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September 26, 2007

Mr. Jay Maisler
Enercon Corporation
14502 North Dale Mabry Hwy
Suite 200
Tampa, FL 33618

Ref: Bellefonte ETE Report

Dear Jay:

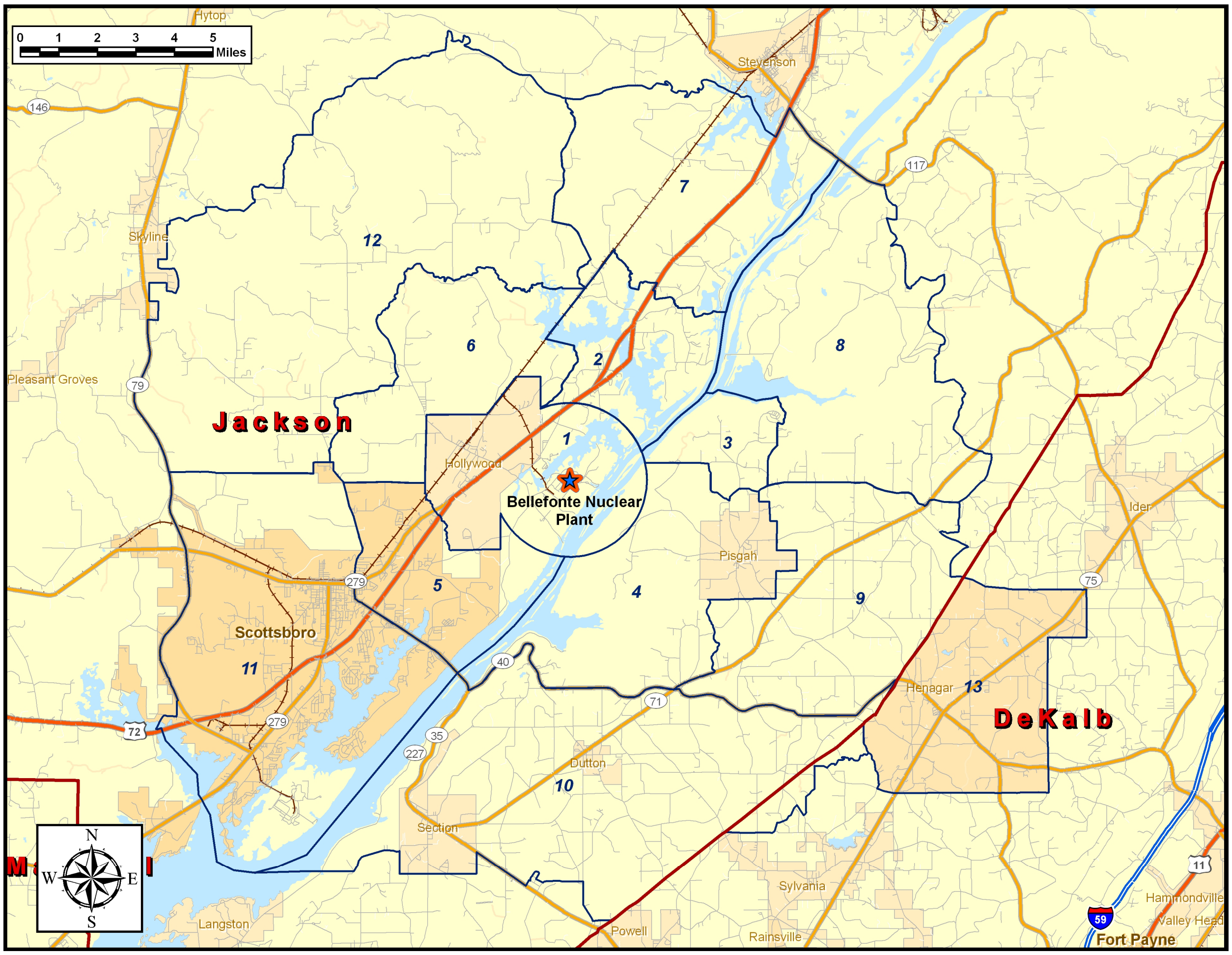
Enclosed is a PDF file containing the final version of the Bellefonte Nuclear Plant ETE Report. We have addressed the comments provided by Enercon, NuStart and the counties over the past several months. We will be mailing you a hard copy version of the report along with CDs containing the electronic version of the report.

Sincerely yours,

Kevin Weinisch, P.E.
Senior Traffic Engineer

Bellefonte Nuclear Plant

Development of Evacuation Time Estimates



Work performed under contract with Enercon Services, Inc. in support of NuStart Energy Development, LLC, by:

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September, 2007 **Final Report** **KLD TR – 410**

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF FIGURES (Cont'd)

LIST OF TABLES

LIST OF TABLES (Cont'd)

EXECUTIVE SUMMARY

This brief summary should be viewed as a preamble of the report. The reader is encouraged to review the entire report.

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the proposed Bellefonte Nuclear Plant (BLN) located in Jackson County, Alabama. Evacuation time estimates provide State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Government agencies. Most important of these are:

- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/FEMA-REP-1, Rev. 1, November 1980.
- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR-1745, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

Overview of Project Activities

This project began in August, 2006 and extended over a period of 8 months. The major activities performed are briefly described in chronological sequence:

- Attended “kick-off” meetings with Tennessee Valley Authority personnel, Enercon Services and emergency management personnel representing state and local governments.
- Accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of BLN,

then conducted a detailed field survey of the highway network.

- Synthesized this information to create an analysis network representing the highway system topology and capacities within the EPZ. We also extended the analysis network out to 15 miles radially from the plant to study the effects of Shadow evacuation on ETE.
- Designed and sponsored a telephone survey of residents within the EPZ to gather focused data needs for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by State and county personnel prior to conducting the survey.
- Data collection forms (provided to the counties at the kickoff meeting) were returned with data pertaining to employment, transients, and special facilities in each county.
- The traffic demand and trip-generation rate of evacuating vehicles were estimated from the gathered data. The trip generation rate reflected the estimated mobilization time (i.e., the time required by evacuees to prepare for the evacuation trip) that was computed using the results of the telephone survey of EPZ residents.
- Following Federal guidelines, the EPZ is subdivided into 13 Emergency Response Planning Areas (ERPA). These ERPA are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define a total of 22 Evacuation Regions.
- The time-varying external circumstances are represented as Evacuation Scenarios, each described in terms of the following factors: (1) Season (Summer, Winter); (2) Day of Week (Midweek, Weekend); (3) Time of Day (Midday, Evening); and (4) Weather (Good, Rain, Ice). One special scenario involving construction of a new unit at the BLN site was considered.

- The Planning Basis for the calculation of ETE is:
  - A rapidly escalating accident at BLN that quickly assumes the status of General Emergency such that the Advisory to Evacuate is virtually coincident with the siren alert.
  - While an unlikely accident scenario, this planning basis will yield ETE, measured as the elapsed time from the Advisory to Evacuate until the last vehicle exits the impacted Region, that represent "upper bound" estimates. This conservative Planning Basis is applicable for all initiating events including the prospect of a terrorist attack.

- If the emergency occurs while schools are in session, the ETE study assumes that the children will be evacuated by bus directly to reception centers located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at school prior to the arrival of the buses dispatched for that purpose. The ETE for schoolchildren are calculated separately.
- Evacuees who do not have access to a private vehicle will either ride-share with relatives, friends or neighbors, or be evacuated by buses provided as specified in the county evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: bus, van, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees and for those evacuated from special facilities.

Computation of ETE

A total of 264 ETE were computed for the evacuation of the general public. Each ETE quantifies the aggregate evacuation time estimated for the population within one of the 22 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 12 Evacuation Scenarios (22 x 12 = 264). Separate ETE are calculated for transit-dependent evacuees, including schoolchildren for applicable scenarios.

Except for Region R03, which is the evacuation of the entire EPZ, only a portion of the people within the EPZ would be advised to evacuate. That is, the Advisory to Evacuate applies only to those people occupying the specified impacted region. It is assumed that 100 percent of the people within the impacted region will evacuate in response to this Advisory. The people occupying the remainder of the EPZ outside the impacted region may be advised to take shelter.

The computation of ETE assumes that a portion of the population within the EPZ but outside the impacted region, will elect to "voluntarily" evacuate. These voluntary evacuees could impede those others who are evacuating from within the impacted region. The impedance that could be caused by voluntary evacuees is considered in the computation of ETE for the impacted region.

The computational procedure is outlined as follows:

- A link-node representation of the highway network is coded. Each link represents a unidirectional length of highway; each node usually represents an intersection or merge point. The capacity of each link is estimated based on the field survey observations and on established procedures.
- The evacuation trips are generated at locations called "zonal centroids" located within the EPZ. The trip generation rates vary over time reflecting the mobilization process, and from one location (centroid) to another depending on

population density and on whether a centroid is within, or outside, the impacted area.

- The computer models compute the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of BLN), then simulate the traffic flow movements over space and time. This simulation process estimates the rate that traffic flow exits the impacted region.
- The ETE statistics provide the elapsed times for 50 percent, 90 percent, 95 percent and 100 percent, respectively, of the population within the impacted region, to evacuate from within the impacted region. These statistics are presented in tabular and graphical formats.

Traffic Management

This study includes the development of a comprehensive traffic management plan designed to expedite the evacuation of people from within an impacted region. This plan is also designed to control access into the EPZ after returning commuters have rejoined their families.

The plan takes the form of detailed schematics specifying: (1) the directions of evacuation travel to be facilitated, and other traffic movements to be discouraged; (2) the equipment needed (cones, barricades) and their deployment; (3) the locations of these “Traffic Control Points” (TCP); (4) the priority assigned to each traffic control point indicating its relative importance and how soon it should be manned relative to others; and (5) the number of traffic control personnel required.

This plan was reviewed with State and local law enforcement personnel.

Selected Results

A compilation of selected information is presented on the following pages in the form of Figures and Tables extracted from the body of the report; these are described below.

- Figure 3-1 displays a map of the BLN site showing the layout of the 13 ERPA that comprise, in aggregate, the Emergency Planning Zone (EPZ).
- Table 3-2 presents the estimates of permanent resident population and permanent resident vehicle by ERPA.
- Table 6-1 defines each of the 22 Evacuation Regions in terms of their respective groups of ERPA.
- Table 6-2 lists the 12 Evacuation Scenarios.
- Tables 7-1C and 7-1D are compilations of Evacuation Time Estimates (ETE). These data are the times needed to *clear the indicated regions* of 95 and 100 percent of the population occupying these regions, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the EPZ and from the shadow region.
- Table 8-5A presents ETE for the schoolchildren in good weather.
- Table 8-7A presents ETE for the transit-dependent population in good weather.
- Table 8-8A presents ETE for the medical facilities in the EPZ in good weather. All these evacuees will be transported by bus, van or ambulance, as appropriate.

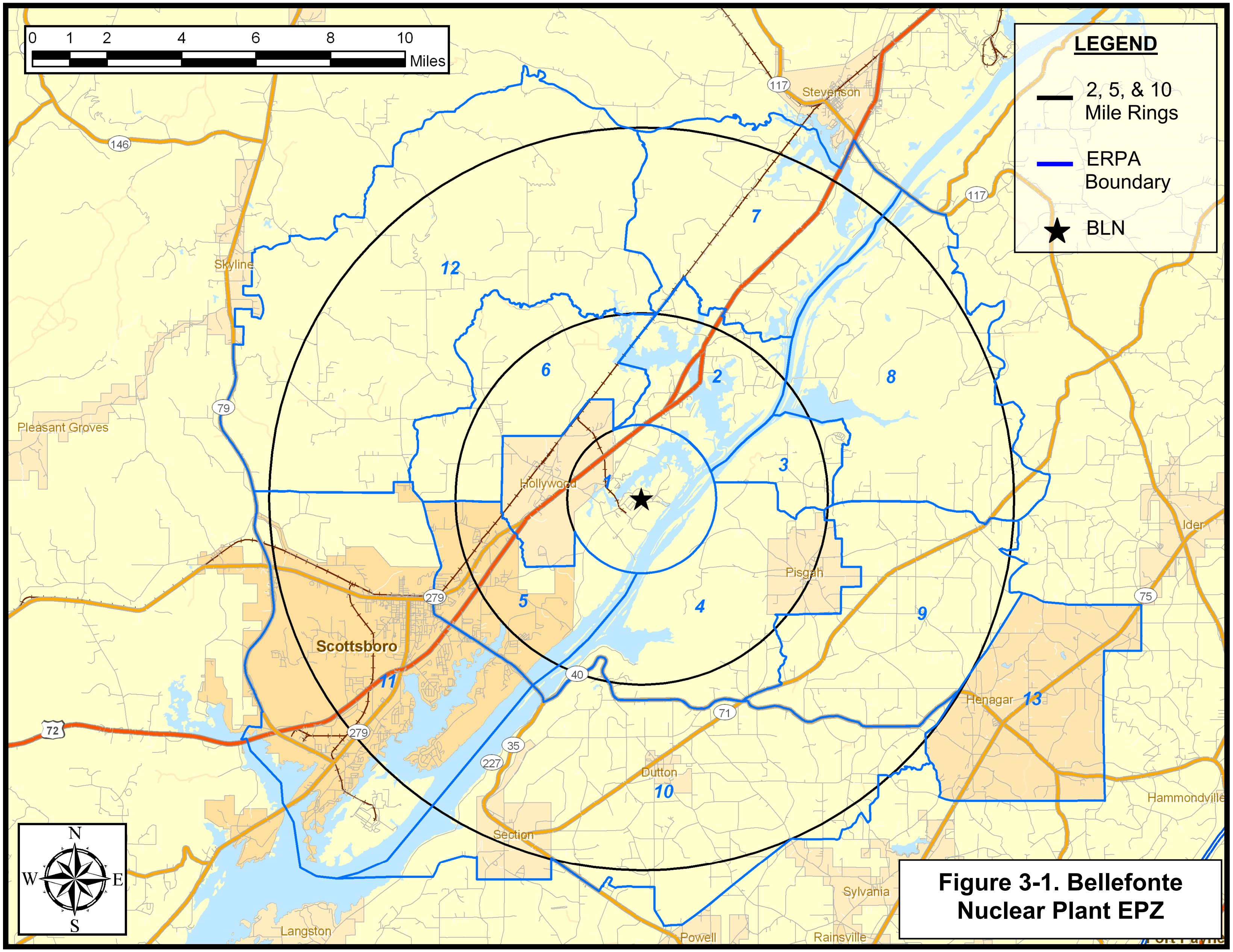

Figure 3-1. Bellefonte Nuclear Plant EPZ

Table 3-2. Permanent Resident Population and Vehicles by ERPA		
ERPA	**POP '07**	**VEH '07**
1	1,258	744
2	963	571
3	227	134
4	1,408	836
5	3,751	2,217
6	491	290
7	656	389
8	953	565
9	1,999	1,181
10	4,387	2,597
11	9,935	5,877
12	2,774	1,640
13	2,764	1,634
TOTAL	**31,566**	**18,675**

Table 6-1. Description of Evacuation Regions

Region	Description	ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13
R01	2 mile ring	■												
R02	5-mile ring	■	■	■	■	■	■							
R03	Full EPZ	■	■	■	■	■	■	■	■	■	■	■	■	■
Evacuate 2 mile ring and 5 miles downwind														
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R04	N,NNE,NNW	■	■				■							
R05	NE	■	■	■										
R06	ENE	■	■	■	■									
R07	E,ESE	■		■	■									
R08	SE,SSE	■			■									
R09	S,SSW,SW	■			■	■								
R10	WSW,W,WNW	■				■	■							
R11	NW	■					■							
Evacuate 5 mile ring and downwind to EPZ boundary														
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R12	N,NNW	■	■	■	■	■	■	■					■	
R13	NNE	■	■	■	■	■	■	■	■				■	
R14	NE	■	■	■	■	■	■	■	■					
R15	ENE	■	■	■	■	■	■	■	■	■				
R16	E	■	■	■	■	■	■		■	■				■
R17	ESE	■	■	■	■	■	■		■	■	■			■
R18	SE,SSE	■	■	■	■	■	■			■	■			■
R19	S	■	■	■	■	■	■				■			
R20	SSW,SW	■	■	■	■	■	■				■	■		
R21	WSW,W,WNW	■	■	■	■	■	■					■	■	
R22	NW	■	■	■	■	■	■						■	

Table 6-2. Evacuation Scenario Definitions

Scenario	Season	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Ice	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Midweek, Weekend	Evening	Good	None
12	Summer	Midweek	Midday	Good	New Plant Construction

Table 7-1C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	2:50	2:50	2:00	2:00	2:30	R01 2-mile ring	2:50	2:50	2:50	2:00	2:00	2:30	R01 2-mile ring	2:55
R02 5-mile ring	3:20	3:20	2:40	2:40	2:40	R02 5-mile ring	3:20	3:20	3:20	2:40	2:40	2:40	R02 5-mile ring	3:20
R03 Entire EPZ	3:30	3:30	2:50	3:00	2:50	R03 Entire EPZ	3:30	3:35	3:50	2:50	2:55	2:50	R03 Entire EPZ	3:50
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	3:10	3:10	2:30	2:30	2:40	R04 N, NNE, NNW	3:10	3:10	3:10	2:30	2:30	2:40	R04 N, NNE, NNW	3:10
R05 NE	3:10	3:10	2:30	2:30	2:40	R05 NE	3:10	3:10	3:10	2:30	2:30	2:40	R05 NE	3:10
R06 ENE	3:20	3:20	2:40	2:40	2:40	R06 ENE	3:20	3:20	3:20	2:40	2:40	2:40	R06 ENE	3:20
R07 E, ESE	3:10	3:10	2:30	2:30	2:40	R07 E, ESE	3:10	3:10	3:10	2:30	2:30	2:40	R07 E, ESE	3:10
R08 SE, SSE	3:10	3:10	2:30	2:30	2:40	R08 SE, SSE	3:10	3:10	3:10	2:30	2:30	2:40	R08 SE, SSE	3:10
R09 S, SSW, SW	3:20	3:20	2:40	2:40	2:40	R09 S, SSW, SW	3:20	3:20	3:20	2:40	2:40	2:40	R09 S, SSW, SW	3:20
R10 WSW, W, WNW	3:10	3:10	2:40	2:40	2:40	R10 WSW, W, WNW	3:10	3:10	3:15	2:40	2:40	2:40	R10 WSW, W, WNW	3:20
R11 NW	3:00	3:00	2:20	2:20	2:40	R11 NW	3:00	3:00	3:00	2:20	2:20	2:40	R11 NW	3:00
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	3:30	3:30	2:50	2:50	2:50	R12 N, NNW	3:30	3:30	3:30	2:50	2:50	2:50	R12 N, NNW	3:30
R13 NNE	3:30	3:30	2:50	2:50	2:50	R13 NNE	3:30	3:30	3:30	2:50	2:50	2:50	R13 NNE	3:30
R14 NE	3:30	3:30	2:40	2:40	2:50	R14 NE	3:30	3:30	3:30	2:40	2:40	2:50	R14 NE	3:30
R15 ENE	3:30	3:30	2:40	2:40	2:50	R15 ENE	3:30	3:30	3:30	2:40	2:40	2:50	R15 ENE	3:30
R16 E	3:30	3:30	2:50	2:50	2:50	R16 E	3:30	3:30	3:30	2:50	2:50	2:50	R16 E	3:30
R17 ESE	3:30	3:30	2:50	2:50	2:50	R17 ESE	3:30	3:30	3:30	2:50	2:50	2:50	R17 ESE	3:30
R18 SE, SSE	3:30	3:30	2:50	2:50	2:50	R18 SE, SSE	3:30	3:30	3:30	2:50	2:50	2:50	R18 SE, SSE	3:30
R19 S	3:30	3:30	2:50	2:50	2:50	R19 S	3:30	3:30	3:30	2:50	2:50	2:50	R19 S	3:30
R20 SSW, SW	3:30	3:30	2:50	2:55	2:50	R20 SSW, SW	3:30	3:35	3:50	2:50	2:55	2:50	R20 SSW, SW	3:50
R21 WSW, W, WNW	3:30	3:30	2:50	3:00	2:50	R21 WSW, W, WNW	3:30	3:35	3:50	2:50	2:55	2:50	R21 WSW, W, WNW	3:50
R22 NW	3:30	3:30	2:45	2:50	2:50	R22 NW	3:30	3:30	3:30	2:40	2:50	2:50	R22 NW	3:30

Table 7-1D. Time To Clear The Indicated Area of 100 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	4:00	4:00	4:00	4:00	4:00	R01 2-mile ring	4:00	4:00	4:00	4:00	4:00	4:00	R01 2-mile ring	4:00
R02 5-mile ring	4:05	4:05	4:05	4:05	4:05	R02 5-mile ring	4:05	4:05	4:05	4:05	4:05	4:05	R02 5-mile ring	4:05
R03 Entire EPZ	4:10	4:10	4:10	4:10	4:10	R03 Entire EPZ	4:10	4:10	4:30	4:10	4:10	4:10	R03 Entire EPZ	4:30
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	4:05	4:05	4:05	4:05	4:05	R04 N, NNE, NNW	4:05	4:05	4:05	4:05	4:05	4:05	R04 N, NNE, NNW	4:05
R05 NE	4:05	4:05	4:05	4:05	4:05	R05 NE	4:05	4:05	4:05	4:05	4:05	4:05	R05 NE	4:05
R06 ENE	4:05	4:05	4:05	4:05	4:05	R06 ENE	4:05	4:05	4:05	4:05	4:05	4:05	R06 ENE	4:05
R07 E, ESE	4:05	4:05	4:05	4:05	4:05	R07 E, ESE	4:05	4:05	4:05	4:05	4:05	4:05	R07 E, ESE	4:05
R08 SE, SSE	4:05	4:05	4:05	4:05	4:05	R08 SE, SSE	4:05	4:05	4:05	4:05	4:05	4:05	R08 SE, SSE	4:05
R09 S, SSW, SW	4:05	4:05	4:05	4:05	4:05	R09 S, SSW, SW	4:05	4:05	4:05	4:05	4:05	4:05	R09 S, SSW, SW	4:05
R10 WSW, W, WNW	4:05	4:05	4:05	4:05	4:05	R10 WSW, W, WNW	4:05	4:05	4:05	4:05	4:05	4:05	R10 WSW, W, WNW	4:05
R11 NW	4:05	4:05	4:05	4:05	4:05	R11 NW	4:05	4:05	4:05	4:05	4:05	4:05	R11 NW	4:05
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	4:10	4:10	4:10	4:10	4:10	R12 N, NNW	4:10	4:10	4:10	4:10	4:10	4:10	R12 N, NNW	4:10
R13 NNE	4:10	4:10	4:10	4:10	4:10	R13 NNE	4:10	4:10	4:10	4:10	4:10	4:10	R13 NNE	4:10
R14 NE	4:10	4:10	4:10	4:10	4:10	R14 NE	4:10	4:10	4:10	4:10	4:10	4:10	R14 NE	4:10
R15 ENE	4:10	4:10	4:10	4:10	4:10	R15 ENE	4:10	4:10	4:10	4:10	4:10	4:10	R15 ENE	4:10
R16 E	4:10	4:10	4:10	4:10	4:10	R16 E	4:10	4:10	4:10	4:10	4:10	4:10	R16 E	4:10
R17 ESE	4:10	4:10	4:10	4:10	4:10	R17 ESE	4:10	4:10	4:10	4:10	4:10	4:10	R17 ESE	4:10
R18 SE, SSE	4:10	4:10	4:10	4:10	4:10	R18 SE, SSE	4:10	4:10	4:10	4:10	4:10	4:10	R18 SE, SSE	4:10
R19 S	4:10	4:10	4:10	4:10	4:10	R19 S	4:10	4:10	4:10	4:10	4:10	4:10	R19 S	4:10
R20 SSW, SW	4:10	4:10	4:10	4:10	4:10	R20 SSW, SW	4:10	4:10	4:30	4:10	4:10	4:10	R20 SSW, SW	4:30
R21 WSW, W, WNW	4:10	4:10	4:10	4:10	4:10	R21 WSW, W, WNW	4:10	4:10	4:30	4:10	4:10	4:10	R21 WSW, W, WNW	4:30
R22 NW	4:10	4:10	4:10	4:10	4:10	R22 NW	4:10	4:10	4:10	4:10	4:10	4:10	R22 NW	4:10

Table 8-5A. School Evacuation Time Estimates - Good Weather

School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Jackson County Schools											
Brownwood Elementary School	90	30	5	6.5	0.2	9	**2:15**	36	0.3	44	**3:00**
Caldwell Elementary School	90	30	5	5.8	0.1	8	**2:15**	36	0.3	44	**3:00**
Collins Elementary School	90	30	5	4.9	0	6	**2:15**	36	0.3	44	**2:55**
Dutton Elementary School	90	30	5	5.9	0.9	9	**2:15**	15.2	1.7	22	**2:40**
Epruett Center of Technology	90	30	5	11.5	0.1	14	**2:20**	36	0.3	44	**3:05**
Hollywood Elementary School	90	30	5	11.5	0.4	15	**2:20**	36	0.3	44	**3:05**
Jackson County Alternative School	90	30	5	11.5	1.5	17	**2:25**	36	0.3	44	**3:10**
Pisgah High School	90	30	5	14.4	1.9	22	**2:30**	7.1	1.7	12	**2:40**
Rosalie Elementary School	90	30	5	2.3	0.1	3	**2:10**	30.3	0.1	37	**2:45**
Scottsboro High School	90	30	5	7.4	0	9	**2:15**	36	0.3	44	**3:00**
Scottsboro Junior High School	90	30	5	4.9	0.6	8	**2:15**	36	0.3	44	**3:00**
Section High School	90	30	5	2.7	0	4	**2:10**	15.2	1.7	22	**2:35**
Thurston T Nelson Elementary School	90	30	5	4	0.1	5	**2:10**	36	0.3	44	**2:55**
DeKalb County Schools											
Henagar Junior High School	90	30	5	3.8	0.1	5	**2:10**	7.1	1.7	12	**2:25**
						Average for EPZ:	**2:16**		**Average:**	36	**2:52**

Table 8-7A. Transit-Dependent Evacuation Time Estimates - GOOD WEATHER

Route Number	Single Wave						Second Wave						
	Mobilization (min)	Travel time to EPZ (min)	Route Length (mi.)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Arrive at RC (min)	Unload (min)	Driver Rest (min)	Return to EPZ (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	150	30	24.9	50	15	**4:05**	172	5	15	36	50	15	**4:55**
2	150	30	11.7	23	15	**3:40**	172	5	15	36	23	15	**4:30**
3	150	30	17.3	35	15	**3:50**	172	5	15	36	35	15	**4:40**
4	150	30	25.9	52	15	**4:10**	172	5	15	36	52	15	**4:55**
5	150	30	17.9	36	15	**3:55**	172	5	15	36	36	15	**4:40**
					Average for EPZ:	**3:56**						**Average for EPZ:**	**4:44**

Table 8-8A. Evacuation Time Estimates for Ambulatory Evacuees from Special Facilities Good Weather							
Facility	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)
				Major Road	Local Road		
Jackson County Special Facilities							
Cloverdale Healthcare Inc	120	30	30	6.1	1.1	10	**3:10**
Highlands Medical Center	120	30	30	6.1	0.8	9	**3:10**
Jackson County Nursing Home	120	30	30	6.1	0.8	9	**3:10**
Mountain Lakes Behavioral Healthcare	120	30	30	6.1	0.9	10	**3:10**
North Jackson Nursing Home	120	30	30	6.4	0	8	**3:10**
Rosewood Manor	120	30	30	5.1	0.2	7	**3:10**
SouthEastern Estates Assisted Living	120	30	30	3.7	0.6	6	**3:10**
The Home Place	120	30	30	5.1	2.6	12	**3:15**
						Average for EPZ:	**3:10**

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained in a study to develop Evacuation Time Estimates (ETE) for the Bellefonte Nuclear Plant (BLN), located in Jackson County, Alabama. Evacuation time estimates provide State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Government agencies. Most important of these are:

- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, US Nuclear Regulatory Commission and Federal Emergency Management Association, NUREG 0654/FEMA-REP-1, Rev. 1, November 1980.
- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, US Nuclear Regulatory Commission/Contractor Report, NUREG/CR-1745, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

We wish to express our appreciation to all the directors and staff members of the Jackson County, DeKalb County, and Alabama Emergency Management Agencies, and local and state law enforcement agencies who provided valued guidance and contributed information contained in this report.

