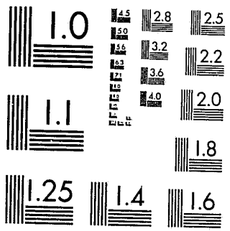

DESCRIPTION OF THE MICROCOMPUTER PROGRAM: MANPOWER

rtment of Law Enforcement
Administration

Richard A. Raub

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DESCRIPTION OF THE MICROCOMPUTER PROGRAM: MANPOWER

Illinois Department of Law Enforcement
Division of Administration
Alex Ferguson, Deputy Director

Richard A. Raub

September 15, 1984

ABSTRACT

This report describes how the Manpower Allocation Model written for the Illinois Department of Law Enforcement Division of State Police operates on a microcomputer. The operating program has been titled "MANPOWER." It describes how to build the parameter and variable files, then the actual operation of the program. Sample output also is included, as well as a listing and documentation for the program written in BASIC. A thorough description of the philosophy and mathematics behind the model has appeared in other reports.

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DESCRIPTION OF THE MICROCOMPUTER PROGRAM: MANPOWER

INTRODUCTION

The computer program MANPOWER and its companion FACTOR INPUT compute allocation of manpower for a geographic area using a microcomputer. They are based on the work of Raub and Sweat[1,2] and the more recent revisions by Raub.[3] The programs are written in BASIC for the APPLE II Plus microcomputer. However, they could be adopted for other microcomputers.

As described in the referenced reports, the computer programs assign police officers to geographic entities (for the Illinois State Police, these are districts). Distribution is based on accidents, criminal activity, size of the district, miles of highway and its volume, rural population, and the number of local police. The basic unit of operation is the county. The allocations made for three shifts within counties; then, are they aggregated into districts. Only results for the districts are shown.

The output has three sections: allocations to answer calls for service (reactive), allocations to policing and patrolling (proactive), and a summary which also shows assignment of administrative support. This latter element is entered as a variable. The information is shown only at the final step.

OPERATION OF THE MODEL

Entry of Parameters and Variables

The user must enter the values of the parameters and variables to be used in the model. Parameters generally are those values that affect the overall operation of the model. There are 39 parameters that must be entered. These are shown in Table 1. All, except the shift coverage factors, apply to the state as a whole. The shift coverage is considered one parameter even though there are three values for each district representing each of the three shifts. A more comprehensive description of each parameter is found elsewhere.[4]

Variables represent those data that are used as a base for computations. Except for the administrative support (overhead), and the district/county cross reference table which is shown for each district, the variables apply to each of the counties. Even if the value is zero, there must be data for each variable for the number of counties specified in the parameters. A list of the variables for the model is given in Table 2. Like the parameters, a more detailed description is given elsewhere.[5]

Both the variables and parameters can be entered or changed either by typing RUN FACTOR INPUT (enter new information without running the model) or RUN MANPOWER (enter or change the data and then run the allocation program). The program FACTOR INPUT allows the user to enter or change any piece of information in either the parameter or variable file. To do so, the user selects one of four operations from the menu (as shown in Figure 1).

TABLE 1

PARAMETERS USED IN THE PROGRAM

Item	Parameter Names	Variable Name Used by Program
1.	Total officers to be allocated	TT
2.	Number of counties in state	NC%
3.	Number of districts in state	ND%
4.	Manhours per year per officer	TA
5.	Enforcement time - time per stop (hours)	TE
6.	Minimum number of state police patrols per shift - rural	RM%
7.	Maximum number of state police patrols per shift - rural	RX%
8.	Rural persons per police patrol	RX
9.	Percent of Average Daily Traffic (ADT) during shift 1	P(1, 1)
10.	Percent of ADT during shift 2	P(2, 1)
11.	Percent of ADT during shift 3	P(3, 1)
12.	Maximum response time in minutes for shift 1	P(1, 2)
13.	Maximum response time in minutes for shift 2	P(2, 2)
14.	Maximum response time in minutes for shift 3	P(3, 2)
15.	Patrol miles per position, four-lane roads	P(1, 3)
16.	Patrol miles per position, two-lane, high-volume roads	P(2, 3)
17.	Patrol miles per position, other rural roads	P(3, 3)
18.	Percent of patrolling assigned to four-lane highways	P(1, 4)
19.	Percent of patrolling assigned to other highways	P(2, 4)
20.	Percent of patrolling assigned to rural policing	P(3, 4)
21.	Accidents - Percent handled	PH(1)
22.	Accidents - Time, in hours, to handle	PH(2)
23.	Accidents - Percent queued during shift 1	P(1, 5)
24.	Accidents - Percent queued during shift 2	P(2, 5)
25.	Accidents - Percent queued during shift 3	P(3, 5)
26.	Criminal complaints - Percent handled	PH(3)
27.	Criminal complaints - Time, in hours, to handle	PH(4)
28.	Criminal complaints - Percent queued during shift 1	P(1, 6)
29.	Criminal complaints - Percent queued during shift 2	P(2, 6)
30.	Criminal complaints - Percent queued during shift 3	P(3, 6)
31.	Starting time shift 1	P(1, 7)
32.	Starting time shift 2	P(2, 7)
33.	Starting time shift 3	P(3, 7)
34.	Ending time shift 1	P(1, 8)
35.	Ending time shift 2	P(2, 8)
36.	Ending time shift 3	P(3, 8)
37.	Shift coverage factor, for each district (k), shift 1	SC%(1, k)
38.	Shift coverage factor, for each district (k), shift 2	SC%(2, k)
39.	Shift coverage factor, for each district (k), shift 3	SC%(3, k)

TABLE 2

VARIABLES USED FOR THE MODEL

Item	Variable Name For Model (Entered)	Variable Name Used by Program
1.	Administrative support for district k	O%(k)
2.	Administrative support for central office	O%(ND%+1)
3.	Accidents per county i, for shift 1	AC%(0, 1, i)
4.	Accidents per county i, for shift 2	AC%(0, 2, i)
5.	Accidents per county i, for shift 3	AC%(0, 3, i)
6.	Criminal complaints per county i, for shift 1	AC%(1, 1, i)
7.	Criminal complaints per county i, for shift 2	AC%(1, 2, i)
8.	Criminal complaints per county i, for shift 3	AC%(1, 3, i)
9.	Miles of highway for county i, four-lane	M(1, i)
10.	Miles of highway for county i, two-lane, high volume	M(2, i)
11.	Miles of highway for county i, other rural	M(3, i)
12.	Volume for county i expessed in thousand vehicle miles, four-lane	M(4, i)
13.	Volume for county i expessed in thousand vehicle miles, two-lane	M(5, i)
14.	Volume for county i expessed in thousand vehicle miles, other rural	M(6, i)
15.	Rural population for county i, in 1000's	R(i)
16.	Area in square miles in county i	Q(i)
17.	Local law enforcement officers in county i	L%(i)
18.	District/county cross reference list, counties i for district k	DN% (i,k)

Other Variable Data Used (Computed)	Name
1. Congestion factor, four-lane roads, shift j, county i	FF(0, j, i)
2. Congestion factor, two-lane roads, shift j, county i	FF(1, j, i)
3. Positions needed for shift j, district k - accidents	CS(0, j, k)
4. Positions needed for shift j district k - criminal complaints	CS(1, j, k)
5. Positions needed for shift j, district k - minimum response	CS(2, j, k)
6. Positions assigned for shift j, district k - calls for service	CS(3, j, k)
7. Positions needed for shift j, district k - four-lane highways*	CS(0, j, k)
8. Positions needed for shift j district k - other highways*	CS(1, j, k)
9. Positions needed for shift j, district k - rural patrol*	CS(2, j, k)
10. Positions assigned for shift j, district k - policing and patrolling*	CS(3, j, k)
11. Number of stops expected per shift based on traffic volume	Y
12. Reduction in speed resulting from congestion	U
13. Equivalent free time for patrol, not involved in calls for service, for district k	DF(k)

*Note: The use of the variable name is repeated in order to conserve memory.

FIGURE 1

MENU FROM FACTOR INPUT

```
UPDATE ALLOCATION FACTORS

1. PARAMETER FILE

2. VARIABLE FILE

3. PRINT DATA

4. STOP

   USE RETURN TO SELECT
   OR SPACE BAR TO ADVANCE
```

Selection at STOP, done by moving the cursor to number "4" using any key, then pressing RETURN, ceases operation of FACTOR INPUT. Had this been the only program chosen, processing would be complete. If this program had been accessed through MANPOWER, operation would return automatically to MANPOWER.

Parameters

Entry of parameters is done when the user selects PARAMETER FILE from the menu (place the cursor over "1" and press RETURN). The computer displays screen 1 as shown in Figure 2. To enter a number, the user types the appropriate digits and presses return. To skip to the next line and maintain what already is entered, the user presses RETURN as the first entry. After the last line, page 2 (screen 2 in Figure 2) appears automatically. At any time, the user can skip

forward or backward full pages by pressing a "P" as the first character for "new page" or "B" for "back one page." After page 5, the screen automatically reverts to page 1.

Once the data have been entered or corrected, the user presses ESC (escape). This brings two questions to the monitor. "Are more corrections to be made?" An answer of YES or Y returns to the first of the five screens. NO brings the second question, "are data to be stored?" The answer of YES causes the computer to store data in a file called PARAMETERS on the same disk as the program. NO brings back the main menu, but it causes all data entered from the keyboard to be lost. A summary of the paging commands also is available by pressing "?". The two questions and response to "?" are shown in Figure 3.

Variables

The screens for entering or changing the variable data are presented when the user selects VARIABLE FILE (number 2) from the menu. Entering the data, skipping lines or pages, or selecting previous pages is performed in the same manner as for entering parameters. When the user is finished, he presses ESC and stores the data answering the same questions that were discussed previously. The stored data reside on the same disk as the program. The first screen requests the number of counties and districts. The next, requests administrative overhead for each district. Then for each district, there is a request (screen) for county numbers cross referenced that district. Finally, there are as many screens, each containing 15 variables, as there are counties (Figure 4).

FIGURE 2

SCREENS FOR UPDATING PARAMETERS

```
UPDATE ALLOCATION FACTORS

(1.) PARAMETER FILE

2. VARIABLE FILE

3. PRINT DATA

4. STOP

USE RETURN TO SELECT
OR SPACE BAR TO ADVANCE
```

SCREEN 1

```
PARAMETERS                                P 1 OF 5
```

```
                GENERAL                          1
TOTAL TO BE ALLOCATED          350
NUMBER COUNTIES                12
NUMBER DISTRICTS               4
MANHOURS PER YEAR              1760
ENFORCEMENT TIME               .25
MINIMUM RURAL ISP              0
MAXIMUM RURAL ISP              1
RURAL PERS. PER OFFICER        0
% ADT SHIFT 1                  15
% ADT SHIFT 2                  45
% ADT SHIFT 3                  40
MAX. RESPONSE - 1              40
MAX. RESPONSE - 2              20
MAX. RESPONSE - 3              20
PATROL MILES  4-LANE           0
PATROL MILES  2-LANE           0
PATROL MILES  OTHER            6000
% PATROL INTERSTATE            60
% PATROL OTHER ROADS           35
% PATROL RURAL                 5

? FOR HELP
```

PARAMETERS (Continued)

SCREEN 2

```
                ACCIDENTS                2
PERCENT HANDLED              100
TIME TO HANDLE               3.0
% QUEUED - 1                 20
% QUEUED - 2                 10
% QUEUED - 3                 10
```

SCREEN 3

```
                CRIMINAL COMPLNT         3
PERCENT HANDLED              200
TIME TO HANDLE               2
% QUEUED - 1                 20
% QUEUED - 2                 10
% QUEUED - 3                 10
```

SCREEN 4

```
                SHIFT START/END          4
FOR SHIFT 1 START            2300
            END              0659
FOR SHIFT 2 START            0700
            END              1459
FOR SHIFT 3 START            1500
            END              2359
```

SCREEN 5

```
                SHIFT COVERAGE           5
DISTRICT   1    2    3
   1       1    1    1
   2       1    1    1
   3       0    1    1
   4       0    1    1
```

```
ARE MORE CORRECTIONS TO BE MADE? NO

ARE DATA TO BE STORED?
  WARNING! A 'NO' DELETES ALL DATA
  JUST ENTERED ON KEYBOARD
    ?NO
```


FIGURE 3

SUMMARY OF COMMANDS

```
        ?
    CURSOR MOVES

TO CHANGE DATA, TYPE NEW NUMBERS

RETURN ADVANCES CURSOR

F  ADVANCE ONE PAGE
B  BACK ONE PAGE

ESC  STOPS INPUT

ARE MORE CORRECTIONS TO BE MADE? NO

ARE DATA TO BE STORED?
  WARNING! A 'NO' DELETES ALL DATA
  JUST ENTERED ON KEYBOARD
    ?YES
```

Printing Parameters and Variables

A list of parameters or variables can be sent to the printer. The user first selects PRINT DATA from the menu. Then, the user is given the choice of PARAMETER FILE or VARIABLE FILE. The appropriate file is selected by placing the cursor over the number and pressing the return key. Once the file is printed, the main menu again returns.

