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QUANTITATIVE ANALYSIS OF POLICE-FIRE MERGERS AND A STUDY OF A MEDIUM-SIZED CITY

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The findings and opinions presented in this report are those of this author. They do not necessarily reflect the opinions of the National Institute of Justice.

EXECUTIVE SUMMARY

City officials must often make difficult decisons in the face of tight budgets. Because emergency services in medium sized cities are a significant portion of the budget, they are natural targets for cost reductions. One proposal for reducing cost while maintaining or improving service levels is police-fire mergers in which officers are trained to handle both roles. Instead of keeping a full staff on fire station standby, a fully merged public safety department stations only enough personnel to drive the fire equipment while the rest of the officers are on regular police patrol. In the case of a fire, these patrolling units respond to the scene and staff the arriving fire equipment.

The largest city to have implemented this concept is Sunnyvale California, which has a population of over 100,000; Michigan is the state with the largest number of public safety departments in the country. In contrast, Durham, North Carolina is also a city with over 100,000 and in 1985 decided to revert back to separate departments after years of phasing in a merger.

Any city official contemplating a change to public safety can expect a heated debate and possibly a political fight that could cost him his job. The debate over the concept is charged with emotions and claims and counterclaims on both sides of the issue. One side claims "a merger will reduce response time to a fire"; the other counterclaims "that it will take longer to get the personnel to the fire scene". One side claims that "when a fire breaks out, police coverage and response to police calls deteriorates"; the other side counters "the additional personnel in patrol units will increase preventive patrol". Lastly, there are claims and counterclaims as to whether a merger saves or costs money.

Although these claims are contradictory, there are elements of truth in both sides of these claims. What has been lacking up to now was any quantitative methodology that could assess the accuracy and magnitude of the claims in a particular locale. In this report we describe a collection of mathematical models that can be used to compare pre-merger and post-merger response patterns to police and fire emergencies. We also present a methodology for costing out the impact of a merger. Finally we apply these models to data from an actual city and explore several scenarios in order to assess cost-effectiveness of a merger in that city.

Key Decisions and Variables

The essence of our approach is to avoid blanket generalizations and to suggest that the impact of a merger may vary from city to city. Among the factors that will influence whether or not the concept is cost effective are the

a. current deployment levels of police patrol

b. the number of firemen at stationhouses

c. the total workload and composition of fire calls and police patrol activities.

Equally important to the concept's cost effectiveness are several key decisions that must be made as part of the implementation program.

Key Decisions

1. The number of firemen to keep at the fire stations.

2. The number of patrol units to deploy throughout the day.

3. The magnitude of the incentive bonuses offered to encourage personnel to volunteer for dual-training

4. The percentage of the department that will receive the bonus and whether or not all future hires are paid at the higher pay scale.

5. The salary and schedule of officers on full-time fire station duty.

6. Policies with regard to dispatch and off-duty call-ins when a major fire of significant duration breaks out.

MATHEMATICAL MODELS

The first half of this report describes a series of mathematical models that can assist in making these decisions and in forecasting system performance under a merger. In particular these models can answer quantitatively the following questions:

What proportion of time will a public safety unit arrive first at the scene?

When a fire engine arrives first, how long will it take for the public safety manpower to arrive afterward?

Under a merger, on average, the first unit arrives faster and the full complement of manpower takes longer to arrive. Two related questions are:

On average how much faster will the first fire-trained officer arrive at the fire scene?

On average how much longer will it take to get a full complement of manpower to the fire scene?

These last two questions reflect the basic tradeoff a manager is likely to face. With our models, and as illustrated in our Roseville example, we can quantify the magnitude of this tradeoff.

Additional questions our models address are:

What is the probability that there will be sufficient available public safety manpower to dispatch to a major fire?

Will a policy that allows for the interruption of non-emergency police activities guarantee that there will sufficient personnel to work a major fire?

How is fire coverage affected by an unusually busy day of police activities?

What happens to police response time and coverage during a major fire?

How many off-duty personnel have to be called-in in order to mitigate the impact of a major fire on police performance?

One obviously crucial quantitative measure we analyze is the impact on cost of a merger. We present a detailed methodology for analyzing the impact of a merger on long-term annual operating budgets. A key point of our methodology is the separation of the analysis into components in order to stress the impact on cost of the key decisions noted above.

The performance models are described in Chapter 2 of this report. The concepts discussed there are highly technical and require advanced training in operations research in order to be applied. Even Chapter 3's presentation would require a reasonable level of quantitive skills to be applied. It is planned that, in the not too distant future, these same models will be converted into more readily useable computer packages that can be applied with limited training and guidance.

A STUDY OF A MEDIUM-SIZED CITY

We gathered data from an actual city in order to illustrate the role of these models as well as explore the potential impact of a merger in a medium-sized city. However, the results of our management. In order to broaden the potential value of this study, we explored several scenarios and alternatives. The data for this study came from the City of Roseville, Michigan and included information on police and fire deployment and workloads as well as detailed cost information.

In this study we were primarily interested in evaluating police-fire mergers and not police-fire-emergency medical mergers. We, therefore, did not include data on the emergency medical services that were also provided within the Roseville fire department during the year of our study although in the recent past that service had been temporarily eliminated. The deployment level at the station house that we evaluated in the final phase of a merger might not be sufficient if the city were also providing emergency medical services. The decision not to evaluate in this study the triple merger concept does not reflect either way our assessment of the feasibility or cost-effectiveness of the concept. Instead, the decision was made in order to simplify this first comprehensive quantitative study of the complex issues involved in a merger. Future research will will evaluate the impact of merging all three services.

The city of Roseville is a suburb of Detroit with a population of 58,000. It is a little more than nine square miles in area. The total city budget (excluding special funds) in 1982-1983 was $13 million of which $6.26 million was allocated to police ($4.4 million) and fire ($1.86 million). The police department had a staff of 91 and the fire department, a staff of 38. This last number must be placed in perspective before any city manager attempts to compare the forecasted impact on costs in Roseville with the potential impact of a merger on his city's costs. The number of firemen in Roseville per 1000 population was only 0.68 which was less than half the national average of 1.62 for cities in the 50,000 to 100,000 population range. Since the major savings, if any, in a merger derive from reduced manpower in fire stations, this statistic would suggest that any savings identified in Roseville might be significantly larger for cities of similar size but with higher fire budgets.

On average the city deployed eight police officers around the clock. Half of the time these officers were in one-officer units the other half of the time they were in two-officer units. These deployment levels vary by time of day and our report breaks these and subsequent statistics into five time periods; however, in this summary we present only aggregate averages. The utilization of two-man units during half the day may be not be the norm in suburban communities and complicates the transferability of our findings to other similar sized cities operating only one-officer patrol units.

Patrol units spent from 40% to 55% of their time on preventive patrol depending on the time of the day. The remaining time was spent on an assortment of activities ranging from highest priority (i.e. crimes-in-progress) to lowest priority including paperwork and breaks. Highest priority activities accounted for less than 10% of the police activities and even if moderate priority activites are included the total is approximately 20% of the activities (which represents about 10% of on-duty time). We had no data that allowed us to differentiate between citizen initiated and patrol initiated activities. The analysis of the merger might therefore slightly underestimate police workloads by not considering increases in patrol initiated activities. The inclusion of this factor would have had only a marginal impact on any of our findings.

The fire department kept ten men on duty in two strategically dispersed fire stations with one of these men serving as a fire/emergency medical dispatcher. The department responded to 727 fire related calls in 1980 which translates to two a day. The average time spent at a fire call was under 25 minutes and, on average, 4 firemen worked at each call. Thus, a fireman was busy at a fire related call less than 2% of the time that he was on-duty during a 24 hour period.

We used mathematical models to estimate police response time during different periods of the day. There was significant variation because of varying workloads and deployment levels. The two components of response time we assessed were (a) any dispatch delays due to patrol unit unavailability and (b) travel time. (Patrol units were assumed to respond at an average speed of 30 m.p.h. at all times of the day.)

POLICE RESPONSE TIMES

The relatively small size of Roseville and moderate police workloads resulted in good average response times. We estimate that police units can respond in an average of three to four minutes to high priority calls and a half minute later to moderate and low priority calls. During periods with one-officer deployment, the backup unit dispatched to a call should arrive an average of a minute and a half after the first officer at the scene.

During unusually busy periods when activity rates are higher by one-third to one-half, response to high priority calls increases to the four to five minute range and the backup officer arrives two minutes after the first officer. Response time to moderate low priority calls increases more significantly. During the daytime, these calls would experience a six minute average response time. At night this would increase to over eleven minutes or more than double its current value.

In the report we analyze performance during two phases of a merger. In phase I a single additional officer would be deployed on patrol at all hours of the day. In phase II, the final stage of a merger, two officers would be added to the deployment. This would raise to ten the average number of officers deployed. At night the two men would be in a single vehicle and during the day, they would be in two separate vehicles. In this summary we focus only on phase II.

This additional patrol manpower has the following effects on average police response time and preventive patrol coverage:

* Reduces response time to high priority calls by 20% throughout the day

* Reduces response time to moderate and low priority calls by 30% throughout the day

* On busy days, reduces response time to high priority calls by 25% and on busy nights by 33%

* On busy days and nights, reduces response time to moderate and low priority calls by 50%

* Increases preventive patrol coverage by 40%-50% and during unusually busy periods by 70%

Obviously, a merger would significantly improve response to police emergencies. However, during a major fire emergency, five patrolling officers would be needed at the fire scene leaving the city with a reduced police presence. We defined a major fire emergency as a fire requiring the working presence of seven or more firefighters for a period of more than one hour. This occurred in Roseville and average of less than once every two weeks (22 times during the year).

In the report we present an illustrative analysis of police performance during and after a three hour fire. During the fire, the department could maintain an average response time of five minutes or less to high priority calls. This could be achieved by closely monitoring the activity and location of the remaining patrol officers. Should a high priority call arise, the department could preempt a lower priority activity in order to dispatch a patrol unit. What would be hurt the most would be response times to moderate and low priority calls. Response time to moderate priority calls would increase to 11 minutes or 30 minutes depending upon the time of day. Response time to low priority calls would increase to one hour or more. In addition almost all preventive patrol coverage would disappear and the remaining units would be constantly busy during the fire.

During the evening shifts, the impact of this fire would be felt even after the fire had been put out. While the patrol officers were fighting the fire, moderate and low priority calls and activities would be backlogged. This backlog would not be eliminated until three hours after the fire.

These problems could be alleviated by calling in off-duty officers. On the basis of our models, we estimate that the call-in of three officers would provide good response to moderate priority calls and eliminate the buildup of any significant backlog of even low priority calls. The issue of call-ins is not unique to public safety departments. Many small fire departments use this policy when faced with a rare major fire. Alternatively, small cities may activate their mutual aid agreement with neigboring cities to handle this situation. The change to merged departments may affect slightly the frequency with mutual aid is requested. At present, we are not able to predict the magnitude or the direction of the change.

FIRE RESPONSE TIMES

We modeled fire engine response times with mathematical formula developed and widely applied during the past ten years by the Rand Corporation. In our analysis we defined response time as the time from dispatch (including turnout of fire equipment) until arrival at the fire scene. We did not include setup time at the fire scene or change of garb time for patrolling public safety officers. These times would vary dramatically depending upon the nature of the fire. We estimate that currently the closest fire engine company can respond in an average of a little more than three minutes. In a major fire, personnel from both of Roseville's fire stations would need to be dispatched. The manpower and equipment from the farther station would arrive in

5.5 minutes.

In the final phase of a merger, we assumed that each station would be staffed by two firefighters. A small fire would be dispatched the personnel from one station and two patrolling public safety officers. A major fire would be dispatched all personnel in the two stationhouses and five patrolling public safety officers. At the time of a fire there would be a dual response of fire equipment and patrol officers. We modeled this deployment plan and dispatch strategy and estimate the following:

* On average, the first arriving officer at the scene would arrive one minute faster than the current response

* Seventy-eight percent of the time the first officer at the scene will be a public safety patrol officer

* When the fire equipment arrives first, the average delay until a patrolling public safety officer arrives will be slightly less than one minute

We explored this last phenomenon in greater depth and found that in 12% of these fire calls the public safety unit would arrive more than one minute later. It also has to be remembered that response to fire calls will now be influenced by police activity. We found that this percentage doubled if during a shift, patrol officers experienced activity that were significantly (one-third to one-half) higher than current averages.

To address this situation we evaluated two forms of preemptive dispatch policies.

a) If all public safety units are involved in activities at the time of a fire call, the patrol unit or units involved in the least critical activity is dispatched to the fire scene irrespective of his location.

b) Whenever a fire breaks out, the unit (or units) that is either on patrol or involved in an interruptable activity and is closest to the fire scene is dispatched.

The latter policy we have called aggressive preemption since the dispatcher may interrupt a unit near the fire scene rather than dispatch an available unit far from the fire scene. The first form of preemption only marginally impacts on the likelihood of a more than one minute delay. The aggressive dispatch policy

* reduces the frequency of a minute delay to under 5% of the calls even when patrol units are unusually busy

The above discussion focused on small fires and the arrival of the first responding units. We also analyzed for a major fire the response pattern of the second fire engine company and the public safety units needed to man it. There would obviously be significant delays in public safety unit response if there were no policy of interrupting non-critical patrol activities. Frequently, there would not be five officers available for dispatch. However, we found that:

* Basic preemption insures that 99% of the time there will be sufficient personnel to staff the fire equipment at a major fire

* Seventy percent of the time all of the patrolling personnel needed to work at the fire scene would arrive before the second set of fire equipment arrives.

* Rarely, would the last arriving public safety unit arrive more than two minutes after the second set of fire equipment arrives.

The above statistics are not dramatically affected by unusually high police activity rates, mainly because the overwhelming majority of Roseville police activities are interruptable. A more aggressive preemption strategy impacts primarily on the second statistic and increases that from 70% to 90%.

COST ANALYSIS

The above analysis assumed a deployment plan that reduced from ten to four the number firefighters on continuous stationhouse duty and added two officers around-the-clock to patrol. (Again we note that this analysis does not include the provision of emergency medical services.) We will cost out this plan under several scenarios as well as briefly summarize a plan that adds three officers on patrol. One fact that should be noted and plays an important role is that:

* One full-time fire position can be covered by three firefighters on-duty an average of 56 hours per week.

* One full-time patrol position requires 4.2 officers who work a 40 hour week.

Vacation, holidays and sick days would increase these numbers proportionately or be reflected in overtime costs. The latter seems to be how Roseville manages to always provide at least specified minimum levels police and fire coverage.

The total personnel cost for a single police officer or first level (pipeman) firefighter including all overtime and benefits averaged approximately $41,000 in fiscal year 1982-1983. (See Table 1.) Overtime cost were 10% of gross pay. The costs for sergeants and lieutenants were $47,000 and $52,000 respectively.

The reduction in fire station manpower would save 21 positions including one assistant chief and results in a savings of $970,000. If the City of Roseville had a firefighter per 1000 population ratio that was closer to the national average, this savings would more than double. This savings is balanced by the cost of two additional patrol officers. These two positions are assumed to require nine men to cover. In addition, for every

TABLE 1

PERSONNEL COST BREAKDOWN: NON-PUBLIC SAFETY

	POLICE			FIRE		
	Basic	Sergeant	Lieut.	Basic	Sergeant	Lieut.
BASE	$24,126	$28,345	$31,150	$23,574	$27,110	$29,821
LONGEVITY	$782	$1,900	$2,519	$1,192	$1,652	$2,410
HOLIDAY	$1,229	$1,465	$1,623	$1,148	$1,333	$1,493
SHIFT DIFF.	$934	$719	$1,007	$1,297	$1,297	$1,297
TOTAL GROSS	$27,071	$32,429	$36,299	$27,211	$31,392	$35,021
COL	$926	$926	$926	$1,174	$1,174	$1,174
OVERTIME	$3,059	$3,664	$4,102	$3,701	$4,269	$4,763
H & L INS.	$2,491	$2,983	$3,340	$2,639	$3,045	$3,397
RETIREMENT	$6,025	$7,182	$8,017	$6,225	$7,146	$7,946
UNEMPLOY. INS.	$41	$49	$54	$41	$47	$53
TOTAL	$39,612	$47,233	$52,738	$40,991	$47,073	$52,353

three policemen there is currently one sergeant or lieutenant. We have, therefore, assumed that will also be three supervisors added to the patrol division. These new patrolmen will need vehicles and all current patrol officers and vehicles will need to be equipped to fight fires. The total added cost to patrol is estimated to be $600,000. The cost of standby and call-in for major fires adds another $20,000. A recent Supreme Court decision and subsequent change in the Fair Labor Standards Act will make the concept of standby personnel prohibitively expensive although the cost for actual call-ins will not increase significantly. This law change is not reflected in our analysis.

In summary if a city were to have a merged department instead of separate fire and police departments and if salaries for public safety officers were the same as for police and firemen then the net impact in a city similar to Roseville would be:

* seven percent reduction in personnel and a $350,000 (5.8%) savings in annual operating costs

In reviewing these numbers and the potential $970,000 savings in fire stationed based personnel, we feel it is important to reiterate that the study city had an unusually low number of fire personnel per 1000 population. This should not be interpreted as a need for more personnel since fire emergency workloads are low and response times are also low.

Few cities, however, are at the stage of their development in which they can choose between the two concepts with no increase in salaries for public safety officers. Instead, they will need to officer financial incentives to encourage a voluntary transition to public safety. Roseville had an actual proposal to implement a merger and had negotitated with the police a $1500 increase in salary for personnel who would agree to train and serve as public safety officers. If overtime and benefits are included, we estimate the cost at $2,200 per person. We used this number to determine the net savings associated with a change from separate police and fire departments to a public safety department.

One question that needs to be addressed is "Who will receive this bonus?" Will all public safety officer salaries be permanently increased by this amount or will only a portion of the current officers who opt immediately for a merger receive this salary increase? We costed out departments in which 54%, 85% and 100% of the merged department personnel experience salary increases. (The rationale for these percentages is discussed in the report.) After costing out these bonuses the net result is

* A net savings ranging from a high of $220,000 (3.7%) to a low of $86,000 (1.4%) (See Table 2.)

An important related alternative not costed out here is keeping salary levels for fire station based personnel at current levels and paying them to work a typical fire work week of 56 hours.

Higher Savings

We noted above that the patrol plan in addition to the nine patrolmen included three additional supervisors. These supervisors were not included in any of our response time analysis as additional personnel who could help out at either a police or fire scene. If these supervisors were counted as part of the basic two additional men deployed in patrol units or if it

TABLE 2

IMPACT OF MERGER ON TOTAL COST OF OPERATION

FIRE STATION PERS.+OTHER SAVINGS		$972,000	$972,000
	ADD PATROL OFFICER	TWO	THREE
ADDED PATROL:PERSONNEL COSTS		($503,000)	($662,000)
ADDED PATROL:EQUIP. + OTHER COSTS		($62,000)	($82,000)
PATROL FORCE CHANGEOVER COSTS		($17,000)	($17,000)
TURNOVER COSTS		($19,000)	($21,000)
STANDBY (3 or 2) & CALL-IN (26)		($21,000)	($14,000)
SUBTOTAL 1 NET SAVINGS		$350,000	$176,000
OVERTIME SAVINGS		$0	$54,000
SUBTOTAL 2 NET SAVINGS		$350,000	$230,000
BONUS COSTS $1500			
MINIMUM ELIGIBILITY 54%	COST	($130,000)	($139,000)
	NET SAV.	$220,000	$91,000
	PCT. SAV.	3.7%	1.5%
MODERATE ELIGIBILITY 85%	COST	($205,000)	($213,000)
	NET SAV.	$145,000	$17,000
	PCT. SAV.	2.4%	0.3%
MAXIMUM ELIGIBILITY 100%	COST	($264,000)	($273,000)
	NET SAV.	$86,000	($43,000)
	PCT. SAV.	1.4%	-0.7%
BONUS COSTS $3000			
MINIMUM ELIGIBILITY 54%	COST	($260,000)	($278,000)
	NET SAV.	$90,000	($48,000)
	PCT. SAV.	1.5%	-0.8%
MODERATE ELIGIBILITY 85%	COST	($409,000)	($427,000)
	NET SAV.	($59,000)	($197,000)
	PCT. SAV.	-1.0%	-3.3%
MAXIMUM ELIGIBILITY 100%	COST	($528,000)	($546,000)
	NET SAV.	($178,000)	($316,000)
	PCT. SAV.	-3.0%	-5.3%

were determined that the additional two men in patrol units would not warrant additional patrol supersivors there would be an additional savings of between $135,000 and $160,000.

The bonus used above amounted to 5.5% of base salary. When Roseville officials negotiated the raise, they were in the midst of negotiating a new police contract. The merger bonus plus the annual raise totaled 10.6%. We looked at other city departments in Roseville and in no case was the personnel raise less than 8.6%. It could be argued that the true cost to Roseville of this bonus was only 2%. If that were the case the $86,000 to $220,000 range noted earlier would become $250,000 to $300,000.

Lower Savings

We also cost out the impact of a base salary increase of $3,000 (11%), double the actual Roseville proposal. Even under this incentive plan, if only 54% of the department were paid this higher salary, there would still be a net savings of $90,000. However, we found that:

* An expansive bonus applied to all current and future public safety personnel would mean that the merger would in total increase operating expenses by $178,000

In addition we costed out the impact of a risk averse city official who decides to deploy three additional patrolmen in exchange for the six men removed from fire station duty. With a 54% eligility and a $1500 bonus, the merger would still save an estimated $90,000. Higher bonuses or broader eligibility would mean the merger would at most break even and more likely would increase operating costs by $50,000 or more.

SUMMARY

A merger of police and fire services would on average clearly improve response time to all police emergencies. During major fires, additional personnel would have to be called in to provide adequate police coverage or mutual aid will need to be initiated. Initial response to fire emergencies should also improve. This, however, would be accompanied by a small deterioration in the time it takes to get all of the manpower to the scene of a fire. The delays in getting all of the public safety units to the scene of a fire can be significantly reduced if the department uses an aggressive preemption dispatch policy. Obviously, these findings will be sensitive to the actual deployment plan the city would implement.

Our analysis of costs indicate a need to carefully cost out the impact of merger and highlights two points:

1. Percentage change in total personnel is not a sufficient statistic for assessing the cost of most mergers.

2. Management decisions with regard to deployment, bonus eligibility and bonus size will significantly affect the magnitude of any savings a merger may generate.

ACKNOWLEDGEMENTS

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I would like to recognize the contribution of the National Science Foundation. NSF funded, under grant number SES-80-22935, much of the early mathematical model development that formed the basis for Chapter II of this report. These original models were enhanced as part of this project.

The project could not have been completed without the openness and assistance of the City of Roseville, the City Manager and his staff, the Chiefs of Police and Fire and their respective staffs. The conclusions presented in this report are those of this author alone and do not represent the opinions of any current or former employees of the City of Roseville. Roseville's data were used in this report but not all factors unique to Roseville were included in the analysis. The report should, therefore, not be viewed as a recommendation to the City to move ahead with a merger.

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CHAPTER I

POLICE-FIRE MERGERS: THE ISSUES

A. INTRODUCTION

City managers and mayors face an increasingly "no-win" dilemma. Municipal budgets are becoming tighter in response to citizen concerns over public largesse and limited tax bases. Since emergency services account for 22.5% of the budget of cities between 50,000 and 100,000 [1], they are natural targets for cost reductions. These services require staffing 24 hours a day and 7 days a week; as a result manpower costs generally account for 80-90% of the department's total budget. The cost of staffing a one-officer patrol unit around the clock is in the $150,000 to $200,000 range [2] and a two-officer patrol unit is approximately double that. The staffing of a four or five man fire engine company can cost more than half a million dollars a year.

One proposal for reducing the cost of emergency services while maintaining or improving service levels is a public safety department in which officers are trained to provide both police and fire services. The motivation behind this concept lies in the fact that in many cities, especially small and medium sized ones, fire personnel are busy at fire calls less than 5% of the time. In between calls-for-service, personnel maintain their vehicles, equipment or facilities, cleanup after fire fighting and carry out limited fire prevention activities. In addition, they use this time for training. These activities, however, rarely consume significant portions of the in-between time, are interruptible in an emergency and some of these activities may be done by lower salaried personnel.