1.1 Overview of the ETE Development Process

The following outline presents a brief description of the work effort in chronological sequence:

1. Information Gathering:
   - Defined the scope of work in discussion with representatives of Enercon Services and Tennessee Valley Authority.
   - Attended meetings with emergency planners from Jackson and DeKalb Counties to identify issues to be addressed and resources available.
   - Conducted a detailed field survey of the EPZ highway system and of area traffic conditions.
   - Obtained demographic data from the Census and from state agencies.
   - Conducted a random sample telephone survey of EPZ residents.
   - Conducted a data collection effort to identify and describe schools, special facilities, major employers, transportation providers, and other important sources of information.
2. Estimated distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the random sample telephone survey.
3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Defined a traffic management strategy. Traffic control is applied at specified Traffic Control Points (TCP) located within the Emergency Planning Zone (EPZ), and at Access Control Points (ACP) located outside the EPZ. Local and state police personnel reviewed all traffic control plans.

5. Defined Evacuation Areas or "Regions". The EPZ is partitioned into 13 Emergency Response Planning Areas (ERPA) using political and geographic boundaries. "Regions" are groups of contiguous ERPA for which ETE are calculated. The configurations of these Regions depend upon wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a "key-hole section" within the EPZ as required by NUREG 0654.

6. Estimated demand for transit services for persons at "Special Facilities" and for transit-dependent persons at home.

7. Prepared the input streams for the IDYNEV system.

   - Estimated the traffic demand, based on the available information derived from Census data, and from data provided by local and state agencies, Enercon Services, and from the telephone survey.
   - Applied the procedures specified in the 2000 Highway Capacity Manual[1] (HCM) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.
   - Developed a link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.

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[1] Highway Capacity Manual (HCM2000), Transportation Research Board, National Research Council, 2000

- Calculated the evacuating traffic demands for each Region and for each Evacuation Scenario. Considered the effects on demand of “voluntary evacuation” and of the “shadow effect”.
- Represented the traffic management strategy.
- Specified the candidate destinations of evacuation travel consistent with outbound movement relative to the location of the BLN.
- Prepared the input stream for the IDYNEV System.
- Executed the IDYNEV models to provide the estimates of evacuation routing and ETE.

8. Generated a complete set of ETE for all specified Regions and Evacuation Scenarios.
9. Documented ETE in formats responsive to NUREG 0654.
10. Calculated the ETE for all transit activities including those for special facilities (schools, health-related facilities, etc.) and for the transit-dependent.

Steps 4 through 9 are iterated as described in Appendix D.

1.2 The Bellefonte Nuclear Plant Site Location

The proposed Bellefonte Nuclear Plant is located on the western shores of Lake Guntersville, just outside of Scottsboro, Alabama and approximately 40 miles east of Huntsville, Alabama. The Emergency Planning Zone (EPZ) consists of parts of two counties: Jackson County and DeKalb County. Figure 1-1 displays the area surrounding the Bellefonte Nuclear Plant. This map identifies the communities in the area and the major roads.

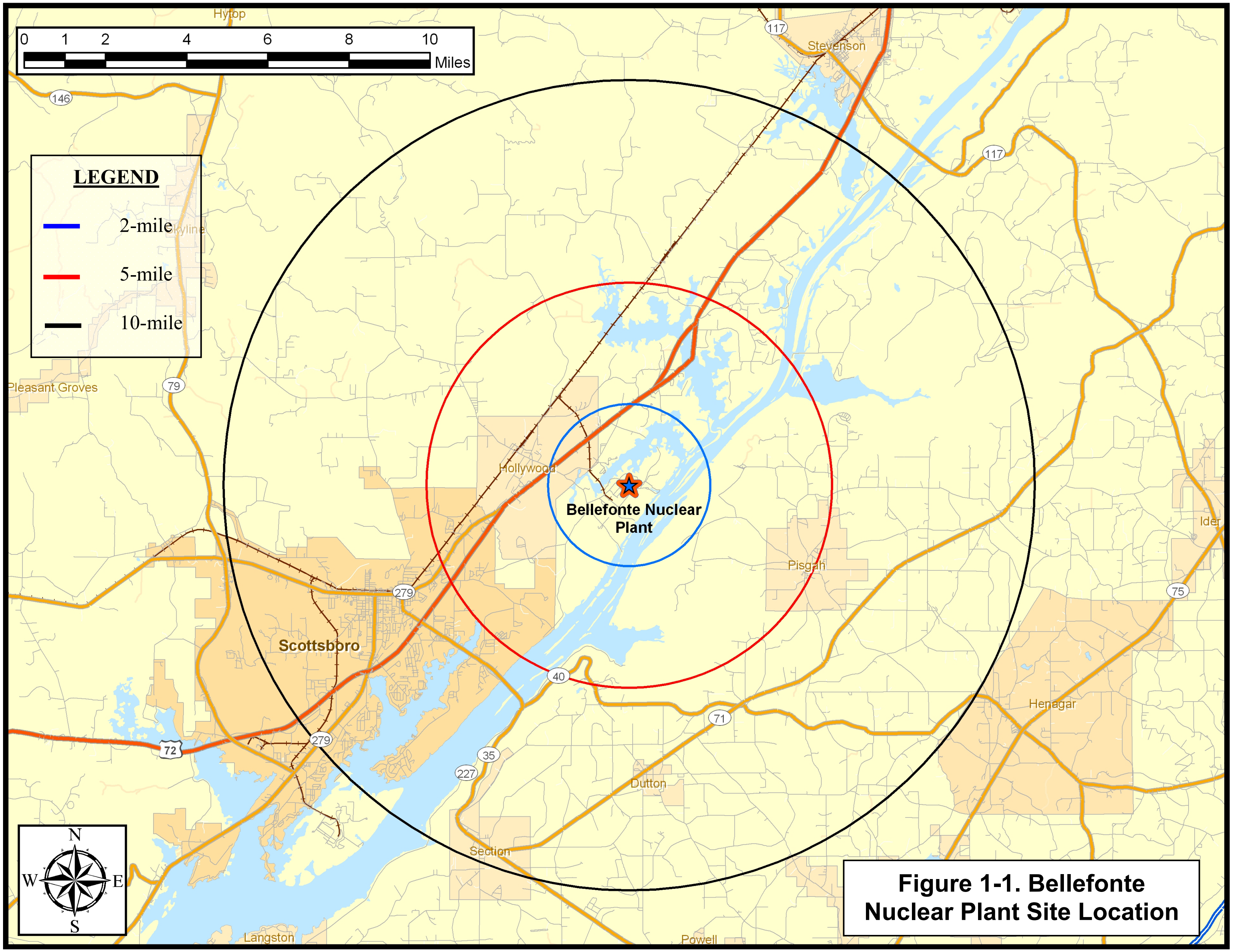


Figure 1-1. Bellefonte Nuclear Plant Site Location

1.3 Preliminary Activities

These activities are described below.

Field Surveys of the Highway Network

KLD personnel drove the entire highway system within the EPZ and for some distance outside. The characteristics of each section of highway were recorded. These characteristics include:

- Number of lanes
- Pavement Width
- Shoulder type & width
- Intersection configuration
- Lane channelization
- Geometrics: Curves, grades
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Interchange geometries

The data were then transcribed; this information was referenced while preparing the input stream for the IDYNEV System. In addition, key highway sections and intersections were video archived.

Telephone Survey

A telephone survey was undertaken to gather information needed for the evacuation study. Appendix F presents the survey instrument, the procedures used and tabulations of data compiled from the survey returns.

These data were utilized to develop estimates of vehicle occupancy during an evacuation and to estimate elements of the mobilization process. This database was also referenced to estimate the number of transit-dependent residents.

Developing the Evacuation Time Estimates

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data.

Highway capacity was estimated for each highway segment based on the field surveys and on the principles specified in the 2000 Highway Capacity Manual (HCM). The link-node representation of the physical highway network was developed using Geographic Information System (GIS) mapping software and the observations obtained from the field survey. This network representation of "links" and "nodes" is shown in Figure 1-2.

Analytical Tools

The IDYNEV System that was employed for this study is comprised of several integrated computer models. One of these is the PC-DYNEV (DYnamic Network EVacuation) macroscopic simulation model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

PC-DYNEV consists of three submodels:

- A macroscopic traffic simulation model (for details, see Appendix C).
- An intersection capacity model (for details, see Highway Research Record No. 772, Transportation Research Board, 1980, papers by Lieberman and McShane & Lieberman).
- A dynamic, node-centric routing model that adjusts the "base" routing in the event of an imbalance in the levels of congestion on the outbound links.

Another model of the IDYNEV System is the TRAD (Traffic Assignment and

Distribution) model. This model integrates an equilibrium assignment model with a trip distribution algorithm to compute origin-destination volumes and paths of travel designed to minimize travel time. For details, see Appendix B.

Still another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System) was used to expedite data entry.

The procedure for applying the IDYNEV System within the framework of developing an ETE is outlined in Appendix D. Appendix A is a glossary of terms.

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths of travel that will expedite their travel from their respective points of origin to points outside the EPZ.
- Restrict movement toward BLN to the extent practicable, and disperse traffic demand so as to avoid focusing demand on a limited number of highways.
- Move traffic in directions that are generally outbound, relative to the location of BLN.

A set of candidate destination nodes on the periphery of the EPZ is specified for each traffic origin (or centroid) within the EPZ. The TRAD model produces output that identifies the "best" traffic routing, subject to the design conditions outlined above. In addition to this information, rough estimates of travel time are provided, together with turn-movement data required by the PC-DYNEV simulation model.

The simulation model is then executed to provide a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to expedite the movement of vehicles.

As outlined in Appendix D, this procedure consists of an iterative design-analysis-redesign sequence of activities. If properly done, this procedure converges to yield an evacuation plan which best services the evacuating public.

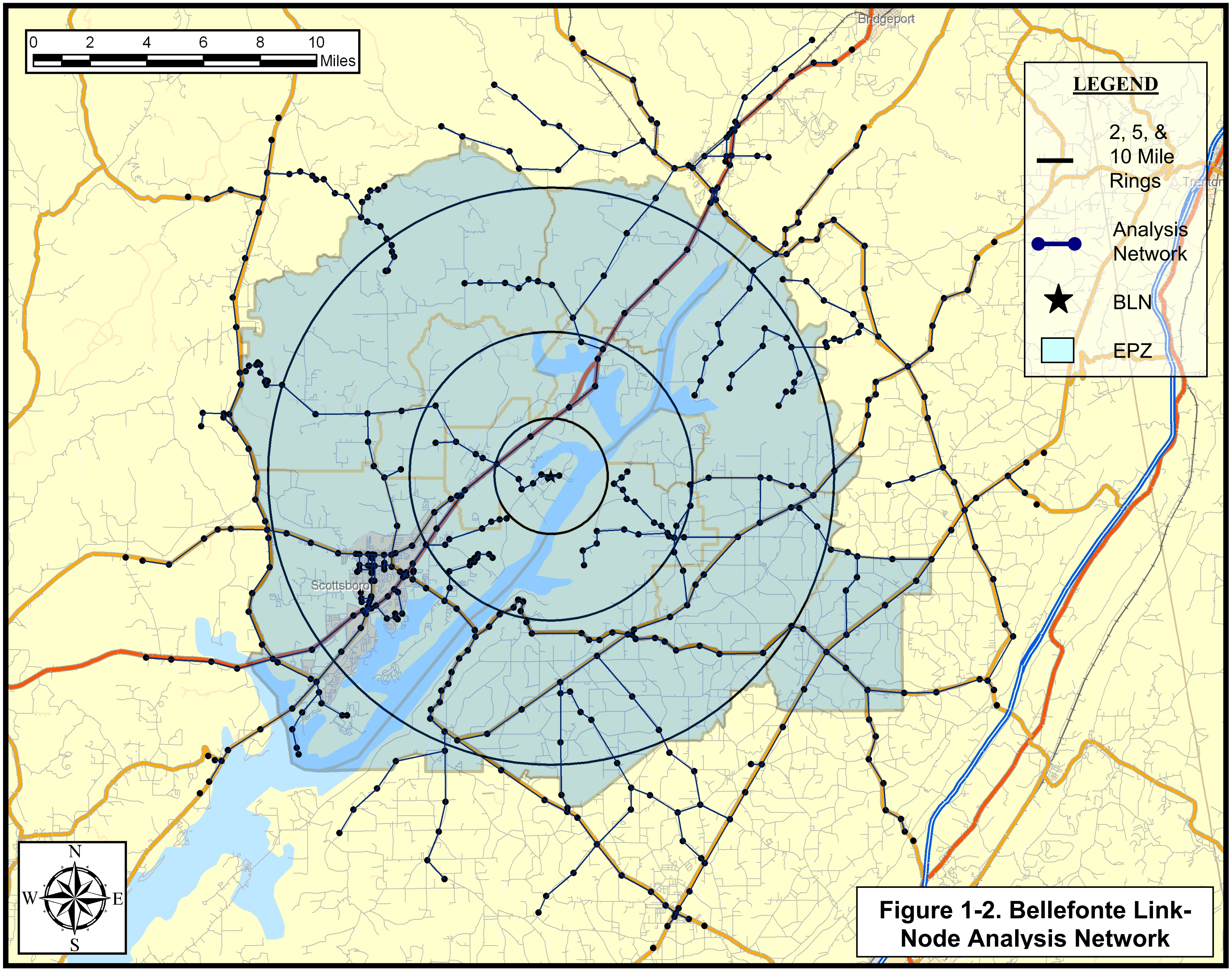


Figure 1-2. Bellefonte Link-Node Analysis Network

2. STUDY ESTIMATES AND ASSUMPTIONS

This section presents the estimates and assumptions utilized in the development of the evacuation time estimates.

2.1 Data Estimates

1. Population estimates are based upon Census 2000 data, projected to year 2007 by Enercon Services using regression analysis on County-specific projections. Estimates of employees who commute into the EPZ to work are based upon the state Census Journey to Work Database for 2000, projected to year 2007 using U.S. Department of Labor job growth rates.
2. Population estimates at special facilities are based on available data from county emergency management agencies.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000[1].
4. Population mobilization times are based on a statistical analysis of data acquired from the telephone survey.
5. The relationship between resident population and evacuating vehicles is developed from the telephone survey. Average values of 2.54 persons per household and 1.50 evacuating vehicles per household are used.
6. The relationship between persons and vehicles for special facilities is as follows:
    a. Shopping: 1 vehicle per family
    b. Employees: 1.03 employees per vehicle (telephone survey results)
7. Evacuation Time Estimates (ETEs) are presented for the evacuation of the 100th percentile of population for each Region and for each Scenario, and for the 2-mile, 5-mile and 10-mile distances. ETEs are presented in tabular

[1] Highway Capacity Manual (HCM2000), Transportation Research Board, National Research Council, 2000.

and graphical format showing the values of ETE associated with the 50th, 90th and 95th percentiles of population. A Region is defined as a group of Emergency Response Planning Areas (ERPAs) that is issued an Advisory to Evacuate.

2.2 Study Methodological Assumptions

1. The Evacuation Time is defined as the elapsed time from when the Advisory to Evacuate is issued to a specific Region of the EPZ, to that time when the Region is clear of people.

2. The ETEs are computed and presented in a format compliant with NUREG 0654. The ETE for each evacuation area ("Region" comprised of included ERPA) is presented in both statistical and graphical formats.

3. Evacuation movements (paths of travel) are generally outbound relative to the power plant to the extent permitted by the highway network, as computed by the computer models. All available evacuation routes are used in the analysis.

4. Regions are defined by the underlying "keyhole" or circular configurations as specified in NUREG 0654. These Regions, as defined, display irregular boundaries reflecting the geography of the ERPAs included within these underlying configurations.

5. Voluntary evacuation is considered as indicated in the accompanying Figure 2-1. Within the circle defined by the distance to be evacuated but outside the Evacuation Region, 50 percent of the people not advised to evacuate are assumed to evacuate within the same time-frame. In the outer annular area between the circle defined by the extent of the Evacuation Region and the EPZ boundary, it is assumed that 35 percent of people will voluntarily evacuate. In the area between the EPZ boundary and a 15-mile circular area centered at the plant (the "shadow region"), it

is assumed that 30 percent of the people will evacuate voluntarily. Sensitivity studies explored the effect on ETE, of increasing the percentage of voluntary evacuees in this area. (Appendix I)

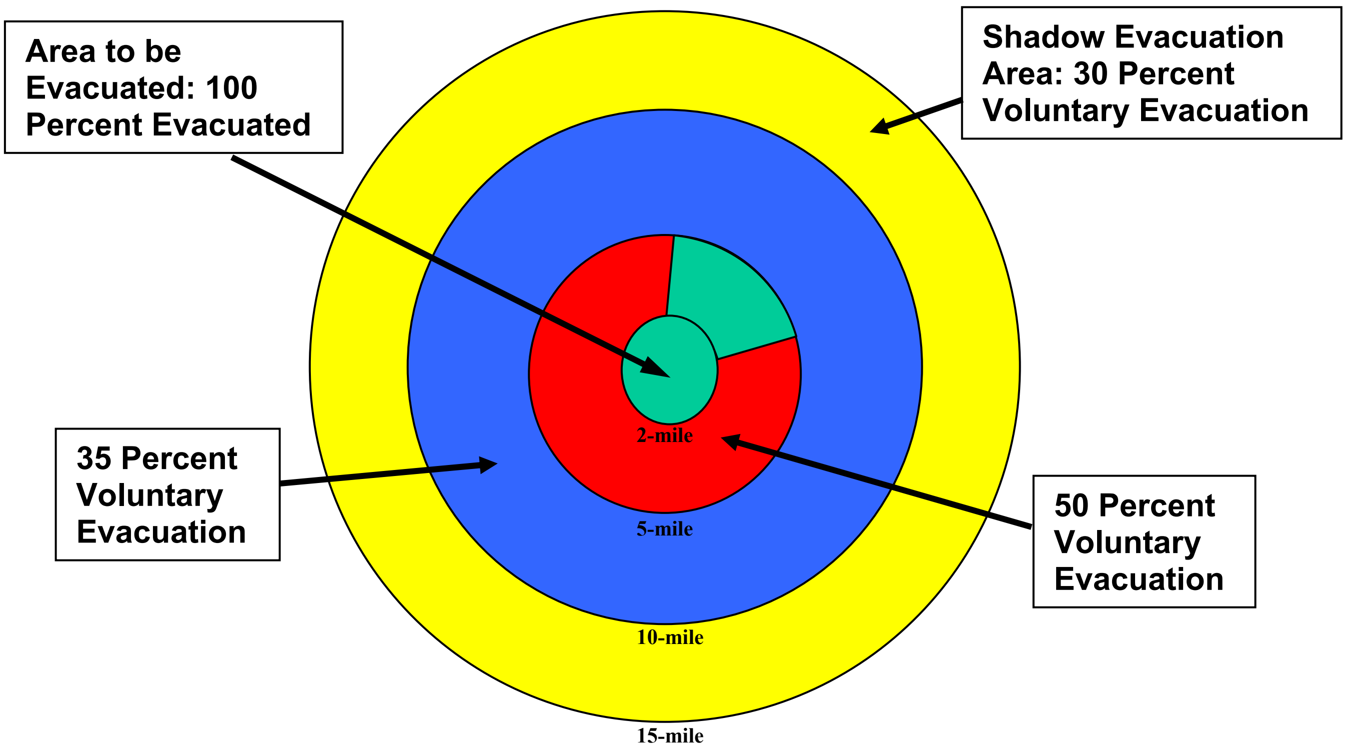


Figure 2-1. Voluntary Evacuation Methodology

The basis for our assumptions on voluntary evacuation is testimony proffered by Dennis Miletti, a professor at Colorado State University, and one of the nations top disaster response experts, at Atomic Safety and Licensing Board (ASLB) hearings, which were deemed acceptable. There are limited data pertaining to nuclear evacuations in the United States. The numbers we use for voluntary evacuation are Professor Miletti's best estimates based on his years of experience in evacuation planning and preparedness.

6. A total of 12 "Scenarios" representing different seasons, time of day, day of week and weather are considered. One special event scenario is studied: the construction period of a new nuclear plant. These Scenarios are tabulated below:

Scenario	Season	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Ice	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Midweek, Weekend	Evening	Good	None
12	Summer	Midweek	Midday	Good	New Plant Construction

7. The models of the IDYNEV System were recognized as state of the art by Atomic Safety & Licensing Boards (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[2]). The models have continuously been refined and extended since those hearings and have been independently validated by a consultant retained by the NRC.

[2] Urbanik, T., et. al. Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code, NUREG/CR-4873, Nuclear Regulatory Commission, June, 1988

2.3 Study Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following:

    a. Advisory to Evacuate is announced coincident with the siren notification.

    b. Mobilization of the general population will commence within 10 minutes after siren notification.

    c. ETEs are measured relative to the Advisory to Evacuate.

2. It is assumed that everyone within the group of ERPA forming a Region that is issued an Advisory to Evacuate will, in fact, respond and evacuate in general accord with the planned routes.

3. It is further assumed that:

    a. Schools will be given the earliest notification possible so they can begin evacuating prior to notification of the general public, if conditions permit. In the case of a rapidly escalating accident, however, this may not be possible.

    b. 64 percent of the households in the EPZ have at least 1 commuter; 69 percent of those households with commuters will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.

4. The ETE will also include consideration of “through” (External-External) trips during the time that such traffic is permitted to enter the evacuated Region. “Normal” traffic flow is assumed to be present within the EPZ at the start of the emergency.

5. Access Control Points (ACP) will be staffed within approximately 1 - 2 hours following the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations would delay returning commuters. It is assumed that no vehicles will enter the EPZ after this 1 –

2 hour time period.

6. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. Their number and location will depend on the Region to be evacuated and resources available. It is assumed that drivers will act rationally, travel in the directions identified in the plan, and obey all control devices and traffic guides.

7. Buses will be used to transport those without access to private vehicles:

   a. If schools are in session, transport (buses) will evacuate students directly to the assigned Reception Centers or host schools.

   b. Medical facilities are required to have a detailed evacuation plan and to provide adequate transportation for all residents. Buses needed to evacuate special facilities are provided through private contracting.

   c. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.

   d. Bus mobilization time is considered in ETE calculations.

   e. Analysis of the number of required “waves” of evacuating transit vehicles, are presented.

8. Provisions are made for evacuating the transit-dependent portion of the general population to reception centers by bus, based on the assumption that some of these people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. We assume that the percentage of people who rideshare is 50 percent. This assumption is based upon reported experience for other emergencies,[3] which cites previous evacuation experience.

[3] Institute for Environmental Studies, University of Toronto, THE MISSISSAUGA EVACUATION FINAL REPORT, June 1981. The report indicates that 6,600 people of a transit-dependent population of 8,600 people shared rides with other residents; a ride share rate of 76% (Page 5-10).

9. Two types of adverse weather scenario are considered. Rain may occur for either winter or summer scenarios. In the case of rain, it is assumed that the rain begins at about the same time as the evacuation advisory is issued. Ice occurs in winter scenarios only. No weather-related reduction in the number of transients who may be present in the EPZ is assumed.

   Adverse weather scenarios affect roadway capacity and the free flow highway speeds. The factors assumed for the ETE study are:

Scenario	**Highway Capacity***	**Free Flow Speed***	**Mobilization Time**
Rain[4]	90%	90%	No Effect
Ice	85%	85%	No Effect
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

10. School buses used to transport students are assumed to transport 70 children per bus for elementary schools, and 50 children per bus for middle and high schools. Transit buses used to transport the transit-dependent general population are assumed to transport 30 people per bus.

[4] Agarwal, M. et. Al. Impacts of Weater on Urban Freeway Traffic Flow Characteristics and Facility Capacity, Proceedings of the 2005 Mid-Continent Transportation Research Symposium, August, 2005.

3. DEMAND ESTIMATION

The estimates of demand, expressed in terms of people and vehicles, constitute a critical element in developing an evacuation plan. These estimates consist of three components:

1. An estimate of population within the Emergency Planning Zone (EPZ), stratified into groups (resident, employee, transient).

2. An estimate, for each population group, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.

3. An estimate of potential double-counting of vehicles.

Appendix E presents much of the source material for the population estimates. Our primary source of population data, the 2000 Census, however, is not adequate for directly estimating some transient groups.

Throughout the year, vacationers and tourists enter the EPZ. These non-residents may dwell within the EPZ for a short period (e.g. a few days or one or two weeks), or may enter and leave within one day. Estimates of the size of these population components must be obtained, so that the associated number of evacuating vehicles can be ascertained.

The potential for double-counting people and vehicles must be addressed. For example:

- A resident who works and shops within the EPZ could be counted as a resident, again as an employee and once again as a shopper.
- A visitor who stays at a hotel and spends time at a park, then goes shopping could be counted three times.

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. Simply adding up the capacities of different types of parking facilities will tend to overestimate the number of transients and can lead to ETE that are too conservative.

Analysis of the population characteristics of the Bellefonte Nuclear Plant (BLN) EPZ indicates the need to identify three distinct groups:

- Permanent residents - people who are year-round residents of the EPZ.
- Transients - people who reside outside of the EPZ, who enter the area for a specific purpose (e.g., shopping, camping) and then leave the area.
- Employees - people who reside outside the EPZ and commute to businesses within the EPZ on a daily basis.

Estimates of the population and number of evacuating vehicles for each of the population groups are presented for each Emergency Response Planning Area (ERPA) and by polar coordinate representation (population rose). The BLN EPZ has been subdivided into 13 ERPA. These ERPA are shown in Figure 3-1.

Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. The average household size (2.54 persons/household) and the number of evacuating vehicles per household (1.50 vehicles/household) were adapted from the telephone survey results.

Enercon Services provided population estimates for 2000 using geographic information systems (GIS) software and Census block data. County projection numbers were obtained for the counties in the EPZ; these numbers were used in a regression analysis with the 2000 Census estimates to project the 2007 EPZ population. Table 3-1 shows that the EPZ population has increased about 6 percent over the last 7 years.

Permanent resident population and vehicle estimates for 2007 are presented in Table 3-2. Figures 3-2 and 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from the BLN. This "rose" was constructed using GIS software.

Special Events

The construction year for the new unit at BLN is assumed to be 2015. Comparison of the 2000 Census data and the 2006 Census estimates for Jackson County and DeKalb County indicate that population is not growing significantly. We use the same population as in 2007 for permanent residents in the EPZ and in the shadow area for the Construction scenario (Scenario 12). Enercon Services estimates the construction workforce as 3,000 employees. The telephone survey results (1.03 employees/vehicle) indicate there is some carpooling in the EPZ. Using this factor, we estimate the construction traffic as 2,913 vehicles. We did not consider any roadway improvements for the construction scenario.

