bridge over the B&M Railway; and
- Walden Street at the bridge over the B&M Railway.

Apparatus were assigned the following average speeds throughout the analysis:

- 20 mph on major roadways as defined during discussions with the Deputy Director, Traffic and Planning and the Steering Committee. These major roadways are shown in Exhibit 13; and
- 15 mph on all other city streets.

While these may be conservative assumptions in some areas of the City, they are a reasonable average.

Response time to fires and emergencies is the sum of three elements:

- the "dispatch time", which is defined as the time between the receipt of the call at the call taker's console at the Communications Center, and the notification of the apparatus designated to respond. The dispatch time was assumed to be 45 seconds which may be less than the actual dispatch time at present. Once the recommendations regarding the

Exhibit 14

Response Times with Correspondence Travel Times and Distances Assuming the Introduction of Computer Aided Dispatch

Response Time	**4 Minutes**	**8 Minutes**
Less Dispatch Time	45 Seconds	45 Seconds
Subtotal	3.25 Minutes	7.25 Minutes
Less Reaction Time	45 Seconds	45 Seconds
Equals Travel Time	2.5 Minutes	6.5 Minutes
Pump or Aerial Response at 15 mph	0.625 Miles	1.625 Miles

communications function are implemented an actual dispatch time of 45 seconds or less should be realized;

- the "reaction time", which is defined to be the time elapsed between receiving notification of the call for service at the station to the time that the apparatus leaves the apron. The "reaction" time was assumed to be 45 seconds; and
- the "travel time" which was assumed to be the time required to travel from the station to the scene of the alarm at the average speeds discussed above.

An additional element is the time from arrival at the scene to initiation and control of the fire or situation. This is a function of time, equipment and personnel that is addressed elsewhere in the analyses.

Given these assumptions, Exhibit 14 presents the travel time component and the corresponding distances that can be travelled within four and eight minute response times for an apparatus travelling at 15 mph or 20 mph on a direct route of response.

5.4 THE EXISTING DEPLOYMENT

5.4.1 Introduction

The assessment of the existing deployment and the development of alternative deployment strategies were based on the response capability objectives and initial response complements provided by the Steering Committee on March 10, 1992. These are:

1. The initial apparatus shall arrive at the scene of the alarm within four minutes of receipt of the alarm in at least 90% of all occurrences;

   AND/OR

   The full initial response complement shall arrive at the scene of the alarm within eight minutes of receipt of the alarm in at least 90% of all occurrences;

   AND

2. The initial response complement shall be comprised of the manpower and equipment necessary to control and extinguish a structural fire in an occupancy of up to 5,000 square feet, and, at the same time, rescue and remove any endangered occupants from the structure;

   AND

3. These response time objectives shall meet the four minute recommendations of the American Heart Association for response to medical emergencies in at least 90% of all occurrences.

Ernst & Young estimated the response capability of the Cambridge Fire Department as at May 12, 1992 by:

- assessing the capability of the initial response complement that is dispatched to a structural fire as required by the Department's response procedures;
- plotting and reviewing 4545 of the calls for service to which the CFD responded during the period January 1, 1988 to December 31, 1991;
- analyzing the dispatch times and response times for a sample of 42 calls received early in 1992;
- analyzing the response times for 200 of the calls for service received during the period April 12 through April 19, 1992; and
- using the GIS software to assess the four minute one pump and eight minute initial response complement coverages achievable given the existing deployment.

5.4.2 The Capability of the Initial Response Complement

For each type of alarm, there is a standard number of apparatus and personnel which respond. The identity of the companies required to respond to a specific alarm depends on the location and the type of alarm. These detailed orders are documented in the Department's response procedures, on maps which are properly distributed to all stations, and on a manual cardex system at the Communications Centre.

The following apparatus and manpower comprise the Cambridge Fire Department's general initial response complement to most structural alarms:

Apparatus	Personnel
3 Pumps	9
2 Aerial Devices	6
1 Rescue	3
1 Deputy Chief's Car	2
	20

Exhibit 15

CAMBRIDGE FIRE DEPARTMENT

DEPLOYMENT OF SUPPRESSION PERSONNEL WHEN 46 FIREFIGHTERS REPORT FOR DUTY

	ENGINE	LADDER	RESCUE	CHIEF'S CAR	TOTAL
Station 1	3	3	3		9
Station 2	3	3			6
Station 3	3	3			6
Station 4	3				3
Station 5	3			2	5
Station 6	3				3
Station 7	3				3
Station 8	3	3		2	8
Station 9	3				3
	27	12	3	4	46

Usually these personnel and apparatus respond from the station in the response area in which the alarm occurred or other stations generally located in nearby response areas (with the exception of the rescue company which has city-wide a response area). The on duty strength in the CFD is 46 or more firefighters. When there are 46 firefighters on duty, then they are usually deployed as set forth in Exhibit 15.

The 20 firefighter complement listed above is an appropriate initial response complement to dispatch to a Code 11 structural alarm in a residential occupancy or separated area under 5000 square feet. It provides:

- sufficient personnel to rescue and remove endangered occupants in the critical early minutes of a fire;
- the capability to establish up to three (3) interior attack lines and two (2) master streams which would provide a water flow in excess of 1,500 U.S. gallons per minute; and
- the fire ground commander with the flexibility necessary to complete other tasks required to effectively control and extinguish the fire.

Water is the universal fire extinguishing agent and water delivery at the fire scene is also an acceptable measure of fire suppression effectiveness. It is of particular value when measuring the effectiveness of the initial alarm assignment at a structural fire.

The amount of water required to manually control and extinguish a structural fire is easily derived from well documented engineering studies and the code requirements for sprinkler protection.

If automatic sprinkler protection is employed to protect a structure of low hazard, the code requires a water discharge coverage of one tenth (.1) U.S. gallon per minute (gpm) per square foot or 10 gpm per 100 square feet.

Manual application of water by hose streams is less efficient and requires about 3 times that water flow or 30 U.S. gpm per 100 square feet of involved fire area based on an average combustible fire loading of 3 pounds per cubic foot. This approximates the situation in the average

residence, while large wood frame dwellings or multi-family residences require a greater water delivery and a longer time for delivery.

The fire area capable of extinguishment by the CFD's present initial alarm response to most structural alarms is:

- 1500 gpm/30 gpm per 100 square feet = 5,000 square feet.

More complex occupancies or commercial properties entail a greater degree of risk and a greater capacity for water delivery.

There is a relationship between crew or company size and the ability of that company to accomplish the critical and simultaneous tasks necessary of an initial alarm assignment on arrival at a structural fire in a residence. Fire fighters arriving on the initial alarm for a typical residence structure in Cambridge should be capable of positioning two interior attack lines within sixty seconds of arrival, each flowing at least 100 gallons per minute, followed by a 2 1/2 inch back-up line positioned within 180 seconds of arrival capable of flowing 200 gallons per minute. The three pump assignment on the initial alarm for the Cambridge Fire Department can accomplish these tasks if staffed by four fire fighters per unit.

At the same time, aerial companies assigned on the initial alarm should have a crew size capable of forcing entry; providing initial roof and horizontal ventilation; positioning area of portable ladders; rescuing or removing any endangered occupants and performing the varied ladder company tasks needed for effective fire control at both the front and the rear of the residence structure. The two ladder assignment policy of the CFD to the initial alarm response can accomplish these tasks if staffed by four fire fighters per unit.

Each of these basic roles require company sizes of not less than four fire fighters per apparatus. Today, firefighters employ modern tools and tactics. Thirty or more years ago it was common to have six or even seven fire fighters assigned to a company. These numbers have been reduced over the years with the introduction of modern equipment such as aerial platform,

CAMBRIDGE FIRE DEPARTMENT FIREFIGHTER INJURIES BY TYPE AND ACTIVITY WHEN SUSTAINED FOR PERIOD JANUARY 1 TO DECEMBER 31, 1991

TYPE OF INJURTY	STRUCTURAL FIRE SUPPRESSION	NON STRUCTURE FIRE SUPPRESSION	EMERGENCY MEDICAL	RESPONDING RETURNING FROM ALARM	LOCATION UNKNOWN/ OTHER	TOTAL ALL INJURIES
Fractures	1					1
Lacerations and Contusions	4			1	3	8
Sprains and Strains	45	15		15		75
Eye	3	1				4
HazMat Exposure (Non Inhalation)	4					4
Inhalation of Hazardous Material	69					69
Cardiac Abnormalities	2					2
Heat	3	1				4
Other Injury	2		9		1	12
Total	133	17	9	16	4	179

ERNST & YOUNG

CAMBRIDGE FIRE DEPARTMENT
FIREFIGHTER INJURY SEVERITY
AND SHIFT LOST

TYPE OF INJURY	NUMBER OF LOST WORK & LIGHT DUTY SHIFTS
Fractures	36
Sprains and Strains	658
Inhalation of Hazardous Material (Including Smoke)	10
Cardiac Abnormalities	675
Heat	2
Other Injury	401
Total Shifts	1,782
Total Hours	21,384

improved hose, approved breathing apparatus, and more effective quality and power tools. Nevertheless even with these advantages, a minimum of four fire fighters per unit is needed to avoid unsafe practices on the fire ground which also reduce the effectiveness of the operation.

Dispatching 3 pumpers, 2 ladders, 1 rescue, one Deputy Chief and a Chief's aide to an initial alarm of fire in a structure provides 20 personnel at the scene as required by CFD policy. However, usually each company is staffed with only three on-duty firefighters and, notwithstanding the three firefighter staffing, the CFD continues to use the "pump and wagon" concept. Consequently, too much equipment is sent with too few personnel per apparatus to realize maximum effectiveness. The pump and wagon concept tends to worsen the disparity and effectiveness between three and four firefighter companies, since often a single firefighter is alone on a piece of apparatus. This accounts in part for the number of multiple alarms relative to the number of structural fires and may contribute to the number of on-duty injuries in the CFD.

Exhibit 16 presents the injuries sustained by members of the CFD during 1991 by type and by activity while sustained. It can be seen that 133, or 74.3%,of the 179 injuries sustained during 1991 were sustained during suppression activities. In addition, 45 of the 133 injuries were sprains, and 69 injuries were categorized as inhalation of hazardous material (including smoke inhalation).

Exhibit 17 sets forth the number of shifts lost due to injuries by type of injury during 1991. Shifts lost due to injury by type of injury are widely accepted as an indicator of the severity of injuries sustained. During 1991, CFD firefighters lost 1782 shifts due to injuries. It should be noted that 675 of these shifts were due to cardiac abnormalities. Since one cardiac abnormality can result in a prolonged period of convalescence, these 675 shifts lost may have been due to only a few occurrences. However 658 shifts were lost due to sprains and strains, and it could be argued that this is due in part to the three firefighter on-duty staffing on most apparatus.

CAMBRIDGE FIRE DEPARTMENT INJURY FREQUENCY AND SEVERITY AS COMPARED TO NATIONAL AVERAGES

Severity:

21384 Hours / 287 personnel = 7450 hours lost per 100 firefighters

7450 hours per 100 CFD FF / 5605 hours per 100 FF National Ave = 1.33

or 33% higher than National Average

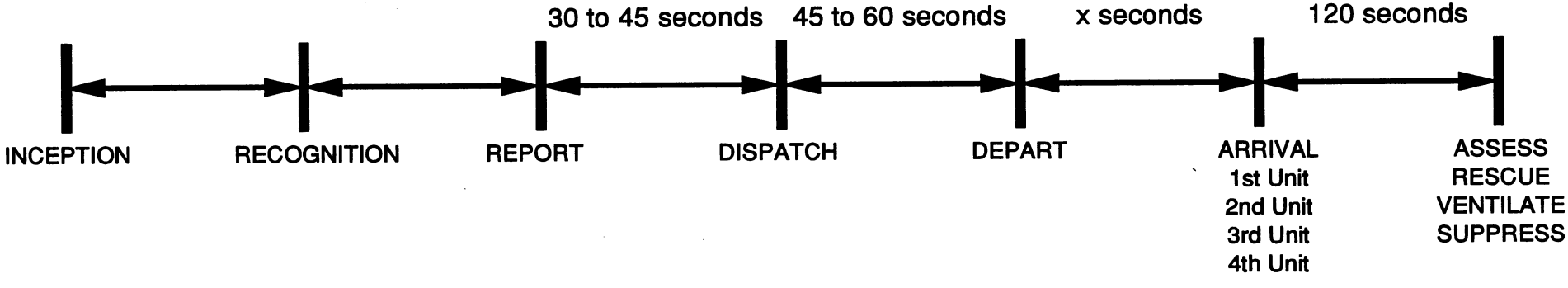
Frequency:

179 CFD Firefighter injuries / 287 personnel = 62.3 per 100 FF

62.3 CFD injuries per 100 FF / 35.3 injuries per 100 FF National Ave = 1.76

or 76% higher frequency than National Average

Cambridge Fire Department
Time Profile From Inception to the Execution of Fire Ground Operations



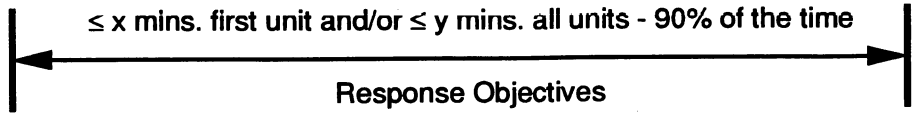


Exhibit 19

Exhibit 18 compares the CFD's injury frequency and severity to national averages using the statistics set forth in Exhibits 16 and 17. The CFD's injury severity, as measured by hours lost per 100 firefighters, is 33% higher than the national average. The CFD's injury frequency, as measured by the number of injuries sustained per 100 firefighters, is 76% higher than the national average. These injury statistics indicate that the CFD should consider staffing all apparatus with at least four firefighters at all times - even if this means removing some apparatus from service.

Staffing levels per unit of response which are lower than necessary to accomplish critical and simultaneous tasks within the limited time frame dictated by a rapidly developing fire can be counter productive. This is reflected in the lost shifts due to line of duty injuries, which are higher for the CFD than for comparable departments.

Less than adequate staffing per unit of response results in:

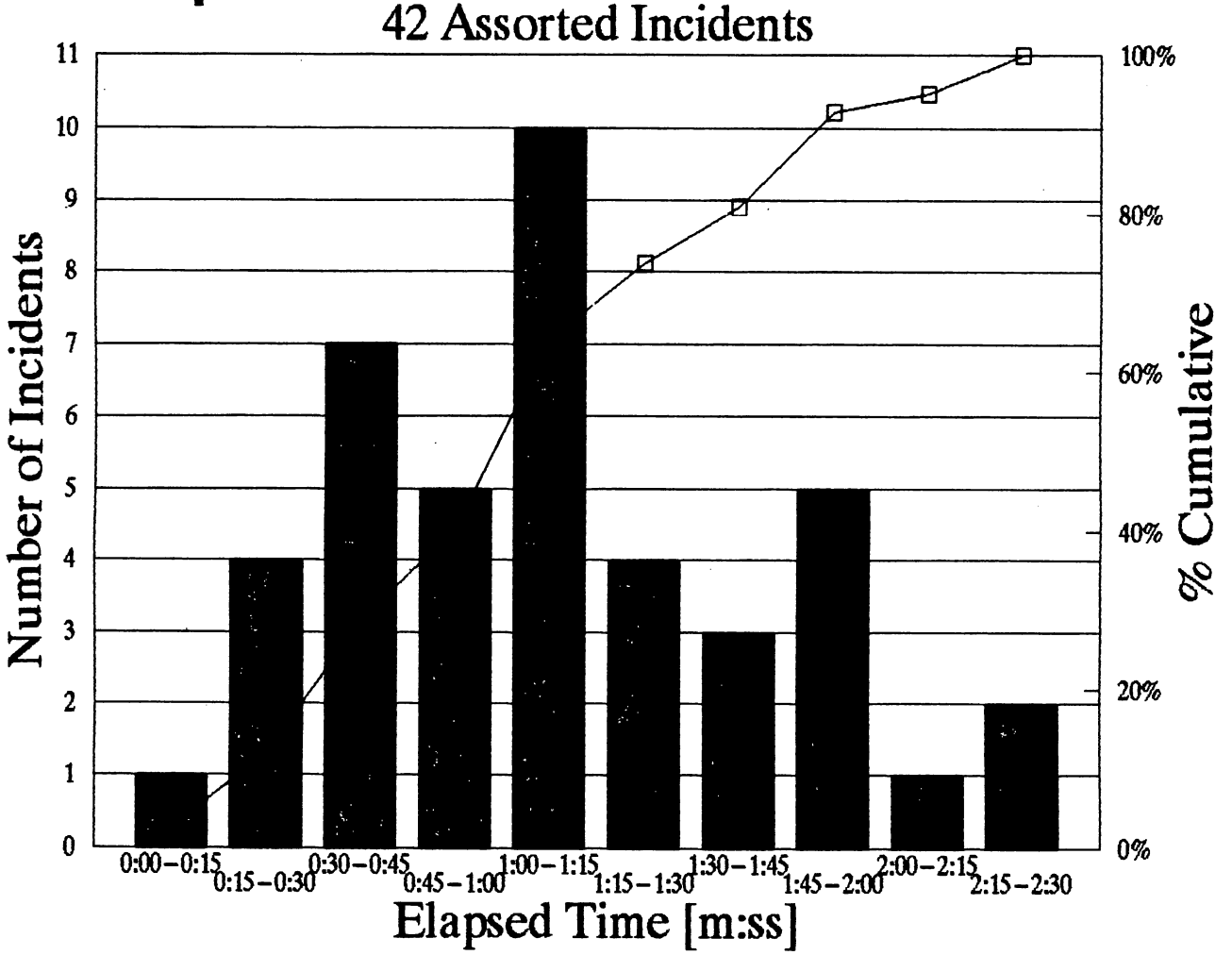
- delays in the performance of critical tasks;
- reduced ability to perform simultaneous tasks;
- increased risk to firefighters when aggressive procedures are undertaken without the support and command structure necessary to safety;
- loss of critical functions; and
- a cumulative effect created by combined delays and lost functions on the part of each crew.

5.4.3 A Time Profile for a Typical Structural Working Fire

The sequence of events leading from the inception of a fire to its extinguishment is shown in Exhibit 19. Each of the time intervals on this chart can be influenced by systems or infrastructure with the goal of reducing the actual response time and meeting the overall response capability objectives:

- the period from inception to recognition can be shortened through the use of early warning systems employing smoke detectors, heat detectors and sprinkler systems;

Dispatch Time Distribution



Average = 00:01:09
90% = ~ 00:02:00

Elapsed Dispatch Time	Frequency	Cumulative	Percent Cumulative
0:00–0:15	1	1	2.38%
0:15–0:30	4	5	11.90%
0:30–0:45	7	12	28.57%
0:45–1:00	5	17	40.48%
1:00–1:15	10	27	64.29%
1:15–1:30	4	31	73.81%
1:30–1:45	3	34	80.95%
1:45–2:00	5	39	92.86%
2:00–2:15	1	40	95.24%
2:15–2:30	2	42	100.00%

Total = 42 Incidents

- the period from recognition to reporting can be shortened by use of the 911 system or other early-warning systems;
- the period from reporting to dispatch can be influenced by the skill level of the dispatchers, the degree of computer aided support, the availability of sufficient radio frequencies and efficient radio dispatch procedures;
- the period from dispatch to departure from the station can be influenced by improved station design and departure protocols;
- the period from station departure to arrival at the fire ground is a function of the number of stations, the type of apparatus deployed and their placement; and
- the length of time to control and extinguish the fire is a function of the number and type of apparatus that respond, the staffing at the scene, the training of the personnel, the operating tactics and the equipment available.

The length of the time profile is also dependent upon other factors including building construction, height, area, occupancy, density, time of day, street conditions, water supply and weather. Each of these factors, individually and collectively, has an impact on the effectiveness of the fire department operation. Of these variables, three are critical and controllable: time, equipment and personnel.

5.4.4 Response Time Realized

Response time is defined as the period of time from the second that the dispatcher recognizes that a call or electronic signal is an alarm, to the second that a responding apparatus arrives at the scene of the alarm.

Ernst & Young analyzed the dispatch times and the response times for a sample of 42 calls received early in 1992. The distribution of these dispatch times is set forth in Exhibit 20. Based on this sample it is estimated that the average dispatch time from receipt of the call for service at the Electric Department's Alarm Center to the notification of companies is 69 seconds. This is approximately 25 seconds slower than the dispatch time in cities that have a fully implemented computer aided dispatch. The 90th percentile of the dispatch times is estimated at 117 seconds. This does not include the time that elapses between the instant that a citizen calls the 911 Center at

the Police Department and the time that the request for service is passed to the Alarm Center at the Electric Department. The dispatch time at the Electric Department's Alarm Center could be reduced significantly by replacing the time consuming, albeit well organized, manual cardex system with a computer aided dispatch system. Unlike most improvements in the deployment of fire suppression and emergency medical response resources, whereby only a segment of the population realizes an immediate benefit, the reduction in dispatch time resulting from a computer aided dispatch would be of significant and equal benefit to all the citizens of Cambridge.