An additional factor motivating a service merger is the perception that the patrol units out in the street are likely to be closer to the scene of the fire and can respond more quickly to the fire than a fire truck housed in the fire station. At present, police officers who arrive first are not trained nor equipped to handle the problem. A single public safety officer arriving first at-the-scene would be able to take constructive action to begin stabilizing the emergency situation.

In a merged public safety department, instead of four or five firemen assigned to staff each vehicle, only one or two are assigned to the station house. They have the responsibility of driving the fire equipment to the scene of the emergency. Additional personnel who are trained to handle fire emergencies are assigned to patrol units. When a fire breaks out, the appropriate vehicle is dispatched from the fire station along with a full complement of public safety officers in patrol cars. These patrol cars typically carry a limited amount of fire suppression equipment, valuable in the early stages of a fire, and protective fire garb.

B. LITERATURE REVIEW

The concept of a dual trained public safety officer is not a theoretical construct; it is in operation in a number of cities around the country. The overwhelming majority of merged services have been in existence less than 30 years. The cities that have implemented the concept are generally small with populations of less than 50,000 [3,4,31]. Sunnyvale, California, which has a population of over 100,000, is the largest city with totally merged police and fire departments. Durham, North Carolina, another city of 100,000+ population, recently decided to eliminate its public safety department and revert back to separate police and fire functions [32].

The debate over the relative merits of a merger is heated and is charged with claims and counterclaims. (See Table 1.1) Any city manager contemplating a merger can expect vocal opposition often lead by the International Association of Firefighters [6]. One side claims "a merger will reduce response time to a fire"; the other counters "that it will take longer to get the personnel to the fire scene". One side claims that "when a fire breaks out, police coverage and response to police calls deteriorates"; the other side counters "the additional personnel in patrol units will increase preventive patrol". Lastly, there are claims and counterclaims as to whether a merger saves or costs money. Although these claims are contradictory, there are elements of truth on both sides of these claims. What has been lacking up to now was a quantitative methodology that could assess the accuracy and magnitude of the claims in a particular locale "prior" to implementing a merger.

The discussions that appear in the literature tend to fall into two categories. The first category includes city and state reports [e.g. 7,8,9,10,11,12,13,14] and the second categtory includes articles that appear in police, fire or city management association journals [5,6,31].

Table 1.1

Police/Fire Consolidation Debate
Adapted From Urban Data Service Report
By L.S. Frankel

ADVANTAGES

1. Faster and better police and fire services including increase patrol and fire prevention activities.
2. Fewer persons needed to provide police and fire services because full use is made of each person's working hours.
3. Substantial economies are effected.
4. Possible duplication of services is eliminated in the areas of budget preparation, record systems, office staff, communications networks, training and personnel quarters, and administrative
5. A single line of command is established.
6. More trained personnel are available for police and fire duty.
7. A reduction of the workweek for public safety officers is realized.
8. Employee morale is improved because of higher pay, a more interesting and challenging job, and greater promotional opportunities.
9. Familiarization with the city's characteristics is more readily accomplished.

DISADVANTAGES

1. City unprotected against crime while public safety officers are fighting fires and similarly against fires during major police action
2. Consolidation breaks up the company unit and weakens team concept of fire fighting.
3. In a well-run fire dept., fire fighters are engaged in a wide range of productive activities between fires.
4. Public safety officers lose crucial fire-fighting time changing from dress uniform into protective clothing.
5. Apparatus must always be ready and manned by a sufficient number of personnel for immediate and effective action. This cannot be achieved when firefighters are out performing police duties.
6. At the time of an alarm public safety officers may be far from the location of a fire. Delays could result in serious damage and loss of life.
7. Patrol vehicles do not carry all of the necessary equipment for extinguishing a fire.
8. One person cannot perform two jobs that involve highly specialized and diverse duties and responsibilities.
9. The usual short intensive training provided to a new officer is not sufficient for the combined jobs.
10. Proper leaders for combined department are hard to find.
11. A city's fire rating usually suffers with consolidation.

The local and state reports which treat this topic, at best, quantify only one variable of the many applicable issues. The major focus is usually on workload statistics of fire and police personnel. Because mathematical models are never incorporated in the analysis, there is no forecast of the impact of a merger on response time. In one report [14] prior to implementation, an attempt was made to estimate potential savings from a merger; however, the supporting analysis was limited and much of the projected savings was cost avoidance.

Other sources [3,4,31,15] provide an overview of the existence of public safety departments drawn from survey questionnaires and interviews. The most significant findings reported are:

1. Insurance ratings are usually unaffected by a change to merged service. (This contradicts one claim in table 1.1)

2. The major motivation for a change has been to improve service and reduce costs. Although service has almost always been improved, in one-third of the reporting cities, the anticipated savings had not occurred.

Later in this paper we discuss the impact of a merger on cost and illustrate how key decisions associated with every merger will have a significant impact on whether or not a merger reduces total operating costs.

The literature also explores why certain cities have succeeded in implementing the concept while others have failed [4,31]. The successes tend to occur in cities which do not force their personnel to become public safety officers. Instead, they phase-in the merger over time. Volunteers within the department are offered salary increases to accept dual training and all new recruits are required to start as public safety officers.

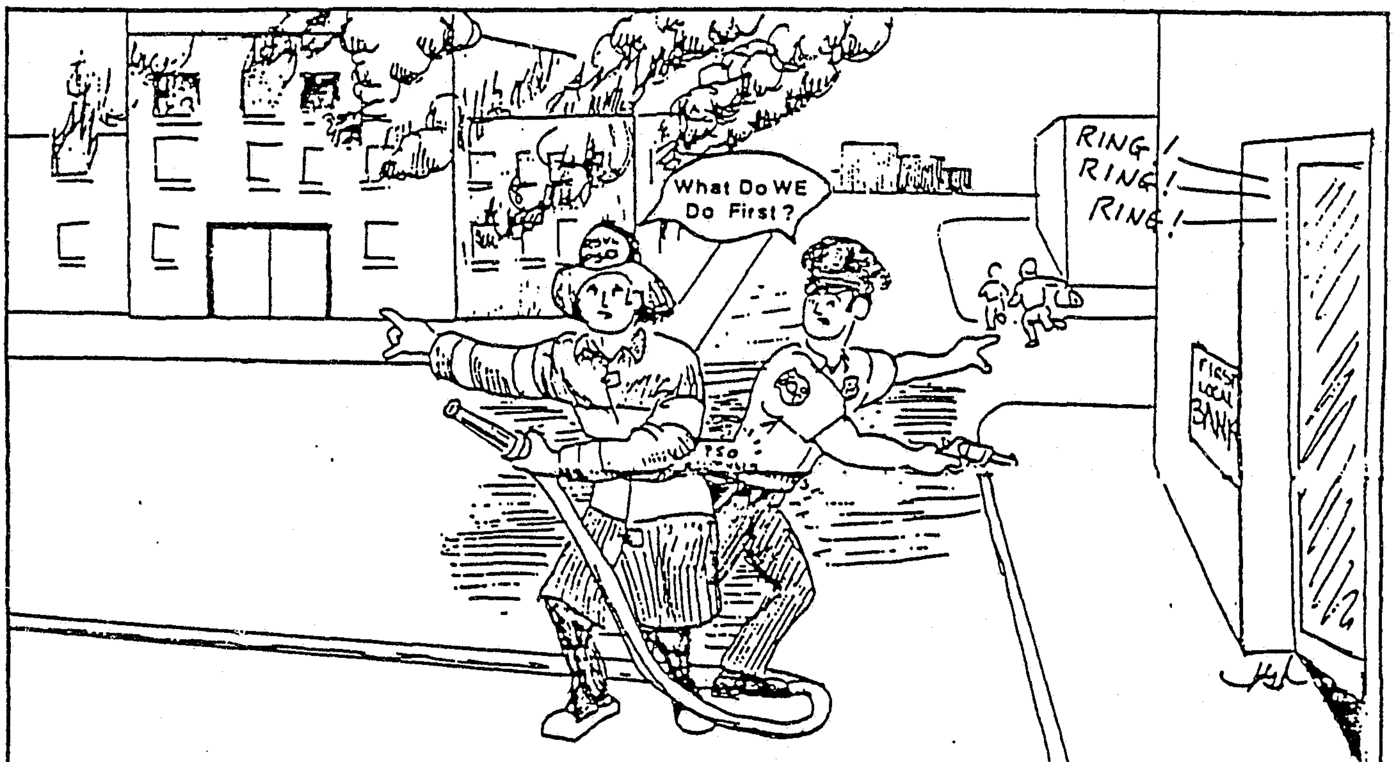
The issues involved in a merger are such that city officials are obligated to carry out good faith negotiations prior to a changeover. For a discussion of the key labor relations issues involved in a merger see Wolkinson and Chelst [17]. Kalamazoo [16] negotiated an agreement with its police and fire unions and is already several years into the process of phasing in a merger.

A voluntary implementation plan with incentives by no means guarantees acceptance. The City of Roseville, Michigan offered such a plan and reached an agreement with the police officers. The firefighters, however, led a citywide campaign that resulted in the defeat of the concept and ultimately the defeat of a majority of the city council.(See Figure 1.1 for an illustration of fliterature used in the campaign.) Hazel Park, MIchigan experienced a similar problem. In contrast, Grosse Pointe Park in 1986 had a referendum initiated by firefighters opposed to a proposed merger. The referendum to keep the departments separate was defeated. The city is continuing its plan to implement to a merged department that will provide not only police and fire

CRC TAXPAYER REPORT

Concerned Roseville Citizens — Election Edition

ARE YOU WILLING TO GAMBLE?



PUBLIC SAFETY IS:

- MORE COSTLY
- ABANDONMENT OF POLICE PROTECTION FIGHTING FIRES
- A STEP BACKWARD TO A VOLUNTEER FIRE DEPARTMENT
- A REDUCTION OF FIRE FIGHTING EFFECTIVENESS

WHEN YOUR LIFE IS AT STAKE... YOU WANT THE VERY BEST

Separate Police and Fire Is The Best Service

VOTE ☒ NO ON PUBLIC SAFETY AMENDMENT

services but also emergency medical services.

There is one context in which cities are unlikely to experience strong opposition to a merger. Small but growing cities often start out with professional police departments but volunteer fire departments. The change to public safety then involves negotiating with only one group, the police organization, and it is generally more receptive to the change . A number of growing cities in the south and far west are going this route. In addition many of these cities do not have police and fire unions and a result are likely to face far less organized opposition.

The most detailed description of a before and after merger experience appears in an ICMA publication [31] and involves the city of Texarkana, Arkansas (23,000). Response times were reported to have been cut from 6 minutes pre-merger to under 3 minutes with a merger. The total manpower, however, was kept "constant" and public safety officers were paid salaries 15% higher than pre-merger. During the years since a merger, Class I offenses have been reduced and clearance rates were reported to have increased. Thus, cost effectiveness is based on dramatically improved emergency service response and higher levels of preventive patrol rather than on actual cost reduction.

Experiences such as Texarkana indicate that the concept can be implemented but the specific impacts are not easily translated to other cities. How is a city official to translate the Texarkana experience to his city if his goal is to keep costs "constant" while improving services? What does the Texarkana experience say to the city official interested in "reducing" costs while maintaining the same service level? Mathematical models enable a city official to explore strategies and tradeoffs within his particular environment. The primary focus of this report is to illustrate the information these models can provide as well as highlight key merger decisions and their impact.

CHAPTER II

QUANTITATIVE METHODOLOGY:SYSTEM PERFORMANCE

The obvious political problems associated with a merger would cause any prudent city official to proceed with caution to attempt a merger. It is therefore critical that the official carry out a quantitative analysis of the impact of a merger on cost and performance. This analysis is needed

1. to assess whether or not the potential savings, if any, and improved performance justify the difficult task of implementing a merger.

2. to define a detailed implementation plan which includes the number of units to be deployed at various times during the day and in different sections of the city.

The development of a detailed deployment plan is crucial to the merger's success because

a) In the early phases of a merger, understaffing that contributes to poor response time to an emergency could scuttle the whole project.

b) Overstaffing to be safe, may be appropriate in the early phase, but over the long haul could easily consume any potential savings associated with the merger. (This point will be elaborated on in our analysis of the City of Roseville, Michigan).

A. MATHEMATICAL MODELS

The nature of the analysis required to support a merger can not simply be done by gathering and analyzing data. This type of data analysis can only provide insight into the system's present performance and at most highlight the low fire workload and infrequent high priority police calls. In addition city officials can't even draw on their own past experiences to predict how this totally new system might perform. The only way to carry out such an analysis is to use mathematical models that allow the manager to explore a range of "what if" questions likely to arise in a merger. The key questions that we will address and quantify are:

Will initial response to fires improve or deteriorate?

Will response to police calls improve or deteriorate?

Will there be sufficient manpower available for dispatch to major fires or will public safety personnel be tied up at police calls at the time a fire breaks out?

Will a fire engine company have to wait for the full complement of manpower to arrive. If so, how frequently will this happen and how long will they have to wait?

What will happen to police coverage and response time during minor and major fires?

Is there a need for a policy to interrupt servicing of minor police calls when fires break out; if so, how frequently will this occur?

In the succeeding sections we will describe specific models that we have used to answer these questions associated with a merger. The emphasis in our presentation will be on specific measures of performance the models can predict. Later, we apply these models to data from the City of Roseville, Michigan.

One key measure of performance we analyze is response time even though we recognize its inherent limits. It is generally observed [18,19,20] that citizen detection and reporting delays can undermine a rapid emergency system response. Nevertheless, in comparing pre-merger and post-merger cost effectiveness, if current response times can be matched or bettered at lower cost, that would be an important factor in supporting a merger. One problem we have involves comparing response times to a fire. With a separate fire department, fire equipment and staffing arrive at the same time. In a merged department equipment and manpower experience a vector of response times and our models predict the arrival time of both the first unit and the full complement of personnel. We do not attempt to merge this vector into a single measure but rather report the paired estimates.

We did not include in our response time statistic setup time at the scene of a fire or the time for public safety officers to don fire gear. These statistics will vary depending upon the nature of the fire emergency confronted at the time of arrival at the fire scene. For example, a simple trash fire may be put out with an extinguisher and no change of clothing; while a public safety officer could not enter a burning building without changing to fire garb.

An important limitation of all of our analysis is that our focus is on the quantifiable measures. This tends to undermine the significance of other factors that may be crucial. One issue in particular we cannot address is the importance of the team concept in fire fighting effectiveness. While noting this concern, these issues are not addressed here and can only be addressed in a pre and post evaluation of an actual merger.
In addition, we have did not obtain data on how firemen spend their time between fires and their seems to be wide variability among cities as to common practices. In particular we have no data on time spent in fire training activities or cleanup after a major fire.

B. MODELS OF PATROL UNIT AVAILABILITY: QUEUEING MODEL

The level of police deployment influences two components of response time; 1) Dispatch delay due to the unavailability of a patrol unit and 2) Travel time. In the analysis of police performance prior to a merger and public safety after a merger, we will introduce models to estimate both components.

In the analysis of fire engine response time we made the simplifying assumption that the closest fire engine would always be available to dispatch. This assumption has frequently been used in earlier modeling of fire engine response time [21] because of relatively low fire engine workloads. The fire call rate in our study city of Roseville was slightly less than than two fire calls per day and the average service time of a fire was 22 minutes. Thus, the total emergency fire workload was less than 2% and justified the above simplifying assumption. (See the Chapter IV for detailed data on fire workloads.) Our modeling of fire response time was therefore, limited to travel related times.

The dispatch queueing delay in a police environment can be and has been modeled using basic multiple server queuing models with assumptions of Poisson arrivals and exponential service time [22]. The original Patrol Car Allocation Model (PCAM) [23] also included grouping of calls by priority. Recently, in a study of the New York Police Department, it was found [24] that this model could not accurately approximate the dispatch of multiple units. Green [25] developed a new queuing model that could accurately capture this more complex dispatch environment and recently her model was incorporated into an updated version of PCAM [26].

The data for Roseville, our study city, showed only a small number of calls needing two police officers and we could have easily ignored the issue of multiple dispatches in the pre-merger evaluation of the police department. However, to model the merged service we had to use this more complex model. In a public safety department many fire calls and especially major ones require the dispatch of multiple public safety units to assist at the fire scene. The Green Model enabled us to answer the following questions:

> What is the likelihood that there will be insufficient manpower available to staff the equipment at a major fire?
>
> How long will it take for all of the manpower needed at the fire scene to arrive?

This model not only predicts the overall dispatch delay but also the staging delay: the delay between the dispatch of the first and second units to a call requiring two units. This staging delay arises when only one unit is available to dispatch to a call requiring the services of two or more patrol units. The first unit will have to wait until other units become available to dispatch and this wait has been labeled the staging delay.

We obtain the following specific performance measures from this queueing model:

1. p(x) = the probability that 'x' units are available at the time of a call.

Initial Delay statistics

2. p(x=0) = the probability that no units will be available at the time of a call and that the call is initially delayed,

3. the averavge time a call will wait until the first unit is available to dispatch.

Full Delay statistics

4. The probability that the full complement of manpower needed to service the call is not available to be dispatched.

5. The average time that a call will have to wait until all of the manpower needed to service the call are available for dispatch.

The difference between statistics 5 and 3 is the above noted staging delay. Each of the above statistics can be calculated for up to three different priority classes.

Although the queuing model is robust, it cannot, in itself, be used to explore a policy of interrupting minor police activities to handle major fires. In addition, the model is incapable of exploring the behavior of the emergency system during the course of fighting a major fire and the time period shortly after the fire is put out. In technical terms, this queuing model estimates steady state, long term averages, and does not model short term aberrations or transient analysis. Later in the section on rare event analysis we present two separate models used to explore performance during major fires.

C. TRAVEL TIME MODELS

The second component, travel time, is often modeled using the square root law. This law is based on the probabilistic analysis of a spatial Poisson process [27] The law states that:

> the average travel time of a unit is inversely proportional to the square root of the number of units per square mile.

This law applies not only to the closest unit but also to the second, third, etc. closest units with only the constant of proportionality increasing. When implementing the model, users are encouraged not to use the theoretically derived constants [21] but rather to fit the model to existing data.

The above relationship relates the number of units to average travel time. However, in any emergency system the number of units available at the time of a call is in itself a random variable. The PCAM [23] model replaces the parameter, "number of units deployed" with the parameter , "the average number of available units". This is just the average fraction of time that patrol units are available for dispatch multiplied by the number of units deployed.

In our analysis of a merger of police and fire, we were interested in going beyond average travel time as the measure of performance. A key factor often referred to in the literature on mergers is which type of unit will arrive at the scene first and will a fire engine have to wait a long time for the arrival of public safety units to staff the fire equipment. In order to analyze these factors, we needed a model that would allow us to determine the distribution of travel time of patrolling units and fire engines. The spatial Poisson process assumptions that underlie the square root law yield a Rayleigh distribution [22]. We explored this distribution in the multiple dispatch environment and found it not to be a good approximation as the number of units dispatched increased. Instead, we developed a simulation model to capture this more complicated dispatch environment. Again, to be consistent we used this new travel time model even to evaluate the current police department.

The model assumes that:

1. Calls for service and patrol units are randomly located in a rectangular region but that fire units are at fixed locations

2. The closest units are always dispatched.

3. Travel time for patrolling units was determined by dividing travel distance by a response speed of 30 m.p.h..

4. Travel time for fire companies was determined by using a previously validated relationship between travel distance and travel time for fire engines [21]. The function is

Travel Time = 0.66 + 1.77*(Travel Distance)

This simulation also added dispatch and turnout time to the travel time. These represent the time for the dispatcher to relay information about the call to the emergency unit and for the unit to begin traveling to the scene. For patrol units we input:

5. an initial half minute from the time the dispatcher contacted the patrol unit until the patrol unit was on its way to the scene of the call.

For fire units this time is labelled 'turnout time' and includes the time for the fire engine to leave the station and begin travel along the street network. We input the following:

6. Turnout time- one minute as the time from when the fire station is notified until the fire equipment is out of the station on the road. [21]

In short a patrolling unit is assumed to have a half-minute dispatch advantage over an in-house stationary fire engine. These parameters can be changed to reflect different experiences in other cities.

For each specified number of public safety units and fire stations, the model generated 1,000 calls to determine the following conditional probabilities and conditional expected values.

PF(1¦x): The probability that the first unit at the scene is a public safety unit if x units are available to be dispatched

PF(2¦x): The probability that the entire complement of public safety officers needed to man one fire engine would arrive no later than one minute after the closest fire engine, if there are x units available.

PF(3¦x): The probability that the full complement of manpower needed to fight a major fire would arrive no later than two minutes after the second fire engine arrives at the scene

In addition the model calculated average statistics:

AT(4¦x): The average response time of the closest public safety unit if x units are available to be dispatched

AT(5¦x): The average response time of the last officer needed to staff the first fire engine if x units are available to be dispatched

AT(6¦x): The average response time at a major fire for the last officer needed to staff the second major piece of fire equipment.

AT(7): The average response time of the closest fire engine

AT(8): The average response time of the second closest fire engine.

AT(9¦x): The average response time of the first unit (either public safety or fire) to arrive at the fire scene if there are x public safety units available for dispatch.

AT(10¦x): The average response time of the second unit (either public safety or fire) to arrive at the fire scene if there are x public safety units available for dispatch.

As we noted above, the statistics AT(7) and AT(8) are assumed not to be dependent on the number of available fire engines because of the relatively low workloads for fire engines. The last two statistics reflect the response pattern that a person at the fire scene would observe.

The travel time simulation model is run only once for the city for every possible combination of public safety units and fire stations. For example with Roseville, we ran the model with two fire stations fixed and from 1 to 12 patrol units available to dispatch.

The above information is independent of the specific fire and police call rates. To obtain performance measures for a specific shift, these statistics must be weighted by the steady state probability, p(x), that there are "x" units available at the time of the call. These steady state probabilities were determined by applying the Green [25] queuing model to a particular shift by inputing the corresponding call rates to the model.

To calculate the shift specific value of the respective performance measures, we used the the probabilistic concept of partitioning. [* : This symbol means multiplication]

PF(1) = SUM[PF(1¦x) * P(x)]   SUM X from 1 to N   (1)

This sum is taken over the values X equal to 1 to N, where N is the actual number of units available at the time of a call. We simplified the analysis by assuming that if 0 units were available, the queuing delay would make it highly unlikely for a public safety unit to be the first at the scene. This was a reasonable approximation in that fire response times are typically in the 2 to 5 minute range. This assumption implies that our estimates of public safety unit performance will be underestimates.

PF(2) = SUM[PF(2¦x) * P(x)]   SUM X from A to N   (2)

PF(3) = SUM[PF(3¦x) * P(x)]   SUM X from B to N   (3)

A= the number of public safety units needed to staff a single fire engine (small fire)

B = the number of public safety units needed to staff two fire engines (major fire)

The specific values of A and B will depend on the number of officers that are assigned to the station house to drive equipment to the scene of the fire. It will also depend upon the number of officers riding in each unit. Later, we will differentiate between the early phases of a merger, when more personnel may be stationed in the firehouse and the completion of a merger when only minimum staffing is maintained at the fire station.

Average queueing delays (AQD) are incorporated in the average response time statistics.

AT(4) = SUM[AT(4¦x) * p(x)] + AQD(1)
Sum X from 0 to N (4)

AT(5) = SUM[AT(5¦x) * p(x)] + AQD(A)
Sum X from 0 to N (5)

AT(6) = SUM[AT(6¦x) * p(x)] + AQD(B)
Sum X from 0 to N (6)

These travel time statistics are summed from X equal to zero. When a unit completes its service and is immediately dispatched to a waiting call the average travel time is the same as the average travel time for X=1. In other words:

AT(i¦X=0) = AT(i¦X=1). (7)

Implicit in our estimates of the vector of response times is that the <u>last arriving unit's</u> response time is equivalent to the response time of the <u>last unit freed up</u> and dispatched to the call. This is not exact because a unit involved in an activity and dispatched upon completion of that activity could, on occasion, arrive sooner than a unit dispatched with no delay. This minor adjustment could be handled by incorporating into the travel time simulation a probability density function for the queuing delay. We felt this minor adjustment did not warrant increasing significantly the complexity of the travel time simulation.