Running the Allocation Model

The operation of the allocation model is initiated by typing RUN MANPOWER. The program first asks "are changes to be made?" An answer of YES automatically transfers operation to the program FACTOR INPUT. The user

FIGURE 4

SCREENS FOR UPDATING VARIABLES

UPDATE ALLOCATION FACTORS

1. PARAMETER FILE

(2.) VARIABLE FILE

3. PRINT DATA

4. STOP

USE RETURN TO SELECT
OR SPACE BAR TO ADVANCE

SCREEN 1

VARIABLES P 1

NUMBER OF COUNTIES	12
NUMBER OF DISTRICTS	4

? FOR HELP

SCREEN 2

DISTRICT	ADMIN. SUPPORT PERSONS	P 2
1	18	
2	22	
3	10	
4	8	
CENTRAL	30	

VARIABLES (Continued)

SCREEN SET 3

DIST./CNTY XREF

P1 OF 4

DISTRICT 1
COUNTIES IN DISTRICT 2
1 2

P2 OF 4

DISTRICT 2
COUNTIES IN DISTRICT 1
3

P3 OF 4

DISTRICT 3
COUNTIES IN DISTRICT 5
4 5 6 7
8

SCREEN SET 4

COUNTY DATA P1 OF 12

COUNTY 1

ACCIDENTS - SHIFT 1	201
ACCIDENTS - SHIFT 2	600
ACCIDENTS - SHIFT 3	438
CRIMINAL COMPLAINTS - 1	190
CRIMINAL COMPLAINTS - 2	338
CRIMINAL COMPLAINTS - 3	230
MILES - 4 LANE	38
MILES - 2 LANE	400
MILES - OTHER	205
VOLUME - 4 LANE	560
VOLUME - 2 LANE	2200
VOLUME - OTHER	360
RURAL POPULATION	17.8
AREA	624
LOCAL LAW ENF.	12

P2 OF 12

COUNTY 2

ACCIDENTS - SHIFT 1	470
ACCIDENTS - SHIFT 2	1250
ACCIDENTS - SHIFT 3	1195
CRIMINAL COMPLAINTS - 1	340
CRIMINAL COMPLAINTS - 2	628
CRIMINAL COMPLAINTS - 3	416
MILES - 4 LANE	64
MILES - 2 LANE	430
MILES - OTHER	260
VOLUME - 4 LANE	1030
VOLUME - 2 LANE	3400
VOLUME - OTHER	460
RURAL POPULATION	23.6
AREA	624
LOCAL LAW ENF.	26

makes changes using the procedures described above. When the user selects "4. STOP" in the program FACTOR INPUT, control returns to the program MANPOWER and the allocations proceed. Note: a printer must be available because of the amount of output.

From this point until the end no further questions are presented. Computations are made and output generated on the printer. At the end, the user is asked if another run is to be made. Because of the large number of computations that are made, the program will run at the rate of approximately six minutes for every 10 counties. Figure 5 shows the output (note: the use of ISP in the output stems from the writing of the program for the Illinois Department of Law Enforcement).

Changes in parameters always are made at the start of the program and then the entire program run. Because of the limited space in the computer, such changes must be stored permanently. Only one run can be made for each set of parameters.

PROGRAM DESCRIPTION

An annotated version of both MANPOWER and FACTOR INPUT are shown as Appendices A and C. Program description for MANPOWER is contained in Appendix B. Up to 110 counties and 30 districts can be handled in the current version. The Tables already have shown the variable names used in the BASIC program, Appendix D contains a cross reference of those names as well as a list of other variable names. Appendix E shows the record layout for the two data files: PARAMETERS and VARIABLES.

FIGURE 5
OUTPUT FROM MODEL

```
*******************************
*                             *
*  MANPOWER ALLOCATION MODEL  *
*     CALLS FOR SERVICE       *
*                             *
*******************************

MANPOWER TO BE ALLOCATED  380
ALLOCATED TO CALLS  113.2
```

ACCIDENTS

		SHIFT					
	TOTAL	1ST		2ND		3RD	
DIST.	NBR	NBR	POS	NBR	POS	NBR	POS
1	4154	671	2.0	1850	5.0	1633	5.0
2	7280	1020	2.0	2950	6.0	3310	7.0
3	1308	261	0.0	484	5.0	563	5.0
4	876	186	0.0	331	4.0	359	4.0
TOT	13618	2138	4.0	5615	20.0	5865	21.0

CRIMINAL COMPLAINTS

		SHIFT					
	TOTAL	1ST		2ND		3RD	
DIST.	NBR	NBR	POS	NBR	POS	NBR	POS
1	2142	530	2.0	966	3.0	646	3.0
2	3701	886	2.0	1730	4.0	1085	3.0
3	519	97	0.0	232	0.0	190	0.0
4	1237	247	1.0	474	1.0	516	2.0
TOT	7599	1760	5.0	3402	8.0	2437	8.0

MINIMUM RESPONSE

	POSITIONS PER SHIFT		
	SHIFT		
DIST.	1ST	2ND	3RD
1	.4	1.6	1.6
2	.2	1.0	1.0
3	1.1	4.3	4.3
4	.8	3.1	3.1

FIGURE 5 (continued)

TOTAL MANPOWER ALLOCATED

POSITIONS PER SHIFT

DIST.	SHIFT 1ST	2ND	3RD	TOTAL OFFICERS	EQUIV. PATROLS
1	4.0	8.0	8.0	33.2	22.3
2	4.0	10.0	10.0	39.8	20.7
3	1.1	5.3	5.2	19.2	16.1
4	1.6	5.0	6.0	20.9	17.0
TOT	10.7	28.3	29.2	113.2	76.1

TOTALS

ACCIDENTS	13618
CRIMINAL RESPONSE	7599
ALLOCATED TO CALLS	113.2

** CFS PARAMETERS **

ACCIDENTS

PERCENT HANDLED	100%
TIME TO HANDLE	3 HRS.
% QUEUED - 1ST	10%
% QUEUED - 2ND	5%
% QUEUED - 3RD	5%

CRIMINAL COMPLAINTS

PERCENT HANDLED	200%
TIME TO HANDLE	2 HRS.
% QUEUED - 1ST	20%
% QUEUED - 2ND	10%
% QUEUED - 3RD	10%

RESPONSE TIME

MAX. RESPONSE - 1ST	40 MINS.
MAX. RESPONSE - 2ND	20 MINS.
MAX. RESPONSE - 3RD	20 MINS.

SHIFT START AND END

FOR SHIFT 1	START	2300	END	0659
FOR SHIFT 2	START	0700	END	1459
FOR SHIFT 3	START	1500	END	2359

FIGURE 5 (continued)

```
**********************************
*                                *
*  MANPOWER ALLOCATION MODEL     *
*   POLICING AND PATROLLING      *
*                                *
**********************************
```

AVAILABLE TO BE ALLOCATED 178.9

FOUR-LANE HIGHWAYS

DIST	TOTAL MILES	POSITIONS PER SHIFT 1ST	2ND	3RD	TOT
1	102.0	4.4	4.6	4.6	13.6
2	180.0	8.6	9.8	9.6	28.0
3	204.0	0.0	7.8	7.8	15.6
4	123.0	0.0	4.8	4.8	9.6
TOT	609.0	13.0	27.0	26.8	66.8

OTHER HIGHWAYS

DIST	TOTAL MILES 2-LANE	OTHER	POSITIONS PER SHIFT 1ST	2ND	3RD	TOT
1	830.0	465.0	2.5	3.5	3.3	9.3
2	240.0	100.0	1.0	1.8	1.7	4.5
3	2140.0	2020.0	0.0	6.9	6.6	13.5
4	1390.0	1335.0	0.0	4.6	4.4	9.0
TOT	4600.0	3920.0	3.5	16.8	16.0	36.3

RURAL LAW ENFORCEMENT

DIST	LOCAL POLICE	POSITIONS PER SHIFT 1ST	2ND	3RD	TOT
1	38	0.0	0.0	0.0	0.0
2	74	0.0	0.0	0.0	0.0
3	26	0.0	1.5	1.5	3.0
4	27	0.0	.8	.8	1.6
TOT	165	0.0	2.3	2.3	4.6

FIGURE 5 (continued)

MANPOWER ALLOCATED

DIST	POSITIONS PER SHIFT 1ST	2ND	3RD	TOT	TOTAL OFFICERS
1	6.9	8.1	7.9	22.9	38.0
2	9.6	11.6	11.3	32.5	53.9
3	0.0	16.2	15.9	32.1	53.3
4	0.0	10.2	10.0	20.2	33.5
TOT	16.5	46.1	45.1	107.7	178.7

MILES OF PATROL PER POSITION
- 4-LANE - 17.3
- 2-LANE - 306.2
- OTHER - 6000

RURAL POP./POLICE OFFICER 6265

TOTAL ALLOCATED TO PATROL 178.7

** POLICING/PATROLLING PARAMETERS **

ENFORCEMENT TIME	15 MINS.
MINIMUM RURAL ISP	0
MAXIMUM RURAL ISP	1
RURAL PERS. PER OFFICER	6266

PERCENT SPLIT OF ADT

% ADT SHIFT 1	15%
% ADT SHIFT 2	45%
% ADT SHIFT 3	40%

ALLOCATION OF PATROL

% PATROL INTERSTATE	60%
% PATROL OTHER ROADS	35%
% PATROL RURAL	5%

PATROLLING MILES

PATROL MILES	4-LANE	17 MILES
PATROL MILES	2-LANE	306 MILES
PATROL MILES	OTHER	6000 MILES

SHIFT COVERAGE

DISTRICT	SHIFT 1	2	3
1	Y	Y	Y
2	Y	Y	Y
3	-	Y	Y
4	-	Y	Y

FIGURE 5 (continued)

****
* *
* MANPOWER ALLOCATION MODEL *
* SUMMARY OF ALLOCATION *
* *
****

DIST.	ADMIN. SUPPORT	CALLS FOR SERVICE	POLICE & PATROL	TOTAL ALLOCATION
1	18	33.2	38.0	89.2
2	22	39.8	53.9	115.7
3	10	19.2	53.3	82.5
4	8	20.9	33.5	62.4
STF	30			
TOT	88	113.2	178.7	379.9

** ALL PARAMETERS USED **

TOTAL TO BE ALLOCATED	380
NUMBER COUNTIES	12
NUMBER DISTRICTS	4
MANHOURS PER YEAR	1760
ENFORCEMENT TIME	15 MINS.
MINIMUM RURAL ISP	0
MAXIMUM RURAL ISP	1
RURAL PERS. PER OFFICER	6266
% ADT SHIFT 1	15%
% ADT SHIFT 2	45%
% ADT SHIFT 3	40%
MAX. RESPONSE - 1ST	40 MINS.
MAX. RESPONSE - 2ND	20 MINS.
MAX. RESPONSE - 3RD	20 MINS.
PATROL MILES 4-LANE	17 MILES
PATROL MILES 2-LANE	306 MILES
PATROL MILES OTHER	6000 MILES
% PATROL INTERSTATE	60%
% PATROL OTHER ROADS	35%
% PATROL RURAL	5%

FIGURE 5 (continued)

ACCIDENTS

PERCENT HANDLED	100%
TIME TO HANDLE	3 HRS.
% QUEUED - 1ST	10%
% QUEUED - 2ND	5%
% QUEUED - 3RD	5%

CRIMINAL COMPLAINTS

PERCENT HANDLED	200%
TIME TO HANDLE	2 HRS.
% QUEUED - 1ST	20%
% QUEUED - 2ND	10%
% QUEUED - 3RD	10%

SHIFT START AND END

FOR SHIFT 1	START	2300	END	0659
FOR SHIFT 2	START	0700	END	1459
FOR SHIFT 3	START	1500	END	2359

SHIFT COVERAGE

	SHIFT		
DISTRICT	1	2	3
1	Y	Y	Y
2	Y	Y	Y
3	-	Y	Y
4	-	Y	Y

Plans are established to convert this program to an IBM PC. With 128K storage, the program will be able to handle up to 150 counties and 50 districts. Additionally, the user will be able to change parameters temporarily without making the permanent changes now required.

NOTES

1. Richard A. Raub and George L. Sweat, Method for Allocating State Police Officers in Illinois, Illinois Department of Law Enforcement, Springfield, Illinois, 1981.

2. Richard A. Raub and George L. Sweat, "Manpower Allocation: Rationale for Methods in State Police Districts", Police Chief, 50:6, June 1983.

3. Richard A. Raub, Model to Allocate State Police Manpower to Districts: Revised Version, Illinois Department of Law Enforcement, Springfield, Illinois, February 1984.

4. Raub, 1984.

5. Ibid.

APPENDIX A

PROGRAM LISTING:

MANPOWER

```
5  REM  MANPOWER ALLOCATION MODEL
10 D$ =  CHR$ (13) +  CHR$ (4)
15  REM  "VARIABLES" IS NAME OF VARIABLES FILE
16  REM  "PARAMETERS" IS NAME OF PARAMETRS FILE
20 F2$ = "VARIABLES":F1$ = "PARAMETERS"
30 UL$ = "---------":BB$ = "         "
35  REM  VARIABLE NAMES USED IN PROGRAM
36  REM  ARE DESCRIBED IN THE OPERATING INSTRUCTIONS
40  DIM P(3,8),PH(4),SC%(3,30),DN%(15,30),AC(1,3),DP(3),DF(30)
50  DIM O%(30),AC%(1,3,140),Q(140),LX(140),RP(140),M(5,140)
60  DIM FF(1,3,110),CS(4,3,30),XC(4,3),SR(2,110)
70  DIM PN$(25),P$(100)
80  DEF  FN RN(X) =  INT (10 * X + .5) / 10
85  REM  READ PARAMETER NAMES FROM DATA STATEMENTS (LINES 8000+)
90  FOR I = 1 TO 25
100  READ PN$(I): NEXT
110  HOME : PRINT  TAB( 13);"MANPOWER ALLOCATION": PRINT : IF  PEEK (800) >
     0 GOTO 150
114  REM  'PEEK' CHECKS IF PROGRAM "FACTOR INPUT" HAS BEEN RUN
115  REM  IF NOT, USER MAY CHANEG PARAMETERS OR VARIABLES
116  REM  THEN "FACTOR INPUT" RUNS AUTOMATICALLY
117  REM  AFTER, "MANPOWER" RUNS AUTOMATICALLY
120  GOSUB 8000: PRINT
130  INPUT "ARE THERE CHANGES? ";Y$
140  IF  LEFT$ (Y$,1) = "Y" THEN  POKE 800,1: PRINT D$"RUN FACTOR INPUT"
145  REM  READ DATA FROM FILES "VARIABLES" AND "PARAMETERS"
150  GOSUB 5000: GOSUB 5500: GOSUB 5800
160 Z% = 1:SF = 2920 / TA:TP = (TT - O%(0)) / SF: REM  AVAILABLE POSITIONS

165  REM  RUN  CALLS FOR SERVICE  SUBROUTINE
170  GOSUB 3000: GOSUB 5900
175  REM  OPENS PRINT -- IDS PAPER TIGER
180  PRINT D$"PR#1": PRINT  CHR$ (9);"80N"
184  REM  PRINT RESULTS FROM CALLS FOR SERVICE COMPUTATIONS
185  REM  VALUE OF 'K' DETERMINES DATA TO BE PRINTED
186  REM  PRINTS - ACCIDENTS, CRIMINAL COMPLAINTS, RESPONSE TIME
187  REM  SHOWING NUMBER OF PERSONS NEEDED TO SATISFY EACH
190  FOR K = 0 TO 3
200  ON K + 1 GOSUB 3300,3380,3430,3440
210  FOR I1 = 1 TO ND% + 1
220 I = I1:X1$ =  RIGHT$ ("  " +  STR$ (I),3)
230  IF I1 = ND% + 1 THEN I = 0:X1$ = "TOT": IF K = 2 GOTO 410
240  PRINT X1$;" ";
```

```
250  IF K > 1 THEN ZF = 10: GOTO 290
260 ZF = 7: IF I = 0 THEN X = AC(K,0): GOSUB 1510: GOTO 280
270 X = ACX(K,0,I + 110): GOSUB 1510
280  PRINT X1$;
290  FOR J = 1 TO 3
300  IF K > 1 GOTO 350
310  IF I <  > 0 THEN  GOSUB 1605
320 ZF = 7: IF I = 0 THEN X = AC(K,J): GOSUB 1510: GOTO 340
330 X = ACX(K,J,I + 110): GOSUB 1510
340  PRINT X1$;:ZF = 6
350 X = CS(K,J,I): GOSUB 1520
360  PRINT X1$;: IF J < 3 OR K < 3 GOTO 400
370 X =  FN RN(CS(K,0,I) * SF): GOSUB 1520
380  PRINT " ";X1$;: IF I > 0 THEN DF(I) = (CS(3,0,I) * TA - DF(I)) / TA:D
    F(0) = DF(0) + DF(I)
390 X =  FN RN(DF(I) * SF): GOSUB 1520: PRINT X1$;
400  NEXT J: PRINT
410  NEXT I1: PRINT : NEXT K
415  REM  PRINT SUMMARY OF CALLS FOR SERVICE COMPUTATIONS
420  PRINT : PRINT "TOTALS"
430  PRINT "  ACCIDENTS";: HTAB 24: PRINT  RIGHT$ (BB$ +  STR$ (AC(0,0)),7
    )
440  PRINT "  CRIMINAL RESPONSE";: HTAB 24: PRINT  RIGHT$ (BB$ +  STR$ (AC
    (1,0)),7)
450  PRINT "  ALLOCATED TO CALLS";:X =  FN RN(CS(3,0,0) * SF):ZF = 7
460  GOSUB 1520: HTAB 24: PRINT X1$:Z% = 2
464  REM  PRINT LIST OF PARAMETER VALUES USED FOR CALLS FOR SERVICE
465  REM  THEN, COMPUTE POLICING AND PATROLLING ALLOCATIONS
466  REM  STARTING AT PATROLLING SUBROUTINE, LINE 4000
470  GOSUB 3600: GOSUB 2700: GOSUB 4000
474  REM  PRINTING ROUTINE FOR POLICING AND PATROLLING COMPUTATIONS
475  REM  VALUE OF 'K'' DETERMINES SUBGROUP TO BE PRINTED
476  REM  FOUR-LANE PATROL, TWO-LANE PATROL, AND RURAL POLICING
480  FOR K = 0 TO 4
490  ON K + 1 GOSUB 6000,6090,6120,2750,6150
500  IF K = 3 GOTO 650
510  FOR I1 = 1 TO ND% + 1
520 I = I1: IF I1 = ND% + 1 THEN I = 0:X1$ = "TOT": GOTO 540
530 X1$ =  RIGHT$ ("   " +  STR$ (I),3)
540  PRINT X1$;" ";: IF K = 4 GOTO 580
550 ZF = 9:X = M(K,I + 110): IF K = 2 THEN X = LX(I + 110): GOSUB 1510: GOTO
    570
560  GOSUB 1520
570  PRINT X1$;: IF K = 1 THEN X = M(2,I + 110): GOSUB 1520: PRINT X1$;
580  FOR J = 1 TO 4
```

```
590 KK = J: IF J = 4 THEN KK = 0
600 ZF = 7:X = CS(K,KK,I)
610  GOSUB 1520: PRINT X1$;: IF K < 4 GOTO 640
620  IF K = 4 AND J < 4 GOTO 640
630 ZF = 10:X =  FN RN(X * SF): GOSUB 1520: PRINT X1$;
640  NEXT J: PRINT : NEXT I1: PRINT
650  NEXT K
655  REM  PRINT SUMMARY OF POLICING AND PATROLLING ALLOCATIONS
660  PRINT : PRINT "MILES OF PATROL PER POSITION"
670  PRINT  TAB( 6);"4-LANE -"; SPC( 3); RIGHT$ (BB$ +  STR$ ( FN RN(P(1,3
     )),5)
680  PRINT  TAB( 6);"2-LANE -"; SPC( 3); RIGHT$ (BB$ +  STR$ ( FN RN(P(2,3
     )),5)
690  PRINT  TAB( 6);"OTHER  -"; SPC( 3); RIGHT$ (BB$ +  STR$ ( FN RN(P(3,3
     )),5)
700  PRINT "RURAL POP./POLICE OFFICER";: HTAB 29: PRINT  RIGHT$ (BB$ +  STR$
     ( INT (RX)),6)
710  PRINT : PRINT "TOTAL ALLOCATED TO PATROL";: HTAB 29: PRINT  RIGHT$ (B
     B$ +  STR$ ( FN RN(CS(4,0,0) * SF)),6)
714  REM  PRINT LIST OF PARAMTER VALUES USED FOR POLICING AND PATROLLING
715  REM  THEN, PRINT SUMMARY STATISTICS FOR THREE PARTS OF ALLOCATIONS
716  REM  ADMINISTRATIVE SUPPORT, CALLS FOR SERVICE, AND
717  REM  POLICING AND PATROLLING ALLOCATIONS
720  GOSUB 6500: GOSUB 7000
730  FOR I1 = 1 TO ND% + 1
740 X1$ =  STR$ (I1):I = I1: IF I <  = ND% GOTO 760
750 I = 0:X1$ = "TOT": PRINT "STF"; SPC( 6); RIGHT$ ("  " +  STR$ (OZ(I1))
     ,3)
760  PRINT  RIGHT$ ("   " + X1$,3); SPC( 6); RIGHT$ ("   " +  STR$ (OZ(I))
     ,3);
770 K = 0:ZF = 11
780  FOR J = 3 TO 4
790 X =  FN RN(CS(J,0,I) * SF): GOSUB 1520: PRINT X1$;
800 K = K + X: NEXT J
810 X = OZ(I) + K: GOSUB 1520
815  REM  PRINT LIST OF ALL PARAMETER VALUES USED IN THIS ALLOCATION
820  PRINT X1$: NEXT I1: GOSUB 7500
830  PRINT : PRINT : PRINT : PRINT
835  REM  PREPARE COMPUTER FOR ANOTHER RUN
840  PRINT D$"PR#0": POKE 800,0
850  HOME : INPUT "ANOTHER RUN OF THE PROGRAM? ";Y$
860  IF  LEFT$ (Y$,1) = "Y" GOTO 110
870  STOP
1000  REM
1005  REM  * * *  FIND CORRECT DISTRICT  * * *
```

```
1006  REM  COMPARES COUNTY NUMBER TO DISTRICT/COUNTY
1007  REM  CROSS REFERENCE TABLE AND ASSIGNS DISTRICT NUMBER
1010  FOR K = 1 TO ND%
1020  FOR K1 = 1 TO DN%(0,K)
1030  IF DN%(K1,K) = I THEN  RETURN
1040  NEXT K1,K: RETURN
1200  REM
1205  REM  * * *   POISSON DISTRIBUTION   * * *
1206  REM  POISSON DISTRIBUTION SUBROUTINE
1210 SX = 0: FOR N = 0 TO 20
1220 XF = XF * N: IF XF <  > 0 THEN XF = 1
1230 SX = SX +  EXP ( - MM) * MM ↑ N / XF: IF SX >  = X THEN  RETURN
1240  NEXT : RETURN
1400  REM
1405  REM   * * *  SHORT ROUTINES FOR COMPUTATIONS  * * *
1406  REM  COMPUTES 4-LANE AND 2-LANE CONGESTION FACTORS
1410 X = M(4,I) * P(J,1) / 100:FF(L,J,I) = X / 8000: IF X > 10300 THEN FF(
     L,J,I) = 3.88 + (X - 10300) / 1300
1420  RETURN
1430 X = M(5,I) * P(J,1) / 100:FF(L,J,I) = X / 2000: IF X > 3400 THEN FF(L
     ,J,I) = 5.15 + (X - 3400) / 70
1440  RETURN
1500  REM
1505  REM   * * *   FORMATTING OUTPUT  * * *
1506  REM  USED TO FORMAT OUTPUT, THERE IS NO 'PRINT USING' STATEMENT
1510 X1$ =  RIGHT$ (BB$ +  STR$ (X),ZF): RETURN
1520 X1$ =  RIGHT$ (BB$ +  STR$ (X),ZF): IF  MID$ (X1$,ZF - 1,1) <  > "." THEN
     X1$ =  RIGHT$ (BB$ +  STR$ (X),ZF - 2) + ".0"
1530  RETURN
1600  REM
1605  REM * * *   ACCIDENT/CRIMINAL COMPLAINT TIME   * * *
1606  REM  HOURS REQUIRCED TO HANDLE ACCIDENTS AND CRIMINAL COMPLAINTS
1610 DF(I) = DF(I) + (1 - P(J,K + 5) / 100) * PM(K * 2 + 1) / 100 * PM(K *
     2 + 2) * AC%(K,J,I + 110)
1620  RETURN
1700  REM
1705  REM  * * *  STOPS PER SHIFT
1706  REM  COMPUTES EXPECTED NUMBER OF STOPS MADE BY OFFICER
1707  REM  FOR MOTORIST SERVICES AND TRAFFIC ENFORCEMENT
1708  REM  BASED ON TRAFFIC VOLUME
1710 Y = 6 * M(3,I) * P(J,1) / 100 * SC%(J,K) / 2920: GOTO 1730
1720 Y = P(J,1) / 100 * SC%(J,K) * (8.7 * M(4,I) + 1.8 * M(5,I)) / 2920
1730 U = 50 / (50 - FF(L,J,I)): RETURN
1800  REM
1805  REM  * * *  CUMMULATE MILES, ACCIDENTS, ETC.  * * *
```

```
1806  REM  CUMMULATES ACCIDENTS, MCRIMINAL COMPLAINTS, AREA, AND
1807  REM  HIGHWAY MILEAGES IN ORDER TO PRINT DISTRICT TOTALS
1810 K1 = K + 110:ACX(0,J,K1) = ACX(0,J,K1) + ACX(0,J,I):ACX(1,J,K1) = ACX
     (1,J,K1) + ACX(1,J,I)
1820 ACX(0,0,K1) = ACX(0,0,K1) + ACX(0,J,I):AC(0,0) = AC(0,0) + ACX(0,J,I)
     :AC(0,J) = AC(0,J) + ACX(0,J,I)
1830 ACX(1,0,K1) = ACX(1,0,K1) + ACX(1,J,I):AC(1,0) = AC(1,0) + ACX(1,J,I)
     :AC(1,J) = AC(1,J) + ACX(1,J,I)
1840  IF J <  > 1 GOTO 1890
1850  FOR L = 0 TO 2
1860 M(L,K1) = M(L,K1) + M(L,I):M(L,110) = M(L,110) + M(L,I): NEXT
1870 Q(K1) = Q(K1) + Q(I):RP(K1) = RP(K1) + RP(I):LX(K1) = LX(K1) + LX(I)
1880 Q(110) = Q(110) + Q(I):RP(110) = RP(110) + RP(I):LX(110) = LX(110) +
     LX(I)
1890  RETURN
2000  REM
2005  REM   * * *  CUMMULATE TOTALS  * * *
2006  REM  CUMMULATES TOTAL ALLOCATIONS OF POSITIONS BOTH
2007  REM  CALLS FOR SERVICE AND POLICING AND PATROLLING
2010  FOR K = 0 TO 4: IF K = 3 AND ZX = 2 GOTO 2070
2020  IF K = 4 AND ZX = 1 GOTO 2070
2030  FOR I = 1 TO NDX: FOR J = 1 TO 3
2040 X =  FN RN(CS(K,J,I)):CS(K,J,I) = X
2050 CS(K,J,0) = CS(K,J,0) + X:CS(K,0,I) = CS(K,0,I) + X
2060 CS(K,0,0) = CS(K,0,0) + X: NEXT J,I
2070  NEXT K: RETURN
2080  FOR K = 0 TO 4: IF K = 3 GOTO 2120
2090  FOR I = 1 TO NDX: FOR J = 1 TO 3
2100 X =  FN RN(CS(K,J,I)):CS(K,J,0) = CS(K,J,0) + X:CS(K,0,I) = CS(K,0,I)
      + X
2110 CS(K,0,0) = CS(K,0,0) + X: NEXT J,I
2120  NEXT K: RETURN
2500  REM
2505  REM  * * *  CONVERT TO ACTUAL PATROLLING POSITIONS  * * *
2506  REM  CONVERTS EQUIVALENT PATROLLING POSITIONS WHICH
2507  REM  INCLUDE FREE TIME FROM CALLS FOR SERVICE
2508  REM  TO ACTUAL POLICING AND PATROLING POSITIONS
2510 FD = TD / (DF(0) + CS(4,0,0))
2520  FOR K = 1 TO NDX
2530 U = FD * (DF(K) + CS(4,0,K)) / CS(4,0,K)
2540  FOR L = 0 TO 4: IF L = 3 GOTO 2580
2550  FOR J = 1 TO 3
2560 CS(L,J,K) =  FN RN(CS(L,J,K) * U)
2570 CS(L,J,0) = 0: NEXT J:CS(L,0,K) = 0:CS(L,0,0) = 0
2580  NEXT L,K: RETURN
```

```
2700  REM
2705  REM     * * *   INTITIALIZE    * * *
2706  REM  INITIALIZE VARIOUS ARRAYS USED IN PROGRAM
2710  FOR I = 0 TO 4: FOR J = 0 TO 3: IF I = 3 GOTO 2740
2720 XC(I,J) = 0: FOR K = 0 TO 30
2730 CS(I,J,K) = 0: NEXT
2740  NEXT J,I
2750  RETURN
2900  REM
2905  REM  * * *   OUTLINE ROUTINE    * * *
2906  REM  PRINTS ASTERISK OUTLINES AROUND TITLES
2910  PRINT  TAB( 11);
2920  FOR I1 = 1 TO 31: PRINT "*";: NEXT
2930  PRINT : RETURN
2940  PRINT  TAB( 11);"*"; SPC( 29);"*": RETURN
3000  REM
3005  REM  * * *   CALLS FOR SERVICE ROUTINE    * * *
3006  REM  SUBROUTINE TO COMPUTE NUMBER OF POSITIONS REQUIRED TO
3007  REM  HANDLE CALLS FOR SERVICE (ACCIDENTS, CRIMINAL COMPLAINTS)
3010  FOR I = 1 TO NCX: GOSUB 1000
3020  FOR J = 1 TO 3
3030  FOR L = 0 TO 1: ON L + 1 GOSUB 1410,1430
3040 MM = PH(L * 2 + 1) / 100 * PH(L * 2 + 2) * ACX(L,J,1) / 2920
3045  REM   USE POISSON DISTRIBUTION SUBROUTINE
3050 X = 1 - P(J,L + 5) / 100: GOSUB 1200
3060 XC(L,J) = N: NEXT L
3070 D = P(J,2) * ((60 - FF(0,J,I)) * M(0,I) + (45 - FF(1,J,1)) * M(1,I)) /
     (60 * M(0,I) + 45 * m(1,I))
3080 XC(2,J) = 2 *  SQR (Q(I)) / (3 * D)
3084  REM  DETERMINES IF POSITIONS NEEDED FOR CALLS FOR SERVICE
3085  REM  ARE GREATER THAN THOSE NEEDED TO MINIMIZE RESPONSE
3086  REM  SELECT THE GREATER
3090 XC(3,J) = XC(0,J) + XC(1,J): IF XC(2,J) > XC(3,J) THEN XC(3,J) = XC(2
     ,J)
3100  GOSUB 1800
3110  FOR L = 0 TO 3
3120 CS(L,J,K) = CS(L,J,K) + XC(L,J) * SCX(J,K): NEXT L
3130  NEXT J,1: GOSUB 2000: RETURN
3300  REM
3305  REM  * * *   PRINTING INSTRUCTIONS FOR CALLS FOR SERVICE  * * *
3306  REM  PRINTS ALL COMPUTATIONS FROM CALLS FOR SERVICE ROUTINE
3310  PRINT : PRINT : GOSUB 2900: GOSUB 2940
3320  PRINT  TAB( 11);"*  MANPOWER ALLOCATION MODEL  *"
3330  PRINT  TAB( 11);"*     CALLS FOR SERVICE       *"
3340  GOSUB 2940: GOSUB 2900: PRINT : PRINT
```

```
3350  PRINT "MANPOWER TO BE ALLOCATED  ";TT
3360  PRINT "ALLOCATED TO CALLS  " FN RN(CS(3,0,0) * SF): PRINT
3370 A$ = "    ACCIDENTS":B$ = "     -" + UL$: GOTO 3390
3380 A$ = "CRIMINAL COMPLAINTS":B$ = UL$ + UL$ + "---"
3390  PRINT : PRINT  TAB( 18);A$: PRINT  TAB( 18);B$
3400  PRINT : PRINT  TAB( 28);"SHIFT"
3410  PRINT  TAB( 7);"TOTAL"; SPC( 7);"1ST"; SPC( 10);"2ND"; SPC( 10);"3RD
     "
3420  PRINT "DIST.   NBR"; SPC( 4);"NBR   POS"; SPC( 4);"NBR   POS"; SPC(
     4);"NBR   POS": RETURN
3430 A$ = "MINIMUM RESPONSE":B$ = UL$ + UL$: GOTO 3450
3435  REM  PRINT TOTALS FOR ALLOCATION TO CALLS FOR SERVICE
3440 A$ = "TOTAL MANPOWER ALLOCATED":B$ = UL$ + UL$ + UL$
3450  PRINT : PRINT  TAB( 15);A$: PRINT  TAB( 15);B$: PRINT
3460  PRINT  TAB( 14);"POSITIONS PER SHIFT": PRINT  TAB( 21);"SHIFT";
3470  IF K = 3 THEN  PRINT  SPC( 15);"TOTAL"; SPC( 4);"EQUIV.";
3480  PRINT : PRINT "DIST."; SPC( 6);"1ST"; SPC( 7);"2ND"; SPC( 7);"3RD";
3490  IF K = 3 THEN  PRINT  SPC( 4);"OFFICERS   PATROLS";
3500  PRINT : RETURN
3600  REM
3605  REM   * * *   PRINTING CFS PARAMETERS   * * *
3606  REM  PRINT PARAMETER VALUES USED FOR CALLS FOR SERVICE
3610  PRINT : PRINT : PRINT  TAB( 5);"**  CFS PARAMETERS  **"
3620  FOR I = 1 TO 2
3630 A$ = "ACCIDENTS": IF I = 2 THEN A$ = "CRIMINAL COMPLAINTS"
3640  PRINT : PRINT A$
3650  FOR J = 21 TO 25
3660  IF J <  > 22 THEN P$((I - 1) * 5 + J) = P$((I - 1) * 5 + J) + "%": GOTO
     3680
3670  IF J = 22 THEN P$((I - 1) * 5 + J) = P$((I - 1) * 5 + J) + " HRS."
3680  PRINT  TAB( 4);PN$(J);: HTAB 23: PRINT P$((I - 1) * 5 + J)
3690  NEXT J,I: PRINT
3700  PRINT "RESPONSE TIME": FOR I = 12 TO 14
3710 P$(I) = P$(I) + " MINS.": PRINT  TAB( 4);PN$(I);: HTAB 25: PRINT P$(I
     ): NEXT
3720  PRINT : GOSUB 8200
3730  PRINT : PRINT : RETURN
4000  REM
4005  REM  * * *   PATROLLING MILEAGE   * * *
4006  REM  COMPUTES POLICING AND PATROLLING ALLOCATIONS FOR
4007  REM  4-LANE AND 2-LANE ROADS.  COMPUTATIONS ARE BASED
4008  REM  ON EQUIVALENT MANPOWER (INCLUDIMG FREE TIME)
4010 TD = TP - CS(3,0,0):DP(0) = TD + DF(0)
4020  FOR I = 1 TO 3:DP(I) = DP(0) * P(I,4) / 100
4030  FOR J = 0 TO 3
```

