$00996.00.000490
ACCESSION NUMBER: 00996.00.000490
TITLE: USE OF PROBABILITY THEORY IN THE ASSIGNMENT OF POLICE PATROL AREAS
PUBLICATION DATE: 7007
AUTHOR(S): BENNETT, W.; DUBOIS, J.
NUMBER OF PAGES: 49
ISSUING AGENCY: EDINA (MN) POLICE DEPT
SPONSORING AGENCY: LEAA
GRANT/CONTRACT: 235
SALES/SOURCE: NTIS PB 195 856, SPRINGFIELD, VA
SUBJECT/CONTENT: POLICE PATROL FUNCTION
PATROL PROCEDURES
POLICE RESPONSE TIME
COMPUTER AIDED OPERATIONS
POLICE
CLEARANCE RATES
EDINA
ANNOTATION:
PROGRAM DEVELOPED A SYSTEM OF RANDOM PATROL THAT REDUCES THE TIME REQUIRED FOR AN OFFICER TO RESPOND TO A CALL.

ABSTRACT:

THE POLICE DEPARTMENT OF EDINA, MINNESOTA, AND NORTH STAR RESEARCH AND DEVELOPMENT INSTITUTE OF MINNEAPOLIS, HAVE CONDUCTED A PROGRAM OF RESEARCH ON THE USE OF PROBABILITY THEORY IN THE ASSIGNMENT OF POLICE PATROL AREAS. THE PURPOSE WAS TO MAKE MORE EFFECTIVE USE OF EXISTING PERSONNEL THROUGH THE USE OF MODERN SCIENTIFIC METHODS. THE MEASURE OF EFFECTIVENESS USED WAS RESPONSE TIME-THE TIME IT TAKES FOR A PATROL OFFICER TO GET TO THE POINT OF NEED AFTER RECEIVING THE CALL. DATA PROCESSING TECHNIQUES WERE USED TO CATEGORIZE REQUESTS FOR POLICE IN THE ENTIRE COMMUNITY AND TO DEVELOP A SERIES OF PATROL AREAS THAT WERE UNEQUAL IN SIZE BUT EQUAL IN CRIME POTENTIAL. EQUAL IN CRIME POTENTIAL MEANS THAT, BASED ON HISTORY OF REQUESTS FOR POLICE AND UPDATING FACTORS, THE PROBABILITY OF A POLICE CAR BEING NEEDED IN ANY OF THE PATROL AREAS AT ANY GIVEN TIME IS THE SAME. IF THE PATROL AREAS OR SUBZONES ARE ASSIGNED TO CARS ON A PURELY RANDOM BASIS, PROBABILITY THEORY PREDICTS THAT PATROL CARS WILL BE CLOSER TO THE POINT OF NEED WHEN THEY ARE REQUESTED THAN UNDER ANY OTHER SYSTEM OF PATROL ASSIGNMENT. THE SPECIFIC GOAL OF THE RESEARCH PROGRAM WAS TO DEVELOP A SYSTEM OF RANDOM PATROL THAT WOULD REDUCE THE TIME REQUIRED FOR A POLICE OFFICER TO RESPOND TO A CALL. ANOTHER DESIRED PRODUCT OF THE PROJECT WAS TO DEVELOP A MODEL PATROLLING TECHNIQUE THAT, IN ADDITION TO SERVING AS THE PATROLLING METHOD FOR THIS PROJECT, WOULD ALSO BE SUITABLE FOR USE BY OTHER POLICE DEPARTMENTS. (AUTHOR ABSTRACT)

The Use of Probability Theory in the Assignment of Police Patrol Areas

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JUSTICE
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The Use of Probability Theory in the Assignment of Police Patrol Areas

PR 70-2

JULY, 1970

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This project was supported by OLEA Grant No. 235 awarded by the Attorney General, U.S. Department of Justice. Persons undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment, findings, and conclusions. Therefore, points of view or opinions stated in this document do not necessarily represent the official position or policy of the U.S. Department of Justice.

U. S. DEPARTMENT OF JUSTICE
Law Enforcement Assistance Administration
National Institute of Law Enforcement and Criminal Justice

FOREWORD

Police departments are well aware that rapid response to emergency calls is paramount to catching a suspect at the scene. Studies have shown that as the response time goes down, the clearance rate goes up because of the increased ability to make on-the-scene arrests. Because of the proven correlation between rapid response and arrests and the desire of officials to develop a convincing posture of effective police presence as well as to aid in apprehension, many police departments are seeking methods to reduce the time for a patrol car to arrive at the scene. Some obvious methods are: a computer-assisted command and control system, improvement in police radio communications, or by increasing the number of patrol units. But when funds are not available or sufficient to develop and implement these methods, the only alternative is for a department to make a more effective reallocation of its police patrol forces.

The police department of Edina, Minnesota, in cooperation with North Star Research and Development Institute, Minneapolis, Minnesota, and with the support of a Law Enforcement Assistance grant from the U.S. Department of Justice, undertook a research program for the purpose of making more effective use of their existing patrol units. The specific goal of the study was to develop a system of random patrol assignments, based on probability theory, that would reduce the time for a patrol car to arrive at the scene after receiving a call.

The evaluation phase of the project showed that the primary goal—reduction of average response time—was achieved. But the evaluation also revealed that, although the average response time dropped sharply during the project, there was no corresponding differences in response time between random patrol and routine patrol. These results were attributed to the intense competition that developed between those officers who were on routine patrol and those on random patrol. Unfortunately, this lapse in experimental control made it difficult to show a clear-cut superiority, in terms of reduced response time, of random patrol over routine patrol. Nevertheless, it is the belief of those involved in the study that random patrol over a long period would be superior to routine patrolling techniques.

This belief has been borne out by the fact that during the final quarter of the project when random patrol was discontinued, the average response time immediately began to rise. In a recent communication, the Edina Police Department informed the Institute th :, from July 1969 to April 1970, the average response time, using routine patrol, has increased by 19 percent; and the Department is making plans to re-establish random patrol with improvements in the techniques developed during the project.

Irving Slott
Acting Director, National
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Enforcement and
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PREFACE

The Edina Project was a two-year joint venture between the Police Department of Edina, Minnesota, and North Star Research and Development Institute of Minneapolis, Minnesota. Edina, Minnesota, is a community with a population of 45,000 and an area of approximately 17 square miles. It is immediately adjacent to Minneapolis.

The Edina Police Department has 43 personnel and an annual budget of $568,000. The Department is oriented towards research on all aspects of police activities, having conducted research programs with community funds in the area of prevention of juvenile delinquency, highway speed analysis, highway accident prevention, and patrol car dispatching using probability theory.

North Star Research and Development Institute is a nonprofit, independent research organization. It conducts scientific research in the physical, biological, and social sciences and engineering on a contract basis for industry and government agencies at local, state, and national levels.

The Edina Project was a successful attempt to use probability theory in the dispatching of police patrol vehicles. A goal of the project was to make more effective use of existing personnel through the use of modern scientific methods. Because the operational and theoretical aspects were entwined, the project was truly a joint effort between the Village of Edina Police Department and North Star Research and Development Institute. In general, the Edina Police Department was responsible for the operational aspects, and North Star was responsible for the theoretical aspects.

Community interest in the project was high. Publicity came through a television newscast over each WCCO TV and KSTP TV, and from several newspaper articles in the *Edina Sun*, the *Edina Courier*, the *Minneapolis Star*, and *Minneapolis Tribune*. The information provided in the newscasts and newspaper articles was descriptive of the project—its goal, methods, and scope. The project results and evaluation are presented for the first time in this report.

This report has two goals. One is to provide a precise, comprehensive documentation of the Edina Project, and the other is to provide the information in such form that the reader, whether police officer, scientist, or layman can turn to and understand those parts of the report that are of greatest interest. The body of the report is basically nontechnical; where technical terms are used, they are explained so they may be understood by general audiences. The highly technical material necessary to permit the Edina Patrol Model to be used by other police departments is included in the three appendixes.

A brief descriptive outline of the project report follows: First, the general technique of using probability theory to assist in dispatching police cars is presented. Next, the background of using the technique in Edina is discussed. That is followed by a complete description of the methods, goals, and variations of the project. Next, the results of the project are presented and that is followed by an evaluation of the project. The final section is a discussion of the generalized random patrol model suitable for use by other police departments.

SUMMARY

The Police Department of Edina, Minnesota, and North Star Research and Development Institute of Minneapolis, Minnesota, have conducted a program of research on the use of probability theory in the assignment of police patrol areas. The purpose of the project was to make more effective use of existing personnel through the use of modern scientific methods. The measure of effectiveness used in the program was response time—the time it takes for a patrol officer to get to the point of need after receiving the call. Data processing techniques were used to categorize previous requests for police in the entire community and to develop a series of patrol areas that were unequal in size but equal in "crime potential". Equal in "crime potential" means that, based on history of requests for police and updating factors, the probability of a police car being needed in any of the patrol areas at any given time is the same. If the patrol areas or subzones as they are called, are then assigned to cars on a purely random basis, probability theory predicts that patrol cars will be closer to the point of need when they are requested than under any other system of patrol assignment. Thus, the specific goal of the research program was to develop a system of random patrol that would reduce the time required for a police officer to respond to a call. Another desired product of the project was to develop a model patrolling technique that, in addition to serving as the patrolling method for this project, would also be suitable for use by other police departments.

The two-year research program was funded by a grant from the Law Enforcement Assistance Administration of the United States Department of Justice. It consisted of three phases: a six-month planning phase, during which a system was developed to divide the community into patrol areas of equal crime potential and to develop the methods of a random system of patrol zone selection; a twelve-month full-scale field test of the random patrol concepts; and a six-month project evaluation phase.

ACKNOWLEDGMENTS

Many people have contributed to the success of this project, including members of the Edina Police Department, Edina Village Officials, and the staffs of North Star Research and Development Institute and the University of Minnesota Computation Center. However, the contribution of a few are given special acknowledgment.

Captain of Detectives Henry Wrobleski contributed greatly to the data tabulation and program planning. Captain Bert Merfeld of the Uniform Division contributed much to the operation of the experimental portion of the program. Edina Village Manager, Warren Hyde, and Village Finance Director, Jarl Dalen, assisted with administration and financial reporting on the project. Mr. Ronald Rengel was responsible for financial reporting of North Star's portion of the project.

Dr. William Munroe and Mr. Phil Houle of the University of Minnesota Computation Center were invaluable to the project in the areas of computer operations, planning, and programming. A special acknowledgement also goes to the entire Edina Police Department because, without their complete cooperation, the project would not have been possible. The Law Enforcement Assistance Administration of the United States Department of Justice provided financial support and encouragement and assistance throughout the entire project.

Procedures for the field test, Phase 2, of the patrolling method designed in Phase 1 included:

1. The entire uniformed division of the Edina Police Force on all shifts was involved.
2. One-half of the patrol zones were patrolled using the random patrol technique; the other half of the patrol zones were "control" zones and were patrolled in the conventional manner. (At the end of each week, the random patrol and the control zones were interchanged.)
3. At the start of each shift, each officer was given a random patrol zone map and a series of random numbers.
4. The officer patrolled the subzones of his assigned zone according to the sequence of random numbers for a period of fifteen minutes per subzone. After fifteen minutes, he proceeded to the subzone corresponding to the next random number on his list. If he received a call, he responded; when the call was completed he proceeded to the subzone corresponding to the next random number on his list.
5. A record was kept of each call, its location, time the call was received, time the officer arrived and cleared, and weather conditions.

The twelve-month experimental period was actually broken down into four three-month periods to permit four variations of random patrol to be investigated.

The evaluation phase of the project showed that the primary goal of the project—reduction of average response time—was achieved. During the one-year field test of random patrol, the average response time decreased 40 percent compared to that for the previous year, even though 19 percent more calls were handled. In the period April 1, 1967, to April 1, 1968, the average response time for all calls was 7.05 minutes. During the year of the field test, April 1, 1968, to April 1, 1969, the average response time for all calls was 4.22 minutes.

While the project was still in the planning phase, the Edina police officers were introduced to the random patrol concept. Through regular meetings between researchers, police administration, and patrol officers, the value of response time was explained and the project methods and goals were discussed. As a result of the early meetings, average response time began to decrease even before the field tests were started.

Once the field tests were initiated, response time continued to drop. Each calendar quarter, new methods were introduced, and the patrol officers were given more information about where and when the various types of requests for service occurred. And for each calendar quarter throughout the project, response time dropped. Because the results of the scheduled field tests were so favorable, the Edina Police Department continued random patrol at all times over the entire Village for three months. The average response time continued to drop. To determine the effect, the use of random patrol was suspended and routine patrol methods were restored. Immediately the average response time started to rise. A great majority of people involved with the random patrol project are convinced that random patrol is better than routine patrolling techniques. It is anticipated that additional random patrol techniques will continue to be investigated and tested by the Edina Police Department.

In addition to the actual improved patrol methods, other benefits were derived from the project. The analysis of previous requests for service made possible by the data processing techniques employed in the project provided great assistance in deployment of police patrol manpower. The entire patrol zone structure was changed so that each zone now has approximately the same activity as each other zone. The data analysis showed that about one-half of all requests for service occur on one shift (3-11 p.m.), so the patrol manpower on that shift was increased. Weekly and yearly trends were identified. Analysis of the effects that weather conditions have on requests for service showed that the likelihood of a request for service is approximately twice as great in bad weather as in clear weather.

Generalized methods for a random patrol model, including all digital computer programs, were developed to permit the techniques of this program to be used by other police departments.

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BACKGROUND

For twelve months in 1962, the Edina Police Department experimented with a form of random patrol. Only the night shift (11 p.m. to 7 a.m.) was involved, and no data processing equipment was used. The Village was divided into four zones and the four zones were subdivided into 51 subzones. The patrol officers were dispatched into the various zones on the basis of probability theory achieved through the use of four special roulette wheels. The limited experiment appeared to be successful in that burglaries dropped 38 percent on the 11 to 7 shift compared to the previous year. 1962 was the only year the number of burglaries in Edina has dropped in the past ten years. In addition, the average response time was reduced, but records for that period are inadequate to permit an exact calculation of the magnitude of the reduction. No control group was included in the experiment, making it difficult to assess the scientific value of the effort; but it did have the result of creating the desire on the part of the Edina Police Department to investigate further the use of probability for dispatching the police cars. Hence, the idea for the present random patrol project was born.

The characteristics that distinguish the police manpower allocation problem from most business and industrial situations is the manner in which police tasks are generated. In most non-police situations, the tasks to be performed are known in advance, and the number of people required to complete them is easy to determine. Thus, if the shoe manufacturer must turn out 10,000 pairs of shoes next week to meet orders, he knows with some precision the tasks that must be performed and the number of people to perform them. Some police tasks are similar. For example, such things as escorting distinguished visitors, or maintaining order along a parade route are usually known ahead of time, and police requirements may be determined and allocated well in advance of the event.

The largest group of police tasks, however, are generated in a probablistic fashion. By probablistic is meant that future police tasks can be predicted only in terms of the likelihood of their occurring at a specific time and place. Tasks generated in this manner make up the bulk of police work and form the basis of the police manpower allocation problem. To understand the problem in this context, it is helpful to view each police task that occurs as having two coordinates. One coordinate specifies the time at which the event occurs and the other, the location where it occurs. By the same reasoning, each police unit on duty may be viewed as passing through a succession of points defined by the same coordinates.

Each time a task is generated, one objective of any police department is to move a police unit to the scene as quickly as possible for the purpose of completing the task. How quickly the police unit will arrive to carry out the task will depend upon its location relative to the location of the task at its time of origin. The time between the occurrence of the event that generates the task and the arrival of the police unit at the scene is related to the distance between the two points. Thus, one of the things sought is to match as nearly as possible the coordinates of the police unit and the task that it must perform.

The delay between the time an event occurs and the time that a police unit arrives at the location to perform the task comprises three distinct parts. The fact that an event has occurred must first be communicated to the police. The speed at which knowledge of the event is communicated to the police is related to both the type of event and the location. The police have only indirect control over this aspect of the delay factor.

The second part of the delay is that involved in transmitting the information to a police unit, which will then perform the task. This part of the delay may be considerable during peak periods, if the communication system is inadequate, but it is not primarily an assignment problem.

The third part of the delay, and one which is directly related to allocation, is the time required for the police unit to travel from its position to the task location. This time will be defined as "lag time" or response time. Assume that an event E occurs at time T on block 1.1 of Figure 1. If at time T the police unit P is at position A, it will take five minutes to reach the task scene.

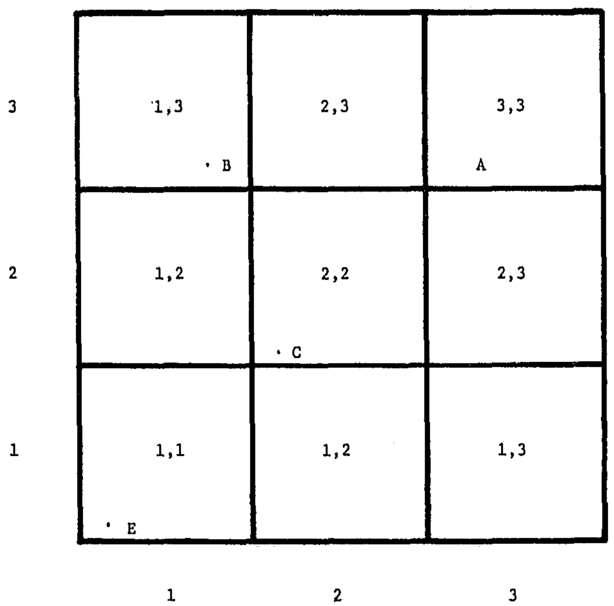

FIGURE 1.—Coordinate matrix.

At position B, it will take three minutes and at position C, two minutes. Thus, the closer the unit P is to the event at time T, the less the response time will be. To minimize the response time, the distance between P and E at time T must be minimized.

Specifying the location of the police unit within its assigned beat at some future point in time is characterized at best by uncertainty. In the same fashion, predictions of when and where future police tasks will occur can be made only in probablistic terms. It, for example, is impossible to predict that at 10:25 a.m. on July 1, a burglary will occur at 7001 France Avenue. It is obvious that methods of dealing with police allocation problems must be capable of dealing successfully with uncertainties.

One of the first considerations is the size of the smallest geographic area about which predictions can be made. A specific point such as 7001 France Avenue is too small for practical purposes. There may never be an event that occurs at that specific location again. For the purpose of the Edina project the quarter-mile by quarter-mile block was selected as the convenient geographic unit with which to work.

For the study, the assumption was made that what occurred during the past year is a good prediction of what will occur during the coming year. Thus, the figures for the previous year concerning requests for police were considered as representing the distribution and number of events that would occur during the next year on each of the three shifts.

PROJECT GOALS

The ever increasing crime rate on the local, state, and national levels, points up the need for an increased effectiveness of police departments. An obvious method to increase a police department's effectiveness is to increase the number of policemen, but available funds are seldom sufficient to provide the staff necessary to stabilize or reduce the crime rate. The alternative is to increase the efficiency of the existing staff.

Application of the most modern scientific techniques is necessary to maximize efficiency of police departments. Scientific methods have been and are being developed for many aspects of police work. One area of police activity that, until recently, has received little in the way of scientific attention is the dispatching and patrolling of police cars. If modern statistical techniques and probability theory can be applied accurately to police patrols, the effectiveness of the patrolmen will be increased with no increase in police department size.

The goal of this research program was to increase the effectiveness of the Edina Police force through the use of scientific techniques in selecting police car patrol assignments. It was proposed to use data processing techniques to categorize previous requests for police (with appropriate updating for new residential, industrial, and road construction), and to develop a series of patrol areas, covering the entire Village, that were equal in "crime potential". Equal in "crime potential" means that, based on history of request for police and updating factors, the probability of a police car being needed in any of the patrol areas at any given time is the same. If the patrol areas are then assigned to cars on a purely random basis, probability theory predicts that patrol cars will be closer to the point of need when they are requested than under any other system of patrol assignment. Thus, the specific goal of the research program was to develop a system of random patrol that would reduce the time required for a police officer to respond to a call (response time).