To calculate the average arrival time of the first and second units, either public safety unit or fire engine, we define two random variables: RTPS1 and RTFE1 the response time of the closest available public safety unit and the closest fire engine respectively. The simulation model determines the minimum and maximum of these two variables and averages each and weights them by p(x) to obtain the following statistics:

$$AT(9|x) = \text{Average}(\ \text{Min}\ \{(RTPS1|x)\ ,\ RTFE1\}) \qquad (8)$$

$$AT(10|x) = \text{Average}(\ \text{Max}\ \{(RTPS1|x)\ ,\ RTFE1\}) \qquad (9)$$

$$AT(9) = \text{SUM}[AT(9|x) * p(x)] \quad \text{Sum X from 0 to N} \qquad (10)$$

$$AT(10) = \text{SUM}[AT(10|x) * p(x)] \quad \text{Sum X from 0 to N} \qquad (11)$$

D. RARE EVENT ANALYSIS: RESPONSE TIME TO MAJOR FIRES

1. Basic Preemption

The above formulae enable us to forecast a number of key long term average statistics. However, they do not sufficiently characterize the system's response to a major fire. Although this is a relatively rare event, occurring in Roseville between once and twice a month, the obvious reason for maintaining a fire department is to control such rare occurences. It would be absurd to simply say that a public safety department on average o tperforms separate police and fire departments and ignore its performance at or during a major fire. The models described below focus on these relatively rare events.

At the outbreak of a major fire, the number of public safety officers not involved in other activites may be insufficient to fully staff the fire equipment. In the models used until now this possibility was captured by the queuing delay resulting from patrol unit unavailability. One option that has been used by a number of public safety departments to deal with situation is to interrupt certain police related activities in case of a fire emergency. In the queuing literature this is known as preemptive priority. The key statistic that defines the feasibility of this strategy is the proportion of activities that are interruptable. In our study of Roseville under the most conservative assumptions, at least 65% of all current police patrol activities which make a unit unavailable for routine dispatch are interruptable. Depending upon the criterion used, this percentage may increase to over 95% of the activities during certain periods of the day. In Chapter IV, Workload, we provide more details with regard to Roseville data.

The queuing model discussed earlier does not include preemption. To model this issue, we superimposed a Binomial distribution on the output of the queuing model. The queuing model determined the probability that there are 'X' units available to dispatch at the time of the call. The remaining 'N-X' units that were busy at the time of the call are then paged to determine if their current activity is interruptable and to see if this pool of manpower can provide the additional officers needed at the fire scene. This process can be viewed as a Binomial experiment in which 'p' is the probability that a service is interruptable and the number of independent repetitions of the experiment is 'N-X', the number of busy units.

This Binomial model assumes that the call types occupying the different public safety units are independent of one another. This assumption is not mathematically exact because a limited number of non-interruptable calls require more than one unit to service then. However, because these calls represent only a small percentage of all calls this assumption seemed to be a reasonable approximation.

To calculate the probability that with a preemptive strategy there will be enough public safety units to fight the fire, we partition the event on the number of available units , X, at the the time the fire broke out. We then apply the binomial distribution to the remaining 'N-X' busy units to determine if there are at least M-X of these units can be interrupted and dispatched to the fire scene.

Let M = the number of public safety units needed at a major fire

X = the number of units readily available for dispatch

M-X = the number of units that will needed to be interrupted

Z = the binomial random variable with parameters p & M-Y

[>= : This symbol means greater than or equal to]

The probability that there will be sufficient patrol units for assignment to the fire is

$$P(\text{sufficient}) = P(X >= M) + P(X=M-1)*P(Z>=1|X=M-1) + P(X=M-2)*P(Z>=2|X=M-2) + P(X=M-3)*P(Z>=3|X=M-3) + \ldots + P(X=0)*P(Z>=M|X=0) \quad (12)$$

This basic preemption policy is designed to insure adequate manpower for immediate dispatch to almost all fires and is applied to both minor and major fire situations. To calculate travel times and arrival probabilities, we assumed that the actual unit or units preempted were selected on the basis of the level of emergency of their current activity irrespective of their location. Consequently, if no units were available but at least one could be preempted, the probability that the preempted unit would arrive before the fire equipment was the same as when there was one unit available at the time of a fire.

$$PF(1 \mid x=0) = PF(1 \mid x=1) \tag{13}$$

Equation (1) is modified to sum X from 0 to N instead of from 1 to N. Similarly if basic preemption provides at least A units for a minor fire and B units for a major one the corresponding formulas (2) and (3) are also summed for X=0 to N

$$\text{with } PF(2 \mid X < A) = PF(2 \mid X = A) \tag{14}$$

$$\text{and } PF(2 \mid X < B) = PF(2 \mid X = B). \tag{15}$$

Analogous adjustments are made to the travel time statistics.

2. Aggressive Preemption

The preemptive dispatch policy considered until now is the following:

> Dispatch the nearest available unit. If all units are unavailable, identify and dispatch the unit involved in the least important activity irrespective of its location.

A more aggressive policy is as follows:

> Identify all available units and all units involved in interruptible activities. Dispatch the nearest of these units even if this means interrupting an activity rather than dispatching an available unit farther away.

This policy increases the number of dispatchable units above the bare minimum required at the fire. To capture this policy, we again superimpose a Binomial distribution on the basic queuing probabilities, p(x).

Let Y = The number of dispatchable units

N = The number of units deployed

X = The number of units currently available

Z = The Binomial random variable

p = The proportion of police activities that are interruptible.

Then p(y) is determined by partitioning as follows:

$$P(y) = \sum_{X \text{ from } 0 \text{ to } y} P(\ Z = (y-x) \mid p, N-x) * P(x) \qquad (16)$$

In this equation (N-x) plays the role of n, the number of repetitions in a Binomial experiment. The term p(y) is then used to replace the corresponding p(x) terms in equations (1) through (6) in order to calculate performance measures.

E. RARE EVENT ANALYSIS: RESPONSE TIME TO POLICE CALLS DURING A MAJOR FIRE

One oft expressed concern with the public safety concept is what happens to police services during a major fire. This concern is often highlighted in public campaigns against a merger by showing a perplexed public safety officer trying to choose between responding to a fire and a bank robbery. (See Figure 1.1 which was used in campaigns to defeat the public safety concept in Roseville, MI) The queuing model described earlier adequately models this potential conflict for the majority of fires in the same way the model captures the possibility of two banks being robbed at the same time. However, the infrequent major fire of long duration is not reflected in the model's long term average (steady state) statistics.

We developed a simulation model to analyze system response to calls for service after a major fire had been reported. The model focuses on both the time period of the fire and several hours after the fire has been put out. We included this post-fire period in the model because a major fire could result in the stacking of non-emergency calls during the fire period and this backlog could affect police response even after the fire has been put out.

The model calculates statistics with regard to waiting time and response time for several call priority classes as well as the probability that a call will be delayed due to the unavailability of patrol units. The model was designed to explore the impact of the following parameters and policies on system performance:

1. The duration of the major fire

2. The dispatch policy during the fire; The model allows low priority calls to be queued during a fire even if one or more units are available in order to keep a unit in reserve for a high priority call.

3. The number of units to be called at the start of the fire

Small fire departments as well as public safety departments when faced with a major fire that will last an extended period of time contact off duty officers to return to duty. Oak Park, MI calls in officers an average of once a month. (Later we will report statistics for Roseville). Thus another issue this simulation modeled can be used to explore is how many officers should be called in to provide coverage. In addition by studying the system's response time statistics after the fire has been put out, it is possible to determine how long these additional manpower will have to stay on duty until the system returns to an acceptable response time level. Another alternative small cities use is mutual aid. We have not explored differences in mutual aid for traditional fire departments versus public safety departments.

In summary, we have outlined a queuing model and a travel time model than have been linked to determine system response time for different classes of call priority for both a pre-merger and merged systems. To model system performance before, during and after major fires, we developed a Binomial model to model preemption of interruptible police activities. The preemption policies modeled include both a basic and an aggressive strategy. Finally, a simulation model was developed to capture performance during and after the fire period.

CHAPTER III

QUANTITATIVE METHODOLOGY: COST ANALYSIS

The motivation for mergers is the assumed cost effectiveness of the combined police and fire services. Decision makers anticipate either reduced operating costs while maintaining system performance or stable costs with improved performance. In this section we discuss the primary factors that affect the relative operating costs of the pre-merged and merged systems. The focus will be on long term annual costs with only a limited discussion of the short-term implementation costs.

A. KEY DECISIONS

An important concept we emphasize here and in our analysis of Roseville is that the costs will be directly linked to two critical decision areas:

1. Deployment levels
2. Bonuses to encourage voluntary dual training

Decisions made in each of these areas not only will affect the magnitude of any potential savings but may also determine whether or not system cost will decrease or increase.

1. Deployment Levels

The primary cost saving feature of a merged police-fire department is its ability to operate the dual emergency response system with fewer personnel. The magnitude of this personnel savings is closely tied to two operational questions that the public safety chief must address.

1. How many officers are to be kept at all times in the fire stations?

2. How many units are to be added to the patrol division?

No simple formula can be used to answer these questions. Instead, the mathematical models described earlier and illustrated in the Roseville example will be crucial in deciding on acceptable deployment levels that meet or exceed pre-merged performance. The final decision will be city specific as each city establishes its own desired level of performance.

Aside from these personnel and associated supervisors, there will be a large number of personnel whose duties are unaffected by the merger. In essence the entire police side of the budget cannot be reduced. Personnel not assigned to patrol will have assignments that still need to be completed and the city will need to deploy at least as many patrol units as it currently operates. Similarly fire personnel assigned full-time responsibilities unrelated to responding to emergencies will still be required in a merged department. Savings accrue mainly from the reduction of fire station based personnel which must in part be compensated for by increased patrol strength.

In planning this tradeoff the manager must remember one crucial factor and that is:

> There is not a one-to-one trade between one firefighter around the clock and one patrol officer around the clock.

Traditionally each firefighter provides as many as 56 hours per week of coverge for his salary while patrol officers usually provide only 40 hours per week of coverage.

2. Merger Incentive Bonuses

Any savings in personnel will be in part negated by any bonuses instituted to encourage personnel to become dual trained. In the area of bonuses several questions must also be addressed.

a) What is the magnitude of the bonuses?

b) How many current employees will be eligible for dual training bonuses?

c) Will the dual training bonus apply to new hires as well?

Although the size of the bonus is obviously important, the latter two concerns may be more critical as to whether or not the merger saves money. The issue of eligibility is crucial because in many police departments less than half the personnel are assigned to the patrol division. Thus, the impact of the bonus may vary by a factor of two depending upon eligibility. If the bonus is paid to all officers who sign up, more than half the people dual trained may never use their fire skills. On the other hand, dual training bonuses which apply to all officers may enhance the image of the department as a public safety department and allow for greater flexibiltiy in moving officers in and out of specialized units.

The impact of limiting bonus eligibility to current personnel assigned to patrol or likely to be assigned to patrol will vary dramatically from one city to the next and therefore should not be viewed categorically. For example, in Flint, Michigan only 39% of the police are assigned to patrol and Des Moines, Iowa the number is 33% [28]. In contrast Grand Rapids, Michigan assigns 61% of the police officers to patrol. Thus, if all police officers in Flint or Des Moines were to opt for a dual training, the incentive salaries pool would be between two and one-half and three times the minimum needed to attract sufficient personnel to staff a dual trained patrol force. At the other end of the spectrum, in a city such as Grand Rapids, there is less flexibility and an expansive bonus eligibility criterion will not add greatly to the cost.

The issue of current employee bonus eligibility has an immediate impact on the cost of a merger. The salary structure of new hires will have a long term affect. Some departments while offering a 10% base pay raise to officers who accept dual training have restricted the raise to officers presently within the fire or police departments. All new officers who are hired are paid at the current police pay scale which is usually higher the the fire pay scale. If this differentiation is not made, then any long term savings from reduced personnel must overcome this across the board increase in the per officer cost of service delivery.

In our evaluation of Roseville we will cost-out a range of assumptions as to the percentage of personnel in the merged department who will be paid at the higher salary. A related policy question which was not explored here is:

> Do fire station personnel remain solely firefighters, to be on duty an average of 56 hours per week and paid a firefighter's salary.

B. Savings

1. Fire Personnel

Traditionally, studies in advance of a merger have focused on the number of policemen plus the number of firemen and contrasted that with the estimated number of people that will be needed in the merged department. This type of analysis simplifies estimates of costs, but is the wrong way to approach the cost analysis. Deployment levels will be the key to the manpower costs and this type of presentation camouflages the old and new deployment levels. In order to emphasize the link between cost and the deployment decision, our cost analysis will be built around the average number of officers assigned fire station duty and patrol under pre- and post-merger rather than total positions. Fire station peronnel changes will be considered savings and patrol increase will be treated as added costs.

To facilitate our discussion, we introduce several key variables in Table 3.1. In general the list is self explanatory. The variables include front-line emergency responders and their salaries as well as their first and second level supervisors. The last variables, which characterize the departments' traditional ratio of supervisors to basic officers, are needed to determine the savings in supervisory pesonnel that would accrue with reduction of frontline personnel. These variables do not include the top most personnel. The potential for savings at this level will depend on the specifics of the department and the merger. An obvious issue is whether or not the merged departments will maintain two people equivalent to the two separate chiefs of fire and police or whether one of the two positions will be

Table 3.1

List of Personnel Variables

P1 = Number of Police officers: patrol

P2 = Number of Police officers: other activities

PS1 = Number of police supervisors: patrol

PS2 = Number of police supervisors: other activities

FO = Number of Fire personnel assigned to fire stations

FC = the number of fire commanders assigned to supervise at fires

FS = the number of fire stations

FSS = the average number of fire personnel on-duty per fire station: Separate Departments

FSM = the average number of fire personnel on-duty per fire station: Merged Departments

NPS = The average number of additional officers on patrol every hour of the day

AP = Annual police officer's compensation

AP1 = Annual police first line supervisor's compensation (Sergeant)

AP2 = Annual police second line supervisor's compensation (Lieutenant)

AF = Annual fireman's compensation

AF1 = Annual fire first line supervisor's compensation (Sergeant)

AF2 = Annual fire second line supervisor's compensation (Lieutenant)

APS = Annual public safety officer compensation

APS1 = Annual public safety first line supervisor's compensation (Sergeant)

APS2 = Annual public safety second line supervisor's compensation (Lieutenant)

RP1, RP2, FP1, FP2 = the ratio of police and fire supervisors (first and second line) to front line personnel totally phased out. Similar issues arise at the command level just below the top and it is hard to generalize as to the potential for savings of one or perhaps two positions at this level. In our study of Roseville we will cost out several likely alternatives.

The primary cost reduction is linked directly to the number of fire personnel kept at all times at fire stations and their associated immediate supervisors. The total Frontline Manpower Savings (FMS) is: [* : This symbol means multiplication.]

FMS = FS * (FSS-FSM) * (168/FHW)

The first component is the number of fire stations multiplied by the reduction in the number of frontline personnel assigned to an average fire station. Emergency coverage is provided 24 hours a day, 7 days a week, for a total of 168 hours per week. Thus, the number of people needed on annual basis to cover these positions is equal to 168 divided by the average fire work week. For example in Roseville firemen work a 24 hour shift and are then off for two days which averages out over a year to a 56 hour work week. Thus 3 people (168/56 = 3) are needed to cover each position. We have not included a factor to cover vacations and sick time because in Roseville these shortages seemed to covered with overtime and not additional personnel. If overtime were sparsely used to provide minimum coverage then this expression would need to increase by 10%.

The total dollar savings (TDS) reflects personnel costs up to the level of second line supervisors (lieutenants).

TDS = (FMS*AF) + ((FMS/RF1)*AF1) + ((FMS/RF2)*AF2)

In the above expression FMS/RF1 and FMS/RF2 represent the anticipated reduction in supervisory personnel assigned solely to firefighting management and AF1 and AF2 are their respective salaries.

In order to separate the decision on fire station manpower reduction and additional patrol units, we also subtract other costs for each of the (FMS) firemen removed from stationhouse duty.

a. The amortized cost of personal fire gear for each fireman

b. The cost of individual liability insurance

c. The cost of uniforms, laundry and continuing education

These costs will be added back into the cost equation for those personnel that are added to the patrol division.

2. Capital Costs of Fire Stations

A reduction of the manpower on duty at fire stations can also result in capital savings. The reduced at-station manpower allows for the building of smaller lodging facilities for personnel. Kalamazoo estimated [14] that a traditional fire station required 7000 square feet while a public safety station would require only 3500. We could translate this cost avoidance into an annual capitalization cost. Realistically, however, in small cities with relatively few firehouses, new station construction is likely to be sporadic and actual cost avoidance will depend upon whether or not the city is growing. Thus this potential savings is not applicable uniformly to cities contemplating a merger. We have, therefore, simply noted this potential savings so that the city offical faced with the

+
construction of new stations, as Kalamazoo was, can include this cost avoidance factor. In our analysis of Roseville, this factor will not be included as there were no current construction or modification plans.

3. Overtime

Lastly, it has been suggested that the merged service could save money on overtime. Part of the overtime costs arise from deployment shortages of scheduled personnel that have to be covered with overtime hours. Under a merged system, although the combined total number of police and fire personnel deployed at any given time is less than with non-merged departments, the dual training means that there are more people who can handle any one type of major emergency. We have not been able to document this type of savings but in our analysis or Roseville, we will consider the impact of a 25% reduction in frontline overtime costs.

C. ADDITIONAL COSTS

The added costs incurred in a merger fall into the following three categories

1. patrol officers and patrol supervisors
   a. increased salary
   b. new fire equipment (clothing and vehicle related)

2. Additional units on patrol
   a. manpower
   b. vehicle and dual equipment

3. Personnel changes
   a. early retirement-longer annuities and bonus
   b. personnel changeover
   c. Continuing education

1. Increased Salaries and Changeover Costs

The first component of added cost is the increased salaries for all current police personnel assigned to patrol as well as the new officers assigned to patrol. All of these officers will have to be able to handle fires or an equivalent number of dual trained officers will have to be assigned to this group within the department. This cost is just the difference in salary multiplied by the number of officers affected including supervisory personnel.

$$C1 = (P1+NPS) * (APS-AP) + ((P1+NPS)/RP1) * (APS1-AP1) + ((P1+NPS)/RP2)*(APS2-AP2)$$

In addition there will be a fire clothing cost incurred by all of these officers which is

$$C2 = FCC * (P1+NPS + (P1+NPS)/RP1 + (P1+NPS)/RP2)$$

As was noted earlier, this increased salary cost may vary dramatically based on eligibility conditions. If all current personnel are eligible and sign up for the program then P1, the number of patrol officers, should be replaced by the total number of police officers.

Fire-Station Personnel

There is another group that may benefit from increased salaries. This group is the personnel that are assigned to fire station duty. In a voluntary merger a number of firemen are likely to opt not to be dual trained. These personnel can be accommodated by assignment to permanent stationhouse duty. The rest of the merger can essentially be fully implemented in the field even though these personnel remain solely fire-trained. In fact, there is a potential cost savings resulting from keeping their salaries at fire salary levels.

If, however, these personnel also opt for dual training, their increased salaries must also be factored into the added cost side as the difference in salary times the number of officers assigned to the fire stations.

(APS - AF) * FSM * FS * (168/FHW)

Although ultimately all personnel will be dual-trained in a merged department, we have have treated this as only a potential cost since hirees several years into the future may be paid salaries equivalent to current levels.

Even if these officers become dual-trained, we recommend that their shift assignments be typical of fire departments 56 hours to a week [29] rather than the 40 hour or less week associated with police. A shift to a 40 hour week for station personnel would add significantly to the cost of staffing the fire stations.

2. Additional Patrol Units

The second major cost component involves the additional personnel deployed all hours of the day. Although in large part this is a transfer cost, we have treated it as an added cost because it is within the control of the decision maker.

C3 = NPS * (168/40) * [AP+(1/RP1)*AP1+(1/RP2)*AP2]

This expression includes the number (NPS) of front line personnel as well as first (NPS/RPS1) and second (NPS/RPS2) line supervisors and their respective salaries. The 168 hour week is divided by 40 hours, which is the typical work week for police and public safety officers. Obviously, the figure can be easily adjusted for any standard work week. In addition there are added uniform and personal police equipment costs (e.g. firearms). The salaries included in this equation of those of a police officer rather than that of a public safety officer. That was done to separate the cost of increased salaries decision from that of the increased patrol manpower decision.

These additional patrol officers generate vehicle and related operational costs. The number of vehicles that will have to be added in the short term depends on the maximum number of officers deployed at any one time and whether the units have two officers or one. To simplify the analysis, we average this cost by determing the average number of officers per unit, AUNIT. We then divide the increase in patrol manpower by this average to determine the number of additional vehicles. In Roseville, half the officers patrolled as one-officer units and the other half patrolled in two-officer units. Thus the average is 1.5 and every three additional officers deployed at any one time adds two patrol cars to the department. (This number might need to be further expanded to allow for spare vehicles and supervisor vehicles.)

The vehicle cost is just the purchase price minus the trade in price divided by the number of years of service. The data from Roseville indicated a two year time frame. The same data showed an operating and maintenance of $6,000 for an average of 50,000 miles per year. In addition the vehicle must be equipped with both police and fire equipment. These costs are relatively small with the exception of the communications component. Specific values are provided in the Roseville example.

3. Public Safety Unit Call-in and Standby

In small public safety departments, a major fire which ties up a large number of personnel for several hours will require the call-in of off-duty personnel to provide patrol and fire coverage. The annual cost of this call-in is a function of its frequency, average number of officers called in, the cost per officer and the duration of the call-in

Frequency * No. Officers * Time * Salary Rate

The city of Oak Park, Michigan, which has had public safety since the early 1950's, has a population estimated at 36,000. Over the past several years, it has called in personnel an average of once a month. Later, we will provide an estimate of the call-in rate for Roseville.

When instituting a call-in program, the city may have a policy that requires payment personnel for a minimum of four hours work, irrespective of the actual duration of the fire. Roseville currently has such a policy. Their policy also specifies an alternative pay formula which is 1.5 times the hourly rate times the number of hours actually worked. Officers are to be paid the higher of the two values. Thus, for any call-in period that is less than two hours and forty minutes, the minimum four hour pay is the higher of the two. In our analysis we will use this four hour minimum exclusively since our fire data indicate that rarely will the call-in period last as long as two hours and forty minutes. If the call-in averages three officers and occurs even at a rate more than double Oak Park's (i.e. once every two weeks) the total annual manhour cost would be (26 * 3 * 4) or 312 manhours. This is approximately one-sixth the annual manhours of each officer and would represent an annual cost of under $10,000.

One closely related cost involves officially designating a group of officers to be on standby for immediate call-in. Currently the department pays officers $15 for one 24-hour day's status as a standby. The cost of one officer on standby 24 hours a day, 365 days a year is $5475. If at any one time 3 officers are so designated, this policy will cost $13,700.

Since completing this study, there was a Supreme Court decision and amendment to the Labor Relations Act which would make the cost of standbys prohibitive. The option the city has is to simply telephone officers not on specified standby and locate enough to be called in. Alternatively, the city can invoke its mutual aid agreement. This problem, however, is not unique to public safety departments and must be addressed by most small departments that do not have sufficient personnel to fight the rare major fire in their city.