MANPOWER (continued)

```
4040 XC(J,I) = 0: NEXT J,I
4050  FOR I = 1 TO NC%: GOSUB 1000
4060  FOR L = 0 TO 1:LL = L
4070 X1 = 0:X2 = 0: FOR J = 1 TO 3
4080 X1 = X1 + SC%(J,K) * U: IF L = 1 THEN X2 = X2 + SC%(J,K)
4090  ON L + 1 GOSUB 1710,1720
4100 XC(L,2) = XC(L,2) + Y * U: NEXT J
4110 XC(L,1) = XC(L,1) + M(L,I) * X1: IF L = 1 THEN XC(2,1) = XC(2,1) + M(
     2,I) * X2
4120  NEXT L,I
4125  REM  COMPUTE AVERAGE MILES OF PATROL, 4-LANE AND 2-LANE
4130 P(1,3) = XC(0,1) / (DP(1) - TE * XC(0,2))
4140 P(2,3) = XC(1,1) / (DP(2) - XC(2,1) / P(3,3) - TE * XC(1,2))
4150  FOR I = 0 TO ND%
4160 DF(I) = CS(3,0,I) - DF(I): NEXT
4170  FOR I = 1 TO NC%: GOSUB 1000
4180  FOR L = 0 TO 1: FOR J = 1 TO 3
4190  ON L + 1 GOSUB 1710,1720
4200 X = M(L,I) * SC%(J,K) * U / P(L + 1,3) + TE * Y * U
4210  IF L = 1 THEN X = X + M(2,I) * SC%(J,K) / P(3,3)
4220 CS(L,J,K) = CS(L,J,K) + X:CS(4,J,K) = CS(4,J,K) + X
4230  NEXT J,L,I: GOSUB 4500: GOSUB 2080
4240  GOSUB 2500: GOSUB 2000: RETURN
4500  REM
4505  REM    * * *   COMPUTE RURAL PATROL   * * *
4506  REM  COMPUTES NUMBER OF STATE POLIC OFFICERS NEEDED TO
4507  REM  SUPPLEMENT RURAL LOCAL LAW ENFORCEMENT.  AMOUNT DEPENDENT
4508  REM  UPON RURAL POPULATION AND NUMBER OF LOCAL OFFICERS
4510 RX = 1000 * RP(110) / (DP(3) + LX(110)):H2 = DP(3) - .05 * DP(3):H3 =
     DP(3) + .05 * DP(3):H1 = 0
4520 X2 = 0:L = 2
4530  FOR I = 1 TO NC%: GOSUB 1000
4540 U = 1000 * RP(I) / RX:X1 = LX(I) / 3
4550  FOR J = 0 TO 2
4560 SR(J,I) = U * SC%(J + 1,K) - X1: IF SR(J,I) <  VAL (P$(6)) THEN SR(J,
     I) =  VAL (P$(6)): GOTO 4580
4570  IF SR(J,I) >  VAL (P$(7)) THEN SR(J,I) =  VAL (P$(7))
4580 X2 = X2 + SR(J,I): NEXT J
4590  IF X2 > H3 THEN Z = NC% / I: GOTO 4620
4600  NEXT I: IF X2 > H2 GOTO 4630
4610 Z =  - 1
4620 D = RX:RX = RX + Z * ( ABS (RX - H1)) / 2:H1 = D: GOTO 4520
4630  FOR I = 1 TO NC%: GOSUB 1000
4640  FOR J = 1 TO 3
4650 CS(2,J,K) = CS(2,J,K) + SR(J - 1,I):CS(4,J,K) = CS(4,J,K) + SR(J - 1,
```

```
    I)
4660  NEXT J,I: RETURN
5000  REM
5005  REM  * * *   READ PARAMETERS  * * *
5006  REM  READ ALL PARAMETER VALUES FROM FILE "PARAMETERS"
5010  PRINT D$"OPEN "$F1$: PRINT D$"READ "$F1$
5020  INPUT X: INPUT TT: INPUT NC%: INPUT ND%
5030 P$(1) =  STR$ (TT):P$(2) =  STR$ (NC%):P$(3) =  STR$ (ND%)
5040  INPUT TA: INPUT TE: INPUT RM%: INPUT RX%: INPUT RX
5050 P$(4) =  STR$ (TA):P$(5) =  STR$ (TE):P$(6) =  STR$ (RM%):P$(7) =  STR$
    (RX%):P$(8) =  STR$ (RX)
5060  FOR I = 1 TO 7: ON I GOTO 5070,5070,5070,5070,5100,5100,5140
5070  FOR J = 1 TO 3
5080  INPUT P(J,I):P$(8 + (I - 1) * 3 + J) =  STR$ (P(J,I))
5090  NEXT J: GOTO 5170
5100  FOR J = 1 TO 5
5110  IF J < 3 THEN  INPUT PH((I - 5) * 2 + J):P$(20 + (I - 5) * 5 + J) =
    STR$ (PH((I - 5) * 2 + J)): GOTO 5130
5120  INPUT P(J - 2,I):P$(20 + (I - 5) * 5 + J) =  STR$ (P(J - 2,I))
5130  NEXT J: GOTO 5170
5140  FOR J = 1 TO 3
5150  INPUT P(J,I): INPUT P(J,I + 1)
5160 P$(30 + (J - 1) * 2 + 1) =  STR$ (P(J,I)):P$(30 + (J - 1) * 2 + 2) =
    STR$ (P(J,I + 1)): NEXT J
5170  NEXT I
5180  FOR I = 1 TO ND%
5190  FOR J = 1 TO 3
5200  INPUT SC%(J,I):P$(36 + (I - 1) * 3 + J) =  STR$ (SC%(J,I))
5210  NEXT J,I
5220  PRINT D$"CLOSE "$F1$: RETURN
5500  REM
5505  REM  * * *   READ VARIABLES  * * *
5506  REM  READ ALL VARIABLE VALUES FROM FILE "VARIABLES"
5510  PRINT D$"OPEN "$F2$: PRINT D$"READ "$F2$
5520  INPUT X: INPUT X: INPUT X
5530  FOR I = 1 TO ND% + 1
5540  INPUT O%(I):O%(0) = O%(0) + O%(I): NEXT
5550 DN%(0,0) = ND%:PY = 0
5555  REM  DISTRICT/COUNTY CROSS REFERENCE TABLE
5560  FOR I = 1 TO ND%: INPUT X
5570 DN%(0,I) = X - PY:PY = X: NEXT
5580  FOR I = 1 TO ND%: FOR J = 1 TO DN%(0,I)
5590  INPUT DN%(J,I): NEXT J,I
5595  REM  READ VARIABLE VALUES FOR EACH COUNTY
5600  FOR K = 1 TO NC%
```

```
5610  FOR L = 0 TO 1: FOR J = 1 TO 3
5620  INPUT AC%(L,J,K): NEXT J,L
5630  FOR J = 0 TO 5
5640  INPUT M(J,K):M(J,0) = M(J,0) + M(J,K): NEXT J
5650  INPUT RP(K): INPUT Q(K): INPUT LX(K): NEXT K
5660  PRINT D$"CLOSE "$F2$: RETURN
5800  REM
5805  REM  * * *   CHECK CALLS FOR SERVICE COUNT AGAINST AVAILABLE OFFICER
      S   * * *
5810  IF OX(0) < TT THEN  RETURN
5820  PRINT D$"PR#0": HOME : PRINT  CHR$ (7); CHR$ (7)
5830  PRINT OX(0)$" ADMINISTRATIVE OFFICERS EQUAL OR": PRINT  TAB( 4)$"EXC
      EED "$TT$" AVAILABLE OFFICERS"
5840  PRINT : PRINT "CHANGE ANY OF FOLLOWING -"
5850  PRINT  TAB( 4)$"ADMINISTRATIVE OFFICCERS": PRINT  TAB( 4)$"TOTAL OFF
      ICERS TO BE ALLOCATED"
5860  PRINT : PRINT "PRESS ANY KEY TO CONTINUE "$: GET A$: PRINT A$
5870  PRINT D$$"RUN FACTOR INPUT"
5900  REM
5905  REM  * * *    CHECK CALLS FOR SERVICE AGAINST AVAILABLE OFFICERS   *
      * *
5910  IF CS(3,0,0) < TP THEN  RETURN
5920  PRINT D$"PR#0": HOME : PRINT  CHR$ (7); CHR$ (7)
5930  PRINT  FN RN(CS(3,0,0) * SF)$" OFFICERS ASSIGNED TO CALLS": PRINT  TAB(
      4)$"EXCEEDS "$TT - OX(0)$" OFFICERS AVAILABLE"
5940  PRINT : PRINT "CHANGE ANY OF FOLLOWING -"
5950  PRINT  TAB( 4)$"CALLS FOR SERVICE PARAMETERS": GOTO 5850
6000  REM
6005  REM  * * *   PRINTING INSTRUCTIONS FOR PATROLLING   * * *
6006  REM  PRINT HEADINGS AND TITLES FOR POLICING AND PATROLLING
6010  PRINT : PRINT : GOSUB 2900: GOSUB 2940
6020  PRINT  TAB( 11)$"*  MANPOWER ALLOCATION MODEL  *"
6030  PRINT  TAB( 11)$"*   POLICING AND PATROLLING   *"
6040  GOSUB 2940: GOSUB 2900: PRINT : PRINT
6050  PRINT "AVAILABLE TO BE ALLOCATED  "$ FN RN(TO * SF): PRINT : PRINT
6060  PRINT : PRINT  TAB( 14)$"FOUR-LANE HIGHWAYS"
6070  PRINT  TAB( 14)$UL$$UL$$"--": PRINT
6080  PRINT  TAB( 9))"TOTAL"$ SPC( 7)$: GOTO 6180
6090  PRINT : PRINT  TAB( 18)$"OTHER HIGHWAYS"
6100  PRINT  TAB( 18)$UL$$"-------": PRINT
6110  PRINT  TAB( 10)$"TOTAL MILES"$ SPC( 9)$: GOTO 6180
6120  PRINT : PRINT  TAB( 14)$"RURAL LAW ENFORCEMENT"
6130  PRINT  TAB( 14)$UL$$UL$$"------": PRINT
6140  PRINT  TAB( 9)$"LOCAL"$ SPC( 7)$: GOTO 6180
6145  REM  PRINT SUMMARY ALLOCATIONS FOR POLICING AND PATROLLING
```

```
6150  PRINT : PRINT  TAB( 14);"MANPOWER ALLOCATED"
6160  PRINT  TAB( 14);UL$;UL$;"--": PRINT
6170  PRINT  SPC( 11);
6180  PRINT "POSITIONS PER SHIFT";: IF K < 4 THEN  PRINT : GOTO 6200
6190  PRINT  SPC( 7);"TOTAL"
6200  PRINT "DIST";: ON K + 1 GOTO 6210,6220,6230,6240,6240
6210  PRINT  SPC( 4)"MILES";: GOTO 6240
6220  PRINT  SPC( 3);"2-LANE"; SPC( 4);"OTHER";: GOTO 6240
6230  PRINT  SPC( 3);"POLICE";
6240  PRINT  SPC( 4);"1ST"; SPC( 4);"2ND"; SPC( 4);"3RD"; SPC( 4);"TOT";
6250  IF K < 4 THEN  PRINT : RETURN
6260  PRINT  SPC( 3);"OFFICERS": RETURN
6500  REM
6505  REM  * * *   POLICING/PATROLLING PARAMETERS   * * *
6506  REM  PRINT PARAMETER VALUES USED FOR POLICING AND PATROLLING
6510  PRINT : PRINT : PRINT  TAB( 5)"**  POLICING/PATROLLING PARAMETERS  *
     *": PRINT
6520  FOR I = 5 TO 8
6530  IF I = 5 THEN P$(I) =  STR$ ( INT ( VAL (P$(I)) * (60) + .5)) + " MI
     NS."
6540  IF I = 8 THEN P$(I) =  STR$ ( INT (RX + .5))
6550  PRINT PN$(I);: HTAB 25: PRINT P$(I): NEXT
6560  PRINT : PRINT "PERCENT SPLIT OF ADT"
6570  FOR I = 9 TO 11
6580 P$(I) = P$(I) + "%": PRINT  TAB( 4);PN$(I);: HTAB 25: PRINT P$(I): NEXT

6590  PRINT : PRINT "ALLOCATION OF PATROL"
6600  FOR I = 18 TO 20
6610 P$(I) = P$(I) + "%": PRINT  TAB( 4);PN$(I);: HTAB 25: PRINT P$(I): NEXT

6620  PRINT : PRINT "PATROLLING MILES"
6630  FOR I = 15 TO 17
6640 P$(I) =  STR$ ( INT (P(I - 14,3) + .5))
6650 P$(I) = P$(I) + " MILES": PRINT  TAB( 4);PN$(I);: HTAB 26: PRINT P$(I
     ): NEXT
6660  PRINT : GOSUB 8400
6670  PRINT : PRINT : RETURN
7000  REM
7005  REM   * * *   SUMMARY OF ALLOCATIONS   * * *
7006  REM  PRINTS SUMMARY OF ALLOCATIONS BY DISTRICT
7007  REM  FOR EACH OF THREE CATEGORIES - ADMINISTRATIVE SUPPORT,
7008  REM  CALLS FOR SERVICE, AND POLICING AND PATROLLING
7010  PRINT : PRINT : GOSUB 2900: GOSUB 2940
7020  PRINT  TAB( 11);"*  MANPOWER ALLOCATION MODEL  *"
7030  PRINT  TAB( 11);"*"; SPC( 4);"SUMMARY OF ALLOCATION"; SPC( 4);"*"
```

```
7040  GOSUB 2940: GOSUB 2900: PRINT : PRINT
7050  PRINT  TAB( 19);"CALLS"; SPC( 5);"POLICE": PRINT  TAB( 9);"ADMIN."; SPC(
     5);"FOR"; SPC( 8);"&"; SPC( 8);"TOTAL"
7060  PRINT "DIST.  SUPPORT   SERVICE"; SPC( 4);"PATROL   ALLOCATION"
7070  RETURN
7500  REM
7505  REM  * * *   PRINT ALL PARAMETERS USED   * * *
7506  REM  PRINT LIST OF PARAMETERS AND PARAMETER VALUES
7507  REM  USED FOR ALLOCATION PROGRAM
7510  PRINT : PRINT : PRINT  TAB( 8);"** ALL PARAMETERS USED **": PRINT
7520  FOR I = 1 TO 20
7530  PRINT PN$(I);: HTAB 26: PRINT P$(I): NEXT
7540  PRINT : FOR J = 0 TO 1
7550  ON J + 1 GOTO 7560,7570
7560  PRINT  TAB( 4);"ACCIDENTS": PRINT : GOTO 7580
7570  PRINT  TAB( 4);"CRIMINAL COMPLAINTS": PRINT
7580  FOR I = 21 TO 25
7590  PRINT PN$(I);: HTAB 23: PRINT P$(I + J * 5): NEXT
7600  PRINT : NEXT J
7610  PRINT : GOSUB 8200
7620  PRINT : GOSUB 8400: RETURN
8000  REM
8005  REM   * * *   TITLE   * * *
8006  REM  PRINTS ALL TITLES
8010  PRINT D$"PR#1": PRINT  CHR$ (9);"80N"
8020  GOSUB 2900: GOSUB 2940
8030  PRINT  TAB( 11);"*  MANPOWER ALLOCATION MODEL  *"
8040  PRINT  TAB( 11);"*"; SPC( 15);"BY R.A. RAUB  *"
8050  GOSUB 2940: PRINT  TAB( 11);"*  COPYRIGHT  1984"; SPC( 12);"*"
8060  PRINT  TAB( 11);"*  ILL. DEPT LAW ENFORCEMENT  *"
8070  GOSUB 2940: GOSUB 2900: PRINT
8080  PRINT D$"PR#0": RETURN
8200  PRINT  TAB( 4);"SHIFT START AND END": PRINT
8210  FOR I = 1 TO 3
8220  PRINT "FOR SHIFT ";I;
8230  PRINT "  START  "; RIGHT$ ("0" + P$(29 + I * 2),4);
8240  PRINT  SPC( 3);"END  "; RIGHT$ ("0" + P$(30 + I * 2),4): NEXT
8250  RETURN
8400  PRINT  TAB( 4);"SHIFT COVERAGE": PRINT
8410  PRINT  TAB( 14);"SHIFT": PRINT "DISTRICT   1   2   3"
8420  FOR I = 1 TO  VAL (P$(3))
8430 Z$ =  RIGHT$ ("   " +  STR$ (I),4) + "    ": PRINT Z$;
8440 J1 = (I - 1) * 3: FOR J = 1 TO 3
8450 A$ = P$(36 + J1 + J): IF A$ < "0.1" THEN A$ = "-"
8460  IF A$ = "1" OR A$ = "1.0" THEN A$ = "Y"
```

```
8470  PRINT  RIGHT$ ("    " + A$,4);: NEXT J: PRINT
8480  NEXT I: RETURN
9000  REM
9005  REM  * * *   DATA STATEMENTS   * * *
9006  REM  DATA STATEMENTS USED FOR TITLES
9010  DATA   TOTAL TO BE ALLOCATED,NUMBER COUNTIES,NUMBER DISTRICTS,MANHOU
      RS PER YEAR,ENFORCEMENT TIME,MINIMUM RURAL ISP,MAXIMUM RURAL ISP,RURA
      L PERS. PER OFFICER
9020  DATA % ADT SHIFT 1,% ADT SHIFT 2,% ADT SHIFT 3,MAX. RESPONSE - 1ST,M
      AX. RESPONSE - 2ND,MAX. RESPONSE - 3RD
9030  DATA PATROL MILES  4-LANE,PATROL MILES  2-LANE,PATROL MILES  OTHER,%
      PATROL INTERSTATE,% PATROL OTHER ROADS,% PATROL RURAL
9040  DATA PERCENT HANDLED,TIME TO HANDLE,% QUEUED - 1ST,% QUEUED - 2ND,%
      QUEUED - 3RD
```