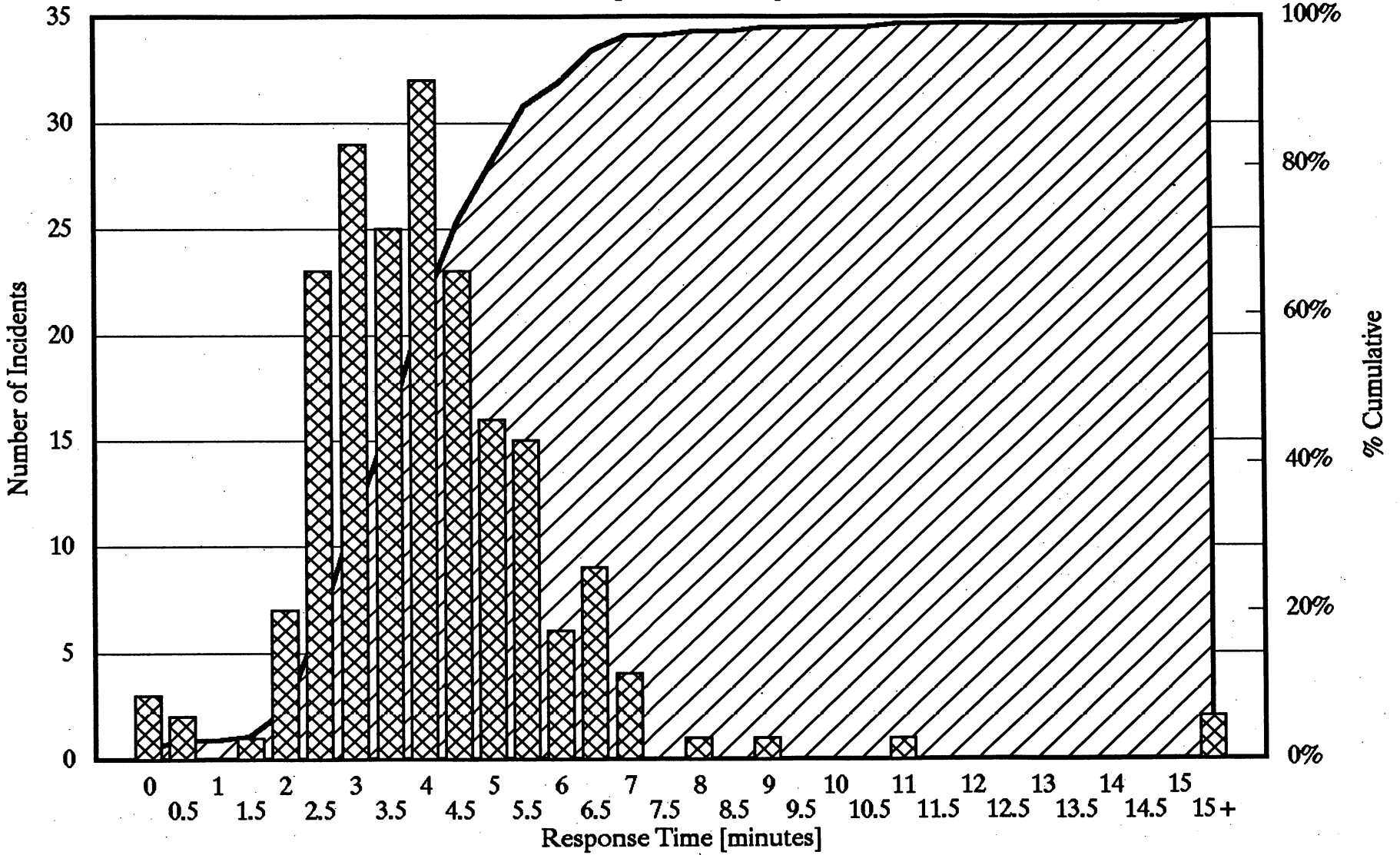
It should be noted that, without a computer aided dispatch system or excellent time reporting systems, it is very difficult for a municipality to accurately determine the existing dispatch and reaction time, and therefore the actual travel time. The average dispatch time in the small sample provided by the CFD was 69 seconds and the 90th percentile was 117 seconds. (The larger sample provided did not disclose dispatch times.) Assuming a 30 to 45 second reaction time, it could reasonably be assumed that a combined dispatch and reaction time of two minutes or less is realized 65 to 75 percent of the time; not 90% of the time as targeted in the response capability objectives. However this would be achievable more than 90% of the time with computer aided dispatch.

It is recommended that the City of Cambridge replace the existing cardex system with computer aided dispatch as soon as practicable. It is estimated that the reduction in dispatch time that would result will range between 20 and 40 seconds. A somewhat large reduction in the 90th percentile should be realized because a CAD reduces the variance in the time required to dispatch apparatus and makes it easier to dispatch multiple apparatus.

In addition, the time spent passing information, or a caller requesting service, from the 911 Center at the Police Department to the Electric Department Communications Center should be eliminated by establishing one, and only one, Communications Center to service all emergency response organizations in the City. Persons staffing the fire protection consoles at such a

First–in Response Time Distribution

200 Incidents During the Period April 12 –19, 1992



Mean Resopnse Time = 3:50, 90% of Calls in 5:45.
Response Time = Timeoff – Timein

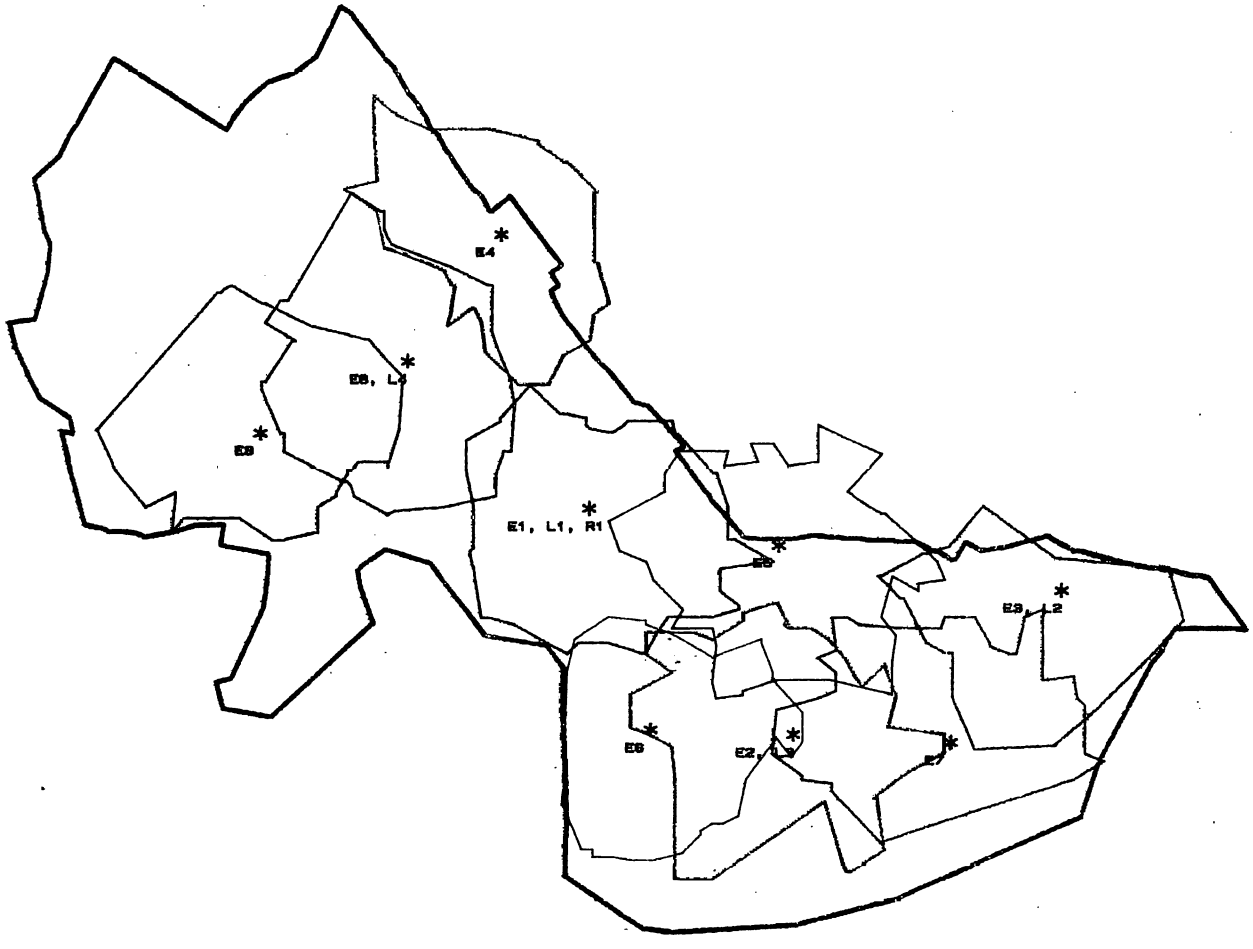
consolidated Communications Center must be proficient in the dispatch of fire protection apparatus and be familiar with fire ground command procedures and communications protocols at the fire ground. However, there is little need for a separate Communications Center to serve the CFD; in fact, the existence of a second facility may lengthen the dispatch time.

If the CFD dispatch function is integrated into a single 911 communications center, a CFD supervisory presence will be required to ensure effective communications since fire department communications and dispatch procedures differ significantly from police or ambulance dispatch and communications.

The average response time for the 39 calls for service in the first sample that were within the City of Cambridge was 4 minutes 21 seconds. The 90th percentile was 6 minutes 5 seconds. A second, larger sample provided the response times for the first apparatus to arrive at the scene for 200 calls for service received during the period April 12 through April 19, 1992 (this sample did not provide dispatch times). The distribution of these response times is set forth in Exhibit 21. The average response time for the first arriving apparatus for these 200 calls for service was 3 minutes 50 seconds. The 90th percentile was 5 minutes 45 seconds. Since the 90th percentile for the arrival of the first apparatus exceeds four minutes, the four minute, one pump response time objective is not being achieved in several areas of the City. However, it will be demonstrated later that the CFD is achieving the agreed upon response capability objectives set forth in Section 3, since three pumps and two aerial devices are able to respond to a call for service within eight minutes more than 90% of the time.

5.4.5 The One Pump Four Minute Coverage Area

The GIS software will indicate graphically the streets that an apparatus can cover within a specified response time. The street network in most cities, and Cambridge is no exception, is not a perfect grid and the major arterials are interspersed with the other streets. In addition, the density



0 0.46 miles

Exhibit 22

Four minute coverage areas plotted for all nine existing stations.

Actual apparatus travel time set at 2.0 minutes.

Speed assumptions:
20 mi/hr on major roads
15 mi/hr on all other roadways

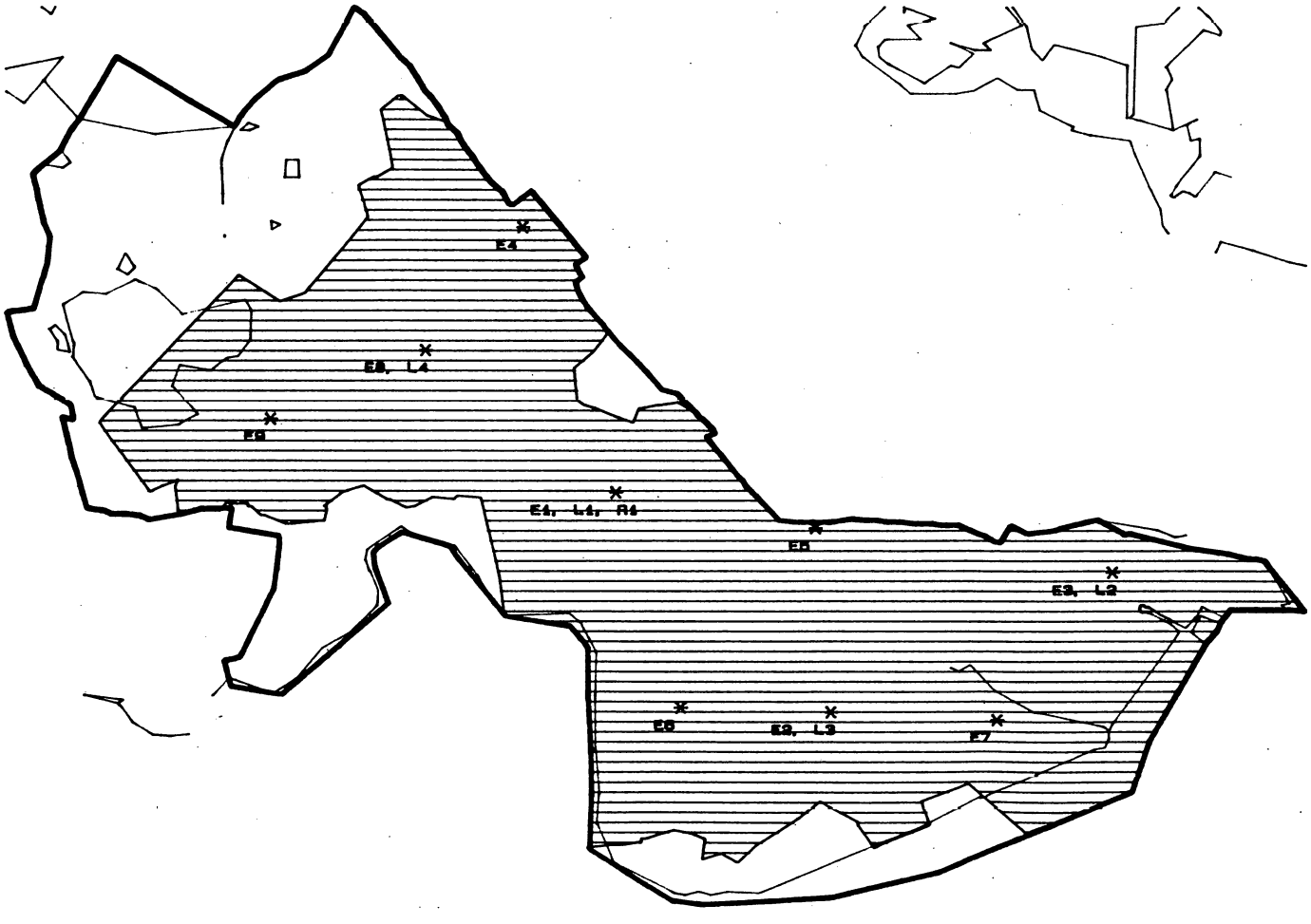
No access across Boston & Maine RR at Alewife Brook Pkwy and at Walden St.

AREA/FEATURE

— CITY

* STATIONS

Exhibit 23



0 0.46 miles

FOUR MINUTE COVERAGE AREA

EXISTING DEPLOYMENT

FOUR MINUTE - ONE ENGINE MERGED COVERAGE AREA

Actual Travel Time set at 2.0 Minutes.

Water Features - plotted

Streets - not plotted

AREA/FEATURE

CITY

* STATIONS

Exhibit 24

Populated Areas Within Which RCOs May Not Be Achieved For The Existing Deployment.

Each Area is Labeled With its Respective Population.

AREA/FEATURE

— CITY

— NOTCOV2

* STATIONS

of the network varies depending on the topography and the degree to which an area is developed. Therefore, the area covered by an apparatus is very rarely a circle or a square; rather it will look like a polygon. Also, the size of the response area covered by a particular apparatus will depend on its location and the street network.

Throughout the rest of this report there are several exhibits, which were generated by the GIS, that depict estimates of the response area covered by an apparatus responding from various locations. In the interests of providing a higher degree of resolution, the street network has been suppressed in these exhibits. (One can refer to Appendix A to review the GIS's generation of the street network.)

Exhibits 22 and 23 depict the four minute response time coverage of one pump emanating from each of the existing 9 stations and the union of the nine four minute coverage areas **assuming a two minute travel time.** It can be seen that:

- there is a substantial amount of overlap in the four minute response time coverage provided by the pumps in Stations Two, Three, Five, Six and Seven in the east half of Cambridge; and
- there is a substantial amount of overlap on the four minute response time coverage between Stations Eight and Nine.
- there are gaps in the four minute response time coverage in the following areas:
  - south east of Station Nine in the peninsula extending south. This area is not populated. There is a large cemetery in this area; and
  - the west most area of the City.

Exhibit 24 shows the populated areas of the west end of Cambridge that cannot be reached within a two minute travel time. Approximately 4039 people, or 4.2% of the population, live in these areas including:

- 1351 citizens in the very northwest corner;
- 835 persons just north of Concord Avenue at the west edge of the City; and
- 1853 residents west of Aberdeen in the southwest corner of the City.

Exhibit 25

EXISTING CONFIGURATION

8 Minute Ladder Coverage

Group A

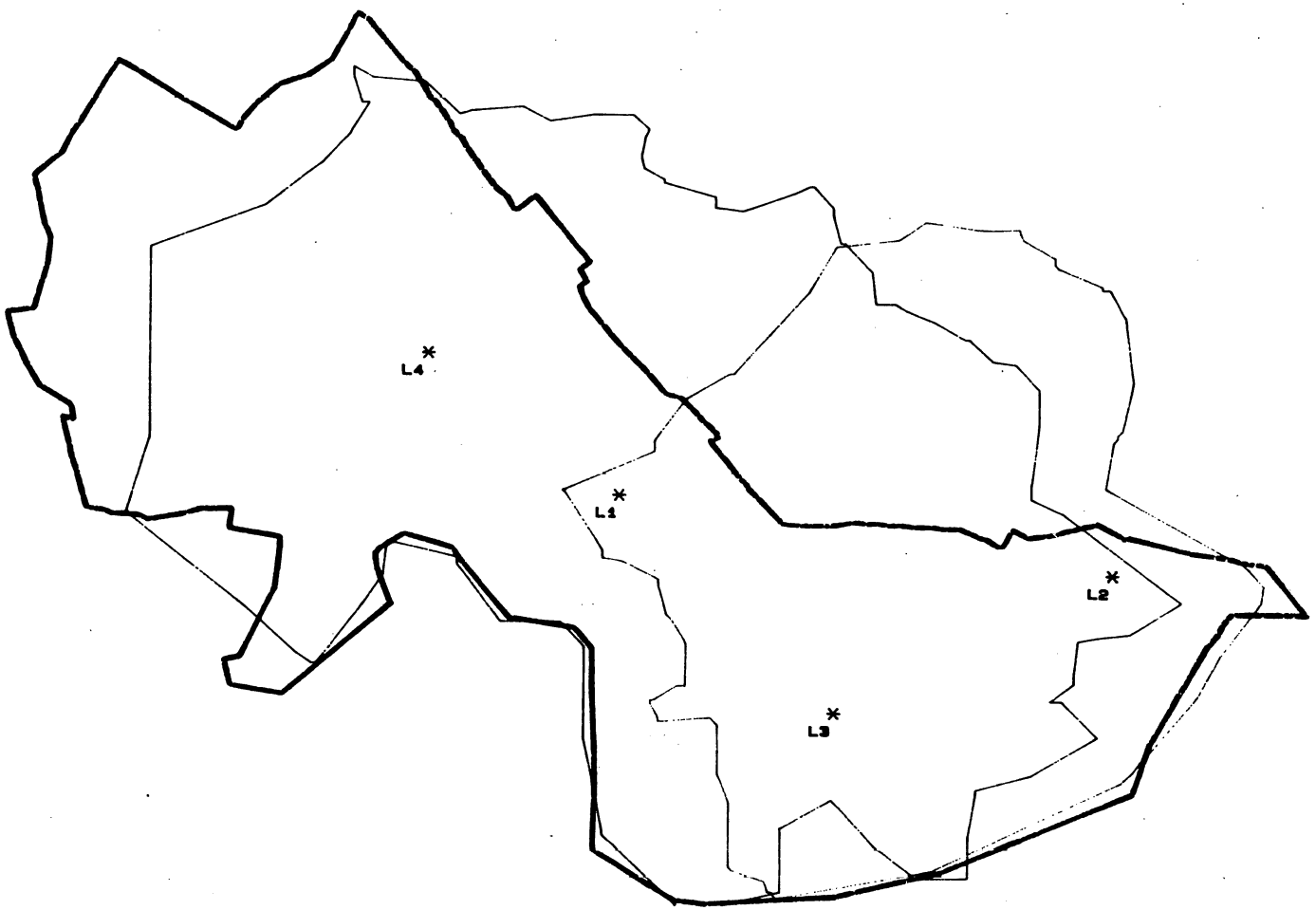
L1, L2

Speed Assumptions are:

15/20 on Major/Other

Actual Apparatus Travel

Time set at 6.0 minutes.