D. Ambiguous Costs and Savings

1. Pensions

A third category of cost which is linked to changes in personnel is a mixture of costs that can be viewed as start up costs and others which may or may not occur. The first component involves retirement benefits and should be viewed from both the short and long term. In the short term these costs are likely to go up. As part of the merger implementation plan, the city may offer a lump sum early retirement bonus or modify the retirement benefit formula in order to speed the changeover (i.e. hire dual trained officers to replace retiring single trained officers). We have used the term early retirement to reflect a reduction in the average actual retirement age and or years of service and not necessarily a change in eligibility. If the retirement benefit formula is not modified, then these added costs can be grouped as part of the implementation cost and are just the sum of any cash retirement bonus plus the annual retirement benefit times the extra years of retirement.

One city we visited considered a different incentive. The retirement benefit formula is often based on some multiple of an officer's most recent salary. Since an officer could have become dual trained and thereby increased his annual salary, the city offered to calculate retirement benefits as if they had become public safety officers for those officers retiring immediately. This increased annual retirement benefits 10% and reflected a long term cost rather than a startup cost. In this case the added annual cost was easily calculated: 10% of the annual retirement benefit multiplied by the number of officers who opted for early retirement.

The long term retirement costs associated with a merger may, in fact, produce savings because the total number of officers within the department will be reduced. To fund these retirement benefits, cities are often required to make annual deposits to cover this long term liability. One method of comparison is to forecast the department's composition five year's down the road, by which time the merger should have been completed and the department reached or neared its manpower goal. Contrast the non-merged and merged forecasts of total personnel, their salary structure, age and years of service and use the same actuarial procedure to determine annual retirement fund deposits. This will result in either an annual cost or savings that can be coupled with the earlier analysis to provide an annual cost differential between merged and unmerged departments.

In the above paragraph we have not attempted to spell out in greater detail how to forecast these as the analysis involves actuarial methods that are beyond the scope of this report and are usually available to city governements. One simplified approach is to assume that annual deposits will be proportional to the total manpower and average salary level. Thus if a merger in aggregate reduces total personnel to P% of its pre-merger total but salaries for existing personnel increase by S%, then the percentage decrease in payments to the retirement fund is:

$$\text{Percentage Retirement Savings} = 100 - [P * (100 + S)]$$

If, for example, the merged department results in a total personnel that is 90% of the pre-merged departments and salaries on average increase by 6%, the net pension savings will be 4.6% of retirement payments. In general there will be a long term pension savings if the decrease in personnel is greater than the average salary increase.

In our analysis of the City of Roseville, we included all of the retirement benefits into the total compensation package for each officer. In addition health and life insurance costs were also included this way. Thus the AP, AF and APS variables defined in Table 3.1 were interpreted broadly to include all costs that can be linked directly to personnel salary, wages and benefits. The same concept was applied to supervisor personnel costs.

2. Added Cost of Personnel Turnover

Another factor that adds to the cost of operating the merged department is personnel turnover. The primary cost associated with turnover is training of the new officers. The magnitude of this cost will depend upon departmental policies. In some departments officers are hired without any training and all training is at departmental expense with the officers paid a salary during the training period. In others new personnel are expected to have received a degree from an accredited program before being accepted into the department. In the latter case there will still be an internal departmental orientation program but this would be relatively short and the hiring cost rather limited. In either case the cost is defined by the length of the training or orientation program until the officer can take a regular assigned position and is to be multiplied by the salary scale for that interim period. (Often the training salary is significantly less than the regular salary.)

The primary difference between the merged and unmerged systems is the extent of training and the number of officers replaced annually. With two unmerged departments and more officers, the total number of personnel replaced annually will be larger than for a merged department but new personnel will require either police or fire training. Under a merger with fewer total officers, the total annual turnover should be lower but the length of the training period will be longer. However, in composite this will result in a net cost. The total number of officers replaced each year in a public safety department should be larger than that of either the pre-merged police or fire departments. Thus, each year the merged department will train more individuals in police work and more individuals in fire work than before the merger.

The simplest situation to cost out involves a T% turnover rate that is assumed constant for both merged and unmerged departments and an assumption that all training is done while on the payroll. Salaries during the training period are assumed to be PTS, FTS, and PSTS for policemen, firemen and public saftey officers respectively. Let NP, NF, and NPF represent the number of personnel in the respective departments. The training period in weeks for police and fire are defined as PTW and FTW. In addition there may be other related educational costs such as tuition which we have aggregated as PEC, and FEC. In absence of hard data, we have assumed that public safety officers undergo a training period and incur other educational costs that are equal to the sum of corresponding police and fire values. The increased new hiree educational cost is:

$$T\% * [NPF*(PSTS*(PTW+FTW) + FEC + PEC)] - T\% * [NP*(PTS*PTW + PEC) + NF*(FTS*FTW + FEC)]$$

This formula can be easily modified to incorporate different turnover rates for police, fire and public safety.

This analysis would be complicated if fire training is mainly on-the-job training with little out-of-pocket costs. If that is the case then the public safety program will have an added cost because it will not be possible to rely solely upon on-the-job training. Fire personnel have few calls for service each day and the in-between time could be used effectively to provide that training. In addition because personnel at a firehouse work as a team, the new officer can be consistently assigned a specific simple task at the fire scene until he gains added experience. In contrast the patrolling public safety officer could not be allowed to patrol and respond to fire calls without more extensive formal training since he may be the first officer to arrive at a fire scene. FTM for firemen would therefore cost effectively nothing while for public safety officers it would entail a salary of several weeks or more.

3. Dispatch Savings

Many small cities still maintain separate dispatchers for police and fire despite the fact that many cities have shown that one individual can be trained to dispatch police, fire and even emergency medical vehicles. In small to medium sized cities, the fire dispatcher workload could easily be integrated into the current workload of the police dispatch operation and in the process save one full time position. The savings is equal to 4.6 times the annual salary of a dispatcher if he works a 40 hour week and 3.3 times his annual salary if he is a fireman who is on duty an average of 56 hours per week.

There may be initial start-up costs associated with dispatcher training but these are likely to be small. A potentially larger cost may be incurred if the two dispatch operations are currently far apart. The fire dispatch room is likely to have automatic alarms that will have to be moved or linked to the new centralized dispatch operation at considerable expense.

This dispatcher consolidation and associated savings can be achieved without a full merger. We have included the issue here because the implementation of a public safety department will certainly eliminate any dispatcher duplication. When officers are being trained to fight both fires and crime, the claim that one individual can not dispatch both types of services becomes untenable. The presence of separate dispatch operations prior to a merger allows the city manager in costing out a merger to cover much of his implementation cost with the dispatch savings. Kalamazoo forecast that a merger would save money even in the first year. In reality the merger initially was costing money but the consolidation of dispatching eliminated four positions and duplicative equipment and more than compensated for the early implementation costs.

E. Implementation Costs

The discussion until now has focused on long term costs and savings. In the short term there will be significant costs incurred in implementing the merger. The major implementation cost involves providing cross-training for officers volunteering to become public safety officers. During the training program, their slots will have be filled by other officers often at overtime pay. The number of officers that have to be temporarily replaced will be reduced by the number of new public safety officers that are to be hired to replace retiring personnel. It will be expanded to reflect departmental policy as to who is eligible and required to undergo this dual training. Included in this training will also be supervisory personnel up to and including the chief. Although in all likelihood these top officers may never actually use the basic skills they learn, there is a sense that for a merger to work, senior level personnel must intimately understand the two roles and even set an example by becoming dual trained themselves.

If NPD, ASPO and NFD, ASFO are the respective number of police and fire personnel who opt for dual training and their average overtime salaries then the cost of implelmentation training is:

Training Cost = NPD*APSO*FTW + NFD*AFSO*PTW

In all likelihood the number of police becoming dual trained will be several times larger than the number of fire officers. A city's police department is usually much larger than its fire department and also police officers are generally more receptive to agreeing to dual training in exchange for a moderate salary increase. This will help hold down the cost of implementation because formal training of police officers to handle the fire role will often involve only several weeks of training. In contrast, the training of firemen to handle police calls will require at least a couple of months and could take as long as a half-year. In Roseville the police training program was four weeks longer than the fire program.

The above training is likely to be supplemented by a probationary period as officers adjust to their second role.

Nevertheless, this probationary period need not require supplemental deployment to compensate for inexperienced officers since every officer who is on duty is at least experienced in handling one of the two roles.

As officers become dual trained, they begin earning their higher salary. However, in the early stages of a merger this increased salary can not be offset by a reduction in personnel until the pool of dual trained officers is sufficient to staff at least a significant porion of the city.

This added cost at any stage of the implementation can be approximated by multiplying the percentage of the personnel that have been dual trained by the percentage salary increase and subracting from that the percentage reduction in personnel. Thus when 25% of the original personnel are dual trained and paid a 10% higher salary, that implementation cost can be offset by an approximate 2.5% reduction in these personnel.

Summary

In the above discussion we have identified a number of key variables that we will concretize with Roseville data. Although Roseville had contemplated a merger it was never implemented. We will therefore consider several scenarios when costing out the long-term impact of a merger with the key components listed below.

Savings	Added Costs
Reduced Fire Station Personnel	Higher Salaries
Reduction in Dispatch Personnel	Additional Patrol Units
New Fire Station Cost Avoidance	Higher Training Costs
Reduced Overtime Costs	Emergency Callback Cost

CHAPTER IV.

ROSEVILLE: SYSTEM PERFORMANCE

A. BACKGROUND

The previous chapters presented models for estimating system performance and a methodology for costing out the impact of a merger. In order to concretize this analysis, we have applied it to data of an actual city. The discussion that follows uses data from the City of Roseville, MI as an illustration. However, the results should not be interpreted as a specific recommendation to city officials as this report does not explore the dynamics of a specific implementation in Roseville. Rather, Roseville police and fire data are used to illustrate the potential impact of a merger on a city similar to Roseville. To broaden the findings, our analysis of cost will involve several scenarios.

The city of Roseville, Michigan is located two miles north of the Detroit city limits and had a population of 57,000 as of 1980. The city is 9.5 square miles and is mainly a residential area. The government is run by a city manager who is appointed by the City Council. The city's total budget for fiscal year 1982-1983 was $13 million.

The fire department's budget in 1982-1983 was $1.86 million of which $1.65 million (90%) went to personnel services. The fire department had 38 members that were used to staff two fire stations. The headquarters station is located close to police headquarters and had its own fire dispatcher.

The city has an unusually small fire department for cities its size. In Table 4.1 we present 1978 data on 19 medium sized cities in Michigan. Roseville, at that time was ranked next to last in terms of fire personnel per 1000 population and in that study Roseville was listed as having four more personnel that it did in 1982. National fire data [1] for cities in the 50,000 to 100,000 population range display a rate of 1.62 per 1000 population which is more than double the current Roseville value of 0.68.

The police department's budget was $4.4 million, of which $3.86 million (88%) covered the personnel costs of a staff of 91. This last figure translates into 1.57 personnel per 1000 population which is 25% below the national average for cities in the 50,000-100,000 population range. When viewed as a ratio, the fire budget is 40% as large as the police budget. Nationwide, fire budgets are proportionately larger and on average are 69% as large as the police budget [1]. These statistics have important ramifications in terms of generalizing our analysis. The major savings in a merger essentially come from the fire side of the budget equation. Thus, we hypothesize that:

> Savings that might accrue to Roseville from a merger are likely to be significantly smaller than the savings that could accrue to other cities of similar size but with higher fire personnel staffing rates.

In total police and fire services account for slightly less than half (48%) of the city's total budget. The city is not responsible for education.

TABLE 4.1

MICHIGAN FIRE DEPARTMENT DATA: 1978
RANK ORDERED FROM HIGHEST TO LOWEST BY PERSONNEL PER 1000 POPULATION

CITY	POPULATION	AREA	FIRE PERSONNEL	FIRE STATIONS	FIRE PERSONNEL PER 1000 POP.
Battle Creek	38,000	18.2	90	5	2.36
Saginaw	91,000	16	180	6	1.97
Lansing	131,000	33.87	251	10	1.91
Kalamazoo	85,000	25	158	6	1.84
Flint	174,000	33.5	300	9	1.7
Bay City	47,000	11	80	4	1.7
Port Huron	37,000	7.96	61	3	1.64
Jackson	46,000	10.4	75	4	1.6
Pontiac	80,000	20	122	4	1.52
Muskegon	44,600	18.2	66	5	1.47
Southfield	84,500	26.6	105	5	1.24
Ann Arbor	106,000	22.5	108	5	1.01
Royal Oak	87,000	12	90	4	.96
East Lansing	52,000	8.9	49	2	.94
Sterling Hgts.	92,000	36	81	4	.88
St. Clair Shrs	85,600	11.6	64	3	.74
ROSEVILLE	58,000	9.75	42	2	.72
Westland	97,000	21.8	65	4	.67
TOTALS	1,435,700		1,987		1.4

B. THE FIRE DEPARTMENT

In 1981, the fire department responded to 727 fire related emergencies. In addition the department provided ambulance service; however, that component of the workload will not be included in our analysis. We have not included this because our focus is on police and fire mergers and not emergency medical care. Many fire departments do not provide ambulance service and even in Roseville the city relatively recently attempted to eliminate this service but was overruled in a major political fight. In addition there is a private ambulance service that also services the city and offers a higher level of service: Advanced life support as compared to basic life support provided by the fire department. Even without the emergency medical service, current fire manning levels would need to be maintained.

The fire department staff of 38 included:

a. Fire Chief and a Fire Marshall

b. Two assistant chiefs and a fire inspector

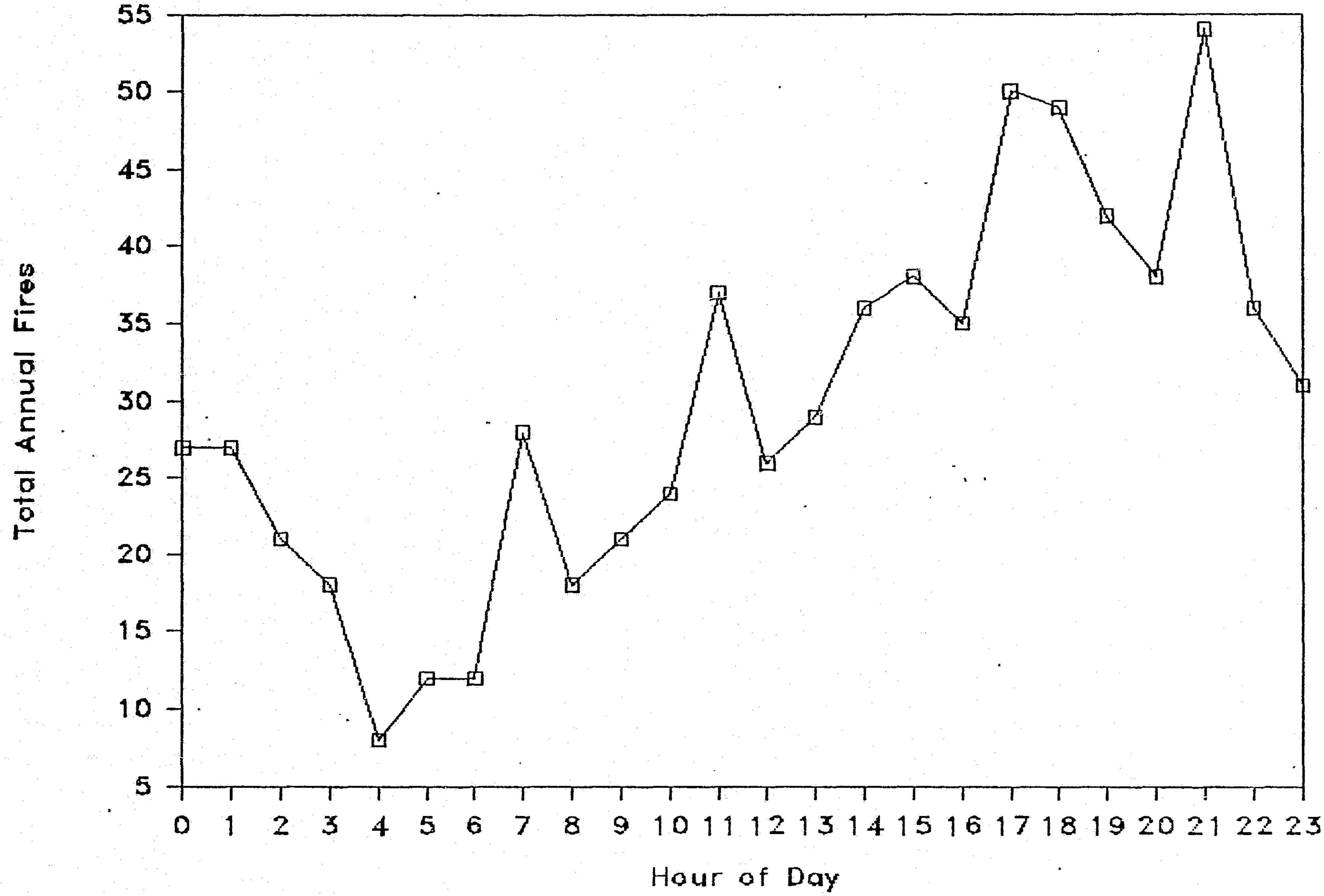
c. Four lieutenants and four sergeants

d. Twenty four pipemen and an administrative clerk

Ten men are stationed in fire houses at all times. Six are at headquarters with one of the six serving as the dispatcher. The other four are at the second fire station. The major equipment includes four pumpers, a mini-pumper, a rescue squad vehicle and 2 ambulances. In addition there is the chief's car and 2 cars assigned to fire prevention.

FIGURE 4.1

FIRE CALL RATE BY HOUR OF DAY



1. Workload

A firefighter's duty schedule is 24 hours on-duty followed by 48 hours off-duty. This averages out to 56 hours per week. On average the department handles 2 fire related calls per day. Of this total, 12% are structural for a rate of one structural fire every four days. Figure 4.1 illustrates the breakdown of calls by type. The largest category is minor calls, 32%, and includes grass fires, vehicle fires, garbage dumpster fires, etc.. Two other major categories are potential fires (16%) and false alarms (14%).

The average time spent at a fire call is 26 minutes and on average 4 men work at a fire call. (In the State of Michigan, fire departments fill out a form on which they record the number of men who worked at the fire.) Thus the total annual fire call workload is 1260 manhours:

(727 calls * 26 minutes * 4 men/60)

The annual total number of manhours for 9 people available for dispatch 24 hours a day is 8760 * 9 manhours. The ratio of these two numbers represents the proportion of time that an average officer spends on fire calls.

On average firemen spend only 1.6% of their time at fire calls.

This calculation of percent utilization involves an approximation because it involves multiplying averages by averages. The exact way to calculate the percentage utilization is to determine first the total manhours for each individual call and then to add together the manhours to determine the annual total which is divided by the annual available manhours. We carried out this calculation and it had a negligble impact on the percentage utilization. We, therefore, used this simpler approach.

The time spent at a fire call and the number of personnel-at-the-scene varies by call type. Structural fires average between 6 and 7 firemen and in 62% of the incidents, 6 or more firemen worked the fire. In contrast 93% of the minor fires required five or fewer men. Potential fires, man-made fires and the catchall "other" category rarely require more than 5 men.

TABLE 4.2

FIRE PERSONNEL AT FIRE SCENE

NUMBER of PERSONNEL	FREQUENCY	RELATIVE FREQUENCY	CUMULATIVE RELATIVE FREQUENCY
3 or less	491	68%	68%
4 or 5	73	10%	78%
6	28	4%	82%
7 or 8	79	11%	93%
9 or more	54	7%	100%

The personnel-at-the-scene data are summarized in Table 4.2. Approximately one in every 13 calls utilized all of the available fire personnel, which averages out to once a week. Later, when we consider public safety deployment levels, we will explore how this number and the deployment level interact to determine the frequency with which off-duty personnel might have to be called in to help provide coverage during a major fire.

The cumulative distribution of time spent at a call is represented in Figure 4.2. Over 80% of the calls are handled in under 30 minutes and only 6% tie up personnel for more than one hour. About one call in 60 (i.e. once a month) takes longer than two hours to handle. Structure fires, however, take significantly longer than the overall average. Their average service time is 49 minutes. Nevertheless more than 75% of these calls are serviced in under one hour.

The call rate varies by time of day with the peak between 9 and 10 P.M. with an hourly call rate of .14 calls per hour. (see Figure 4.3) At the other extreme is 4 to 5 A.M. which has an hourly call rate of 0.02 per hour. If we group the data by time of day and day of week, Friday evening (4 P.M. to Midnight) has the highest call rate. On average the department will respond to one and a half calls during this eight hour time block.

Another way to view the peak call rate is to describe it in terms of the amount of work generated. On average 4 firemen work at a fire for an average of 26 minutes. Thus a call rate of .14 per hour translates into an average of .28 manhours of work per hour for the city as a whole. Consequently, in a police-fire merger, this number implies that the addition of even one officer to patrol will result in an average increase in patrol coverage even after this fire workload is subtracted out.