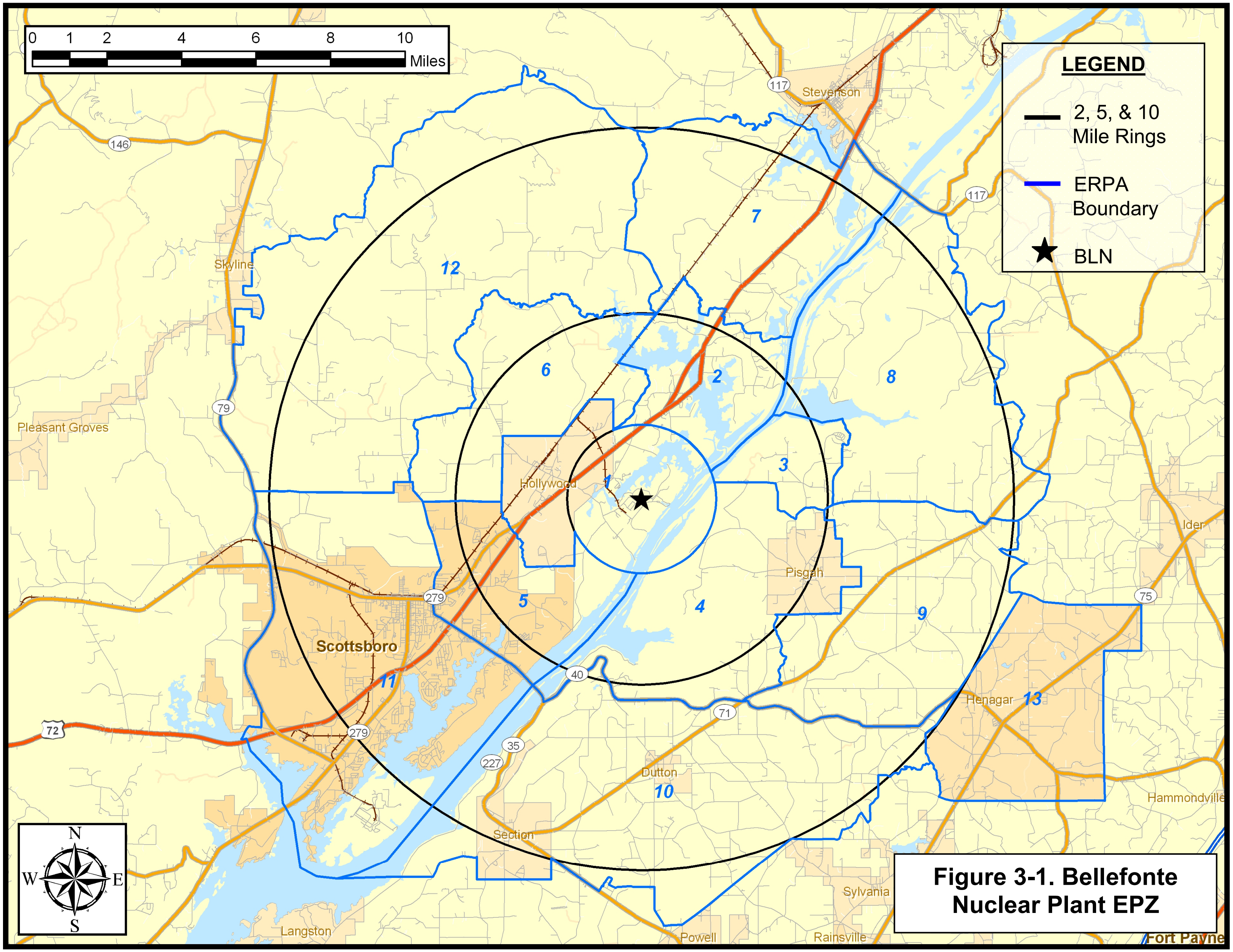
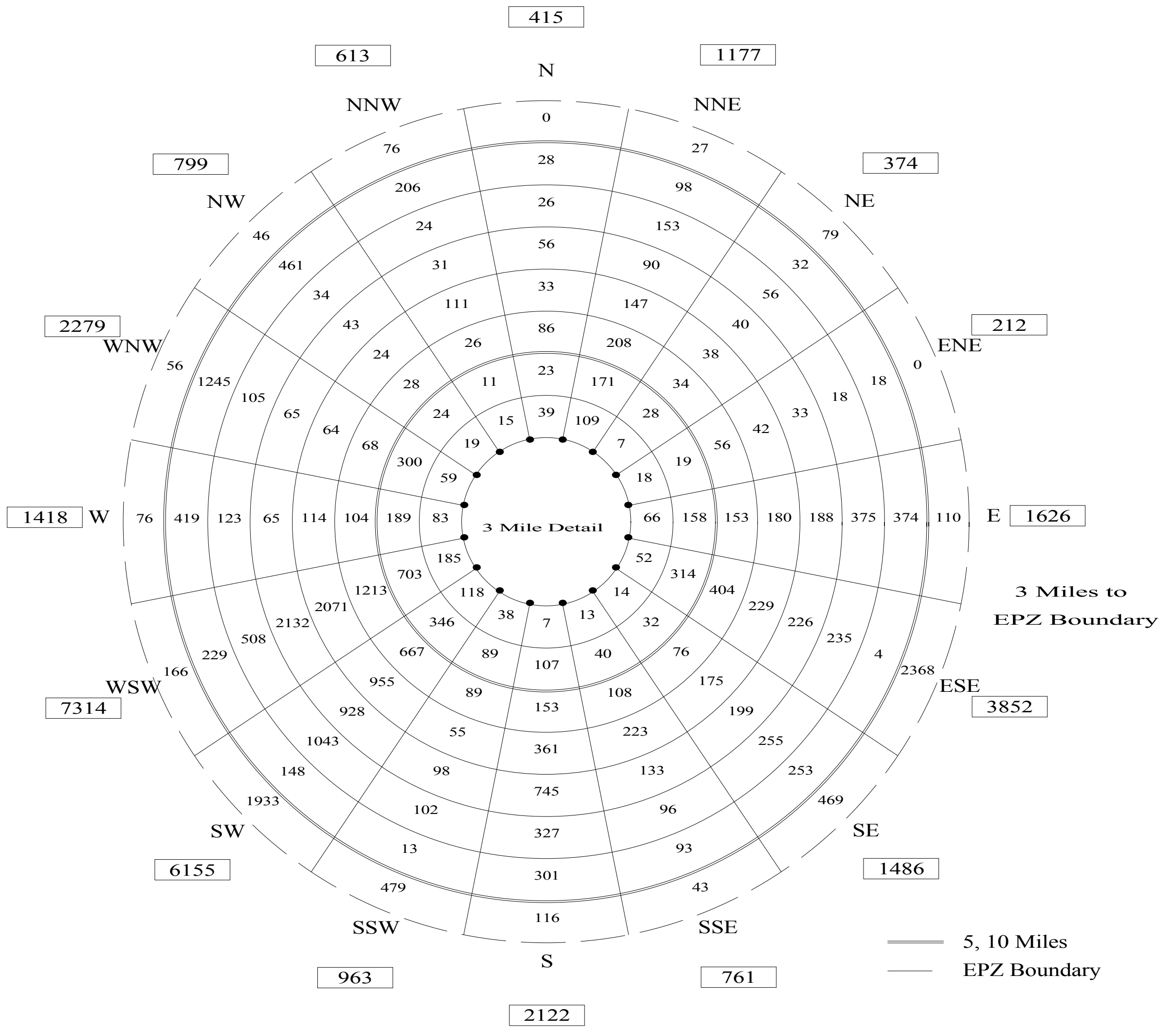


Figure 3-1. Bellefonte Nuclear Plant EPZ

Table 3-1. EPZ Permanent Resident Population		
ERPA	**POP'00**	**POP '07**
1	1,174	1,258
2	784	963
3	242	227
4	1,235	1,408
5	3,323	3,751
6	520	491
7	732	656
8	828	953
9	2,226	1,999
10	4,013	4,387
11	11,310	9,935
12	1,000	2,774
13	2,400	2,764
TOTAL	**29,787**	**31,566**
	Population Growth:	**5.97%**

Table 3-2. Permanent Resident Population and Vehicles by ERPA		
ERPA	**POP '07**	**VEH '07**
1	1,258	744
2	963	571
3	227	134
4	1,408	836
5	3,751	2,217
6	491	290
7	656	389
8	953	565
9	1,999	1,181
10	4,387	2,597
11	9,935	5,877
12	2,774	1,640
13	2,764	1,634
TOTAL	**31,566**	**18,675**



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	47	0-1	47
1-2	320	0-2	367
2-3	990	0-3	1357
3-4	842	0-4	2199
4-5	2554	0-5	4753
5-6	3473	0-6	8226
6-7	4822	0-7	13048
7-8	5072	0-8	18120
8-9	3480	0-9	21600
9-10	3922	0-10	25522
10-EPZ	6044	0-EPZ	31566

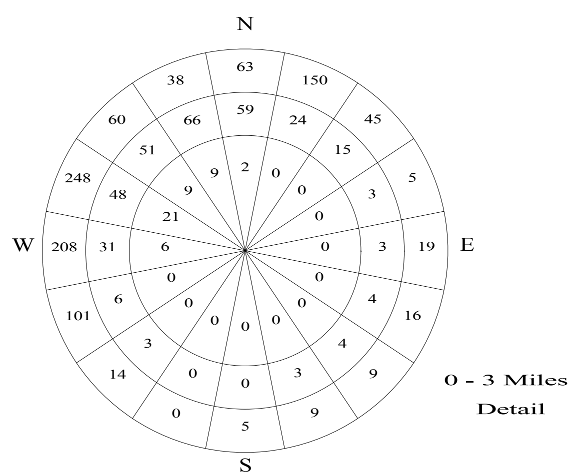
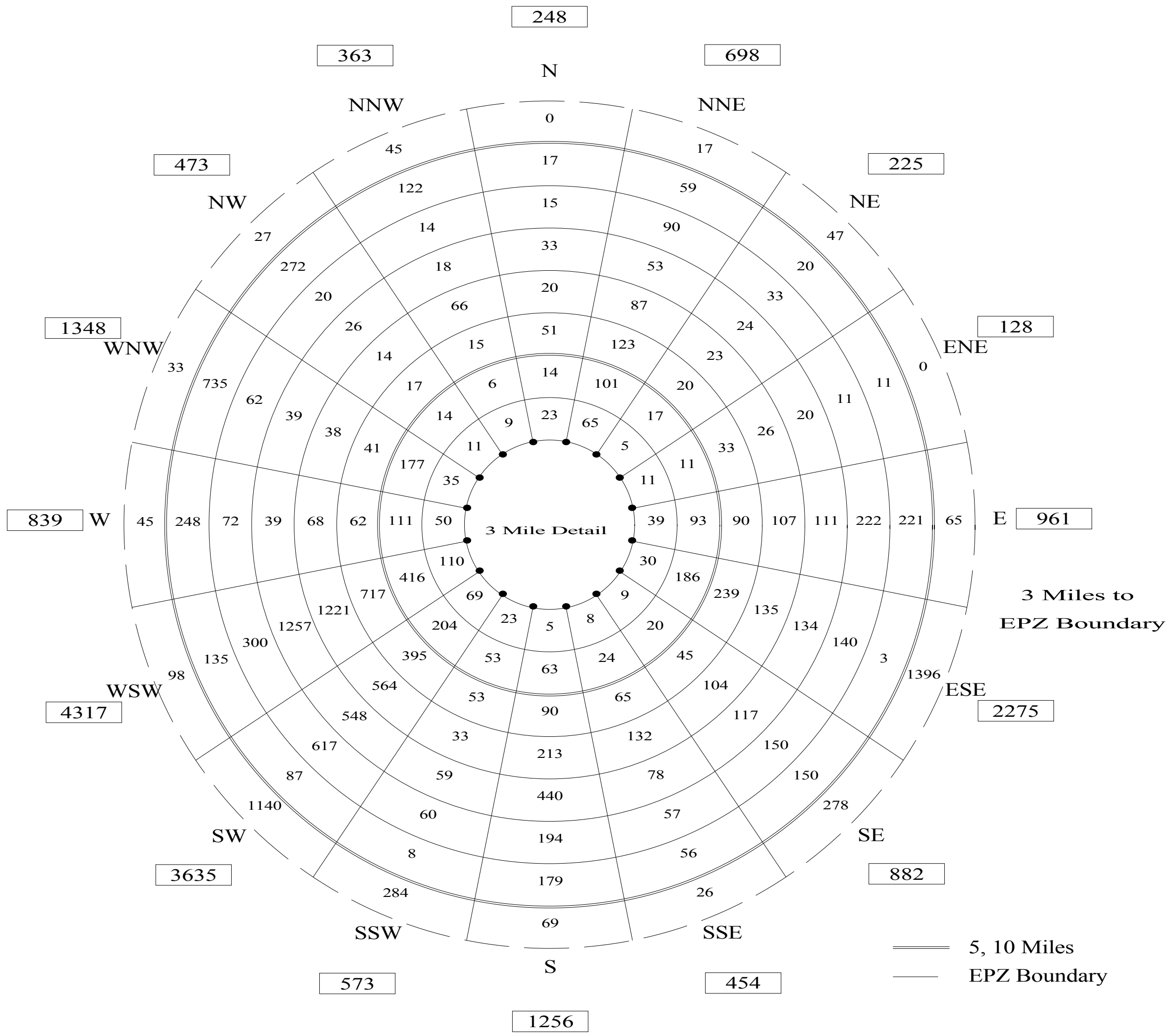


Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	29	0-1	29
1-2	191	0-2	220
2-3	590	0-3	810
3-4	502	0-4	1312
4-5	1510	0-5	2822
5-6	2056	0-6	4878
6-7	2851	0-7	7729
7-8	2996	0-8	10725
8-9	2057	0-9	12782
9-10	2323	0-10	15105
10-EPZ	3570	0-EPZ	18675

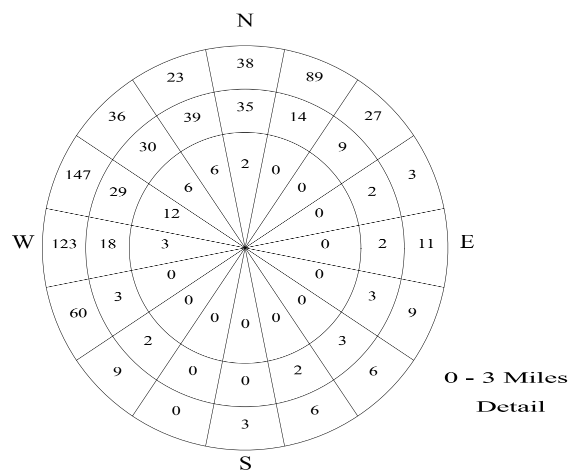


Figure 3-3. Permanent Resident Vehicles by Sector

Transient Population

Transient population groups are defined as those people who are not permanent residents and who enter the EPZ for a specific purpose (shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. The Bellefonte EPZ has a number of areas that attract transients, including:

- Goose Pond Colony Plantation
- Jackson County Park
- The Unclaimed Baggage Center

Estimates of the peak attendance at these transient facilities were provided by County emergency management offices. Internet searches were also used to obtain more detailed information about these facilities and supplement the data provided. The average household size of 2.54 persons per household was applied to the transient facilities to estimate the number of visiting families; one evacuating vehicle per transient family was assumed. The following are estimates of transient population for each of these facilities:

Goose Pond Colony Plantation

The Goose Pond Colony Plantation is located on the shores of Lake Guntersville. It features two 18-hole championship golf courses, lake side cottages, a lodge, waterfront campground, a full service marina, and other amenities. Data on the campground and lake side cottages was provided by county emergency management offices. Overhead imagery was used to estimate the parking capacity for the golf courses and marina. Two passenger car equivalents are used for boats towing trailers and for Recreational Vehicles (RV's). The peak transient population for Goose Pond Colony is estimated as 1,294 people evacuating in 682 vehicles.

Jackson County Park

Jackson County Park, located in Scottsboro, offers visitors fishing, swimming, walking trails, camping and boat ramps. The park has 156 campsites which are typically fully occupied during summer weekends. There are also 2 boat ramps with parking for 75 cars with boat trailers. The peak attendance, provided by Jackson County is estimated as 1,500 people evacuating in 612 vehicles.

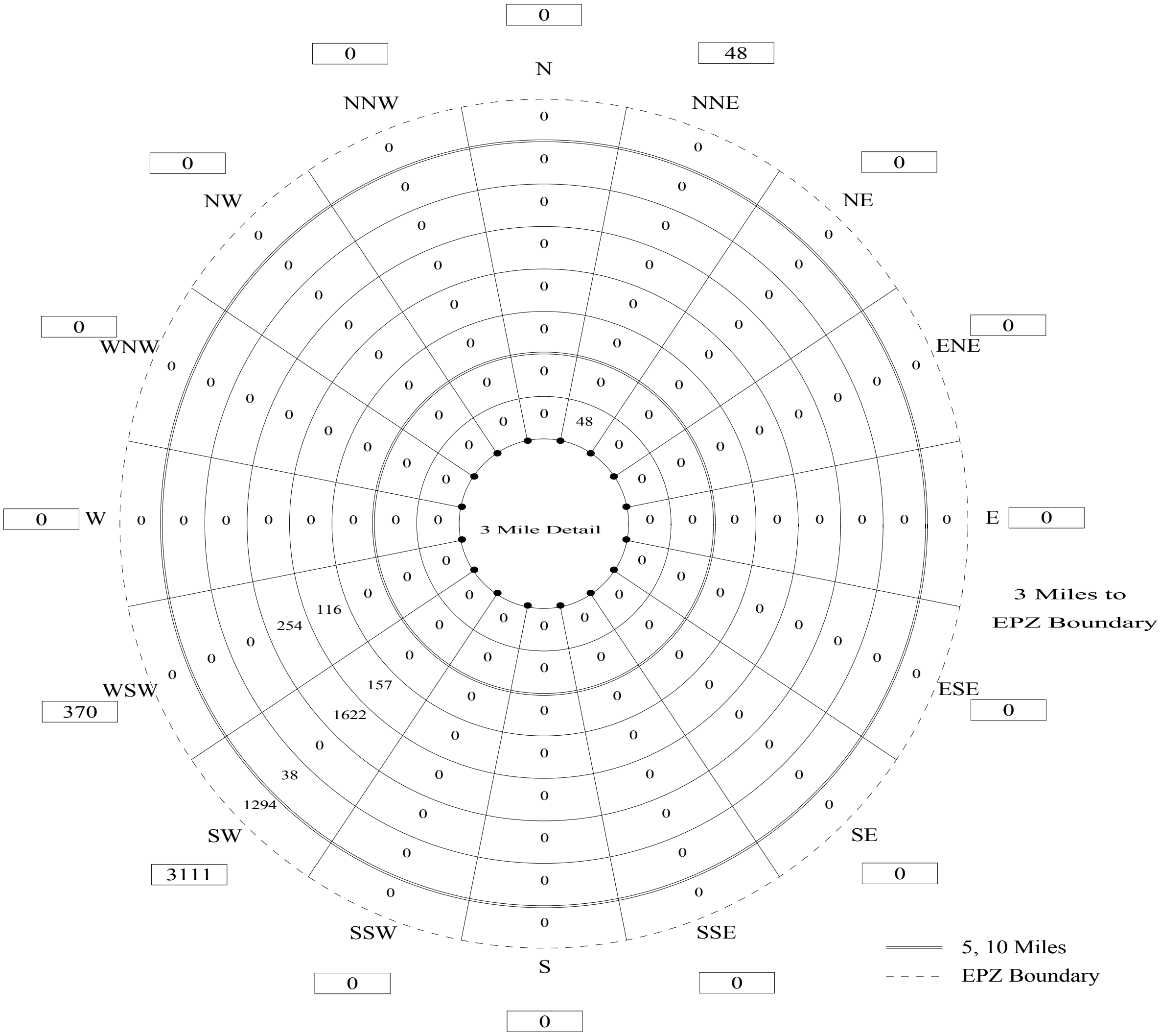
The Unclaimed Baggage Center

The unclaimed baggage center is a one-of-a-kind retail store located in Scottsboro. It sells items from unclaimed baggage at discounted prices. The store covers more than a city block and attracts many regular customers as well as transient visitors. The parking capacity of the facility was estimated using overhead imagery. The peak attendance is estimated as 254 people evacuating in 100 vehicles.

Hotels and Motels

There are a total of 8 hotels and motels within the EPZ. Appendix E details the hotel data provided by county emergency management offices. The peak attendance at the hotels and motels is estimated as 467 people evacuating in 274 vehicles.

Table 3-3. Summary of Transients			
Facility Name	**ERPA**	**Transients**	**Vehicles**
Hotels and Motels			
Creekstone Lodge	2	48	24
Best Value Inn	11	96	48
Budget Inn	11	36	18
Comfort Inn	11	122	61
Goose Pond Colony Resort	11	24	12
J & W Motel	11	20	20
Jameson Inn	11	61	61
Liberty Inn	11	60	30
	Subtotal:	**467**	**274**
Camps/Parks			
Jackson County Park	11	1,500	612
Goose Pond Colony Campsite	11	450	200
Crawford Mobile Home/RV Park	11	38	38
	Subtotal:	**1,988**	**850**
Marinas and Boat Ramps			
Goose Pond Colony Marina	11	700	350
Golf Courses			
Goose Pond Colony Golf Course	11	120	120
Major Retail			
Unclaimed Baggage Center	11	254	100
	TOTAL:	**3,529**	**1,694**



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	48	0-4	48
4-5	0	0-5	48
5-6	0	0-6	48
6-7	273	0-7	321
7-8	1876	0-8	2197
8-9	0	0-9	2197
9-10	38	0-10	2235
10-EPZ	1294	0-EPZ	3529

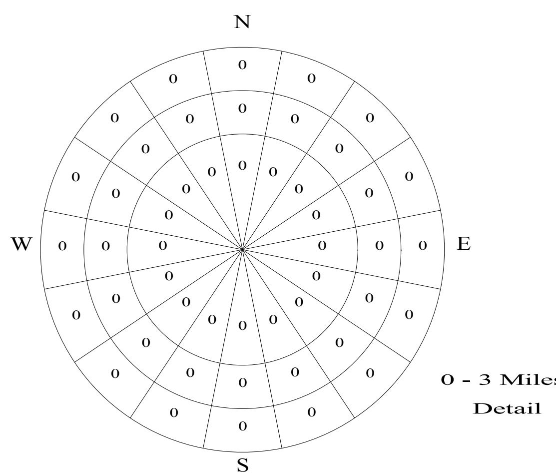
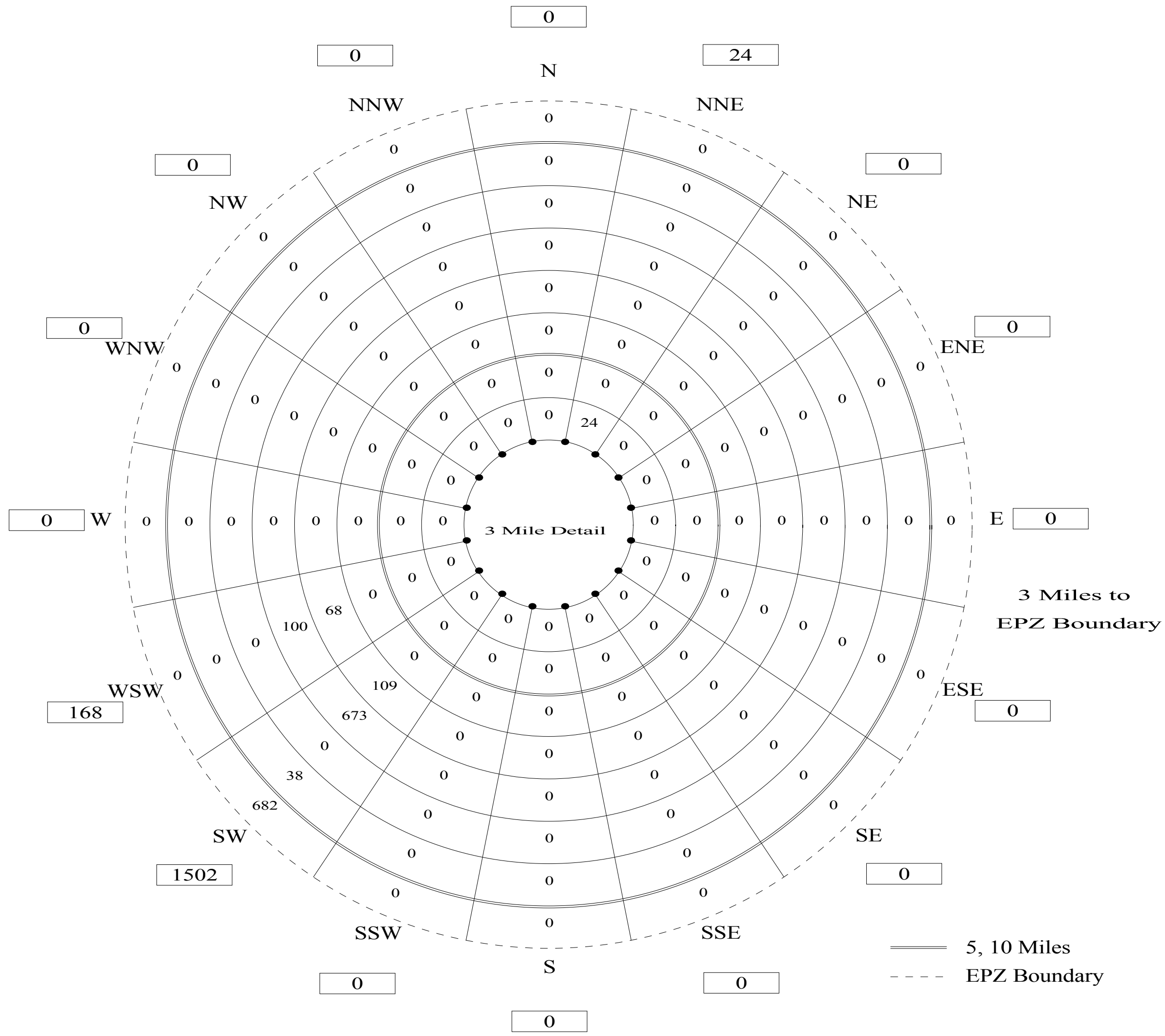


Figure 3-4. Transient Population by Sector



Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	24	0-4	24
4-5	0	0-5	24
5-6	0	0-6	24
6-7	177	0-7	201
7-8	773	0-8	974
8-9	0	0-9	974
9-10	38	0-10	1012
10-EPZ	682	0-EPZ	1694

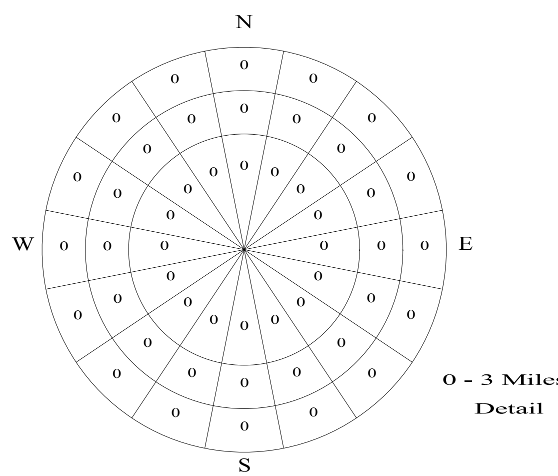


Figure 3-5. Transient Vehicles by Sector

Employees

Employees who work within the EPZ fall into two categories:

- Those who live and work in the EPZ
- Those who live outside of the EPZ and commute to jobs within the EPZ.

Those of the first category are already counted as part of the permanent resident population. To avoid double counting, we focus on those commuting employees who will evacuate along with the permanent resident population.

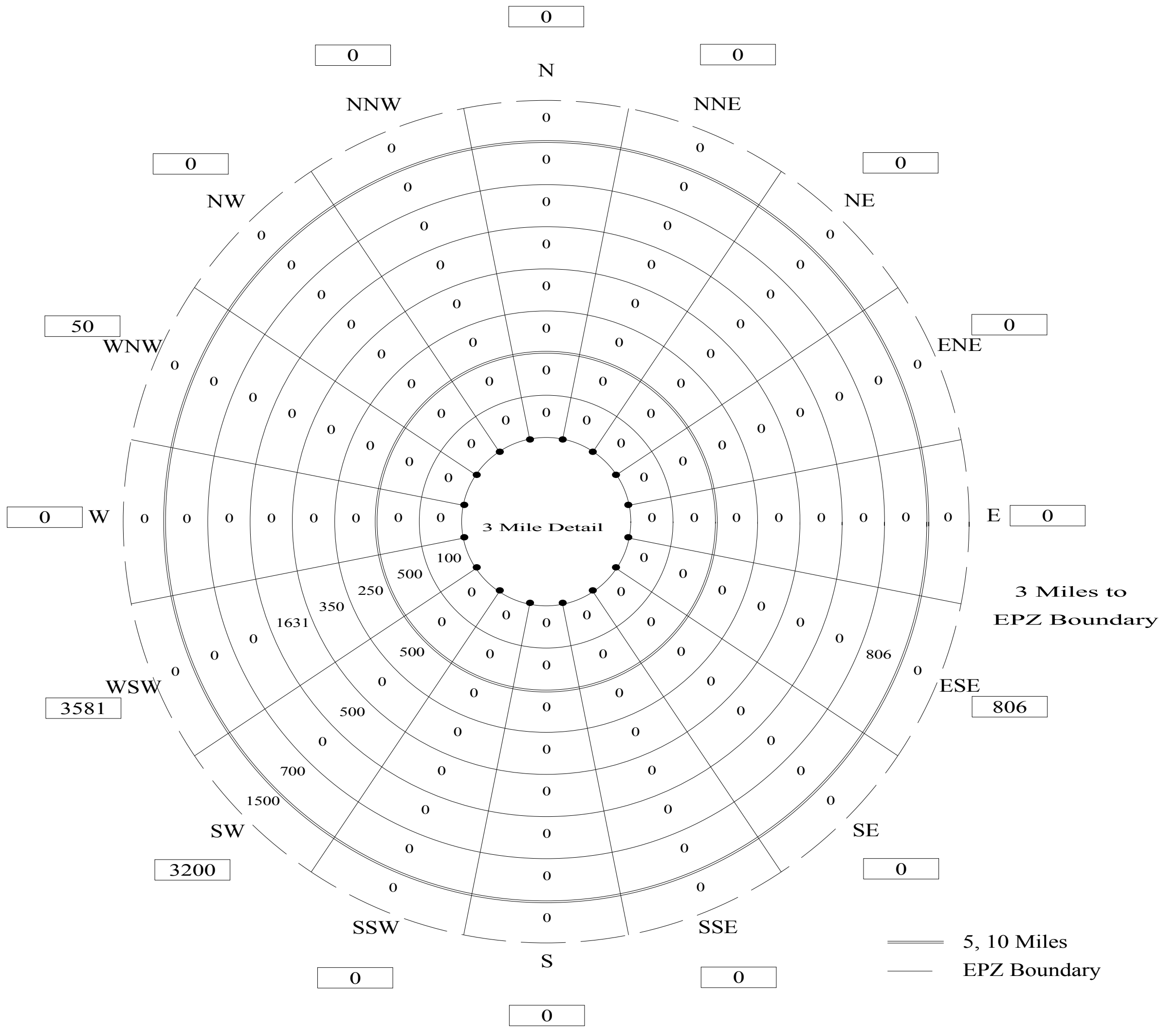
To represent the number of persons that work in the EPZ but live outside the EPZ, year 2000 Census journey-to-work data was used for the State of Alabama. This data defines the number of persons working in a specified location (municipality) by their place of residence (origin municipality). Employment growth rates for DeKalb and Jackson County were obtained from the US Department of Labor website; these rates were used to extrapolate the 2000 employment numbers to 2007.