Studies by the Federal Bureau of Investigation have shown that as response time goes down, the clearance rate goes up. The figures show that police solve two-thirds of the crimes that they respond to within two minutes; the same study shows that less than one crime in five is solved when the response time is five minutes or longer.

Additional benefits of reduced response time are the crime deterrent effect, the better public relations, and possible saving of lives. Crime deterrent effect refers to a criminal's greater reluctance to commit a crime when he knows that the police response will be rapid, thereby increasing the criminal's likelihood of arrest. Better public relations are promoted through reduced response time by instilling in the residents the feeling that police assistance is always close at hand. The life saving benefit of reduced response time refers to rapid emergency medical treatment for victims of medical emergencies or victims of traffic accidents.

The research program was divided into three phases: a study phase, an experimental phase, and an evaluation phase. The goal of Phase I, the study phase, was to develop a system for division of the community into a patrol area of equal crime potential and to develop a random system of patrol area selection. The goal of the second or experimental phase was a full-scale trial of the random patrol concept. In the final or evaluation phase, the goal was to compare the results of a control group and the random patrol group. The primary parameter of comparison was response time.

Another overall goal of the project was to produce a model patrolling technique suitable for continued use by the Edina Police Department, and, at the same time a technique that would be general enough to be used by police departments across the country.

PROJECT DESCRIPTION

In simple terms, the concept of random patrol used in this project was to divide the community into police patrol areas unequal in size but equal in the probability that a crime or a request for service will occur at any given time, and then to select the police patrol assignment in a random manner. If the police patrol areas are truly equal in crime potential and patrol assignments are made on a truly random basis, the laws of probability predict that the effectiveness of the patrol officer will be maximized, making the technique better than any other dispatching method.

The most complex aspect of the concept is determination of patrol areas that are truly equal in crime potential. Crime potential is not a static parameter; it varies with the hour of the day, day of the week, month and season of the year, weather conditions, and with the physical changes in a community (residential, commercial, and road construction). One practical method to determine crime potential, and the technique used in this project, is to analyze the police reports of past years and classify each report regarding location, time, date, and then to weigh each call on its seriousness. The reports should be evaluated for monthly or yearly trends, and changes in the community should be introduced into the classification system in some manner. Because of the many variables and the quantity of data, the task of determining areas of crime potential is staggering; without the use of modern data processing techniques it would be impossible.

A digital computer program was developed to evaluate the vast amount of data and to provide the capability of continued updating to handle trends and changes in the system. Appendix A contains a complete technical discussion of the computer program. The computer provided the information necessary to develop a series of patrol areas that were equal in crime potential for a given period of time. The time period selected for this project was eight hours; each shift had a separate map of patrol areas. Digital techniques also provided the simplest method of generating the series of random numbers which served as the random patrol assignments. Appendix B contains a complete technical discussion of the random number generation program. Combining the random patrol assignment with the patrol areas of equal crime potential resulted in an optimized dispatch system.

The procedure for establishing areas of equal crime potential was as follows: The 9,608 reports of Edina Police Officers for the period of January 1, 1967, to January 1, 1968, were tabulated on the basis of:

1. Complaint number
2. Nature of the complaint (coded according to Appendix C)
3. Month of the year (1=January; 2=February, etc.)
4. Day of the week (1=Monday; 2=Tuesday, etc.)
5. Day of the month
6. Time the call was received (24 hour clock, hour and minute)
7. Time the officer arrived (same as above)
8. Time the officer cleared (same as above)
9. Location coordinate number (coordinates from map)
10. Precipitation (1=Dry; 2=Rain; 3=Sleet; 4=Snow)
11. Temperature (1=101–110°F; 2=91–100°F; 3=81–90°F, etc.)

Figure 2 is a typical page of tabulated data. Item 9, the coordinate number, shows the location of the incident. The Village was divided into areas one quarter mile square, or "blocks". As shown in Figure 3, each block was assigned an X and Y coordinate number. An incident occurring anywhere in the block was given the coordinate number of that block.

The information was transcribed onto punch cards for analysis by the digital computer. It was decided to evaluate the data for each of the three

Complaint Number	Month 1 — 12	Day of Week 1 — 7 Monday is 1	Day of Month 1-31	Call Time 0001–2400	Arrival Time	Clearance Time	Nature of Complaint 1–200	Coordinate	Prec. Cond.	Temp. Cond.
1902	4	3	2	0524	0526	0531	4	15–6	1	8
1903	4	3	2	0644	0651	0704	125	16–9	1	8
1904	4	3	2	0808	0813	0833	3	8–15	1	8
1905	4	3	2	0819	0821	0831	144	16–9	1	8
1906	4	3	2	0830	0835	0848	140	16–10	1	8
1907	4	3	2	0837	0839	0840	144	16–10	1	8
1908	4	3	2	0952	0956	1014	33	13–1	1	8
1909	4	3	2	0932	0939	0959	144	10–7	1	8
1910	4	3	2	1010	1019	1027	33	13–4	1	8
1911	4	3	2	1018	1018	1030	20	13–7	1	8
1912	4	3	2	1100	–	1110	84	16–9	1	8
1913	4	3	2	1115	1117	1136	3	15–8	1	8
1914	4	3	2	1258	1307	1319	35	8–16	1	8
1915	4	3	2	1259	1300	1311	39	16–8	1	8
1916	4	3	2	1313	1315	1332	144	10–13	1	8

FIGURE 2.—Typical page of tabulated data.

shifts that the officers worked: (1) 7 a.m.–3 p.m., (2) 3 p.m.–11 p.m., (3) 11 p.m.–7 a.m.

The Control Data Corporation Model 6600 digital computer of University of Minnesota Computation Center was programmed to provide the percentage of total number of requests for service per quarter mile block per shift. Figure 4 is the computer printout showing the percentage of calls for the year that occurred in each of the blocks on the second shift. Printouts also were made for the other two shifts. The blocks that show zero percentage either had no calls (Coordinate 2,2 for example) or were located outside the Village of Edina limits (Coordinate 2,18 for example). The information was then transcribed onto the coordinate map of the Village (see Figure 5). The Village was then divided into four patrol zones, and each zone subdivided into subzones. The subzones were selected (consistent with natural barriers, boundaries, etc.) to be equal in crime potential; that is, quarter-mile blocks were added together geographically, to form larger areas (subzones) each having the same probability of originating a request for service. Figures 6, 7, and 8 are the maps showing the areas of equal crime potential for each of the three shifts. (Actual maps used in the project were 16″x20″ in size.) The large number in each block identifies the block; the small number is the percentage of total calls for the year that were received in that block. Because some areas with a high percentage of calls cannot be conveniently subdivided, two or more identifying subzone numbers are assigned to the subzone: on Figure 7, subzones 6, 7, and 8 in zone 2, for example. Thus, each identifying subzone number represents an area of equal crime potential; assignment of two numbers to an area shows that the crime potential in that area is approximately double that of an area assigned only one identifying number.

Assignment of the patrol zones was to be completely at random, and the digital computer was also programmed to provide a series of random numbers using only the numbers 1–15.

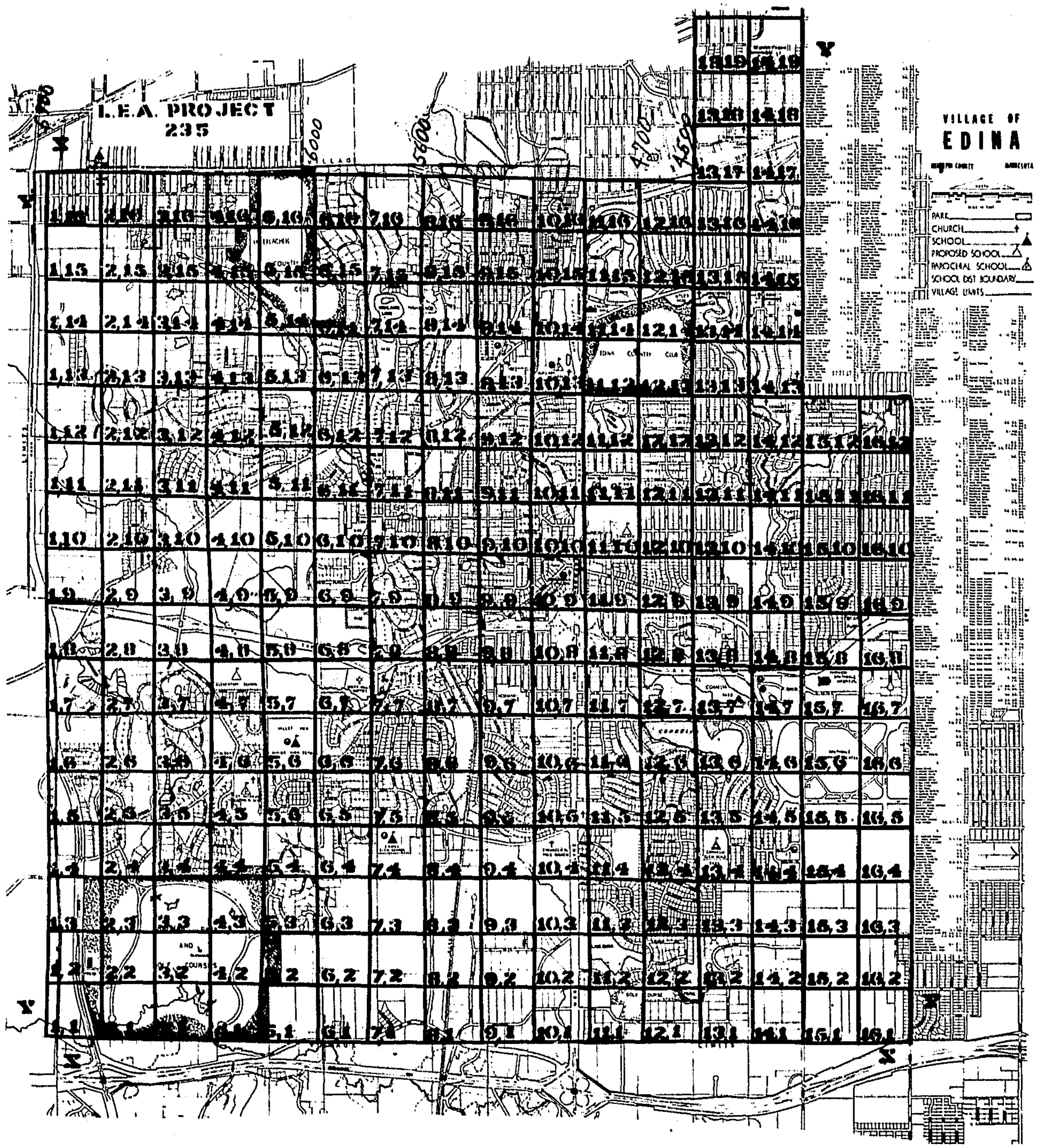

FIGURE 3.—Coordinate map of Edina.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.229	.208	0.000	0.000
18	.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.385	.364	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.312	.978	0.000	0.000
16	1.010	.406	.323	.062	0.000	.125	.010	.062	.448	.427	.156	.708	.583	.375	0.000	0.000
15	.021	.010	.114	.114	.052	.062	.094	.198	.125	.396	.198	.219	.229	1.114	0.000	0.000
14	.094	.010	.073	.062	.031	.042	.052	.135	.583	.666	.291	.239	.146	.812	0.000	0.000
13	.021	.021	.031	.052	.042	.114	.125	.062	.219	.167	0.000	0.000	.239	.302	0.000	0.000
12	.031	.177	.094	.198	.239	.125	.271	.260	.135	.510	.177	.219	.333	.156	.271	.448
11	0.000	0.000	.146	.104	.156	.083	.208	.114	.219	.198	.677	.354	.146	.291	.291	.323
10	0.000	.031	.021	.010	.010	.073	.167	.250	.156	.385	.125	.219	.167	.114	.239	.343
9	.083	.052	.031	.010	.021	.146	.114	.271	.271	.229	.167	.250	.323	.125	.312	.260
8	.219	0.000	.073	0.000	0.000	.031	.198	.125	.271	.208	.094	.187	.104	.208	.271	.531
7	.010	.031	.104	.114	0.000	.010	.083	.052	.354	.385	.073	.052	.291	.198	.614	.427
6	.052	.052	.062	.042	.167	.177	.260	.062	.229	.167	.198	.187	.167	.208	4.465	.354
5	.052	.073	.031	.135	.125	.125	.167	.083	.177	.114	.208	.187	.375	.333	.978	.291
4	.104	.021	.010	.010	.114	.094	.042	.291	.073	.208	.114	.208	.208	.239	.083	.042
3	.021	0.000	0.000	0.000	.021	0.000	0.000	.021	0.000	.021	.135	.167	.177	.031	.062	.062
2	.239	0.000	.156	0.000	0.000	.010	.010	.010	.052	.073	.062	.114	.177	.031	.083	.114
1	.042	0.000	0.000	.010	.010	0.000	.010	.083	.062	.250	.125	.042	.052	.021	.031	.094

FIGURE 4.—Computer print-out showing percentage of total calls that occurred in each quarter mile block on the 3 PM.—11 PM. Shift.

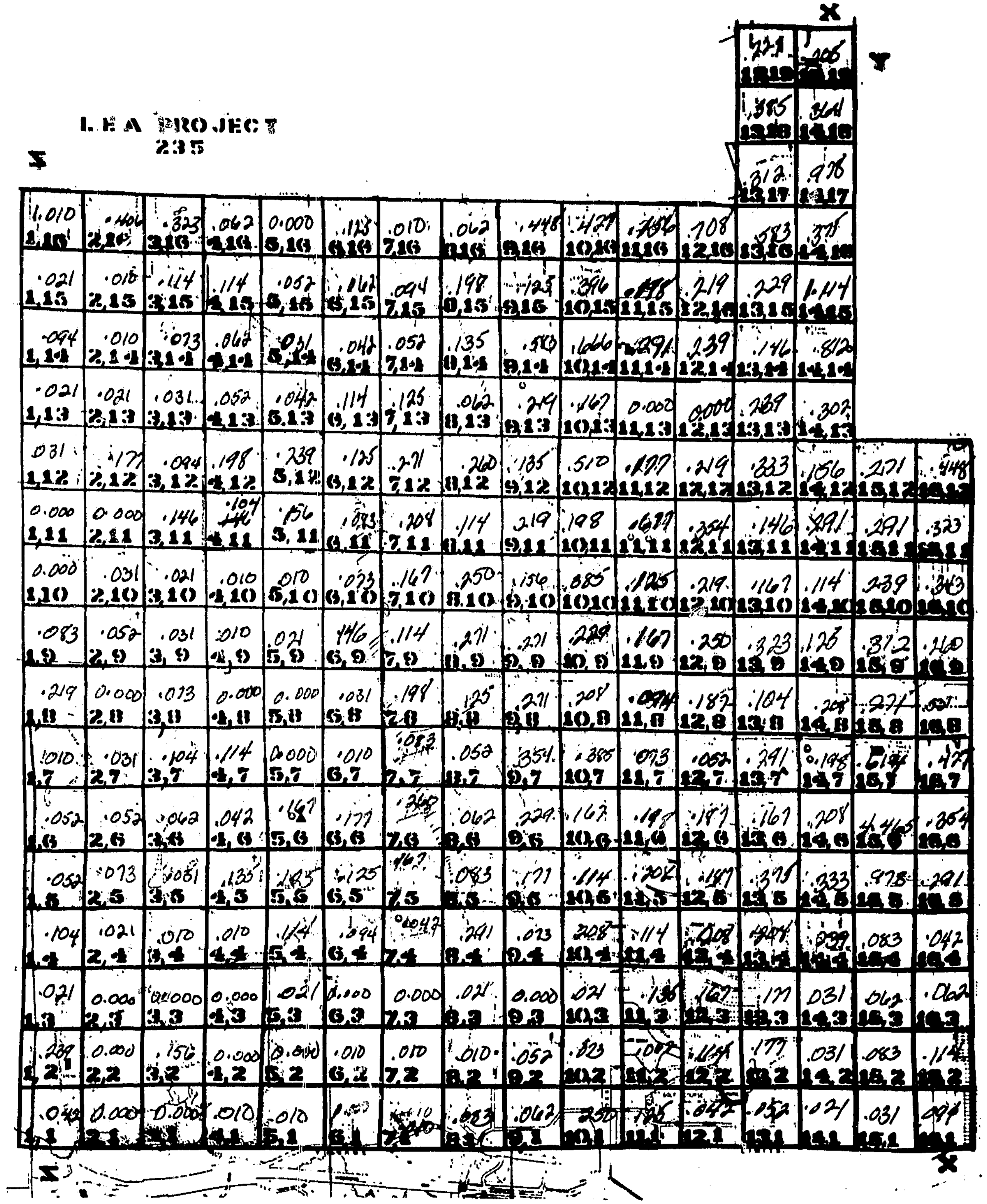

FIGURE 5.–Coordinate map with percentage of total calls per block.

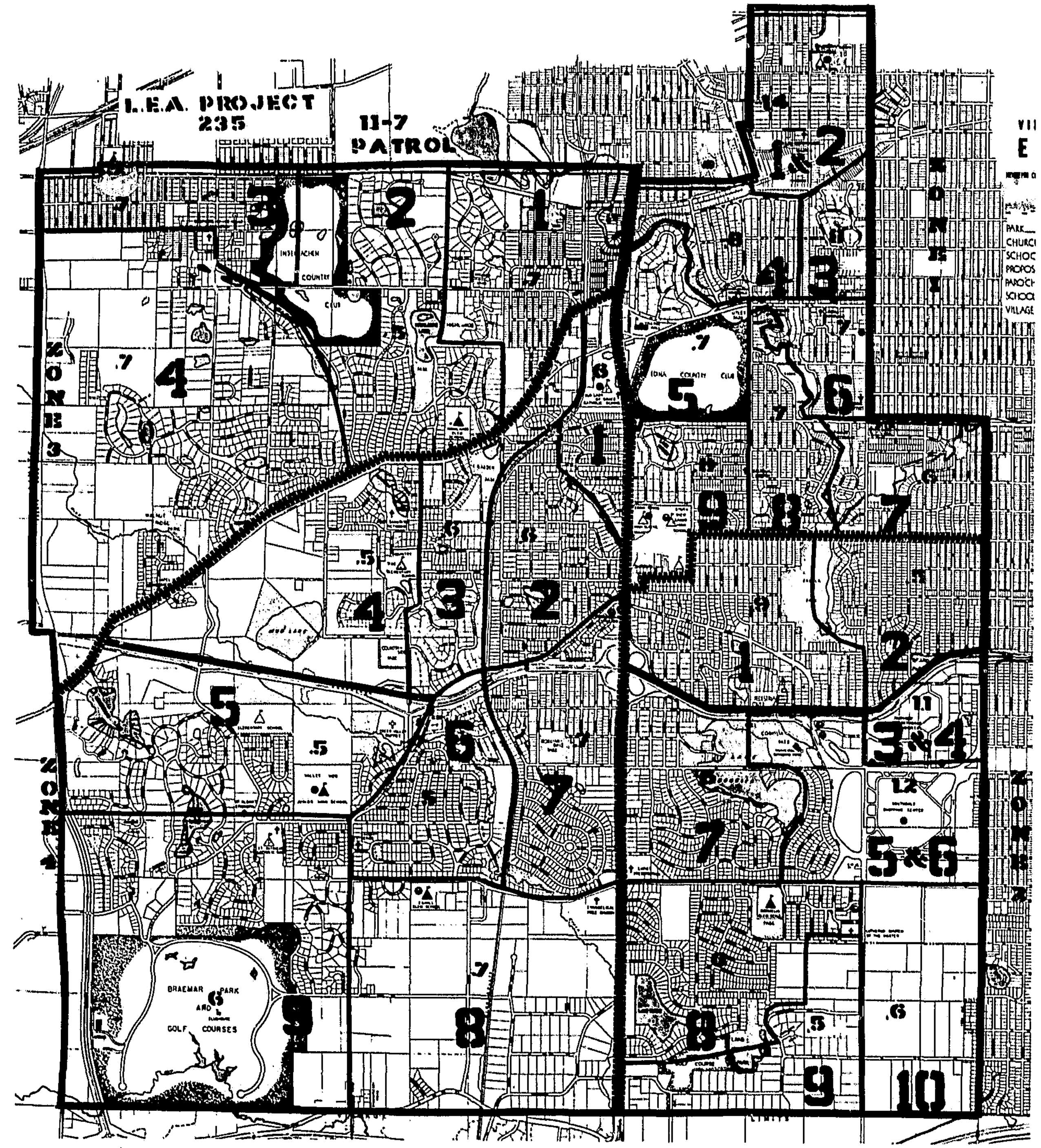

FIGURE 6.–Zone Map 11 p.m.–7 a.m. shift; used April–July 1968.