FIGURE 4.2

CUMULATIVE DISTRIBUTION OF TIME AT FIRE

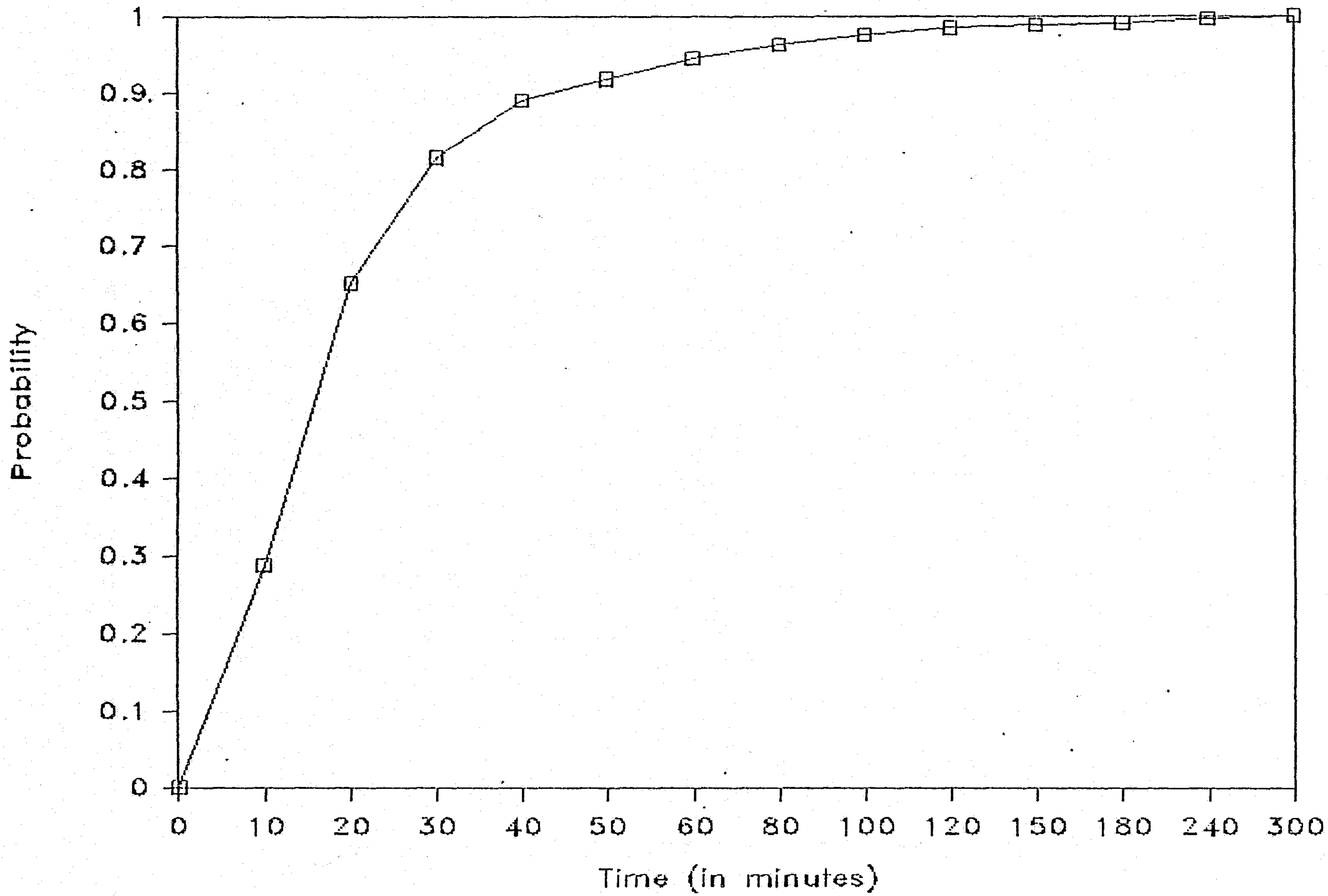
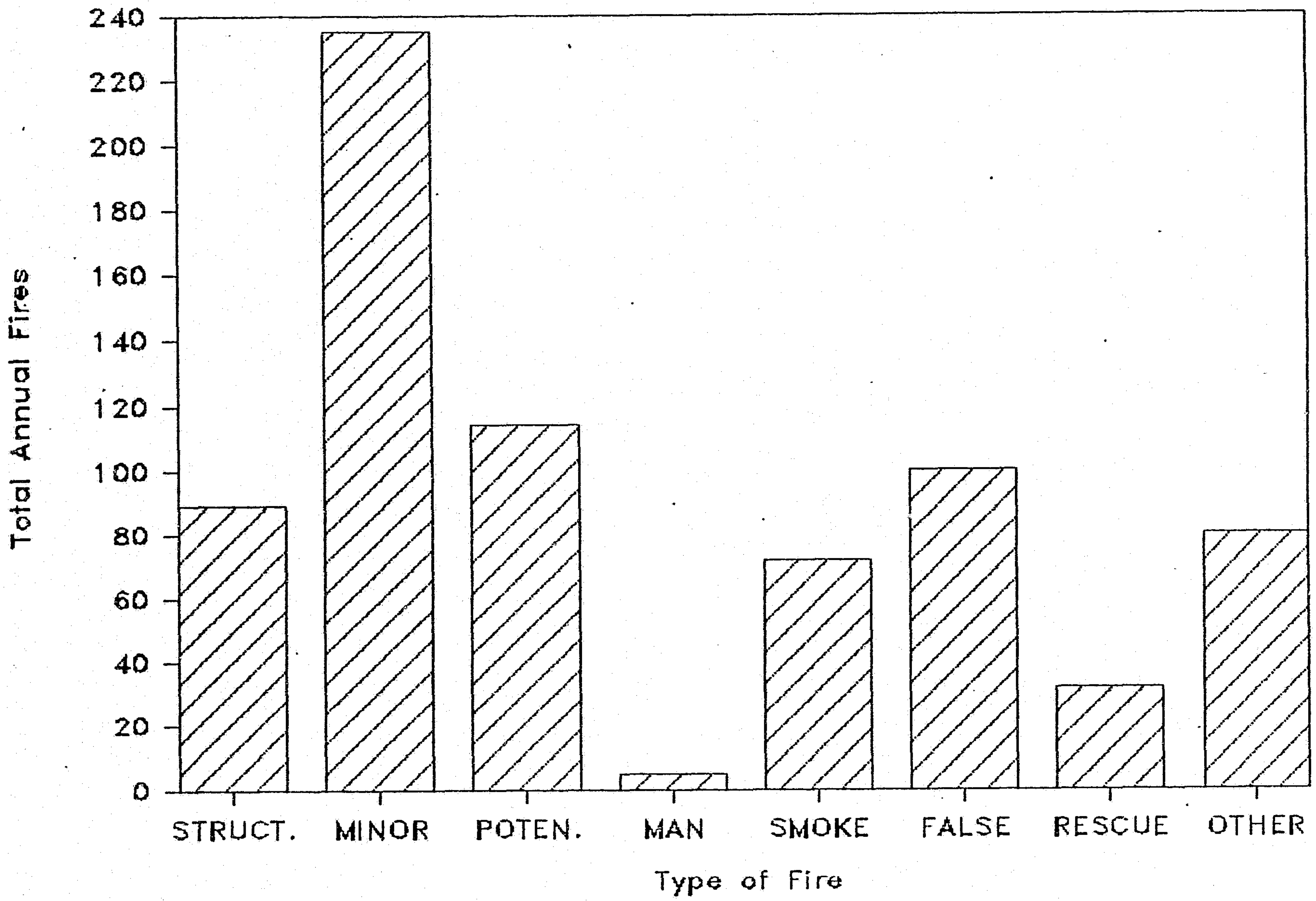


FIGURE 4.3

FIRE CALLS BY TYPE OF FIRE



2. Response Time

The response time of fire department equipment was estimated using the model described earlier. Fire equipment were presumed to be always available and stationary at specific coordinates at the time of the call. The time from announcement of the call until the unit was on the road towards the fire scene was assumed to be a minute. The model generated random calls throughout the region and calculated travel distance. This distance was translated into time with the Rand [21] developed formula:

Travel Time = 0.66 + 1.77 * Travel Distance

The average response time of the closest unit was estimated to be 3.3 minutes. The model estimated that seventy-eight percent of the calls were responded to in under 4 minutes and in no case was response time more than 6 minutes.

For major fires equipment from both stations would be sent. The response time of the second unit at-the-scene was estimated to be 5.3 minutes or two minutes after the first unit. In over 99% of the randomly generated calls, the second unit arrived in under 7 minutes.

C. THE POLICE DEPARTMENT

The Roseville Police Department consists of 91 employees composed as follows:

a. Police Superintendant and an inspector
b. Eight lieutenants
c. Ten sergeants
d. Sixty-one patrolmen
e. One dog warden, 3 secretaries and 6 clerks.

The reported crime rate in 1981 was approximately 330 Part I crimes per month and 315 part II crimes or about 7740 crimes per year. Of these almost 40% were reported cleared.

In order to obtain a comprehensive picture of the activities of officers out on patrol, we gathered data from officer logs for the month of June 1982. A special memo from the chief initiated special codes that were to be used to categorize all activities. The 9 categories were:

1. Crime in progress
2. Alarm-not-false
3. Fire Assist
4. Ambulance Assist
5. Alarm-False
6. Report of Crime
7. Non-criminal report
8. Traffic Accident or Violation
9. Other (Break, Lunch, Desk relief, Transportation, etc.)

These data were collected for both regular patrol and for traffic officers. However, our discussion will focus on the patrol division to the exclusion of traffic. In total we gathered data on over 5700 activities.

1. Deployment Levels

Officers are assigned to any one of three shifts: midnight to 8A.M. shift, the 8AM to 4PM and from 4PM to Midnight. During the early morning shift, officers generally ride in two-officer units. In June on weekdays an average of 3.6 units were fielded with an average of close to 7 officers. On weekends the numbers were slightly higher. (See Table 4.3). The day shift officers rode individually. On average slightly more than 6 officers were deployed in an average of 5.5 cars. The evening shift was different in that officers began the shift in one-officer units. However, between 7 and 8PM they generally met to convert into two-officer units. An average of about nine officers were deployed during this shift in 8 units at the start and deployed in 5 units during the late evening until midnight.

During the closing week of school extra officers were deployed to handle seasonal problems that often arose as graduation neared. These units were assigned to a special shift from 8PM to 4 AM. At times as many as 4 units were deployed and throughout the month at least one unit was deployed. In addition the Traffic Safety Bureau deployed two officers during the daytime and evening shifts. The traffic safety officers were not included in our analysis except under a merger as backup units available for emergency response to police calls while public safety units are tied up at a major fire.

2. Workload

In Figure 4.4 we illustrate the composition of the patrol force's activities. Crimes in progress accounted for 5.7% of the total. Categories 2, 3 and 4 another 2%. False alarms were 3.8% of the total. In total 97 out of every 100 reported alarms were false. Report taking (criminal 11.4% and non-criminal 6.6%) accounted for 18% of the activities. Traffic and accident related activities added another 10.1%. The largest category by far was the other category of non-citizen related activities. This accounted for 60.4%. This last fact is crucial because any dispatch priority system would interrupt this last activity category in case of an emergency. In addition if we add to the interruptable list of activities: traffic and report taking, then 88.5% of the departments activities are interruptable. Under a

TABLE 4.3

POLICE DEPLOYMENT LEVELS
JUNE 1982 AVERAGES

	PATROL UNITS	PATROLMEN
MIDNIGHT - 8 A.M.		
Mon. - Fri.	3.6	6.8
Saturday	4.5	8.5
Sunday	3.8	7.3
AVERAGE	3.8	7.1
8 A.M. - 4 P.M.		
Mon. - Fri.	5.5	6.1
Saturday	4.7	4.7
Sunday	5.3	5.7
AVERAGE	5.4	5.8
4 P.M. - 7(8) P.M.		
Mon. - Thurs.	7.9	9.2
Friday	9.3	10.5
Saturday	8.0	9.3
Sunday	6.3	6.5
AVERAGE	7.9	9.0
7(8) P.M. - Midnight		
Mon. - Thurs.	5.0	8.8
Friday	6.0	9.8
Saturday	5.0	9.0
Sunday	4.0	6.5
AVERAGE	5.0	8.6

Additional Units

One two-officer Patrol Unit	8 P.M. - 4 A.M.
Two one-officer Traffic Safety Units	7 A.M. - 7:30 P.M.
One two-officer Traffic Safety Unit	7:30 P.M. - 11:00 P.M.

MODEL ANALYSIS

Midnight - 3 A.M.	5 Two-officer Units
3 A.M. - 8 A.M.	4 Two-officer Units
8 A.M. - 4 P.M.	5 or 6 One-officer Units
4 P.M. - 7 P.M.	8 One-officer Units
7 P.M. - Midnight	6 Two-officer Units

merger, a major fire will likely require the interruption of these activities.

The composition does change by time of day. In the late evening (7 P.M. to Midnight) crimes in progress account for 9.1%, while during the day (8 A.M. to 4 P.M.) the percentage drops to 2.4%. At the other end of the spectrum, category 9 never accounts for less than 53% of the activities and categories 6, 7, 8, and 9 never account for less than 85%.

In total tours 1 (early morning) and 2 (day) account for approximately the same share of the departments activities, 28.5% and 27.5% respectively, with the remaining 44% in tour 3. On an hourly basis this represents 7.4, 7.1 and 11.4 activities in the corresponding tours. These aggregates camoflouge variability within two of the tours. From Midnight to 3 AM the hourly activity rate is 11.6 but drops to 4.9 between the hours of 3AM to 8AM. In the evening there is a similar but less dramatic change from 12.6 before 7PM to 10.7 after.

One last dimension of variability involves the day of the week. Not surprisingly the most dramatic difference arises in the Midnight to 3 AM time slot. On weekdays the activity rate is 10 per hour and in early Sunday morning this increases to over 15 per hour.

To determine the percentage of time spent on activities we multiplied the department's activity rate by the average time per activity and divided by the number of units deployed. In general, throughout the day, the average time for an activity was 20 minutes. The midnight to 3AM time slot was an exception in that the average time spent per activity dropped to 15 minutes. We included in the 7 PM to 3AM time period analysis only one additional unit that was deployed the entire month. The results are summarized below:

TABLE 4.4

PATROL UNIT WORKLOADS AND PATROL COVERAGE

Time Period	Activity Rate per Hour	Service Time (min.)	Average Number of units	Percentage Busy	Average # of units on Patrol
Midnight-3 A.M.	11.6	15	4.8	60%	1.9
3 A.M. - 8 A.M.	4.9	20	3.8	43%	2.2
8 A.M. - 4 P.M.	7.1	20	5.4	44%	3.0
4 P.M. - 7 P.M.	12.6	20	7.9	53%	3.7
7 P.M. - Midnt.	10.7	20	6.0	59%	2.5

In the late evening and early morning, activities consumed sixty percent of a patrol unit's time. At other times during the day the percentage was in the 40 to 50% range. Preventive patrol coverage levels are presented in the final column. On average during the early morning hours, there were approximately two two-officer units involved in preventive patrol at any given time. In contrast, there were more than three one-officer units involved in preventive patrol from 8 A.M. to 7 P.M..

Our analysis of pre-merger and post-merger response time patterns is built on mathematical models. To simplify the modeling we assumed that all units between 8 A.M. and 7 P.M. were one-officer and during the rest of the day were two-officer units. In addition we chose a specific deployment plan similar but not identical with the averages. The deployment plans were split into five groups in order to reflect the change in deployment between 7 and 8 P.M.. In addition we wanted to capture the dramatic difference in call rates before and after 3 A.M. and therefore chose that time slot as a breakpoint.

The deployment is listed in Table 4.3. There are assumed to be five units with ten officers between 7 P.M. and 3 A.M.. From 3 A.M. to 8 A.M., there are only four two-officer units. During the day shift, half the time there are five one-officer units and half of the time there are six. From 4 P.M. to 7 P.M. there are eight one officer units. This deployment plan averages 8.25 officers around the clock as compared to the 7.9 average observed in June (excluding several additional late night units). To maintain this deployment level all week long requires 4.2 times this number of patrolmen or over 36 patrolmen assigned to patrol. In our cost analysis in Chapter V, we will assume that 36 patrolmen and a proportionate number of officers are assigned to the regular patrol division.

The key paramter for our models is the activity rate. For the majority of the analysis, we will use call rates slightly lower than those reported in Table 4.3 in order to reflect the weekday averages. However, because there are systematic differences in call rates among weekdays, we will apply our models to a second set of call rates that are one-third above the average. For the Midnight to 3 A.M. time period, we will model a 50% higher call rate in order to model performance on an early Sunday morning.

3. Response Time

In this next section we will discuss system performance in terms of response time to different calls for service. Response time in our analysis includes two major components 1) travel time including a half-minute to dispatch a patrol unit and 2) dispatch delay due to the unavailability of patrol units. Our estimates of response time are based on the travel time simulation used for the fire response time analysis with one major difference. In the fire analysis we assumed that the nearest fire unit was always available for dispatch. In the police analysis a multiple dispatch queuing model is used to predict the probability distribution of the number of available units and the probabilities are used to weight the travel times. In addition the model calculates the dispatch delay due to patrol unit unavailability.

We will simplify the presentation by first reporting response time statistics for all of the time periods in which two officers are placed in each patrol unit. During these times, all calls are dispatched a single two-officer unit. Afterwards, we will discuss the response time pattern when only one-officer is placed in each unit. We assume all high priority calls will be dispatched two officers in two separate patrol units. All moderate/low calls are assumed to be dispatched only a single officer. For the highest priority calls, there are potentially two stages of dispatch delay that we will estimate. The first stage ends when at least one unit is available to dispatch and the second stage ends when a second unit is available. These two stages will be reflected in pairs of statistics in Table 4.6. The first pair differentiates between the probability of an initial delay, which occurs if no units are available to dispatch, and the probability of a full delay, which occurs when there is one or fewer units available and two are needed. Another pair of statistics reported are the response time of the first and second unit dispatched to the same call.

Midnight - 3 A.M. : 5 Two-officer Patrol Units

As was mentioned earlier, the Midnight to 8 A.M. tour will be analyzed in two parts: Midnight to 3 A.M. and 3 A.M. to 8 A.M.. During the first time period, weekday activities average a rate of 10 per hour and each activity consumes an average of 15 minutes per activity. When five units are deployed, they are busy 51% of the time and on average 2.4 units are on patrol. The probability that a call will occur when all officers are busy is 0.14 or one-in-seven calls face a potential dispatch delay. (See Table 4.5) On average calls are delayed slightly less than one minute. If the dispatcher does not interrupt busy units for high-priority calls, the delay for high priority calls will be half the overall delay or less than a half minute. If we include the travel time, then total response time averages 3.7 minutes for all calls and a half-minute less for high priority calls. (We assume that average response speed is 30 miles per hour for all priority levels.)

We also explored how the system would respond on a busy night with the same number of patrol units. A busy night is assumed to have 50% more activities per hour (15 per hour). In this case utilization rises to 68% and on average there are 1.6 units on actual preventive patrol at any one time. Now slightly more than one-third of all calls will be delayed and the average delay for moderate and low priority calls is 3.3 minutes and for high-priority calls is 1.1 minutes. When this is coupled to travel time, the corresponding average response time totals are 4.3 and 6.7 minutes respectively. Even under a conservative definition of uninterruptable, only 28% of the calls would fall within this category. Thus in an extreme emergency in which the dispatcher considers sending a currently busy unit, it is highly unlikely (less than one in a thousand) that all patrol units will be involved in uninterruptable activities.

<u>3 A.M. - 8 A.M. : Four Two-Officer Units</u>

Currently four two-officer units are deployed in this time period to respond to an average of almost 5 calls per hour. The average response time to high priority calls is 3.4 minutes and only slightly higher for low priority calls. Only one-in-eleven calls will experience a dispatch delay and on average there are 2.4 units on patrol. On a busy night response time to high priority calls would increase by a minute and increase by 2 minutes to low priority calls. In addition the likelihood that a call would be delayed has now more than doubled.

TABLE 4.5
POLICE RESPONSE TIMES: PRE-and POST MERGER
TWO-OFFICER PATROL UNITS

TIME	# UNITS	AVERAGE DISP. DELAY Call Priority High	AVERAGE DISP. DELAY Call Priority Mod/Low	AVERAGE RESPONSE TIME Call Priority High	AVERAGE RESPONSE TIME Call Priority Mod/Low	PROBAB. of DELAY	UNITS on Prev. Patrol
12AM - 3AM: Activity Rate 10 Per Hour - 15 Minutes per activity							
CURRENT	5	0.4	0.9	3.3	3.8	0.14	2.4
PHASE I	5-6	0.3	0.6	3	3.3	0.1	2.9
PHASE II	6	0.2	0.3	2.8	2.9	0.06	3.3
3AM - 8AM: Activity Rate 4.9 Per Hour - 20 Minutes per activity							
CURRENT	4	0.5	0.8	3.4	3.7	0.09	2.4
PHASE I	4-5	0.3	0.5	3	3.2	0.06	2.9
PHASE II	5	0.1	0.2	2.6	2.7	0.03	3.3
7PM - 12AM: Activity Rate 11.3 Per Hour - 15 Minutes per activity							
CURRENT	6	0.8	2.2	3.8	5.2	0.23	2.2
PHASE I	6-7	0.6	1.5	3.4	4.3	0.17	2.7
PHASE II	7	0.4	0.8	2.8	3.2	0.11	3.1
HIGH ACTIVITY RATES							
12AM - 3AM: Activity Rate 15 Per Hour - 15 Minutes per activity							
CURRENT	5	1.1	3.5	4.3	6.7	0.35	1.6
PHASE I	5-6	0.8	2.5	3.9	5.6	0.27	2.1
PHASE II	6	0.5	1.1	3.4	4	0.17	2.5
3AM - 8AM: Activity Rate 6.5 Per Hour - 20 Minutes per activity							
CURRENT	4	1.1	2.4	4.3	5.6	0.22	1.8
PHASE I	4-5	0.8	1.5	3.7	4.4	0.15	2.3
PHASE II	5	0.3	0.6	3	3.3	0.08	2.7
7PM - 12AM: Activity Rate 15 Per Hour - 15 Minutes per activity							
CURRENT	6	2.2	13.3	5.7	16.8	0.59	1
PHASE I	6-7	1.7	9.2	4.9	12.4	0.48	1.4
PHASE II	7	1.1	4.1	4.3	7.3	0.35	1.8

7 P.M. - Midnight : 6 Two-officer Units

At approximately 7 PM the one officer units on duty meet and officers change to riding two in a patrol unit. The typical deployment plan involves five units on patrol. However, as noted before, during the month of June additional units were deployed from 7PM to 3AM. We have focused our analysis on a deployment plan of six units that was employed during the last two weeks of June.

The patrol units were involved in 11.3 activities per hour and an activity averaged 20 minutes. Average response times to high priority calls would be under four minutes. The other priority calls would see an average of just over five minutes. All units would be busy simultaneously 23% of the time. On a busy night these six units could handle the workload but response times would deteriorate. Response time to high priority calls would be between 5 and 6 minutes. However, low/moderate priority calls would experience almost 17 minute response times.

8 A.M. - 4 P.M. : 5-6 One-officer Units

During this tour, the police department fields either 5 or 6 one-officer units to handle an average of 7 activities an hour. For low priority calls, response time averages 3.3 minutes. However, high priority calls now require the dispatch of two units to the scene. Our model calculates the average response time of both the first and second units. The first unit will arrive on average in three minutes. The second unit will have to travel farther and in addition is more likely to experience a queuing delay. His response time averages 4.7 minutes. In other

TABLE 4.6
POLICE RESPONSE TIMES: PRE-and POST MERGER
ONE-OFFICER PATROL UNITS

TIME	NUMBER of UNITS	INITIAL DELAY PROB.	INITIAL DELAY AVE.	FULL DELAY PROB.	FULL DELAY AVE.	AVE. RESP. TIME PRIORITY HIGH 1st	AVE. RESP. TIME PRIORITY HIGH 2nd	AVE. RESP. TIME PRIORITY LOW 1st	# of Units on Prevent. Patrol
8AM - 4PM: Activity Rate: 7 Per Hour - 20 minutes per Activity									
CURRENT	5-6	0.07	0.3	0.16	1	3.0	4.7	3.3	3.2
PHASE I	6-7	0.03	0.1	0.07	0.3	2.5	3.6	2.5	4.0
PHASE II	7-8	0.01	0.1	0.03	0.1	2.3	3.2	2.3	4.9
4PM - 7PM: Activity Rate: 12.4 Per Hour - 20 minutes per Activity									
CURRENT	8	0.08	0.2	0.15	0.7	2.7	4.1	3.1	3.8
PHASE I	9	0.04	0.1	0.08	0.3	2.4	3.5	2.5	4.6
PHASE II	10	0.02	0.1	0.04	0.1	2.2	3	2.2	5.5

HIGH ACTIVITY RATES

TIME	NUMBER of UNITS	INITIAL DELAY PROB.	INITIAL DELAY AVE.	FULL DELAY PROB.	FULL DELAY AVE.	AVE. RESP. TIME PRIORITY HIGH 1st	AVE. RESP. TIME PRIORITY HIGH 2nd	AVE. RESP. TIME PRIORITY LOW 1st	# of Units on Prevent. Patrol
8AM - 4PM: Activity Rate: 9.2 Per Hour - 20 minutes per Activity									
CURRENT	5-6	0.19	0.8	0.33	2.3	3.8	6.1	5.4	2.4
PHASE I	6-7	0.09	0.3	0.17	0.9	2.9	4.5	3.2	3.2
PHASE II	7-8	0.04	0.2	0.09	0.4	2.4	3.7	2.6	4.1
4PM - 7PM: Activity Rate: 16.5 Per Hour - 20 minutes per Activity									
CURRENT	8	0.29	0.8	0.4	2	3.8	5.7	6.6	2.3
PHASE I	9	0.16	0.4	0.25	1	3.1	4.5	3.8	3.2
PHASE II	10	0.09	0.2	0.15	0.6	2.6	3.9	2.9	4

words the first unit arrives 1.7 minutes before his bakckup arrives. On average there are more than three units on preventive patrol at any one time.

Seven percent of the calls should experience a dispatch delay due to patrol unit unavailability. Calls requiring two units are more than twice as likely to find that there are no two units available at the instant of the call. Again, if there is a need, the busy units are almost certainly to be involved in activities that can be preempted.

If the daytime shift were one-third busier than average, the difference between the two dispatched unit response times would be more pronounced. The two response times would be 3.8 and 6.1 minutes respectively. Thus, the first arriving unit would have to wait 2.3 minutes for the backup to arrive.

<u>4 P.M. - 7 P.M. : 8 One-officer Units</u>

During this time period, there are on average 8 one-officer units deployed. Activities occur at a rate of 12.4 per hour and last an average of twenty minutes. This represents a slightly more than 50% workload and leaves, on average, 3.8 units for preventive patrol. Initial response time (excluding problems of rush-hour) is at its best, 2.7 minutes. If two officers are needed, the average response time of the backup would be 4.1 minutes. The likelihood that all units are busy at the time of a call is .08 but the probability that there will not be two officers available at the time of a more dangerous call is .15. These last statistics are the same as for the 8AM to 4PM shift.