Street addresses and data for major employers in the EPZ were obtained from the Economic Development Authority websites for DeKalb and Jackson Counties. The location of these facilities was mapped using GIS software. Additional commercial properties were located using overhead imagery and mapped in GIS; estimates of parking lot capacity were also made using the imagery. The GIS map was overlaid with the evacuation analysis network and employees were loaded onto appropriate links. The estimated major employer data can be seen in Appendix E.

An occupancy of 1.03 persons per employee-vehicle obtained from the telephone survey, was used to determine the number of evacuating employee vehicles.

Table 3-4 presents non-EPZ Resident employee and vehicle estimates by ERPA. Figures 3-6 and 3-7 present these data by sector.

Table 3-4. Summary of Non-EPZ Employees by ERPA		
ERPA	**Total Non-EPZ Employees**	**Employee Vehicles**
1	800	777
2	**NO EMPLOYMENT**	
3		
4		
5	1,350	1,310
6	**NO EMPLOYMENT**	
7		
8		
9		
10		
11	4,681	4,545
12	**NO EMPLOYMENT**	
13	806	783
TOTAL:	**7,637**	**7,415**



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	750	0-1	750
1-2	50	0-2	800
2-3	0	0-3	800
3-4	100	0-4	900
4-5	500	0-5	1400
5-6	750	0-6	2150
6-7	350	0-7	2500
7-8	2131	0-8	4631
8-9	0	0-9	4631
9-10	1506	0-10	6137
10-EPZ	1500	0-EPZ	7637

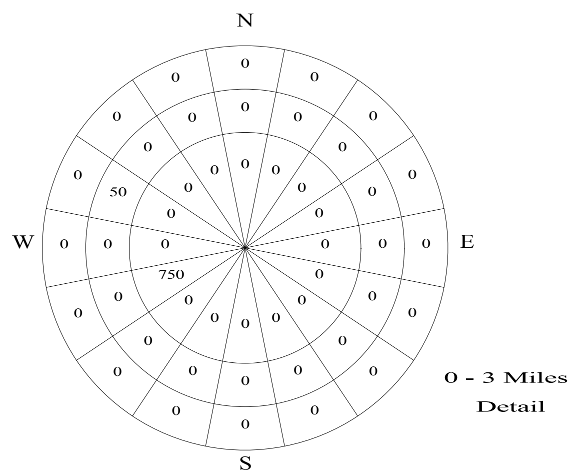
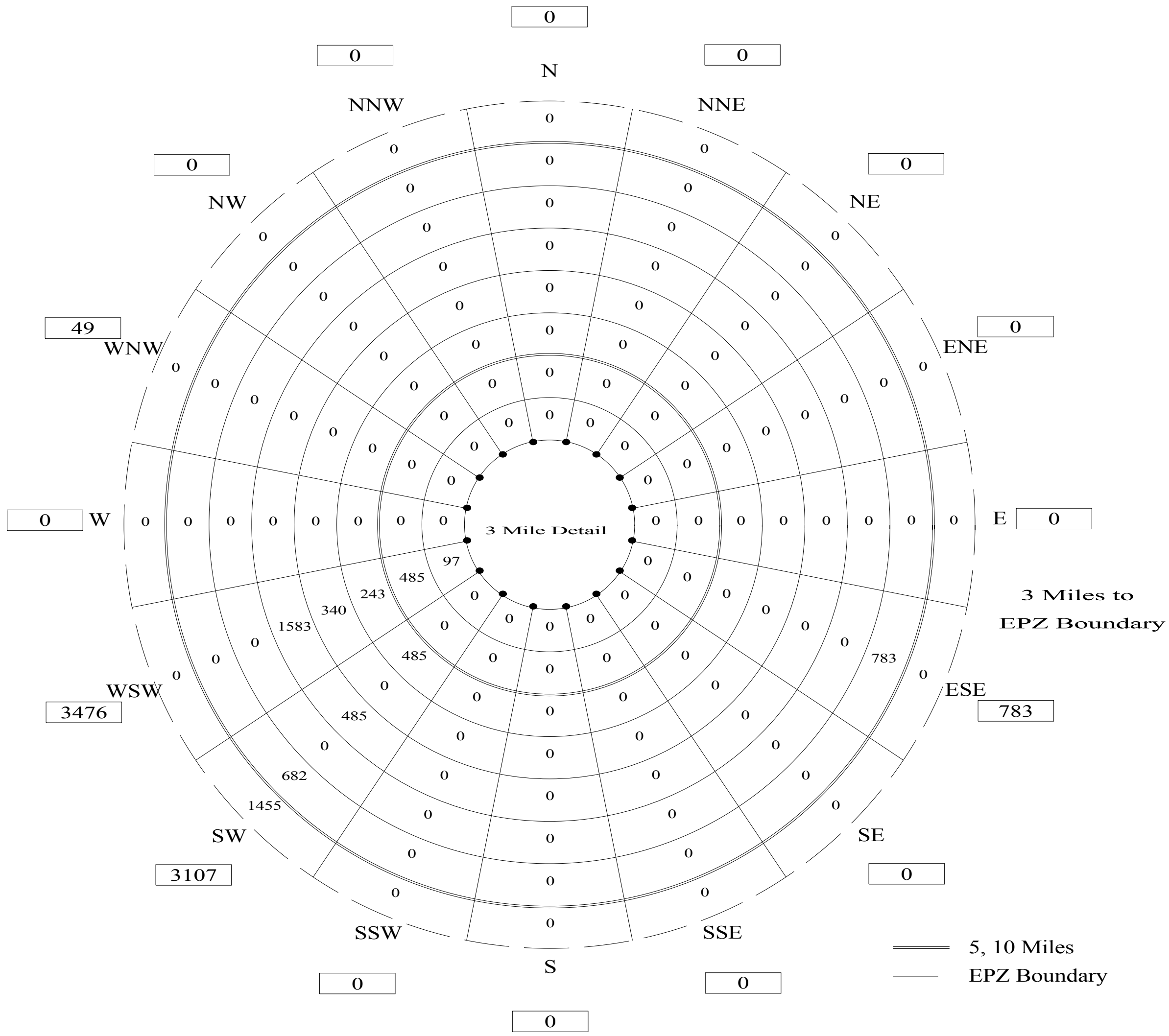


Figure 3-6. Employee Population by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	728	0-1	728
1-2	49	0-2	777
2-3	0	0-3	777
3-4	97	0-4	874
4-5	485	0-5	1359
5-6	728	0-6	2087
6-7	340	0-7	2427
7-8	2068	0-8	4495
8-9	0	0-9	4495
9-10	1465	0-10	5960
10-EPZ	1455	0-EPZ	7415

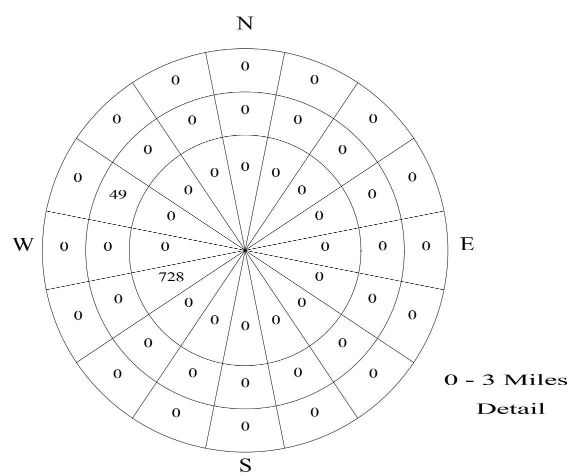


Figure 3-7. Employee Vehicles by Sector

Medical Facilities

Data request forms were completed for each of the medical facilities within the BLN EPZ. Chapter 8 details the evacuation of medical facilities and their patients. The number and type of evacuating vehicles that need to be provided depends on the patients' states of health. Buses can transport up to 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

Total Demand in Addition to Permanent Population

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major routes through the EPZ (e.g. US Route 72). It is assumed that this traffic will continue to enter the EPZ during the first 60 minutes following the Advisory to Evacuate. We assume 300 vehicles per lane; external-external trips have been loaded northbound and southbound on U.S. Highway 72, which is two lanes in each direction. Therefore, we estimate approximately 1,200 vehicles enter the EPZ as external-external trips during the first hour following the Advisory to Evacuate.

4. ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions. (From the 2000 Highway Capacity Manual)

In discussing capacity, different operating conditions have been assigned alphabetical designations, A through F, to reflect the range of traffic operational characteristics. These designations have been termed "Levels of Service" (LOS). For example, LOS A connotes free-flow and high-speed operating conditions; LOS F represents a forced flow condition. LOS E describes traffic operating at or near capacity.

Because of the effect of weather on the capacity of a roadway, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as heavy rain reduce the values of free speed and of highway capacity by approximately 10 percent. Over the last decade new studies have been made on the effects of rain on traffic capacity. These studies indicate a range of effects between 5 and 20 percent depending on wind speed and precipitation rates.

Given the rural character of the EPZ and the availability of well-maintained highways, congestion arising from evacuation is not likely to be significant except in certain areas (e.g. Scottsboro). Regardless, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices. The Traffic Management Plan identifies these locations (called Traffic Control Points, TCP) and the suggested traffic management procedures (See Appendix G).

The per-lane capacity of an approach to a signalized intersection can be expressed (simplistically) in the following form:

$$Q_{cap,m} = \left(\frac{3600}{h_m}\right) \bullet \left[\frac{G-L}{C}\right]_m = \left(\frac{3600}{h_m}\right) \bullet P_m$$

where:

Qcap,m	=	Capacity of a single lane of traffic on an approach, which executes movement, *m*, upon entering the intersection; vehicles per hour (vph)
h_m	=	Mean queue discharge headway of vehicles on this lane that are executing movement, *m*; seconds per vehicle
G_m	=	The mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds
L	=	The mean "lost time" for each signal phase servicing movement, m; seconds
C	=	The duration of each signal cycle; seconds
P_m	=	The proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified as part of the control treatment.
m	=	The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, diagonal.

The turn-movement-specific mean discharge headway h_m, depends in a complex way upon many factors: roadway geometrics, turn percentages, the extent of conflicting traffic streams, the control treatment, and others. A primary factor is the value of "saturation queue discharge headway", h_{sat}, which applies to through vehicles that are not impeded by other conflicting traffic streams. This value, itself, depends upon many factors including motorist behavior. Formally, we can write,

$$h_m = f_m (h_{sat}, F_1, F_2, ...)$$

where

h_{sat}	=	Saturation discharge headway for through vehicles; seconds per vehicle
F_1, F_2	=	The various known factors influencing h_m
$f_m (\cdot)$	=	Complex function relating h_m to the known (or estimated) values of $h_{sat}, F_1, F_2, \ldots$

The estimation of h_m for specified values of $h_{sat}, F_1, F_2, ...$ is undertaken within the PC-DYNEV simulation model and within the TRAD model by a mathematical model[1]. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

That is, the turn-movement-specific discharge headways are always greater than, or equal to the saturation discharge headway for through vehicles. These headways (or its inverse equivalent, “saturation flow rate”), may be determined by observation or using the procedures of the Highway Capacity Manual.

Capacity Estimation Along Sections of Highway

The capacity of highway sections -- as distinct from approaches to intersections -- is a

1 Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the far Left Lane of an Approach". Both papers appear in Transportation Research Record 772, 1980.

function of roadway geometrics, traffic composition (e.g. percent heavy trucks and buses in the traffic stream) and, of course, motorist behavior. There is a fundamental relationship which relates service volume (i.e. the number of vehicles serviced within a uniform highway section in a given time period) to traffic density. Figure 4-1 describes this relationship.

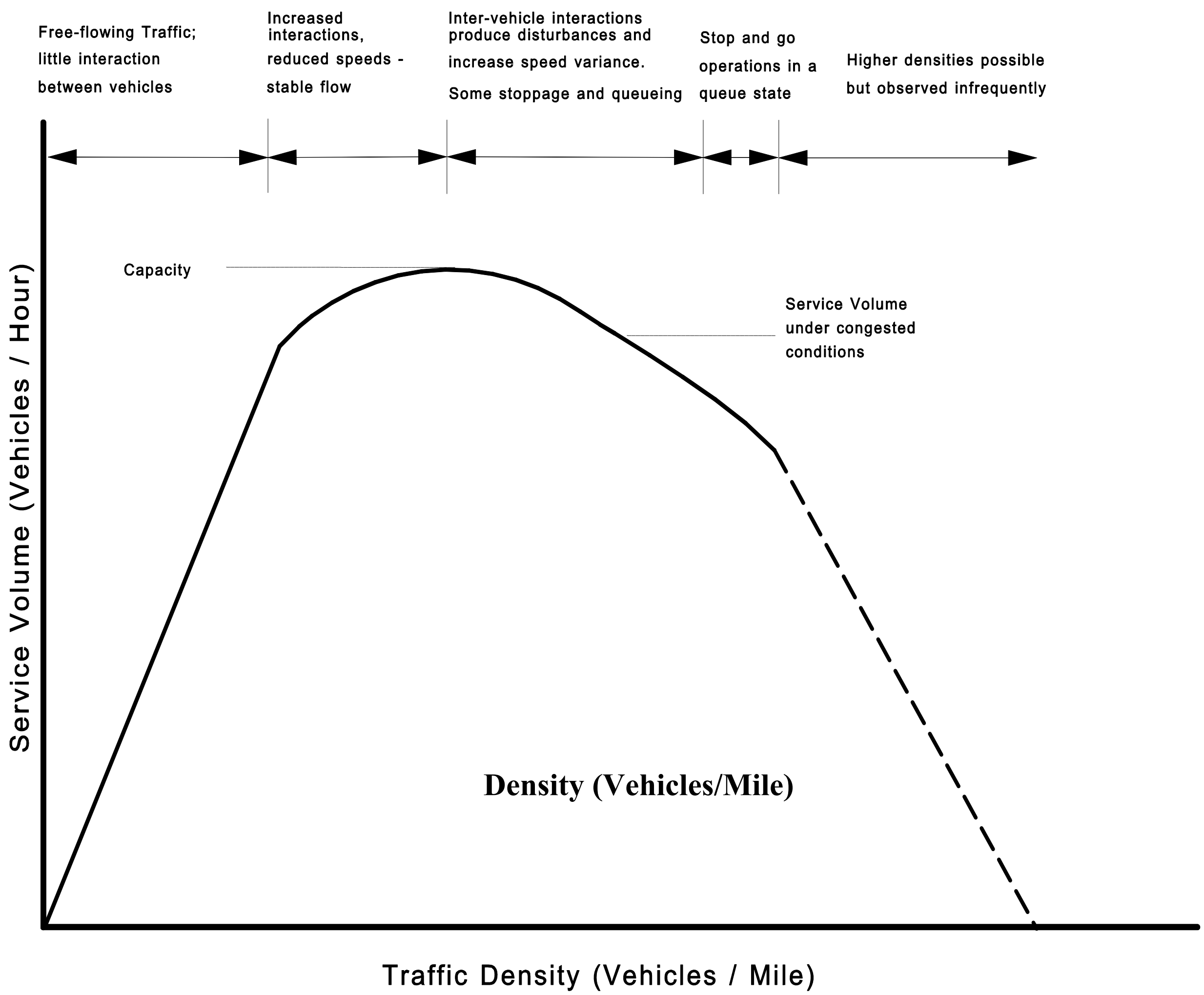


Figure 4-1. Fundamental Relationship Between Volume and Density

As indicated, there are two flow regimes: (1) Free Flow (left side of curve); and (2) Forced Flow (right side). In the Free Flow regime, the traffic demand is fully serviced; this service volume increases as demand volume and density increase, until the service volume attains its maximum value, which is the capacity of the highway section. As traffic demand and the resulting highway density increase beyond this "critical" value, the rate at which traffic can be serviced (i.e. the service volume) can actually decline below capacity. Therefore, in order to realistically represent traffic performance during congested conditions (i.e. when demand exceeds capacity), it is necessary to estimate the service volume, V_F, under congested conditions.

The value of V_F can be expressed as:

$$V_F = R \times \text{Capacity}$$

where R = Reduction factor which is less than unity.

Based on empirical data collected on freeways, we have employed a value of R=0.85. It is important to mention that some investigators, on analyzing data collected on freeways, conclude that little reduction in capacity occurs even when traffic is operating at Level of Service, *F*. While there is conflicting evidence on this subject, we adopt a conservative approach and use a value of capacity, V_F, that is applied during LOS F conditions; V_F, is lower than the specified capacity.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity.

The procedure used here was to estimate "section" capacity, V_E, based on observations made traveling over each section of the evacuation network, by the posted speed limits and travel behavior of other motorists and by reference to the 2000 Highway Capacity Manual. It was then determined for each highway section, represented as a network link, whether its capacity would be limited by the "section-specific" service volume, V_E , or by the intersection-specific capacity. For each link, the model selects the lower value of capacity.

Application to the Bellefonte Nuclear Plant EPZ

As part of the development of the Bellefonte Nuclear Plant (BLN) EPZ traffic network, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

2000 Highway Capacity Manual (HCM)
Transportation Research Board
National Research Council
Washington, D.C.

The highway system in the BLN EPZ consists primarily of two categories of roads and, of course, intersections:

- Two-lane roads: Local, State
- Multi-lane Highways (at-grade)

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapter 20
Two lane roads comprise the majority of highways within the EPZ. The per-lane capacity of a two-lane highway is estimated at 1700 passenger cars per hour (pc/h). This estimate is essentially independent of the directional distribution of traffic volume except that, for extended distances, the two-way capacity will not exceed 3200 pc/h. The HCM procedures then estimate Level of Service (LOS) and Average Travel Speed. The evacuation simulation model accepts the specified value of capacity as input and computes average speed based on the time-varying demand:capacity relations.

Based on the field survey and on expected traffic operations associated with evacuation scenarios:

- Most sections of two-lane roads within the EPZ are classified as “Class I”, with "level terrain"; some are “rolling terrain”.
- “Class II” highways are mostly those within city limits.

Multi-Lane Highway

Ref: HCM Chapter 21
Exhibit 21-23 (in the HCM) presents a set of curves that indicates a per-lane capacity of approximately 2100 pc/h, for free-speeds of 55-60 mph. Based on observation, the multi-lane highways outside of urban areas within the EPZ (i.e. Scottsboro), service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand:capacity relationship and the impact of control at intersections.

Intersections

Ref: HCM Chapters 16, 17
Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapters 16 (signalized intersections) and 17 (un-signalized intersections). These are the two longest chapters in the HCM 2000, reflecting the complexity of these procedures. The simulation logic is likewise complex, but different; as stated on page 31-21 of the HCM2000:

> *“Assumptions and complex theories are used in the simulation model to represent the real-world dynamic traffic environment. “*

5. ESTIMATION OF TRIP GENERATION TIME

US Nuclear Regulatory Commission (NRC) guidelines (see NUREG 0654, Appendix 4) specify that the planner estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the adapted telephone survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

Background

An accident at a nuclear power plant is characterized by the following Emergency Action Classification Levels (see Appendix 1 of NUREG 0654 for details):

1. Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

At each level, the Federal guidelines specify a set of Actions to be undertaken by the Licensee, and by State and Local offsite authorities. As a Planning Basis, we will adopt a conservative posture, in accord with Federal Regulations, that a rapidly escalating accident will be considered in calculating the Trip Generation Time. We will assume:

a. The Advisory to Evacuate will be announced coincident with the emergency notification.

b. Mobilization of the general population will commence up to 10 minutes after the alert notification.

c. Evacuation Time Estimates (ETEs) are measured relative to the Advisory to Evacuate.

d. Schools will begin evacuating prior to the Advisory to Evacuate.

We emphasize that the adoption of this planning basis is not a representation that these events will occur at the Bellefonte Nuclear Plant (BLN) within the indicated time frame. Rather, these assumptions are necessary in order to:

- Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Appendix 4 of NUREG 0654.
- Identify temporal points of reference that uniquely define "Clear Time" and Evacuation Time Estimates (ETE).

It is more likely that a longer time will elapse between the various classes of an emergency at BLN.

For example, suppose one hour will elapse from the siren alert to the Advisory to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the Emergency Planning Zone (EPZ) will be lower when the Advisory to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Advisory to Evacuate, will be less than the estimates presented in this report.

The notification process consists of two events:

- Transmitting information (e.g. using sirens, tone alerts, EAS broadcasts, loud speakers).
- Receiving and correctly interpreting the information that is transmitted.

The peak population within the EPZ approximates 40,000 persons (permanent residents, employees, and transients) who are deployed over an area of approximately 314 square miles and engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

The amount of elapsed time will vary from one individual to the next depending where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the EPZ at the time that the emergency is declared. These people may be commuters, shoppers and other travelers who reside within the EPZ and who will return to join the other household members upon receiving notification of an emergency.

As indicated in NUREG-0654, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the EPZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETEs may be obtained.

For example, people at home or at work within the EPZ will be notified by siren, and/or tone alert and/or radio. Those well outside the EPZ will be notified by telephone, radio, TV and word-of-mouth, with potentially longer time lags. Furthermore, the spatial distribution of the EPZ population will differ with time of day - families will be united in the evenings, but dispersed during the day. In this respect, weekends will differ from weekdays.

Generally, the information required can be obtained from a telephone survey of EPZ residents. Such a survey was conducted. Appendix F presents the raw survey results. It is important to note that the shape and duration of the evacuation trip mobilization distribution is important at sites where traffic congestion is not expected to cause the evacuation time estimate to extend in time well beyond the trip generation period.

Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips consists of a sequence of events and activities. Each event (other than the first) occurs at an instant in time and is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e. to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one-another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	Notification-accident condition
2	Awareness of accident situation
3	Depart place of work to return home
4	Arrive home
5	Leave to evacuate the area

Associated with each sequence of events are one or more activities, as outlined below:

Table 5-1. Event Sequence for Evacuation Activities

Event Sequence	Activity	Distribution
1 → 2	Public receives notification information	1
2 → 3	Prepare to leave work	2
2,3 → 4	Travel home	3
2,4 → 5	Prepare to leave for evacuation trip	4

These relationships are shown graphically in Figure 5-1.

An employee who lives outside the EPZ will follow sequence (e) of Figure 5-1; a resident of the EPZ who is at work, and will return home before beginning the evacuation trip will follow sequence (c) of Figure 5-1. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. That is, activity 2 → 5 by a resident at home can be undertaken in parallel with activities 2 → 3, 3 → 4 and 4 → 5 by a commuter returning to that home, as shown in Figure 5-1 (a) and (c). Specifically, one adult member of a household can prepare to leave home (i.e. secure the home, pack clothing, etc.), while others are traveling home from work. In this instance, the household members would be able to evacuate sooner than if such trip preparation were deferred until all household members had returned home. For this study, we adopt the conservative posture that all activities will occur in sequence.

It is seen from Figure 5-1, that the Trip Generation time (i.e. the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities preceding that event. That is, to estimate the time distribution of Event 5, we must obtain estimates of the time distributions of all preceding events.

Estimated Time Distributions of Activities Preceding Event 5

The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since we are operating on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 $\rightarrow$ 2

It is reasonable to expect that 85 percent of those within the EPZ will be aware of the accident within 30 minutes of its occurrence, with the remainder notified within the following 20 minutes. The notification distribution is given below:

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Percent of Population Notified
0	0
5	7
10	13
15	26
20	46
25	65
30	85
35	90
40	95
45	98
50	100

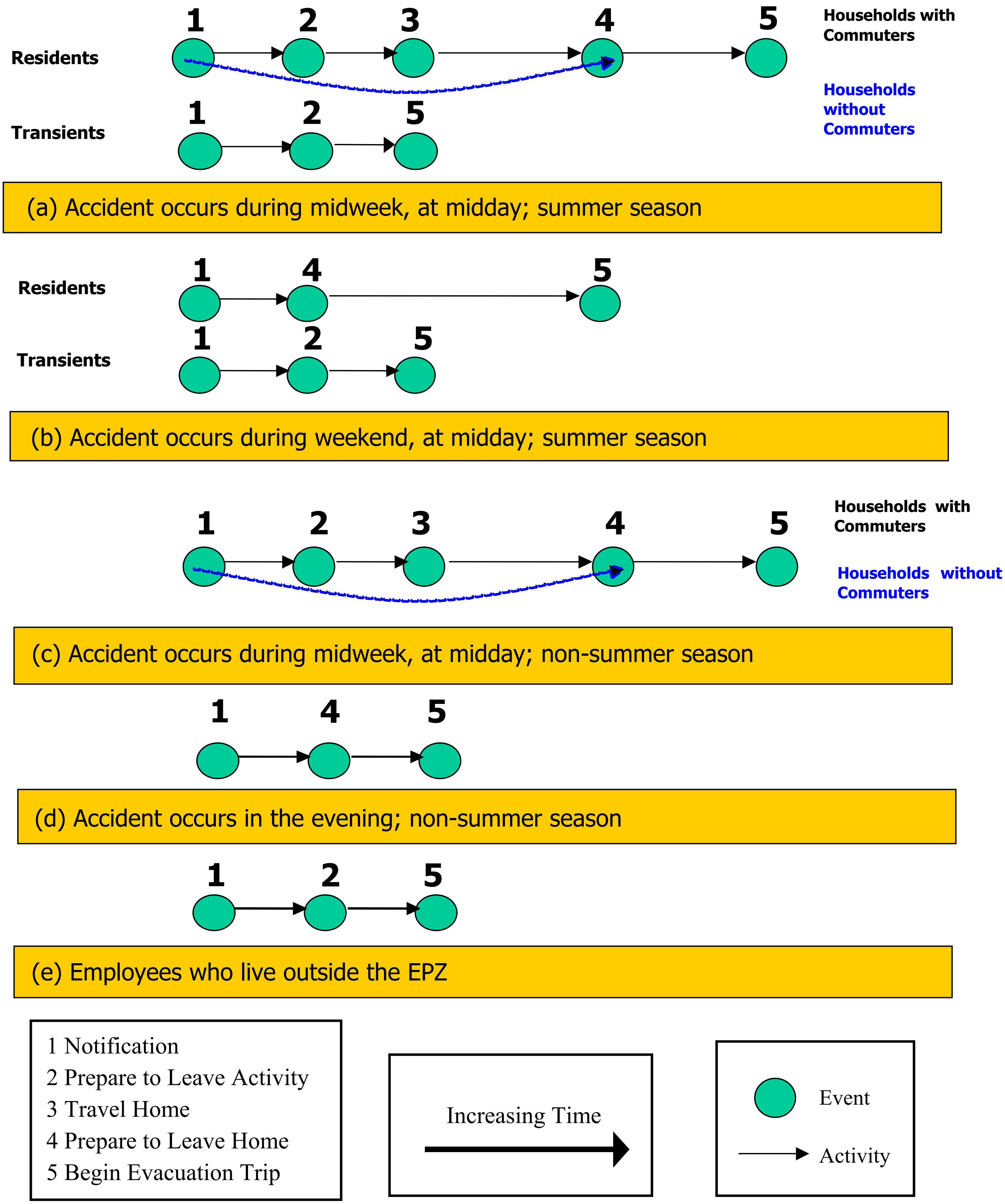


Figure 5-1. Events and Activities Preceding the Evacuation Trip

Distribution No. 2, Prepare to Leave Work: Activity 2 $\rightarrow$ 3

It is reasonable to expect that the vast majority of business enterprises within the EPZ will elect to shut down following notification and most employees would leave work quickly. Commuters, who work outside the EPZ could, in all probability, also leave quickly since facilities outside the EPZ would remain open and other personnel would remain. Personnel or farmers responsible for equipment would require additional time to secure their facility. The distribution of Activity 2 $\rightarrow$ 3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-3. Time Distribution for Employees to Leave Work

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0
5	22
10	32
15	39
20	48
25	56
30	66
35	71
40	76
45	79
50	82
55	85
60	88
65	92
70	95
75	96
80	97
85	98
90	99
95	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 3, Travel Home: Activity 3 → 4

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-4. Time Distribution for Commuters to Return Home

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0
5	19
10	37
15	49
20	59
25	65
30	72
35	78
40	84
45	89
50	91
55	93
60	96
65	96
70	97
75	98
80	99
85	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 4, Prepare to Leave Home: Activity 2,4 → 5

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-5. Time Distribution of Population Ready to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0
5	10
10	21
15	31
20	41
25	51
30	57
35	62
40	65
45	69
50	73
55	77
60	81
65	84
70	85
75	86
80	87
85	88
90	89
95	89
100	90
105	91
110	92
115	93
120	94
125	95
130	96
135	97
140	98
145	99
150	100

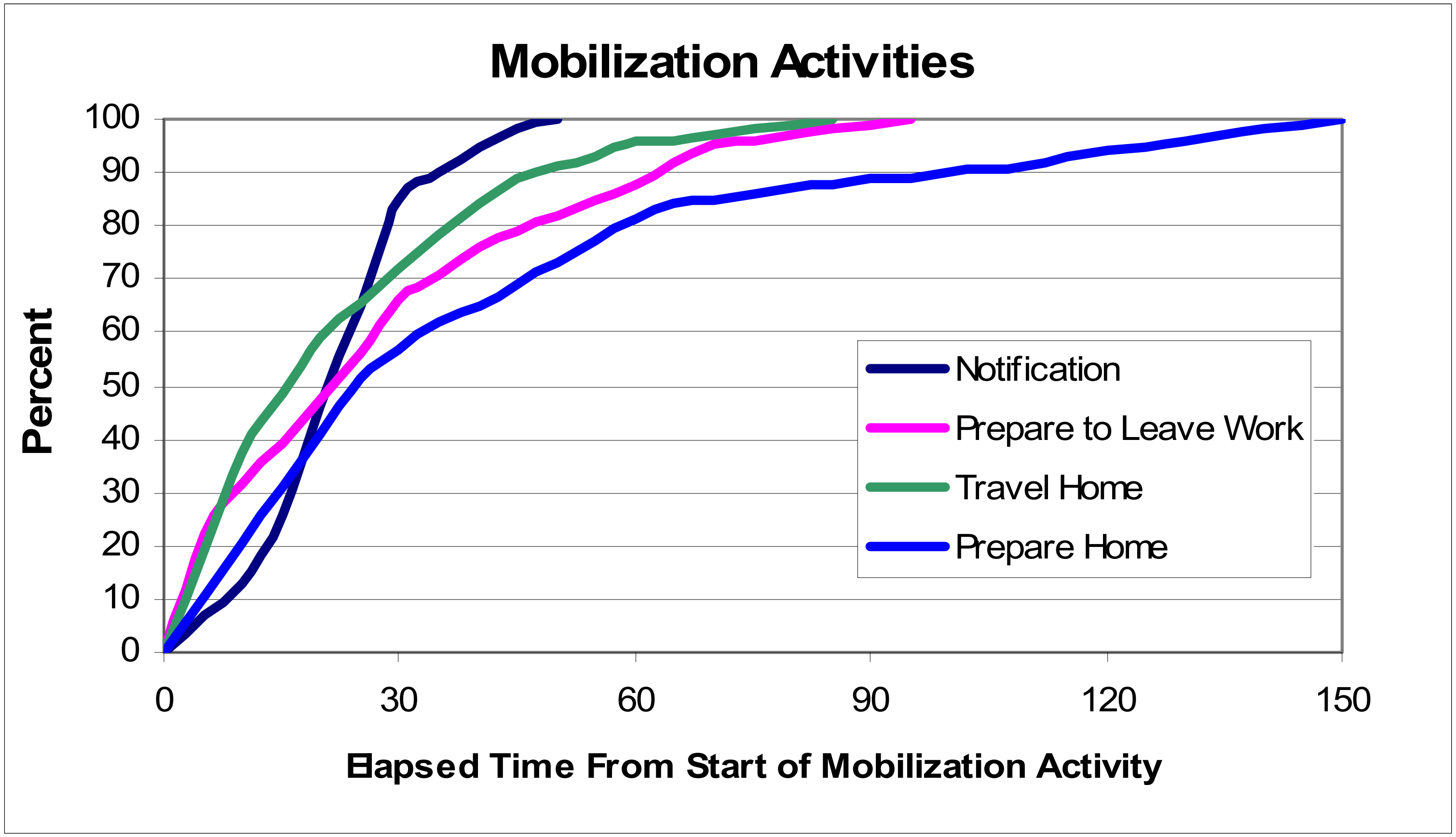


Figure 5-2. Evacuation Mobilization Activities

Calculation of Trip Generation Time Distribution

The time distributions for each of the mobilization activities presented herein must be combined to form the appropriate Trip Generation Distributions. We assume that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 → 4) must precede Activity 4 → 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure.