0 0.46 miles

AREA/FEATURE

CITY

* TRUCKS

E3 8MIN

E1 8MIN

Exhibit 26

EXISTING CONFIGURATION

8 Minute Ladder Coverage

Group B

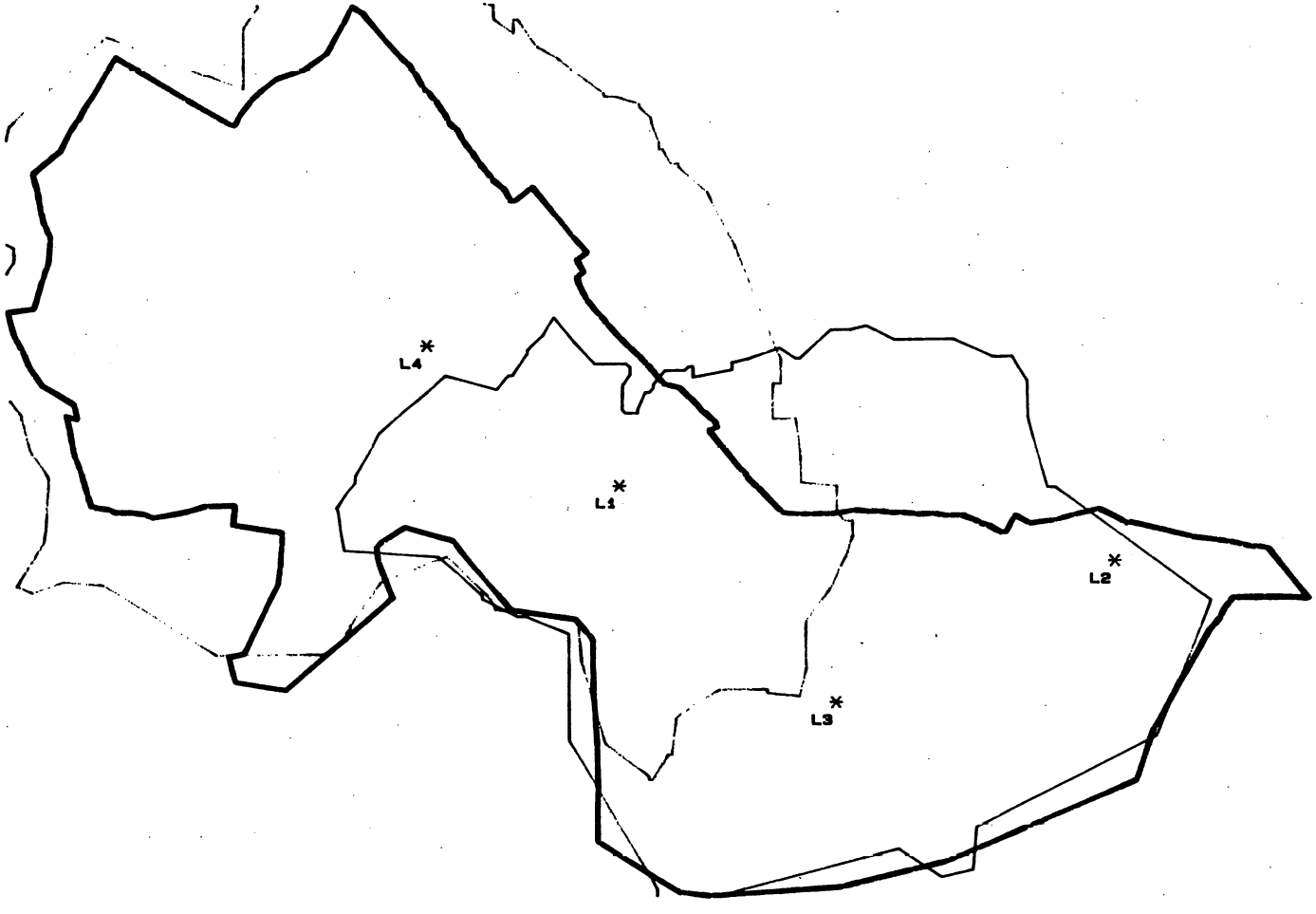
L3, L4

Speed Assumptions are:

15/20 on Major/Other

Actual Apparatus Travel

Time set at 6.0 Minutes.



0 0.46 miles

AREA/FEATURE

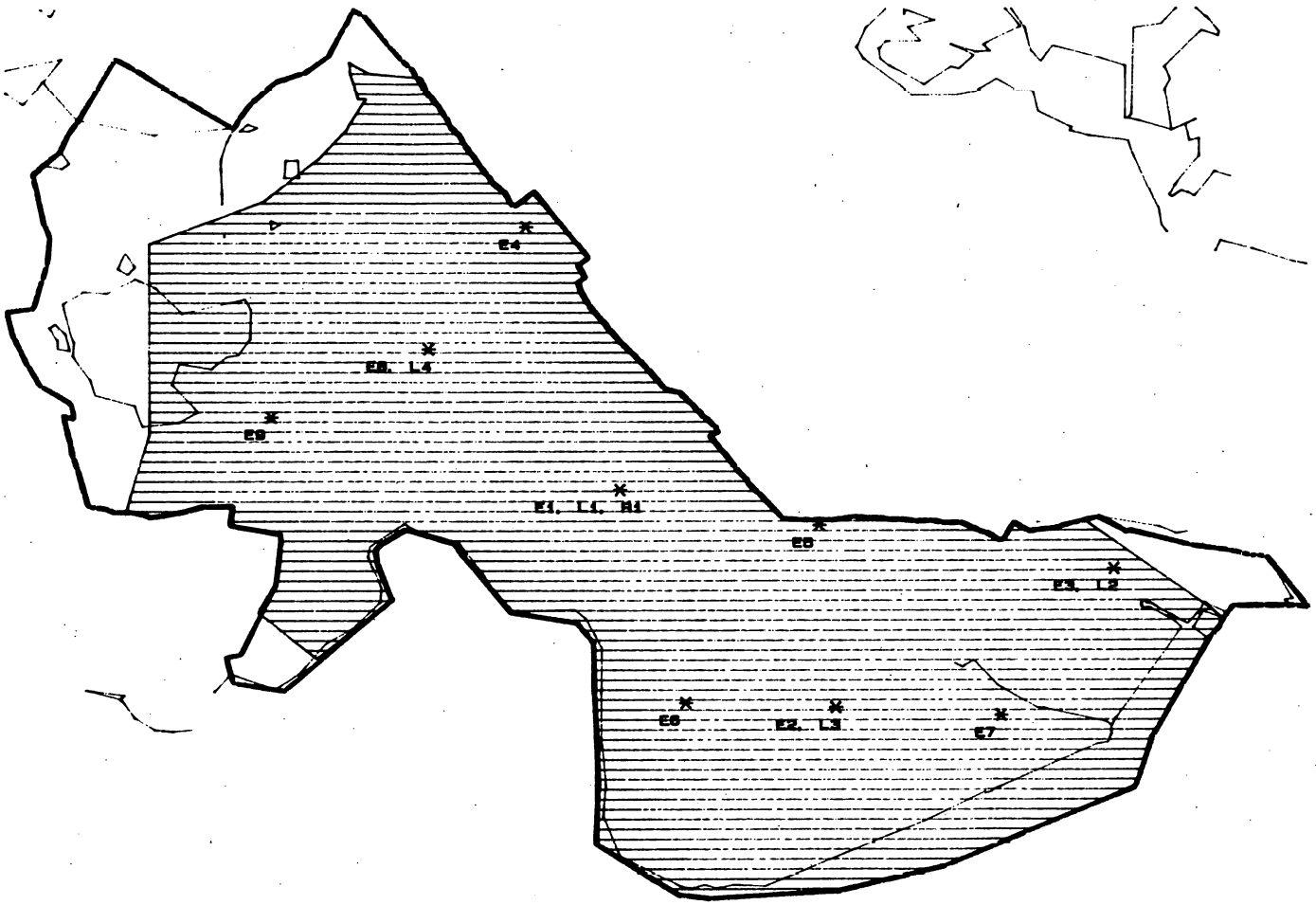
* TRUCKS

CITY

E2 8MIN

E8 8MIN

Exhibit 27



0 0.46 miles

EIGHT MINUTE COVERAGE AREA

EXISTING DEPLOYMENT

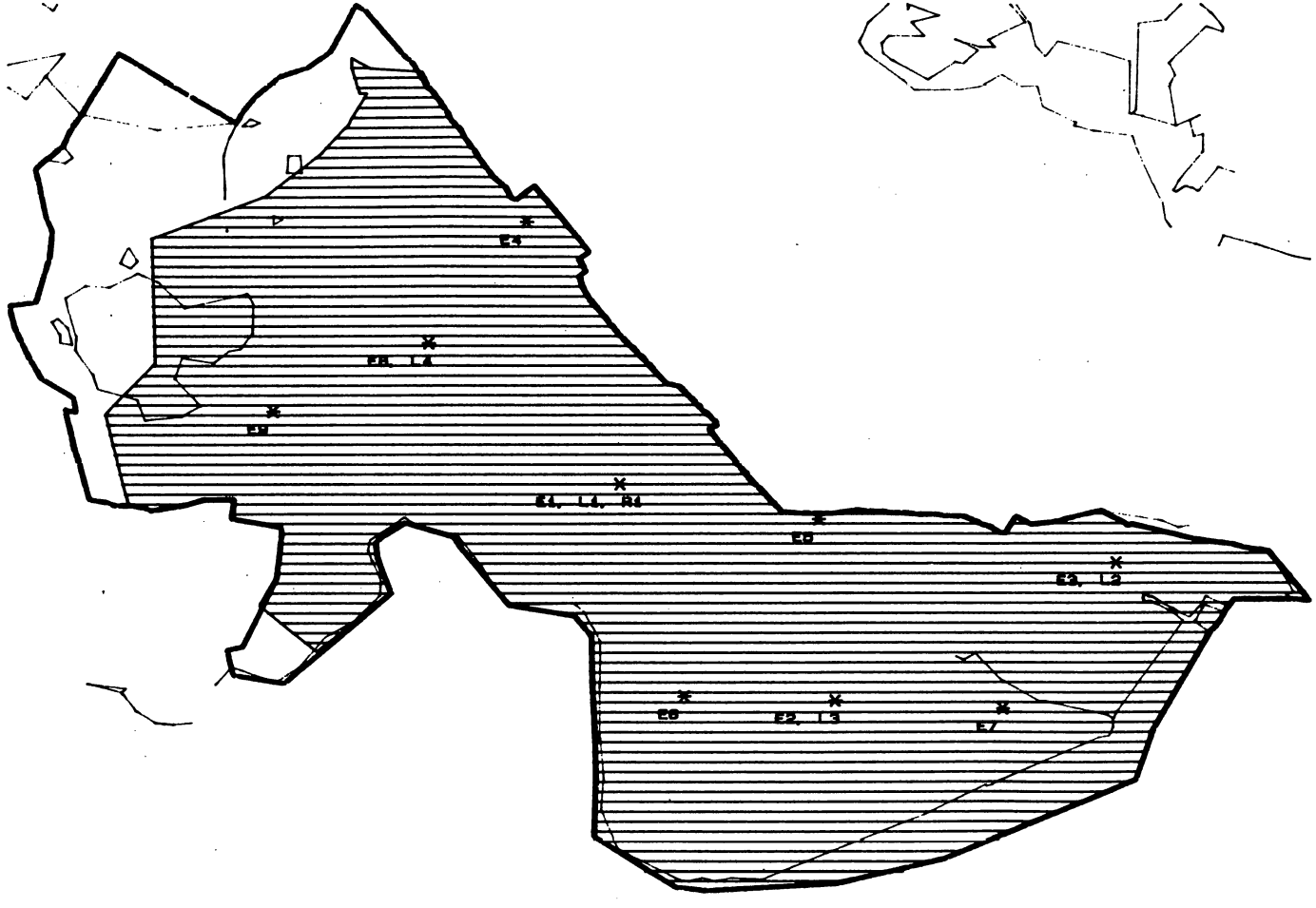
EIGHT MINUTE
- 3 ENGINE, 2 TRUCK
MERGED COVERAGE AREA

Actual Travel Time set
at Six Minutes.

Water Features - plotted
Streets - not plotted

AREA/FEATURE
— CITY
* STATIONS

Exhibit 28



0 0.46 miles

4 AND/OR 8 COVERAGE

EXISTING DEPLOYMENT

UNION OF FOUR AND EIGHT MINUTE RCOs

Actual Travel Time set at Two and Six Minutes.

Water Features - plotted

Streets - not plotted

AREA/FEATURE

— CITY

* STATIONS

Approximately 86.5% percent of the the population, or 82,864 citizens, reside within a two minute travel time of a pump company deployed in one of the existing stations. About 85.6% of the code 11 structure fires, that occurred during the four period 1988 to 1991, occurred within a two minute travel time of a pump company deployed in one of the existing stations.

5.4.6 The Existing Ladder Company Response Capability

Exhibits 25 and 26 depict the current deployment of the four ladder companies at Stations One, Two,Three and Eight and the the eight minute - two ladder coverage areas assuming a six minute travel time for each ladder company. Exhibit 25 indicates that Ladders 3 and 4 can cover the entire City within a six minute travel time. Exhibit 26 shows that Ladders 1 and 2 can cover the most of the City within a six minute travel time. It can be seen that there is an area along the west edge of the City that only one ladder company, Ladder 4, can reach within a six minute travel time.

5.4.7 The Initial Response Complement Eight Minute Coverage

Exhibit 27 depicts the area within the City of Cambridge within which three pump companies, two ladder companies and one Deputy Chief's car, together with 17 firefighters, can arrive at the scene of an alarm within a six minute travel time. It should be noted that:

- 91,593, or 95.6%, of the population of Cambridge reside within this area; and
- 760 of the 811, or 93.7%, of the code 11 structure fires that occurred during 1988 to 1991, occurred within this area.

Exhibit 28 depicts the area within the City of Cambridge within which either one pump can arrive within a two minute travel time, **or** three pump companies, two ladder companies and one Deputy Chief's car, together with 17 firefighters, can arrive at the scene of an alarm within a six minute travel time. It should be noted that:

- 91,762, or 95.8%, of the population of Cambridge reside within this area; and
- 760 of the 811, or 93.7%, of the code 11 structure fires that occurred during 1988 to 1991, occurred within this area.

5.4.8 Summary

1. The existing deployment enables the pump and ladder apparatus to reach 95.8% of the City of Cambridge's population within two or six minute travel times. In addition, the City of Cambridge's response time objectives are being achieved, since three pump companies, two ladder companies and a Deputy Chief's car, together with 17 firefighters, can arrive at the scene of an alarm within eight minutes of the receipt of a call for service at least 90% of the time.

2. There is an area along the west edge of the City in which the response capability objectives are not being achieved due to the nature of the road network and current station locations.

3. While the existing deployment enables the pump and ladder apparatus to cover the City of Cambridge within the response time objectives, the staffing of each apparatus is too low. This makes it more difficult to:

   - work well as a team at the fireground;
   - deliver sufficient water in some cases; and
   - carry out necessary tasks at the fireground simultaneously.

4. There are only three firefighters on duty on a pump and on a ladder. A smaller number of pump and ladder companies, each staffed with four firefighters, is strongly recommended for the following reasons:

   - a four firefighter company is over 150% more effective than a three firefighter unit;

   - firefighters frequently work in pairs, particularly when inside a structure since working as a single firefighter is not considered a safe operation;

   - NFPA Standard 1500 addresses fire department occupational health and safety and in its appendix recommends four firefighter staffing as a minimum acceptable level; and

   - four-firefighter companies are more effectively managed on the fireground to insure prompt execution of critical tasks and more prompt accomplishment of critical functions of fire control.

5. Notwithstanding the three-firefighter on-duty staffing, there are overlaps and redundancies in the deployment, especially in the eastern areas of the City of Cambridge.

6. Significant improvements in the existing deployment can be achieved by increasing the on-duty staffing on all pump, ladder and rescue apparatus to four firefighters and reducing the number of pump and ladder companies.

5.5 EMERGENCY MEDICAL RESPONSE

5.5.1 Emergency Medical Response Models

Several models are used by municipalities throughout North America to provide emergency medical response services. Usually, these models involve both public and private sector service delivery organizations, and in recent years, the fire protection service has become recognized as an ideal organization to provide some or all of the emergency medical response service. The service delivery models comprise policies regarding the services that a municipality mandates and supports, and designates which public and private sector organization(s) shall provide each service. The services might include:

- advanced life support at the paramedic level
- life support at the EMT level
- automatic external defibrillation
- victim stabilization
- emergency transportation
- non- emergency transportation
- stabilization and transportation when extrication is required.

Once the services to be provided are decided upon and the role of the organization(s) are established, then response capability objectives and service level objectives for each service need to be established.

The CFD is well positioned to provide any or all of these services because:

- fire companies must be deployed throughout the City, in any case, to meet fire suppression response capabilities;
- all fire fighters are qualified first responders;
- more than 100 of the CFD firefighters are already fully licensed EMTs; and
- given a random call for service, the probability that the first due company will be available for response to an alarm of fire, even in municipalities with high alarm rates, is over 80%.

5.5.2 Automatic External Defibrillation

A little over ten years ago, only certified paramedics were permitted to defibrillate cardiac arrest patients in the field. However, a shift in emphasis has taken place and the perception of defibrillation as a fundamental skill not only for Emergency Medical Technicians (EMT) but also for non-emergency medical technician first responders has occurred. This emphasis on early defibrillation by other than paramedics has been endorsed by the American Hospital Association, the Advanced Coronary Treatment Foundation, the American Medical Association EMS Committee and the National Association of EMS Physicians since the evidence supporting its success is compelling.

Supported by the convincing evidence of the value of rapid defibrillation, the movement for early defibrillation has been further propelled by introduction of automatic defibrillators. There is now on the market a number of reliable automatic or semi-automatic external defibrillators at a reasonable cost of under $5,000 per unit. Initial training in their use takes less than eight hours and refresher training is needed not more than twice a year, and is required only once a year by the State of Massachusetts.

In May of this year, the State of Massachusetts amended Chapter 111 of the General Laws regulating early cardiac defibrillation and now permits firefighter members of an organized department, such as Cambridge, who are not EMT certified to use automatic or semi-automatic defibrillators. As awareness of the benefits of early defibrillation increase so will public demand for the availability of this pre-hospital treatment. State of the art emergency medical care now dictates ready access to automatic defibrillation by first responders. Over 100 of the Cambridge firefighters are crosstrained and certified as Emergency Medical Technicians making the case even more compelling for wide distribution of defibrillators to CFD units.

5.5.3 The Existing Scope and Service Level for Emergency Medical Response

In the City of Cambridge, for all emergencies not considered life threatening, the CFD dispatches the nearest engine company. The Rescue Company is only dispatched to those situations normally considered to be potentially life threatening. The Rescue Company also responds to all calls for service that are possible structure fires.