In other words one-in-six calls requiring the presence of two officers will experience a dispatch delay due to unit unavailability.

On busy evenings in which the activity rate increases by one-third, there would be a one minute increase in the response time of the first unit and 1.6 minute increase in the backup unit's response time. Low priority calls would experience an even greater increase. Average response time to these calls would more than double from 3.1 minutes (average night) to 6.6 minutes for these nights. There would a high probability of a dispatch delay. Twenty nine percent of the calls would find no unit available at the time of the call. If two units were needed, there is a 40% chance that less than two units would be free to dispatch. In extreme emergencies this problem would likely be handled by interrupting a low priority activity of one or more patrol units.

D. MERGER: POLICE SYSTEM PERFORMANCE

1. Phase I

A merger of police and fire forces will take several years to implement. Sufficient personnel must be dual trained before there can be any reduction in the number of firemen on duty at stations. In the following two sections we will analyze response time to police calls during two phases of a merger. In phase I of a Roseville, merger one fireman would be eliminated from each station in addition to the elimination of the specially assigned fire dispatcher. Three officers around the clock translate into a total of 10 positions in the fire department. If half of these were reassigned to the patrol force, it would be possible to add one more patrol officer around the clock. This would allow the deployment of one additional two-officer unit between 8PM and 8AM on half of the days and the deployment of one additional one-officer unit everyday during the daytime from 8AM to 8PM.

<u>Midnight - 3AM: Five or Six Two-Officer Units</u>

During phase I, the addition of one unit half of the time will reduce police response time to high priority calls by 10% to 15% for high priority calls. (See Table 4.5) This range holds for both average and busy periods. The impact on low priority calls is slightly greater. For current levels of 5 units, the reduction is 14% to 17% depending on the activity levels.

Another statistic is the proportion of calls/activities that will be delayed because all units are busy. On a busy pre-merger night, 35% of the calls would be delayed. In phase I of a merger, this is reduced to 27%. If for the highest priority calls, current activities are interrupted, then the above statistics reflect how frequently acticvities are interrupted when a high priority call occurs. The phase I merger correspondingly reduces the frequencies of interruptions.

The partial merger has the greatest impact on the level of preventive patrol coverage. On an average workload night, the merger increases patrol coverage by 20% over a 5 unit deployment and on busy nights increases it by 30%.

3A.M. - 8A.M.: Four or Five Two-Officer Units

In Phase I of a merger, a fifth unit would be deployed on half the shifts. This additional manpower would cut response time by about 10% on an average night and by almost 15% on a busy night. In addition patrol coverage would increase by 20% or more. The likelihood of all units being busy when a call comes in is reduced from .09 to .06.

7P.M. - Midnight: Six or Seven Two-officer Units

In Phase I of a merger, the addition of a seventh unit half of the time has a dramatic impact especially on busy nights. Average response time is currently the highest during this time period. High priority calls have response times near 4 minutes and lesser priority calls experience more than five minute response times. This additional manpower cuts 10% of of the high priority response time and saves almost a minute for the other calls.

On a busy night if calls are not preempted in an emergency, then even high priority calls experience response times of almost six minutes. Lesser priority calls would experience long delays of over 13 minutes before a unit could be dispatched and a total response time of almost 17 minutes. The system on a busy night is near saturation and only one unit is typically on actual patrol. The phase I merger provides sufficient personnel to save almost a minute for high priority calls and over 4 minutes for other calls. In addition there would be a 40% increase in patrol coverage.

8A.M. - 4P.M. : Six or Seven One-Officer Units

Phase I would add one unit to the patrol force. Average response time for the first unit dispatched to a high priority call would 15% below current levels. The reduction in the second unit response time would be more than 20% and as a result the time delay between the two would drop from 1.7 to 1.1 minutes. In addition there would be a 25% reduction in the average response time to lower priority calls and a 25% increase in preventive patrol coverage over current levels. On a busy shift, this additional unit would cut one minute off the initial responder's time and one and a half minutes off of the backup's response time. In addition the likelihood of an initial or full delay would be cut in half by this addtional manpower.

4P.M. - 7P.M. : Nine One-Officer Patrol Units

Response time and patrol coverage are currently good. The addition of a ninth one-officer unit reduces intitial response by 10% and the backup's response by 14%. In total patrol coverage would increase by more than 20%. The likelihood of a dispatch due to patrol unit availability would again be cut in half on an average night.

The unit's impact is naturally greater on busy nights. Response times to high priority calls are now reduced by close to 20% which for the backup unit represents a more than one minute reduction in response time. For moderate and low priority calls, the reduction is from 6.6 minutes to 3.8 minutes. Currently, on a busy tour, almost 30% of the calls would be delayed by patrol unit unavailability and this would be cut in half in Phase I.

2. Phase II: Full Merger

Once sufficient personnel have been dual trained, the City can move into phase II of a merger. In this phase only two firemen would be at each station. In essence even if these fire station personnel remain singly trained, the city has,in practice, achieved a full merger. Dual training for the personnel assigned to stationhouse duty or for police assigned to non-patrol activities can only have a minimal impact on patrol deployment or response time. For the city of Roseville we estimate that this phase would require a total of 45 dual trained patrolmen and a proportionate number of sergeant (8) and lieutenant (6) supervisors.

The net reduction in personnel would be 6 personnel during each tour or approximately 20 firemen in total. If half of these were added to the patrol force, the city could deploy an additional two officers around the clock and still save ten positions.

Midnight - 3A.M. : Six Two-Officer Units

The additional officers would be assigned to one additional two-officer patrol unit between midnight and 3 A.M.. With a current deployment level of five units, the sixth unit saves a half minute to high priority calls and one-minute to lesser priority calls (See Table 4.5). The additional unit also increases preventive patrol coverage by from 37% over the current deployment level.

On a busy night the impact is more significant. The additional unit cuts average response time to high priority calls by one minute (from 4.3 minutes to 3.4 minutes) and for the remainder of calls the reduction is 2.7 minutes. Patrol coverage increases by over 50%. Lastly, this additional manpower would cut by half the probability that a call would be delayed due to manpower unavailability or equivalently cut by half the frequency with which a patrol unit would have to be preempted from a minor activity to handle a major emergency. We estimate that currently on a busy night, 35% of the calls would expereince a dispatch delay as compared to 17% under a full merger.

3A.M. - 8A.M. : Five Two-Officer Units

Under a full merger and five units deployed, the system would respond at least 20% more rapidly to both high and low priority calls. This represents slightly slightly less than a minute for high priority calls and more than a minute for moderate and low priority ones. Even on a busy night response time with a full merger would be 10% better than the current response time on an average night. When performance on busy nights are compared, the merger saves more than a minute for high priority calls and over two minutes for other calls.

Patrol coverage would also significantly increase by more than a third on an average night. On a busy night this additional would increase coverage by 50%. At present there is only a small likelihood that a call will be delayed due to patrol unit unavailability. On a busy night, however, more than one-in-five calls would be delayed. The additonal patrol again significantly reduces this probability to one-in-twelve.

<u>7P.M. - Midnight : Seven Two-Officer Units</u>

A full merger would add one two-officer unit, the seventh. Response times to high priority calls would now be a full minute below current levels on both average and busy nights. Response time to moderate/low priority calls response time on average would improve by two minutes. On a busy night response to high priority calls would be in the four minute range and even low priority calls would receive a close to 7 minute response time instead of 17 minutes. This additional unit translates into an increase of 40% in patrol coverage as compared to current levels of patrol coverage and double that on a busy night.

Because of the relatively high workload levels, almost one-in-four calls currently will experience a queueing delay. On a busy night more than half of the calls would be delayed. Again, the additional unit cuts this probability in half for the average night and reduces to one-call-in-three the likelihood of a dispatch delay on a busy night.

8A.M. - 4P.M. : Seven or Eight One-Officer Units

A full merger would bring the patrol complement up to an average of 7.5 units. Again we assume the two units will be dispatched to all high priority calls and only one to moderate/low priority calls. Initial response to high priority calls would then be 20% lower than under a pre-merger deployment. (See Table 4.6) Again the impact on the backup's response would be greater, a 33% reduction or 1.5 minutes. On an average day patrol coverage would increase by 50%. During a busy shift, these two additional units would translate into a 1.4 minute reduction in initial response and 2.4 minute reduction in the backup's response time.

Current response times and patrol coverage are more than adequate during this time period. Even on a busy shift only one-in-five calls would experience an initial queue delay. The only significant delays occur if two units are needed on a busy shift. In that case the backup would arrive more than two minutes after the first unit. The additional manpower from a merger would almost eliminate the chance of a queue delay.

Because response time is currently satisfactory, the department may decide to use both or one of these additional officers for non-patrol activities. These activities would have to be easy to interrupt in order to guarantee sufficient manpower availability for a major fire. Remember a major fire during this time period would draw five of these officers to the scene of a fire.

4P.M. - 7P.M. : Ten One-Officer Patrol Units

During the final phase of a merger, response times would drop 20% for the initial responder and an 27% for the backup unit. Even the backup unit would now average a 3 minute response time. The likelihood of a dispatch delay would now be cut to one call in fifty for calls requiring one-officer. For calls requiring two units, there would still be only a relatively small chance that both units could not be dispatched immediately. Patrol coverage would increase to an average of five an a half units, or 45% above current levels.

On a busy evening response time would not dramatically increase and would still be below three minutes in a merger. Again even without the merger personnel, system initial response is excellent. The only significant delays occur on a busy night when a call requires two officers. The backup would arrive in an average of 5.7 minutes or almost two minutes after the first unit. Under a merger the backup would arrive in under four minutes. As was noted before, would have the option of using at least one of these two additional officers for non-patrol activities.

3. Summary of Response Time Estimates

Two-Officers Per Unit

In Table 4.7 we aggregate the data into one-officer patrol unit response and two-officer patrol unit response and report it for both average and busy shifts. During the hours when two-officers are deployed per vehicle, response times decrease by 10% during Phase I and an additional 10% during Phase II, full

TABLE 4.7

POLICE RESPONSE TIMES PRE- and POST MERGER: SUMMARY STATISTICS

TWO-OFFICER PATROL UNITS

STAGE	# of UNITS	AVERAGE DISP. DELAY Call Priority High	Mod/Low	AVERAGE RESPONSE TIME Call Priority High	Mod/Low	PROBAB. of DELAY	UNITS on PREV. PATROL
AGGREGATE 7 P.M. to 8 A.M. : Activity Rate - 8.5 per Hour							
CURRENT	5	0.6	1.5	3.6	4.5	.17	2.3
PHASE I	5-6	0.5	1.0	3.2	3.8	.13	2.8
PHASE II	6	0.3	0.5	2.8	3.0	.08	3.2
AGGREGATE 7 P.M. to 8 A.M. : HIGH Activity Rate - 11.7 per Hour							
CURRENT	5	1.7	8.3	5.0	11.6	.44	1.3
PHASE I	5-6	1.3	5.7	4.4	8.8	.35	1.8
PHASE II	6	0.8	2.5	3.8	5.5	.24	2.2

ONE-OFFICER PATROL UNITS

STAGE	# of UNITS	INITIAL DELAY Prob.	Time	FULL DELAY Prob.	Time	AVE. RESP. TIME PRIORITY HIGH 1st	2nd	LOW 1st	UNITS on PREV. PATROL
AGGREGATE- 8 A.M. to 7 P.M. : Activity Rate - 8.5 per Hour									
CURRENT	6.2	.07	0.3	.16	0.9	2.9	4.5	3.2	3.4
PHASE I	7.2	.03	0.1	.07	0.3	2.5	3.6	2.5	4.2
PHASE II	8.2	.01	0.1	.03	0.1	2.3	3.1	2.2	5.1
AGGREGATE- 8 A.M. to 7 P.M. : HIGH Activity Rate - 11.3 per Hour									
CURRENT	6.2	.23	0.8	.36	2.2	3.8	5.9	5.9	2.4
PHASE I	7.2	.11	0.3	.20	0.9	3.0	4.5	3.4	3.2
PHASE II	8.2	.06	0.2	.11	0.5	2.5	3.8	2.7	4.1

merger. Average response time to high priority calls in a full merger would be under three minutes. The impact on moderate/low priority call response would be greater as a full merger would reduce this by 1.5 minutes or 33%. Patrol coverage levels would increase by 40% under a full merger with half of the increase arising from Phase I.

The percentage impact on response time during a busy shift is greater than for an average shift. Response times to high priority calls are reduced by 1.2 minutes. The impact on response to moderate/low priority calls is more dramatic. Currently we estimate that these calls would receive resonses that exceed 11 minutes. The additional patrol strength provided by a merger would cut this in half. During a busy shift, patrol coverage would currently be severely depleted. The merger personnel would increase coverage by 70% during busy periods.

Lastly, the likelihood of a call being queued would be cut in half by a merger, from .17 (i.e. one-in-six) to .08 (i.e. one-in-twelve). There is a proportionately similar impact during busy shifts when currently the probability of a queue delay would rise to .44 and under amerger this would drop to .24.

<u>One-Officer Units</u>

We noted earlier that current response time patterns are good. Still the addition of a two officers in two patrol units reduces initial response times to high priority calls by 20%. (Remember that two units are dispatched to high priority calls.) The impact on the second unit's response time is closer to 30% and the same percentage reduction applies to moderate/low priority calls.

During busy periods, the reduction in initial response time to high priority calls is over 30%, reducing it from almost four minutes to two and a half minutes. These additional units also cut off two minutes from the backup unit's response time to a high priority call. Finally, response times to moderate/low priority calls are cut in half with this additional patrol stregnth.

Preventive patrol coverage during these time periods is increased by at least 50% under a merger. In addition the problem of a call occurring when all patrol units are busy is almost eliminated under a full merger of police and fire services.

E. POLICE PERFORMANCE DURING MAJOR FIRES

The analysis above indicated that a merger would improve significantly police performance on average. However, one charge, in particular, against public safety is that during a major fire police protection is severely reduced if not eliminated. In this section we explore the magnitude of this concern. In addressing this issue there are a number of specific questions to address.

1. How frequently will this problem arise?

2. During a major fire, what does happen to police response time?

3. What actions can be taken to alleviate this problem and waht are the associated costs?

The overwhelming majority of fires would require no more than two patrolling public safety officers to assist at the fire and would have no greater impact than any other police call that requires two officers. Of specific concern are those fire calls that tie up more than just two officers. During the course of the year, there were fifty-four fire calls at which nine or more firemen worked. (These calls would require the dispatch of five public safety officers to help out.) This amounts to one call a week. However, even among these calls only twenty-two lasted more than an hour. In Table 4.8 we present data on the number of personnel at the scene of a fire and the time spent at the fire.

TABLE 4.8

DATA on FIRE PERSONNEL and TIME SPENT AT A FIRE SCENE

TIME (minutes)	NUMBER of FIRES — PERSONNEL at SCENE: 6 or less	7 or 8	9 or more
20 or less	406	45	22
21 to 40	139	18	16
41 to 60	29	7	3
61 to 120	14	8	7
121 to 180	2	0	2
181 or more	2	1	4

During the progress of the fire, obviously police response time would deteriorate as the remaining few officers would almost certainly be continuously busy handling police activities. Nevertheless, our analysis indicates that more than 95% of the time, at least one of the remaining officers could be preempted in order to respond to a major police emergency. In addition from 7AM to 11PM, the department currently fields two traffic safety officers who could be used to provide police coverage during these calls.

The calls that should be of primary concern are those that tieup a large number of public safety officers for an extended period of time. We expanded the definition of major calls to calls involving seven or more firemen and lasting an hour or more. There were 22 calls of this magnitude and duration (Table 4.8) during the year for an average of less than one every two weeks. We developed a simulation model to specifically analyze what happens to police system performance during fires of this type.

It should be remembered that even in these situations the department has the following policy option:

Call-in off-duty officers for the duration of the fire. Oak Park, Michigan which operates a public safety department, calls in officers an average of once a month. We used the model to determine the number of officers that should be called in when a major fire does occur. In particular, we considered calling in fewer officers than were tied up at the fire.

As an illustration we ran the simulation model once for each of two time periods under a range of assumptions as to the fire's duration and the number of officers on patrol. The simulation is not, however, an analytic model and to get statistically reliable results the model should be run repeatedly with a different set of random numbers.

1. 8 A.M. - 4 P.M.: Major Fire

With the above caveat in mind, we will first explore a major fire occurring during the 8AM to 4 PM shift. During this time period under a full merger, there would be 8 one-officer units deployed to carry out an average of 7 activities per hour. Each activity lasts an average of 20 minutes. Dispatching five officers to a fire would leave the three remaining officers to handle the above rate of activites. At the instant these units are assigned to the fire call, there is a .44 probability that the remaining three units will be involved in police related activities and not on patrol. Thus, there will surely be a significant reduction in preventive patrol. However, in case of a high priority call one or more of these activities could be preempted. Even a conservative definition of preemptible activities indicates that 74% of this time period's activities are preemptible. If we restrict even further the definition of non-preemptible calls, then this percentage rises to 94%.

We modeled the system with eight units and a one hour fire. During this single run, only one high priority call occured and it was handled with no delay and without preempting a unit. The response time to that call was 3.8 minutes. Moderate priority calls experienced 12 minute response times and the lowest priority had 18 minute response times. During the hour after the fire, response to moderate and low priority calls was still slow with 7 and 14 minute response times respectively. By the second hour after the fire things had returned to normal.

Although police response time to moderate priority calls did deteriorate, fires of this duration would not seem to warrant a call-in. High priority calls could be handled promptly. Also the model did not include the two traffic safety units that were on patrol and they could assist by responding to the moderate priority calls.

We also generated a scenario involving a three hour fire. Response time to moderate priority calls during the fire was now 11 minutes but low priority calls experienced 50 minute delays. However, in this instance within one hour after the fire was concluded the system was down to acceptable response times of 4 and 5 minutes for these priority levels.

When we analyzed the impact of a ninth unit, we still found significant delays especially for low priority activities. Moderate priority activities were responded to on average in nine minutes and low priority in twenty-one minutes. Within an hour after the fire was over, response times were back to pre-fire levels. The addition of a tenth unit eliminated any significant delays even during the course of the fire. In conclusion a major fire during this time period would require the call-in of only 2 officers to partially replace the five assigned to the fire.

2. 7 P.M. - Midnight: Major Fire

We carried out a similar analysis for the 7PM to Midnight time period in which 7 two-officer units would be deployed to handle an average of 11 activities per hour. We again analyzed response patterns during and after a three hour fire. A major fire would again need five patrolling public safety officers. To provide this, three two-officer units would need to be dispatched; however, the sixth man could be returned to patrol.

At the beginning of the fire, there is a .54 probability that all of the remaining units will be involved in activities. However, there is only a small probability of .04 that all of these activities will be non-preemptible. Even in that rare instance, we estimate that on average in five minutes time at least one of these units would be available for emergency dispatch. We recommend that once one or more units become available for dispatch, that one of them be kept in reserve for an emeregency rather than assigning it to a waiting lower priority activity. Our modeling of this three hour fire assumes that this is the policy. This policy trades off longer response times to lower priority activities in order be sure of the immediate availability of one patrol unit in case of an extreme emergency.

With only seven units deployed and no call-ins, response time to non-high priority calls deteriorates. In our run of the model, there was one high priority call during the fire and the response time was 4 minutes. In contrast, moderate priority calls received over thirty minute responses and low priority activities were delayed over an hour. In addition a long backlog of activities developed during this fire. Even three hours after the fire had been put out, response times to moderate priority calls were over 12 minutes and to low priority calls were still in the thirty minute range.

We analyzed the impact of an eighth and ninth unit. The eigth unit alleviated the problem but did not resolve it. During the fire, response to moderate priority activities was significantly improved and was is only six minutes but low priority activities were still delayed an hour. Again the impact of the activity backlog did not wear off for a long period of time. Response times for low priority activities were still nearly thirty minutes several hours after the fire was out. The ninth unit did resolve the problem. During the fire, average response time to moderate priority calls was 4 minutes and even low priority activities could be gotten to in 11 minutes. Once the fire was over, system performance immediately reverted back to pre-fire levels.

In summary, this limited analysis suggests the need for call-ins when a major fire breaks out. In general, the call-in would not need to replace all of the fire-fighting officers. Three additional officers called in for the duration of the fire would be sufficient to provide good response times for moderate priority calls and adequate response to low priority calls. In the section on cost we will estimate the cost of having three officers on stanby as well as the cost for actually calling in these officers on an average of once every two weeks.

F. RESPONSE TIME TO FIRES

We reported earlier that the average response time of the first engine company dispatched to a fire is 3.3 minutes and the second company is 5.5 minutes. Because emergency fire workloads are low, these statistics are based on the assumption that all fire units will be available when a fire breaks out. Thus, there is no variation in these statistics by time of day except perhaps during peak traffic periods when travel speeds must be reduced. Our analysis of a public safety department is sensitive to the availability of patrol units which will vary by time of day due to varying workloads.

1. Phase I

<u>Two-officer Units</u>

During Phase I, there would be three men in one station and four in the other. A minor fire would entail the dispatch of one patrolling public safety officer to complement the manpower dispatched from one station. In a major fire all station manpower would be dispatched along with two public safety officers. During the time period from 7PM to 8AM when all units contain two officers, all fires would be dispatched one patrolling unit. The rest of the time, minor fires would be dispatched one one-officer public safety unit and major fires would be dispatched two one-officer patrol units.

When two officers are assigned to each unit, average response time for the public safety unit dispatched to a minor or major fire will be 3.0 minutes during the morning shift (Midnight-8AM) and 3.4 minutes in the late evening. (See Table

TABLE 4.9
PUBLIC SAFETY UNIT RESPONSE TIMES TO FIRES: TWO-OFFICER UNIT DEPLOYMENT

MIDNIGHT-3AM — PHASE I: 5-6 UNITS

	RESPONSE TIME (minutes)	PUBLIC SAFETY UNIT ARRIVAL PROBABILITY — MINOR FIRES: FIRST	MINOR FIRES: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: FIRST	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 2 MINUTES
AVERAGE SHIFTS						
Priority	3.0	.64	.79	.87	.9	.9
B.Preemption	2.7	.68	.85	.95	1.0	1.0
BUSY SHIFTS						
Priority	3.9	.50	.62	.70	.73	.73
Preemption	3.1	.61	.79	.93	.99	1.0

3AM-8AM — PHASE I: 4-5 UNITS

	RESPONSE TIME (minutes)	PUBLIC SAFETY UNIT ARRIVAL PROBABILITY — MINOR FIRES: FIRST	MINOR FIRES: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: FIRST	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 2 MINUTES
AVERAGE SHIFTS						
Priority	3.0	.68	.84	.91	.94	.94
Preemption	2.7	.70	.88	.96	1.0	1.0
BUSY SHIFTS						
Priority	3.7	.57	.73	.82	.84	.84
Preemption	2.9	.63	.82	.95	.99	1.0

7PM-MIDNIGHT — PHASE I: 6-7 UNITS

	RESPONSE TIME (minutes)	PUBLIC SAFETY UNIT ARRIVAL PROBABILITY — MINOR FIRES: FIRST	MINOR FIRES: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: FIRST	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 1 MINUTE	MAJOR FIRES: 2ND ENGINE CO.: WITHIN 2 MINUTES
AVERAGE SHIFTS						
Priority	3.4	.59	.73	.80	.82	.82
Preemption	2.8	.66	.83	.94	.99	1.0
BUSY SHIFTS						
Priority	4.9	.34	.43	.49	.51	.51
Preemption	3.2	.52	.73	.89	.98	1.0

4.9) In over 60% of the fire calls, the public safety unit will arrive before the first fire engine, thereby improving initial response to a fire in the first crucial minutes. (This statistic does not, however, include the time to change clothing before a public safety officer would be ready, for example, to enter a burning building.) The complement of this is that in 30% to 40% of the calls the engine company will arrive first with three or four firemen depending upon the station nearest to the fire. The public safety unit containing the necessary manpower to complete the company's staffing would arrive (in these 30%-40% of the cases) an average of 1.0 minute after the fire engine.