Table 5-6. Mapping Distributions to Events

Apply "Summing" Algorithm To:		
Distributions 1 and 2	To Obtain Distribution A	That defines Event. 3
Distributions A and 3	To Obtain Distribution B	That defines Event. 4
Distributions B and 4	To Obtain Distribution C	That defines Event. 5
Distributions 1 and 4	To Obtain Distribution D	That defines Event. 5

Distributions A through D are described below; distributions A, C, and D are shown in Figure 5-3:

Table 5-7. Description of the Distributions

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ who live outside, and to Transients within the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters leaving home to begin the evacuation trip.
D	Time distribution of residents without commuters returning home to begin the evacuation trip.

Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms.

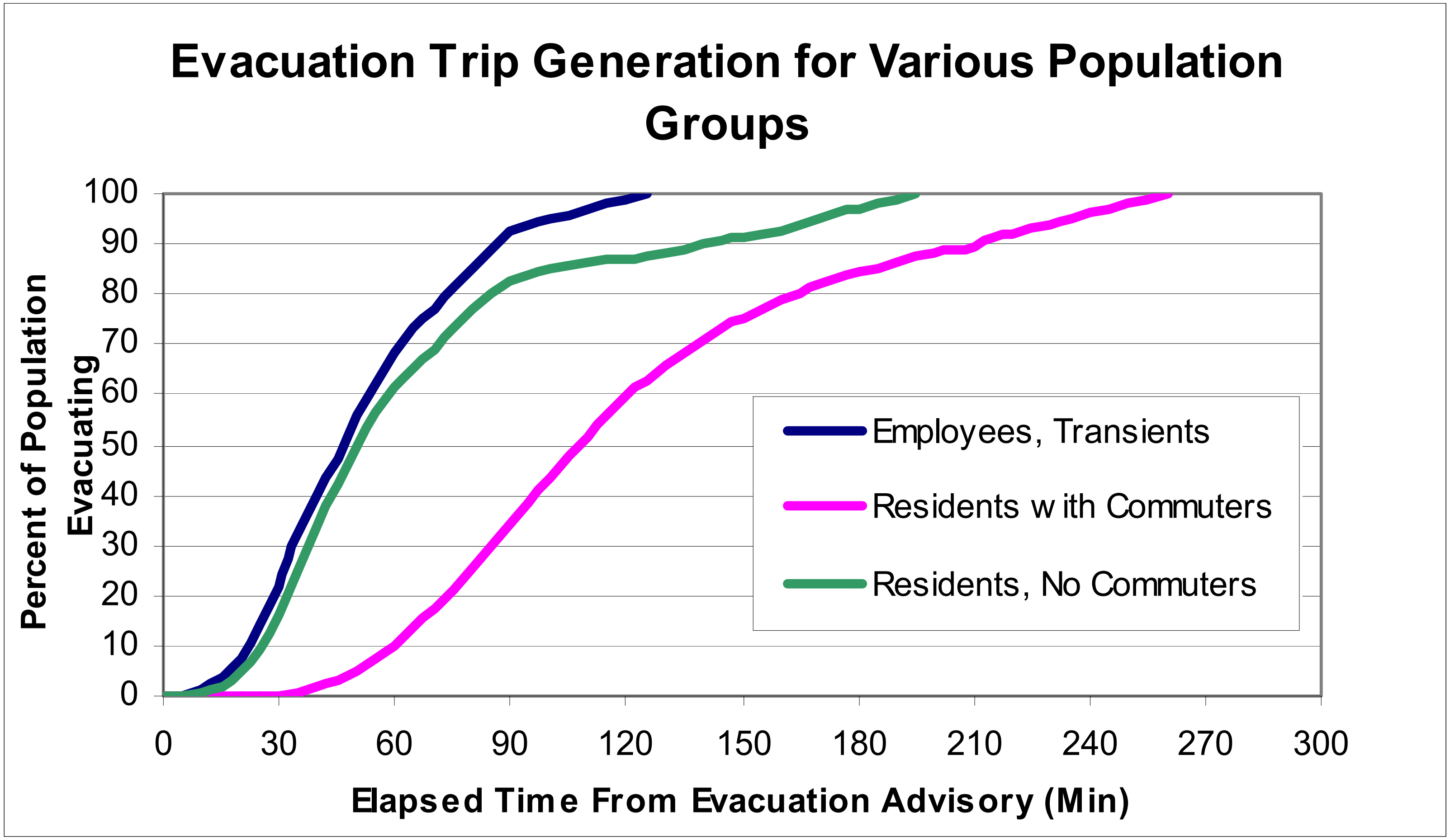


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-8. Trip Generation for the EPZ Population

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period			
		Residents With Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Employees (Distribution A)	Transients (Distribution A)
1	15	0	4	5	5
2	15	0	14	16	16
3	30	10	43	49	49
4	30	22	22	22	22
5	30	28	7	8	8
6	30	16	1	0	0
7	30	6	8	0	0
8	30	8	1	0	0
9	30	10	0	0	0
10	900	0	0	0	0

6. DEMAND ESTIMATION FOR EVACUATION SCENARIOS

An evacuation "case" defines a combination of Evacuation Region and Evacuation Scenario. The definitions of "Region" and "Scenario" are as follows:

Region: A grouping of contiguous evacuation ERPA, that forms either a "keyhole" sector-based area, or a circular area within the EPZ, that must be evacuated in response to a radiological emergency.

Scenario: A combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions.

A total of 22 Regions were defined which encompass all the groupings of ERPA considered. These Regions are defined in Table 6-1; Appendix H provides maps of all Regions. The ERPA configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the Bellefonte Nuclear Plant (BLN), and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from BLN (Regions R04 to R11), or to the EPZ boundary (Regions R12 to R22). The azimuth of the center sector defines the orientation of these Regions.

A total of 12 Scenarios were evaluated for all Regions. Thus, there are a total of 12 x 22=264 evacuation cases. Table 6-2 is a description of all Scenarios.

Each combination of region and scenario implies a specific population to be evacuated. Table 6-3 presents the percentage of each population group assumed to evacuate for each scenario. Table 6-4 presents the vehicle counts for each scenario.

Table 6-1. Description of Evacuation Regions														
		ERPA												
Region	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R01	2 mile ring	■												
R02	5-mile ring	■	■	■	■	■	■							
R03	Full EPZ	■	■	■	■	■	■	■	■	■	■	■	■	■
Evacuate 2 mile ring and 5 miles downwind														
		ERPA												
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R04	N,NNE,NNW	■	■				■							
R05	NE	■	■	■										
R06	ENE	■	■	■	■									
R07	E,ESE	■		■	■									
R08	SE,SSE	■			■									
R09	S,SSW,SW	■			■	■								
R10	WSW,W,WNW	■				■	■							
R11	NW	■					■							
Evacuate 5 mile ring and downwind to EPZ boundary														
		ERPA												
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R12	N,NNW	■	■	■	■	■	■	■					■	
R13	NNE	■	■	■	■	■	■	■	■				■	
R14	NE	■	■	■	■	■	■	■	■					
R15	ENE	■	■	■	■	■	■	■	■	■				
R16	E	■	■	■	■	■	■		■	■				■
R17	ESE	■	■	■	■	■	■		■	■	■			■
R18	SE,SSE	■	■	■	■	■	■			■	■			■
R19	S	■	■	■	■	■	■				■			
R20	SSW,SW	■	■	■	■	■	■				■	■		
R21	WSW,W,WNW	■	■	■	■	■	■					■	■	
R22	NW	■	■	■	■	■	■						■	

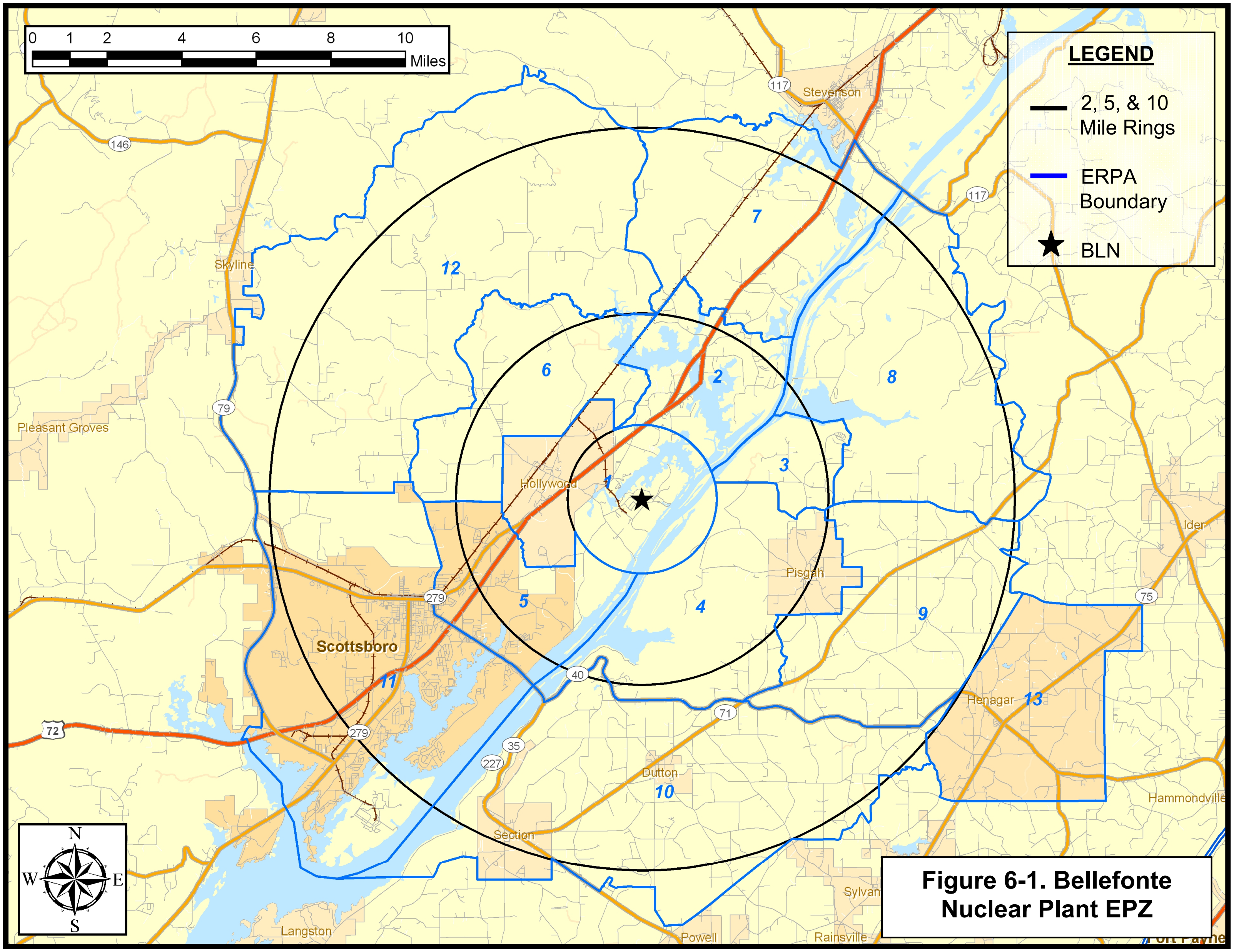


Figure 6-1. Bellefonte Nuclear Plant EPZ

Table 6-2. Evacuation Scenario Definitions					
Scenario	**Season**	**Day of Week**	**Time of Day**	**Weather**	**Special**
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Ice	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Midweek, Weekend	Evening	Good	None
12	Summer	Midweek	Midday	Good	New Plant Construction

Note: Schools are assumed to be in session for the Winter season (midweek, midday).

Table 6-3. Percent of Population Groups for Various Scenarios

Scenarios	Residents With Commuters in Household	Residents With No Commuters in Household	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Through Traffic
1	64%	36%	96%	50%	41%	0%	50%	100%	100%
2	64%	36%	96%	50%	41%	0%	50%	100%	100%
3	10%	90%	47%	100%	36%	0%	25%	100%	100%
4	10%	90%	47%	100%	36%	0%	25%	100%	100%
5	10%	90%	10%	25%	31%	0%	0%	100%	60%
6	64%	36%	100%	25%	42%	0%	100%	100%	100%
7	64%	36%	100%	25%	42%	0%	100%	100%	100%
8	64%	36%	100%	25%	42%	0%	100%	100%	100%
9	10%	90%	47%	40%	36%	0%	50%	100%	100%
10	10%	90%	47%	40%	36%	0%	50%	100%	100%
11	10%	90%	10%	15%	31%	0%	0%	100%	60%
12	64%	36%	96%	50%	41%	100%	50%	100%	100%

Resident Households With Commuters .... Households of EPZ residents who await the return of commuters prior to beginning the evacuation trip.

Resident Households With No Commuters .... Households of EPZ residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.

Employees ....EPZ employees who live outside of the EPZ.

Transients ....People who are in the EPZ at the time of an accident for recreational or other (non-employment) purposes.

Shadow ....Residents and employees in the shadow region (outside of the EPZ) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 30% relocation of shadow residents along with a proportional percentage of shadow employees. The percentage of shadow employees is computed using the scenario-specific ratio of EPZ employees to residents.

Special Events..Additional vehicles in the Bellefonte Nuclear Plant area during the construction phase of the new unit.

School and Transit Buses................................Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).

External Through Traffic ....Traffic on local highways and major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately 1-2 hours after the evacuation begins.

Table 6-4. Vehicle Estimates By Scenario

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Traffic	Total Scenario Vehicles
1	12,022	6,653	7,118	847	5,135	-	90	42	1,200	33,107
2	12,022	6,653	7,118	847	5,135	-	90	42	1,200	33,107
3	1,202	17,473	3,485	1,694	4,412	-	45	42	1,200	29,553
4	1,202	17,473	3,485	1,694	4,412	-	45	42	1,200	29,553
5	1,202	17,473	742	424	3,866	-	-	42	720	24,469
6	12,022	6,653	7,415	424	5,194	-	180	42	1,200	33,130
7	12,022	6,653	7,415	424	5,194	-	180	42	1,200	33,130
8	12,022	6,653	7,415	424	5,194	-	180	42	1,200	33,130
9	1,202	17,473	3,485	678	4,412	-	90	42	1,200	28,582
10	1,202	17,473	3,485	678	4,412	-	90	42	1,200	28,582
11	1,202	17,473	742	254	3,866	-	-	42	720	24,299
12	12,022*	6,653*	7,118	847	5,135*	2,913	90	42	1,200	36,020

*The projected construction year is 2015. Based on discussion with Enercon Services, the permanent resident population and shadow population have not been extrapolated to 2015. Comparison of the 2000 Census and 2006 Census estimates indicate that the population is growing (See Table 3-1); however, the 2007 population estimates have been maintained for 2015 as a conservative basis.

7. GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the current results of the computer analyses using the IDYNEV System described in Appendices B, C and D. These results cover 22 regions within the BLN EPZ and the 12 Evacuation Scenarios discussed in Section 6.

The ETE for all Evacuation Cases are presented in Tables 7-1A through 7-1D. **These tables present the estimated times to clear the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios.** The tabulated values of ETE are obtained by interpolating the PC-DYNEV simulation model outputs which are generated at 10-minute intervals, then rounding these data to the nearest 5 minutes.

7.1 Voluntary Evacuation and Shadow Evacuation

We define "voluntary evacuees" as people who are within the EPZ in ERPA for which an Advisory to Evacuate *has not* been issued, yet who nevertheless elect to evacuate. We define "shadow evacuation" as the movement of people from areas *outside* the EPZ for whom no protective action recommendation has been issued. Both voluntary and shadow evacuation are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for the BLN addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the circle defined by the farthest radial distance of the Evacuation Region, 50 percent of those people located in ERPA not advised to evacuate, are assumed to do so. Within the annular ring extending from the furthest distance of the Evacuation Region (if less than 10 miles), to the EPZ boundary, it is assumed that 35 percent of the people located there will elect to evacuate.

Figure 7-2 presents the area identified as the Shadow Evacuation Region. This region extends radially from the boundary of the EPZ to a distance of 15 miles.

Traffic generated within this Shadow Evacuation Region, traveling away from the BLN location, has a potential for impeding evacuating vehicles from within the Evacuation Region. We assume that the traffic volumes emitted within the Shadow Evacuation Region correspond to 30 percent of the residents there plus a proportionate number of employees in that region. **All ETE calculations include this shadow traffic movement.**

7.2 Patterns of Traffic Congestion During Evacuation

Figures 7-3 through 7-6 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R03) is advised to evacuate during the summer, midweek, midday period under good weather conditions.

Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (2000 HCM):

> Level of Service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount that can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level of Service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow, which causes the queue to form, and Level of Service F is an appropriate designation for such points.

This definition is general and conceptual in nature, and applies primarily to uninterrupted flow. Levels of Service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

All highway "links" which experience LOS F are delineated in these Figures by a red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks. Congestion begins on the major routes (US Route 72 and State Route 35) leaving the Scottsboro area by 30 minutes (Figure 7-3) after the evacuation advisory.

Figure 7-4 presents the congestion pattern 1 hour after the Advisory to Evacuate; congestion continues to build on the routes leaving Scottsboro, and also on the major roads within the City of Scottsboro. Figure 7-5 presents the congestion pattern 2 hours after the Advisory to Evacuate. This represents the peak congestion period.

By 3 hours (Figure 7-6), most congestion in the area has cleared. The absence of congestion on network links implies that traffic demand there has decreased below the roadway capacity for a period of time sufficient to dissipate any traffic queues. It does not imply that traffic has completely cleared from these roadway sections.

7.3 Evacuation Rates

Evacuation is a continuous process, as implied by Figures 7-3 through 7-6. Another format for displaying the dynamics of evacuation is depicted in Figure 7-7. This plot indicates the rate at which traffic flows out of the indicated areas for the case of an evacuation of the entire EPZ (Region R03) under the indicated conditions. Appendix J presents these plots for all Evacuation Scenarios for Region R03.

As indicated in Figure 7-7, there is typically a long "tail" to these distributions. Vehicles evacuate an area slowly at the beginning, as people respond to the Advisory to Evacuate at different rates. Then traffic demand builds rapidly (slopes of curves increase). When the system becomes congested, traffic exits the EPZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand. It is reasonable to expect that some evacuees may delay or lengthen their mobilization activities and evacuate at a later time as a result; these ETE estimates do not (and should not) be distorted to account for these few laggards.

This decline in aggregate flow rate, towards the end of the process, is characterized by these curves flattening and gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes equally so that all will service traffic near capacity levels and all will clear at the same time. For this ideal situation, all curves would retain the same slope until the end -- thus minimizing evacuation time. In the real world, this ideal is generally unattainable reflecting the variation in population density and in highway capacity over the EPZ.

7.4 Guidance on Using ETE Tables

Tables 7-1A through 7-1D present the ETE values for all 22 Evacuation Regions and all 12 Evacuation Scenarios. They are organized as follows:

Table	Contents
7-1A	ETE represents the elapsed time required for 50 percent of the population within a Region, to evacuate from that Region.
7-1B	ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region.
7-1C	ETE represents the elapsed time required for 95 percent of the population within a Region, to evacuate from that Region.
7-1D	ETE represents the elapsed time required for 100 percent of the population within a Region, to evacuate from that Region.

The user first determines the percentile of population for which the ETE is sought. The applicable value of ETE within the chosen Table may then be identified using the following procedure:

1. Identify the applicable **Scenario**:
   - The Season
     - Summer
     - Winter (also Autumn and Spring)
   - The Day of Week
     - Midweek
     - Weekend
   - The Time of Day
     - Midday
     - Evening
   - Weather Condition
     - Good Weather

- Rain
- Ice

- Special Event (if any)
  - New Plant Construction

While these Scenarios are designed, in aggregate, to represent conditions throughout the year, some further clarification is warranted:

- The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenario (4) applies.
- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenario (10) applies.
- The seasons are defined as follows:
  - Summer implies that public schools are *not* in session.
  - Winter (also Autumn and Spring) implies that public schools *are* in session.
- Time of Day: Midday implies the time over which most commuters are at work.

2. With the Scenario identified, now identify the **Evacuation Region**:

- Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: *towards* N, NNE, NE, …
- Determine the distance that the Evacuation Region will extend from the Bellefonte Nuclear Plant. The applicable distances and their associated candidate Regions are given below:
  - 2 Miles (Region R01)
  - 5 Miles (Regions R02 and R04 through R11)
  - to EPZ Boundary (Regions R03 and R12 through R22)
- Enter Table 7-2 and identify the applicable group of candidate Regions

based on the distance that the selected Region extends from BLN. Select the Evacuation Region identifier in that row from the first column of the Table.

3. Determine the **ETE for the Scenario** identified in Step 1 and the Region identified in Step 2, as follows:
   - The columns of Table 7-1 are labeled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number determined in Step 1.
   - Identify the row in this table that provides ETE values for the Region identified in Step 2.
   - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

<u>Example</u>

It is desired to identify the ETE for the following conditions:

- Sunday, August 10th at 4:00 AM.
- It is raining.
- Wind direction is *to* the northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 95 percent of the population from within the impacted Region.

Table 7-1C is applicable because the 95th-percentile population is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1C, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of

circumstances to Scenario 4.

2. Enter Table 7-2 and locate the group entitled “Evacuate 5-Mile Ring and Downwind to EPZ Boundary”. Under “Wind Direction”, identify the NE (northeast) azimuth and read REGION R14 in the first column of that row.

3. Enter Table 7-1C to locate the data cell containing the value of ETE for Scenario 4 and Region R14. This data cell is in column (4) and in the row for Region R14; it contains the ETE value of **2:40**.