APPENDIX B

DOCUMENTATION OF PROGRAM:

MANPOWER

APPENDIX B

DOCUMENTATION OF PROGRAM:
MANPOWER
(Refers to Steps in
Operation of Program)

1. Read parameter titles to be used for printing lists of parameters at the end of each allocation subsection.

2. Are parameters or variables to be changed?

   YES - Call in FACTOR INPUT, program to change parameters and variables.
   NO - Continue step 3.

3. Print title of output and page 1 title, "Calls for Service".

4. Read Parameter file (items read).

   a. Total Officers to be Allocated*
   b. Number of Counties and DISTRICTS
   c. Manhours per Officer worked per year
   d. Time per Stop enforcement and motorist assist (in hours)
   e. Minimum and Maximum number of State Police patrols per shift to support local rural law enforcement
   f. Rural Population per Rural Police Patrol*
   g. Percent of ADT during each of three shifts
   h. Maximum Average Response Time for each of three shifts
   i. Patrolling Mileage per patrol - Interstate,* Two-lane Primary,* and Other Local Roads
   j. Percent of Available Patrol positions assigned - Interstate, Two-lane Roads (all), and Support for Local Rural Law Enforcement (total of three percents must equal 100)
   k. Accidents
      - Percent Handled
      - Time to Handle in hours
      - Percent Queued per shift
   l. Criminal Complaints
      - Percent Handled
      - Time to Handle
      - Percent Queued per shift
   m. Starting and ending time for each of three shifts
   n. Shift Coverage Factor for each of three shifts in each district: 0 - shift not covered, 1 - shift covered with one-officer patrol, 2 - shift covered with two-officer patrol.

*If the program computes a requisite strength then Total Officers = 0, and Rural Population per Patrol, Patrolling Mileage Interstate and Two-lane Primary must have values greater than zero. Otherwise, Total Officers must be greater than zero.

5. Read Variable File (items read).

   a. Administrative Support (overhead) for each district and for central office.
   b. County/District cross reference table, county numbers in each district (for each county)
   c. Accidents occurring or handled during each shift.
   d. Criminal Complaints occurring or handled during each shift.
   e. Miles of Highway - Interstate, Two-lane Primary, and Other Local Roads.
   f. Volume expressed in thousands of vehicle miles - Interstate, Two-lane Primary, and Other Local Roads.
   g. Rural Population in 1,000's
   h. Area in square miles
   i. Number of Local Rural Law Enforcement Officers.

6. Does program allocate fixed number of officers? If "yes," then continue with Step 7 (Total Officers must be greater than zero). Otherwise, program determines requisite strength. Continue at Step 12.