The CFD's existing emergency medical response delivery system and the effectiveness of the CFD relies very heavily on one, active Rescue Company:

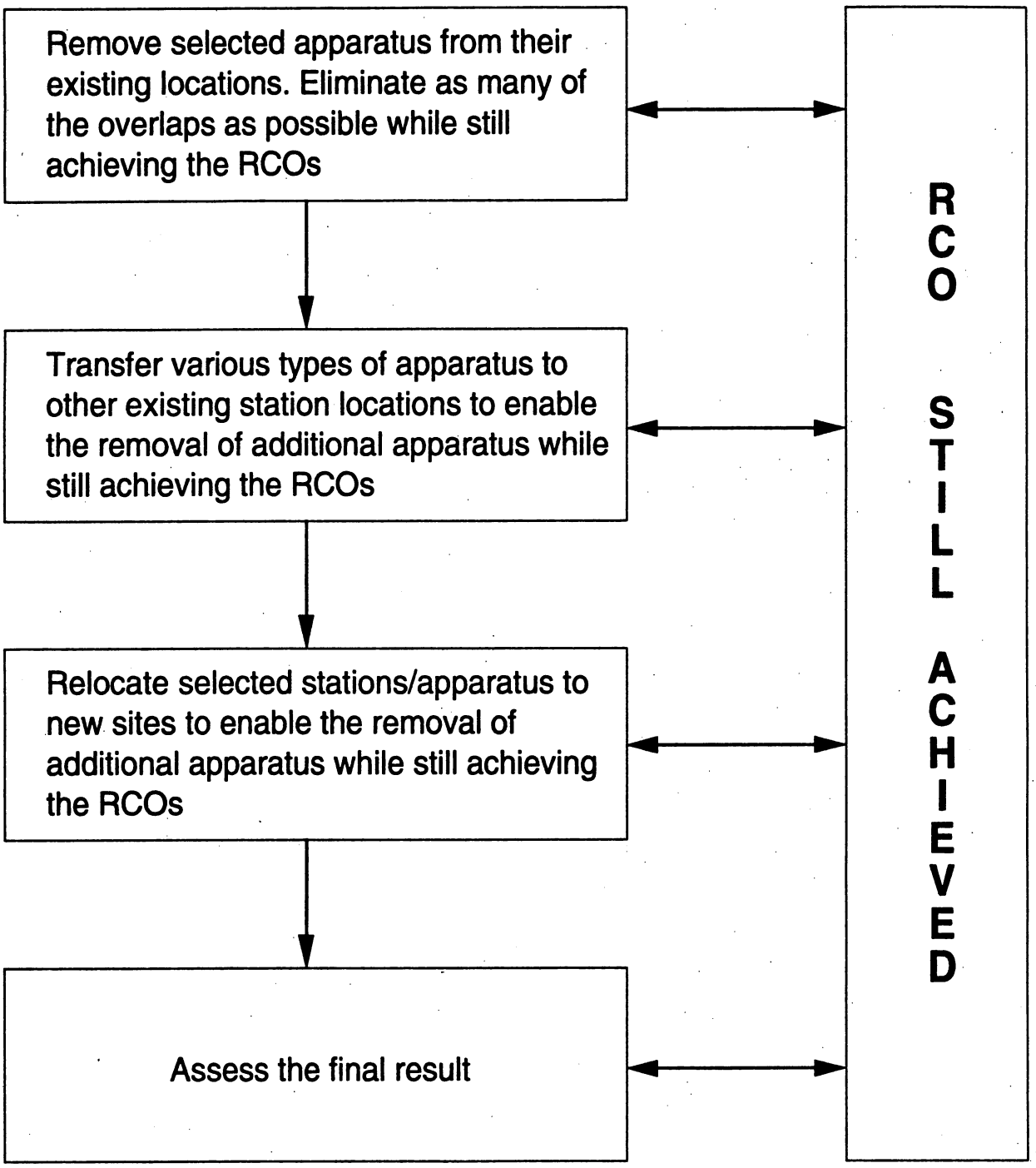
1. The Rescue Company is the only CFD company that provides an AED service. The AHA recommendation regarding response time to incidents requiring the use of an AED is four minutes. Only 27,235 citizens, or 28.4 % of the population resides within a 2 1/2 minute travel time (four minute response) of Station One, where the Rescue Company is housed.

   During 1991 there were 3202 EMS response for which address matches were available. These are plotted in Exhibit 9. There were:

   - 1443 EMS responses within a 3.5 minute travel time (five minute response time) of Station One
   - 2180 EMS responses within a 4.5 minute travel time (six minute response time) of Station One
   - 2659 EMS responses within a 5.6 minute travel time (seven minute response time) of Station One
   - 3105 EMS responses within a 6.5 minute travel time (eight minute response time) of Station One

2. The Rescue Company is the only CFD company that provides an EMT response.
3. The Rescue Company is the only CFD company that has EMS transport capability.
4. The Rescue Company provides additional firefighters that are currently critical to effective operations at a working fire because the existing on duty staffing is only three firefighters on each apparatus.
5. The Rescue Company carries the extrication and other special tools needed by all suppression companies at the fire ground.
6. The Rescue Company is an integral part of the CFD's hazardous materials response team.

OVERVIEW OF THE PROCESS USED TO DEVELOP THE RECOMMENDED DEPLOYMENT



The Rescue Company responded to almost 3500 calls for service during 1990, or to approximately 9.5 calls for service per day. On average, this equated to about five calls for service per shift. At this level of activity there is a significant probability that this company could be busy when another call for service occurs that requires AED, the EMS skills, the extrication equipment currently carried only by the Rescue Company, a response to a hazardous materials incident, or the Rescue Company's personnel and equipment in order to operate effectively at the fireground.

5.6 DEPLOYMENT ALTERNATIVES

5.6.1 Introduction

In developing and assessing deployment alternatives the objective was to minimize the number of companies necessary to achieve the response capability objectives assuming an on-duty staffing of four firefighters per company.

The deployment alternatives were developed over a ten week period of interactive decision support analysis using the GIS software. Exhibit 29 depicts the four step process which generated the deployment recommendations:

- eliminated selected overlaps in the coverage inherent in the existing deployment by interactively removing selected apparatus and identifying the impact of the eliminated apparatus on the achievement of the response capability objectives (RCOs) interactively on the computer screen;
- determined the largest possible proportion of the developed area in the City of Cambridge within which the RCOs could be achieved by deploying the minimum possible number of apparatus of each type in any of the **existing** stations.
- identified situations where station relocations or mergers might:
  - increase the proportion of the developed area within which the RCOs would be achieved without increasing the number of apparatus; or
  - permit a further reduction of apparatus without significantly affecting the proportion of developed areas within which the RCOs are achieved.

- assessed the results by:
  - identifying areas within which RCOs may not be achieved;
  - determining the proportion of the developed area in each response area within which the RCOs will be achieved; and
  - identifying the apparatus comprising the initial response complement in each response area.

At each stage of the analysis checks were made to ensure that the City's RCOs would still be achieved. This was done by:

- ensuring that the proportion of the 811 code 11 structure fires, which occurred during the period January 1, 1988 to December 31, 1991 and plotted by address in the map data base, that were within a four minute one pump response or an eight minute response by the entire initial response complement exceeded 90%; and
- ensuring that the proportion of the population that inhabited areas within a four minute one pump response or an eight minute response by the entire initial response complement exceeded 85%, since this proportion is a reasonable indicator that more than 90% of the calls for service would fall within the response criteria.

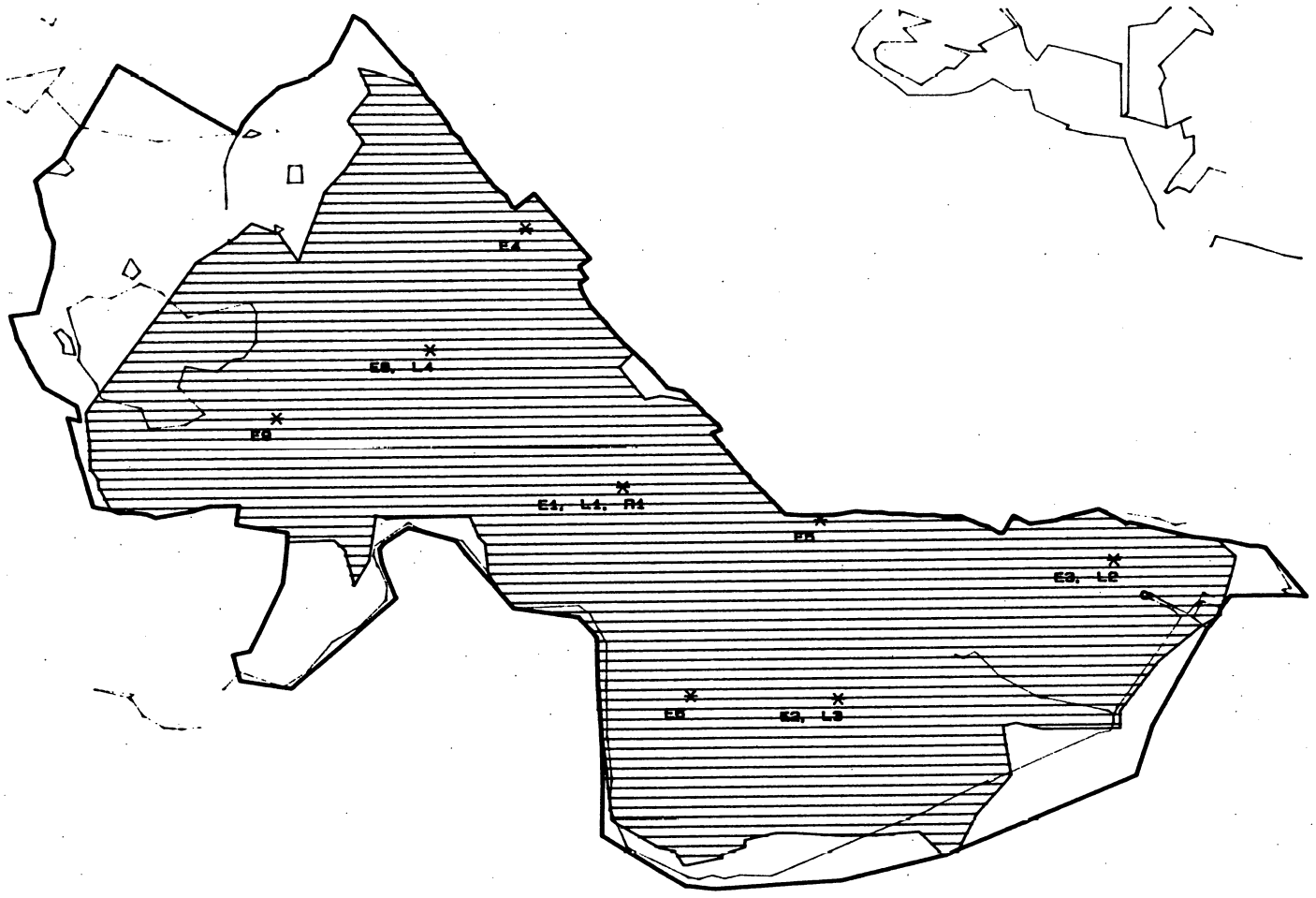
It was assumed, for the purposes of developing deployment alternatives, that the City of Cambridge will acquire a computer aided dispatch system and integrate the operations of the Electric Department Communications Center with those of the 911 Communications Center and that, as a result, the combined dispatch and reaction time component of the CFD's response time will be equal to or less than 1 minute 30 seconds for at least 90% of the calls for service.

This section sets forth the three deployment alternatives considered and, for each of these, provides:

- exhibits which depict the locations of the deployment for each type of apparatus and the four and eight minute coverage areas;
- the proportion of the code 11 structure fires that occurred during the period January 1, 1988 to December 31, 1991 for which the RCOs would have been achieved with the deployment alternative; and
- the proportion of the population that is within areas where the RCOs will be achieved.

Each of these deployment alternatives was discussed at the Steering Committee meeting on May 12, 1992. Any one of these alternatives, if implemented, would achieve the response

Exhibit 30



0 0.46 miles

FOUR MINUTE COVERAGE

EXISTING DEPLOYMENT
LESS ENGINE 7

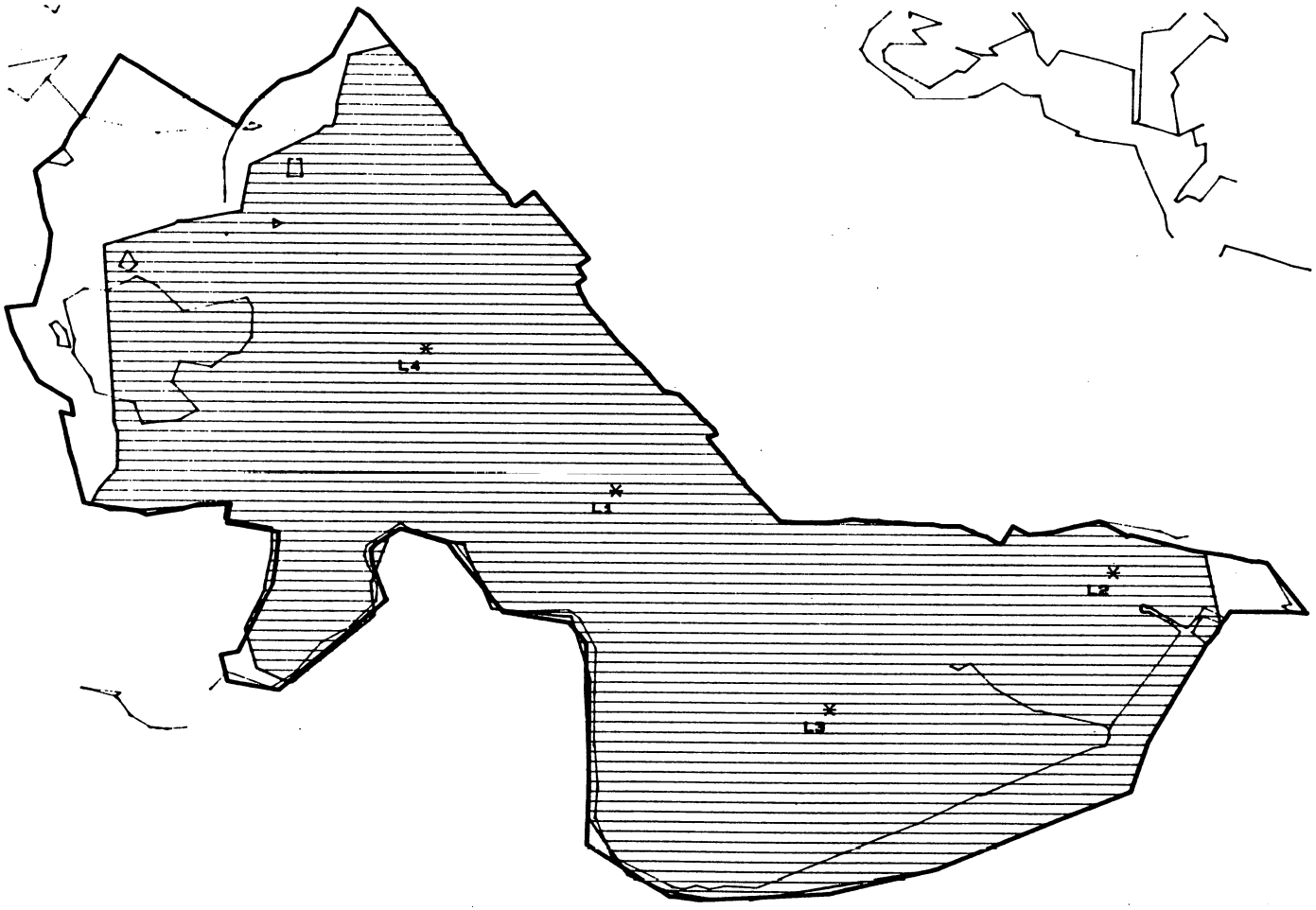
FOUR MINUTE - ONE ENGINE
MERGED COVERAGE AREA

Actual travel Time set
at 2.5 Minutes.

Water Features - plotted
Streets - not plotted

AREA/FEATURE
— CITY
* STATIONS

Exhibit 31



0 0.46 miles

EIGHT MINUTE COVERAGE

EXISTING DEPLOYMENT
LESS ENGINE 7

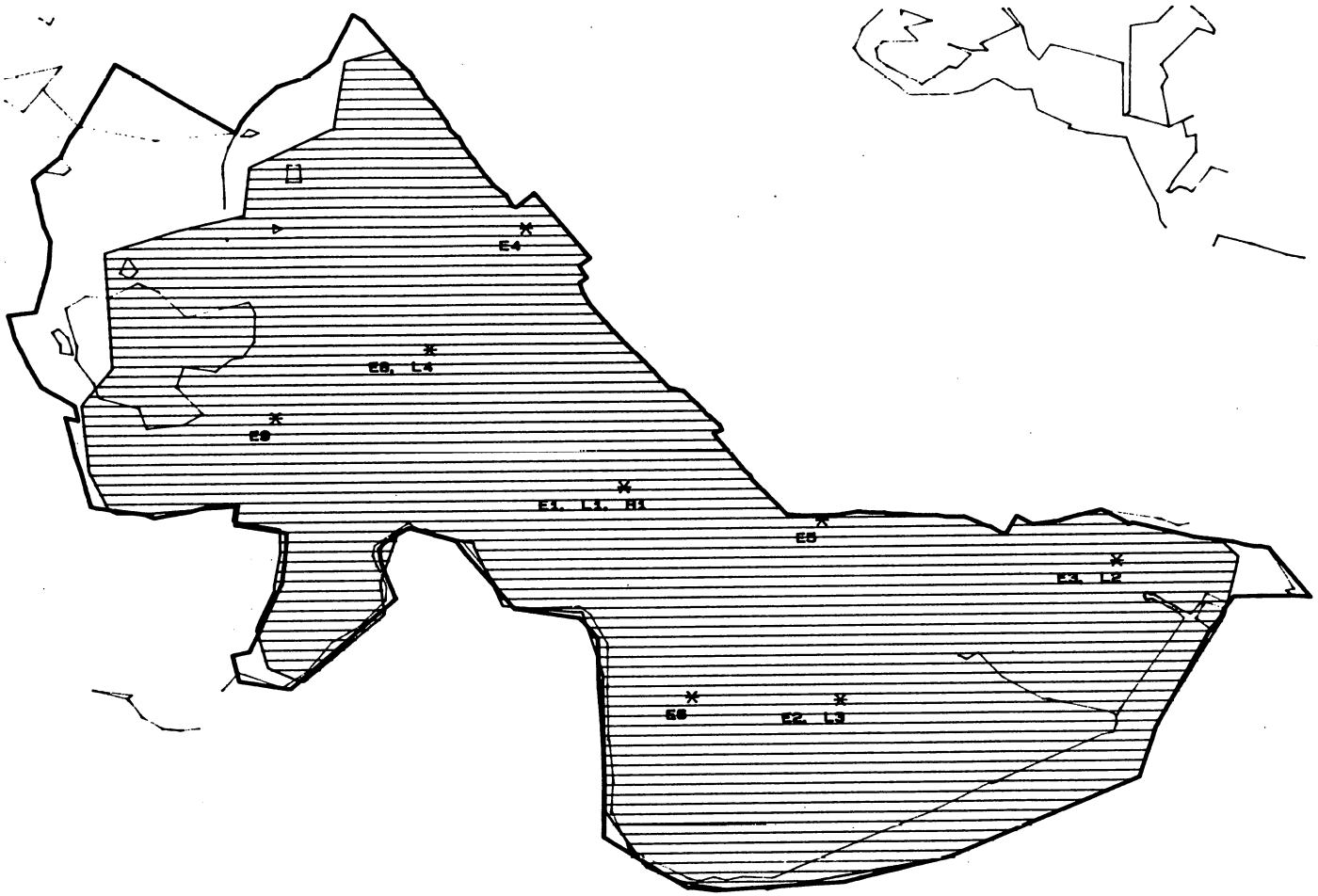
EIGHT MINUTE
2 TRUCK, 3 ENGINE
MERGED COVERAGE AREA

Actual Travel Time set
at 2.5 Minutes.

Water Features - plotted
Streets - not plotted

AREA/FEATURE
— CITY
* TRUCKS

Exhibit 32



0 0.46 miles

4 AND/OR 8 COVERAGE

EXISTING DEPLOYMENT
LESS ENGINE 7

UNION OF FOUR AND EIGHT
MINUTE RCOs

Actual Travel Time set
at 2.5 and 6.5 Minutes.

If staffing is at 3 firefighters per apparatus, then the hatched area is where a minimum of 20 firefighters (3 Eng. 2 Trk.) can arrive within the 4 and/or 8 RCO

CITY

* STATIONS

capabilities agreed upon during the Steering Committee meetings, but the costs vary from one alternative to another.

5.6.2 Alternative One - The Existing Deployment Less Station Seven

Exhibit 30 depicts the engine and aerial device deployments and the one pump, four minute coverage area for Alternative One. Alternative One consists of the existing deployment less the engine deployed at Station 7. The deployment alternative comprises eight pumps, one at each of the eight stations and four aerials as they are currently deployed.

Approximately 91,222 citizens, or 95.2% of the population, reside within the four minute coverage area in Alternative One. In addition, 747, or 92.1% of the 811 code 11 structure fires that occurred during the four year period 1988 to 1991, occurred within the Alternative One one pump, four minute coverage area. One can see by comparing Exhibits 23 and 30 the increase in the coverage area resulting from the 30 second increase in travel time. Provided that the CAD were put into place and the on duty staffing on other pumps proximate to Station 7 were increased prior to the elimination of Engine 7, the elimination of Engine 7 would have little effect on the four minute coverage area in eastern Cambridge.

Exhibit 31 depicts the three pump, two ladder eight minute coverage. Approximately 93,111 citizens, or 97.2% of the population, reside within the four minute coverage area. In addition, 791, or 97.5% of the 811 code 11 structure fires that occurred during the four period 1988 to 1991, occurred within the Alternative One three pump, two ladder eight minute coverage area.

Exhibit 32 depicts the four and/or eight minute coverage for Alternative One. This is the area within which either the four minute, the eight minute or both objectives can be achieved. It should be noted that:

- 94,499, or 98.6%, of the population reside at addresses at which the response capability objectives would have been achieved given the Alternative One deployment; and

Exhibit 33

FOUR MINUTE COVERAGE

Alternative Two

FOUR MINUTE - ONE ENGINE MERGED COVERAGE AREA

Actual Travel Time set at 2.5 Minutes.