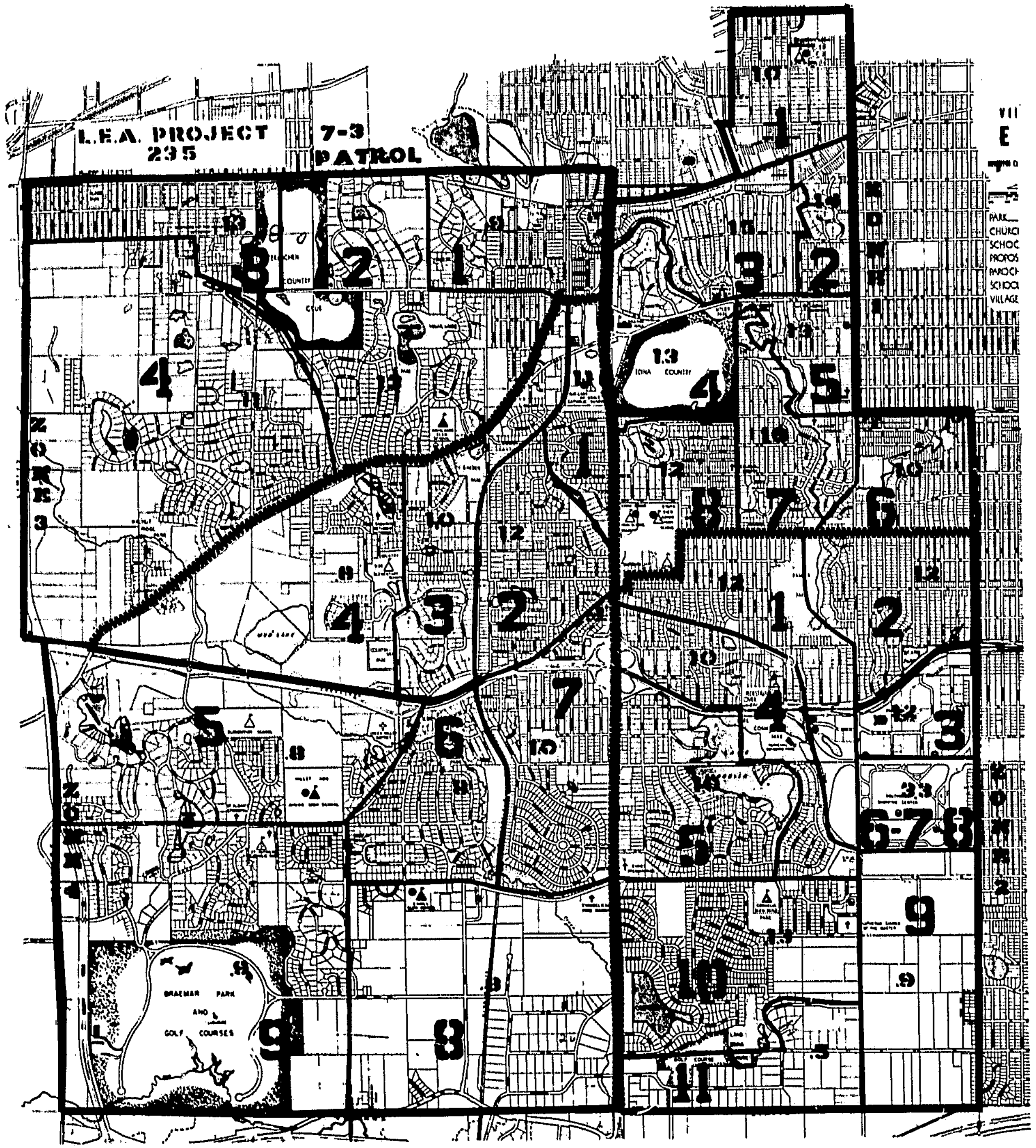

FIGURE 7.—Zone map 7 a.m.—3 p.m. shift; used April—July 1968.

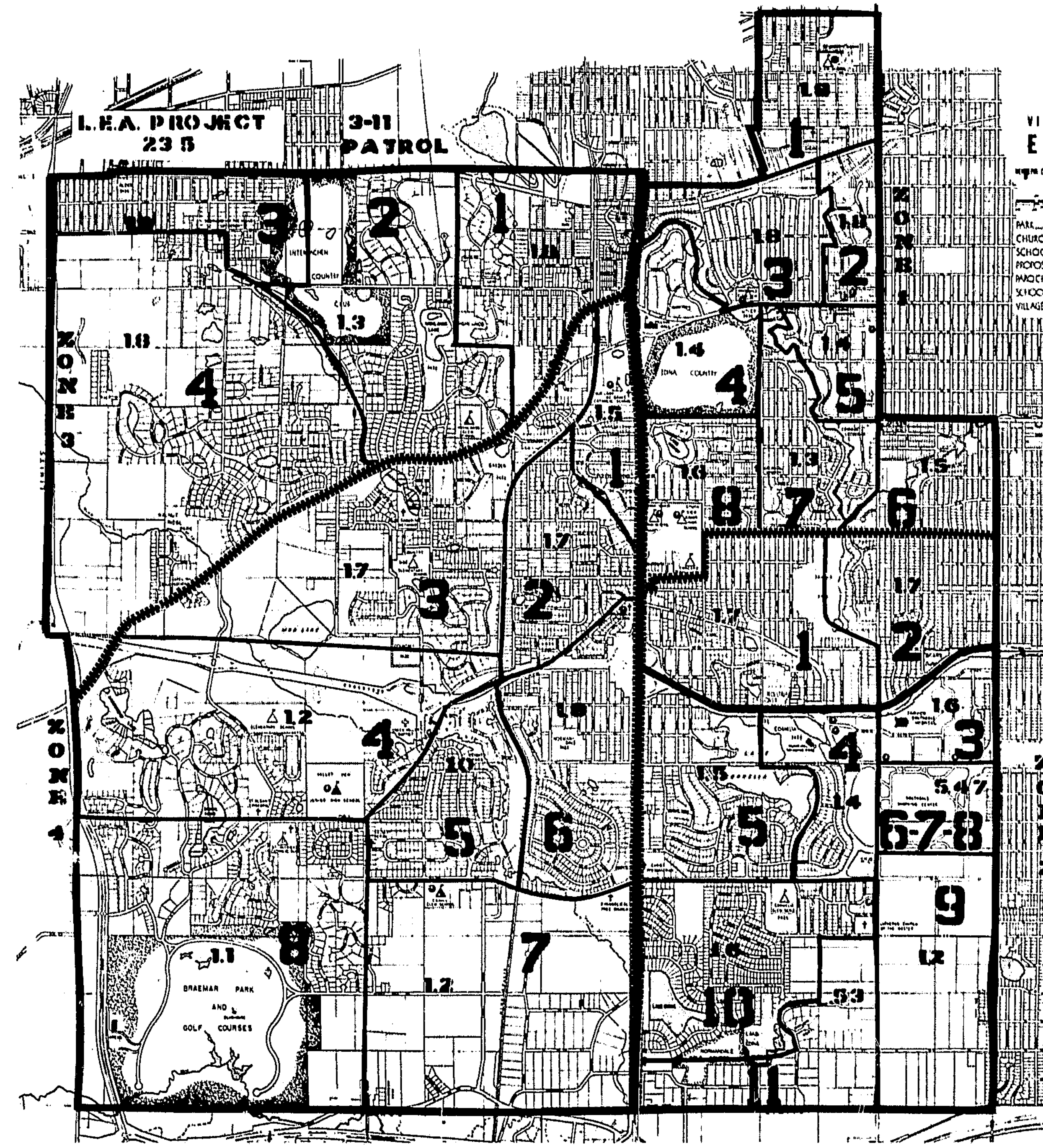

FIGURE 8.—Zone map 3 p.m.—11 p.m. Shift; used April—July 1968.

IMPLEMENTATION

On April 1, 1968, a full-scale field test of the Edina version of random patrol concept was implemented. Guidelines established for the field experimentation included:

1. The entire uniformed police force of the Village of Edina, on all shifts, was involved; all were given zone maps.
2. Two of the four zones were patrolled using the random patrol technique; the other two zones were the control zones and were patrolled in the conventional manner. At the end of each week the random patrol and the control zones were interchanged.
3. At the start of each shift, each officer was given a series of random numbers and patrolled the subzones corresponding to the random numbers in the sequence for a period of 15 minutes. After 15 minutes, he proceeded to the subzone corresponding to the next random number on his list. If he received a call, he responded. When the call was completed, he proceeded to the subzone corresponding to the next random number on his list.
4. The field tests proceeded as outlined above for a period of three months. After a period of three months, changes in the system were considered.
5. Patrol assignments were made so that, if an officer was in a control zone one day, he would be in an experimental zone the next day.

On every call for every patrol officer, the 11 parameters mentioned previously and shown in Figure 2 were recorded. The radio dispatcher stamped each complaint sheet with the complaint number, call time, arrival time, and clearance time. He also noted the location and nature of the complaint on each sheet for later conversion into the numerical designation for location and nature of complaint. The information on temperature was added later from the U. S. Weather Bureau records.

VARIATIONS

The length of the experimental portion of the project (12 months) permitted several variations on the random patrol concept outlined above to be tried. Therefore, the experimental portion of the project was divided into four three-month periods, and four slightly different approaches to random patrol were tried.

For Period 2, July 1, 1968, to October 1, 1968, the experimental operation was changed to include a weighting factor to take into account the seriousness of the call. The various complaints were weighted with a value between two and twenty as shown in Appendix C. After the weighting factors were applied to each complaint, the areas of equal crime potential were drawn up in the manner described previously. The resulting maps of equal crime potential zones for the three shifts are shown in Figures 9, 10, and 11. The primary difference between the second period maps using weighting functions and the maps used in the previous quarter without weighting function is that areas where there is a predominance of serious calls (auto accidents, burglaries, medical emergencies, etc.) would get more coverage under the new system. The revised experimental approach of Period 2 used the same method of operation as in the previous period. During experimental Period 3, October 1, 1968, to January 1, 1969, the experimental operation was modified, and new maps were drawn (see Figures 12, 13, and 14). The maps are the result of an evaluation of all request for service for October 1, 1966, to July 1, 1968,—a total of 13,847 calls. This represents an updating of the information by adding data for six additional months. The additional data show trends that show up on the map as subzones of smaller or larger areas—smaller, if the trend has been toward more requests for service (compared to the entire Village) and larger subzones if the trend has been toward fewer requests for service. No other changes were made in the method of drawing up the maps.

The other change in the field operation for Period 3 was that all officers were provided with a complete list of quantity and type of calls in each of the subzones for each shift. The Control Data Corporation Model 6600 digital computer was programmed to provide the number and type of request for service for each of the quarter-mile square blocks, and the data for each subzone was compiled from the quarter-mile data. The list (see Figure 15) shows the types of calls the officer can expect, enabling him to patrol more effectively. No other changes in the field operation in Period 3 were made.

The changes in the fourth period of the experimental portion of the project, January 1, 1969, to April 1, 1969, permitted a determination of the effect that additional manpower has on response time. Additional men and vehicles were provided so that, on the busiest shift (3 p.m.—11 p.m.), a six patrol zone structure could be used. The addition of two zones meant that each officer had a smaller area to patrol and because he should theoretically be closer to the point of need, response time should be reduced. No other changes were made on the method of patrol described previously. The zone map for the 11 p.m.—7 a.m. shift and the 7 a.m.—3 p.m. shift were unchanged from Period 3; the six-zone 3 p.m.—11 p.m. shift map is shown on Figure 16.

On April 1, 1969, the experimental portion formally ended and the analysis phase began. However, because of an obvious reduction in response time during the project, it was decided to continue with the project informally in the following manner: during the period April, 1969, through June, 1969, the entire Village was patrolled using the random control concept, that is, no control zones were used. All other conditions remained the same. During the period July, 1969, through September, 1969, random patrol was not used. This informal continuation of the experimental portion of the project was to determine if the response time could be low-

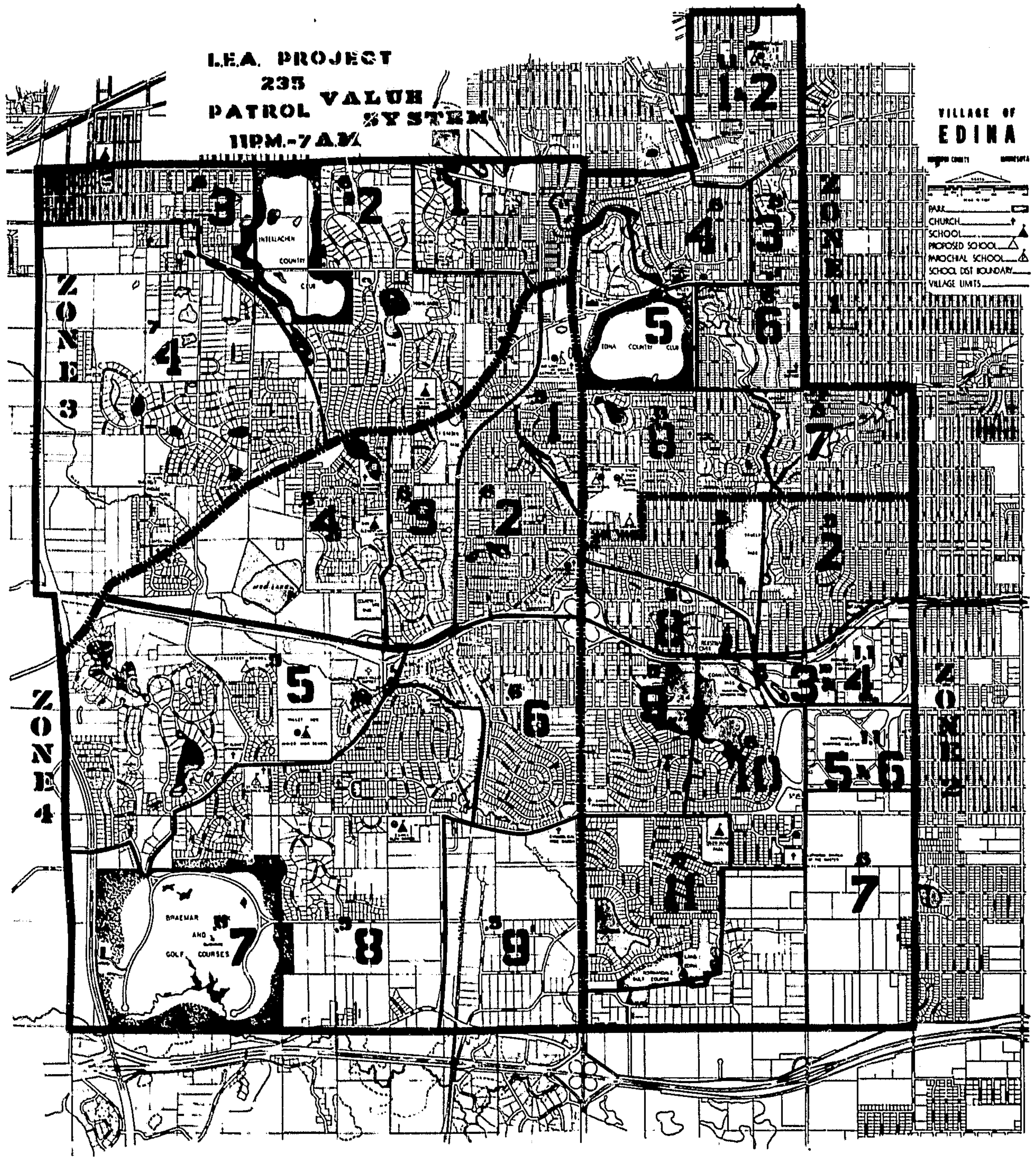

FIGURE 9.—Zone map 11 p.m.—7 a.m. Shift; used July—October 1968.

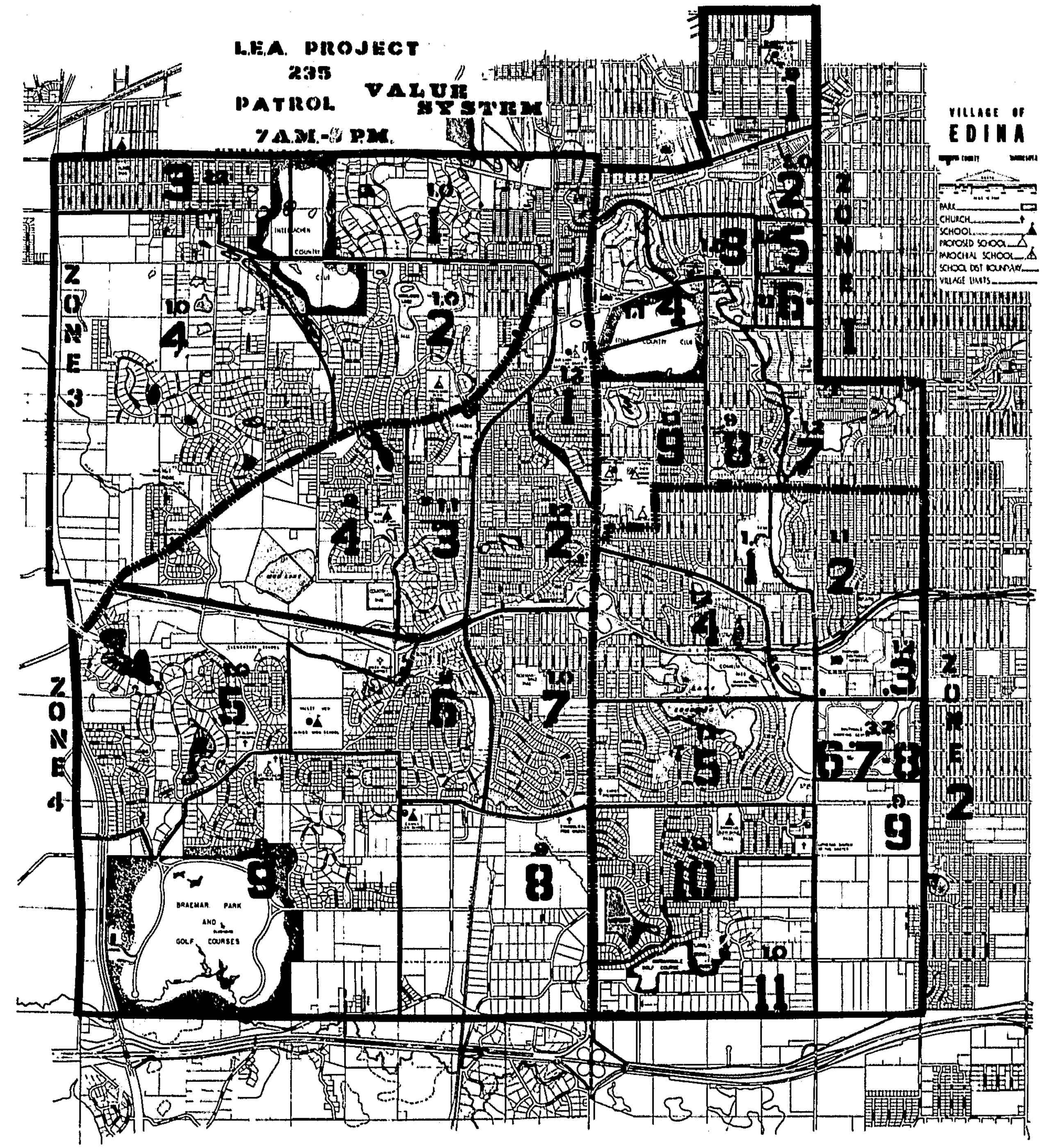

FIGURE 10.—Zone map 7 a.m.—3 p.m. shift; used July—October 1968.