7. Administrative Support

   7.1. Compute Total Administrative Support, sum all Administrative Support
   7.2. Compare Total Administrative Support to Total Officers
      a. Total Administrative Support is less, go to 7.3.
      b. Total Administrative Support is equal to or greater, then change either Total Officers to be allocated, or Administrative Support by district and for central office. Return to Step 7.1.
   7.3. Subtract Total Administrative Support from Total Officers leaving Allocated Officers.
   7.4. Convert Allocated Officers to Equivalent Positions.
      7.4.1. Compute Officers per Patrol from 2920/Man-hours per Officer*
      7.4.2. Divide Allocated Officers by Officers per Patrol
      *2920 is the number of hours in one 8-hour shift, 365 days a year

8. Calls for Service Positions
   (Performed for each county and within the county for each of three shifts.)
   8.1. Determine district number from county/district cross reference table (5b)

   8.2. If Shift Coverage Factor for district is equal to zero, then select next shift or next county (return to 8.1 if next county)
   8.3 Accidents - Number of Patrols needed to handle
      8.3.1. Multiply Accidents during shift by Percent Handled
      8.3.2. Compute Average Arrival Rate for shift from results of 8.3.1 x Time to Handle/2920
      8.3.3. Using Poisson distribution, compute cumulative probability of occurrence using X = 0, 1 . . . n, until cumulative probability just equals or exceeds the value 1.0 - (percent Queued per shift/100)
   8.4. Criminal Complaints - follow steps in 8.3
   8.5. Add Number of Patrols, Accidents and Criminal Complaints: 8.3 + 8.4
   8.6. Compute Minimum Patrols needed to meet Maximum Average Response Time for the shift
      8.6.1. Compute ADT from Volume/Miles of Highway (each type road)
      8.6.2. Compute Actual Speed based on Miles of Highway - Interstate and Two-Lane Primary, and ADT times Percent of ADT for shift. This yields a value of 60 or less
      8.6.3. Compute Congestion Factor which is Actual Speed/60
      8.6.4. Compute Average Driving Distance
      8.6.5. Multiply Average Driving Distance by Congestion Factor and divide by Maximum Average Response Time
   8.7. Compare 8.5 and 8.6 and select the greater number which yields CFS Patrols
   8.8. Multiply CFS Patrols by Shift Coverage Factor
   8.9. Compute 8.8 for all shifts and counties, combining into district to yield Calls for Service Positions
   8.10. Is Calls for Service Positions greater than Equivalent Positions?
      a. YES
         Can change parameters for Calls for Service and return to Step 8.1 to recompute positions or
         Can change either Total Officers or Administrative Support and return to Step 7
      b. NO - go to Step 9
   8.11. Convert the Calls for Service Positions to Calls for Service Officers for each district by multiplying Positions by Officers per Patrol

9. Computation of Free Time for Patrolling
   9.1. Subtract Calls for Service Positions from Equivalent Positions to yield Patrolling Positions
   9.2. Compute Equivalent Patrol
      9.2.1. Multiply Calls for Service Positions by 8 (hours in a shift)
      9.2.2. Multiply Accidents by Percent Handled by Time to Handle
      9.2.3. Multiply Criminal Complaints by Percent Handled by Time to Handle

9.2.4. Add 9.2.2. and 9.2.3. and subtract from 9.2.1.
9.2.5. Divide 9.2.4. by "8" to yield Free Time From Calls for Service
9.2.6. Add Free Time from Calls for Service to Patrolling Positions to Yield Equivalent Patrol

9.3. Maintain by district and total, a record of the Free Time from Calls for Service

10. Policing and Patrolling Positions (for counties and shifts)
10.1 Divide Equivalent Patrol into its three components: Interstate, Two-lane Roads, and Support for Rural Enforcement using the parameters for percent of available patrolling positions assigned
10.2. Compute Average Length of Interstate Patrol and allocate
10.2.1. For each shift, compute the Mileage to be Patrolled from
10.2.1.1. Compute Actual Speed as in 8.6
10.2.1.2. Compute the Expected Number of Stops to be made base on volume
10.2.1.3. Reduce Actual Speed by using the Expected Number of Stops times Time per Stop yielding Revised Actual Speed
10.2.1.4. Compute the Patrol Speed Factor from 50/Revised Actual Speed
10.2.1.5. Multiply the Actual Mileage by the Patrol Speed Factor
10.2.2. Cumulate all Mileage to Be Patrolled for all counties and shifts
10.2.3. Compute the Average Length of Interstate Patrol by dividing Total Mileage to Be Patrolled by number of Interstate Positions Available for Patrolling
10.2.4. Allocate Patrolling Positions - Interstate by dividing Mileage to be Patrolled for each county and shift by the Average Length of Interstate Patrol
10.3. Compute Average Length of Two-lane Primary Patrol and allocate
10.3.1. Subtract the number of positions needed to patrol other roads
10.3.2. If the result of 10.3.1. is negative then increase either the Percent of Free Time assigned to Two-Lane Roads or increase Patrolling Mileage - Other Local Roads. Repeat starting at 10.3
10.3.3. Compute the Average Length of Two-lane Patrol in the same manner as Average Length of Interstate Patrol, starting at Step 10.2
10.3.4. Allocate the Patrolling Positions per Shift - Two-lane Primary using the Average Length of Two-lane Patrol similar to 10.2.4
10.3.5. Allocate the Patrolling Positions per Shift - Local using the Average Length of Local Road Patrol similar to 10.2.4
10.4. Compute the allocation of Patrol to Support Local Law Enforcement
10.4.1. Compute Local Patrols by dividing Local Law Enforcement Officers by the quantity "3" times Officers per Patrol
10.4.2. Cumulate all Local Patrols and add Support of Local Law Enforcement to yield Rural Police

10.4.3. Divide total Rural Population by Rural Police to Yield Persons per Rural Police
10.4.4. Allocate state police (per shift)
10.4.4.1. Divide Rural Population by Persons per Rural Police
10.4.4.2. Subtract Local Patrols to yield state Supporting Patrols
10.4.4.3. Constrain State Supporting Patrols to the Minimum/Maximum Patrols per Shift
10.4.4.4. Cumulate all State Supporting Patrols and compare to Support Local Law Enforcement
a. If it is within plus or minus 10 percent go to Step 10.5
b. If it is less, then decrease the Persons per Rural Police by one-half the difference between the previous computation and the new computation and repeat 10.4.4
c. If it is greater, then increase the Persons per Rural Police by one-half the difference between the previous computation and the new computation and repeat 10.4.4
10.5 Add Patrols, Interstate, Two-lane (both Primary and Local), and Support of Local Law Enforcement
10.6. Reduce Equivalent Patrols by Free Time from Calls for Service
10.6.1. Compute the Statewide Adjustment by dividing the Patrolling Positions (9.1) by the sum of all Calls for Service Positions (8.9) and all Equivalent Patrol (9.2)
10.6.2. Compute County Factor by dividing sum of Calls for Service Positions (8.9) and Equivalent Patrol (10.2) by Equivalent Patrolling Positions (10.5) times Statewide Adjustment
10.6.3. Multiply County Factor times each of the Equivalent Patrols, Interstate, Two-lane Primary, Two-lane Local, and Support of Local Law Enforcement yielding Actual Patrol Allocation
10.7. Multiply Actual Patrol Allocations by Officers per Patrol to obtain Officers Allocated to Patrol

11. Print Summaries
11.1. Print a summary for Calls for Service showing by district and shift
a. Accidents
b. Criminal Complaints
c. Calls for Service Positions allocated to a. and b
d. Minimum Patrols
e. Calls for Service officers allocated
f. Parameters used
11.2. Print a summary for Policing and Patrolling showing by district
a. Miles of Highway for three highway types - Interstate, Two-lane Primary, and Two-lane Local
b. Patrolling Positions - Interstate, Two-Lane Primary, and Local
c. Number local law enforcement officers
d. Patrols to Support Local Law Enforcement
e. Officers Allocated to Patrol

11.3. Summary showing for each district, number of officers
- a. Administrative Support
- b. Calls for Service
- c. Policing and Patrolling
- d. Total
- e. Parameters used

12. Projecting a requisite strength of officers

12.1. Administrative Support

12.1.1. Use Administrative Support from variable file as in Step 7

12.2.2. No comparison made with Total Officers as shown in 7.2.

12.2. Calls for Service

12.2.1. Compute Calls for Service Positions and Calls for Service officers as shown in Step 8

12.2.2. No comparison made with Total Officers and Administrative Support as shown in 8.10

12.2.3. Determine Equivalent Patrols as in Step 9.

12.3. Policing and Patrolling Positions

12.3.1. Compute Mileage to be Patrolled Interstate

12.3.1.1. Compute Actual Speed, Expected number of Steps and Patrol Speed Factor (Steps 10.2.1.1. to 10.2.1.4.)

12.3.1.2. Multiply Miles of Highway - Interstate by Patrol Speed Factor to Yield Mileage to Be Patrolled

12.3.2. Divide Miles to Be Patrolled by Average Length of Interstate Patrol entered as a parameter to yield Interstate Patrolling Positions

12.3.3. Two-lane Primary Patrolling Positions are found in same manners as 12.3.1. and 12.3.2.

12.3.4. Two-lane Local Patrolling Positions are found by dividing Miles of Highway - Local by Average Length per Patrol

12.3.5. Support for Rural Enforcement

12.3.5.1. Divide Rural Population by Rural Population per Police Patrol entered as a parameter

12.3.5.2. Compute Local Patrols as shown in 10.4.1

12.3.5.3. Subtract Local Patrols from 12.3.5.1. to yield State Supporting Patrols

12.3.5.4. Constrain State Supporting Patrols to the Minimum/Maximum State Police

12.3.6. Add all Patrols

12.3.7. Reduce Equivalent Patrols by Free Time as shown 10.6.

12.3.8. Compute Officers Allocated to Patrol as in 10.7

12.4. Print summaries as shown in Step 11.

APPENDIX C

PROGRAM LISTING:

FACTOR INPUT

FACTOR INPUT

```
5  REM  LOAD PARAMETER AND VARIABLE DATA
10 D$ =  CHR$ (13) +  CHR$ (4):RT$ =  CHR$ (13):ES$ =  CHR$ (27)
20 BS$ =  CHR$ (8):FS$ =  CHR$ (21):BL$ = "          "
25  REM  'PARAMETERS' IS FILE OF PARAMETERS
26  REM  'VARIABLES' IS FILE OF VARIABLES
30  NORMAL :F$(1) = "PARAMETERS":F$(2) = "VARIABLES"
35  REM  LIST OF PARAMETER AND VARIABLE NAMES
36  REM  IS GIVEN IN REPORT ON OPERATING PROGRAM.
40  DIM M1$(4),M2$(25),M3$(15),P$(200),XL$(10),P1$(110,15)
50  GOSUB 8000
60  POKE 34,0: POKE 35,24: HOME : REM  SET INITIAL TOP/BOTTOM MARGINS
70  PRINT  TAB( 8);"UPDATE ALLOCATION FACTORS": PRINT
80  FOR I = 1 TO 4
90  PRINT  TAB( 4);M1$(I): PRINT : NEXT
100  PRINT  TAB( 8);"USE RETURN TO SELECT": PRINT  TAB( 8);"OR SPACE BAR T
     O ADVANCE":FT = 1
110  VTAB 1 + FT * 2: HTAB 4
120  GET A$: IF A$ = RT$ THEN  PRINT A$: GOTO 150
130 FT = FT + 1: IF FT > 4 THEN FT = 1
140  GOTO 110
141  REM  VARIABLE 'FT' DETERMINES WHAT SUBPROGRAM
142  REM  WILL BE OPERATED.  WHERE SUBPROGRAM IS PRINTING,
143  REM  THEN FUTHER CHOICE OF
144  REM  PRINT PARAMETERS OR PRINT VARIABLES.
145  REM   FT - 1 PARAMETERS, 2 VARIABLES, 3 PRINTING, 4 STOP
146  REM  'FT'  - 1 PARAMETERS, - 2 VARIABLES,
147  REM  - 3 PRINTING, OR - 4 STOP OR RETURN TO MANPOWER.
150  HOME : IF FT = 4 GOTO 300
160  IF FT = 3 THEN  GOSUB 4000: GOTO 60
170 AV = 1:VX =  - 1
175  REM  START EITHER PARAMETERS OR VARIABLES INPUT ROUTINES
180  HTAB 1: HOME : INVERSE : ON FT GOTO 190,200
190  PRINT "PARAMETERS"; SPC( 21);"P 1 OF 5": GOTO 210
200  PRINT "VARIABLES"; SPC( 22);"P 1"
210  NORMAL : ONERR  GOTO 250
215  REM  OPEN EITHER FILE, PARAMETERS OR VARIABLES.
220  PRINT D$"OPEN ";F$(FT): PRINT D$"READ ";F$(FT)
230  INPUT X
235  REM  READ IN DATA FROM EITHER FILE, PARAMETERS OR VARIABLES.
240  POKE 216,0: ON FT GOSUB 6000,6500
245  REM  GOTO EITHER PARAMETER OR VARIABLES SUBROUTINE.
250  POKE 216,0: ON FT GOSUB 2000,3000
260  IF Y$ <  > "Y" GOTO 60
```