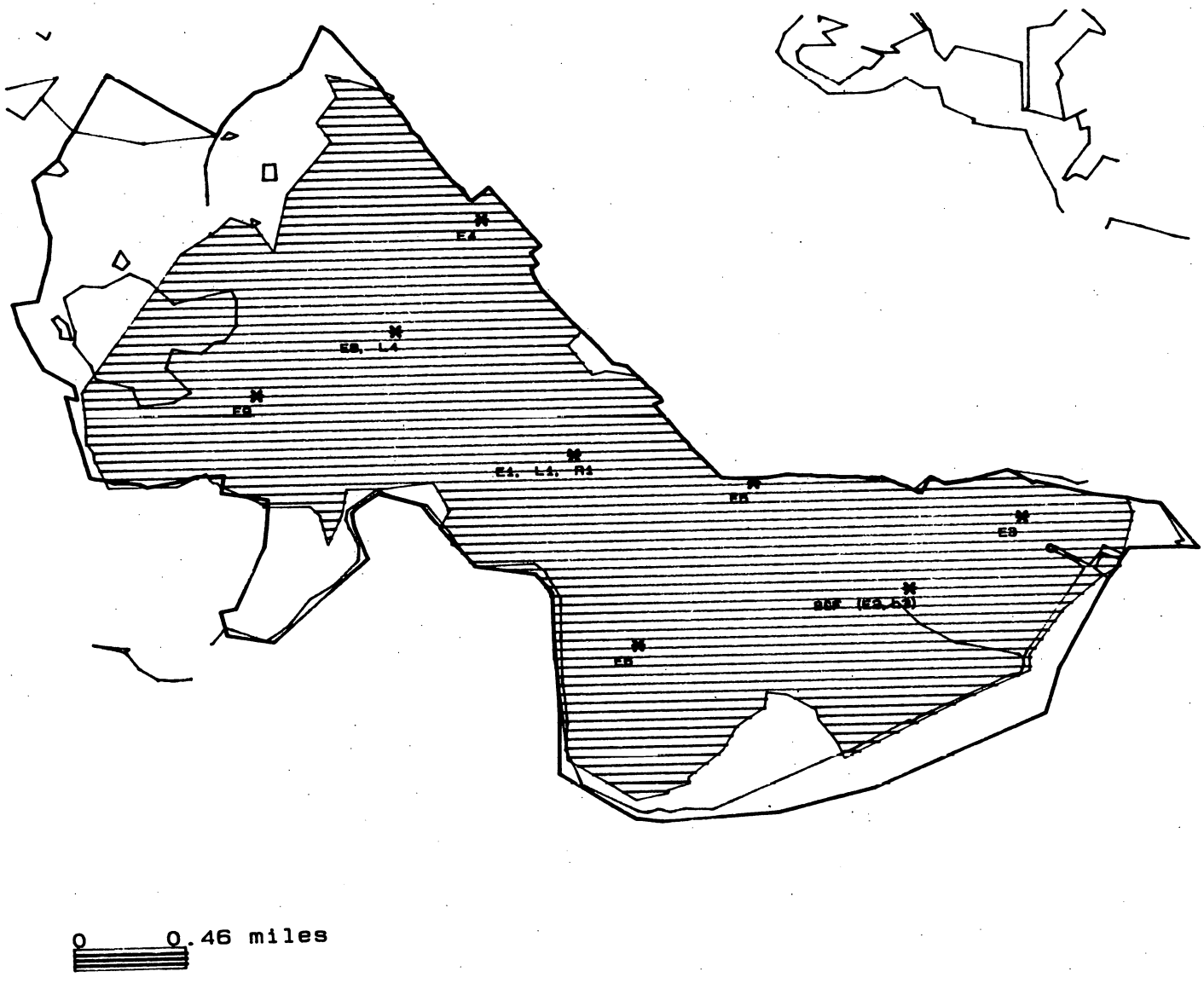
Water Features - plotted

Streets - not plotted

AREA/FEATURE

CITY

ALT1



0 0.46 miles

- 799, or 98.5%, of the 811 code 11 structure fires that occurred during the four year period 1988 to 1991, occurred at addresses at which the response capability objectives would have been achieved given the Alternative One deployment.

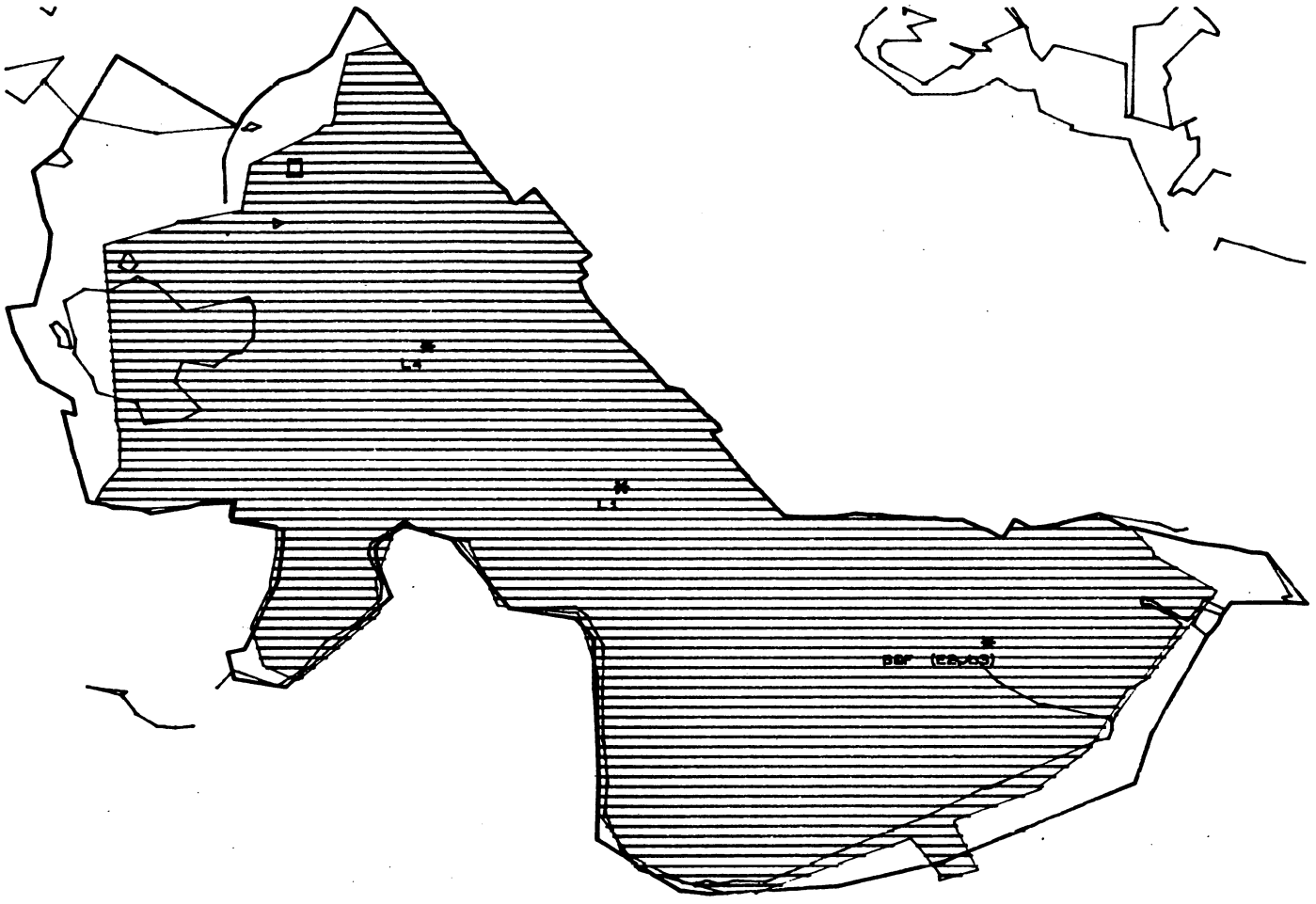
5.6.3 Alternative Two - Close Engine 7 and Ladder 2. Move Engine 2 and Ladder 3 to Binney and Fulkerson

Exhibit 33 indicates the engine and aerial device deployments and the one pump, four minute coverage area for Alternative Two. Alternative Two consists of the existing deployment less Engine 7, which is deployed at Station 7, and Ladder 2, which is deployed at Station 3. In addition, Station Two, which houses Engine 2 and Ladder 3, would be relocated to a new station at the intersection of Binney and Fulkerson Streets. Facilities for a new repair shop could be provided at this new station or the repair function could be relocated from Station 5 to Station 3. The deployment alternative comprises eight pump companies, one at each of the eight stations, and three ladder companies deployed at Stations One, Two and Eight.

One can see, by comparing Exhibits 23 and 33, that given the 30 second increase in travel time which would be provided by the introduction of CAD, the elimination of Engine 7 and the relocation of Station Two would result in a very small reduction in the one pump four minute coverage in the south east area of the City. Specifically, 89,639 citizens, or 93.6% of the population, reside within the four minute coverage area in Alternative Two (as compared to 91,222 citizens, or 95.2% of the population in Alternative One). In addition, 741, or 91.4%, of the 811 code 11 structure fires that occurred during the four period 1988 to 1991, occurred within the Alternative Two one pump, four minute coverage area (as compared to 747, or 92.1% of the 811 code 11 structure fires in Alternative One).

Exhibits 1 through 5 of Appendix B depict the 3 1/2, 4 1/2, 5 1/2 and 6 1/2 minute travel times (or the five, six, seven and seven minute response times) for ladders responding from stations One, Two, Three and Eight, and a proposed new station at the intersection of Binney and Fulkerson Streets. A close examination of these maps indicates that three aerial devices, deployed

Exhibit 34



0.46 miles

EIGHT MINUTE COVERAGE

Alternative Two & Three

EIGHT MINUTE
2 TRUCK, 3 ENGINE
MERGED COVERAGE AREA

Actual Travel Time set
at 2.5 Minutes.

Water Features - plotted
Streets - not plotted

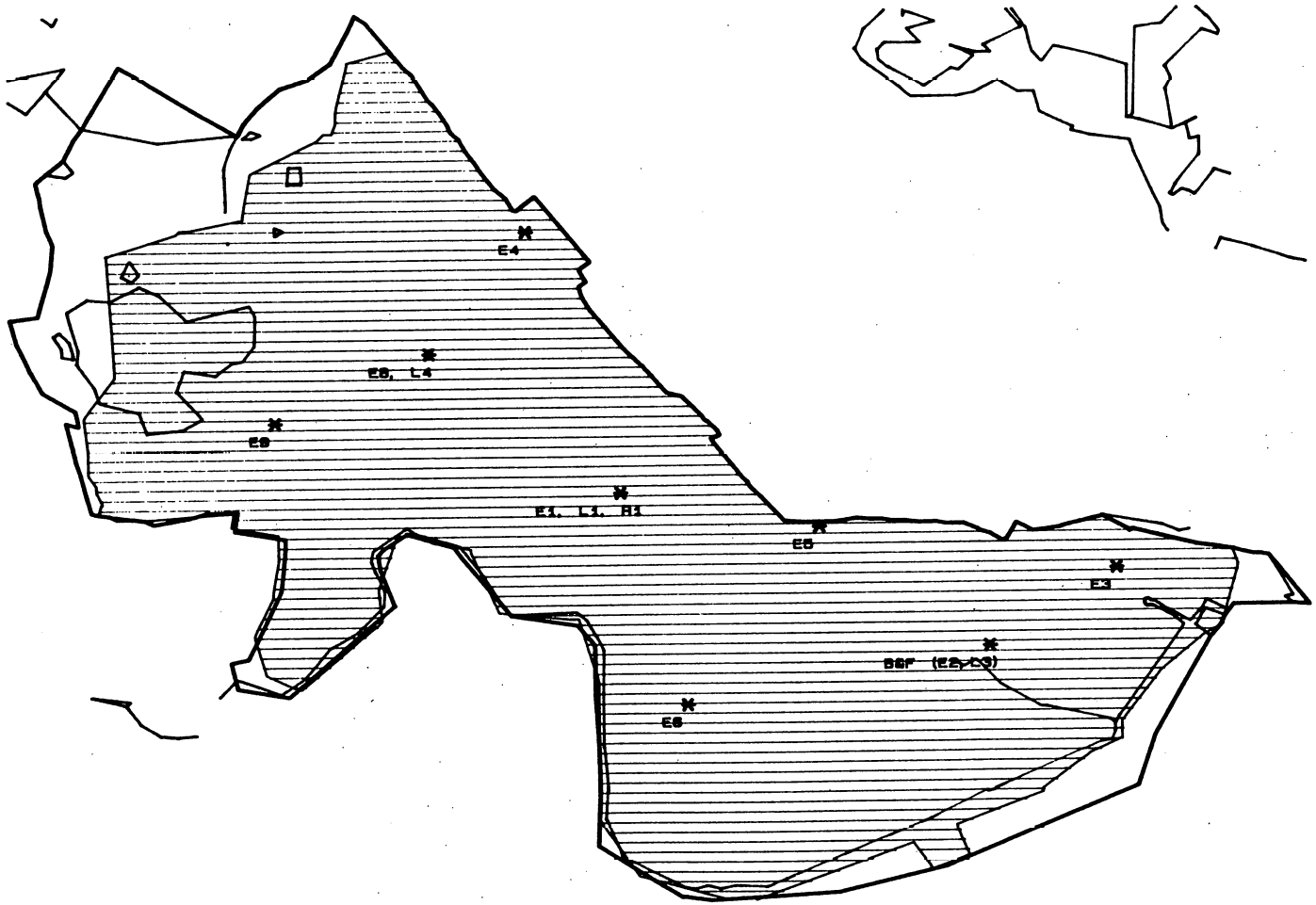
AREA/FEATURE

— CITY

✱ TRUCKS

Exhibit 35

4 AND/OR 8 COVERAGE



0 0.46 miles

Alternative Two

UNION OF FOUR AND EIGHT MINUTE RCOS

Actual Travel Time set at 2.5 and 6.5 Minutes.

Water Features - plotted

Streets - not plotted

at Station One, Binney and Fulkerson, and Station Eight, can effectively provide an eight minute, two ladder response to more than 97% of the population of the City. In fact, the deployment of three ladders in these locations, rather than four ladders in the existing locations, does not reduce the proportion of the population that resides within a two ladder, eight minute response. In addition, more than 97% of the code 11 structure fires that occurred during the period 1988 to 1991, occurred at locations within a two ladder eight minute response from these three locations.

An inspection of the exhibits in Appendix B indicates that, in most instances, three ladders deployed in these locations will result in two ladders arriving at the scene before eight minutes elapsed time. Specifically, three ladders deployed in these locations can provide:

- an eight minute, two ladder response to more than 93,111 residents, or 97% of the population, of the City. There were 790, or 97.4%, of the code 11 structure fires that occurred during the period 1988 to 1991, which occurred at locations within a two ladder eight minute response from these three locations; and

- a seven minute, two ladder response to more than 78,845 residents, or 82% of the population, of the City. There were 656, or 80.8%, of the code 11 structure fires that occurred during the period 1988 to 1991, which occurred at locations within a two ladder seven minute response from these three locations; and

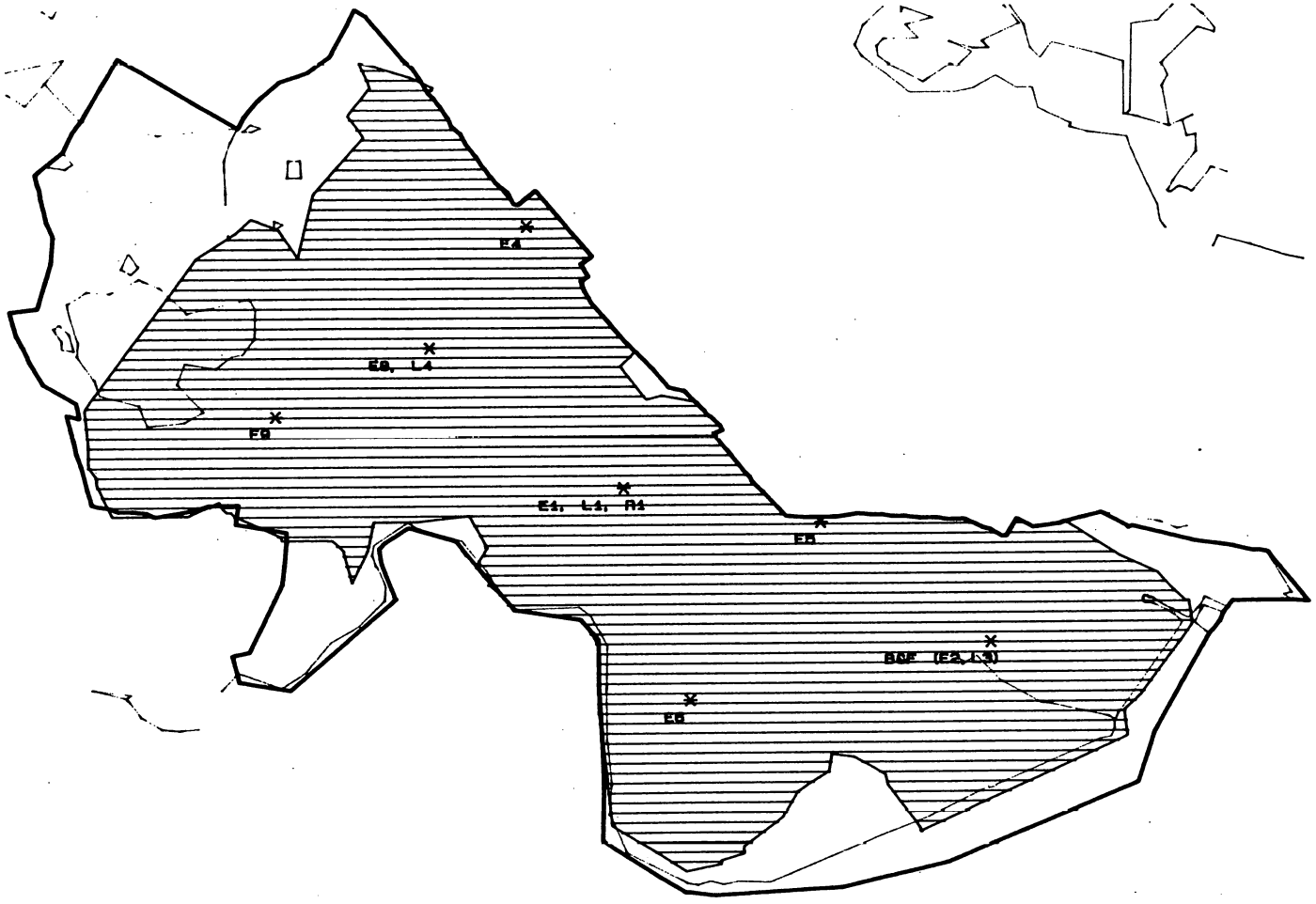
- a six minute, two ladder response to more than 69,711 residents, or 72% of the population, of the City. There were 563, or 69.4 %, of the code 11 structure fires that occurred during the period 1988 to 1991, which occurred at locations within a two ladder six minute response from these three locations.

Accordingly, these three locations are the proposed ladder locations for both Alternative Two and Alternative Three.

Exhibit 34 depicts the three pump, two ladder eight minute coverage for Alternative Two. While there is a narrow strip of land along the Charles River which is no longer within the three pump, two ladder eight minute coverage area, the proportion of the population and the number of code 11 structure fire that occurred during 1988 to 1991 that fall within the three engine two ladder eight minute coverage area is no different than in Alternative One.

Exhibit 35 depicts the four and/or eight minute coverage for Alternative Two. This is the area within which either the four minute, the eight minute or both objectives can be achieved. It

Exhibit 36



0 0.46 miles

FOUR MINUTE COVERAGE

Alternative Three

FOUR MINUTE - ONE ENGINE
MERGED COVERAGE AREA

Actual Travel Time set
at 2.5 Minutes.

Water Features - plotted
Streets - not plotted

AREA/FEATURE

— CITY

* ALT5

can be seen by comparing Exhibit 35 to the corresponding exhibit for Alternative One (Exhibit 32), that, except for the narrow strip along the Charles River, there is no difference in the area that falls within the RCO's. Therefore, population residing at addresses at which the response capability objectives would have been achieved and the proportion of the code 11 structure fires that occurred during the four year period 1988 to 1991, which occurred at addresses at which the response capability objectives would have been achieved, given that the Alternative Two deployment is the same as for Alternative One.