Table 7-1A. Time To Clear The Indicated Area of 50 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	1:05	1:05	0:55	0:55	0:55	R01 2-mile ring	1:05	1:05	1:05	0:55	0:55	0:55	R01 2-mile ring	1:25
R02 5-mile ring	1:20	1:25	1:05	1:05	1:00	R02 5-mile ring	1:25	1:25	1:35	1:05	1:05	1:00	R02 5-mile ring	1:40
R03 Entire EPZ	1:40	1:45	1:20	1:25	1:10	R03 Entire EPZ	1:40	1:45	1:50	1:20	1:25	1:10	R03 Entire EPZ	1:50
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	1:10	1:10	0:55	0:55	0:55	R04 N, NNE, NNW	1:10	1:10	1:10	0:55	0:55	0:55	R04 N, NNE, NNW	1:25
R05 NE	1:10	1:10	0:55	0:55	0:55	R05 NE	1:10	1:10	1:10	0:55	0:55	0:55	R05 NE	1:25
R06 ENE	1:15	1:15	0:55	0:55	0:55	R06 ENE	1:15	1:15	1:15	0:55	0:55	0:55	R06 ENE	1:25
R07 E, ESE	1:10	1:10	0:55	0:55	0:55	R07 E, ESE	1:10	1:10	1:15	0:55	0:55	0:55	R07 E, ESE	1:25
R08 SE, SSE	1:10	1:10	0:55	0:55	0:55	R08 SE, SSE	1:10	1:10	1:15	0:55	0:55	0:55	R08 SE, SSE	1:25
R09 S, SSW, SW	1:20	1:25	1:05	1:05	1:00	R09 S, SSW, SW	1:20	1:25	1:35	1:00	1:05	1:00	R09 S, SSW, SW	1:40
R10 WSW, W, WNW	1:20	1:25	1:05	1:05	1:00	R10 WSW, W, WNW	1:20	1:25	1:30	1:05	1:05	1:00	R10 WSW, W, WNW	1:40
R11 NW	1:05	1:05	0:55	0:55	0:55	R11 NW	1:05	1:05	1:05	0:55	0:55	0:55	R11 NW	1:25
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	1:30	1:30	1:10	1:15	1:05	R12 N, NNW	1:30	1:35	1:40	1:05	1:10	1:05	R12 N, NNW	1:45
R13 NNE	1:30	1:35	1:10	1:15	1:05	R13 NNE	1:30	1:35	1:40	1:05	1:10	1:05	R13 NNE	1:45
R14 NE	1:25	1:30	1:05	1:05	1:00	R14 NE	1:25	1:30	1:35	1:05	1:05	1:00	R14 NE	1:40
R15 ENE	1:25	1:30	1:05	1:05	1:00	R15 ENE	1:25	1:30	1:35	1:05	1:05	1:00	R15 ENE	1:40
R16 E	1:25	1:30	1:05	1:05	1:00	R16 E	1:25	1:30	1:35	1:05	1:05	1:00	R16 E	1:40
R17 ESE	1:25	1:30	1:05	1:05	1:00	R17 ESE	1:25	1:30	1:35	1:05	1:05	1:00	R17 ESE	1:40
R18 SE, SSE	1:25	1:30	1:05	1:05	1:00	R18 SE, SSE	1:25	1:30	1:35	1:05	1:05	1:00	R18 SE, SSE	1:40
R19 S	1:25	1:30	1:05	1:05	1:00	R19 S	1:25	1:30	1:35	1:05	1:05	1:00	R19 S	1:40
R20 SSW, SW	1:35	1:40	1:15	1:15	1:10	R20 SSW, SW	1:35	1:40	1:45	1:15	1:15	1:05	R20 SSW, SW	1:45
R21 WSW, W, WNW	1:40	1:45	1:20	1:25	1:10	R21 WSW, W, WNW	1:40	1:45	1:50	1:20	1:25	1:10	R21 WSW, W, WNW	1:50
R22 NW	1:25	1:30	1:10	1:15	1:05	R22 NW	1:25	1:30	1:40	1:05	1:10	1:05	R22 NW	1:45

Table 7-1B. Time To Clear The Indicated Area of 90 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	2:00	2:00	1:40	1:45	1:45	R01 2-mile ring	2:00	2:00	2:00	1:40	1:45	1:45	R01 2-mile ring	2:40
R02 5-mile ring	2:40	2:40	2:00	2:05	2:10	R02 5-mile ring	2:40	2:45	3:00	2:00	2:05	2:10	R02 5-mile ring	3:05
R03 Entire EPZ	3:05	3:15	2:35	2:45	2:30	R03 Entire EPZ	3:05	3:20	3:35	2:35	2:45	2:30	R03 Entire EPZ	3:30
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	2:20	2:20	1:45	1:50	1:50	R04 N, NNE, NNW	2:20	2:20	2:20	1:45	1:50	1:50	R04 N, NNE, NNW	2:45
R05 NE	2:20	2:20	1:45	1:50	1:50	R05 NE	2:20	2:20	2:20	1:45	1:50	1:50	R05 NE	2:40
R06 ENE	2:40	2:40	1:50	1:50	2:00	R06 ENE	2:40	2:40	2:40	1:50	1:50	2:00	R06 ENE	2:45
R07 E, ESE	2:30	2:30	1:50	1:50	1:50	R07 E, ESE	2:30	2:30	2:30	1:50	1:50	1:50	R07 E, ESE	2:45
R08 SE, SSE	2:30	2:30	1:50	1:50	1:50	R08 SE, SSE	2:30	2:30	2:30	1:50	1:50	1:50	R08 SE, SSE	2:45
R09 S, SSW, SW	2:40	2:40	2:00	2:05	2:00	R09 S, SSW, SW	2:40	2:40	2:55	1:55	2:05	2:00	R09 S, SSW, SW	3:05
R10 WSW, W, WNW	2:30	2:35	1:55	2:05	2:00	R10 WSW, W, WNW	2:30	2:40	3:00	1:55	2:05	2:00	R10 WSW, W, WNW	3:05
R11 NW	2:10	2:10	1:45	1:45	1:50	R11 NW	2:10	2:10	2:10	1:45	1:45	1:50	R11 NW	2:40
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	2:50	2:50	2:30	2:30	2:30	R12 N, NNW	2:50	2:55	3:05	2:20	2:30	2:30	R12 N, NNW	3:10
R13 NNE	2:50	2:55	2:30	2:30	2:30	R13 NNE	2:50	2:55	3:05	2:20	2:30	2:30	R13 NNE	3:10
R14 NE	2:50	2:50	2:05	2:10	2:10	R14 NE	2:50	2:55	3:05	2:05	2:10	2:10	R14 NE	3:10
R15 ENE	2:50	2:50	2:05	2:10	2:10	R15 ENE	2:50	2:55	3:05	2:05	2:10	2:10	R15 ENE	3:10
R16 E	2:50	2:50	2:10	2:20	2:20	R16 E	2:50	2:55	3:05	2:10	2:10	2:20	R16 E	3:10
R17 ESE	2:50	2:55	2:10	2:20	2:20	R17 ESE	2:50	2:55	3:05	2:10	2:20	2:20	R17 ESE	3:10
R18 SE, SSE	2:50	2:55	2:10	2:20	2:20	R18 SE, SSE	2:50	2:55	3:05	2:10	2:20	2:20	R18 SE, SSE	3:10
R19 S	2:50	2:55	2:10	2:20	2:20	R19 S	2:50	2:55	3:05	2:10	2:20	2:20	R19 S	3:10
R20 SSW, SW	3:05	3:15	2:30	2:40	2:20	R20 SSW, SW	3:05	3:15	3:35	2:30	2:40	2:20	R20 SSW, SW	3:30
R21 WSW, W, WNW	3:05	3:15	2:35	2:45	2:30	R21 WSW, W, WNW	3:05	3:20	3:35	2:35	2:45	2:30	R21 WSW, W, WNW	3:30
R22 NW	2:50	2:50	2:20	2:30	2:30	R22 NW	2:50	2:55	3:05	2:20	2:30	2:30	R22 NW	3:10

Table 7-1C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	2:50	2:50	2:00	2:00	2:30	R01 2-mile ring	2:50	2:50	2:50	2:00	2:00	2:30	R01 2-mile ring	2:55
R02 5-mile ring	3:20	3:20	2:40	2:40	2:40	R02 5-mile ring	3:20	3:20	3:20	2:40	2:40	2:40	R02 5-mile ring	3:20
R03 Entire EPZ	3:30	3:30	2:50	3:00	2:50	R03 Entire EPZ	3:30	3:35	3:50	2:50	2:55	2:50	R03 Entire EPZ	3:50
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	3:10	3:10	2:30	2:30	2:40	R04 N, NNE, NNW	3:10	3:10	3:10	2:30	2:30	2:40	R04 N, NNE, NNW	3:10
R05 NE	3:10	3:10	2:30	2:30	2:40	R05 NE	3:10	3:10	3:10	2:30	2:30	2:40	R05 NE	3:10
R06 ENE	3:20	3:20	2:40	2:40	2:40	R06 ENE	3:20	3:20	3:20	2:40	2:40	2:40	R06 ENE	3:20
R07 E, ESE	3:10	3:10	2:30	2:30	2:40	R07 E, ESE	3:10	3:10	3:10	2:30	2:30	2:40	R07 E, ESE	3:10
R08 SE, SSE	3:10	3:10	2:30	2:30	2:40	R08 SE, SSE	3:10	3:10	3:10	2:30	2:30	2:40	R08 SE, SSE	3:10
R09 S, SSW, SW	3:20	3:20	2:40	2:40	2:40	R09 S, SSW, SW	3:20	3:20	3:20	2:40	2:40	2:40	R09 S, SSW, SW	3:20
R10 WSW, W, WNW	3:10	3:10	2:40	2:40	2:40	R10 WSW, W, WNW	3:10	3:10	3:15	2:40	2:40	2:40	R10 WSW, W, WNW	3:20
R11 NW	3:00	3:00	2:20	2:20	2:40	R11 NW	3:00	3:00	3:00	2:20	2:20	2:40	R11 NW	3:00
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	3:30	3:30	2:50	2:50	2:50	R12 N, NNW	3:30	3:30	3:30	2:50	2:50	2:50	R12 N, NNW	3:30
R13 NNE	3:30	3:30	2:50	2:50	2:50	R13 NNE	3:30	3:30	3:30	2:50	2:50	2:50	R13 NNE	3:30
R14 NE	3:30	3:30	2:40	2:40	2:50	R14 NE	3:30	3:30	3:30	2:40	2:40	2:50	R14 NE	3:30
R15 ENE	3:30	3:30	2:40	2:40	2:50	R15 ENE	3:30	3:30	3:30	2:40	2:40	2:50	R15 ENE	3:30
R16 E	3:30	3:30	2:50	2:50	2:50	R16 E	3:30	3:30	3:30	2:50	2:50	2:50	R16 E	3:30
R17 ESE	3:30	3:30	2:50	2:50	2:50	R17 ESE	3:30	3:30	3:30	2:50	2:50	2:50	R17 ESE	3:30
R18 SE, SSE	3:30	3:30	2:50	2:50	2:50	R18 SE, SSE	3:30	3:30	3:30	2:50	2:50	2:50	R18 SE, SSE	3:30
R19 S	3:30	3:30	2:50	2:50	2:50	R19 S	3:30	3:30	3:30	2:50	2:50	2:50	R19 S	3:30
R20 SSW, SW	3:30	3:30	2:50	2:55	2:50	R20 SSW, SW	3:30	3:35	3:50	2:50	2:55	2:50	R20 SSW, SW	3:50
R21 WSW, W, WNW	3:30	3:30	2:50	3:00	2:50	R21 WSW, W, WNW	3:30	3:35	3:50	2:50	2:55	2:50	R21 WSW, W, WNW	3:50
R22 NW	3:30	3:30	2:45	2:50	2:50	R22 NW	3:30	3:30	3:30	2:40	2:50	2:50	R22 NW	3:30

Table 7-1D. Time To Clear The Indicated Area of 100 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	4:00	4:00	4:00	4:00	4:00	R01 2-mile ring	4:00	4:00	4:00	4:00	4:00	4:00	R01 2-mile ring	4:00
R02 5-mile ring	4:05	4:05	4:05	4:05	4:05	R02 5-mile ring	4:05	4:05	4:05	4:05	4:05	4:05	R02 5-mile ring	4:05
R03 Entire EPZ	4:10	4:10	4:10	4:10	4:10	R03 Entire EPZ	4:10	4:10	4:30	4:10	4:10	4:10	R03 Entire EPZ	4:30
2-Mile Ring and Downwind to 5 Miles														
R04 N, NNE, NNW	4:05	4:05	4:05	4:05	4:05	R04 N, NNE, NNW	4:05	4:05	4:05	4:05	4:05	4:05	R04 N, NNE, NNW	4:05
R05 NE	4:05	4:05	4:05	4:05	4:05	R05 NE	4:05	4:05	4:05	4:05	4:05	4:05	R05 NE	4:05
R06 ENE	4:05	4:05	4:05	4:05	4:05	R06 ENE	4:05	4:05	4:05	4:05	4:05	4:05	R06 ENE	4:05
R07 E, ESE	4:05	4:05	4:05	4:05	4:05	R07 E, ESE	4:05	4:05	4:05	4:05	4:05	4:05	R07 E, ESE	4:05
R08 SE, SSE	4:05	4:05	4:05	4:05	4:05	R08 SE, SSE	4:05	4:05	4:05	4:05	4:05	4:05	R08 SE, SSE	4:05
R09 S, SSW, SW	4:05	4:05	4:05	4:05	4:05	R09 S, SSW, SW	4:05	4:05	4:05	4:05	4:05	4:05	R09 S, SSW, SW	4:05
R10 WSW, W, WNW	4:05	4:05	4:05	4:05	4:05	R10 WSW, W, WNW	4:05	4:05	4:05	4:05	4:05	4:05	R10 WSW, W, WNW	4:05
R11 NW	4:05	4:05	4:05	4:05	4:05	R11 NW	4:05	4:05	4:05	4:05	4:05	4:05	R11 NW	4:05
5-Mile Ring and Downwind to EPZ Boundary														
R12 N, NNW	4:10	4:10	4:10	4:10	4:10	R12 N, NNW	4:10	4:10	4:10	4:10	4:10	4:10	R12 N, NNW	4:10
R13 NNE	4:10	4:10	4:10	4:10	4:10	R13 NNE	4:10	4:10	4:10	4:10	4:10	4:10	R13 NNE	4:10
R14 NE	4:10	4:10	4:10	4:10	4:10	R14 NE	4:10	4:10	4:10	4:10	4:10	4:10	R14 NE	4:10
R15 ENE	4:10	4:10	4:10	4:10	4:10	R15 ENE	4:10	4:10	4:10	4:10	4:10	4:10	R15 ENE	4:10
R16 E	4:10	4:10	4:10	4:10	4:10	R16 E	4:10	4:10	4:10	4:10	4:10	4:10	R16 E	4:10
R17 ESE	4:10	4:10	4:10	4:10	4:10	R17 ESE	4:10	4:10	4:10	4:10	4:10	4:10	R17 ESE	4:10
R18 SE, SSE	4:10	4:10	4:10	4:10	4:10	R18 SE, SSE	4:10	4:10	4:10	4:10	4:10	4:10	R18 SE, SSE	4:10
R19 S	4:10	4:10	4:10	4:10	4:10	R19 S	4:10	4:10	4:10	4:10	4:10	4:10	R19 S	4:10
R20 SSW, SW	4:10	4:10	4:10	4:10	4:10	R20 SSW, SW	4:10	4:10	4:30	4:10	4:10	4:10	R20 SSW, SW	4:30
R21 WSW, W, WNW	4:10	4:10	4:10	4:10	4:10	R21 WSW, W, WNW	4:10	4:10	4:30	4:10	4:10	4:10	R21 WSW, W, WNW	4:30
R22 NW	4:10	4:10	4:10	4:10	4:10	R22 NW	4:10	4:10	4:10	4:10	4:10	4:10	R22 NW	4:10

Table 7-1. Description of Evacuation Regions														
		ERPA												
Region	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R01	2 mile ring	■												
R02	5-mile ring	■	■	■	■	■	■							
R03	Full EPZ	■	■	■	■	■	■	■	■	■	■	■	■	■
Evacuate 2 mile ring and 5 miles downwind														
		ERPA												
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R04	N,NNE,NNW	■	■				■							
R05	NE	■	■	■										
R06	ENE	■	■	■	■									
R07	E,ESE	■		■	■									
R08	SE,SSE	■			■									
R09	S,SSW,SW	■			■	■								
R10	WSW,W,WNW	■				■	■							
R11	NW	■					■							
Evacuate 5 mile ring and downwind to EPZ boundary														
		ERPA												
Region	**Wind Direction**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
R12	N,NNW	■	■	■	■	■	■	■					■	
R13	NNE	■	■	■	■	■	■	■	■				■	
R14	NE	■	■	■	■	■	■	■	■					
R15	ENE	■	■	■	■	■	■	■	■	■				
R16	E	■	■	■	■	■	■		■	■				■
R17	ESE	■	■	■	■	■	■		■	■	■			■
R18	SE,SSE	■	■	■	■	■	■			■	■			■
R19	S	■	■	■	■	■	■				■			
R20	SSW,SW	■	■	■	■	■	■				■	■		
R21	WSW,W,WNW	■	■	■	■	■	■					■	■	
R22	NW	■	■	■	■	■	■						■	

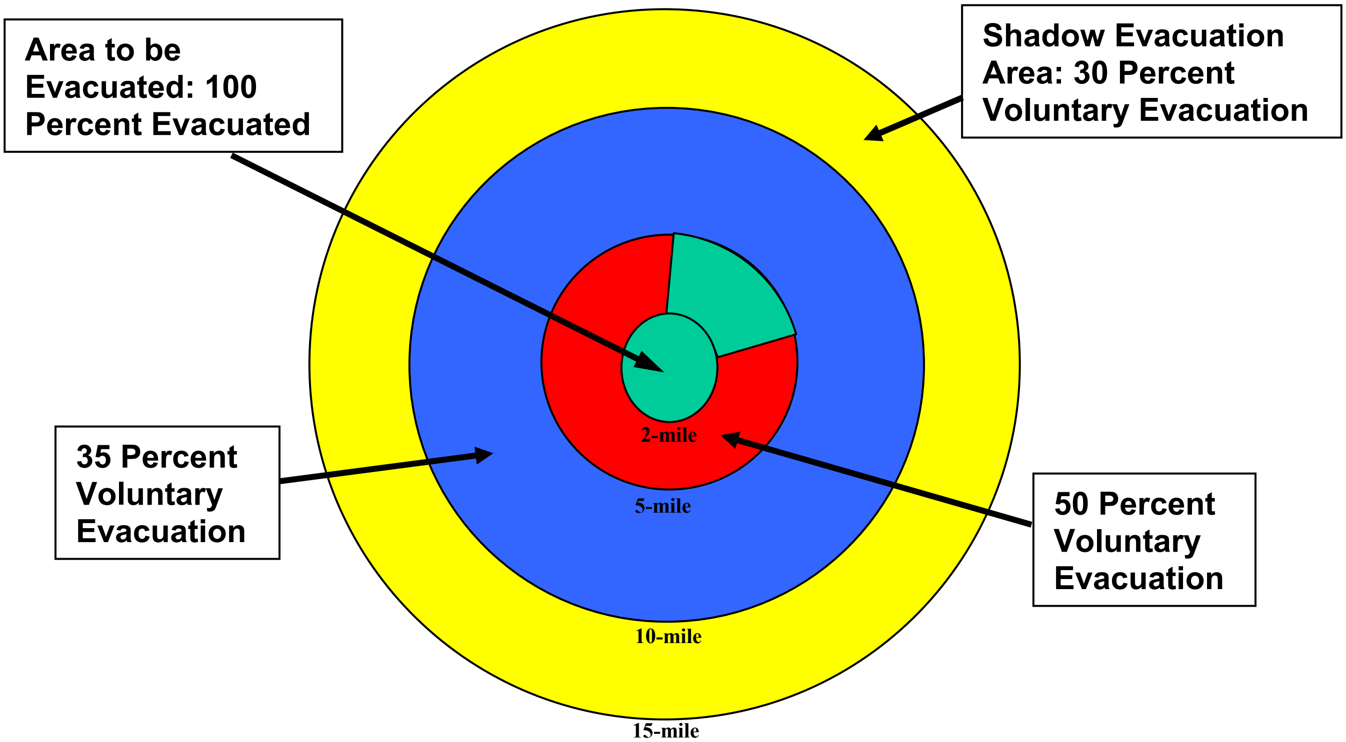


Figure 7-1. Voluntary Evacuation Methodology

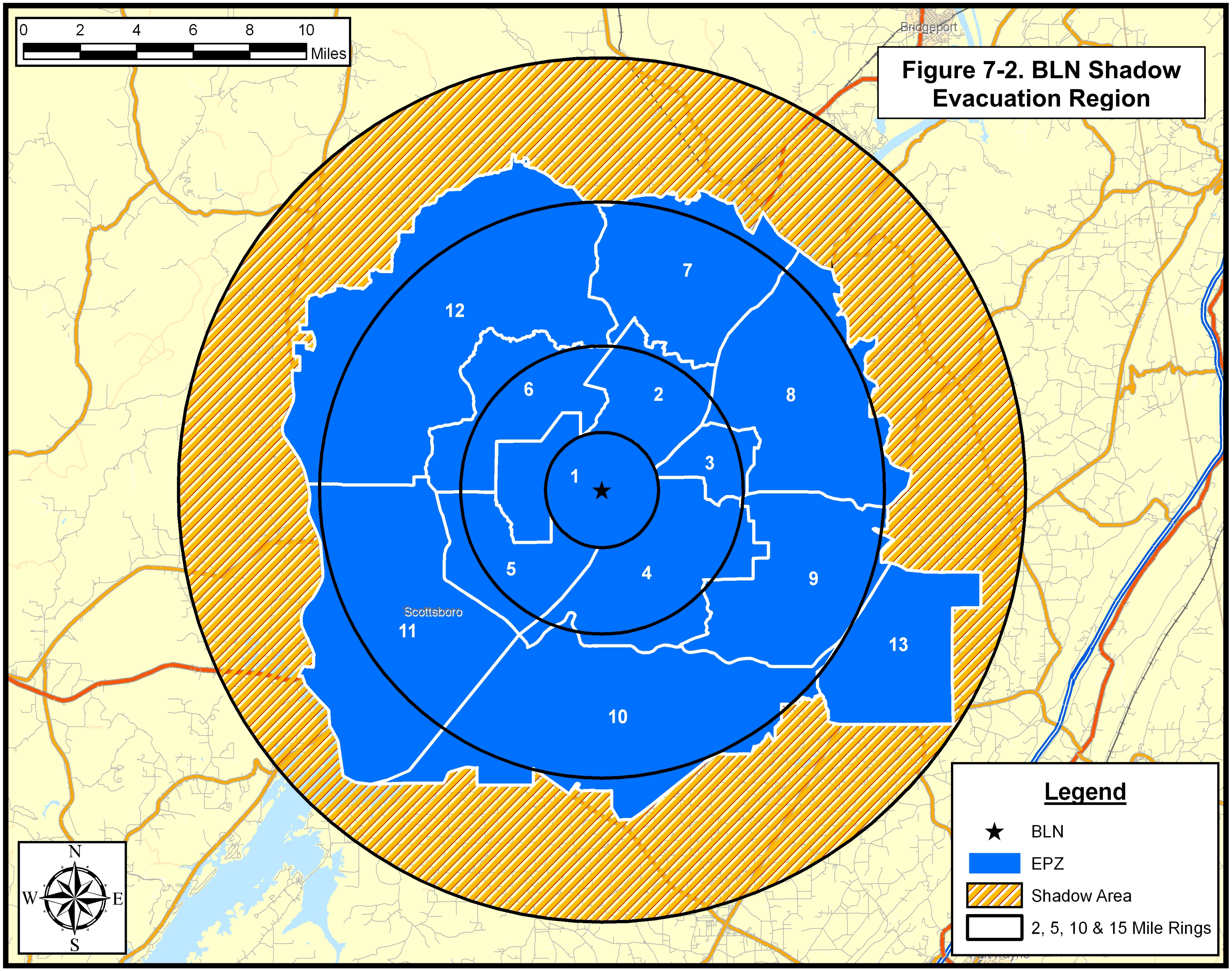


Figure 7-2. BLN Shadow Evacuation Region
0
2
4
6
8
10
Miles
Bridgeport
Scottsboro
1
2
3
4
5
6
7
8
9
10
11
12
13
N
S
E
W
Legend
BLN
EPZ
Shadow Area
2, 5, 10 & 15 Mile Rings