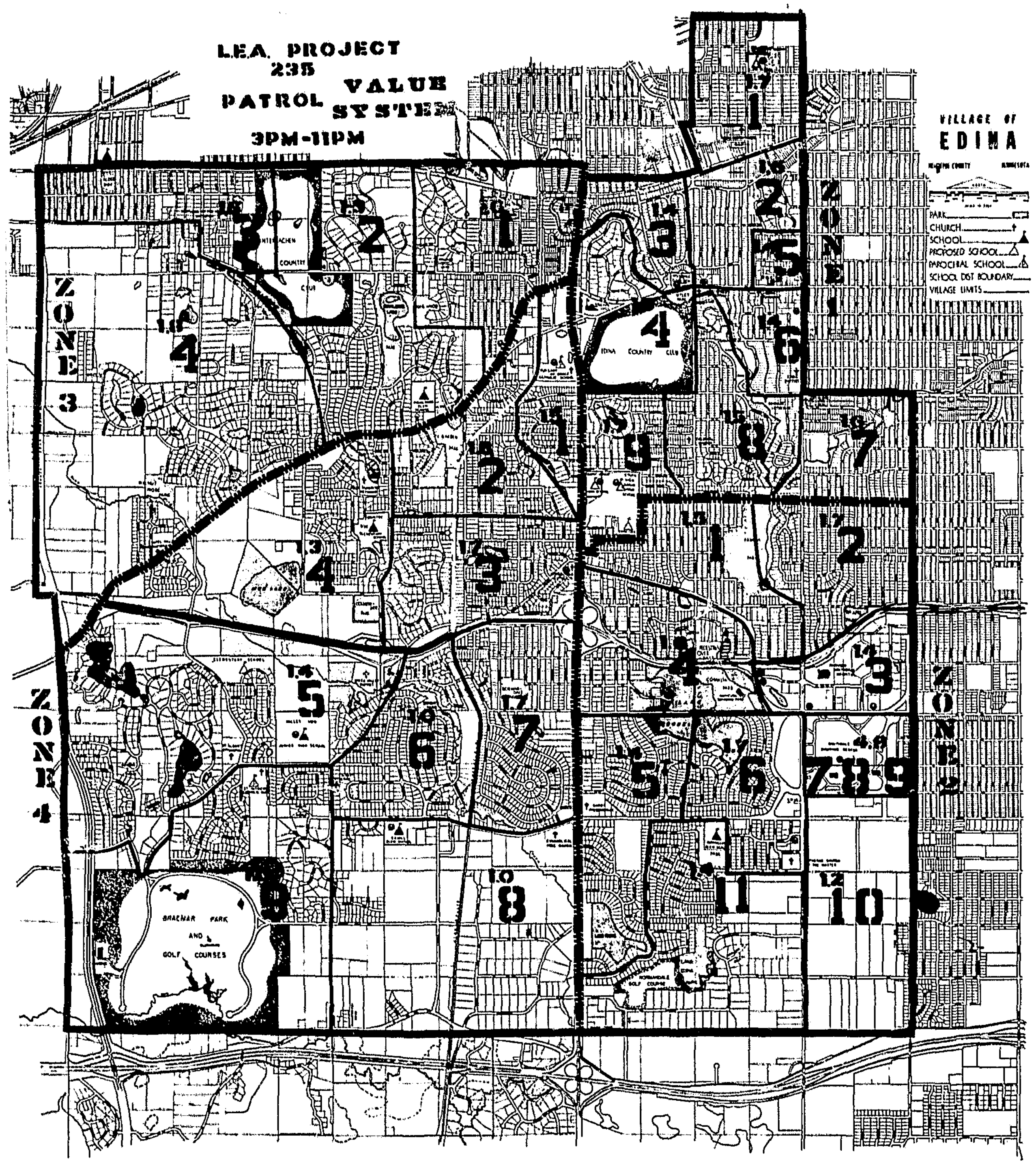

FIGURE 11.—Zone map 3 p.m.—11 p.m. Shift; used July—October 1968.

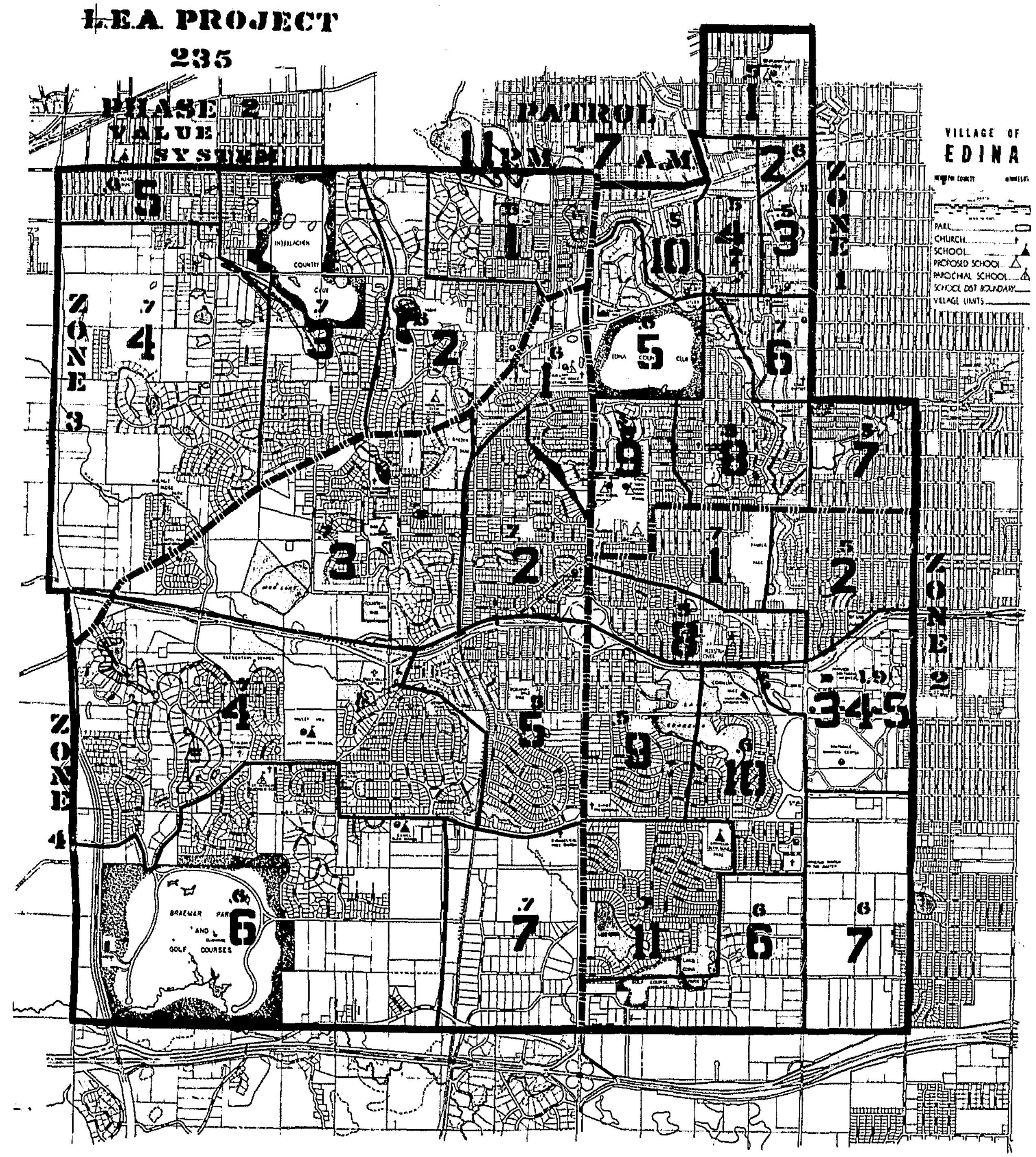

FIGURE 12.—Zone map 11 p.m.—7 a.m. shift; used October 1968—April 1969.

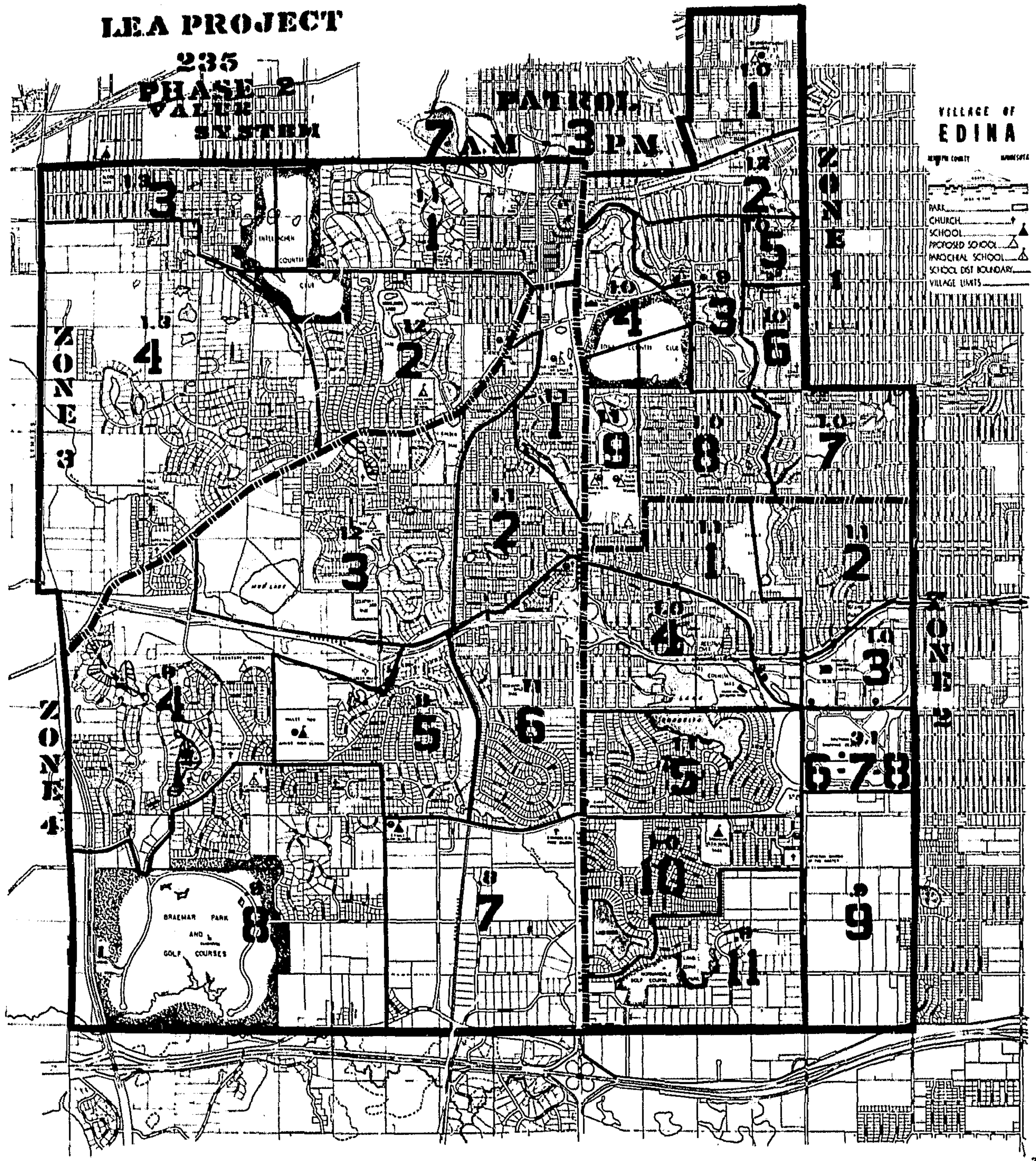

FIGURE 13.—Zone map 7 a.m.—3 p.m.; used October 1968—April 1969.

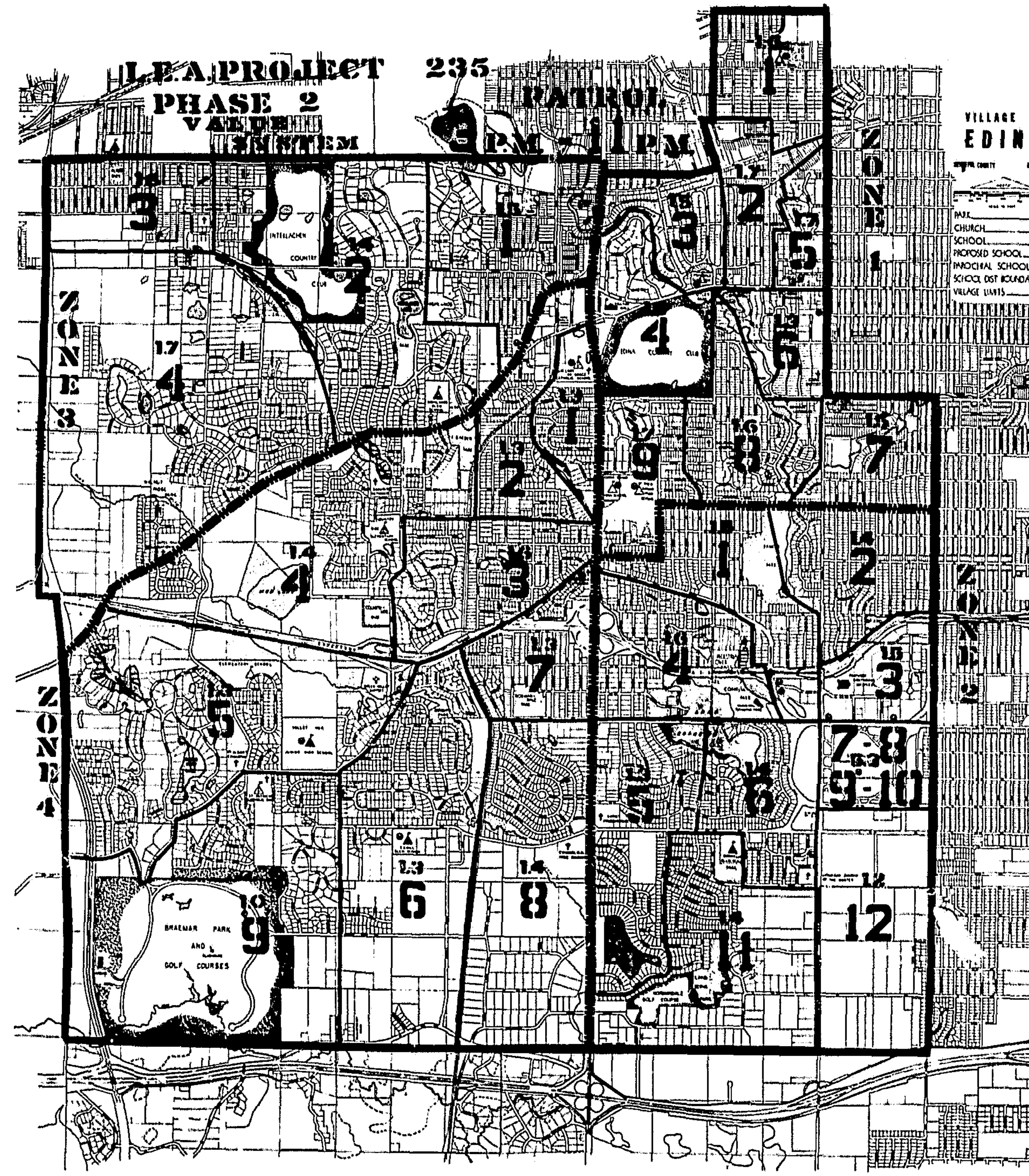

FIGURE 14.—Zone map 3 p.m.—11 p.m. shift; used October 1968—January 1969.

LEA Project 235
Requests for services and Incidents Report — Edina Police Department
Period covered: October 1966 to July 1968
Shift: 7–3
ZONE 1

Sub Zone 1

Fires	9
Animal calls	7
Vandalism	6
Med. emer	6
Kid calls	6
Accidents	4
Thefts	4
Burglaries	4
Domestics	3
Susp. car, open door, assist, lockout, missing person, prowler, assult	1

Sub Zone 2

Fires	16
Thefts	16
Accidents	13
Med. emer	12
Bike theft	12
Burglaries	10
Animal calls	9
Vandalism	8
Kid calls	7
Assist	6
Prowler	6
Susp. persons	5
Alarms	3
Missing person	3
Domestic, auto theft, robbery	1

Sub Zone 3

Accidents	14
Bike thefts	7
Thefts	6
Animal calls	5
Kid calls	5
Med. emer	4
Fires	4
Burglaries	3
Vandalism	2
Susp. car, susp. person, missing person, drunk	1

Sub Zone 4

Bike thefts	10
Accidents	6
Fires	5
Vandalism	4
Med. emer	3
Thefts	3
Assists	3
Auto thefts	2
Animal calls, Kid calls	1

Sub Zone 5

Accidents	28
Thefts	12
Alarms	9
Bike thefts	5
Fires	4
Animal calls	3
Kid calls	3
Med. emer	3
Susp. persons	3
Burglary	2
Robbery, domestic, Missing person, Vandalism	1

Sub Zone 6

Accidents	32
Alarms	13
Thefts	8
Assists	7
Vandalism	6
Burglaries	6
Med. emer	4
Fires	4
Susp. person	2
Auto theft	2
Bike theft	1

FIGURE 15.—Sample page of List of Events given to all Patrol Officers.

ered even more by having all patrol units use random patrol, and also to determine if response time would rise once the random patrol technique was abandoned. A 75-day project extension was requested and received from the sponsoring agency (The Law Enforcement Assistance Administration) to permit inclusion of the additional data in this report.

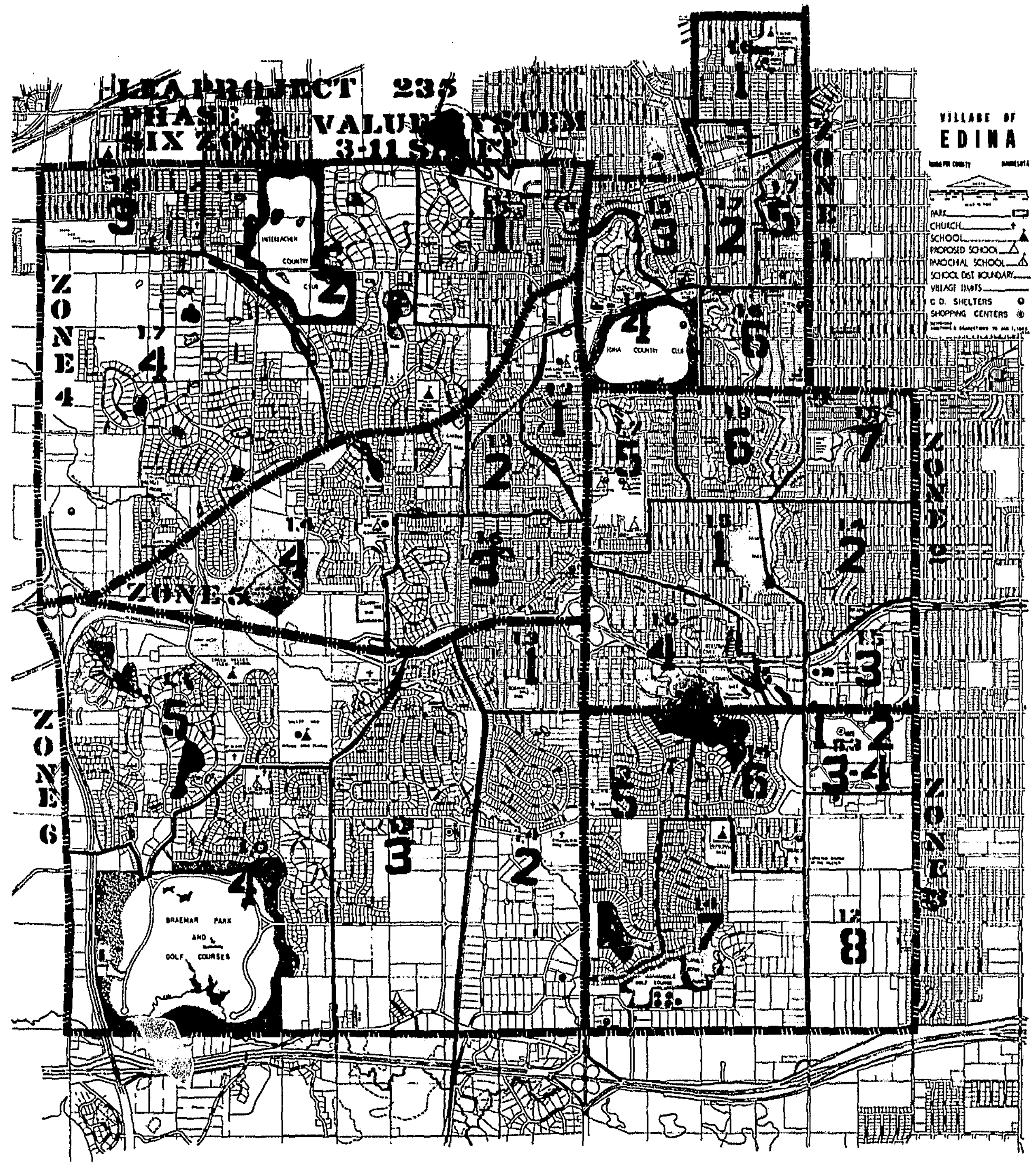

FIGURE 16.—Zone map 3 p.m.–11 p.m. shift; used January–April 1969.