The above analysis assumes that if all patrol units are busy, the first unit to complete its activity is then dispatched. If, however, the dispatcher is allowed to preempt an activity, then public safety response time is reduced further. The data in Table 4.10 describes the proportion of police activities that can be interrupted. The conservative definition considers only activity categories 7, 8 and 9 that were discussed in Chapter IV. The more liberal definition includes all activities except the highest priority ones, categories 1, 2 and 3. In all cases at least 65% of the activities can be interrupted. This preemption strategy insures that in over 99% of the minor and major fire calls there will be sufficient manpower to staff the fire equipment.

TABLE 4.10

PERCENTAGE OF POLICE ACTIVITIES THAT CAN BE INTERRUPTED

Time Period	Conservative Definition	Liberal Definition
12 A.M. - 3 A.M.	72%	87%
3 A.M. - 8 A.M.	77%	90%
8 A.M. - 4 P.M.	74%	94%
4 P.M. - 7 P.M.	68%	85%
7 P.M. -12 A.M.	65%	86%

In total, with preemption two-thirds of the calls would first see a public safety unit and for 85% of the calls the unit would arrive no later than 1 minute after the fire engine. In this phase since each fire engine is accompanied by at least 3 firemen this delay of more than one minute in 15% of the cases may be acceptable. Later, we will discuss a more aggressive preemption strategy which would reduce the average delay and the frequency of this more than one minute delay to under 5% of the fires.

Response times to major fires in Phase I would clearly be improved while two officers are assigned to each unit. The first responder at the scene would be just as for minor fires, more than 60% of the time it would be a public safety unit. In addition, when the unit does not arrive first, it will generally arrive before the second fire engine company. With preemption, the public safety unit will arrive at least before the second fire engine company over 95% of the time and in the remaining calls it rarely arrives more than a minute later than the second company.

Because of the dual role of public safety officers, police activity rates that are one-third or more above current average levels will negatively affect fire response. With preemption, the public safety unit will still arrive first more than 50% of the time. However, there would be a 20%-25% probability that the unit would arrive more than a minute after the fire equipment. If this standard is unacceptable, then the department would have to implement a more aggressive preemption policy. Later, in the context of a full merger, we explore in detail an aggressive preemption policy.

<u>One-Officer</u> <u>Units</u>

One officer is deployed in each unit between 8AM and 7PM. In Phase I a minor fire would be dispatched a single unit and a major one would be dispatched two units. On average the public safety unit would arrive a minute earlier than the first fire engine dispatched to a fire. (See Table 4.11) The second unit dispatched would arrive on average one and a half minutes before the second fire engine. This performance is also reflected in the estimate that 80% of the time a public safety unit would arrive first and over 90% of the time would arrive no later than one minute after the fire engine. When two units are needed, they are both likely (near 90%) to arrive before the second fire engine. The small percentage of late arrivals is due to a 7% probability that the units would be involved in police activities at the time of the fire. A basic preemption strategy eliminates this problem.

TABLE 4.11

PUBLIC SAFETY UNIT RESPONSE TIMES TO FIRES: ONE-OFFICER DEPLOYMENT

8AM - 4PM PHASE I: 6-7 PUBLIC SAFETY UNITS

	MINOR FIRES: ONE UNIT			MAJOR FIRES: TWO UNITS			
	RESP. TIME (mins.)	ARRIVAL PROB. First	ARRIVAL PROB. Within 1 Minute	RESP. TIME (mins.)	ARRIVAL PROB. vs. 2ND Co. First	ARRIVAL PROB. vs. 2ND Co. Within 1 Minute	ARRIVAL PROB. vs. 2ND Co. Within 2 Minutes
AVE. SHIFTS							
Priority	2.5	.78	.91	3.6	.88	.92	.93
B. Preempt	2.4	.79	.92	3.4	.93	.99	1.0
BUSY SHIFTS							
Priority	2.9	.69	.82	4.5	.76	.81	.82
B. Preempt	2.6	.72	.88	3.7	.89	.98	.99

4PM- 7PM PHASE I: 9 PUBLIC SAFETY UNITS

	MINOR FIRES: ONE UNIT			MAJOR FIRES: TWO UNITS			
	RESP. TIME (mins.)	ARRIVAL PROB. First	ARRIVAL PROB. Within 1 Minute	RESP. TIME (mins.)	ARRIVAL PROB. vs. 2ND Co. First	ARRIVAL PROB. vs. 2ND Co. Within 1 Minute	ARRIVAL PROB. vs. 2ND Co. Within 2 Minutes
AVE. SHIFTS							
Priority	2.4	.81	.92	3.5	.90	.93	.93
B. Preempt	2.3	.82	.94	3.2	.96	1.0	1.0
BUSY SHIFTS							
Priority	3.1	.63	.75	4.5	.69	.73	.74
B. Preempt	2.7	.69	.85	3.5	.87	.97	.99

Unusually high workloads, do cause some deterioration in response time but public safety unit response times still are below their fire engine counterparts. The likelihood of not arriving within a minute of their fire engine counterpart increases to 20% without preemption. Basic preemption resolves the problem for major fires simply because of the small size of Roseville. If preemption can provide the manpower, which it does, the small travel distances make it highly unlikely for the public safety unit to travel even one minute more than the second fire engine. There is still over a 10% likelihood that the public safety unit would arrive more than a minute after the fire engine dispatched to the same small fire. An aggressive preemption would reduce this percentage significantly. We do not, however, report this since in Phase I there are always at least three men at each fire station travelling with the fire equipment.

2. Phase II: Full Merger

Two-Officer Units

In Phase II, the number of firemen at the stations is reduced to two apiece. A minor fire is still dispatched one two-officer public safety unit. The increased patrol strength accompanying this phase means that initial response to both minor and major fires improves. Average response time of the first public safety unit drops below 3 minutes across all shifts. (See Table 4.12) In 70% of the cases the public safety unit will arrive first, thereby cutting the intial response time. In approximately 85% of the calls, the unit will arrive no later than a minute after the fire engine and this percentage increases

TABLE 4.12

PUBLIC SAFETY UNIT RESPONSE TIMES TO FIRES: TWO-OFFICER UNIT DEPLOYMENT

PHASE II: 6 PUBLIC SAFETY UNITS

MIDNIGHT-3AM

	MINOR FIRES: ONE UNIT			MAJOR FIRES: THREE UNITS			
	RESP. TIME (mins.)	ARRIVAL PROB. FIRST	ARRIVAL PROB. WITHIN 1 MINUTE	RESP. TIME (mins.)	ARRIVAL PROB. vs. 2ND Co. FIRST	WITHIN 1 MINUTE	WITHIN 2 MINUTES
AVERAGE SHIFTS							
Priority	2.8	.71	.86	5.8	.59	.71	.73
B. Preemption	2.6	.73	.90	4.2	.75	.96	.99
A. Preemption	2.1	.87	.98	3.8	.93	.99	.99
BUSY SHIFTS							
Priority	3.4	.58	.73	7.4	.40	.50	.52
B. Preemption	2.9	.65	.84	4.2	.70	.95	.99
A. Preemption	2.1	.86	.97	3.9	.91	.98	.99

PHASE II: 5 PUBLIC SAFETY UNITS

3AM-8AM

	MINOR FIRES: ONE UNIT			MAJOR FIRES: THREE UNITS			
	RESP. TIME (mins.)	ARRIVAL PROB. FIRST	ARRIVAL PROB. WITHIN 1 MINUTE	RESP. TIME (mins.)	ARRIVAL PROB. vs. 2ND Co. FIRST	WITHIN 1 MINUTE	WITHIN 2 MINUTES
AVERAGE SHIFTS							
Priority	2.6	.74	.89	6.4	.61	.75	.77
B. Preemption	2.5	.75	.91	4.3	.75	.96	.99
A. Preemption	2.2	.85	.97	4.0	.89	.99	.99
BUSY SHIFTS							
Priority	3.0	.66	.82	8.1	.47	.60	.62
B. Preemption	2.7	.69	.87	4.3	.70	.95	.99
A. Preemption	2.2	.84	.97	4.1	.87	.98	.99

7PM-MIDNIGHT

PHASE II: 7 PUBLIC SAFETY UNITS

	MINOR FIRES: ONE UNIT			MAJOR FIRES: THREE UNITS			
	RESP. TIME (mins.)	ARRIVAL PROB. FIRST	ARRIVAL PROB. WITHIN 1	RESP. TIME (mins.)	ARRIVAL PROB. vs. 2ND Co. FIRST	WITHIN 1	WITHIN 2
AVERAGE SHIFTS							
Priority	3.0	.67	.81	6.5	.53	.63	.65
B. Preemption	2.7	.71	.88	4.5	.74	.96	.99
A. Preemption	2.0	.89	.98	3.6	.94	.99	.99
BUSY SHIFTS							
Priority	4.3	.45	.57	9.2	.30	.37	.38
B. Preemption	3.2	.59	.79	4.1	.68	.96	.99
A. Preemption	2.1	.87	.98	3.8	.91	.98	.99

to 90% with a moderate preemption strategy.

Although this percentage is higher than in Phase I, the remaining calls may be of greater concern now. In Phase II, the fire engine company is travelling with only two men. Therefore, any delay in the arrival of the patrolling public safety unit is more critical. The preemptive dispatch policy considered until now is the following:

> Dispatch the nearest available unit. If all units are unavailable, identify and dispatch the unit involved in the least important activity irrespective of its location.

A more aggressive policy is as follows:

> Identify all available units and all units involved in interruptible activities. Dispatch the nearest of these units even if this means interrupting an activity even though other more distant units are available for dispatch.

The table presented below suggests that this policy should be used as long as three or fewer units are available if the goal is to have the public safety unit at the scene no later than one minute after the fire engine 95% of the time.

TABLE 4.13

PROBABILITY THAT PUBLIC SAFETY UNIT ARRIVES
NO LATER THAN ONE MINUTE AFTER THE FIRST FIRE ENGINE

No. of Available Units	1	2	3	4	5	6	7
Probability	.63	.84	.92	.96	.98	.99	.99

The more aggressive preemption policy described above would increase this percentage to 97%-98% even when activity rates are unusually high.

Major fires would, in phase II, require the dispatch of three units. In the majority of cases, all three units would arrive before the second engine company. The average response time for the last arriving of these three units would be slightly more than six minutes if preemption is not used. In addition there would be a more than 25% likelihood that the last unit would not arrive within two minutes of the the second engine company. This is primarily due to the fact that for 27% of the calls there would not be three units available for immediate dispatch.

If police related activity levels are significantly above average, the response to small fires degrades dramatically only during the 7PM-Midnight period. Even with basic preemption, there is over a 20% chance that the first public safety unit will arrive more than a minute after the first fire engine. Clearly, on very busy nights, the aggressive preemption strategy will be needed to respond effectively to minor fires. This aggressive strategy reduces the likelihood of a more than delay to under 3%.

Major fires occurring on busy nights would be assured that all units were in place within two minutes of the last fire engine's arrival even with a basic preemption strategy.

Average response time to major fire calls increases more than a minute and a half if police activity levels are unusually high. However, this problem is essentially eliminated even with a modest preemption policy. Average response time would be reduced to the 3.9-4.3 minute range, which is a minute less than the the second fire engine response time. In addition preemption increases the likelihood to 75% that all of the units will be on the scene when the second engine arrives.

One-Officer Units

The first responding public safety unit arrives, on average, more than a minute faster than the first fire engine. (Table 4.14) Even the second public safety will arrive almost two-thirds of the time before the fire engine. Thus the full complement of personnel will be on the scene most of the time with the arrival of the fire engine and 85% of the time within one minute of its arrival.

The basic preemption strategy has almost no impact on performance with regard to minor fires. However, the aggressive strategy does have a significant impact especiallly during busy periods. This strategy results in a 95% likelihood that the full complement arrives no later than one minute after the fire engine even during unusually active tours.

Major fires are dispatched two fire engines and five public safety units. There is a one-in-four chance that without preemption there will not be sufficient public safety units available to dispatch. As a result the average response time of the fifth public safety unit is longer than that of the second fire engine even during average tours. Busy tours produce average response times that are more than two minutes longer than the corresponding fire engine value. The basic preemptive strategy reduces the fifth public safety unit average response time to slightly below that of the second fire engine. In addition, this basic policy reduces below 1% the chance that the

TABLE 4.14

PUBLIC SAFETY UNIT RESPONSE TIMES TO FIRES: ONE-OFFICER DEPLOYMENT

PHASE II: 8 PUBLIC SAFETY UNITS

8AM - 4PM

MINOR FIRES: TWO UNITS DISPATCHED

	RESPONSE TIME		ARRIVAL PROBABILITIES		
			First at Scene	Full Complement	
	First	Second		First	Within 1 minute
AVE. SHIFTS					
Priority	2.1	3.1	.87	.65	.87
B. Preempt	2.1	3.0	.88	.66	.88
A. Preempt	1.8	2.6	.94	.79	.96
BUSY SHIFTS					
Priority	2.3	3.3	.81	.56	.79
B. Preempt	2.2	3.2	.83	.57	.81
A. Preempt	1.8	2.6	.92	.77	.94

MAJOR FIRES: FIVE UNITS DISPATCHED

	RESPONSE TIME	ARRIVAL PROBABILITIES vs. 2ND Co.		
		Full Complement		
	Fifth Unit	First at Scene	Within 1 minute	Within 2 minutes
AVE. SHIFTS				
Priority	6.3	.56	.75	.78
B. Preempt	5.0	.66	.95	1.0
A. Preempt	4.3	.89	1.0	1.0
BUSY SHIFTS				
Priority	7.9	.40	.57	.6
B. Preempt	5.1	.57	.91	.99
A. Preempt	4.3	.85	.97	.99

TABLE 4.14
Continued
PUBLIC SAFETY UNIT RESPONSE TIMES TO FIRES: ONE-OFFICER DEPLOYMENT

PHASE II: 10 PUBLIC SAFETY UNITS

4PM - 7PM

MINOR FIRES: TWO UNITS DISPATCHED

	RESPONSE TIME		ARRIVAL PROBABILITIES		
			First at Scene	Full Complement	
	First	Second		First	Within 1 minute
AVE. SHIFTS					
Priority	2.1	3.0	.85	.64	.84
B. Preempt	2.1	3.0	.87	.65	.86
A. Preempt	1.7	2.4	.95	.83	.97
BUSY SHIFTS					
Priority	2.6	3.9	.73	.48	.68
B. Preempt	2.3	3.4	.80	.51	.75
A. Preempt	1.8	2.4	.94	.81	.96

MAJOR FIRES: FIVE UNITS DISPATCHED

	RESPONSE TIME	ARRIVAL PROBABILITIES vs. 2ND Co.		
			Full Complement	
	Fifth Unit	First at Scene	Within 1 minute	Within 2 minutes
AVE. SHIFTS				
Priority	6.1	.56	.71	.73
B. Preempt	4.8	.68	.94	1.0
A. Preempt	4.0	.95	1.0	1.0
BUSY SHIFTS				
Priority	8.2	.33	.45	.47
B. Preempt	5.1	.56	.90	.98
A. Preempt	4.1	.91	.99	1.0

fifth unit will arrive more than two minutes after the second fire engine.

More aggressive preemption reduces this average still further to one minute less than its fire engine counterpart and results in all public safety units being at the scene prior to the arrival of the second set of equipment in over 85% of the emergencies. This level of performance is maintained even during the busier tours.

3. PUBLIC SAFETY UNIT AVAILABILITY

Preemption insures that there will be sufficient manpower in well over 99% of the major fires. This 99% goal is achieved whether we use a liberal (i.e. police activities classified 5 or higher) or conservative (i.e. police activities classified 7 or higher) definition of interruptible police activities. Under the liberal definition, (Table 4.10) interruptible activities account for at least 85% of the police activities at all times of the day. Under the conservative definition, this percentage drops as low 65%. Despite this significant difference, the conservative criterion allows for sufficient manpower to be preempted in an emergency more than 99% of the time. The only time this criterion can't be met is during an unusually busy 7PM-Midnight time period, when this probability drops to 97.7%

4. FIRST ARRIVAL

Earlier we discussed the probability that the first unit at the scene will be a public safety unit. We also discussed the complement of this, the first arriving unit is a fire engine. In this next section we discuss this phenomenon in more detail but without the application of a preepmtive dispatch policy which would improve still further the results we present in Table 4.15. The average response times that we have presented until now have separated the public safety unit's arrival from the fire engine's. From the perspective of the caller who is awaiting the arrival of the first unit at the fire scene, the statistic of importance is the smaller of the response times of the fire engine and the closest public safety unit. It is this statistic that is most greatly impacted by a merger.

At present all personnel arrive with the fire engine in an average of 3.3 minutes. Under a merger, the first unit's arrival will be speeded up by an average of at least one minute throughout all time periods of the day. (See Table 4.15) This statistic does not dramatically change even when police workloads are unusually high. Once the merger is fully completed in Phase II, more than 75% of the time, the first unit will be a public safety unit.

In those instances in which the fire engine arrives before the public safety unit, the system's emergency response is not as good as it was pre-merger when all of the manpower arrived at the same time. We begin looking at this phenomenon by analyzing the response time of the later arriving unit. In Phase II this is consistently near 3.6 minutes or ten percent higher than the 3.3 minute average response time for the full engine company pre-merger. In essence a manager reviewing this analysis must tradeoff a 30% reduction in first response against a 10% increase

TABLE 4.15

DUAL RESPONSE OF PUBLIC SAFETY UNIT AND FIRE ENGINE WITHOUT PREEMPTION

CURRENT 3.3 Minute Response Time of First Engine with all of its manpower

PHASE I	FIRST ARRIVAL Res.Time (minutes)	SECOND ARRIVAL Res.Time (minutes)	PUBLIC SAFETY UNIT ARRIVES AFTER THE FIRST FIRE ENGINE Probab.	Ave.Delay (minutes)	Ave.R. T. (minutes)
12AM-3AM	2.3	3.6	.36	1.0	3.9
3AM-8AM	2.4	3.7	.32	1.0	3.9
8AM-4PM	2.1	3.5	.22	0.8	3.6
4PM-7PM	2.1	3.5	.19	0.8	3.6
7PM-12AM	2.4	3.7	.41	1.1	4.0
DAILY AVERAGE	2.2	3.6	.29	0.9	3.8

PHASE II: FULL MERGER					
12AM-3AM	2.3	3.6	.29	0.9	3.8
3AM-8AM	2.3	3.6	.26	0.9	3.8
8AM-4PM	2.0	3.5	.13	0.7	3.4
4PM-7PM	1.9	3.4	.15	0.6	3.2
7PM-12AM	2.3	3.7	.33	1.0	3.9
DAILY AVERAGE	2.1	3.6	.22	0.8	3.6

in the average time of arrival of the last personnel needed to staff fully the fire engine.

Another perspective on this issue is obtained by focusing on those calls in which the fire engine arrived first. In aggregate we estimate this will occur 22% of the time. The question is "How long will the fire engine unit be at the scene before the first public safety unit arrives?" The models indicate than on average this time lag will be under one minute.

This time lag between the arrival of the fire engine and the later public safety unit is generally caused by incidence of short fire engine response time and not by unusually long public safety unit response time. Even when the public safety unit arrives after the fire engine, its average response time in those cases is still under 4.0 minutes.

In summary, on average, first response to all fires will improve with the adoption of the public safety concept. In a small but not significant proportion of cases there may be some deterioration of service because the fire engine arrived without its full complement. This problem can be reduced significantly by the use of aggressive preemption in these latter cases.

CHAPTER V

CITY OF ROSEVILLE: COST ANALYSIS

A. INTRODUCTION

The cost analysis of Roseville was done with data for budget year 1982-1983. In translating these numbers to another city, one crucial dimension must be kept in mind. In data collected in 1978 for 19 medium sized cities in Michigan, the City of Roseville had one of the state's lowest ratios of fire personnel to 1000 population, 0.72 officers per 1000 population. (See Table 4.1 earlier). In addition the personnel figures reported here are 10% below that of the 1978 data and would place Roseville at the bottom of the list and at half the survey average. The comparable nationwide average for cities in the 50,000 to 100,000 population range is 1.62 [1].

The analysis that we present proceeds in stages in order to assess the impact of several decisions. The first analysis focuses on savings accrued by reducing the station based personnel from ten to four men. The second step addresses the cost of placing either two or three additional officers on patrol at all times. The last component of the analysis explores the impact of two different increases in salary as well as a range of estimates as to the number of people within the merged department who will be earning this higher salary. The first salary increase considered is $1500 (5.5% of base) which is the actual offer that was made by the City of Roseville. The second is double this, $3,000.

In the discussion that follows, we have attempted to identify and report costs to the nearest hundred or thousand dollars. Realistically, the final results should be viewed with wider leeway as accurate to several tens of thousands.

1. Current Costs

The 1982-1983 budget for the City of Roseville was $18.2 million. The police department accounted for $4.4 million (24%) and the fire department accounted for $1.8 million (10%). The breakdown of these costs within each department is presented in Table 5.1. Personnel costs represented 87% of the police budget and 90% of the fire budget. The annual cost of the basic patrol officer was almost $42,000 and for the first level fireman, whose classification is pipeman, was $41,000. These first level position personnel costs in total are 67% and 60% of the respective personnel costs.

The police numbers in Table 5.1 reflect a change that occurred in the preceding year. At that time the city introduced a plan to start a public safety department and offered a $1,500 raise in base salary for any personnel, police and/or fire, who would agree to dual training. This raise was effective immediately and was agreed to by the police union. A contract was signed and all of the police volunteered to participate. They began drawing this higher salary even though the merger had not yet started. In contrast, the fire personnel rejected the offer and as a result their salary base and gross pay were almost $1,500 less.

TABLE 5.1

BUDGET 1982-1983 POLICE DEPARTMENT

Classification	NUMBER	GROSS PAY	COST PER PERSON	TOTAL COST
Superintendant	1	$42,500	$55,800	$55,800
Inspector	1	$36,600	$48,300	$48,300
Lieutenant	8	$37,800	$54,900	$439,200
Sergeant	10	$33,900	$49,400	$494,000
Patrolmen	61	$28,600	$41,800	$2,549,800
Other	10	$17,200	$22,800	$228,000
SUBTOTAL: Personnel	91			$3,815,100
Insurance & Bonds				$160,600
Equipment				$134,900
Equipment Maintenance				$45,100
Non-Labor: Operating				$143,700
Uniform & Laundry				$50,200
Educational				$20,100
SUBTOTAL: Other				$554,600
TOTAL POLICE DEPARTMENT COST				$4,369,700

BUDGET 1982-1983 FIRE DEPARTMENT

CLASSIFICATION	NUMBER	GROSS PAY	COST PER PERSON	TOTAL COST
Fire Chief	1	$41,500	$55,000	$55,000
Fire Marshall	1	$34,800	$46,300	$46,300
Fire Inspector	1	$28,700	$38,500	$38,500
Assistant Chief	2	$38,900	$51,700	$103,400
Lieutenant	4	$35,000	$52,400	$209,600
Sergeant	4	$31,400	$47,100	$188,400
Pipeman	24	$27,200	$41,000	$984,000
Other	1	$17,900	$23,100	$23,100
SUBTOTAL	38			$1,648,300
Insurance & Bonds				$80,600
Equipment				$35,800
Equipment Maintenance				$16,700
Non-Labor: Operating				$41,300
Uniform & Laundry				$15,200
Educational				$6,000
SUBTOTAL: Other				$195,600

TABLE 5.2

PERSONNEL COST BREAKDOWN: NON-PUBLIC SAFETY

	POLICE			FIRE		
	Basic	Sergeant	Lieut.	Basic	Sergeant	Lieut.
BASE	$24,126	$28,345	$31,150	$23,574	$27,110	$29,821
LONGEVITY	$782	$1,900	$2,519	$1,192	$1,652	$2,410
HOLIDAY	$1,229	$1,465	$1,623	$1,148	$1,333	$1,493
SHIFT DIFF.	$934	$719	$1,007	$1,297	$1,297	$1,297
TOTAL GROSS	$27,071	$32,429	$36,299	$27,211	$31,392	$35,021
COL	$926	$926	$926	$1,174	$1,174	$1,174
OVERTIME	$3,059	$3,664	$4,102	$3,701	$4,269	$4,763
H & L INS.	$2,491	$2,983	$3,340	$2,639	$3,045	$3,397
RETIREMENT	$6,025	$7,182	$8,017	$6,225	$7,146	$7,946
UNEMPLOY. INS.	$41	$49	$54	$41	$47	$53
TOTAL	$39,612	$47,233	$52,738	$40,991	$47,073	$52,353

TABLE 5.3

ACTUAL OVERTIME COSTS 1982-83
Patrolmen, Pipemen, Sergeants & Lieutenants

	POLICE		FIRE
	Total	Percent	
Coverage	$123,500	46%	NA
Holidays (12)	$78,000	29%	NA
Sched. Court	$13,900	5%	$0
Other Court	$48,800	18%	$0
Other	$6,000	2%	NA
TOTAL OVERTIME	$270,200		$125,000
PERCENT of GROSS PAY	11.3%		13.6%

In our analysis we will compare a pre-merged department with a merged one. Table 5.2 which contains a detailed breakdown of personnel costs and discounts the gross pay of police officers by the merger bonus. Because benefits add 67% to the cost, the net impact of subtracting out this bonus is a $2,200 reduction in the average patrolman, police sergeant and police lieutenant cost. In total the police department's budget is reduced from $4.4 million to $4.2 million and the combined police and fire to $6.0 million.