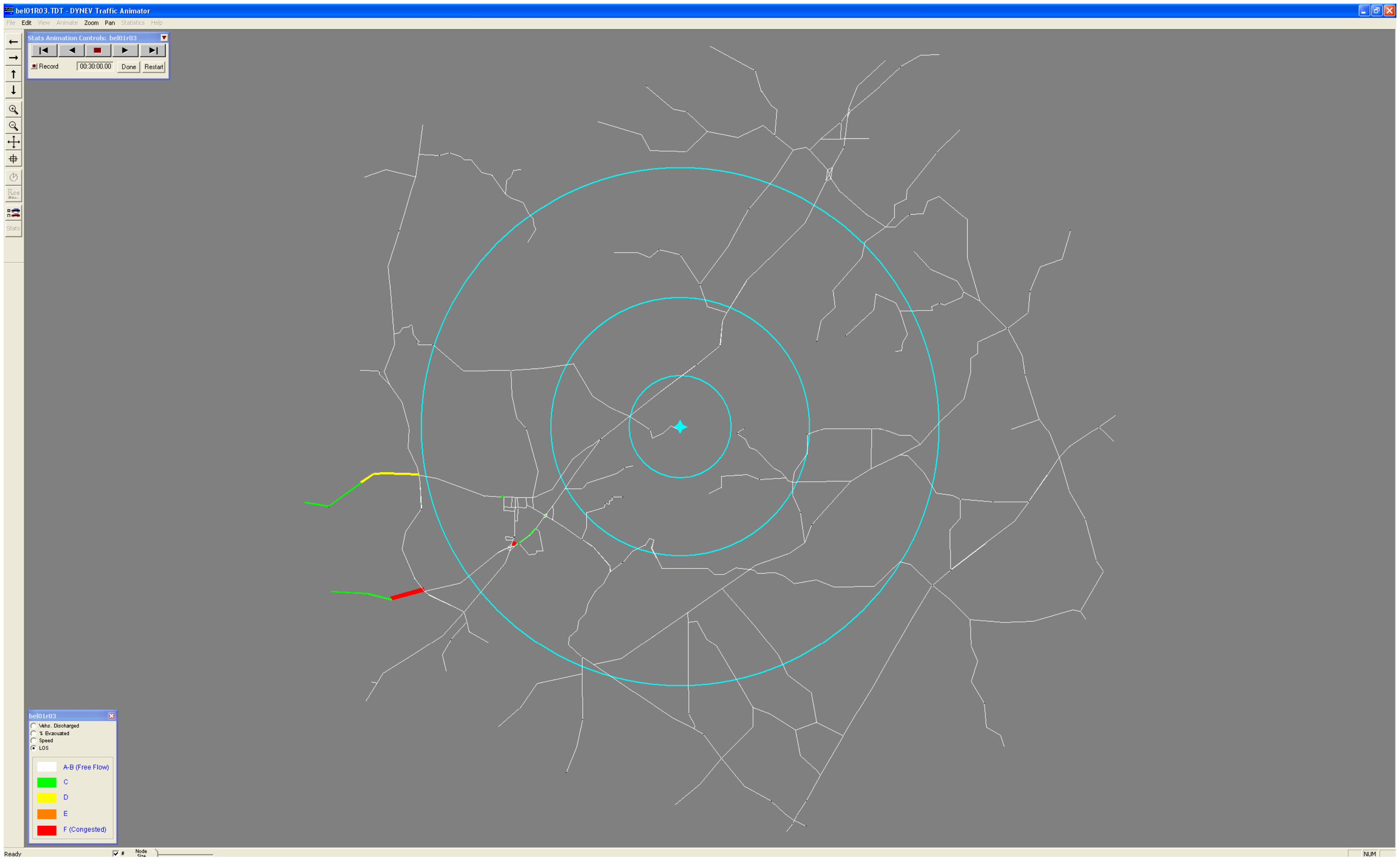


Figure 7-3. Congestion Patterns at 30 Minutes After the Advisory to Evacuate

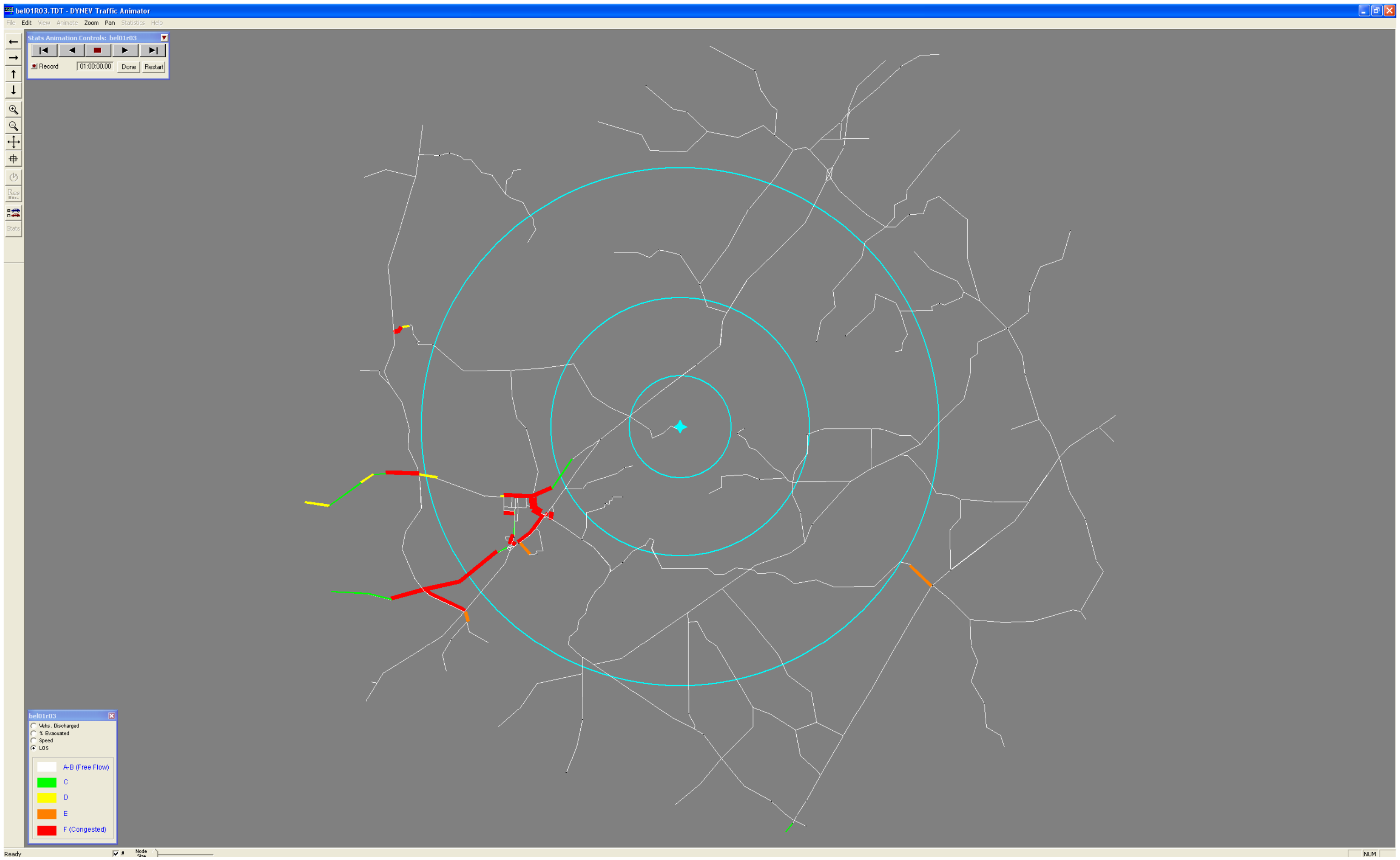


Figure 7-4 Congestion Patterns at 1 Hour After the Advisory to Evacuate

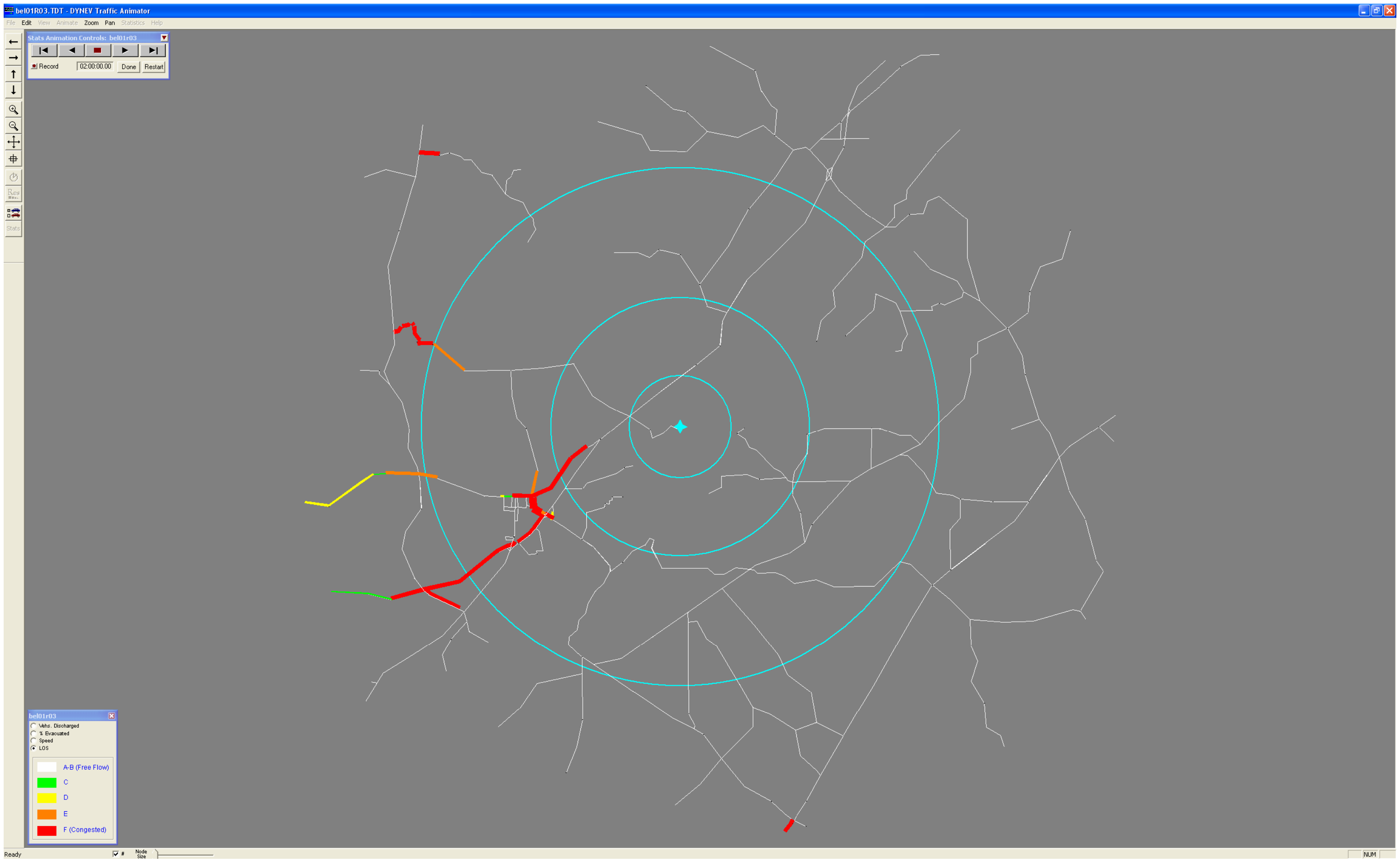


Figure 7-5 Congestion Patterns at 2 Hours After the Advisory to Evacuate

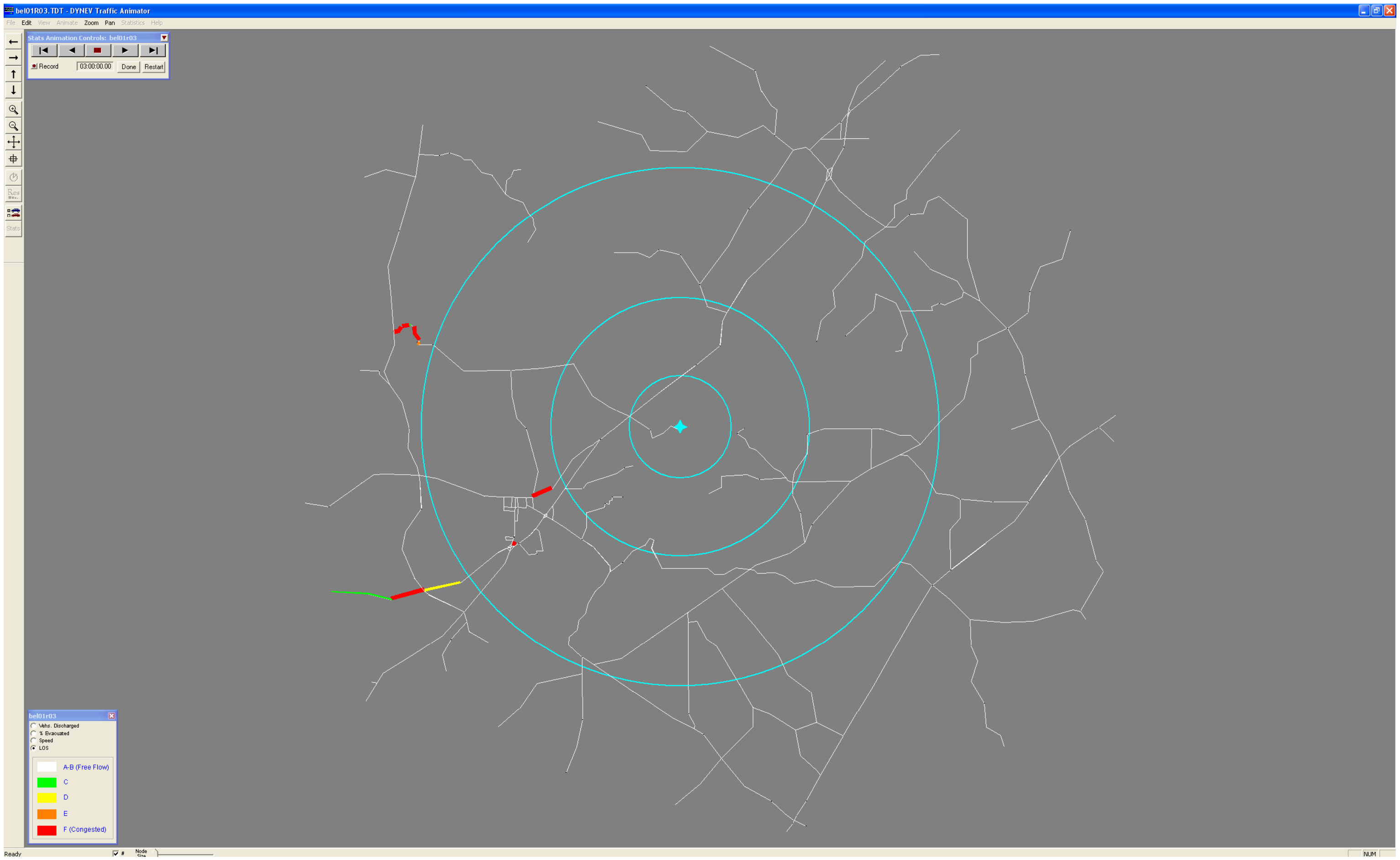


Figure 7-6 Congestion Patterns at 3 Hours After the Advisory to Evacuate

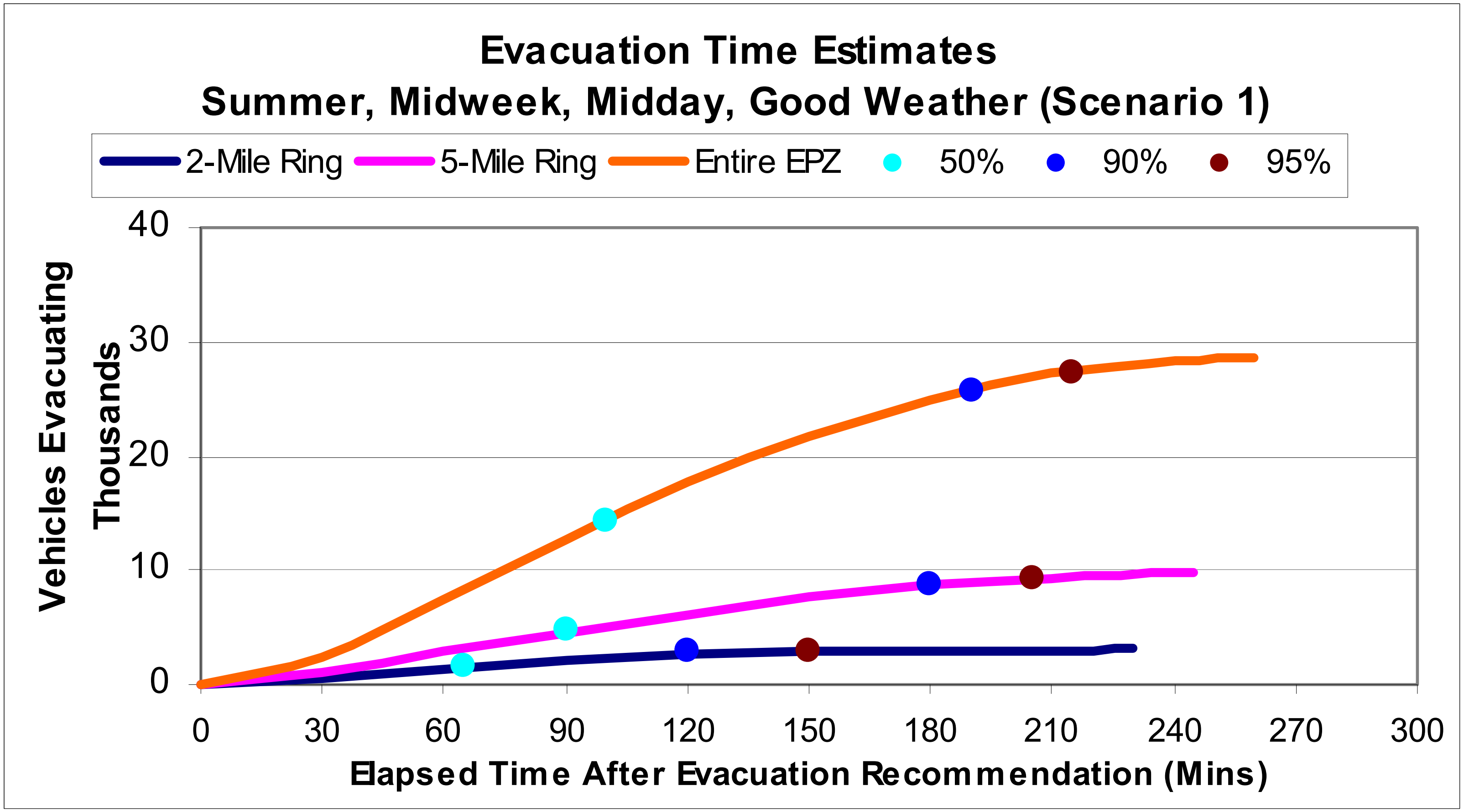


Figure 7-7. Evacuation Time Estimates for BLN Summer, Midweek, Midday, Good Weather Evacuation of Region R3 (Entire EPZ)

8. TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES

This section details the analyses applied and the results obtained in the form of evacuation time estimates for transit vehicles (buses). The demand for transit service reflects the needs of two population groups: (1) residents, employees and transients with no vehicles available; and (2) residents of special facilities such as schools, health-support facilities, institutions and child-care facilities.

These transit vehicles merge into and become a part of the general evacuation traffic environment that is comprised mostly of "passenger cars" (pc's). The presence of each transit vehicle in the evacuating traffic stream is represented within the modeling paradigm described in Appendix D as equivalent to two pc's. This equivalence factor represents the longer size and more sluggish operating characteristics of a transit vehicle relative to those of a pc.

Transit vehicles must be mobilized in preparation for their respective evacuation missions. Specifically:

- Bus drivers must be alerted
- They must travel to the bus depot
- They must be briefed there and assigned to a route or facility

These activities consume time. Based on experience at other rural plants, it is estimated that bus mobilization time will average approximately 90 minutes extending from the Advisory to Evacuate to the time when buses are dispatched from their respective depots.

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents, neighbors, relatives and friends to pick up children from school prior to the arrival of buses, so that they may join their families. Virtually all studies of evacuations have concluded that this "bonding" process of uniting family units is universally prevalent during emergencies and should be anticipated in the planning process. Many emergency plans, however, call for parents to pick up children at host schools or reception centers to speed the evacuation of the schoolchildren in the event that buses need to return to the EPZ and evacuate transit dependents. We provide estimates of buses under the assumption that no children will be picked up, to present an upper bound estimate of the transit vehicles needed.

The procedure is:

- Estimate demand for transit service
- Estimate time to perform all transit functions
- Estimate route travel times to the EPZ boundary and to the assumed school reception centers

8.1 Transit-Dependent People - Demand Estimate

The telephone survey (see Appendix F) results were used to estimate the portion of the population requiring transit service:

- Those persons in households that do not have a vehicle available.
- Those persons in households that do have vehicle(s) that would not be available at the time the evacuation is ordered.

In the latter group, the vehicle(s) may be used by a commuter(s) who does not return (or is not expected to return) home to evacuate the household.

Table 8-1 presents estimates of transit-dependent people. Note:

- Estimates of persons requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is advised, separate transportation is provided for the school-children. The actual need for transit vehicles by residents is thereby less than the given estimates. However, we will not reduce our estimates of transit vehicles since it would add to the complexity of the implementation procedures.
- It is reasonable and appropriate to consider that many transit-dependent persons will evacuate by ride-sharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario who did not use their own cars, shared a ride with neighbors or friends. Other documents report that approximately 70 percent of transit-dependent persons were evacuated via ride-sharing. **We will adopt a conservative estimate that 50 percent of transit-dependent persons will ride-share.**

The estimated number of bus trips needed to service transit-dependent persons is based on an estimate of average bus occupancy of 30 persons at the conclusion of the bus run. Transit vehicle seating capacities typically equal or exceed 60 children (equivalent to 40 adults). If transit vehicle evacuees are two-thirds adults and one-third children, then the number of “adult seats” taken by 30 persons is 20 + (2/3 x10) = 27. On this basis, the average load factor anticipated is (27/40) x 100 = 68 percent. Thus, if the actual demand for service exceeds the estimates of Table 8-1 by 50 percent, the demand for service can still be accommodated by the available bus seating capacity.

Table 8-1 indicates that transportation must be provided for 609 people. Therefore, a total of 21 bus runs are required to transport this population to reception centers.

To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses, B, required for the Bellefonte EPZ:

$$P = 12{,}500 \times (0.034 \times 1.28 + 0.238 \times (1.91 - 1) \times 0.64 \times 0.31 + 0.407 \times (2.67 - 2) \times (0.64 \times 0.31)^2)$$
$$P = 12{,}500 * (0.0973) = 1{,}217$$
$$B = (0.5 \times P) \div 30 = 21$$

The telephone survey conducted in the EPZ collects all the relevant information to estimate the total population requiring public transit or ride-share. These calculations are explained as follows:

1. Households with No Vehicles: The average size of a household without access to a vehicle is 1.28. 3.4% of all the households in the EPZ do not have any vehicles. All the members of these households (HH) will evacuate by public transit or ride-share. The term 12,500(total households) x 0.034 x 1.28, accounts for these people.

2. Households with One Vehicle: The average size of a household with only one vehicle is 1.91. If a household commuter is using the car, the number of people who are at home is 1.91 - 1 = 0.91. There are 23.8% households in the EPZ with one vehicle. 64% of the households in the EPZ have at least one commuter; the commuter in 31% of those households, on average, will not return home. The number of HH where the commuter will not return

home is equal to (12,500 x 0.238 x 0.64 x 0.31). The number of persons in these households who will evacuate by public transit or ride-share is equal to the product of this number of households and the average household size of 0.91.

3. Households with Two Vehicles: The average size of a household with two vehicles is 2.67. If both available vehicles are used by non-returning commuters, the number of people who are at home is 2.67 – 2 = 0.67. There are 40.7% households in the EPZ with 2 vehicles. Hence, the number of HH where neither commuter will return home is equal to 12,500 x 0.407 x $(0.64 \times 0.31)^2$. The number of persons in these households who will evacuate by public transit or ride-share is equal to the product of this number of households and the average household size of 0.67.

4. Households with 3 or More Vehicles: Households with 3 or more vehicles are assumed to have no need for transit vehicles.

5. The total number of persons requiring public transit is the sum of such people in HH as described in items 1, 2, and 3.

6. 50% of the estimated number of persons require public transit, while others ride-share with neighbors. Knowing the capacity of a transit bus (30 adults/bus), the total number of buses can be estimated as: $(0.5 \times P) \div 30$.

8.2 School Population – Transit Demand

Table 8-2 presents the school population and transportation requirements for the direct evacuation of all schools within the EPZ. The column in Table 8-2 entitled "Bus Runs Required" specifies the number of buses required for each school under the following set of assumptions and estimates:

- No students will be picked up by their parents prior to the arrival of the buses.

- Bus capacity, expressed in students per bus, is set to 70 for primary schools and 50 for middle and high schools.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism which is in the neighborhood of 3 percent, daily.

We recommend that the Counties introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot (approximately 90 minutes after the Advisory to Evacuate), to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. Those buses originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing.

Reception centers have not yet been established for the Bellefonte EPZ. We assume that reception centers will be located in the neighboring cities: Huntsville to the west, Bridgeport to the north, and Fort Payne to the east. Table 8-3 presents a list of the school reception center city for each school in the EPZ. Students will be transported to these centers where they will be subsequently retrieved by their respective families.

8.3 Special Facility Demand

Table 8-4 presents the census of special facilities in the EPZ as of the end of 2006. The facilities listed were found using Internet searches. Detailed data on the number of residents at each facility were not available. Typically, this census also indicates the number of wheelchair-bound people and the number of bed-ridden people; however this data was also not available. The transportation requirements for this group are presented where data is available. The number of bus runs estimated assumes 30 ambulatory patients per trip.

8.4 Evacuation Time Estimates for Transit-Dependent People

EPZ bus resources are assigned to evacuating schoolchildren as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat “inefficient”, or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the reception center after completing their first evacuation trip, to complete a “second wave” of providing transport service to evacuees. For this reason, the ETE will be calculated for both a one wave transit evacuation and for two waves (Table 8-6). Of course, if the impacted Evacuation Region is other than R3 (the entire EPZ), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

When school bus needs are satisfied, subsequent assignments of buses to service the transit-dependent should be sensitive to their mobilization time. Clearly, the buses should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive at the pick-up points.

Evacuation Time Estimates for Transit Trips were developed using both good weather and adverse weather conditions. Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

Activity: Mobilize Drivers (A→B)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses are dispatched from their respective depots. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would likely require 90 minutes to arrive at the depot, be briefed, and begin their trips to the transit-dependent facilities. Mobilization time is slightly longer – 100 minutes – when raining.

Activity: Travel to Facility (B→C)

It is assumed that buses will be traveling from nearby cities (i.e. Huntsville) and will require approximate 30 minutes to travel from the depot to the facility in good weather, and 35 minutes in rain.

Activity: Board Passengers (C→D)

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school) is about 5 minutes. A loading time of 10 minutes will be used for rain scenarios. For multiple stops along a pick-up route we must allow for the additional delay associated with stopping and starting at each pick-up point. This additional delay to service passengers expands this estimate of boarding time to 15 minutes in good weather, and 20 minutes in rain.

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

The distance from a school to the EPZ boundary is measured using Geographical Information Systems (GIS) software along the most likely route out of the EPZ. The measurements are divided between those distances traveled on local roads and those distances traveled on major routes. We will conservatively assert that bus travel speeds are 30 mph on local roads, and 50 mph on major routes such as US Route72.

Travel speeds are reduced by 10 percent for rain scenarios. Tables 8-5A (good weather) and 8-5B (rain) present the following evacuation time estimates (rounded up to the nearest 5 minutes) for schools in the EPZ: (1) The elapsed time from the Advisory to Evacuate until the bus exits the EPZ; and (2) The elapsed time until the bus reaches the School Reception Center. The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B, B→C, C→D, and D→E (For example: 90 min. + 30 + 5 + 9 = 2:15 for Scottsboro High School, with good weather). The evacuation time to the School Reception Center is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

Evacuation of Transit-Dependent Population

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As indicated in Table 5-8, more than 90 percent of the evacuees will complete their mobilization when the first buses will begin their routes, 90 minutes after the Advisory to Evacuate.

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ. Table 8-6 details the proposed bus routes to service the transit dependent people in the Bellefonte EPZ, while Figure 8-2 maps the proposed bus pick-up routes. The travel distance along the respective pick-up routes within the EPZ is measured using GIS software. Most of the evacuation traffic will have dissipated when the transit dependent buses begin their routes; however the frequent stops for passenger pickup will likely slow the buses down. As such, the associated travel times are computed assuming an average speed of 30 mph.

Table 8-7 presents the transit-dependent population evacuation time estimates for each route obtained using the above procedures. For example, the ETE for Route 1 is computed as 90 + 30 + 15 + 50 = 3:05 hours for good weather. Here, 50 minutes is the time to travel 24.9 miles at 30 mph. The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers.

<u>Activity: Travel to School Reception Centers (E→F)</u>

The distances from the EPZ boundary to the assumed reception center city are measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ to the reception area. For a one-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. For a two-wave evacuation, the ETE for buses must be considered separately, since it could exceed the ETE for the general public. Bus speeds of 30 mph on local roads and 50 mph on major routes will also be applied for this activity.

<u>Activity: Passengers Leave Bus (F→G)</u>

A bus can empty within 5 minutes.

Activity: Bus Returns to Route for Second Wave Evacuation (G→C)

The buses assigned to return to the EPZ to perform a "second wave" evacuation of transit-dependent evacuees will be those that evacuated the schoolchildren. These buses are assigned since they will be the first buses to complete their evacuation service and are therefore the first to be available for the second wave. The passengers leave the bus, and the bus then travels to its route and proceeds to pick up transit-dependent evacuees along the route. The travel time back to the EPZ is calculated using distances estimated from GIS and the assumed bus travel speeds.

The travel time for Route Number 1 is computed as follows:

- Bus arrives at reception center at 2:53 on average in good weather (Table 8-5A).
- Bus discharges passengers (5 minutes) and driver takes a 15-minute rest: 20 minutes.
- Bus returns to EPZ: 36 minutes on average (Table 8-5A).
- Bus completes pick-ups along route and departs EPZ: 15 minutes + (24.9 miles @ 30 mph) = 1 hour and 5 minutes.
- Bus exits EPZ at time 2:53 + 0:20 + 0:36 + 1:05 = 4:55 after the Advisory to Evacuate.

The ETE for the completion of the second wave are given in Table 8-7.

Evacuation of Ambulatory Persons from Special Facilities

The bus operations for this group are similar to those for school evacuation except:

- These buses will leave the depots later, approximately 2 hours after the Advisory to Evacuate.
- The passenger loading time will be longer at approximately 30 minutes to account for the time to move patients from inside the facility to the vehicles.

The time that these buses will leave these special facilities to begin their respective evacuation trips out of the EPZ is calculated as follows:

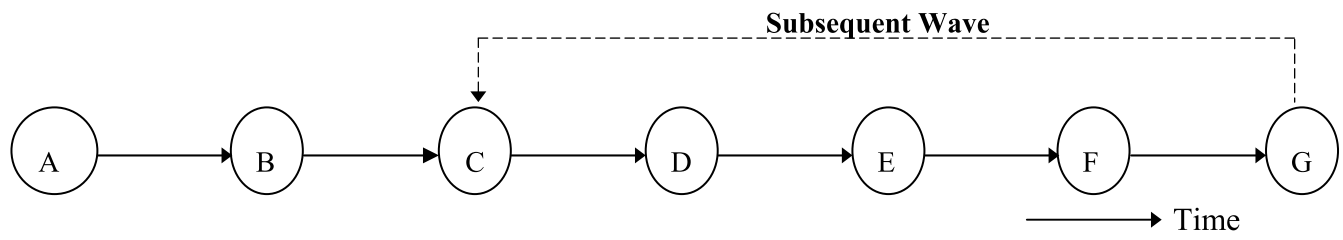
- Bus leaves depot at 2:00 (2:15 for rain).
- Bus travels to facility, 30 minutes (35 for rain).
- Passengers board bus, 30 minutes (35 for rain).

Thus, the bus will leave the facility at 3:00 after the Advisory to Evacuate. These buses will travel out of the EPZ at the assumed speeds of 30 mph for local roads and 50 mph for major routes. As was done for the schools, the distance from the facility to the EPZ boundary is measured using GIS and the travel time is found using the bus travel speeds. For example, the travel time for Cloverdale Healthcare, Inc. to the EPZ boundary will be 10 minutes and the resulting ETE will be three hours and 10 minutes. The ETE to evacuate ambulatory residents from special facilities are presented in Table 8-8.

Emergency Medical Services (EMS) Vehicles

The previous discussion focused on transit operations for ambulatory and wheelchair-bound persons within the Region. It is also necessary to provide transit services to non-ambulatory persons who do not -- or cannot -- have access to private vehicles. Data on the number of bed-ridden patients was not available, but several ambulance trips will likely be needed for an evacuation of the entire EPZ. A single wave of service is assumed. Additional ambulances are assumed to travel from the neighboring cities (i.e. Huntsville) if the resources available within the EPZ are not sufficient.

It is reasonable to expect that the response times of EMS vehicles should be less than for the buses dispatched to evacuate special facilities. We will conservatively estimate the same ETE for these EMS vehicles as for the vehicles evacuating ambulatory evacuees from special facilities. This approach takes into account that a somewhat longer vehicle loading time for these passengers, relative to that for the ambulatory evacuees, will balance the earlier arrival times of these vehicles at the facilities. Therefore, the ETE for EMS vehicles to leave the EPZ are the same as for the vehicles evacuating ambulatory evacuees from special facilities; see Table 8-8.