RESULTS

As explained earlier, the response time was the main dependent variable under investigation in the project. Comparing the average response time for the year of the random patrol field test (April 1968—March 1969) with the average response time for the year just prior to the field test (April 1967—March 1968), Table 1 shows that the average response time decreased by 40 percent from 7.05 minutes to 4.22 minutes. Comparing the number of calls during the experimental year (8,097) and the number of calls in the previous year (6,522), the 40 percent decrease in response time was achieved despite a 19 percent increase in requests for service.

TABLE 1.—*Data Summary—Response time versus number of calls*
APRIL 1967—SEPTEMBER 1969

Year	Month	Number Police Calls	Average response time—(min.)
1967	Apr	356	6.99
1968	Apr	762	4.32
1969	Apr	697	3.70
1967	May	386	7.45
1968	May	672	4.73
1969	May	656	3.77
1967	Jun	628	7.43
1968	Jun	928	5.01
1969	Jun	840	3.75
1967	Jul	593	7.73
1968	Jul	958	4.65
1969	Jul	821	3.93
1967	Aug	612	8.6
1968	Aug	867	4.08
1969	Aug	817	4.17
1967	Sep	554	8.11
1968	Sep	731	4.25
1969	Sep	673	3.98
1967	Oct	642	6.71
1968	Oct	662	4.30
1967	Nov	667	6.73
1968	Nov	627	3.80
1967	Dec	553	6.02
1968	Dec	632	4.16
1968	Jan	468	6.14
1969	Jan	651	3.95
1968	Feb	399	6.23
1969	Feb	664	3.84
1968	Mar	684	6.44
1969	Mar	607	3.69

Average response time—April 1967-March 1968 = 7.05 minutes
Average response time—April 1968-March 1969 = 4.22 minutes
Average response time—April 1969-Sept. 1969 = 3.88 minutes

Although the average response time did not decrease for each month of the project—slight monthly rises are apparent from Table 1—examination of the change in response time per calendar quarter (Table 2) is revealing. The quarterly results are shown in Figure 17. Note that for the first two quarters (April—September, 1967) the average response time is 7.29 minutes and 8.12 minutes. During these two quarters, no part of the project had been initiated. During the next two quarters, (October, 1967—March, 1968) in which the response time dropped to 6.45 minutes and 5.94 minutes, the planning phase of the project was in progress. During this period, meetings were held with the patrol officers to discuss the project and to point out the importance of response time. For the next four quarters (April, 1968—March, 1969) field tests of the random patrol concept were in progress, and the response time dropped successively from 4.68 minutes to 4.33 minutes to 4.08 minutes to 3.82 minutes. Because of the improved response to calls during the field test period, it was decided to use random patrol at all times in all zones for one quarter (April—June, 1969). The average response time decreased further to 3.74 minutes in this period. During the final quarter of the project (July—September, 1969), it was decided to determine the effect of stopping the use of random patrol by having the patrol cars operate as they were prior to the experiment. During this period, the average response time rose for the first time in eight calendar quarters. The increase was from 3.74 to 4.03 minutes, or about eight percent.

TABLE 2.—*Average response times for the ten quarters involved in the Edina project*

Quarter	Number of calls	Average response time (min.)
April 1967 – June 1967	1370	7.29
July 1967 – September 1967	1759	8.12
October 1967 – December 1968	1862	6.45
January 1968 – March 1968	1531	5.94
April 1968 – June 1968	2362	4.68
July 1968 – September 1968	2556	4.33
October 1968 – December 1969	1921	4.08
January 1969 – March 1969	1922	3.82
April 1969 – June 1969	2193	3.74
July 1969 – September 1969	2311	4.03

In Tables 3 and 4, the average response times in the experimental and control zones are given for the four quarters and for the 12 months of the field tests. The data obtained after the official field tests were concluded are also given. It is noteworthy that for both the 12-month period and the 18-month period the number of calls and the average response time in the control zones and the experimental zones were nearly identical (average response time in the experi-

TABLE 3.—*Response times for the six experimental quarters of the project for both control and experimental zones*

Quarter	Control Zones		Experimental Zones		Totals	
	Average response time (min.)	Number of calls	Average response time (min.)	Number of calls	Average response time (min.)	Number of calls
APR – JUN 1968	4.64	1157	4.73	1205	4.68	2362
JUL – SEP 1968	4.4	1225	4.26	1331	4.33	2556
OCT – DEC 1969	4.15	1048	4.03	873	4.08	1921
JAN – MAR 1969	3.79	995	3.88	927	3.82	1922
APR – JUN 1969	....	....	3.74	2193	3.74	2193
JUL – SEP 1969	4.03	2311	....	....	4.03	2311

TABLE 4.—*Data Summary—Response time and number of calls for experimental and control zones*
APRIL 1968—SEPTEMBER 1969

Date	Experimental zones		Control zones		Combined control and experimental	
	Number of calls	Average response time (min.)	Number of calls	Average response time (min.)	Number of calls	Average response time (min.)
Apr 1968	396	4.15	366	4.50	762	4.32
May	335	5.04	337	4.41	672	4.73
Jun	474	5.00	454	5.01	928	5.01
Jul	503	4.48	455	4.83	958	4.65
Aug	432	4.04	435	4.12	867	4.08
Sep	396	4.25	335	4.25	731	4.25
Oct	296	4.35	366	4.26	662	4.30
Nov	270	3.82	357	3.79	627	3.80
Dec	307	3.92	325	4.38	632	4.16
Jan 1969	298	3.99	353	3.92	651	3.95
Feb	307	3.92	357	3.80	664	3.84
Mar	322	3.72	285	3.66	607	3.70
Apr	697	3.70	...	....	697	3.70
May	656	3.77	...	....	656	3.77
Jun	840	3.75	...	....	840	3.75
Jul	...	....	821	3.93	821	3.93
Aug	...	....	817	4.17	817	4.17
Sep	...	....	673	3.98	673	3.98
Totals	6529	4.08	6736	4.20	13265	4.14

TABLE 5.—*Response time and number of calls for the three shifts*

Shift	YEAR 1		YEAR 2 — APRIL 1968 — MARCH 1969					
	April 1967 — March 1968		Control zones		Experimental zones		Control and Experimental zones	
	Response time (min.)	Number of calls	Response time (min.)	Number of calls	Response time (min.)	Number of calls	Response time (min.)	Number of calls
11 p.m. - 7 a.m.	6.111	1194	3.439	833	3.462	829	3.451	1662
7 a.m. - 3 p.m.	7.666	1944	5.192	1284	4.950	1300	5.070	2584
3 p.m. - 11 p.m.	6.877	3384	4.132	1951	4.210	1900	4.171	3851
Average response time	7.05		4.25		4.20		4.23	
Total calls		6522		4068		4029		8097

Net change from Year 1 to Year 2:
Number of Calls +19%
Response Time —40%

mental zones was approximately 3 percent lower than in the control zones).

In Tables 5 and 6, average response times and number of calls for the experimental year and for the prior year are given on a per-shift basis. For both years, the percentage of total calls per shift was approximately: 11 p.m.—7 a.m., 20 percent; 7 a.m.—3 p.m., 30 percent; 3 p.m.—11 p.m., 50 percent. The average response time on each shift for the experimental year was approximately 40 percent less than for the corresponding shift of the previous year. The number of calls and the average response times are approximately the same for the experimental and control zones for each of the three shifts.

Table 7 shows the average response time and number of calls for each day of the week of the experimental year and of the prior year. In addition, average response time and number of calls for each day of the week are given for the experimental and control zones. The most noteworthy observation from the data is that the number of calls rises gradually from Monday and reaches a peak on Saturday and then drops sharply on Sunday. Comparing response times for the days of the week between the experimental year and the previous year, the trend mentioned previously continues: average response time for each day of the week during the experimental year is approximately 40 percent less than the average response time for each day of the week during the previous year. There is no applicable difference in average response time for the days of the week when the experimental zones are compared with the control zones during the experimental year.

TABLE 6.—*Percent of total calls per shift*

SHIFT	YEAR 1	YEAR 2
	Percent	Percent
11 p.m. - 7 a.m.	18.3	20.6
7 a.m. - 3 p.m.	29.9	32.0
3 p.m. - 11 p.m.	51.8	47.4

TABLE 7.—*Response times for days of the week*
APRIL 1967–MARCH 1969 (Years 1 and 2)

Day of week	Year 1 Response time (min.)	Year 1 Number of calls	Year 2 Response time (min.)	Year 2 Number of calls
Monday	7.569	916	4.487	1139
Tuesday	6.712	808	4.102	1094
Wednesday	6.870	840	4.232	1064
Thursday	6.840	924	4.314	1159
Friday	7.105	1029	4.315	1213
Saturday	6.781	1202	4.298	1355
Sunday	6.919	804	4.415	1073

Day of week	Year 2 control zones Response time (min.)	Year 2 control zones Number of calls	Year 2 experimental zones Response time (min.)	Year 2 experimental zones Number of calls
Monday	4.546	568	4.429	571
Tuesday	4.260	577	3.926	517
Wednesday	4.179	525	4.284	539
Thursday	4.298	568	4.330	591
Friday	4.628	613	3.995	600
Saturday	4.120	674	4.474	581
Sunday	4.243	543	4.591	530

In Table 8, average response times and number of calls are given for the various slot weights for the experimental year and prior year and for control and experimental zones. Slot weight refers to the weighting system for type of call mentioned in a previous section and is described in detail in Appendix C. As expected, for both the experimental year and the prior year, the average response time is highest for the low priority category (weights 2, 4, and 6) and lowest for the high priority categories (weights 18 and 20). Figure 18 shows that the relationship between slot weight and average response time for the two years have the same general shape and differ only in the magnitude of response time. There is no apparent difference in the relationship between average response time and slot weight in the experimental zones as compared to the control zones. In both cases average response time is highest for low priority slot weights and lowest for highest priority slot weights.

During the quarter January—March 1969, it was decided to determine if additional police patrol manpower could further reduce response time. A six-zone structure was set up on the busiest shift (3–11 p.m.), while the other two shifts retained the four-zone structure. During January—April, 1969, the average response time for all shifts was 3.82 minutes; on the 3–11 p.m. shift the average response time was 3.25 minutes, and on the other two shifts the response time was 4.1 minutes. During the quarter, 46 percent of the calls occurred on the 3–11 p.m. shift, and the remaining 54 percent was split between the other two shifts.

All of the data on which the results mentioned above were based were obtained from the infor-

TABLE 8.—*Response time versus slot weight and number of calls*

Slot weight	Year 1 April 1967 — March 1968 Response time (min.)	Year 1 Number of calls	Slot weight	Year 2 Total April 1968 — March 1969 Response time (min.)	Year 2 Total Number of calls
2	8.135	954	2	4.663	1244
4	7.659	1142	4	4.225	1540
6	8.409	1115	6	4.810	1342
8	6.251	299	8	3.951	448
10	7.086	569	10	4.360	539
12	5.758	33	12	3.929	84
14	6.281	577	14	4.129	574
16	6.194	1178	16	4.404	1506
18	3.713	216	18	3.015	272
20	3.757	399	20	3.371	510

Slot weight	Year 2 Experimental zones Response time (min.)	Year 2 Experimental zones Number of calls	Slot weight	Year 2 Control zones Response time (min.)	Year 2 Control zones Number of calls
2	4.686	612	2	4.641	632
4	4.210	775	4	4.239	765
6	4.896	642	6	4.731	700
8	4.005	214	8	3.902	234
10	4.234	282	10	4.498	257
12	3.872	39	12	3.978	45
14	3.927	301	14	4.352	273
16	4.382	775	16	4.428	731
18	2.883	120	18	3.118	152
20	3.374	254	20	3.367	256

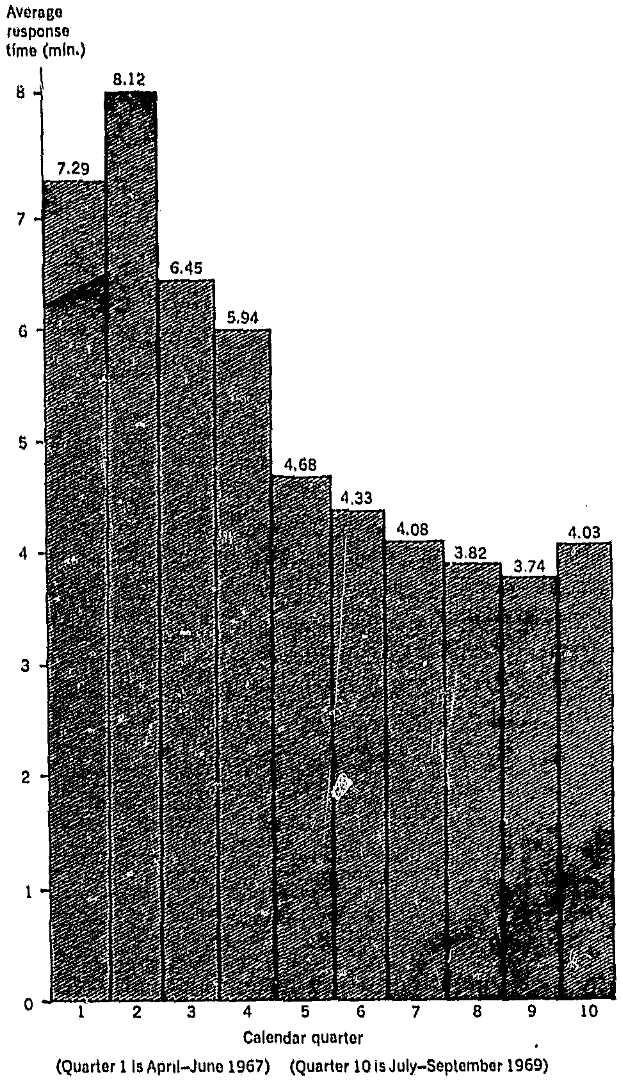

FIGURE 17.—Average response time for the ten calendar quarters involved in the Edina project.

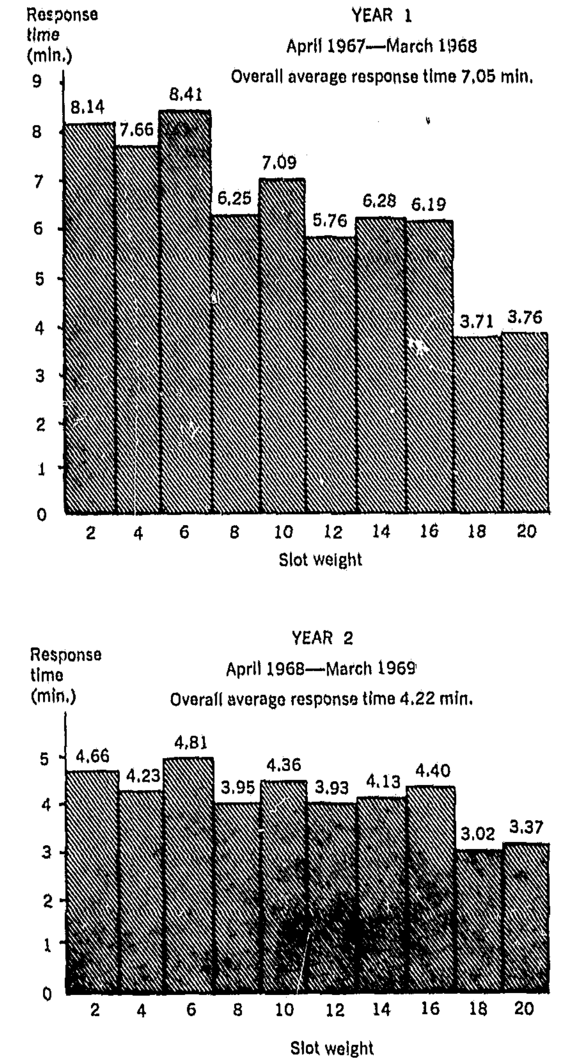

FIGURE 18.—Response time versus slot weight for year 1 and 2.

mation stored in the digital computer memory through the use of the computer program described in Appendix A. Comparisons between the experimental year and the prior year were obtained simply by applying the program between the limits of April, 1968—March, 1969, and the limits April, 1967—March, 1968. During the planning phase of the program, it was decided that an evaluation of the calendar year of data might provide assistance in deployment of police patrol manpower. The calendar year January 1, 1967, to January 1, 1968, was selected for the analysis, and the computer was programmed using those limits. Figures 19, 20, 21, and 22 are the results of the analysis. Figure 19 shows percentage of total annual calls for each month on the three shifts. The graph confirmed what was suspected: the number of calls on all shifts gradually rises to a broad maximum in the summer months and gradually drops to a minimum in the winter time. Figure 20 shows percentage of total weekly calls for each day of the week on each of the three shifts. It too confirms what was suspected: the graph rises gradually from Tuesday to a peak on Saturday with a sharp drop on Sunday. Figure 21, a comparison of a percentage of total daily calls for the various weather conditions for each of the three shifts, shows how rain or snow affected the number of requests for service; 9.6 percent of all calls

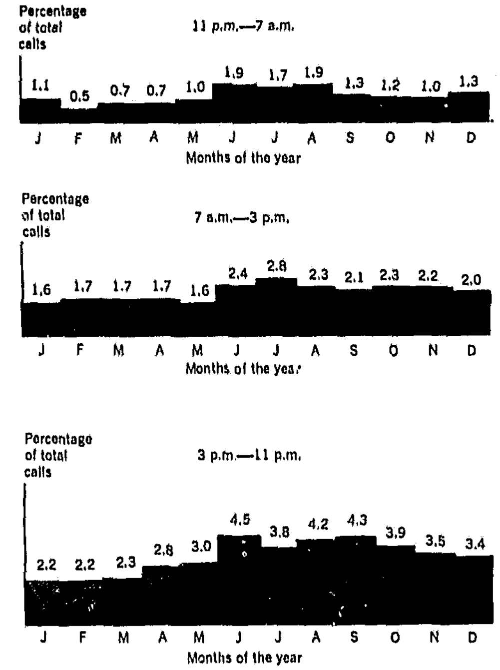

FIGURE 19.—Percentage of total calls versus month of the year for each shift, January—December 1967.

occurred when it was snowing, and 7.5 percent of all calls occurred when it was raining. Even in a year with record snow fall, snow is falling in Edina less than 4 percent of the time. Figure 22 shows the percentage of calls for each temperature range for the three shifts. As expected, the shape of the graph approximates the shape of the temperature distribution curve over the year for Edina, thus confirming the results of Figure 19: almost equal distribution of request for services throughout the year with a slight increase in the summer months.