5.6.4 Alternative Three - Close Engine 3, Ladder 2 and Engine 7. Move Engine 2 and Ladder 3 to Binney and Fulkerson

The engine and aerial device deployments and the one pump, four minute coverage area for Alternative Three are set forth in Exhibit 36. The Alternative Three deployment is the Alternative Two deployment less Engine 3. In other words, Alternative Three could be achieved by making the following change to the existing deployment of engine and ladder companies:

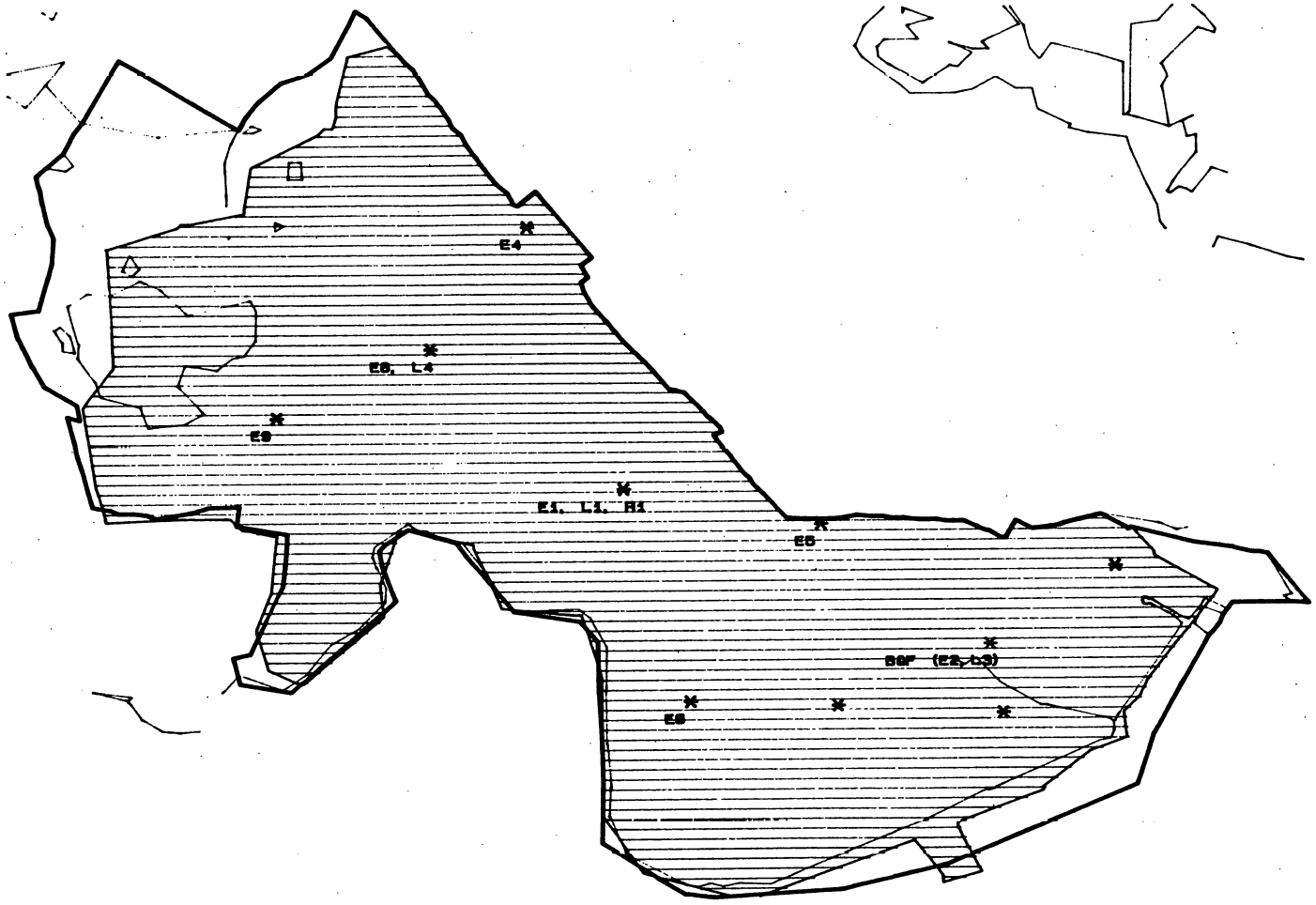
- close Engine 7.
- close Engine 3 and Ladder 2
- relocate Engine 2 and Ladder 3 to the intersection of Binney and Fulkerson Streets and close the existing Station 2.

As with Alternative Two, facilities for a new repair shop could be provided at a new station at Binney and Fulkerson, or the repair function could be relocated from Station 5 to Station~3.

The deployment alternative comprises seven pump companies, one at each of seven stations, and three ladder companies deployed at Stations One, Two and Eight.

One can see the impact of the elimination of Engine 3 by comparing the Alternative Three one pump, four minute coverage to the corresponding coverage in Alternative Two (Exhibit 33). The result of the closure of Engine 3 is a small reduction in the one pump, four minute response area that is confined to a virtually unpopulated area at Northpoint near the Big Dig. For this reason, there is no reduction in the proportion of the population that resides within a one pump,

Exhibit 37



4 AND/OR 8 COVERAGE

Alternative Three

UNION OF FOUR AND EIGHT MINUTE RCOs

Actual Travel Time set at 2.5 and 6.5 Minutes.

Water Features - plotted

Streets - not plotted

AREA/FEATURE

— CITY

* ALT5

four minute response. During the four year period 1988 to 1991, four code 11 structure fires occurred within a four minute response of Engine 3 that were not within a four minute response of any other engine.

The ladder coverage is the same for Alternative Three as it was for Alternative Two. This, combined with the limited impact of the elimination of Engine 3, makes the following service level measures the same for Alternative Three as they were for Alternative Two (see Exhibits 34, 35 and 37):

- the three pump, two ladder eight minute coverage,
- the proportion of the population residing at addresses at which the response capability objectives would have been achieved; and
- the proportion of the code 11 structure fires that occurred during the four year period 1988 to 1991, which occurred at addresses at which the response capability objectives would have been achieved.

It should be noted that Alternative Three leaves little room for unanticipated demands or increased activity, particularly if the emergency medical response capability is enhanced. This will be discussed later in the context of simultaneous demand.

5.6.5 Alternatives for Providing Emergency Medical Response

The scope of the emergency medical response service provided by the CFD and level of service are matters of public policy that should should be set by the City Council in consultation with the Chief of the CFD, the medical community and other knowledgeable sources. The purpose of this section is to set forth alternatives through which the CFD could deliver a selection of the emergency medical response services listed in Section 5.5.

There are three primary alternatives through which the CFD could deliver a selection of the emergency medical response services listed in Section 5.5:

1. Maintain the status quo. That is, continue to provide life support at the EMT level and emergency transport capability with one Rescue Company deployed at Station One, and provide a first responder capability via the engine companies deployed at each station;

2. Increase the service level and broaden the scope of the first responder service by introducing AEDs in each engine company, and maintain the current scope and level of service with respect to life support at the EMT level and emergency medical transport ; or

3. Increase the service level and broaden the scope of the first responder service by introducing AEDs in each engine company **and** improve the service levels in the life support at the EMT level and in the emergency medical transport services.

Maintaining the Status Quo

The American Heart Association response time recommendation for situations requiring AED is four minutes. Dr. Setnick, the physician who directs the training and medical supervision of the CFD with respect to emergency medical response, indicated that the probability of saving a life when AED is required to do so declines exponentially as the time between the occurrence of a cardiac problem and the administering of the shock.

A significant level of effort is required to provide the initial training, the refresher training and the monitoring necessary for the firefighters to offer an effective response with AEDs. However, there is a substantial benefit to be gained by doing so and this should be feasible over a period of time. If two firefighters on each engine were qualified to use AEDs and the CAD were implemented, then the CFD could respond to incidents requiring AED within a four minute period in more than 86 percent of the incidents using any of the deployment alternatives discussed earlier.

Given the benefits associated with the phased introduction of AEDs into the engine companies, the first alternative for providing emergency medical response services - maintaining the status quo- is easily dismissed. The primary cost would be the cost of the time required to compensate the firefighters for taking the required training. This is a worthwhile investment, since it increases the scope of the service that the firefighters can provide and no increase in on duty strength would be necessary to provide this service.

For these reasons, the City of Cambridge should, at a minimum, select the second emergency medical response alternative . That is, increase the service level and broaden the scope

of the first responder service by introducing AEDs in each engine company, and maintain the current scope and level of service with respect to life support at the EMT level and emergency medical transport . This would require the continued operation of the Rescue Company as it is currently configured. We suggest that the City consider enhancing the level of emergency medical response through the creation of three combination Engine - EMT companies which would replace the existing Rescue Company as described below.

Improve the Service Levels With Respect to Life Support at the EMT Level and Emergency Medical Transportation

The CFD's existing emergency medical response delivery system and the effectiveness of the CFD relies very heavily on one, active Rescue Company. The CFD accepts the risk that the Rescue Company, the only company that can provide extrication equipment, life support at the EMT level, AED, equipment required at the fireground and hazardous materials response, may be unavailable when needed.

There are currently more than 100 licensed EMTs in the CFD. However the only apparatus that is equipped to provide life support at the EMT level and/or transport a victim is the Rescue Company at Station One. This company can reach only 28.4% of the population within four minutes of its station house and, given its call rate, it could be busy on a previous call when a call for an EMT response is required.

Emergency medical response in the Cambridge Fire Department could be enhanced significantly by the creation of three combination pumper/EMS units deployed at Stations 1, 3 and 8. These combination pumper/EMS companies would respond as a Task Force unit to either fire or medical calls. Staffed with 6 firefighers, the combination unit could respond as a unit or be divided by the chief officer on duty if conditions require it. Generally, 4 firefighters would ride with the pumper and 2 would ride the emergency medical unit resulting in an enhanced response to either fire or medical calls.

The EMS apparatus employed as part of the combination company would be a class 1 ambulance suitable for patient transport. It would replace the second piece hose wagon now employed. The length and width of the EMS unit would be less than the second piece wagon and is more maneuverable. The cost of a fully equipped EMS/ambulance vehicle is approximately $75,000. The EMS unit should be designed for quick response and maneuverability in congested traffic. There are available on the market a range of vehicles with bodies not exceeding 13 feet and extended cabs so that the overall length of the vehicle is not more than 22 feet.

Unlike fire apparatus, emergency medical units do not require custom design or extended periods for delivery. They are commercially available and meet both federal and state standards for ambulances providing patient transport. From the outset of the program these combination units could be staffed by state certified Emergency Medical Technicians qualified to provide enhanced basic life support employing treatment protocols approved by a medical coordinator and a cooperating hospital. The ambulance service for patient transport could readily meet the standards set forth in state regulations governing ambulance service and emergency medical care.

Once established, the Cambridge Fire Department could also establish a program for crosstrained firefighters/EMTs to earn certification as intermediate level EMT, which would permit limited advanced life support including airway and circulatory maintenance and the use of esophageal airways.

The use of combination EMS/Pumper companies makes maximum use of highly skilled firefighter/EMT for both fire and medical response. It has been successfully introduced in several American cities and most recently in Norfolk, VA, a municipality of 275,000 population, covering 53 square miles.

The deployment of three such companies would provide three companies equipped and staffed to provide EMT services and emergency medical transport without delay throughout the City. In particular, these three companies could provide a response to:

FREQUENCY OF SIMULTANEOUS DEMAND DURING THE PERIOD JANUARY 1, 1988 TO DECEMBER 31, 1991

Number of occasion when three code 11structure fire occurred within 30 minutes	1
Occasions when two code 11occurred within 30 minutes	16
Occasions when a non code 11call occurs within 30 minutes of a code 11	662
Occasions when either a code 11or a code 30 - 39 call occurred with 30 minutes of one another	5,059
Occasions when three code 30-39 calls occurred within 30 minutes	795
Occassions when two (30-39) occured within 30 minutes	4,645
Total calls considered	45,265
Total code 30 to 39 calls	17,574
Total code 11 structure fires	919

- 61,959 citizens, or 64 % of the population,within a 2 1/2 minute travel time (four minute response time); and
- 90,121 citizens, or 94 % of the population,within a 4 1/2 minute travel time (four minute response time).

The existing rescue vehicle would no longer be staffed and the company would be reassigned to establish the combination Engine/EMT companies. The tools and specialized equipment currently carried on the Rescue Unit would be transferred to the ladder companies or to the combination Engine/EMT companies.

Some of the cost of improving life support at the EMT level and emergency medical transport service levels could be recovered by charging a fee for the transportation service. Senior management of the CFD estimate that 80% to 90%, or 2560 to 2880, of the 3200 code 32 calls for service during 1991 required emergency medical transport. At a fee in the amount of $250 per transport and an 80% recovery of fees invoiced, the revenue generated by this transportation service would amount to about $575,000 per annum. This would cover the annual compensation costs for 10 firefighters and contribute to the staffing of the three combination Engine - EMT companies.

5.6.6 Simultaneous Demand

In addition to determining whether or not a deployment alternative will meet agreed upon RCOs, one must assess the capacity of an alternative to address simultaneous demands for service. Exhibit 38 sets forth the frequency of simultaneous demands for service in the City of Cambridge during the period January 1, 1988 to December 31, 1991. The 45,265 calls for service that were recorded during this period were taken into account in this analysis. These included 919 code 11 calls for service (structure fires) and 17,574 code 30 to 39 calls for service (emergency medical response).

The important statistics with respect to assessing simultaneous demand include:

- the number of times that two or more simultaneous code 11 structure fires occurred over an extended period of time;
- the number of times that code 11 structure fires or code 30 to 39 calls occurred simultaneously over an extended period of time; and
- the number of times that two or more simultaneous code 30 to 39 calls occurred simultaneously over an extended period of time.

It can be seen that there were no instances when four code 11 structure fires occurred within 30 minutes of one another during this four year period. There was only one instance when three code 11 structure fires occurred within 30 minutes of one another. This occurred on June 29, 1991. However, there were 16 instances during the four year period when two code 11 structure fires occurred within 30 minutes of one another.

There were 795 instances when three code 30 to 39 calls for service occurred within 30 minutes of one another. This means that, on average, once every 1.84 days throughout the four year period there were three simultaneous code 30 to 39 calls for service in progress. As it happens, 13.6% of all code 30 to 39 calls for service occurred when two other code 30 to 39 calls were already in progress. Given the existing response procedures, this means that at least three engines and probably the Rescue company are simultaneously unavailable for response to a fourth call for service, and in particular for response to a code 11 call for service. Given its level of activity and the degree of simultaneity, it highly probable that there have been occasions when the existing Rescue Company has not been available to respond immediately to a code 11 structure fire. It would be far less likely that any one of three combination EMT- Engine companies would be unavailable to respond immediately, since the demand for EMS response would be spread across three companies.

There were 4,645 instances when two code 30 to 39 calls for service occurred within 30 minutes of one another. This means that, on average, there are two simultaneous code 30 to 39 calls for service in progress approximately three times per day throughout the four year period.

Given the existing response procedures, this means that at least two engines and perhaps the Rescue company are simultaneously unavailable for response to a third call for service, and in particular for response to a code 11 call for service three times daily.

There were 662 occasions when a non-code 11 call for service occurred within 30 minutes of a code 11 call for service. Also, there were 5,059 occasions when either a code 11 or a code 30 to 39 call occurred within 30 minutes of one another (Most of these were code 30 to 39).

A capacity that can effectively address two simultaneous code 11 structure fires and respond immediately to the emergency medical response calls is sufficient capacity to maintain on a day to day basis. Each alternative set forth in this report has the capacity to effectively address two simultaneous code 11 structure fires. Given the degree of simultaneity, especially with respect to the emergency medical response calls for service, and the need to be able to take a company out of service from time to time for training purposes, eight engine companies are required in the City of Cambridge.

One might be able to manage with seven engine companies under the following conditions;

- carefully managed step-ups or covers whenever a company is expected to be busy for a period exceeding 30 minutes;
- better integration between surrounding fire departments that are parties to mutual aide agreements;
- carefully monitoring response times and time in response and attendance to a call using the management reporting capability of a computer aided dispatch system; and
- calling back personnel to staff additional apparatus when conducting multi company training.

However, the CFDs' operations would have to be very carefully directed on a day to day basis if only seven engine companies were deployed.

The CFD does not have enough accurate data over a protracted period to determine the time distributions for a company that is out of service while attending to a call for service (such data is very difficult to obtain without CAD reporting capability). It is not possible to ensure, given the

Comparison of Population and Code 11 Coverage For the Existing Deployment and Various Alternatives

Exhibit 39

	POPULATION COVERED	% TOTAL	1988–1991 CODE 11's COVERED	% TOTAL
Existing Deployment:				
Dispatch Time Set At 2.0 Minutes				
Travel Time Set at 2.0 and 6.0 Minutes				
Four Min. Response – One Engine Cover	82,864	86.5%	694	85.6%
Eight Min. Response – Three Eng, Two Trk Cover	91,593	95.6%	760	93.7%
Intersection (4 AND 8)	82,524	86.1%	687	84.7%
Union (4 AND/OR 8)	91,762	95.8%	760	93.7%
Alternative One – Existing Deployment Less Station 7:				
Dispatch Time Set At 1.5 Minutes				
Travel Time Set at 2.5 and 6.5 Minutes				
Four Min. Response – One Engine Cover	91,222	95.2%	747	92.1%
Eight Min. Response – Three Eng, Two Trk Cover	93,111	97.2%	791	97.5%
Intersection (4 AND 8)	89,834	93.8%	739	91.1%
Union (4 AND/OR 8)	94,499	98.6%	799	98.5%
Alternative Two – Close E7 and L2. Move E2, L3 to Binney & Fulkerson Sts:				
Dispatch Time Set At 1.5 Minutes				
Travel Time Set at 2.5 and 6.5 Minutes				
Four Min. Response – One Engine Cover	89,639	93.6%	741	91.4%
Eight Min. Response – Three Eng, Two Trk Cover	93,111	97.2%	790	97.4%
Intersection (4 AND 8)	88,051	91.9%	731	90.1%
Union (4 AND/OR 8)	94,499	98.6%	799	98.5%
Alternative Three – Close E3, L2 and E7. Move E2, L3 to Binney & Fulkerson Sts:				
Dispatch Time Set At 1.5 Minutes				
Travel Time Set at 2.5 and 6.5 Minutes				
Four Min. Response – One Engine Cover	89,639	93.6%	737	90.9%
Eight Min. Response – Three Eng, Two Trk Cover	93,111	97.2%	790	97.4%
Intersection (4 AND 8)	88,051	91.9%	727	89.6%
Union (4 AND/OR 8)	94,499	98.6%	799	98.5%
City Totals	**95,802**	**100.0%**	**811**	**100.0%**

data available, if the response capabilities set forth in Section 3 could be achieved with only seven engines, but it is clear that the RCOs can be achieved with eight engines.

It is clear from the analysis of simultaneous structure fires that only one Deputy Chief is needed on duty per shift. On average, there are only four occasions per annum when there are two simultaneous code 11 structure fires. On average, at least one of these instances will occur during business hours, in which case another Deputy in the CFD can attend. Otherwise the Senior Captain responding can command until a Chief arrives. A response by a Deputy Chief is not required for emergency medical response calls.

5.6.7 Deployment Recommendation

Exhibit 39 sets forth the population and the four year code 11 structure fire coverage statistics for the existing deployment and the three deployment alternatives discussed. Each and every alternative meets the agreed upon RCOs.

There are only three firefighters on duty on a pump and on a ladder. A smaller number of pump and ladder companies, each staffed with four firefighters at all times, is very strongly recommended for the reasons set forth in section 5.4.

Adopting an on duty strength of four firefighters per company increases the total strength required to staff one company by 33% less the savings that result from a reduction in time lost due to injuries and other absences that usually results when the on duty staffing per apparatus is increased from three to four firefighters.

The existing deployment and all three alternatives meet the RCOs from a geographical standpoint. That is, if the apparatus were all in station, then apparatus responding from appropriate stations could respond to any call for service within four and/or eight minutes in at least 90% of the instances. However, given the volume of calls (primarily emergency medical response calls) and the degree of simultaneity, it is recommended that eight engines be deployed.

If the City of Cambridge decides to improve the service levels with respect to life support at the EMT level and emergency medical transportation, then it is recommended that the City adopt Alternative Two with the three, combination Engine - EMT configuration. The key elements of this alternative include:

- acquire and implement a computer aided dispatch;
- establish combination EMT - Engine companies at Station One, the relocated Station Two (Binney & Fulkerson) and Station Eight, each staffed with six firefighters;
- eliminate the Rescue Company and transfer the firefighters to staff the combination Engine - EMT companies;
- deploy five engine companies at Stations Three, Four, Five Six and Nine, each staffed with four firefighters;
- deploy ladder companies at Stations One, Two and Eight each staffed with four firefighters;
- discontinue the two - apparatus wagon engine company concept;
- relocate the repair facility to Station Three; and
- reduce the number Deputy Chiefs' on duty at any given time in the Suppression Division from two to one.