The total gross includes the base salary, a longevity bonus, holidays and a shift differential. The police contract specifies a longevity bonus of 2% of pay for policemen with five full years of service. For each additional five years this increased by an additional 2%. The number in Table 5.2 was a department average which for patrolmen averaged 3.2% of their base. Not surprisingly, the average percentage for police sergeants was 6.7% of base and for police lieutenants was 8.1% of base. The average length of service for the pipemen in Roseville was significantly higher than that of patrolmen and was reflected by the much higher 5.1% longevity bonus. The fire sergeant and lieutenant bonuses were not significantly different from the corresponding police values.

Police and fire officers received 12 paid holidays. There was also a shift differential payment that was 5% for late afternoon and evening shifts and 10% for shifts that start after 11 PM and go into the early morning hours. As part of their contracts, police and fire unions had negotiated different cost-of-living clauses which were reflected in the $250 higher payment to firemen. Health and life insurance were 9.2% and 9.6% of the respective gross salaries for policemen and firemen.

One particular cost of interest is overtime. For police officers overtime was 11.3% of their total gross and for fire the corresponding figure was 13.6%. In total overtime cost the city $270,000 for police and $125,000 for fire. We were able to obtain a breakdown of this cost for the police (see Table 5.3) but not for the fire department. Of the police total, 22% are for court related activities that have no obvious counterpart for fire. Another significant component, but which is unavoidable, was the holiday overtime. If an officer works a holiday, in addition to holiday pay noted above, he receives doubletime pay for the hours worked.

The statistic of greatest interest was the $123,000 paid in overtime to officers in order to provide minimum police coverage at all times. If the same ratio (60:40) of minimum coverage overtime to holiday overtime applies to fire, then the minimum coverage for fire accounted for $75,000 of the total $125,000 overtime cost. Later, in our discussion we will consider the possible savings in overtime costs that might result from a merger. However, all of the analysis will be limited to the minimum coverage cost component of overtime.

The retirement cost per officer were 19.4% of his total gross, plus cost-of-living and overtime. In absolute dollars this cost ranged from $6,000 to $8,000 for the ranks up to lieutenant. We collected five year's data, 1979-1983, on retirements in both the police and fire departments. The police department experienced 9 full retirements and the fire department had 7. In both cases the average years of service at retirement was 25 years. In addition the police department reported 5 disability retirements with years of service ranging from 13 to 17 years and averaging 15 years. These numbers translate into a long-term average turnover rate due to retirement of 4% for fire and 5% for police. These percentages will be used to calculate the cost due to turnover. We will assume that public safety officers will follow the slightly higher rate indicative of the police department. We did not have data on non-retirement departures but our later analysis suggests that this component of the annual turnover cost will be less than $10,000.

B. FIRE STATION RELATED SAVINGS

Earlier we outlined a cost analysis strategy that separated the savings due to fire station manpower reduction from the cost of adding patrol units even though some of the same personnel were being transfered. Under a merger, we envision a reduction in personnel stationed at firehouses from an average of 10 to an average of four to handle just fire emergencies. The four would consist of three pipemen and one sergeant or lieutenant. Prior to the proposed merger there were 24 pipemen and 8 supervisors (4 sergeants plus 4 lieutenants). This new deployment plan maintains the ratio of 1 supervisor station manpower reduction from the cost of adding patrol units even though some of the same personnel were being transfered. Under a merger, we envision a reduction in personnel stationed at firehouses from an average of 10 to an average of four. The four would consist of three pipemen and one sergeant or lieutenant. Prior to the proposed merger there were 24 pipemen and 8 supervisors (4 sergeants plus 4 lieutenants). This new deployment plan maintains the ratio of 1 supervisor apital and equipment cost is related to the number of personnel and this too was proportionately reduced. The total of these reductions is $59,000 and the total combined savings is $972,000.

C. COST OF ADDITIONAL PATROL UNITS

1. Two officers around the clock

The Roseville police department currently averages eight officers in patrol units with variations from shift to shift as noted in Chapter III. To staff these eight positions during the 21 shifts in a week, we estimate requires 34 officers. The ratio of lieutenants and sergeants to patrolmen in the Roseville departments suggests that these 34 patrolmen would be supervised by six sergeants and five lieutenants.

In order to field an additional two patrolmen around the clock, the city would need to add between eight and nine additional men to the patrol division. To simplify our analysis and to insure that during the day shift there are at least eight officers on patrol, we have chosen to evaluate the cost of adding nine basic personnel to the patrol division. These nine personnel are to be supervised by an additional two sergeants and one lieutenant for a total of twelve (See Table 5.5). Under this plan, the combined departments would have a total of 120 personnel, a reduction of nine positions or 7%.

TABLE 5.4
PRE-MERGER COSTS & FIRE STATION PERSONNEL AND RELATED SAVINGS

	PRE-MERGED FIRE			MERGED		
	Total	Personnel Cost	Tot. Cost	Total	Personnel Sav.	Savings
Fire Chief	1	$55,000	$55,000	1	0	$0
Fire Marshall	1	$46,300	$46,300	1	0	$0
Assistant Chief	2	$51,700	$103,400	1	1	$51,700
Lieutenant	4	$52,400	$209,600	2	2	$104,800
Fire Inspector	1	$38,500	$38,500	1	0	$0
Sergeant	4	$47,100	$188,400	1	3	$141,300
Pipeman	24	$41,000	$984,000	9	15	$615,000
Other	1	$23,100	$23,100	1	0	$0
SUBTOTAL	38		$1,648,300	17	21	$912,800
Insurance & Bonds			$80,600			$44,542
Capital & Equipment			$35,800			$3,000
Equipment Maintenance			$16,700			$0
Non-Labor: Operating			$41,550			$0
Uniform & Laundry			$14,950			$8,400
Educational			$6,000			$3,316
SUBTOTAL			$195,600			$59,258
TOTAL FIRE			$1,843,900			$972,058

PRE-MERGED POLICE

	Personnel	Cost	Tot. Cost
Superintendant	1	$53,600	$53,600
Inspector	1	$46,100	$46,100
Lieutenant	8	$52,700	$421,600
Sergeant	10	$47,200	$472,000
Patrolmen	61	$39,600	$2,415,600
Other	10	$22,800	$228,000
SUBTOTAL: Personnel	91		$3,636,900
Insurance & Bonds			$160,600
Equipment			$134,900
Equipment Maintenance			$45,100
Non-Labor: Operating			$143,700
Uniform & Laundry			$50,200
Educational			$20,100
SUBTOTAL: Other			$554,600
TOTAL POLICE			$4,191,500
TOTAL POLICE & FIRE			$6,035,400

These twelve personnel generate total personnel costs, including overtime, retirement, etc., of $503,000 as well as insurance costs of $24,000 (i.e. $2,000 apiece). The basic patrolmen are deployed half of the time in two-officer units and the other half in one-officer units. The department is assumed to have purchased and equipped two additional vehicles for these twelve personnel. (See Table 5.6). These two vehicles based on 50,000 miles per year are estimated to incur total operating and maintenance costs of $12,000. The vehicles are kept for two years and the difference between purchase cost and trade-in value was found to be $7,400 per vehicle. In addition these vehicles must be dual equipped at an annual total cost of $4,300 for the additional vehicles. This cost includes a radio and two breathing apparatus (i.e. Scott air paks) for each vehicle that has been amortized over four years. Finally, these officers are provided with portable gear and a uniform and laundry allowance that amounts to just over $10,000 for the new patrolmen and their supervisors (See Table 5.6).

The thirty-four patrolmen and their eleven immediate supervisors currently assigned to patrol units also need equipment for their vehicles as well as special personal fire gear. Sufficient Scott air paks are purchased to provide two for each of ten vehicles and forty-seven fire uniforms are purchased to be used by the current patrolmen, their supervisors and the two top police executives. These costs are again amortized over four years and add $9,500 to the annual budget.

TABLE 5.5
ADDITIONAL PATROL COSTS DUE TO MERGER

	2 ADDITIONAL PATROL OFFICERS			3 ADDITIONAL PATROL OFFICERS		
	Personnel Total	Add.	TOTAL COST	Personnel Tot.	Add.	TOTAL COST
Superintendant	1	0	$0	1	0	$0
Inspector	1	0	$0	1	0	$0
Lieutenant	9	1	$52,700	9	1	$52,700
Sergeant	12	2	$94,400	12	2	$94,400
Patrolmen	70	9	$356,400	74	13	$514,800
Other	10	0	$0	10	0	$0
SUBTOTAL: Personnel	103	12	$503,500	107	16	$661,900

Insurance & Bonds	EXTRA MEN	$24,000	EXTRA MEN	$32,000
Equipment	ALL/UNITS	$23,400	ALL/UNITS	$27,700
Equipment Maintenance	EXTRA UNITS	$1,500	EXTRA UNITS	$1,800
Non-Labor: Operating	EXTRA UNITS	$10,400	EXTRA UNITS	$13,500
Uniform & Laundry	EXTRA MEN	$7,200	EXTRA MEN	$9,600
Educational	ALL	$11,900	ALL	$13,500
SUBTOTAL: Other		$78,400		$98,100
TURNOVER		$19,000		$20,700
TOTAL ADDED PATROL COSTS		$600,900		$780,700

TABLE 5.6

EQUIPMENT & OTHER COSTS FOR NEW VEHICLES AND CHANGEOVER OF OLD ONES
1982-1983 DATA

CATEGORY	ASSUMPTION	COST PER	THE NO. OF ADD. PATROL OFFICERS: TWO #	TWO Tot. Cost	THREE #	THREE Tot. Cost
New Patrol Vehicles						
Purchase		$9,000				
Trade-in		$1,600				
NET PRICE	2 years	$7,400	2	$7,400	2.6	$9,620
Radio	4 years	$2,800	2	$1,400	2.6	$1,82
Other	1 year	$500	2	$1,000	5.2	$1,30
Breathing (2)	4 years	$1,000	4	$1,000	5.2	$1,300
Operating	1 year	$5,200	2	$10,400	2.6	$13,52
Maintenance	1 year	$750	2	$1,500	2.6	$1,950
New Patrol Officers & Supervisors						
Uniform Allowance	1 year	$600	12	$7,200	16	$9,60
Pers. Radios/misc.	3 years	$500	12	$2,000	16	$2,66
Fire uniform	4 years	380	12	$1,140	16	$1,520
Converted Police Units						
Breathing	4 years	$2,000	10	$5,000	10	$5,00
Fire Uniform	4 years	$380	47	$4,465	47	$4,465
All Patrol & Their Supervisors						
Cont. Educational	1 year	$150/$400	47/12	$11,850	47/16	$13,45
TOTAL COST OF THE ABOVE				$54,355		$66,212

TURNOVER:	Retire. Rate	Training Cost Tuition	Training Cost Salary	Pers.	Total	Pers.	Total
Police	0.05	$2,200	$3,395	81	$22,660	81	$22,660
Fire	0.04	$350	$2,405	38	$4,187	38	$4,18
Pub. Saf.	0.05	$2,550	$5,800	110	$45,925	114	$47,59
NET INCREASE IN RETIREMENT TURNOVER COST					$19,077		$20,74

Turnover:Leave	Rate	Tot. Cost	Tot. Cost
	0.01	$3,600	$3,731
All Departments	0.02	$7,200	$7,46
	0.03	$10,800	$11,195
	0.04	$14,400	$14,924

Another cost we considered involved continuing eduation. We divided the current police and fire budgets for education by the respective numbers of personnel and came up with a cost of $250 per policeman and $150 per fireman. Public safety officers are assumed to incur costs equal to the sum of these or $400. The added cost is $150 for each of the forty-five police currently assigned to patrol as well as for the two top executives in the department. There is a comparable cost for the twelve officers transferred to this division. The sum total of all of these non-pay or benefit costs is $78,000.

One final cost relates to the turnover of personnel. In this analysis we focus only on the net change. As was noted earlier, the turnover due to retirement of fire personnel averages 4% and for police 5% due to higher rates of disability. Public safety officers are assumed to experience turnover rates similar to police. When an officer is replaced in Roseville, the new hire is paid a salary while he takes a police or fire training course at Macomb County Community College. The annualized salary is $14,700, which is 60% of the regular base pay scale with no benefits (e.g. no insurance coverage or vacation days). The police training program is twelve weeks and the fire is eight and a half weeks. THe public safety officer would take the two course for a total of 20.5 weeks. The salary cost associated with these time frames is $3,400, $2,400 and $5,800 for police, fire and public safety respectively.

The tuition charges for each of these programs are dramatically different. The police course, which meets the State of Michigan standards for police certification, costs $2,200. The

State of Michigan does not have minimum standards for fire certification and the tuition for the fire training program is only $350. The total annual net increase in turnover costs associated with basic education is $19,000.

One savings we did not include is that officers throughout their first year are paid at a much lower scale than the senior officer they would replace. The reason was that, in equilibrium, there would be officers at all levels of seniority who are increasing in longevity each year. Thus, the new officer's salary is replacing the salary of another officer at the bottom rung who has just completed his probationary year.

At the bottom of Table 5.6, we illustrate the impact of each percentage point increase in the turnover rate due to simple departures. The cost for each percentage point is $3,600 and even for a rate comparable to the retirement turnover rate, the costs only amount to $14,000.

2. Three Officers Around the Clock

The above analysis assumed a deployment of two additional officers around the clock. It is easy to envision a manager who is concerned that six personnel were removed from the fire stations and replaced by only two officers on patrol. Thus to be cautious the manager might consider deploying three officers around the clock especially if attrition has not yet allowed the planned reduction. In this section we cost out this alternative.

In evaluating this deployment we assumed that these additional personnel were not also accompanied with an increase in supervisors. To field these positions four officers are needed and this brings the department total to 124, a savings of five positions. The total additional personnel patrol costs would now be $662,000. These officers are provided with an average of 2.6 vehicles for patrol with the projections specified in Tables 5.5 and 5.6. The cost of refitting the current patrol force does not change and the total non-personnel added costs are just under $100,000. Lastly, the turnover cost is only slightly higher than before.

These added personnel should at least generate an overtime savings since they are not needed for minimum coverage. We have, therefore, subtracted out the minimum coverage overtime component of each of these four officers. In addition, we believe that these same units would also be helpful in satisfying the minimum coverage demands when other personnel are unavailable. We conservatively suggest at least a 25% savings in the $120,000 minimum patrol coverage overtime cost that appears in the current Roseville budget. We have not assumed any coverage savings for the two officer plan as we would anticipate a strong need to meet the minimum coverages analyzed in Chapter IV.

3. Standby and Call-in

In Chapter 4 we discussed the need to call-in additional personnel to provide patrol coverage in the case of a major fire tieing up a significant portion of the patrol force for an extended period of time. We estimate that depending upon the criterion used this could occur as frequently as twenty-two times a year. Based on our earlier analysis it would seem to be sufficient to call-in three officers for the duration of the fire and perhaps one hour longer. Assuming that officers are paid for a minimum of four hours work, the cost is only $3900. In fact, the larger cost is the payment for three officers to be available on standby 365 days a year at $15 a day. (As was noted earlier, a recent Supreme Court Decision [30] would drive this cost up dramatically. A department could not afford to maintain officers on official standby and may have to rely on mutual aid a little more frequently.) These two components cost a total of $20,000 for the proposed two officer plan. Under the second plan with three additional officers deployed, only two officers would need to be on standby and called in when necessary. The resultant cost is slightly lower, $13,000.

There is one caveat to the above cost. This cost is assumed to occur because a major fire has tied up a significant portion of the public safety department, leaving the city short of both police and fire coverage. The call-in provides both coverages. However, under a pre-merger arrangement, these same fires would have left the city with no available fire coverage in case a second fire arose. Thus, there was probably a need and a cost associated with these same fires prior to a merger.

4. Merger Incentive Salary Increases

Up to this juncture we have discussed the key savings and costs associated with a change to public safety. The net savings under these plans at this stage of the analysis are $351,000 (5.9%) for the first deployment plan and $231,000 (3.9%) for this more risk averse deployment. Although these costs include no increased salary, they may, in fact, be an indication of the true cost of the merger to the City of Roseville. At the time of this budget the State of Michigan and its cities were in the midst of a near depression. The proposed public safety officer pay scale was part of a new police union agreement that was reached in 1981. In Table 5.7 we compare the increase in salaries and wages paid in budget year 1980-1981 as compared to 1981-1982 for the six largest Roseville city departments.

The Police Department increase was 10.6% with no additional personnel. The lowest percentage increases were for the Highway and Recreation departments and each increased by 8.6%. If we discount the cost of the additional clerk typist hired by the court the percentage again approaches this figure. Only the Sanitation department's increase was different and that was even higher than the corresponding police value. The Fire Department numbers reflect the reduction of one sergeant and no increase due to an impass in negotiating a new agreement.

TABLE 5.7

COMPARISON OF FULL-TIME PERSONNEL COST INCREASES
SIX ROSEVILLE DEPARTMENTS

Department	Year Ending 6-30-81	Year Ending 6-30-82	% Increase
Police (0)	$2,232,000	$2,468,000	10.6%
Fire (-1)	$1,136,000	$1,078,200	-5.1%
Highway(0)	$440,000	$478,000	8.6%
Recreation(0)	$187,000	$203,000	8.6%
39th Dist. Ct. (+1)	$216,000	$254,000	17.6%
Sanitation(0)	$208,000	$237,000	13.9%

If we use the 8.6% as a base, then the actual pay incentive offered the police was only 2% and not 5.5%. In the sections that follow we used the $1500 value as written in the contract even though police negotiators probably viewed this as part of an overall salary increase. To adjust the numbers that follow to reflect only a 2% bonus, reduce all bonus costs by 64%.

We will also analyze the impact of bonus eligibility. The minimum eligibilty criterion assumes that at the startup bonuses will only be offered to sufficient personnel to staff all of the patrol units, their supervisors and the two top executives. Officers on duty in fire stations and assigned to other police roles would not be included and are assumed to have remained single trained. Although ultimately, all personnel in the department will become public safety, this analysis is still valid if all future hires are not offered the bonus but instead are paid at current police salary levels. This policy results in 54% of the uniformed personnel of the new smaller department receiving the higher salary. This 54% mix of higher and lower salaries would also arise if several years into the future, 46% of the department were personnel hired after the merger had been started.

Roseville offered all of its current personnel bonuses but kept future hires at the current salary scale. All of the police opted for the bonuses but none of the fire personnel did. The second scenario we analyze assumes a broader bonus eligibilty experience or equivalently a larger proportion of the two departments volunteering to be public safety officers. If we assume that the merger will be phased in through a) attrition of the current fire personnel and b) all current police officials become dual trained, then 85% of the personnel in the merged department will draw this incentive pay. This scenario is what we assume to be the closest to what Roseville would have experienced in the short-term if a merger had been implemented.

The final alternative assumes that all personnel are on this new higher scale. This would occur if this new pay scale were not just a bonus for current personnel but rather reflected the department's commitment to pay a higher salary in the long term even to future hires.

The $1500 bonus and its associated increased benefits generates total costs of $130,000 for the 54% elgibility and $264,000 for a 100% eligibility. In any case there is still a net savings the City of Roseville ranging from a high of almost $221,000 (3.7%) to a low of $87,000 (1.4%). The most likely scenario produces a net savings of $146,000 or 2.4% of the budget even though there is a 7% reduction in personnel.

These numbers would be significantly higher if we assume, instead, that the bonus was only 2% above the 8.6% salary increase that would have been given anyway. This smaller bonus makes the percentage of personnel eligible for the bonus a less important factor and reduces the range in net savings. This 2% bonus results in net savings that are in the $250,000 to $300,000 depending upon the number of personnel who receive the bonus.

TABLE 5.8
IMPACT OF MERGER ON TOTAL COST OF OPERATION

FIRE STATION PERS.+OTHER SAVINGS		$972,000	$972,000
	ADD PATROL OFFICER	TWO	THREE
ADDED PATROL:PERSONNEL COSTS		($503,000)	($662,000)
ADDED PATROL:EQUIP. + OTHER COSTS		($62,000)	($82,000)
PATROL FORCE CHANGEOVER COSTS		($17,000)	($17,000)
TURNOVER COSTS		($19,000)	($21,000)
STANDBY (3 or 2) & CALL-IN (26)		($21,000)	($14,000)
SUBTOTAL 1 NET SAVINGS		$350,000	$176,000
OVERTIME SAVINGS		$0	$54,000
SUBTOTAL 2 NET SAVINGS		$350,000	$230,000
BONUS COSTS $1500			
MINIMUM ELIGIBILITY 54%	COST	($130,000)	($139,000)
	NET SAV.	$220,000	$91,000
	PCT. SAV.	3.7%	1.5%
MODERATE ELIGIBILITY 85%	COST	($205,000)	($213,000)
	NET SAV.	$145,000	$17,000
	PCT. SAV.	2.4%	0.3%
MAXIMUM ELIGIBILITY 100%	COST	($264,000)	($273,000)
	NET SAV.	$86,000	($43,000)
	PCT. SAV.	1.4%	-0.7%
BONUS COSTS $3000			
MINIMUM ELIGIBILITY 54%	COST	($260,000)	($278,000)
	NET SAV.	$90,000	($48,000)
	PCT. SAV.	1.5%	-0.8%
MODERATE ELIGIBILITY 85%	COST	($409,000)	($427,000)
	NET SAV.	($59,000)	($197,000)
	PCT. SAV.	-1.0%	-3.3%
MAXIMUM ELIGIBILITY 100%	COST	($528,000)	($546,000)
	NET SAV.	($178,000)	($316,000)
	PCT. SAV.	-3.0%	-5.3%

The total cost of bonuses does not increase significantly if the City adds three patrol officers instead of two. However, the net savings are significantly different because of the higher patrol costs noted earlier. For the moderate eligibility criterion, the department would just about break even with a net savings of $18,000. More limited eligibility or a smaller proportion of current volunteers would increase this to $92,000 (1.1%) and a permanent increase for all personnel would cause a NET INCREASE of $42,000 in operating cost.

If the proposed bonus were doubled, the city would probably incur a net increase in cost as a result of the merger. Under a scenario of two additional patrol officers and the most restricted assumption on bonus eligibility, the City could still net an estimated $91,000 or 1.5%. A bonus this size which were standardized for all employees, current and future, as a new salary scale would increase the total operating cost by $177,000 or 3.0%. An expansive bonus coupled with a conservative deployment of three patrol units, naturally generates even higher increases which are in the $50,000 to $315,000 range.

In summary these last costs indicate the need to carefully cost out the impact of a merger and highlight two points:

1. Management decisions with regard to deployment, bonus eligibility and size could spell the difference between a merger saving money and costing money.

2. Percentage change in total personnel is not a sufficient statistic for assessing the cost of a merger.

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