Response time was the primary dependent variable under investigation in this project. It was hoped that if response time could be reduced there would be a resulting favorable effect on the crime rate. Analysis of the data for the experimental year and the prior year for the Federal Bureau of Investigation Classification of Part I Crimes (categories 29–40 of the listing of Appendix C) shows that for the year April 1967—March 1968, there were 1,100 Part I crimes; for April 1968—March 1969, there were 1,221 Part I crimes. These figures indicate an 11 percent increase in Part I crimes.

Reports from the Minnesota Bureau of Criminal Apprehension for all of Hennepin County (of which Edina is a part) shows that for the period April, 1967—March, 1968, there were 40,283, and for the period April, 1968—March, 1969, there were 47,135 Part I crimes. These figures indicate an increase of 17 percent in Part I crimes for the entire County.

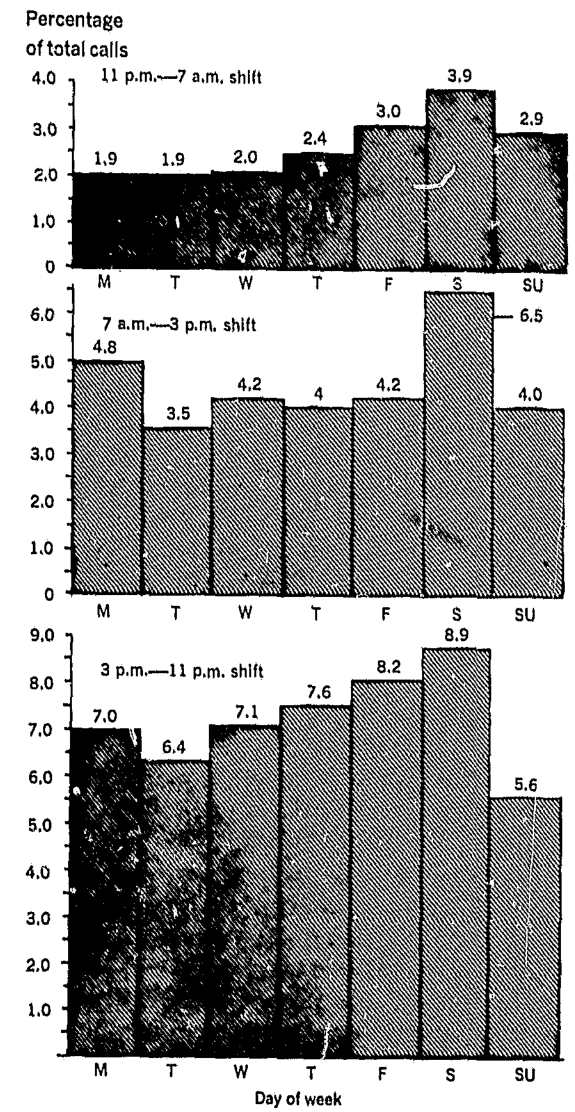

FIGURE 20.—Percentage of the total calls versus day of the week for each shift January—December 1967.

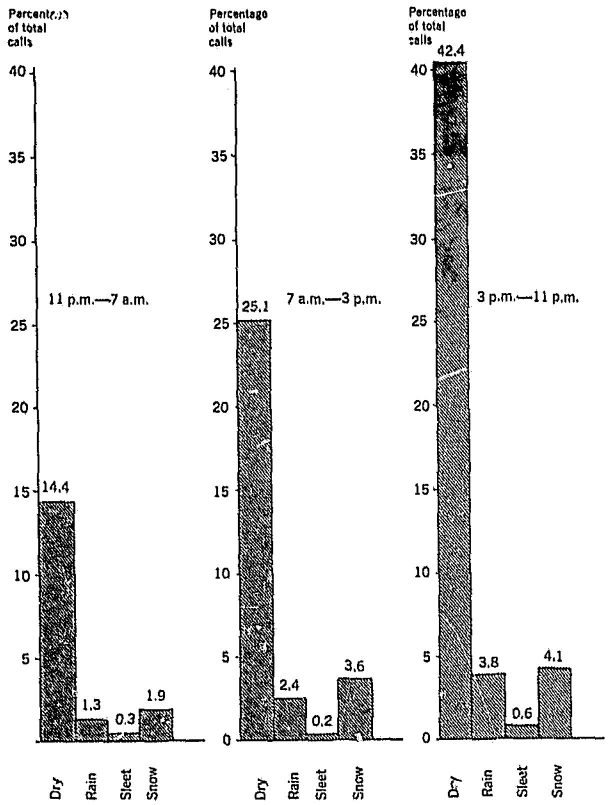

FIGURE 21.—Percentage of total daily calls for the various weather conditions on each shift January—December 1967.

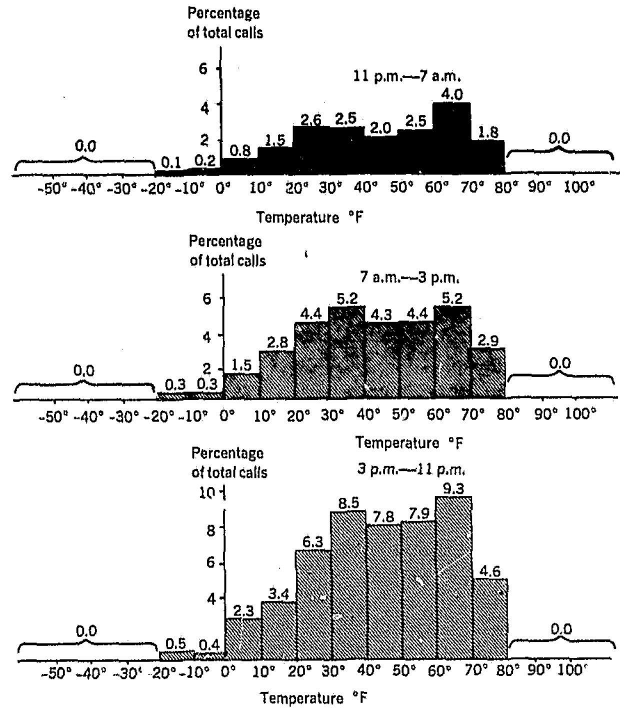

FIGURE 22.—Percentage of calls for each temperature range for the three shifts during the period January—December 1967.

PROGRAM EVALUATION

The primary goal of the project—reduction of average response time—has been realized. During the year-long field tests of random patrol, the average response time decreased 40 percent compared to the previous year. While the project was still in the planning phase, the Edina police officers were introduced to the random patrol concept. Through regular meetings between researchers, police administration, and patrol officers, the value of reduced response time was explained, the project methods and goals were described, and questions and comments from everybody involved were discussed. As a result of the early meetings, average response time started dropping even before the field tests were started.

Once the field tests were initiated, response time continued to decrease. Each calendar quarter, new methods were introduced, and the patrol officers were given more information about where and when the various types of requests for service occurred. And for each calendar quarter throughout the project, response time dropped. When the one year of scheduled field tests was concluded, the favorable results caused the Edina Police Department to continue random patrol for three months over the entire Village, and the average response time continued to drop. Only after the use of random patrol was stopped and routine patrol methods restored did the average response time start to rise. The vast majority of people involved with the random patrol project are convinced that random patrol is better than routine patrolling techniques. It is anticipated that new and improved random patrol techniques will continue to be investigated and tested by the Edina Police Department.

In addition to the actual improved patrolling methods, other benefits were derived from the project. The analysis of previous request for service made possible by the data processing techniques employed in the project provided great assistance in deployment of police patrol manpower. The entire patrol zone structure was changed so that each zone now has approximately the same activity as each other zone. The data analysis showed that about one-half of all request for service occur on one shift (3–11 p.m.) so the manpower on that shift was increased. Weekly and yearly trends were identified. Analysis of the effect that weather conditions have on requests for service showed that the likelihood of a request for service is approximately twice as great in bad weather as in clear weather.

As expected, response time can be decreased by increasing the number of police patrol units in an area. During the quarter when the 3–11 p.m. shift was patrolled with six zones (six patrol vehicles), while the other two shifts used four zones, the average response time was 20 percent lower on the 3–11 p.m. shift even though that shift handled 46 percent of total calls.

Crime rate is influenced by many factors. During the course of the project, the crime rate in Edina rose 11 percent while in the rest of Hennepin County it rose 17 percent. Part of that difference may have been due to random patrol.

Another benefit of the project is that better reporting techniques certainly resulted. More care was taken in ensuring that the correct times were recorded on each incident. By involving the patrol officers in the planning as well as the operations of the project, they realized more fully the importance of reporting techniques.

This involvement of the patrol officers in the project probably accounted for the fact that, although the average response time dropped sharply during the project, there was no corresponding difference in response time between the control zones and experimental zones. The patrol officers freely admitted that when they were operating in a control zone they "were trying to beat the computer", and they admitted that they used every bit of information at their disposal to accomplish that. The random patrol zone map and sheets showing breakdown of call types per zone were available to patrol officers in the control zones, and many apparently used them.

The project was not without its shortcomings. Despite the success of the random patrolling technique, some officers complained that the random assignment of patrol zones prohibited them from using their intuition. They felt that they could do a better job of guessing where requests for service would occur than could a computer.

One real disadvantage of random patrol is that the use of radar speed timing devices by patrol officers under random patrol is difficult. Because the officer spent only 15 minutes in a zone, there was insufficient time to set up and check out the radar set. As a result, the number of arrests through radar speed detection dropped during the project period.

Another difficulty observed is that during extremely busy periods random patrol could not be used as described in this report. When two or more calls occurred in the same zone at the same time, a car from another zone would be sent to the call. It is not known what effect this difficulty had on the overall project results. It did have the obvious effect of raising the average response time. One solution to the problem that was used was to have the sergeant on duty go into any patrol zone where the regular patrol officer was out of service.

Because no data processing equipment is used routinely by the Edina Police Department, the process of getting the data from the officer's reports into the computer memory was a tedious task. The procedure required that someone manually transcribe the data from the complaint sheet onto master sheets and then have the master sheets transcribed onto data punch cards to be read into the computer. Had data processing equipment been available at Edina Police Department, the data could have been transcribed directly from the complaint sheets to punch cards, thus saving one step and a great deal of time.

OVERVIEW BY POLICE ADMINISTRATION

The best commentary on the project by the Edina Police Administration can be obtained by quoting, in part, from a memorandum Wayne W. Bennett, Director of Public Safety for Edina directed to the Edina Police Department and Edina Officials.

The percentage of decrease in response time for each individual month, where three years of data were available, was approximately 40 percent During the year 1967 and the first three months of 1968, the application of the computer techniques was not in effect in the field operations. In the year 1967, the average response time was rather consistently in the seven-minute range. After the start of the project in April 1968, the response time was lowered to the four-minute range for the first six months of the project and gradually decreased to the three-minute range. During the year 1969, the three-minute range was maintained with the exception of one month. It is interesting to note that before the start of the project, we were attempting to achieve an average response time in the three-minute range for emergency calls. But it is indicated by the statistics that the project achieved the low three-minute range average for all requests for service of which only a small percentage are emergency calls.

It should be noted that the project decreased the response time from 1967 to 1969 by 40 percent which is slightly under one-half of the response time that was needed before the project began. Another important point is the consistency of the decline pattern.

It is significant that there was no increase in the number of patrol zones from January 1, 1967, until January 1, 1969, when two more patrol zones were added on the 3–11 shift only. Therefore, perhaps an assumption can be made that the decreases in response time were due principally to the techniques developed in the project. Another factor which may have improved the response time was the bringing into the development of the techniques, all of the police department personnel through department meetings and including all subjects in the development of the techniques, therefore providing an important factor, which is the sense of participation in the development phase.

Another factor was the competition among men that were assigned to the computer zones and the noncomputer zones to see which could respond to calls the fastest, and after having patrol zones under the computer technique, it was found that the officers in the noncomputer zones tended to operate in much the same way as they did when they were in the computerized zone.

I think another factor in the response time may have been the alertness of the dispatchers to put a time as close as possible to the dispatch time and the arrival time by putting the initial complaint in the time stamp device as soon as possible after dispatching the vehicle to the scene and receiving the call from the officer that he had arrived at the scene.

During the months of April 1968, through March of 1969, the project was operated under a technique of placing one-half the police patrol zones under the computer and one-half noncomputer. These zones were then interchanged at assigned intervals. From April 1968 to the end of March 1969, it appears that a somewhat steady decrease in average response time was achieved—with the first six months in the four-minute range and the second six months in three-minute range. During the months of April, May, and June of 1969, all police patrol zones were operated under the computer technique. The response time for the three months was very consistent as indicated by a 3.7 minute response in April, 3.77 minutes in May, and 3.75 in June. During the months of July, August, and September, 1969, all police patrol zones were operated under noncomputer technique, and it is interesting to note that in all three months the response time was greater than it was in the three months of operation under the computer technique. In fact, the month of August 1969, even with the additional two zones (3–11 shift) was higher than August of 1968. September 1969, was, for all intents and purposes, an average of four minutes (3.98), which indicates that, without the computer techniques, we have returned to a 4.05 average response time, which was the response time a year previously, in August 1968. This is true even though the dispatcher does have an awareness of keeping more accurate time and in spite of the fact that the officers are very well aware of the importance of response time. This is significant since it suggests that if the computer technique is not continued, we will soon return to a four-minute, or greater, response time.

According to the statistics for the 15 months of operation under the computer, the average response time was 4.08 minutes. For the 15 months of operation in the zones that were not under the computer, it was an average response time of 4.20 minutes. While the difference here is not significant, it should be noted that during April, May, and June, when all patrol zones were under computer, it was an average of 3.74 minutes, and during the following three-month period—July, August, and September 1969—the average was slightly over four minutes per call.

It is my conclusion from the statistics contained in this report that the application of the computer technique to the assignment of police patrol vehicles is more efficient from the standpoint of faster response time, even though all other factors are the same. I think this is proven by the fact that the 1967 response time was significantly higher (40 percent); the fact that during the three-month period when all patrol zones were under the computer the response times were consistently lower than those during the following three months when the entire patrol zones were not under the computer technique; by the fact that, during 15 months of operation, those zones under the computer were lower in response time than those zones not under the computer; and during the entire 15-month study the patrol zones which were operated under the computer technique were lower in response time 11 of the 15 months of operation.

It is very clear that the application of the computer technique to the assignment of police vehicles and personnel is in its infancy, but in spite of this the technique indicates a better response time under this system than under any other type of patrol assignment system. It would also appear that since the technique is in its infancy, improvements can be made in the computer technique which would additionally decrease the response time.

USE OF RANDOM PATROL BY OTHER POLICE DEPARTMENTS

The techniques developed in the Edina Project are transferable to other police departments. The random patrol methods can serve as a model for use by other departments simply by substituting that department's records on requests for service in the computer program of Appendix A. The step-by-step techniques for using the Edina Random Patrol Model are presented in the section of this report called Project Description. If it is only desired to use the records on request for service to set up areas of equal crime potential and not to do a complete analysis on the request for service, the data needed can be reduced to:

1. Complaint number
2. Nature of complaint
3. Location of complaint
4. Time the call was received
5. Time the officer arrived

A coordinate system and a category designation system similar to the ones described in this report must be established. Then, the five items of data (above) are transcribed onto digital computer punch cards and read into the digital computer. Both the key punching and computer services are available from commercial sources if the sources are not available within the police department or other agencies of the government. The computer program of Appendix A is then used to generate a printout of percentage of calls that occurred in each of the coordinate blocks for each shift. The blocks are then combined to form the geographical areas equal in crime potential as described previously. Once the zone and subzone structures are established, the actual dispatching is done using random numbers; the computer program of Appendix B can be used to provide the random numbers for any number of subzones.

Actual operation can be handled exactly as described in the section of this report entitled Implementation, or any variation of it can be used. The key to the Edina version of Random Patrol is the establishment of subzones equal in crime potential and the use of random numbers for patrol assignments into those subzones.

APPENDIX A

PROGRAM "POLICE"

Program POLICE is basically a four dimensional frequency tabulation exercise where multipass techniques are required because of memory restrictions in the computer. It operates from a data tape which is prepared in blocks of up to 25 observations or complaints. Each complaint consists of 19 items as follows:

Item	*Content*
1	Complaint number
2	Month
3	Day of week
4	Day of month
5	Call time, hour
6	Call time, minute
7	Arrival time, hour
8	Arrival time, minute
9	Clearance time, hour
10	Clearance time, minute
11	Nature of complaint
12	Coordinate 1
13	Coordinate 2
14	Precipitation condition
15	Temperature range
16	Lag time (arrival–call)
17	Delay time (Clearance–arrival)
18	Weight associated with nature of call
19	Year

Each block of the data tape is up to 25 of such vectors preceded by a count of the actual number of vectors to enable the processing of short records.

Program POLICE defines logically Item 20 set to one, hence allowing analysis to be done with no item breakdown.

The basic analysis is a frequency analysis for the four dimensional cell

Coordinate 1 × Coordinate 2 × time × item
and

time × item
where item is specified as one of the above 20 items. The solution is determined by control cards to POLICE.

The control cards for POLICE consist of a card which shall be called Card 1, followed by various optional cards as determined by Card 1.

Card 1

Col 1–10—This field is for identification purposes (and also to terminate processing if "END" occurs left justified). It serves no function to the analysis described by this card.

Col 11, 12—This field is the specification of the type of analysis desired. If it contains K where $0<K\leqslant20$ then POLICE performs a four dimensional analysis on the indicate time scale (see time field) and item K. Note that Item 20 causes the four dimensional problem to reduce to a three dimension problem. If $K\leqslant0$ then an analysis results independent of the coordinate pair. This option implies another control card called card Z. Also a lag time average is calculated under this option for each weight category.

Col 13, 14, 15—This field specifies the range on the item selected. If no item was selected the field is ignored. If the range on item selected is zero, only a Village analysis on the selected item will result.

Col 16—This column is used to indicate the procedure for handling double observations (these observations with multiple cards, eg. 10019 and 10019½). If an X is punched in Col 16 then only the first of the two cards of the observation is considered.

Col 17, 18—This field specifies the number of divisions in the 24-hour clock. The 24-hour day is split into this many slots, hence the only legal values are 1, 2, 3, 4, 6, 8, 12, 24. *Example* to get 11–7, 7–3, 3–11 shifts use the value 3. The algorithm in POLICE originates the first division at 2300 hours.

Col 19—This field is termed the Village key and controls the option selected by Col 11 and 12. If four dimensional analysis was indicated in 11 and 12 this field, if nonzero, implies an analysis for the entire Village (independent of coordinates) in addition to the indicate coordinate analysis. If the analysis selected in 11 and 12 is independent of coordinate, then this field indicates the number of item descriptions (see Card 2) to expect.

Col 20, 21 M_1	Date window for analysis is (inclusively) M_1/Y_1 to M_2/Y_2
Col 22, 23 M_2	
Col 24–27 Y_1	
Col 28–31 Y_2	

Col. 32—This field is used to handle different weight schemes. If other than W or blank is selected, it is necessary that the preceding Card 1 have selected the following (Col 33) option. If W is selected, then the frequency analysis is done with the weight values from the data tape (Item 18). If blank, then the frequency analysis is done with each occurrence of equal weight or one. If 1, then the weighted analysis is performed using a selected transformation on weight value. Presently the weight used w^1 is $w_i^1 = p_i w_i$ where w_i is the weight from the data tape and p_i is the probability of occurrence of this weight as calculated on the setup run (see next field).

Col 33—This field allows a setup for weight transformation. If a p, then the probabilities of the weight values is calculated and can be used by the next Card 1 definitions.

Col 34, 35—This field allows grouping of coordinate × coordinate squares into a given region. It can be selected only if a four dimensional analysis is selected.

If zero, no group analysis.

Col 36—If positive, then groups are defined by following cards (see Card 3) and the number of groups is taken to be this field. If negative, then the previous group definitions are assumed. This field allows selection of the experimental verses control window (experimental complaints have negative identification numbers).

If C, then only control observations are used for the analysis. If X, then only experimental observations are used in the analysis. If not X or C, then no window is defined, and all otherwise legal complaints are considered.