FACTOR INPUT (Continued)

```
270  PRINT D$"OPEN "+F$(FI): PRINT D$"WRITE "+F$(FI)
275  REM  WRITE CORRECTED INFORMATION OUT TO
276  REM  EITHER PARAMETERS OR VARIABLES FILE.
280  ON FI GOSUB 6200,6700
290  GOTO 60
295  REM  DETERMINE IF 'FACTOR INPUT' CALLED BY 'MANPOWER'.
296  REM  IF SO, THEN RUN 'MANPOWER'.
300  IF  PEEK (800) > 0 THEN  PRINT D$"RUN MANPOWER"
310  STOP
1000  REM
1005  REM  * * *   READ DATA FROM KEYBOARD   * * *
1006  REM  READS ONE CHARACTER AT A TIME FROM KEYBOARD.
1010  GET A$: IF A$ = RT$ GOTO 1080
1020  IF A$ <  > BS$ GOTO 1050
1030  PRINT A$;:II = II - 1: IF II <  = 0 THEN II = 0
1040  GOTO 1010
1050  IF A$ = FS$ THEN II = II + 1: PRINT XL$(11);: GOTO 1010
1060  IF  ASC (A$) < 46 OR  ASC (A$) > 57 GOTO 1010
1070  PRINT A$;:II = II + 1:XL$(II) = A$: GOTO 1010
1080 A$ = "": FOR JJ = 1 TO 11
1090 A$ = A$ + XL$(JJ): NEXT : RETURN
1400  REM
1405  REM   * * *   REM INITIATE KEYBOARD OPERATION   * * *
1406  REM  READ FIRST KEYSTROKE ENTERED.
1410 II = 1: GET A$: IF A$ = RT$ OR A$ = ES$ OR A$ = "F" OR A$ = "B" GOTO
     1480
1420  IF A$ = "?" THEN  PRINT A$: GOSUB 5000: GOTO 1400
1430  IF  ASC (A$) < 46 OR  ASC (A$) > 57 GOTO 1410
1440  PRINT A$;:XL$(1) = A$: GOSUB 1060
1450  IF ZZ = 0 THEN P$(Z) = A$
1460  IF ZZ = 1 THEN F1$(1,Z) = A$
1470 AX = 1: RETURN
1480 AX = 1:AV = 1: IF A$ = "?" THEN AX = 2
1490  IF A$ = "F" OR A$ = "B" THEN AX = 3: IF A$ = "F" THEN AV =  - 1
1500  IF A$ = ES$ THEN AX = 4
1510  RETURN
1700  REM
1705  REM  * * *  HELP NOTES  * * *
1706  REM  'HELP' NOTE PRINTED AT BOTTOM OF EVERY SCREEN.
1710  VTAB 24: INVERSE : HTAB 6
1720  PRINT "F  FOR HELP";: NORMAL
1730  HTAB 1: POKE 35,23: RETURN
2000  REM
2005  REM  * * *   CORRECT PARAMETERS  * * *
2006  REM  ENTER NEW PARAMETERS OR CORRECT EXISTING ONES.
```

FACTOR INPUT (Continued)

```
2007  REM  USES FIVE SCREENS WITH PARAMETER NAMES.
2008  REM  USER ENETERS DATA OR CHANGES PAGES.
2010 VX = VX + AV:AW = 0:AV = 1: IF VX < 0 THEN VX = 0
2020  ON VX + 1 GOTO 2050,2170,2170,2290,2410,2030
2030 VX = 0
2040  REM   PAGE 1 - GENERAL PARAMETERS
2050  VTAB 1: INVERSE : HTAB 15: PRINT BL$;BL$: NORMAL : CALL  - 958
2060  INVERSE : VTAB 1: HTAB 15:ZZ = 0
2070  PRINT "GENERAL";: HTAB 34: PRINT "1"
2080  NORMAL : POKE 34,2
2090  HOME : HTAB 1: FOR I = 1 TO 20
2100  PRINT M2$(I);: HTAB 26: PRINT P$(I): NEXT
2110  GOSUB 1700:VT = 1
2120  VTAB VT + 2:Z = VT: HTAB 26: GOSUB 1400
2130  ON AX GOTO 2140,2090,2010,2590
2140 VT = VT + 1: IF VT <  = 20 GOTO 2120
2150  GOTO 2010
2160  REM  PAGES 2 AND 3.  PAGE 2 - ACCIDENTS, 3 - CRIMINAL COMPLAINTS
2170  VTAB 1: INVERSE : HTAB 15: PRINT BL$;BL$
2180  VTAB 1: HTAB 15: ON VX GOTO 2190,2200
2190  PRINT "ACCIDENTS";: GOTO 2210
2200  PRINT "CRIMINAL COMPLNT";
2210  HTAB 34: PRINT VX + 1: NORMAL
2220  HOME : FOR I = 21 TO 25
2230  PRINT M2$(I);: HTAB 26: PRINT P$(I + (VX - 1) * 5): NEXT :VT = 1
2240  VTAB VT + 2:Z = VT + 20 + (VX - 1) * 5: HTAB 26: GOSUB 1400
2250  ON AX GOTO 2260,2220,2010,2590
2260 VT = VT + 1: IF VT <  = 5 GOTO 2240
2270  GOTO 2010
2280  REM  PAGE 4 - SHIFT STARTING/ENDING TIMES
2290  VTAB 1: HTAB 15: INVERSE : PRINT BL$;BL$: NORMAL : CALL  - 958
2300  VTAB 1: HTAB 15: INVERSE : PRINT "SHIFT START/END  ";
2310  HTAB 34: PRINT "4": NORMAL
2320  HOME : HTAB 1: FOR I = 1 TO 3
2330  PRINT "FOR SHIFT ";I;" START";: HTAB 26: PRINT P$(29 + I * 2)
2340  PRINT  TAB( 13);"END";: HTAB 26: PRINT P$(30 + I * 2)
2350  NEXT :VT = 1
2360  VTAB VT + 2:Z = VT + 30: HTAB 26: GOSUB 1400
2370  ON AX GOTO 2380,2320,2010,2590
2380 VT = VT + 1: IF VT <  = 6 GOTO 2360
2390  GOTO 2010
2400  REM  PAGE 5 - SHIFT COVERAGE FACTORS.  0 - NO COVERAGE, 1 - ONE OFFI
     CER/POSITION, 2 - TWO OFFICERS/POSITION
2407  REM  DETERMINE WHETHER INFORMATION ENETERED,
2408  REM  LINE SKIPPED, PAGE SKIPPED,OR
```

```
2400  REM  DATA TO BE SAVED AND RETURN TO MENU.
2410  VTAB 1: HTAB 15: INVERSE : PRINT "SHIFT COVERAGE ";
2420  HTAB 34: PRINT "5":AW = 1
2430  PRINT "DISTRICT    1    2    3": NORMAL
2440  HTAB 1: HOME :I = 0
2450 I = I + 1: IF I >  VAL (P$(3)) GOTO 2490
2460 Z$ =  RIGHT$ ("    " +  STR$ (I),4): PRINT Z$; SPC( 7);
2470 J1 = (I - 1) * 3: FOR J = 1 TO 3
2480  PRINT  LEFT$ (P$(36 + J1 + J) + "     ",4);: NEXT J: PRINT : GOTO 245
     0
2490 VT = 1
2500  VTAB VT + 2: HTAB 12
2510  FOR J = 1 TO 3
2520 Z = 36 + J + (VT - 1) * 3: GOSUB 1400
2530  ON AX GOTO 2540,2440,2010,2590
2540  IF A$ = RT$ GOTO 2560
2550  HTAB 12 + 4 * J: NEXT J: PRINT :AW = 0
2560 VT = VT + 1: IF VT <  =  VAL (P$(3)) GOTO 2500
2570  GOTO 2030
2580  REM   ENDING ROUTINE AFTER CHANGING PARAMETERS
2590  GOSUB 2800: IF  LEFT$ (Y$,1) = "C" THEN VX =  - 1: GOTO 2010
2600  RETURN
2800  REM
2805  REM   * * *   ENDING ROUTINE, STORE DATA?  * * *
2806  REM  ENDING ROUTINE IS CALLED BY PRESSING 'ESC'.
2807  REM  CAN REINITIATE CORRECTIONS OR
2808  REM  STORE DATA ON DISK.
2810  HOME : PRINT : INPUT "ARE MORE CORRECTIONS TO BE MADE? ";Y$
2820  IF  LEFT$ (Y$,1) = "Y" THEN Y$ = "C": RETURN
2830  HOME : PRINT : PRINT "ARE DATA TO BE STORED?": PRINT  TAB( 5);"WARNI
     NG: A 'NO' DELETES ALL DATA"
2840  PRINT  TAB( 5);"JUST ENTERED ON KEYBOARD": PRINT  TAB( 5);: INPUT Y$
2850  RETURN
3000  REM
3005  REM  * * *   CORRECT VARIABLES  * * *
3006  REM  ENTER NEW VARIABLES OR CORRECT EXISTING ONES.
3007  REM  USES THREE SETS OF SCREENS.
3008  REM  FIRST SHOWS NUMBER OF COUNTIES AND DISTRICTS.
3010  POKE 34,2: HOME : HTAB 1:ZZ = 0
3014  REM  SECOND SET OF SCREENS SHOW COUNTY/DISTRICT
3015  REM  CROSS REFERENCE TABLES.
3016  REM  THIRD SET SHOWS VARIABLES FOR EACH
3017  REM  OF THE COUNTIES.
3020  REM   ENTER NUMBER OF COUNTIES AND DISTRICTS
```