The on duty staffing by company for each of the 11 companies, based on Alternative Two with enhanced emergency medical response and transport capability, would be as follows:

3 EMT / Engine Companies @ 6 firefighters	=	18	firefighters
5 Engine Companies @ 4 fighters	=	20	firefighters
3 ladders Companies @ 4 fighters	=	12	firefighters
1 Deputy Chiefs	=	1	chief
1 Deputy Chief's Aide	=	1	firefighter
	=	52	firefighters

If the City of Cambridge decides to introduce AED's, but opts not to improve the service levels with respect to life support at the EMT level and emergency medical transportation, then it is recommended that the CFD maintain the existing Rescue Company staffed with four firefighters and deploy eight, four fire fighter engine companies in the locations set forth in Alternative Two.

All the other elements of Alternative two should be implemented.

Exhibit 40

Populated Areas Within Which The RCOs Are Achieved For a 2.5 But Not For A 2.0 Minute Travel Time.

Each Area is Labelled With Its Respective Population.

AREA/FEATURE

— CITY

* STATIONS

— NOTCOV25

— NOTCOV2

The on duty staffing by company for each of the 11 companies, based on this deployment would be as follows:

8 Engine Companies @ 4 fighters	=	32	firefighters
3 Ladders Companies @ 4 fighters	=	12	firefighters
1 Rescue Company @ 4 fighters	=	4	firefighters
1 Deputy Chief	=	1	chief
1 Deputy Chief's Aide	=	1	firefighter
	=	50	firefighters

An implementation plan is set forth in Section 6.

5.6.8 Areas Within Which the RCOs May Not Be Achieved

Exhibit 24 in Section 5.4.5 depicted the three populated areas of the west end of Cambridge that cannot be reached within a two minute travel time given the existing deployment and dispatch time. Approximately 4039 people, or 4.2% of the population, live in these areas.

Exhibit 28 in Section 5.4.7 indicated that these are the same areas as the areas within which three pumps and two aerial apparatus cannot arrive within a six minute travel time. This is due primarily to the fact that the second due aerial, which responds from Station One, cannot reach the west edge of Cambridge within a six minute travel time and the third due engine cannot reach some areas in the west and southwest within a six minute travel time.

An analysis of the individual apparatus response templates shows that, with the existing deployment and dispatch time (and therefore a two minute travel time), two engines and one aerial can reach all areas within the City boundary within a six minute travel time.

If a computer aided dispatch system is introduced enabling a significant reduction in the combined dispatch and reaction time, then the travel time component of the response time would be increased by the same amount. This substantially reduces the number of citizens residing in areas within which the RCOs would not be achieved. Exhibit 40 presents, for each of the three areas set forth in Exhibit 24, the number and location of residents that are within a 2.5 minute travel time, but who are not within a two minute travel time:

- the number of citizens in the northwest corner who are not within the RCO coverage area is reduced by 737, or from 1351 to 614;
- the number of citizens just north of Concord Avenue at the west edge of the City who are not within the RCO coverage area is reduced by 253, or from 835 to 582; and
- the number of citizens west of Aberdeen in the southwest corner of the City who are not within the RCO coverage area is reduced by 1747, or from 1853 to 106.

This leaves approximately 1300 residents, or 1.4% of the population, residing in areas within which the RCOs may not be achieved. It should be recognized that there are three small areas within which the RCOs may not be achieved and that this is difficult to address without substantial annual expenditures. In addition, if the CAD is implemented, two or three pumps and one aerial will be able to respond within eight minutes to most of the areas within which the RCOs would not be achieved.

From a geographical perspective, if the City wished to meet the eight minute objective throughout all of west Cambridge, the CFD would have to either;

- deploy one additional pump and one additional aerial in the existing stations at an estimated annual cost in the amount $2.3 million;
- improve the reaction time in the stations responding; or
- improve the road network in the area.

Achieving the four minute objective in all areas in west Cambridge would be extraordinarily expensive since there are three small, separated areas that are not covered within a 2.5 minute travel time. We examined the possibility of moving stations to address this matter. This invariably resulted in creating other areas which would not be covered as well, and these areas would contain as many or more residents as the areas within which the RCOs would not be achieved with the recommended deployment.

PRELIMINARY ESTIMATE OF THE EXISTING STAFFING FACTOR FOR THE SUPPRESSION DIVISION

Hours per tour		48
Days per tour		8
Tours per year		45.63
Annual hours per fire fighter		2,190
On duty strength		46
Hours per year per position		8,760
Total on duty hours required		402,960
Vacation for 240		80,640
Injury leave for 240		25,609
Other leave at 2%		10,424
		519,633
Hours per firefighter	÷	2,190
Firefighters		237.27
Ratio (÷ 46)		5.16

ESTIMATED ON DUTY STRENGTH, TOTAL STRENGTH REQUIREMENT AND COST BY DEPLOYMENT ALTERNATIVE*

Alternative	Staffed Apparatus	Total On Duty Strength	Total Suppression Division Strength	Cost Estimate For Suppression ($000)	Notes
Status Quo	9E, 4L, 1R, 2DC, 2A	46	240	$13,640	3FF per unit
Alternative One (Status Quo Less E7)	8E, 4L, 1R, 1DC, 1A	54	280	$15,910	4FF per unit
Alternative Two With Enhanced EMT	3E/EMT, 5E, 3L, 1DC, 1A	52	270	$15345 - $575 =14,770	6FF per E-EMT 4FF per Engine 4FF per Ladder
Alternative Two Without Enhanced EMT	8E, 3L, 1R, 1DC, 1A	50	260	$14,777	4FF per unit
Alternative Three	7E, 3L, 1R, 1DC, 1A	46	240	$13,640	4FF per unit

*Excludes 10 uniformed members on Long Term Disability
*16.3 million salaries and wages for establishment of 287 uniformed members = $56,833 per member

Exhibit 42

5.7 THE COSTS OF EACH ALTERNATIVE AND THE RECOMMENDED STRENGTH OF THE SUPPRESSION DIVISION

5.7.1 An Estimate of the CFD Staffing Factor and the Costs of Each Alternative

The Cambridge Fire Department Suppression Division employs a four platoon system for continuous coverage of the City 24 hours a day for each day of the year. A firefighter assigned to this platoon system is scheduled to work 182.5 shifts or 2190 hours per year, less authorized leave for vacation, illness, injury or similar reasons. This platoon system provides both equitable and economical coverage.

Currently the Cambridge Fire Department strives to maintain 46 firefighters on duty per shift (three fire fighters on each of nine pumps, four ladders and one rescue, two Deputy Chiefs and two Deputy Chiefs' aides), totalling 33,580 shifts per year (46 firefighters x 365 days x 2 shifts per day). Thus, 184 personnel are required, at a minimum, without consideration for any authorized leaves.

Exhibit 41 estimates the number of fire fighters that were required to maintain 46 or more firefighters on duty in the CFD during 1991. This exhibit is based on a review of injury leave, a review of the labour agreement and discussions with senior management. The calculations indicate that, currently, approximately 5.2 firefighters are needed on strength to maintain one firefighter on duty around the clock. The assumptions include:

- 28 twelve hour shifts leave for each member of the suppression division
- 107.6 injury hours per member of the suppression division
- 2.0% other leave per member of the suppression division; and level loading of vacations.

The calculation estimates that a total strength of 237 firefighters in the suppression division is required to maintain an on duty strength of 46 firefighters. In 1991 the actual number was 244. Most of the difference can be attributed to the fact that vacations are level loaded.

An estimate of the costs associated with each deployment alternative using this staffing factor is set forth in Exhibit 42.

5.7.2 The Recommended Strength of the Suppression Division

The staffing ratio for the Suppression Division implicit in these assumptions is 5.2. This means that in order to maintain an on duty strength of 52 firefighters per Alternative Two, each of the four platoons should be provided the following 67 established positions:

- 1 Deputy Chiefs;
- 15 Captains; and
- 51 Firefighters.

The recommended total strength of the Suppression Division if Alternative Two is selected, is 270 firefighters. This excludes the 20 personnel assigned to other areas within the CFD and the 10 personnel who are currently on long term leave due to injury.

Alternative Two less the combination Engine - EMT configuration requires an on duty strength of 50 firefighters. Given the 5.2 staffing factor, each of the four platoons should be provided the following 65 established positions:

- 1 Deputy Chiefs;
- 15 Captains; and
- 49 Firefighters.

The recommended total strength of the Suppression Division if this option is selected, is 260 firefighters. This excludes the 20 personnel assigned to other areas within the CFD and the 10 personnel who are currently on long term leave due to injury.

6. IMPLEMENTATION PLAN

The recommendations set forth in this report, especially those pertaining to deployment, training and organization, are closely interrelated and must be adopted as a complete set to be effective. It is important that one alternative or another be implemented in its entirety. The implementation of a mixture of the alternatives discussed or the implementation of a subset or portion of recommendations comprising an alternative, while excluding others, would be difficult and possibly detrimental to the CFD in the longer term.

It should take approximately 18 months to implement, or launch the implementation of the recommendations contained in the report.

APPENDIX A

DIGITIZED STREET NETWORK

(Under Separate Cover)

APPENDIX B

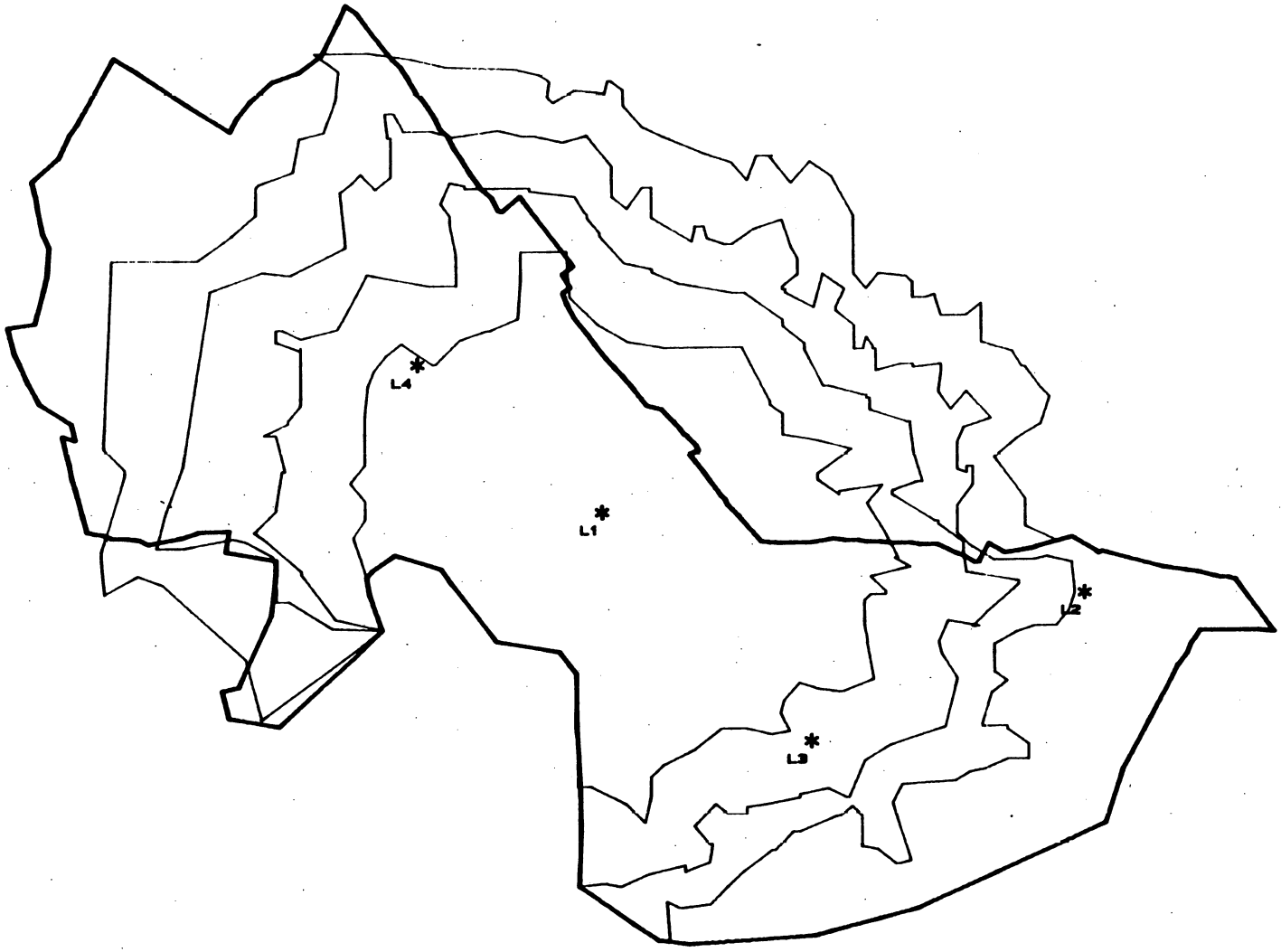
GIS Maps of Ladder Response Areas

APPENDIX B

GIS Maps of Ladder Response Areas

Exhibit 1

LADDER #1



0 0.46 miles

Area covered in

6.5 minutes,

5.5 minutes,

4.5 minutes, and

3.5 minutes.

Speed Assumptions:

20mi/hr on major roads

and freeways

15mi/hr on all other

roadways

(roads not plotted)

If dispatch time is set

at 1.5 minutes, then

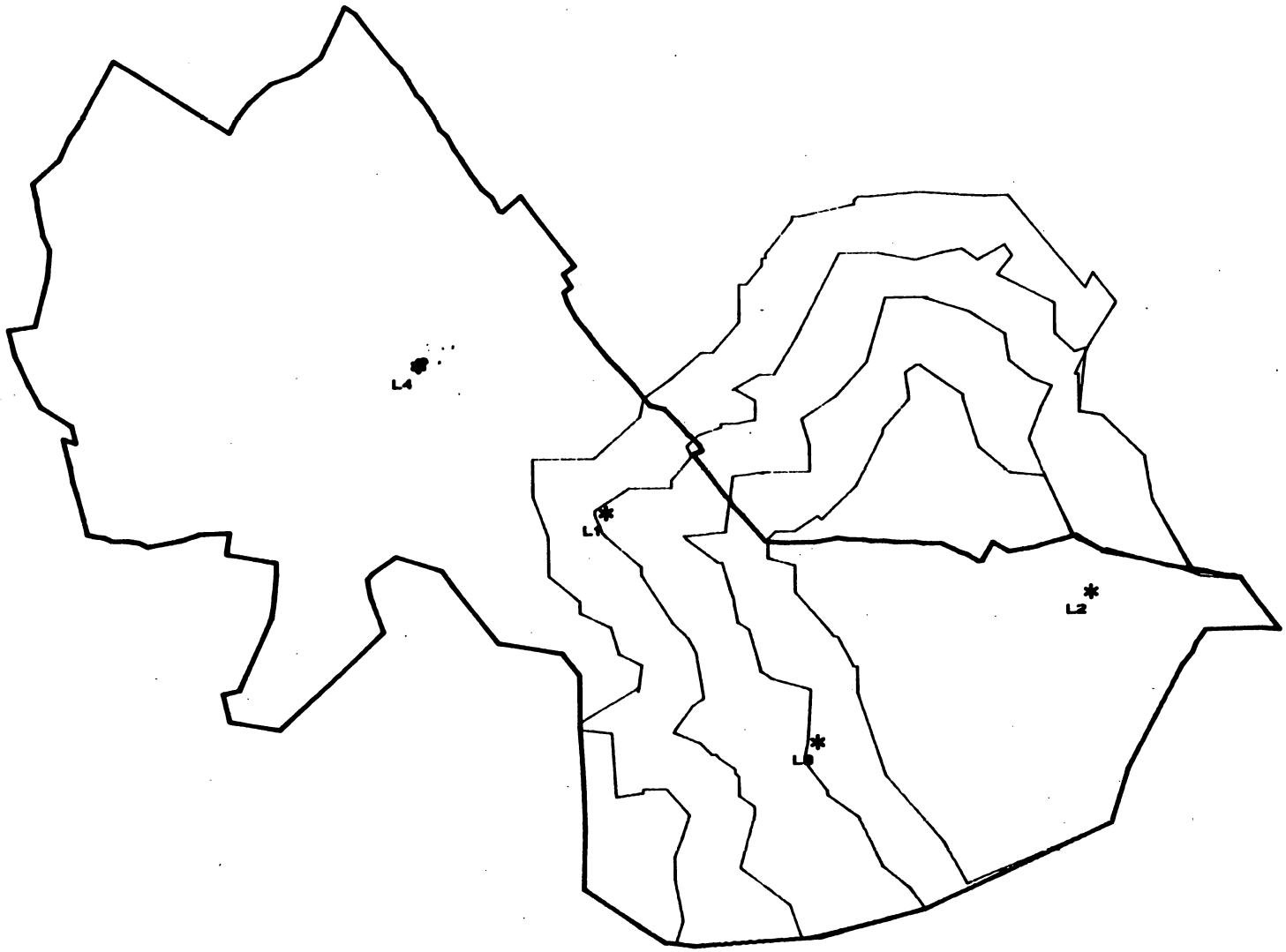
total response times for the

above travel times are 8, 7, 6,

and 5 minutes respectively.

Exhibit 2

LADDER #2



0 0.46 miles

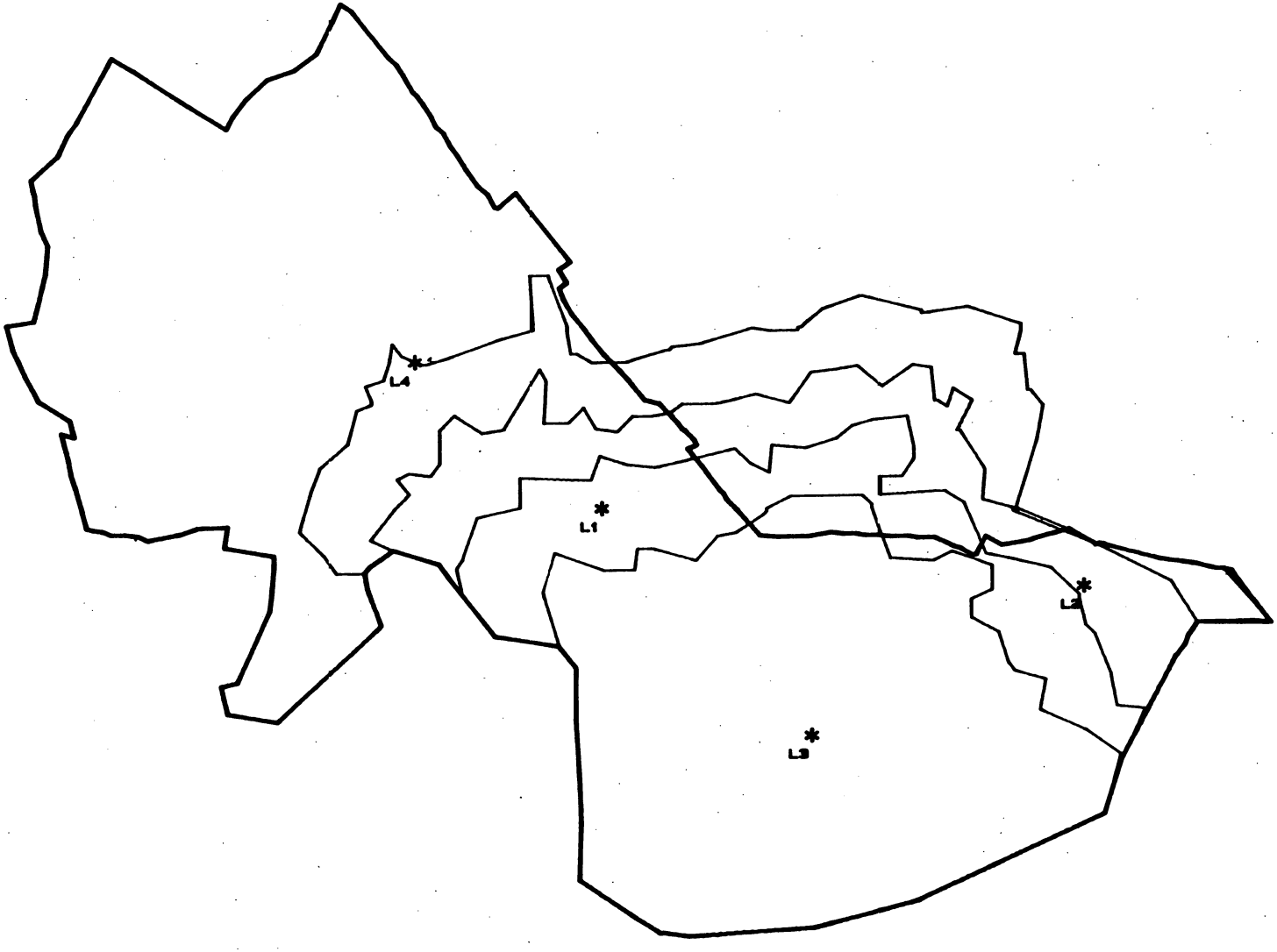
Area covered in
6.5 minutes,
5.5 minutes,
4.5 minutes, and
3.5 minutes.