Card 2

This card is used to define items to be used for a coordinate independent analysis. The number of items expected is supplied by Col 19 of Card 1.

Col 1, 2 Item 1—index (i.e. which item)
Col 3–5 Item 1—lower bound (incl)
Col 6–8 Item 1—upper bound (incl)
Col 9–10 Item 2—index (i.e. which item), *etc*

Card 3

This (these) cards define group definitions. The following card set must follow for each group defined by Col 34, 35 of Card 1.

Card 3a

Col 1–4—Number of C1, C2 pairs in this group eg K.

Card 3b

Punched 2 columns per coordinate number; specifies K coordinates, hence 2K integers must appear, 40 per card. They are associated in twos as coordinate pairs. If 90 coordinate pairs in a group then 3 Card 3b must follow the Card 3a for the group.

System Routine Definition

POLICE uses a routine called QLENGTH which returns the maximum available address available to POLICE. This is done because of the multiprogramming, environment presented by the CDC 6600 which makes memory flexibility desirable. The actual computer program follows:


```
      PROGRAMPOLICE(INPUT,OUTPUT,TAPE4)
      COMMON IA(1)
      DIMENSION A(1),NN(25,20),TT(19),FFF(10)
      DIMENSION NR(9,3),LAG(10),AL(10),FRQ(10)
      DIMENSION NGROUP(823)
      EQUIVALENCE(IA,A),(NN,TT),(LAG,AL)
      LOGICAL NTRS,SETUP
      LOGICAL CONTRL
      LOGICAL CONTRLX
      INTEGER CONTROL
      INTEGER GROUP
      INTEGER W,P
      INTEGER YEAR1,YEAR2
      REAL NFR,NWT
      JNDEX(I,J,K)=((K-1)*NTIME+J-1)*MAXR+I
      INDEX(I,J,K,L)=(((L-1)*NTIME+K-1)*19+J-1)*19+I+MAXNT
      MISS(N)=N.AND.18
  165 FORMAT(*1*)
      DO 50  I=1,25
   50 NN(I,20)=1
      CALL QLENGTH(NFIELD)
      INITIAL=LOCF(IA)
      NTOTAL=NFIELD-INITIAL-20
  100 READ 105,ID,NWV,MAX,NOEXTRA,NTIME,NVILL,M1,M2,YEAR1,YEAR2,W,P
     1,GROUP,CONTROL
  105 FORMAT(A10,I2,I3,A1,I2,I1,2I2,2I4,2R1,I2,R1)
      PRINT 165
      IF(ID.EQ.3HEND) CALL EXIT
      KTM=24/NTIME
      KTN=KTM+1
      IF((KTM*NTIME).NE.24) STOP
      CONTRLX=CONTROL.EQ.1RX
      CONTRL=CONTROL.EQ.1RC
      SETUP=P.EQ.1RP
      IF(MAX.LT.0) MAX=0
      NTRS=NWV.LE.0
      W=W-33B
      IF(W.LE.0.OR.W.GT.9) W=1
      FEFCNT=0
      IF(NTRS) GO TO 300
      DO 108  K=1,10
  108 FRQ(K)=0.0
      IF(GROUP.EQ.0) GO TO 107
      IF(GROUP.GT. 0) GO TO 104
      GROUP=NRECALL
      PRINT 890
  890 FORMAT(* GROUP RECALL REQUESTED AND OBTAINED*)
      GO TO 107
  104 NRECALL=GROUP
      J=GROUP+1
      PRINT 865
      DO 805  K=1,GROUP
      NGROUP(K)=J+1
      READ 810,NGC
      NGC=2*NGC
      READ 815,(NGROUP(I+J),I=1,NGC)
      PRINT 860,K,(NGROUP(I+J),I=1,NGC)
  805 J=J+NGC
      NGROUP(GROUP+1)=J
  810 FORMAT(I4)
  815 FORMAT(40I2)
  860 FORMAT(//* GROUP*I2,* PAIRS */,(19(I4,I3)))
```

```
865   FORMAT(* GROUP DEFINITIONS*)
      PRINT 165
107   MAXNT=MAX*NTIME
      NEEDED=361*NTIME+MAXNT
      IF(NEEDED.LT.NTOTAL) GO TO 115
109   NEEDED=NEEDED+INITIAL
      PRINT 110,NEEDED,ID
110   FORMAT(1X,O8,A10)
      GO TO 100
115   NEACH=(NTOTAL-MAXNT)/(NEEDED-MAXNT)
      NPASS=MAX/NEACH
      IF(NEACH*NPASS.LT.MAX) NPASS=NPASS+1
117   PRINT 120,ID,NWV,MAX,NTIME,NPASS,NOEXTRA,NVILL,M1,YEAR1,M2,YEAR2
     1,W,P,GROUP,CONTROL
      IF(NTRS) GO TO 128
120   FORMAT(* ANALYSIS ID=  *A10,/
     1 * KEY VARIABLE FOR AREA ANALYSIS=  *I5,/
     2 * MAXIMUM VALUE FOR ABOVE VARIABLE=  *I5,/
     3 * NUMBER OF TIME INTERVALS=  *I5,/
     4 * NUMBER OF PASSES THROUGH TAPE=  *I5,/
     5 * X IMPLIES DELETION OF SECONDARIES  *A1,/
     6 * VILLAGE SWITCH VALUE=  *I5,/
     7 * REAL TIME INTERVAL  *I2,*/*I4,* TO *I2,*/*I4,/
     8 * WEIGHT CODE=  *R1,/
     9 * SETUP CODE=  *R1,/
     A * GROUP DIVISIONS REQUESTED AND READ=  *I2,/
     B * CONTROL VARIABLE KEY *R1)
      WTOT=0
      LOWER=1
      NB=MAXNT+1
      DO 125  I=1,MAXNT
125   IA(I)=0
      NPAGE=1
128   IF(NPASS.LE.0) STOP
      M1=M1+12*YEAR1
      M2=M2+12*YEAR2
      DO 205   N=1,NPASS
      IF(NTRS) GO TO 132
      NHONEST=0
      NFR=0
      DO 130   I=NB,NTOTAL
130   IA(I)=0
      ITOP=MIN0(MAX,LOWER+NEACH-1)
132   REWIND 4
      LASTN=0
133   READ(4) MBK,((NN(I,J),J=1,19),I=1,MBK)
      IF(EOF,4) 150,140
140   DO 135  I=1,MBK
      IF(NOEXTRA.NE.1H .AND.NN(I,1).EQ.LASTN) GO TO 135
      LASTN=NN(I,1)
      IF(NN(I).LT.0.AND.CONTRL) GO TO 135
      IF(NN(I).GT.0.AND.CONTRLX) GO TO 135
      NYR=NN(I,2)+12*NN(I,19)
      IF(NYR.LT.M1.OR.NYR.GT.M2) GO TO 135
      GO TO (601,602,603,604,605,606,607,608,609),W
601   NWT=1.0
      GO TO 141
602   NWT=NN(I,18)
      GO TO 141
603   K=NN(I,18)/2
```



```
      IF(K.LE.0.OR.K.GT.10) GO TO 135
      NWT=2.0*K*FFF(K)
      GO TO 141
604   CONTINUE
605   CONTINUE
606   CONTINUE
607   CONTINUE
608   CONTINUE
609   CONTINUE
141   IF(NTRS) GO TO 142
      IF(MISS(NN(I,5)).NE.0.AND.NN(I,5).EQ.0) GO TO 135
      IF(NN(I,12).LE.0.OR.NN(I,12).GE.20) GO TO 135
      IF(NN(I,13).LE.0.OR.NN(I,13).GE.20) GO TO 135
      IF(NN(I,NWV).EQ.0) GO TO 135
      NFR=NFR+NWT
      NHONEST=NHONEST+1
      IF(NN(I,NWV).LT.LOWER.OR.NN(I,NWV).GT.ITOP) GO TO 135
142   IF(NTIME.EQ.24) GO TO 145
      NN(I,5)=(NN(I,5)+KTN)/KTM
      IF(NN(I,5).GT.NTIME) NN(I,5)=1
145   IF(NTRS) GO TO 350
      M=INDEX(NN(I,12),NN(I,13),NN(I,5),NN(I,NWV)-LOWER+1)
      L=NTIME*(NN(I,NWV)-1)+NN(I,5)
      A(M)=A(M)+NWT
      A(L)=A(L)+NWT
      IF(SETUP) GO TO 352
      GO TO 135
350   DO 351  K=5,8
351   IF(NN(I,K).EQ.0.AND.MISS(NN(I,K)).NE.0) GO TO 135
352   K=NN(I,18)/2
      IF(K.LE.0.OR.K.GT.10) GO TO 135
      FFFCNT=FFFCNT+1.0
      FRQ(K)=FRQ(K)+1.
      IF(SETUP.AND..NOT.NTRS) GO TO 135
      LAG(K)=LAG(K)+NN(I,16)
      IF(NVILL.LE.0) GO TO 135
      DO 370  J=1,NVILL
      K=NR(J,1)
      IF(NN(I,K).LT.NR(J,2).OR.NN(I,K).GT.NR(J,3)) GO TO 370
      L=JNDEX(NN(I,K)-NR(J,2)+1,NN(I,5),J)
      A(L)=A(L)+NWT
      WTOT=WTOT+NWT
370   CONTINUE
135   CONTINUE
      GO TO 133
150   IF(NTRS) GO TO 390
      FR=.01*NFR
      NS=ITOP-LOWER+1
      MM=INDEX(19,19,NTIME,NS)
      DO 160   I=NB,MM
160   A(I)=A(I)/FR
      DO 200  L=1,NS
      DO 195   K=1,NTIME
      NPAGE=NPAGE+1
      IF(MOD(NPAGE,2).EQ.0)   GO TO 171
      PRINT 170,K,LOWER
170   FORMAT(////,* TIME SLOT = *  I3,  * VAR VALUE= *I5,/////)
      GO TO 176
171   PRINT 172,K,LOWER
172   FORMAT(*1TIME SLOT = *I3, * VAR VALUE = *I5,/////)
```

```
176   PRINT 175 ,(J,J=1,19      )
175   FORMAT(* COORDINATE 2, DWN, * 19I6,/)
      DO 185  JJ=1,19
      J=20-JJ
      DO 180  I=1,19
      M=INDEX(I,J,K,L)
180   TT(I)=A(M)
185   PRINT 190,J,(TT(I),I=1,19)
190   FORMAT(5X,I10,5X,19F6.3)
      IF(GROUP.LE.0) GO TO 195
      NPAGE=1
      PRINT 840
840   FORMAT(///* GROUPINGS FOR ABOVE*)
      DO 845  I=1,GROUP
      IAD=NGROUP(I)
      JAD=NGROUP(I+1)-2
      SS=0
      DO 820   J=IAD,JAD,2
      J1=NGROUP(J)
      J2=NGROUP(J+1)
      M=INDEX(J1,J2,K,L)
820   SS=SS+A(M)
      NGC=NHONEST*SS+0.5
845   PRINT 835,I,SS,NGC
835   FORMAT(* GROUP*I2,F8.4,*  NUMBER OF WEIGHTED CALLS IS *I10)
195   CONTINUE
200   LOWER=LOWER+1
205   CONTINUE
      PRINT 250,NHONEST
250   FORMAT(*1TOTAL NUMBER OF CARDS ACCEPTED =*I20)
      IF(NVILL.LE.0) GOTO 700
      PRINT 210
210   FORMAT(*  ENTIRE VILLAGE AGAINST TIME*)
      DO 215   K=1,MAXNT
215   A(K)=A(K)/ER
      DO 230  N=1,NTIME
      PRINT 220,N
220   FORMAT(//* TIME SLOT=* I5,////)
      NT=N
      DO 225  I=1,MAX
      PRINT 235,I,A(NT)
225   NT=NT+NTIME
230   CONTINUE
235   FORMAT(I20,F10.3)
      GO TO 700
300   IF(NVILL.LE.0) GO TO 306
      READ 305,((NR(I,J),J=1,3),I=1,NVILL)
305   FORMAT(9(I2,2I3))
      MAXR=0
      DO 310   I=1,NVILL
310   IF((NR(I,3)-NR(I,2)).GT.MAXR) MAXR=NR(I,3)-NR(I,2)
      MAXR=MAXR+1
      NEEDED=NTIME*MAXR*NVILL
      IF(NEEDEED.GE.NTOTAL) GO TO 109
      DO 315   I=1,NEEDED
315   IA(I)=0
306   NPASS=1
      DO 317   K=1,10
```



```
317   FRQ(K)=AL(K)=0
      GO TO 117
390   TOT=AZ=0
      DO 391   I=1,10
      TOT=TOT+FRQ(I)
      AZ=AZ+LAG(I)
391   IF(FRQ(I).NE.0)   AL(I)=LAG(I)/FRQ(I)
      BOT=TOT
      AZ=AZ/TOT
      IF(NVILL.LE.0) GO TO 453
      TOT=100./WTOT
      DO 450   I=1,NVILL
      PRINT 400,(NR(I,J),J=1,3)
400   FORMAT(*1VARIABLE= *I3,* RANGE *I5,* TO *I5,//)
      II=NR(I,3)-NR(I,2)+1
      K=NR(I)
      PRINT 405,(J,J=1,NTIME)
405   FORMAT(* TIME ACROSS *2X,24I5,/)
      L=NR(I,2)
      DO 420    J=1,II
      DO 410    IJ=1,NTIME
      JI=JNDEX(J,IJ,I)
410   TT(IJ)= A(JI)*TOT
      PRINT 430,L,(TT(IP),IP=1,NTIME)
430   FORMAT(* VAR=*I10,24F5.1)
420   L=L+1
450   CONTINUE
453   CONTINUE
      PRINT 455,BOT,AZ
      PRINT 460
455   FORMAT(*1TOTAL FREQUENCY =* F10.0,* AVERAGE LAG (MINUTES) *F10.3,
     1/,* ALL TIMES HERE ARE IN MINUTES *//)
460   FORMAT(//,* WEIGHT SLOT LAG TIME AVERAGES *//,* SLOT *,* LAG TIME
     1*,* FREQUENCY*,//)
      DO 470  I=1,10
      II=2*I
470   PRINT 465,II,AL(I),FRQ(I)
465   FORMAT(I10,F10.3,F10.0)
700   IF(.NOT.SETUP) GO TO 100
      PRINT 725
725   FORMAT(*1WEIGHT PROBABILITIES * //)
      DO 710  I=1,10
      FFF(I)=FRQ(I)/FFFCNT
      J=I+I
710   PRINT 750,J,FFF(I)
750   FORMAT(I20,F20.5)
      GO TO 100
      END
OV-ALL 7-800   X 1 040319671968  00
OV-ALL 8-900   X 1 040319681969  00
CNTRL  8-900   X 1 040319681969  00C
XMNTL  8-900   X 1 040319681969  00X
END
```

APPENDIX B

RANDOM NUMBER GENERATION PROGRAM "IRAN"

All random numbers generated for the project were generated via a routine documented below.

A. IDENTIFICATION

TITLE	Pseudo-random number generators
CLASSIFICATION	VI MINN RANDOM
LANGUAGE	Compass
COMPUTERS	CDC 6400/6500/6600
PROGRAMMER	James Mundstock
DATE	August, 1968

B. ABSTRACT

A group of subroutines for the rapid internal generation of pseudo-random numbers:

RAN2F—Generates arrays of real random numbers having a *uniform* distribution in (0,1).

RAN3F—Generates arrays of real random numbers having a *uniform* distribution in (a,b).

IRAN—Generates arrays of integer random numbers having a *uniform* distribution in [0,NRANGE].

NORMAL—Generates arrays of integer random numbers having a *normal* distribution with mean of 0 and variance of 1.

RANBIN—Generates arrays of random bytes from 1–60 bits each.

PERMUTE—Generates a random sampling without replacement (or permutation) of k items taken from n given items ($k \leqslant n$).

Each subroutine will generate the same sequence as previous runs if the arguments are the same.

C. USAGE

1. Calling sequences:

CALL RAN2F(N,A,SEED)
CALL RAN3F(N,A,SEED)
CALL IRAN(N,IA,NRANGE,SEED)
CALL NORMAL(N,A,SEED)

N—An integer input parameter.

If $N < 0$, a value of SEED is produced from $|N|$

If $N = 0$, this acts as if $N = 1$ below

If $N > 0$, the array A or IA is filled with N random numbers.

N must be < 65536.

There are at least two calls needed for each routine. The first with $N < 0$ initiates the routine and the second or any later calls with $N \geqslant 0$ generates random numbers.

A,IA—An output array, dimensioned at least N, which is filled with N random numbers on a call with $N \geqslant 0$.

SEED—An input-output variable which keeps the current location in the sequence being generated. For *RAN3F*, SEED must be three consecutive words where the user initially sets the values SEED(1)=left endpoint and SEED(2)=right endpoint of the interval (a,b), and the routine sets the value of SEED(3). SEED is changed by each call after the initial one and should not be tampered with by the user.

NRANGE—An integer input parameter, > 0, which specifies the range of integer random numbers generated. The numbers will be in the range [0,NRANGE] or [NRANGE,0] depending as the sign of NRANGE is respectively positive or negative.

CALL RANBIN(N,IA,SEED)

N—An integer input parameter.

If $N < 0$, this sets up SEED using the value of IA to determine byte length

If $N = 0$, this acts as if $N = 1$ below

If $N > 0$, the array IA is filled with N random bytes. Each byte is right-adjusted with zero fill. N must be < 65536.

There are at least two calls needed for this routine. The first with $N < 0$ initiates the routine and the second or any later calls with $N \geqslant 0$ generates random bytes.

IA—An integer input parameter which determines the byte length on a call with $N < 0$, and an output array which is filled with N random bytes on a call with $N > 0$. When $N < 0$, IA must be between 1 and 60.

SEED—An array of dimension 19 holding the history which determines the byte length. SEED is set up by a call with $N < 0$ and should not be changed by the user.

CALL PERMUTE(N,IA,K,SEED)

N—An integer input parameter.

If $N < 0$, this starts the sequence of calls and sets up SEED.

If $N = 0$, this does nothing.

If $N > 0$, this indicates the number of elements from IA to be drawn from.

N must be < 65536.

There are at least two calls needed for this routine. The first with $N < 0$ initiates the routine and the second or any later calls with $N \geqslant 0$ generates random samples without replacement.

IA—The input array of elements to be drawn from and the output array of K elements. IA may be type REAL if supplied by the user.

K—An integer input parameter.

[K] specifies the number of elements to be drawn from IA.

If $K > 0$, these elements are supplied by the calling program.

If $K = 0$, nothing is done, IA is not permuted.

If $K < 0$, the program will generate the integers $1 - N$ in IA and use these numbers as elements to be drawn from.

SEED—A variable used for memory. It is changed with each call to keep from generating the same reordering. Thus, it should not be changed by the user.

3. Space required:

RAN2F	: 20_8 =	16_{10}	cells
RAN3F	: 111_8 =	73_{10}	cells
IRAN	: 25_8 =	21_{10}	cells
NORMAL	: 400_8 =	256_{10}	cells
RANBIN	: 107_8 =	71_{10}	cells
PERMUTE:	120_8 =	80_{10}	cells

4. Error messages:

**** RAN2F ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** RAN2F ERROR **** ARGUMENT 3, SEED = (oct. value SEED) **** SEED MUST BE AN ODD POSITIVE FLOATED INTEGER WHICH HAS NOT BEEN NORMALIZED

**** RAN3F ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** RAN3F ERROR **** ARGUMENT 3, SEED (3) = (octal value of SEED(3)) **** SEED(3) MUST BE AN ODD POSITIVE FLOATED INTEGER WHICH HAS NOT BEEN NORMALIZED

**** IRAN ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** IRAN ERROR **** ARGUMENT 3, NRANGE = (value of NRANGE) **** ABS(NRANGE) MUST BE AN INTEGER BETWEEN 1 AND 2**48 — 1

**** IRAN ERROR **** ARGUMENT 4, SEED = (octal value of SEED) **** SEED MUST BE AN ODD POSITIVE FLOATED INTEGER WHICH HAS NOT BEEN NORMALIZED

**** NORMAL ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** NORMAL ERROR **** ARGUMENT 3, SEED = (octal value of SEED) **** SEED MUST BE AN ODD POSITIVE FLOATED INTEGER WHICH HAS NOT BEEN NORMALIZED

**** RANBIN ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** RANBIN ERROR **** ARGUMENT 2, IA = (value of IA) **** IA MUST BE AN INTEGER BETWEEN 1 AND 60

**** PERMUTE ERROR **** ARGUMENT 1, N = (value of N) **** N MUST BE AN INTEGER < 65536

**** PERMUTE ERROR **** ARGUMENTS 1 and 3, N = (value of N), K = (value of K) **** N MUST ⩾ ABS(K)

**** PERMUTE ERROR **** ARGUMENT 4, SEED = (octal value of SEED) **** SEED MUST BE AN ODD POSITIVE FLOATED INTEGER WHICH HAS NOT BEEN NORMALIZED

9. Error returns:

   If any of the above errors occur, the user's program is terminated and control is returned to the SCOPE system.