FACTOR INPUT (Continued)

```
3030  PRINT "NUMBER OF COUNTIES";: HTAB 26: PRINT P$(2)
3040  PRINT "NUMBER OF DISTRICTS";: HTAB 26: PRINT P$(3):VT = 2
3050  GOSUB 1700
3060  VTAB VT + 1:Z = VT: HTAB 26: GOSUB 1400
3070  ON AX GOTO 3080,3010,3090,3660
3080 VT = VT + 1: IF VT <  = 3 GOTO 3060
3090  IF AV < 0 GOTO 3010
3100  PRINT : VTAB 1
3110  INVERSE : HTAB 15
3120  PRINT "ADMIN. SUPPORT  "; SPC( 6)"P 2";
3130  NORMAL : CALL  - 958: PRINT : INVERSE
3140  PRINT "DISTRICT"; SPC( 15)"PERSONS": NORMAL
3150  HOME : HTAB 1: FOR I = 1 TO  VAL (P$(3)) + 1
3160 Z$ =  RIGHT$ ("    " +  STR$ (I),4): IF I >  VAL (P$(3)) THEN Z$ = "CE
     NTRAL"
3170  PRINT Z$;: HTAB 26: PRINT P$(10 + I): NEXT :VT = 1
3180  VTAB VT + 2:Z = VT + 10: HTAB 26: GOSUB 1400
3190  ON AX GOTO 3200,3150,3210,3660
3200 VT = VT + 1: IF VT <  =  VAL (P$(3)) + 1 GOTO 3180
3210  IF AV < 0 GOTO 3100
3245  REM  SHOWS COUNTY NUMBERS FOR EACH OF THE DISTRICTS.
3250  HOME : VTAB 1: INVERSE :ZZ = 0
3260  HTAB 15:P$(50) = "0":PX =  VAL (P$(3))
3270  PRINT "DIST./CNTY XREF      "
3280  FOR I = 1 TO PX
3290  INVERSE : VTAB 1: HTAB 32: PRINT "P";I;" OF ";PX;: NORMAL
3300  CALL  - 958: PRINT : VTAB 2: INVERSE
3310  HTAB 6: PRINT "DISTRICT ";I: NORMAL
3320 PY =  VAL (P$(49 + I)):PZ =  VAL (P$(50 + I))
3330  VTAB 3: PRINT "COUNTIES IN DISTRICT";: HTAB 24:
3340 Z = PZ - PY: IF Z < 0 THEN Z = 0
3350  PRINT Z: IF Z = 0 GOTO 3390
3360  VTAB 4: HTAB 4: FOR J = 1 TO PZ - PY
3370  PRINT  LEFT$ (P$(80 + PY + J) + "    ",4);: IF J / 4 =  INT (J / 4) THEN
      PRINT : HTAB 4
3380  NEXT J: PRINT
3390  VTAB 3: HTAB 24:Z = 50 + I: GOSUB 1400
3400  ON AX GOTO 3410,3330,3470,3660
3410 PZ =  VAL (P$(Z)) + PY:P$(Z) =  STR$ (PZ):AW = 1
3420  VTAB 4:HT = 4: FOR J = 1 TO PZ - PY
3430  HTAB HT:Z = 80 + PY + J: GOSUB 1400
3440  ON AX GOTO 3450,3330,3470,3660
3450 HT = HT + 4: IF J / 4 =  INT (J / 4) THEN  PRINT :HT = 4
3460  NEXT J:AW = 0: PRINT : GOTO 3490
3470  IF AV > 0 THEN  GOTO 3490
```

```
3480 I = I - 2: IF I < 0 GOTO 3100
3490  NEXT I
3500  REM  VARIABLES FOR INDIVIDUAL COUNTIES
3510  VTAB 1: INVERSE : HTAB 15
3520  PRINT "COUNTY DATA      ";
3530 Z = 1: FOR I = 1 TO  VAL (P$(2)): INVERSE
3540  VTAB 1: HTAB 29: PRINT "P";I;" OF "; VAL (P$(2)): NORMAL
3550  CALL  - 958: PRINT : INVERSE
3560  HTAB 6: PRINT "COUNTY ";I: NORMAL :ZZ = 1
3570  HOME : HTAB 1: FOR J = 1 TO 15
3580  PRINT M3$(J);: HTAB 26: PRINT P1$(I,J): NEXT J:VT = 1
3590  VTAB VT + 2:Z = VT: HTAB 26: GOSUB 1400
3600  ON AX GOTO 3610,3570,3620,3660
3610 VT = VT + 1: IF VT <  = 15 GOTO 3590
3620  IF AV > 0 GOTO 3640
3630 I = I - 2: IF I < 0 GOTO 3220
3640  NEXT I
3650  GOTO 3100
3660  GOSUB 2800: IF  LEFT$ (Y$,1) = "C" GOTO 3100
3670  RETURN
4000  REM
4005  REM  * * *  PRINTING ROUTINE  * * *
4006  REM  PRINT EITHER PARAMETERS OR VARIABLES.
4007  REM  USER SELECTS FILE TO BE PRINTED.
4010  HOME : PRINT  TAB( 6);"PRINT DATA": PRINT
4020  FOR I = 1 TO 2
4030  PRINT  TAB( 4);M1$(I): PRINT : NEXT :FU = 1
4040  VTAB FU * 2 + 1: HTAB 4: GET A$
4050  IF A$ = RT$ GOTO 4080
4060 FU = FU + 1: IF FU > 2 THEN FU = 1
4070  GOTO 4040
4080  PRINT D$"OPEN "F$(FU): PRINT D$"READ "F$(FU)
4090  INPUT A: ON FU GOSUB 6000,6500
4100  PRINT D$"PR#1"
4110  ON FL GOSUB 4200,4600
4120  PRINT D$"PR#0": RETURN
4200  REM
4205  REM  * * *  PRINT PARAMETER FILE  * * *
4206  REM  PRINT FILE OF PARAMETERS.
4210  PRINT  TAB( 8);"PARAMETER FILE DATA": PRINT
4220  FOR I = 1 TO 20
4230  PRINT M2$(I);: HTAB 26: PRINT P$(I): NEXT
4240  PRINT : PRINT
4250  FOR VX = 0 TO 1
4260  ON VX + 1 GOTO 4270,4280
```

```
4270  PRINT  TAB( 4)$"ACCIDENTS": PRINT : GOTO 4290
4280  PRINT  TAB( 4)$"CRIMINAL COMPLAINTS": PRINT
4290  FOR I = 21 TO 25
4300  PRINT M2$(I)$: HTAB 26: PRINT P$(I + VX * 5): NEXT
4310  PRINT : PRINT : NEXT VX
4320  PRINT  TAB( 4)$"SHIFT START/END": PRINT
4330  FOR I = 1 TO 3
4340  PRINT "FOR SHIFT "$I$" START"$: HTAB 26: PRINT P$(29 + I * 2)
4350  PRINT  TAB( 13)$"END"$: HTAB 26: PRINT P$(30 + I * 2): NEXT
4360  PRINT : PRINT
4370  PRINT  TAB( 4)$"SHIFT COVERAGE": PRINT
4380  PRINT "DISTRICT   1   2   3"
4390  FOR I = 1 TO  VAL (P$(3))
4400 Z$ =  RIGHT$ ("   " +  STR$ (I),4) + '    ": PRINT Z$$
4410 J1 = (I - 1) * 3: FOR J = 1 TO 3
4420  PRINT  SPC( 3)$P$(36 + J1 + J)$: NEXT J: PRINT
4430  NEXT I: RETURN
4600  REM
4605  REM  * * *  PRINT VARIABLE FILE  * * *
4606  REM  PRINT FILE OF VARIABLES.
4610  PRINT : PRINT  TAB( 8)$"DATA FROM VARIABLE FILE": PRINT
4620  PRINT "NUMBER OF COUNTIES"$: HTAB 26: PRINT P$(2)
4630  PRINT "NUMBER OF DISTRICTS"$: HTAB 26: PRINT P$(3)
4640  PRINT : PRINT  TAB( 8)$"ADMIN. SUPPORT"
4650  PRINT "DISTRICT"$ SPC( 15)$"PERSONS"
4660  FOR I = 1 TO  VAL (P$(3)) + 1
4670 Z$ =  RIGHT$ ("   " +  STR$ (I),4): IF I >  VAL (P$(3)) THEN Z$ = "CE
     NTRAL"
4680  PRINT Z$$: HTAB 26: PRINT P$(10 + I): NEXT
4690  PRINT : PRINT  TAB( 8)$"DISTRICT/COUNTY XREF."
4700  PRINT "DISTR."$ SPC( 4)$"COUNTIES":PY = 0
4710  FOR I = 1 TO  VAL (P$(3))
4720 Z$ =  RIGHT$ ("   " +  STR$ (I),3): HTAB 2: PRINT Z$$ SPC( 2)$
4730 PZ =  VAL (P$(50 + I)): FOR J = 1 TO PZ - PY
4740 Z$ =  RIGHT$ ("    " + P$(80 + PY + J),4): PRINT Z$$
4750  IF J / 8 =  INT (J / 8) THEN  PRINT : HTAB 7
4760  NEXT J: IF (J - 1) / 8 <  >  INT ((J - 1) / 8) THEN  PRINT
4770 PY = PZ: NEXT I: PRINT : PRINT
4780  PRINT  TAB( 8)$"COUNTY DATA"
4790  FOR I = 1 TO  VAL (P$(2))
4800  PRINT : PRINT  TAB( 8)$"COUNTY "$I: PRINT
4810  FOR J = 1 TO 15
4820  PRINT M3$(J)$: HTAB 26: PRINT P1$(I,J): NEXT J,I
4830  RETURN
5000  REM
```

```
5005  REM  * * *   NOTES   * * *
5010  POKE 34,2: HOME
5020  PRINT  TAB( 8)"CURSOR MOVES": PRINT
5030  PRINT "TO CHANGE DATA, TYPE NEW NUMBERS": PRINT
5040  PRINT "RETURN ADVANCES CURSOR": PRINT
5050  PRINT "P  ADVANCE ONE PAGE": PRINT "B  BACK ONE PAGE": PRINT
5060  PRINT "ESC  STOPS INPUT": PRINT
5070  PRINT  TAB( 4)"PRESS ANY KEY TO CONTINUE";
5080  GET B$: PRINT B$: HTAB 1: RETURN
6000  REM
6005  REM    * * *  READ PARAMETERS  * * *
6006  REM  READ TO AND WRITE FROM FILE 'PARAMETERS'.
6010  FOR I = 1 TO 36
6020  INPUT P$(I): NEXT
6030  FOR I = 1 TO  VAL (P$(3)) * 3
6040  INPUT P$(I + 36): NEXT
6050  PRINT D$"CLOSE "F$(FT): RETURN
6200  REM
6205  REM   * * *  WRITE PARAMETERS  * * *
6210  PRINT "1"
6220  FOR I = 1 TO 36 +  VAL (P$(3)) * 3
6230  PRINT P$(I): NEXT
6240  PRINT D$"CLOSE "F$(FT): RETURN
6500  REM
6505  REM  * * *  READ  VARIABLE DATA  * * *
6506  REM  READ TO AND WRITE FROM FILE 'VARIABLES'.
6510  INPUT P$(2): INPUT P$(3)
6520  FOR I = 11 TO  VAL (P$(3)) + 11
6530  INPUT P$(I): NEXT
6540  FOR I = 1 TO  VAL (P$(3))
6550  INPUT P$(50 + I): NEXT
6560  FOR I = 1 TO  VAL (P$(2))
6570  INPUT P$(80 + I): NEXT
6580  FOR I = 1 TO  VAL (P$(2))
6590  FOR J = 1 TO 15
6600  INPUT P1$(I,J): NEXT J,I
6610  PRINT D$"CLOSE "F$(FT)
6620  RETURN
6700  REM
6705  REM  * * *  WRITE VARIABLE DATA  * * *
6710  PRINT "2": PRINT P$(2): PRINT P$(3)
6720  FOR I = 11 TO  VAL (P$(3)) + 11
6730  PRINT P$(I): NEXT
6740  FOR I = 1 TO  VAL (P$(3))
6750  PRINT P$(50 + I): NEXT
```

FACTOR INPUT (Continued)

```
6760  FOR I = 1 TO  VAL (P$(2))
6770  PRINT P$(80 + I): NEXT
6780  FOR I = 1 TO  VAL (P$(2))
6790  FOR J = 1 TO 15
6800  PRINT P1$(I,J): NEXT J,I
6810  PRINT D$"CLOSE ";F$(FT)
6820  RETURN
8000  REM
8005  REM  * * *  READ DATA STATEMENTS  * * *
8006  REM  READ IN DATA STATEMENTS WHICH CONTAIN
8007  REM  TITLES AND HEADINGS USED ON SCREENS.
8010  FOR I = 1 TO 4
8020  READ M1$(I): NEXT
8030  FOR I = 1 TO 25
8040  READ M2$(I): NEXT
8050  FOR I = 1 TO 15
8060  READ M3$(I): NEXT
8070  RETURN
9000  REM
9005  REM  * * *  DATA STATEMENTS  * * *
9010  DATA   1. PARAMETER FILE,2. VARIABLE FILE,3. PRINT DATA,4. STOP
9020  DATA   TOTAL TO BE ALLOCATED,NUMBER COUNTIES,NUMBER DISTRICTS,MANHOU
      RS PER YEAR,ENFORCEMENT TIME,MINIMUM RURAL ISP,MAXIMUM RURAL ISP,RURA
      L PERS. PER OFFICER
9030  DATA    % ADT SHIFT 1,% ADT SHIFT 2,% ADT SHIFT 3,MAX. RESPONSE - 1,
      MAX. RESPONSE - 2,MAX. RESPONSE - 3
9040  DATA  PATROL MILES  4-LANE,PATROL MILES  2-LANE,PATROL MILES  OTHER,
      % PATROL INTERSTATE,% PATROL OTHER ROADS,% PATROL RURAL
9050  DATA  PERCENT HANDLED,TIME TO HANDLE,% QUEUED - 1,% QUEUED - 2,% QUE
      UED - 3
9060  DATA  ACCIDENTS - SHIFT 1,ACCIDENTS - SHIFT 2,ACCIDENTS - SHIFT 3,CR
      IMINAL COMPLAINTS - 1,CRIMINAL COMPLAINTS - 2,CRIMINAL COMPLAINTS - 3

9070  DATA   MILES - 4 LANE,MILES - 2 LANE,MILES - OTHER,VOLUME - 4 LANE,V
      OLUME - 2 LANE,VOLUME - OTHER
9080  DATA   RURAL POPULATION,AREA,LOCAL LAW ENF.
```

APPENDIX D

VARIABLE NAME

CROSS REFERENCE

APPENDIX D

VARIABLE NAME CROSS REFERENCE

AC(z, j) - Total number of accidents (z = 0) or criminal complaints (z = 1) for shift j.

AC%(z, j, i)* - Number of accidents (z = 0), or criminal complaints (z = 1) for shift j and county i, and for i + 110, for each district i.

CS(z, j, k) - Positions assigned for shift j (where j = 0 is total for all shifts), district k, and z representing:
- 0 - Accidents: 4-lane patrol (the first is calls for service routine; the second is policing and patrolling routine.)
- 1 - Criminal complaints: Other highway patrol
- 2 - Minimize response time: Rural patrol
- 3 - Calls for Service
- 4 - Policing and Patrolling

DF(k) - Equivalent free time for patrol, district k.

DN%(k, i) - County numbers, i, cross referenced for each of k districts. DN%(0, 0) is number of districts.

FF(z, j, i) - Congestion factor for shift j, county i: (z = 0) 4-lane highways, or (z = 1) 2-lane highways.

L%(i)* - Local law enforcement persons for county i.

M(z, i)* - Miles of highway or vehicle miles for county i, where z represents:

4-lane roads:	1 - miles,	4 - volume
2-lane primary roads:	2 - miles,	5 - volume
2-lane rural roads:	3 - miles,	6 - volume

NC% - Number of counties.

ND% - Number of districts.

O%(k) - Number of administrative officers in district k; central office administrative staff is 0% (ND% + 1).

P(j, 1) - Percent of ADT for shift j.

P(j, 2) - Maximum response time for shift j.

P(z, 3) - Patrol miles per position assigned (z = 1) 4-lane roads, (z = 2) 2-lane primary roads, (z = 3) two-lane rural roads.

P(z, 4) - Percent of patrolling assigned: (z = 1) 4-lane roads, (z = 2) all 2-lane roads, (z = 3) rural law enforcement support.

APPENDIX D (continued)

VARIABLE NAME CROSS REFERENCE (continued)

P(j, 5) - Percent of accidents queued during shift j.

P(j, 6) - Percent of criminal complaints queued during shift j.

P(j, 7) - Starting time of shift j (24-hour clock).

P(j, 8) - Ending time of shift j (24-hour clock).

PH(z) - Percent handled and time to handle, where z represents:
accidents: 1 - percent, 2- time criminal complaints: 1 - percent,
2 - time

PN$(M) - Parameter names for all m parameters.

Q(i)* - Area of county i.

R(i)* - Rural population in 1000's for county i.

RM% - Minimum number of state police positions for support of rural law enforcement for any shift.

RX% - Maximum number of state police positions for suport of rural law enforcement for any shift.

RX - Rural population per police patrol per shift.

SC%(j, k) - Shift coverage factor, for shift j and district k. The value is either a 0, 1, or 2.

SR(z, i) - Temporary values for policing and patrolling for each county i, converted to variable name CS(z, j, k) for: (z = 0) 4-lane roads, (z = 1) other roads, and (z = 2) rural patrol.

TA - Man-hours per position per year.

TE - Time in hours per stop for traffic enforcement or motorist assist.

TT - Total manpower to be allocated.

U - Reduction in speed resulting from congestion.

Y - Number of stops expected per shift based on traffic volume.

XC(z, j) - Temporary values for calls for service where responses are compared to positions required for minimum response.

*Note: AC%(1, j, 110 + k), L%(110 + k), M(1, 110 + k), Q(110 + k), and R(110 + k) are summations for districts k.

APPENDIX E

RECORD LAYOUT FOR DATA FILES

APPENDIX E

RECORD LAYOUT FOR DATA FILES

PARAMETERS

File design is same list of Parameter Names shown in Table 1, page 3. Record 1 is a dummy record. The files start with record 2.

VARIABLES

Record*	Item
2	Number of counties (n)
3	Number of districts (z)
4 to 4 + z	Number of administrative staff for each of the z districts plus administrative support for central office

Starting at record 5 + z, one record for each district number of counties, then cross referenced county numbers. There are n + 2z records.

Following the cross/reference table are the county variable data. There are 15 records per county. These data start at record 5 + n + 3z.

Field

1. Accidents, shift 1
2. Accidents, shift 2
3. Accidents, shift 3
4. Criminal complaints, shift 1
5. Criminal complaints, shift 2
6. Criminal complaints, shift 3
7. Miles of road, 4-lane
8. Miles of road, 2-lane
9. Miles of road, other rural
10. Volume in 1000's of vehicle miles, 4-lane
11. Volume in 1000's of vehicle miles, 2-lane
12. Volume in 1000's of vehicle miles, other rural
13. Rural population in 1000's
14. Area in square miles
15. Local law enforcement officials

END