Speed Assumptions:
20mi/hr on major roads
and freeways
15mi/hr on all other
roadways
(roads not plotted)

If dispatch time is set
at 1.5 minutes, then
total response times for the
above travel times are 8, 7,
and 5 minutes respectively.

Exhibit 3

LADDER #3



0 0.46 miles

Area covered in
6.5 minutes,
5.5 minutes,
4.5 minutes, and
3.5 minutes.

Speed Assumptions:
20mi/hr on major roads
and freeways
15mi/hr on all other
roadways
(roads not plotted)

If dispatch time is set
at 1.5 minutes, then
total response times for the
above travel times are 8, 7, 6
and 5 minutes respectively.

Exhibit 4

LADDER #4

0 0.46 miles

Area covered in

6.5 minutes,

5.5 minutes,

4.5 minutes, and

3.5 minutes.

Speed Assumptions:

20mi/hr on major roads

and freeways

15mi/hr on all other

roadways

(roads not plotted)

If dispatch time is set

at 1.5 minutes, then

total response times for the

above travel times are 8, 7, 6,

and 5 minutes respectively.

Exhibit 5

BINNEY AND FULKERSON

0 0.46 miles

Area covered in

6.5 minutes,

5.5 minutes,

4.5 minutes, and

3.5 minutes.

Speed Assumptions:

20mi/hr on major roads

and freeways

15mi/hr on all other

roadways

(roads not plotted)

If dispatch time is set

at 1.5 minutes, then

total response times for the

above travel times are 8, 7, 6,

and 5 minutes respectively.

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EXECUTIVE DEPARTMENT
ROBERT W. HEALY
City Manager

RICHARD C. ROSSI
Deputy City Manager

January 4, 1993

To the Honorable, the City Council:

As the City Council is aware, the City has undertaken a comprehensive analysis of fire station locations, staffing patterns and emergency medical response for the purpose of increasing the efficiency of our fire suppression and emergency service operations. The recommendations that resulted from this study are far-reaching, and will become an integral part of public safety planning for the 1990s. At this time, Fire and City Management have agreed to implement the following recommendations that will result in increased efficiencies in fire suppression capabilities: implementation of a coordinated public safety computer-aided dispatch system (CAD) that will serve the Police and Fire Departments and will significantly enhance our response capabilities; introduction of automatic external defibrillation (AED) at specific engine companies which will broaden the scope of our First Responder service and meet - or exceed - the American Heart Association's recommendation regarding response time to coronary incidents; move towards four-person staffing, as often as possible on each pump and ladder company, and away from the current three fire fighter staff, which should result in more effectively managed fireground operations; and close Engine Seven at 350 Main Street and redeploy all personnel to increase the number of four-person crews.

Below, I outline the background and process for carrying out this study, and the range of alternatives and recommendations presented. Attached is the full evaluation of our Fire Protection Services conducted by Ernst & Young Consultants.

BACKGROUND

Although our emergency medical response (EMS) was first identified for review in my FY1992 Budget Message, it was acknowledged that EMS needed to be evaluated in conjunction with our fire suppression services, and it was my desire to remove this analysis from the emotion and time limitations of the annual budget process. Public safety is one of our highest priorities, and it is imperative that Cambridge have reliable, comprehensive and statistically sound information so that the Fire Department and City can determine appropriate policies and staffing.

In September, 1991, I formed a task force to identify areas to be studied and to develop a

Request for Proposal (RFP) for outside assistance in reviewing those areas of concern. The task force was comprised of Fire Chief Kevin Fitzgerald, Firefighters Union President John Lawless, Personnel Director Michael Gardner, Assistant to the City Manager Lisa Peterson, and Finance Director James Maloney. In December, 1991, the task force unanimously recommended that I award the contract to the international management consulting firm Ernst & Young, and the City Council approved the $95,000 appropriation to fund this study.

Ernst and Young has strong credentials in the field, having completed similar studies in numerous locations including Pittsburgh, PA and Calgary and Thunder Bay, Ontario. The team was headed by a former New York City Deputy Fire Chief with an extensive professional and academic career that includes over 20 years experience in fire prevention and suppression. The second principal in the team is a specialist in statistical analysis with a great deal of experience in computer assisted mapping and geographic information systems.

As the study was implemented, the task force formed to develop the RFP and hire the consultants became the study's Oversight Committee; this committee expanded to include additional Fire Department expertise: Deputy Chiefs Reardon (communications), O'Donaghue (emergency medical response) and Ellis (staffing and administration).

PROCESS OF CONSULTING TEAM

The consultants' analysis included: an assessment of the existing fire station locations to determine if they should remain in place, relocate to a more appropriate location, or merge with an existing fire station; an evaluation of staffing patterns in the fire fighting division and the rescue unit; and an assessment of the pieces of apparatus at each engine company, ladder company and the rescue unit.

At the beginning of the process, the Consultants met with the Oversite Committee, Deputy City Manager Richard Rossi and me to develop measurable response capability objectives around which alternatives could be developed. The entire committee agreed upon the following response capability objectives:

> The initial apparatus (one pump and one ladder) shall arrive at the scene of the alarm within four minutes of receipt of the alarm in at least 90% of all occurrences;
>
> AND/OR
>
> The full initial response complement (three pumps and two ladders) shall arrive at the scene of the alarm within eight minutes of the receipt of the alarm in at least 90% of all occurrences.

The process for developing response capability objectives, for developing an understanding of

the demand for service, and for conducting a deployment analysis was participative and based on building consensus. Throughout the course of the study, various methodologies were used in conducting the analysis:

on-site visits at each engine company, and discussions with fire personnel, including senior management and on-duty station captains at each engine company, about the hazards, target risks and demands for service;

analysis of calls for service and types of response, which included plotting all structural fires to which the Fire Department responded during the four-year period 1988 to 1991 on a geographic information system;

comparisons to similar jurisdictions: Ernst & Young compiled 17 measures from 11 similarly situated American cities to develop a comparative assessment of the demand and supply of fire protection in the City of Cambridge relative to these municipalities (see Section 2.3);

review of demographic and planning information (see Section 2.5), which includes population trends, housing stock, traffic flow and patterns, and proposed developments over the next ten years;

conduction of a deployment analysis (see Section 5.0) which in and of itself involves various methodologies, and includes the use of a geographic information system (GIS) with the 1991 US Census Bureau TIGER file for the City of Cambridge to assist in the analysis. By using GIS, which incorporated various traffic data, maps were created around each fire station depicting the area that is covered by a piece of fire apparatus within a 2 and 2 1/2 minute response time area (4 and 4 1/2 minutes when including dispatch time); and

periodic meetings with the oversight committee to verify data.

PRELIMINARY FINDINGS/ALTERNATIVES

The consultants presented three sets of alternatives as well as an expanded EMS alternative. Briefly, they are as follows (see Section 5.6):

Alternative One: The Existing Deployment Less Engine Seven

This deployment alternative includes eight pumps, one at each of eight stations, and four ladders as they are currently deployed. 98.6% of the population reside at addresses at which the response capability objectives would be achieved given the Alternative One deployment. Provided that CAD were put into place and the on-duty staffing on other pumps proximate to Station Seven were increased prior to its elimination, the elimination of Engine Seven would

have essentially no effect on the four minute coverage area in eastern Cambridge.

Alternative Two: **Close Engine Seven and Ladder Two. Move Engine Two and Ladder Three to Binney and Fulkerson**

This deployment alternative includes eight pump companies, one at each of eight stations, and three ladder companies deployed at Stations One, Two and Eight. Station Two, which houses Engine Two and Ladder Three, would be relocated to a new station at the intersection of Binney and Fulkerson. The computer mapping shows that three ladders deployed in these locations will result in two ladders arriving at the scene before eight minutes elapsed time: at eight minutes, two ladders can response to 97% of the populations of the City.

Alternative Three: **Close Engine Three, Ladder Two and Engine Seven. Move Engine Two and Ladder Three to Binney and Fulkerson**

The deployment alternative comprises seven pump companies, one at each of seven stations, and three ladder companies deployed at Stations One, Two and Eight. The result of the close of Engine Three is a small increase in area (in the Northpoint area) in which the four-minute response capability objective is not achieved.

Emergency Medical Response (EMS) Alternatives:

The Consultants outlined three alternatives through which EMS services could be delivered (see Section 5.6.5).

* Maintain the status quo: to continue to provide life support at the EMT level and emergency transport capability with one Rescue Company deployed at Station One, and provide a First Responder capability via the engine companies deployed at each station.

* To introduce automatic external defibrillation (AED) in each engine company, and otherwise maintain the current scope of service.

* To introduce AED at each engine company AND create three combination pump/EMS units deployed at Stations One, Three and Eight. These combination pump/EMS companies would be staffed with six fire fighters and would respond as a task force unit to either fire or medical calls. Generally, four fire fighters would ride with the pump and two would ride the emergency medical unit. The EMS apparatus would be suitable for patient transport. In this alternative, the City would charge a fee for the transportation service. At a fee of $250 per transport and an 80% recovery rate of fees invoiced, the revenue generated by this transportation service would amount to about $575,000 per year.

Areas in which the Response Capability Objectives may not be achieved:

Exhibit 24 in Section 5.4.5 depicts three small areas in west Cambridge that cannot be reached with a two minute travel time, given the existing deployment and dispatch time. Approximately

4.2% of the population live in these areas. Three pumps and two ladders cannot arrive to these areas within an eight minute response time; this is primarily due to the fact that the second ladder, which responds from Station One, and the third due engine cannot reach the west end of Cambridge within an eight minute response time.

A computer aided dispatch system would enable a significant reduction in the combined dispatch and reaction time, subsequently reducing the number of citizens residing in areas within which the response capability objectives would not be achieved. This leaves only approximately 1.4% of the population residing in areas within which the response capability objectives may not be achieved. It should be recognized that achieving the response capability objective in all areas in west Cambridge would be extraordinarily expensive since there are three small, separated areas that are not covered within a 4 1/2 minute response time.

It should also be noted that fire apparatus are restricted from using the railroad bridges at Alewife Brook Parkway and Walden Street, due to weight restrictions, thus forcing a more convoluted path to certain sections of the City. The bridge at Alewife Brook Parkway is scheduled to be rebuilt; Fire apparatus should be able to travel on it beginning in 1995, and the response time to certain sections of the City should be improved.

FIRE CHIEF'S RESPONSE

At the conclusion of the study, Fire Chief Kevin Fitzgerald's response consisted of the following points:

Wants to maintain four ladder companies;

Does not want to get into the business of transporting on a regular basis, and charging fees. The experience of the Fire Department is that we would not be able to charge $250 per transport;

Would like to introduce automatic external defibrillation (AED), but only at three stations at this time: Stations Three, Four and Nine. The Fire Department would prefer to phase it in because of demand and training issues;

Supports the closure of Engine Seven along with full redeployment of those personnel;

Supports CAD and a centralized communications center; and

Concerned about West Cambridge response time.

The Fire fighters' union, represented by John Lawless, is very interested in four-person crews on each piece of apparatus, and making sure there are no demotions in rank, or cuts in

commanding officer positions (Lieutenants, Captains, Deputy Chiefs).

CITY MANAGER'S RESPONSE

Throughout the course of the study, I have listened to and considered all of the alternatives and recommendations while trying to achieve an increase in effectiveness in our fire and emergency medical response. The consultants strongly recommended that the City function with one less ladder company, a recommendation with which the Fire Department vehemently disagreed. While I was interested in this alternative, I also recognize the strain on a department when undergoing too much change, and recognize that to truly achieve an increase in fire response capabilities, there needs to be a consensus among City and Fire Management in implementing change. Consequently, a decision was made to comply with the feelings of the Chief on the ladder and medical transport role.

In addition, I have a strong interest in closing Station Seven, implementing CAD and introducing automatic external defibrillation.

The alternative suggesting the closure of two engine companies was ultimately rejected due to several factors. The eventual development of North Point will necessitate the East Cambridge Fire Station. In addition, the closure of two engine companies leaves little room for unanticipated demands or increased activity. Because of the rate of simultaneous demand (see Section 5.6.6), especially with respect to emergency medical response calls for service and the need to take a company out of service from time to time for training purposes, it was determined that eight engine companies are required in Cambridge.

OVERALL APPROVED RECOMMENDATIONS

The Oversight Committee agreed to the following points, subject to certain bargaining obligations. All of these recommendations are interrelated; failure to achieve one or more of these objectives may have a negative impact on another.

(1) Much of the time - particularly during peak vacations times - there are only three fire fighters on duty on a pump and on a ladder. Our goal is to increase the number of four-person crews on pumps, ladders and on the Rescue; this may result in a reduction of injuries, and should result in an increase in effectiveness at a fire. A four fire fighter company is over 150% more effective than a three fire fighter unit; four fire fighter companies are more effectively managed on the fireground to insure prompt execution of critical tasks and more prompt accomplishment of critical functions of fire control. As a result, absent a major financial setback, we will hire fire fighters up to budgeted strength (282, less the 4 administrative positions).

(2) Implement a computer-aided dispatch system as soon as practicable, which will replace the existing cardex system, the Electric Department's Communications Center and the 911 Center at the Police Department with a single Communications Center serving all emergency response organizations in the City. It is estimated that the reduction in dispatch time will increase the Fire Department's response time by at least 30 seconds.

The introduction of computer-aided dispatch is the most far-reaching and equitable improvement that can be made to our fire protection service in that it reduces the response times to almost all citizens by the same amount. It is also the best way to significantly reduce the area in West Cambridge where the response capability objectives are not achieved.

The time spent passing information, or transferring a caller requesting service, from the 911 Center at the Police Department to the Electrical Department's Communications Center should be eliminated by establishing one, and only one, Communications Center to service all emergency response organizations in the City.

(3) Close Engine Seven. Even with this station closing, 94,499 or 98.6% of the total population - and all residents of the Engine Seven service area - reside at addresses which the response capability objective are achieved. Fire fighters currently deployed at Engine Seven will be redeployed to other stations, increasing the number of four-person crews.

(4) Increase the service level and broaden the scope of First Responder service by introducing automatic external defibrillation (AED) at three Engine Companies specified by the Fire Department: Engines Three, Four & Nine. The American Heart Association recommendation regarding response time to coronary incidents requiring the use of AED is four minutes. The Rescue Company is the only company currently equipped and trained to provide AED. Only 28.4% of the population resides within a four-minute response time of Station One, where the Rescue Company is housed.

Maintain the current service levels with respect to life support at the EMT level and emergency medical transportation.

(6) No demotions in existing rank.

(7) Goal of equalizing vacations throughout the year. This will stabilize the number of fire fighters available throughout the year. Currently vacations are concentrated in peak periods which makes achievement of four-person crews more difficult to achieve.

(8) No current cuts in Deputy Chiefs or Chiefs' aides (12 deputies).

(9) Eight fire fighter vacancies is the target for calling a new recruit class.

FIRE STATIONS, LADDER COMPANIES & LOCATIONS

Engine Company 1 Aerial Tower Unit Rescue Company	Headquarters, 491 Broadway
Engine Company 2 Ladder Company 3	Lafayette Sq., 378 Mass. Ave.
Engine Company 3 Ladder Company 2	E. Cambridge, 173 Cambridge St.
Engine Company 4	Porter Sq., 2029 Mass. Ave.
Engine Company 5	Inman Sq., 1384 Cambridge St.
Engine Company 6	176 River St.
Engine Company 7	Kendall Sq., 350 Main St.
Engine Company 8 Ladder Company 4	Taylor Sq., 113 Garden St.
Engine Company 9	167 Lexington Ave.

NOTICE OF COMMUNITY MEETING ON THE OFFER BY STOP & SHOP, INC. TO PURCHASE RIVERSIDE ROAD

Thursday, February 4, 1993

7:00 p.m.

Morse School Auditorium

As required in Section 2.110.010 of the Cambridge Municipal Code, Disposition of City Property, the City Manager will hold a community meeting on Thursday, February 4, 1993 at 7:00 p.m. in the Morse School Auditorium to discuss the offer by Memorial Realty Trust (Stop & Shop) to purchase Riverside Road. In their proposal of October 27, 1992, Stop & Shop has offered to pay the sum of $1,000,000 (one million dollars) for Riverside Road if they are permitted to build a new Super Stop & Shop supermarket at this location. As part of this proposal, Stop & Shop would agree to build only a Super Stop & Shop supermarket on the assembled site.

This community meeting will be an opportunity to discuss any issues and concerns residents and property owners may have relating to Stop & Shop's offer to purchase Riverside Road. As outlined in the Disposition of City Property Ordinance, the City Manager shall prepare a report which includes these concerns and submit this report to both the Planning Board and the City Council. The Planning Board shall hold a public hearing on the disposition and then submit its recommendation to the City Council. The City Council, after a public hearing on the disposition, shall then vote on the disposition.

Stop & Shop has submitted its Draft Environmental Impact Report (DEIR) to the Massachusetts Environmental Protection Agency (MEPA) for review of the Super Stop & Shop proposal. Copies are available for review at the Morse School Library, the Central Square Branch Library on Pearl Street, the Cambridge Main Library on Broadway, or by contacting David Albrecht of Vanasse Hangen Brustlin, Inc. at 617-924-1770. Written comments on the DEIR may be submitted to MEPA before 5:00 p.m. on February 8, 1993.

For further information, call Stuart Dash at the Cambridge Community Development Department at 349-4600

11.

CITY OF CAMBRIDGE
CAMBRIDGE, MASSACHUSETTS 02139
TEL 349-4300
FAX. 349-4307

EXECUTIVE DEPARTMENT
ROBERT W. HEALY
City Manager

RICHARD C. ROSSI
Deputy City Manager

January 11, 1993

To The Honorable, The City Council:

For your information, the City Manager's community meeting concerning the possible disposition of Riverside Road will be held on Thursday evening, February 4 at 7:00 at the Morse School Auditorium. As you know, that community meeting is a required step in the process for the disposition of city owned land pursuant to the Ordinance governing the disposition of City property. The issues raised at the community hearing will be addressed in the Report that I will send to the Planning Board and to the City Council as required by the terms of the Ordinance.

You will also want to know that the comment period on the Draft Environmental Impact Report submitted for the Super Stop and Shop proposed project runs from January 8 until February 8. Copies of the Draft EIR will be made available to the Council upon request and will be available to the public at the Central Square and Main Libraries and at the Morse School Library. The Director of the Environmental Program will be coordinating the responses of the various City Departments.

Very truly yours,

Robert W. Healy

CONSENT AGENDA ITEM #11

F.

Communication from Robert W. Healy, City manager, relative to the City Manager's community meeting concerning the possible disposition of Riverside Road, scheduled for Thursday, February 4, at 7:00 p.m.

In City Council,

January 11, 1993

Placed on file

TIMELINE/OUTSTANDING ISSUES

The implementation plan for the agreed upon recommendations - and outstanding issues - are as follows:

(1) Hire up to budgeted strength: a class of 23 fire fighters will graduate in June 1993.

(2) Close Engine Seven on July 1, 1993, and redeploy personnel to other stations.

(3) Introduce automatic external defibrillation (AED) at Engines Three, Four & Nine. The costs of the defibrillators (approximately $5,000 each) and training will be included in FY93 budget discussions.

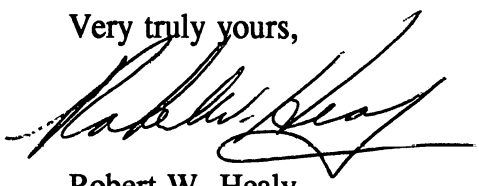
(4) A CAD planning group which includes personnel from the Fire, Police, Electrical and Data Processing Departments has been meeting since the spring of 1992. The need now is to develop the request-for-proposal, and to determine the costs and location of the communications center. Within the next few months, once a final determination is made, It is likely I will be coming to the City Council for authorization to fund this project.

(5) Underprotected areas in West Cambridge - After CAD and the Alewife Brook Parkway bridge is reconstructed, we will closely study that area, particularly if development returns to Alewife.

CONCLUSION

The study of the City's fire response system has been extremely helpful in identifying and quantifying service needs in this vital public safety service. I would like to thank all of the members of the Fire Department who worked with the outside consulting group in producing data and responding to the various alternatives. This project was purposefully undertaken outside the annual budget process in order to analyze our fire protection needs independently of the often emotionally charged debates that occur during budget deliberations. As a result, I believe our final recommendations offer the residents of Cambridge a fire response plan that affords the City the highest level of response capabilities.

Very truly yours,



Robert W. Healy
City Manager

Attachment

AGENDA ITEM #17

F-8

Communication from Robert W. Healy, City Manager, relative to the Fire Study (Awaiting Report Item No. 19.)

See 1992 F # 511 for Order.

In City Council,

January 4, 1993

Tabled
1/11/93 Referred to the Public Safety Committee & Finance Committee for joint hearing
1/13/93 Copies sent to both Committees CW