10. Timing:

RAN2F	:	8.5 + .80*N microseconds with N > 0
RAN3F	:	10.0 + 1.80*N microseconds with N > 0
IRAN	:	11.0 + 1.75*N microseconds with N > 0
NORMAL	:	10.00*N microseconds with N > 0
RANBIN	:	9.0 + 6.10*N microseconds with N > 0
PERMUTE:		10.1 + 2.30*N microseconds if the numbers are supplied; 4.4 + .65*N microseconds additional if the routine generates these numbers

12. Cautions to user:

    If any of the routines are not initialized (i.e. not called at the beginning with a negative first argument), random numbers will not be produced because a proper seed has not been generated. If it is desired, all the random number generators have the capability of being restarted for a second separate program at the next element of the sequence by use of SEED. At the end of a first program, SEED should be printed or punched with ∅22 fields and at the beginning of the next separate program SEED should be read in with ∅22 fields. The generators would not be initialized in the second program because proper values for SEED have already been generated in the first program. (See the examples.)

    For all the routines, A or IA must be dimensioned at least N when N > 0. Also, in RAN3F, SEED must be dimensioned with at least 3 elements and in RANBIN, SEED must be dimensioned with at least 19 elements.

13. References:

a. Hamming, R. W., *Numerical Methods for Scientists and Engineers*, McGraw Hill, p. 383

b. Barnett, V. C., "The Behavior of Pseudo-Random Sequences Generated on Computers by the Multiplicative Congruential Method," *Mathematics of Computation*, Vol. 16, 1962, pp. 63-69

c. Marsaglia, G., and Gray, T. A., "A Convenient Method for Generating Normal Variables," *SIAM Review*, Vol. 6, No. 3, July, 1964, pp. 260-264

d. Hull, T. E., and Dobell, A. R., "Random Number Generators," *SIAM Review*, Vol. 4, No. 3, July, 1962, pp. 230-254 (Very good survey article)

e. Abramowitz, M., and Stegun, I. A., *Handbook of Mathematical Functions*, National Bureau of Standards, Applied Mathematics Series No. 55, 1964, pp. 949-953

f. Balbine, G. de, "Notes on Random Permutations," *Mathematics of Computation*, October, 1967, p. 716

g. Ralston, A., and Wilf, H., *Mathematical Methods for Digital Computers*, Vol. 2, Wiley, 1967, p. 249

D. METHOD

1. Uniform random numbers (RAN2F, RAN3F, IRAN).

   Given one random element, X_r, in the sequence, the next element is generated by $X_{r+1} = X_r \cdot S \pmod M$, i.e., X_{r+1} = remainder of $(X_r \cdot S)/M$. With proper choice of X_0 and S (see Ref. b), long sequences of integers are generated. Even though each X_r is exactly determined, the numbers in the sequence have many of the properties of uniform random numbers. The choice of S and X also affect this "randomness". With a negative parameter N, $X_0 = 2 \cdot |N| + C$ (C is an odd constant) in these routines, S is 5^{13} and M is 2^{47}. Thus, 2^{45} random numbers are generated before repetition occurs. (See Ref. b.) Arithmetic is done in unrounded unnormalized floating-point using double-precision commands. Normalization, range reduction, and conversion to integer are done where necessary. (Integer random numbers are obtained by multiplying uniform floating-point random numbers by NRANGE + 1 and truncating to integer.)

2. Normal random numbers (NORMAL).

   Normal random numbers are generated from uniform random numbers (see 1. above) by using one of four schemes as determined by the uniform random numbers, U_i generated:

   a. $X = 2(U_1 + U_2 + U_3 - 1.5)$
   b. $X = 1.5(U_1 + U_2 - 1.0)$

   c. $X = 6U_1 - 3$
   d. $X = V_1 \text{ (or } V_2) \{[9 - 2(V_1^2 + V_2^2)]/(V_1^2 + V_2^2)\}^{1/2}$

   where $V_i = 2U_i - 1$ and $V_1^2 + V_2^2 < 1$

   See Reference e for further details and references.

3. Random permutations (PERMUTE).

   The permutation is generated by a sequence of K—1 interchanges of the original (or generated) array of elements. The *Ith* stage proceeds as follows: a random integer NK in the range 0—(K—I) is generated and the *Ith* and (I+NK)*th* elements of the array IA are interchanged. Each step draws one of the remaining elements without replacement and puts it in the sequence. If K = N a random permutation on N elements is generated. A sequence of permutations may have duplications in the sequence.

4. Generation of other distributions.

   Occasionally a new distribution is defined in terms of an available distribution. In these cases, an easy way of getting the same distribution is to apply the definition. Examples of this kind of generation would be the F, chi-square, and T distributions which are defined as:

$C^2 = \sum_{i=1}^{n} X_i^2$	with X_i normally distributed in (0,1). (See 2. Normal random numbers, above.) C^2 is a chi-square distribution having *n* degrees of freedom.
$F = \dfrac{C_1^2/n_1}{C_2^2/n_2}$	with C_1^2, C_2^2 chi-square having n_1 and n_2 degrees of freedom respectively. F is an F-distribution having n_1 and n_2 degrees of freedom.
$T = C/\sqrt{C^2/n}$	with C^2 chi-square having n degrees of freedom. T is a T-distribution having n degrees of freedom.

As can be readily seen these can be applied only if few random deviations are required or the number of degrees of freedom are small.

If the above method is not useable another method that is sometimes useful is inverting the cumulative distribution function. Let f(x) be the density function and let

$$F(y) = \int_a^y f(x)dx$$

be the cumulative distribution function. Then with z uniform on (0,1),

$$w = F^{-1}(z)$$

is a random deviate with the specified distribution. An example of this would be the exponential distribution:

$$F(y) = \int_0^y \frac{1}{\theta} e^{-x/\theta} dx$$

where

$$F^{-1}(z) = -\theta \ln(1-z).$$

A similar procedure can be carried out for each chi-square distribution with an even number of degrees of freedom. As an example of deriving the inverse, take the Cauchy distribution with density

$$f(x) = \frac{1}{\pi} \cdot \frac{a}{a^2+x^2}.$$

The cumulative distribution function is

$$\begin{aligned} F(y) &= \frac{1}{\pi} \int_{-\infty}^{y} \frac{a}{a^2+x^2} dy \\ &= \frac{\tan^{-1}}{\pi} \left(\frac{x}{a}\right) \Big|_{-\infty}^{y} \\ &= \frac{\tan^{-1}(y/a)}{\pi} - \frac{a}{\pi} \cdot \left(\frac{1}{a} \cdot \frac{-y}{2}\right) \\ &= \frac{\tan^{-1}(y/a)}{\pi} - \frac{1}{2} \\ &= z \end{aligned}$$

The inverse will be

$$\begin{aligned} \frac{1}{\pi} \tan^{-1}(y/a) &= z + 1/2 \\ \tan^{-1}(y/a) &= \pi(z + 1/2) \\ y/a &= \tan(\pi(z + 1/2)) \\ y &= a \cdot \tan(\pi(z + 1/2)) \end{aligned}$$

with z uniform on (0,1), and y will be Cauchy with parameter a. If the cumulative distribution function cannot be inverted analytically, numerical inversion techniques should be applied. Either some root-finding technique or, if time is important, an approximation or series of approximations to the inverse would be an appropriate method.

Another means of generating an arbitrary distribution is the acceptance-rejection technique. (See Reference e for further information.)

Method 1.

Let $F = \max_{a \leqslant x \leqslant b} f(x)$ (where F is a distribution function) and let u_1, u_2 be a pair of uniform random numbers on (0,1). (See 1. Uniform random numbers, above). Compute $y = a + (b - a) \cdot u_2$. If $a_1 < f(y)/F$, accept the y, else reject the y and try again. $1.0/((b - a) \cdot F)$ is the probability of a pair being accepted. A way to increase the speed of this method is to split the domain, and apply the method to each sub-domain.

Method 2.

$$f(y) = \int_{\alpha}^{\beta} g(y,t)dt \qquad \alpha < t < \beta \quad a < y < b$$

$$g = \max_{\substack{\alpha<t<\beta \\ a<y<b}} g(y,t)$$

Generate uniform u_1,u_2,u_3 (See 1. Uniform random numbers, above). Let $s = \alpha + (\beta - \alpha)u_2$; $z = a + (b - a)u_3$. Accept z if $u_1 < \frac{g(z,s)}{g}$, else try again. The probability of acceptance is $1.0/((b-a) \cdot g)$.

Method 3.

Suppose f(x) and $c \cdot g(x)$ are density functions and $f(x) \geqslant c \cdot g(x)$ for all x. Let $F(x) = \int_{-\infty}^{x} f(t)dt$ be the cumulative distribution function of f(x). Generate u_1,u_2 uniform on (0,1). (See 1. Uniform random numbers, above). Take $y = F^{-1}(u_1)$ and accept y if $c \cdot g(y)/(f(y)) \leqslant u_2$.

Examples:

a. Conventional one-program use.

```
      DIMENSION X(100)
C     INITIALIZATION (N IS SOME
      POSITIVE INTEGER VARIABLE
C     OR CONSTANT)
      CALL RAN2F(—N,X,SEED)
C     GENERATE 100 UNIFORMLY
C     DISTRIBUTED RANDOM NUM-
C     BERS ON (0.0, 1.0)
      CALL RAN2F(100,X,SEED)
C     CHANGING N WILL YIELD DIF-
C     FERENT RANDOM SEQUENCES
C     ON DIFFERENT CALLS
```

b. Multi-program use with continuing sequence.

```
      1st program:
      PROGRAM SAM(INPUT,OUT-
      PUT,PUNCH)
      DIMENSION PT(70)
C     INITIALIZATION (N AS ABOVE)
      CALL RAN2F(—N,X,SEED)
C     GENERATE 70 RANDOM NUM-
C     BERS
      CALL RAN2F(70,PT,SEED)
      .
      .
      .
C     PUNCH OUT SEED
      PUNCH 20,    SEED
   20 FORMAT(Ø22)
      successive programs:
      PROGRAM JOE(INPUT,OUT-
      PUT)
      DIMENSION UJ(695)
C     READ IN SEEDP FROM PREVI-
C     OUS PROGRAM
      READ 57, SEEDP
   57 FORMAT(Ø22)
C     GENERATE 695 RANDOM NUM-
C     BERS
      CALL RAN2F(695,UJ,SEEDP)
```


APPENDIX C

NATURE OF COMPLAINT BREAKDOWN AND VALUE

LEA PROJECT 235

VALUE	NATURE OF COMPLAINT
	ACCIDENTS
20	1. Fatal
20	2. Personal Injury
16	3. Property Damage
	ALARMS
18	4. Burglar
18	5. Fire
18	6. False
	ANIMAL CALLS
14	7. Bite, impounding
2	8. Injured, sick and dead
2	9. Running
2	10. Nuisances at bus stops, school crossing, barking, obnoxious
2	11. Animals in window wells
14	12. Vicious animals
2	13. Cruelty to animals, drowning
4	14. Animals in house, birds up chimney
2	15. Bird, ducks, birds frozen in ponds, trapped
2	16. Strays, wild animals, unknown or strange animals, leashing, lost
	ASSISTS—LOCAL AND OTHER DEPARTMENTS
2	17. Breaks in sewer, water lines, backing up sewer
2	18. Holes in street and breaks in streets
8	19. Abnormal street conditions, sanding, barricading, lights
2	20. Materials and objects lying in street
2	21. Recovery of property for other departments
2	22. Fire, accident and traffic direction assists — other departments
2	23. Pick up persons on warrants — other departments
2	24. Messages, emergencies — other departments
14	25. Alarms — buildings outside of Edina
2	26. Assist — locating or recovery of stolen property — other departments
4	27 Assist — criminal offenses — other departments
4	28. Assist — Southdale Security
	CRIMES—Part I CLASSIFICATION
20	29. Criminal Homicide
20	30. Rape

VALUE	NATURE OF COMPLAINT
20	31. Robbery
20	32. Aggravated Assault
16	33. Burglary
10	34. Larceny—over $50.00
6	35. Larceny—under $50.00 from auto
6	36. ————Auto accessory
6	37. ————Bicycle
2	38. ————Shoplifting
6	39. ————All other larceny
10	40. ————Auto Theft
	CRIMES—Part II CLASSIFICATION
14	41. Simple assault
14	42. Arson
6	43. Forgery
6	44. Fraud
6	45. Embezzlement
6	46. Stolen Property
8	47. Weapons
6	48. Prostitution—vice
6	49. Sex offenses
8	50. Narcotics
6	51. Gambling
6	52. Family—children
6	53. Liquor laws
6	54. Drunkenness
6	55. Disorderly conduct
6	56. Vagrancy
6	57. Curfew-Loitering
6	58. All other Part II
	DOMESTICS
16	59. Husband-Wife, ex-husband
6	60. Parents-Child, Child-Child, Son, Daughter
6	61. Parents-boy or girl friend
6	62. Boy-Girl Friend
6	63. Relatives
6	64. Parents-Grandparents
6	65. Neighbors
	FIRE CALLS
16	66. Furnace, stoves, grease on stove
16	67. Lightning, wires down, sparking wires
20	68. House or garage, other out buildings, fences
20	69. Commercial buildings
16	70. Smoke calls, overheated motors, mattresses, heaters, electrical appliances, furniture

VALUE	NATURE OF COMPLAINT
	FIRE CALLS—Cont'd.
14	71. Grass, burning in streets, rubbish, stumps, garbage, leaves, tires, brush
14	72. Vehicles
10	73. Strange odors, gas smells, test, false
16	74. Explosions, miscellaneous objects burning
	ILLEGAL BURNING AND DUMPING
2	75. Garbage burning or dumping
2	76. Illegal materials dumped in vacant lots, swamps, clean fill areas
2	77. Burning-before hours, after hours, too close to buildings, without permit, not in proper container
	KID CALLS
6	78. Firecrackers, BB guns, bow and arrow, other guns, hunting
6	79. Vehicles-go karts, cars, hot rodders, drag racing, snowmobiles
6	80. Playing with fire, matches
4	81. Loitering-obstructing street or sidewalk, disturbing in store, harassing
4	82. Throwing objects-on lawns, toilet paper, cans, bottles, smoke bombs, water bags, in lakes
4	83. Incorrigibility
4	84. Throwing stones, snowballing, dummies or objects in street
4	85. Parks-vandalism to buildings, golf course greens and fairways. disturbances
8	86. Constructions-in houses, on top of, on construction equipment
8	87. Smoking, drinking, fighting, pestering other kids, taking items of clothing from kids, threats, rumbles
4	88. Trespassing, ringing doorbells, in ponds, swimming pools
4	89. Spraying with paint, shaving cream
4	90. Looking into cars on street or parking lots, gas syphon attempts
4	91. Using obscene or abusive language or signs, loud language, parties, attempt to sell obscene literature
8	92. On or in other buildings without permission, on ice
4	93. Carrying objects away from yards, street, sewer covers
	LOCK-OUTS
4	94. House-locked out
4	95. House-locked in inside room
4	96. Vehicle—lock outs, or in
4	97. Other buildings—locked out
	LOST OR MISSING PERSONS
4	98. Runaways
4	99. Missing adult—teenagers
8	100. Hospital patients
8	101. Aged or from home for aged
6	102. Lost children

VALUE	NATURE OF COMPLAINT
	MEDICAL EMERGENCIES
20	103. Dead on Arrival
20	104. Heart attack, difficult breathing, severe pain in chest
20	105. Cave-ins, drowning
20	106. Suicides and attempts, overdoses
20	107. Caught in devices-machines, mixers
20	108. Hemorrhage, severe bleeding
18	109. Unconscious, fainting, need oxygen
14	110. Cuts and lacerations, gunshot wounds
14	111. Broken bones, falls
18	112. Choking, seizures, convulsions, strokes, reactions
14	113. Hysterical problems, nervous breakdown
18	114. Overcome by fumes-gases
18	115. Amputated extremities-toes, fingers
14	116. Mental cases
12	117. Slumpers-cars, street or on lawns, falls out of bed-assist, sick, unfounded
	PROWLER CALLS
10	118. Prowler-noises or person in house
8	119. Prowler-noises or person outside of house
	SEX OFFENDER
6	120. Peepers
10	121. Molesters
6	122. Exposers
2	123. Phone calls-obscene, heavy breathing, suggestive
	SUSPICIOUS PERSONS, CARS, NOISES
14	124. Vacant or vacation houses or buildings, lights on, or persons in or on house
14	125. Man-walking between houses, looking in cars, following woman, offering rides, using binoculars, standing in bushes, parking lots, trying door, bums
10	126. Vehicles-without lights, driving around area, abnormally parked, lovers, persons sleeping in, suspected drunk driver, in ditch, child left in car
6	127. Suspicions of persons stealing or committing theft, counterfeit money, sounds, noises
4	128. Ringing of door bells, salesman
4	129. Equipment running, water running, strange noises
4	130. Phone calls-threatening, no answer, phone dead, fake or assumed voices, anonymous, threatening letters, annoying, suspicious calls
4	131. Persons needing assistance, going in or out of buildings that are empty, cemeteries, on water towers, strange lights
	VANDALISM
12	132. Setting minor fires
10	133. Shooting birds or animals, or at them
10	134. Putting, burning, or throwing substances on houses, cars, or street, eggs, shaving cream, paint, obscene words
10	135. Damaging property-parks, buildings, inside rooms of buildings, equipment or machines in buildings, abandoned buildings

VALUE	NATURE OF COMPLAINT
	VANDALISM—Cont'd.
10	136. Damaging property-construction equipment, survey crew equipment, buildings under construction, concrete or cement
4	137. Damaging property-street or yard lights, windows, doors, Christmas lights, wreaths, yard ornaments, displays
4	138. Damaging property-trees, shrubs, lawns, fences, markers, posts, vehicles over lawn
4	139. Damaging property-signs, signals, mailboxes, newspaper boxes, phone booths
4	140. Damaging property-vehicles, bicycles, tricycles
4	141. Damaging property-cutting clotheslines, convertible tops, awnings, garden hose, swings
4	142. Damaging property-concrete blocks, bricks, letting water out, sand, other
	MISCELLANEOUS
4	143. Traffic arrests, complaints of driving, hazards
2	144. Recovered or abandoned property, lost, misplaced
4	145. Moving of buildings

VALUE	NATURE OF COMPLAINT
6	146. Emergency message delivery
2	147. Parking offenders, blocked drives, overtime, street full of cars, lawns—snow pushed into street
6	148. Loud parties-adult, unwanted guests
2	149. Low flying planes
2	150. Requests to repossess vehicles
2	151. Signal or sign requests and problems
2	152. Open doors and windows, skylights, lights on
2	153. Keys, articles left in vehicles, motors running
10	154. Chases-on foot, in vehicles and assists, speeding vehicles
2	155. Equipment or other items left on strange property, nuisances
2	156. Complaints on or about police officers, or other Village employees.
16	157. Bomb threats, bombs
8	158. Damage from wind, trees down
2	159. Civil matters
2	160. Employee Problems

☆ U.S. GOVERNMENT PRINTING OFFICE: 1970 O—385-551

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