Event

A	Advisory to Evacuate
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Pick-up Route
D	Bus Departs for Reception Center
E	Bus Exits Region
F	Bus Arrives at School Reception Center
G	Bus Available for "Second Wave" Evacuation Service

Activity

A→B	Driver Mobilization
B→C	Travel to Facility or to Pick-up Route
C→D	Passengers Board the Bus
D→E	Bus Travels Towards Region Boundary
E→F	Bus Travels Towards School Reception Center Outside the EPZ.
F→G	Passengers Leave Bus; Driver Takes a Break

Figure 8-1. Chronology of Transit Evacuation Operations

Table 8-1. Transit Dependent Population Estimates

Facility Name	2007 EPZ Population	Survey Average Household Size With Indicated No. of Vehicles			Estimated Number of Households	Survey Percent Households With			Survey Percent Households With Commuters	Survey Percent Households With Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent of Population Requiring Public Transit
		0	1	2		0 Veh-icle	1 Veh-icle	2 Veh-icle						
Bellefonte Nuclear Plant	31,566	1.28	1.91	2.67	12,500	3.4%	23.8%	40.7%	64%	31%	1,217	50%	609	1.9%

Table 8-2. School Population Demand Estimates							
ERPA	Distance (miles)	Direction	School Name	Municipality	Enroll-ment	Staff	Bus Runs Req'd
Jackson County Schools							
1	2	WNW	Epruett Center of Technology	Hollywood	N/A	N/A	2*
1	2.3	WNW	Hollywood Elementary School	Hollywood	205	17	3
1	2.7	WNW	Jackson County Alternative School	Hollywood	N/A	N/A	2*
4	4.9	ESE	Pisgah High School	Pisgah	564	35	11
5	6.1	WSW	Brownwood Elementary School	Scottsboro	391	29	6
5	5.3	WSW	Scottsboro High School	Scottsboro	719	51	14
9	9.1	E	Rosalie Elementary School	Pisgah	308	22	4
10	7.5	S	Dutton Elementary School	Dutton	270	18	4
10	9.6	SSW	Section High School	Section	558	36	11
11	7.1	WSW	Caldwell Elementary School	Scottsboro	430	30	6
11	7.7	SW	Collins Elementary School	Scottsboro	455	29	7
11	7.8	WSW	Scottsboro Junior High School	Scottsboro	467	29	9
11	9.6	SW	Thurston T Nelson Elementary School	Scottsboro	294	22	4
				Jackson County Totals:	**4,661**	**318**	**79**
DeKalb County Schools							
13	10.5	ESE	Henagar Junior High School	Henagar	341	24	7
				DeKalb County Totals:	**341**	**24**	**7**
				EPZ Totals:	**5,002**	**342**	**86**

N/A – Not Available; *Assumed number of buses needed

Table 8-3. Assumed School Reception Centers		
ERPA	School	City
1	Epruett Center of Technology	**Huntsville, AL**
1	Hollywood Elementary School	
1	Jackson County Alternative School	
5	Brownwood Elementary School	
5	Scottsboro High School	
11	Caldwell Elementary School	
11	Collins Elementary School	
11	Scottsboro Junior High School	
11	Thurston T Nelson Elementary School	
4	Pisgah High School	**Fort Payne, AL**
9	Rosalie Elementary School	
10	Dutton Elementary School	
10	Section High School	
13	Henagar Junior High School	

Table 8-4. Special Facility Transit Demand							
ERPA	**Distance (miles)**	**Direction**	**Facility Name**	**Municipality**	**Capacity***	**Staff**	**Bus Runs Req'd**
Jackson County Facilities							
4	4.8	ESE	The Home Place	Pisgah	N/A	N/A	N/A
11	7.8	WSW	Cloverdale Healthcare Inc	Scottsboro	141	N/A	5
11	7.8	WSW	Highlands Medical Center	Scottsboro	220	N/A	8
11	7.8	WSW	Jackson County Nursing Home	Scottsboro	50	N/A	2
11	7.8	WSW	Mountain Lakes Behavioral Healthcare	Scottsboro	N/A	N/A	N/A
11	6.2	SW	North Jackson Nursing Home	Scottsboro	100	N/A	4
11	7.6	SW	Rosewood Manor	Scottsboro	N/A	N/A	N/A
11	9.2	SW	Southern Estates Assisted Living	Scottsboro	N/A	N/A	N/A
				EPZ Totals:	**N/A**	**N/A**	**N/A**

N/A = Not Available
*Details about number of bed ridden, wheel-chair bound, and ambulatory residents not provided.

Table 8-5A. School Evacuation Time Estimates - Good Weather

School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Jackson County Schools											
Brownwood Elementary School	90	30	5	6.5	0.2	9	**2:15**	36	0.3	44	**3:00**
Caldwell Elementary School	90	30	5	5.8	0.1	8	**2:15**	36	0.3	44	**3:00**
Collins Elementary School	90	30	5	4.9	0	6	**2:15**	36	0.3	44	**2:55**
Dutton Elementary School	90	30	5	5.9	0.9	9	**2:15**	15.2	1.7	22	**2:40**
Epruett Center of Technology	90	30	5	11.5	0.1	14	**2:20**	36	0.3	44	**3:05**
Hollywood Elementary School	90	30	5	11.5	0.4	15	**2:20**	36	0.3	44	**3:05**
Jackson County Alternative School	90	30	5	11.5	1.5	17	**2:25**	36	0.3	44	**3:10**
Pisgah High School	90	30	5	14.4	1.9	22	**2:30**	7.1	1.7	12	**2:40**
Rosalie Elementary School	90	30	5	2.3	0.1	3	**2:10**	30.3	0.1	37	**2:45**
Scottsboro High School	90	30	5	7.4	0	9	**2:15**	36	0.3	44	**3:00**
Scottsboro Junior High School	90	30	5	4.9	0.6	8	**2:15**	36	0.3	44	**3:00**
Section High School	90	30	5	2.7	0	4	**2:10**	15.2	1.7	22	**2:35**
Thurston T Nelson Elementary School	90	30	5	4	0.1	5	**2:10**	36	0.3	44	**2:55**
DeKalb County Schools											
Henagar Junior High School	90	30	5	3.8	0.1	5	**2:10**	7.1	1.7	12	**2:25**
						Average for EPZ:	**2:16**		**Average:**	36	**2:52**

Table 8-5B. School Evacuation Time Estimates - Rain

School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi)		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Jackson County Schools											
Brownwood Elementary School	100	35	10	6.5	0.2	10	**2:35**	36	0.3	49	**3:25**
Caldwell Elementary School	100	35	10	5.8	0.1	8	**2:35**	36	0.3	49	**3:25**
Collins Elementary School	100	35	10	4.9	0	7	**2:35**	36	0.3	49	**3:25**
Dutton Elementary School	100	35	10	5.9	0.9	10	**2:35**	15.2	1.7	25	**3:00**
Epruett Center of Technology	100	35	10	11.5	0.1	16	**2:45**	36	0.3	49	**3:30**
Hollywood Elementary School	100	35	10	11.5	0.4	17	**2:45**	36	0.3	49	**3:35**
Jackson County Alternative School	100	35	10	11.5	1.5	19	**2:45**	36	0.3	49	**3:35**
Pisgah High School	100	35	10	14.4	1.9	24	**2:50**	7.1	1.7	14	**3:05**
Rosalie Elementary School	100	35	10	2.3	0.1	4	**2:30**	30.3	0.1	41	**3:10**
Scottsboro High School	100	35	10	7.4	0	10	**2:35**	36	0.3	49	**3:25**
Scottsboro Junior High School	100	35	10	4.9	0.6	8	**2:35**	36	0.3	49	**3:25**
Section High School	100	35	10	2.7	0	4	**2:30**	15.2	1.7	25	**2:55**
Thurston T Nelson Elementary School	100	35	10	4	0.1	6	**2:35**	36	0.3	49	**3:20**
DeKalb County Schools											
Henagar Junior High School	100	35	10	3.8	0.1	6	**2:35**	7.1	1.7	14	**2:45**
						Average for EPZ:	**2:37**		**Average:**	40	**3:17**

Table 8-6. Summary of Transit Dependent Bus Routes for the Bellefonte Nuclear Plant

Route Number	Number of Buses	Route Description	Length (mi.)
1	7	US Route 72 from entrance into the EPZ near Scottsboro, north out of the EPZ near Stevenson	24.9
2	5	State Route 279 from entrance into the EPZ north into Scottsboro, then west on State Route 35 out of the EPZ	11.7
3	5	State Route 279 from the intersection with State Route 35 in Scottsboro north to Bellefonte Ave (CR 33); north to CR 31; west on CR 31 to CR 21; CR 21 south, becomes State Route 35, continue south to US Route 72; US Route 72 south out of EPZ	17.3
4	2	State Route 35 from entrance into EPZ north to State Route 40; east on State Route 40 through Henagar and out of the EPZ	25.9
5	2	State Route 71 from the intersection with State Route 35 north out of the EPZ	17.9

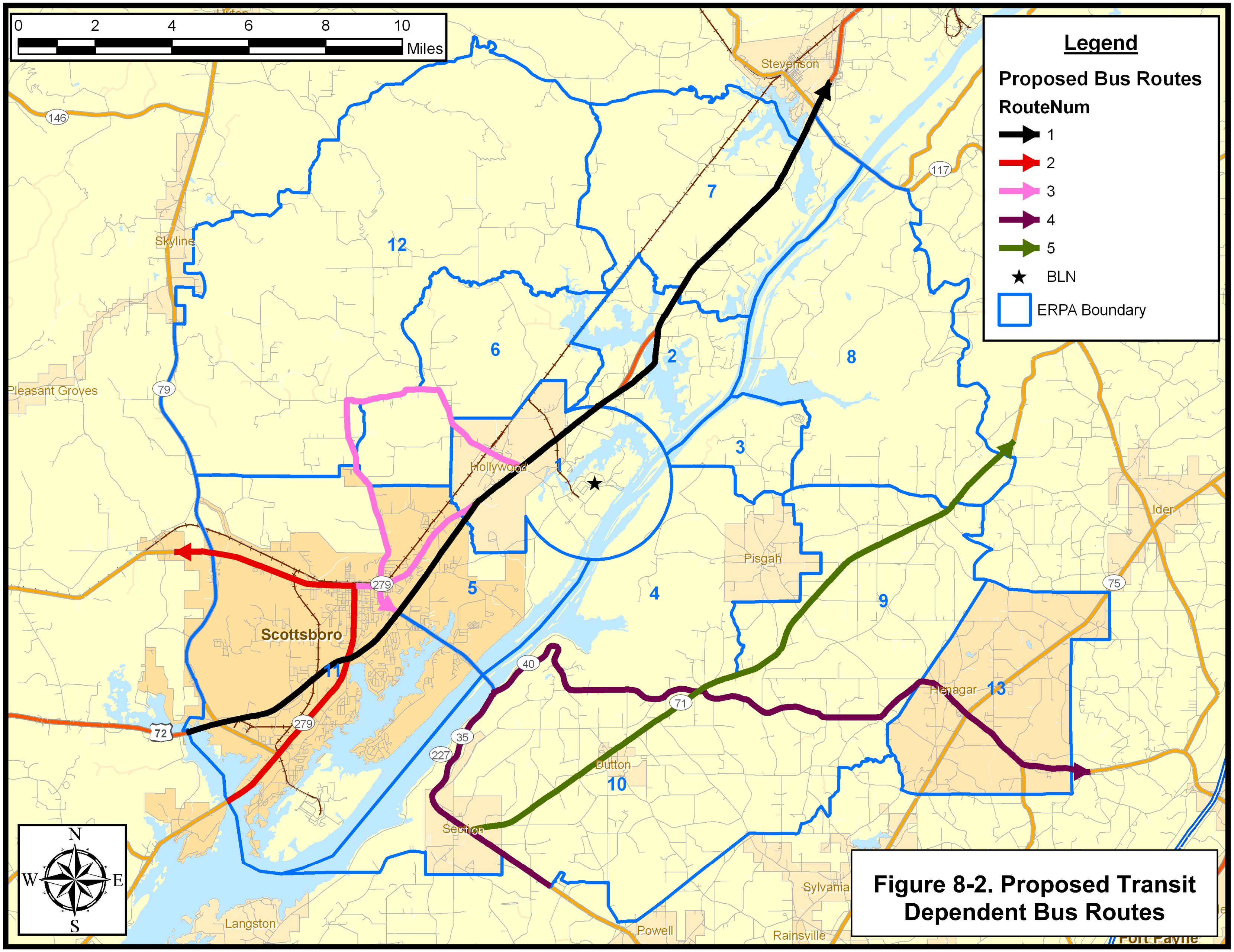


Figure 8-2. Proposed Transit Dependent Bus Routes

Table 8-7A. Transit-Dependent Evacuation Time Estimates - GOOD WEATHER

Route Number	Single Wave						Second Wave						
	Mobilization (min)	Travel time to EPZ (min)	Route Length (mi.)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Arrive at RC (min)	Unload (min)	Driver Rest (min)	Return to EPZ (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	150	30	24.9	50	15	**4:05**	172	5	15	36	50	15	**4:55**
2	150	30	11.7	23	15	**3:40**	172	5	15	36	23	15	**4:30**
3	150	30	17.3	35	15	**3:50**	172	5	15	36	35	15	**4:40**
4	150	30	25.9	52	15	**4:10**	172	5	15	36	52	15	**4:55**
5	150	30	17.9	36	15	**3:55**	172	5	15	36	36	15	**4:40**
					Average for EPZ:	**3:56**						**Average for EPZ:**	**4:44**

Table 8-7B. Transit-Dependent Evacuation Time Estimates - RAIN

Route Number	Single Wave						Second Wave						
	Mobilization (min)	Travel time to EPZ (min)	Route Length (mi.)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Arrive at RC (min)	Unload (min)	Driver Rest (min)	Return to EPZ (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	165	35	24.9	55	20	**4:35**	197	10	15	40	55	15	**5:35**
2	165	35	11.7	26	20	**4:10**	197	10	15	40	26	15	**5:05**
3	165	35	17.3	38	20	**4:20**	197	10	15	40	38	15	**5:15**
4	165	35	25.9	58	20	**4:40**	197	10	15	40	58	15	**5:35**
5	165	35	17.9	40	20	**4:20**	197	10	15	40	40	15	**5:20**
					Average for EPZ:	**4:25**						**Average for EPZ:**	**5:22**

Table 8-8A. Evacuation Time Estimates for Ambulatory Evacuees from Special Facilities Good Weather							
Facility	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.) Major Road	Local Road	Travel Time to EPZ Bdry (min)	ETE (hr:min)
Jackson County Special Facilities							
Cloverdale Healthcare Inc	120	30	30	6.1	1.1	10	**3:10**
Highlands Medical Center	120	30	30	6.1	0.8	9	**3:10**
Jackson County Nursing Home	120	30	30	6.1	0.8	9	**3:10**
Mountain Lakes Behavioral Healthcare	120	30	30	6.1	0.9	10	**3:10**
North Jackson Nursing Home	120	30	30	6.4	0	8	**3:10**
Rosewood Manor	120	30	30	5.1	0.2	7	**3:10**
SouthEastern Estates Assisted Living	120	30	30	3.7	0.6	6	**3:10**
The Home Place	120	30	30	5.1	2.6	12	**3:15**
						Average for EPZ:	**3:10**

Table 8-8B. Evacuation Time Estimates for Ambulatory Evacuees from Special Facilities Rain							
Facility	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.) Major Road	Local Road	Travel Time to EPZ Bdry (min)	ETE (hr:min)
Jackson County Special Facilities							
Cloverdale Healthcare Inc	135	35	35	6.1	1.1	11	**3:40**
Highlands Medical Center	135	35	35	6.1	0.8	10	**3:35**
Jackson County Nursing Home	135	35	35	6.1	0.8	10	**3:35**
Mountain Lakes Behavioral Healthcare	135	35	35	6.1	0.9	11	**3:40**
North Jackson Nursing Home	135	35	35	6.4	0	9	**3:35**
Rosewood Manor	135	35	35	5.1	0.2	8	**3:35**
SouthEastern Estates Assisted Living	135	35	35	3.7	0.6	7	**3:35**
The Home Place	135	35	35	5.1	2.6	13	**3:40**
						Average for EPZ:	**3:36**

9. TRAFFIC MANAGEMENT STRATEGY

This section presents the current traffic management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy include:

- Personnel with the capabilities of performing the planned control functions of traffic guides.
- Equipment to assist these personnel in the performance of their tasks:
  - Traffic Barriers
  - Traffic Cones
  - Signs
- A plan that defines all necessary details and is documented in a format that is readily understood.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that serve to expedite travel out of the EPZ along routes that the analysis has found to be most effective.
2. Discourage traffic movements that permit evacuating vehicles to travel in a direction which takes them significantly closer to the power plant, or which interferes with the efficient flow of other evacuees.

We employ the terms "facilitate" and "discourage" rather than "enforce" and "prohibit" to indicate the need for flexibility in performing the traffic control function. There are always legitimate reasons for a driver to prefer a direction other than that indicated. For example:

- A driver may be traveling home from work or from another location, to join other family members preliminary to evacuating.

- An evacuating driver may be taking a detour from the evacuation route in order to pick up a relative.
- The driver may be an emergency worker en route to perform an important activity.

The implementation of a plan must also be flexible enough for the application of sound judgment by the traffic guide.

The traffic management strategy is the outcome of the following process:

1. A field survey of these critical locations.

   The schematics of Appendix G are based on data collected during field surveys, upon large-scale maps, and on overhead imagery.

2. Consultation with emergency management and enforcement personnel.

   Trained personnel who are experienced in controlling traffic and who are familiar with the likely traffic patterns have reviewed these control tactics.

3. Prioritization of TCPs.

   Application of traffic control at some TCPs will have a more pronounced influence on expediting traffic movements. Thus, during the mobilization of personnel to respond to the emergency situation, those TCPs, which are assigned a higher priority, will be manned earlier. This setting of priorities has been undertaken with the concurrence of emergency management and law enforcement personnel. These priorities are compatible with the availability of local manpower resources.

In each schematic that appears in Appendix G, the control tactic at each TCP is presented.

10. EVACUATION ROUTES

Evacuation routes are composed of two distinct components:

- Routing from an ERPA being evacuated to the boundary of the Evacuation Region and thence out of the Emergency Planning Zone (EPZ).

- Routing of evacuees from the EPZ boundary to the reception centers.

Evacuees should be routed within the EPZ in such a way as to *minimize their exposure to risk*. This primary requirement is met by routing traffic to move away from the location of the Bellefonte Nuclear Plant, to the extent practicable, and by delineating evacuation routes that expedite the movement of evacuating vehicles. This latter objective is addressed by developing evacuation routes to achieve a balancing of traffic demand relative to the available highway capacity to the extent possible, subject to satisfying the primary requirement noted above. This is achieved by carefully specifying candidate destinations for all origin centroids where evacuation trips are generated, and applying the TRAD model effectively. See Appendices A-D for further discussion.

The routing of evacuees from the EPZ boundary to the reception centers should be responsive to several considerations:

- Minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary, to the reception centers.

- Relate the anticipated volume of traffic destined to the reception center, to the capacity of the reception center facility.

Figure 10-1 presents a map showing the general population reception centers. The major evacuation routes for the EPZ are presented in Figures 10-2 through 10-5.

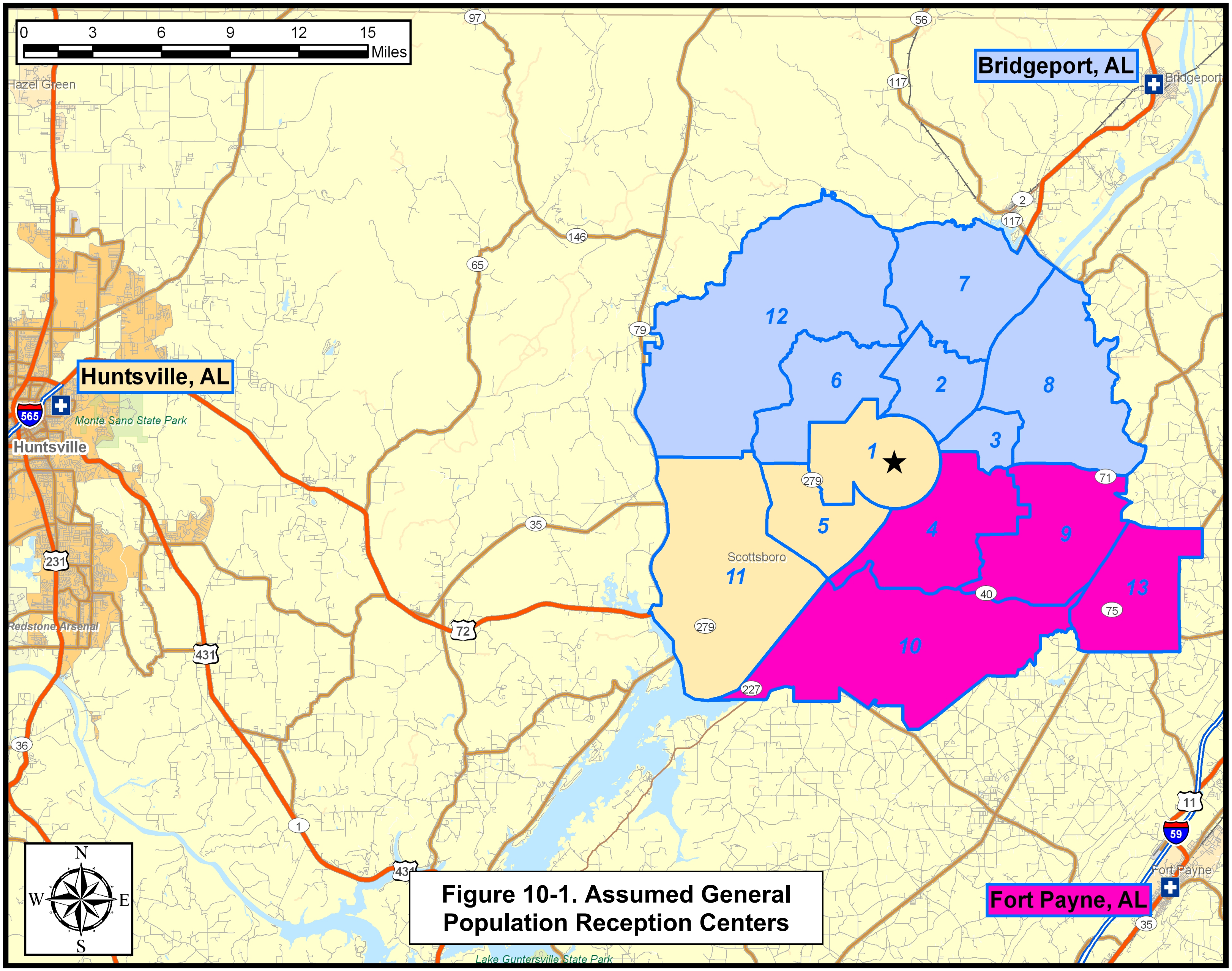
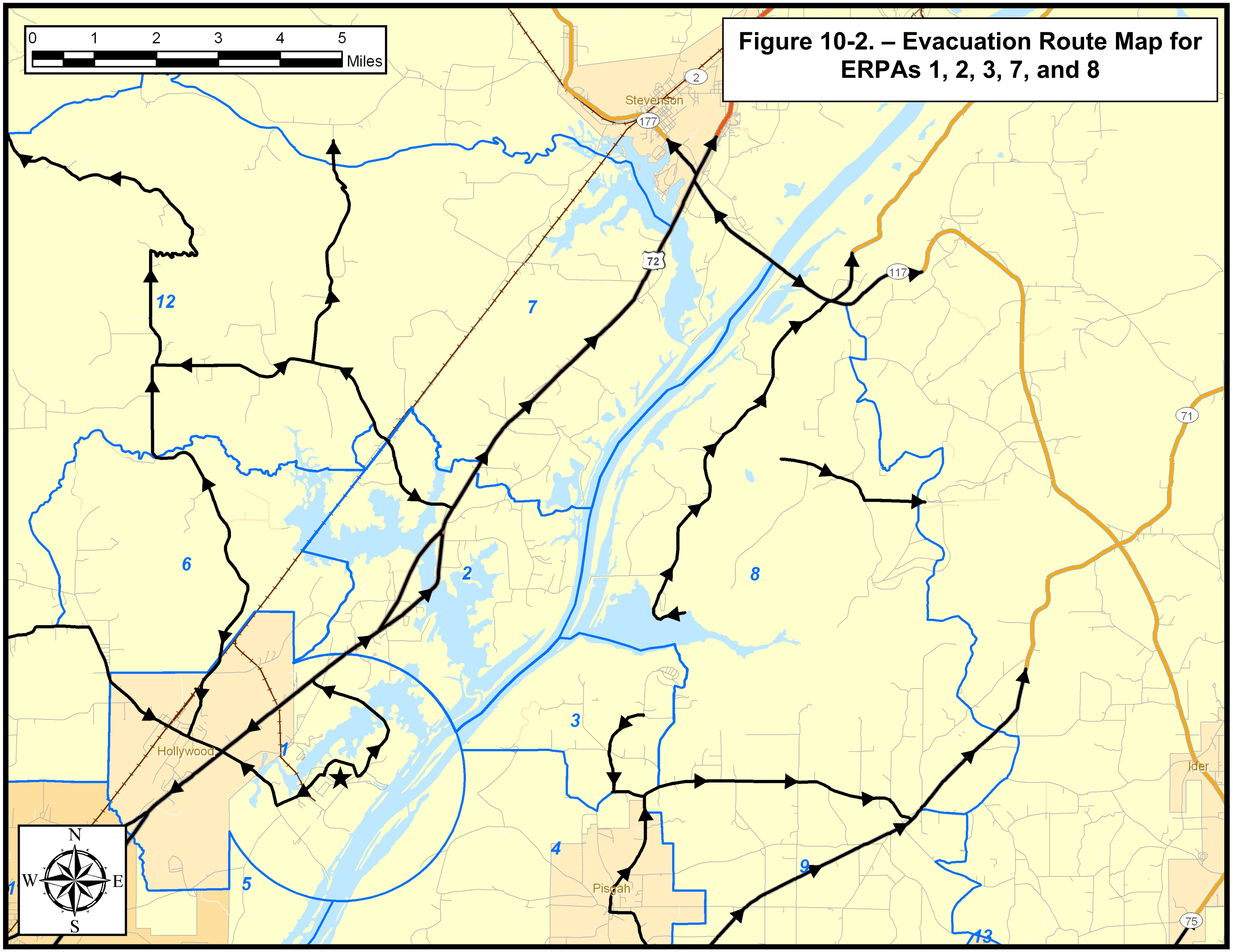


Figure 10-1. Assumed General Population Reception Centers

Figure 10-2. – Evacuation Route Map for ERPAs 1, 2, 3, 7, and 8



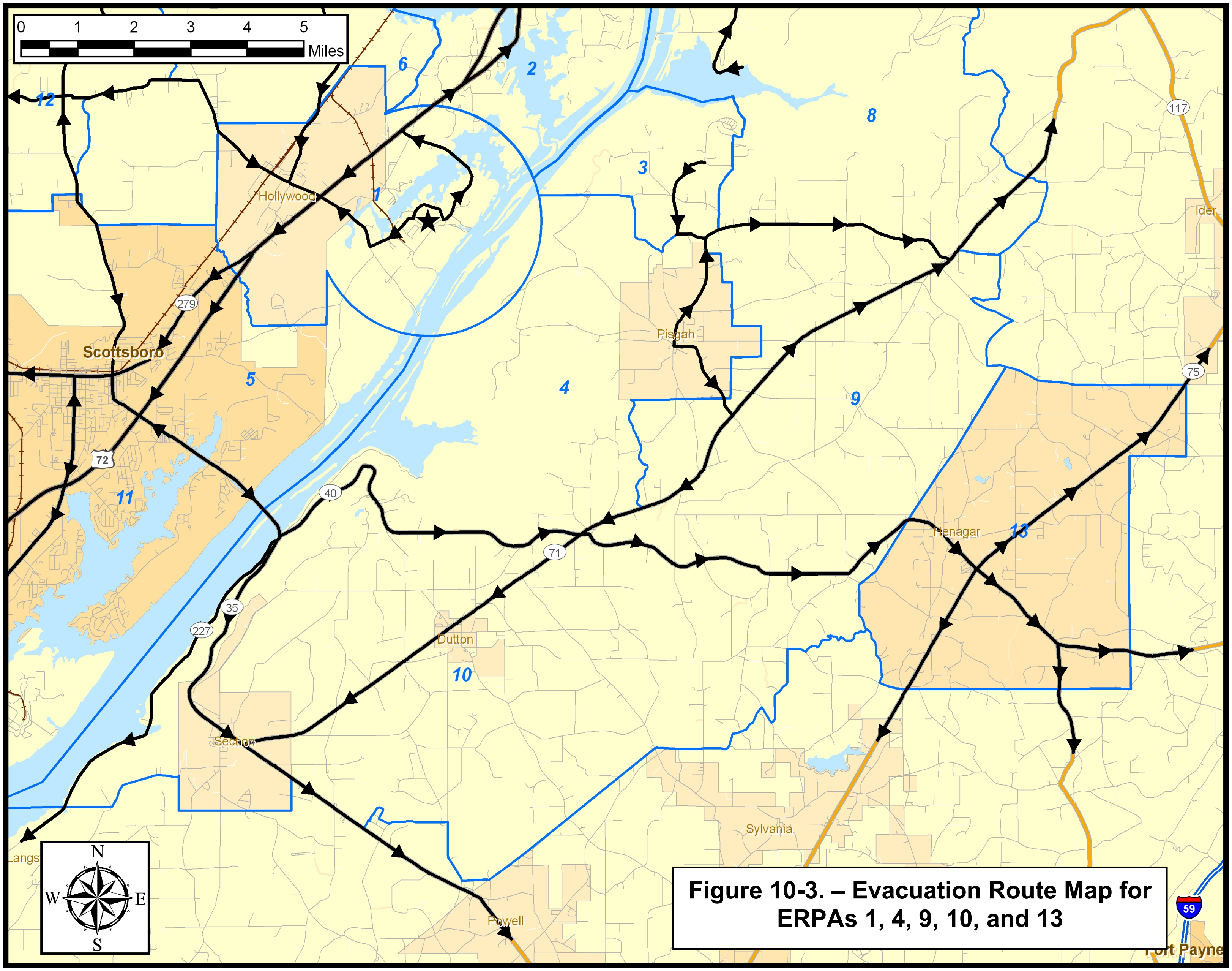


Figure 10-3. – Evacuation Route Map for ERPAs 1, 4, 9, 10, and 13

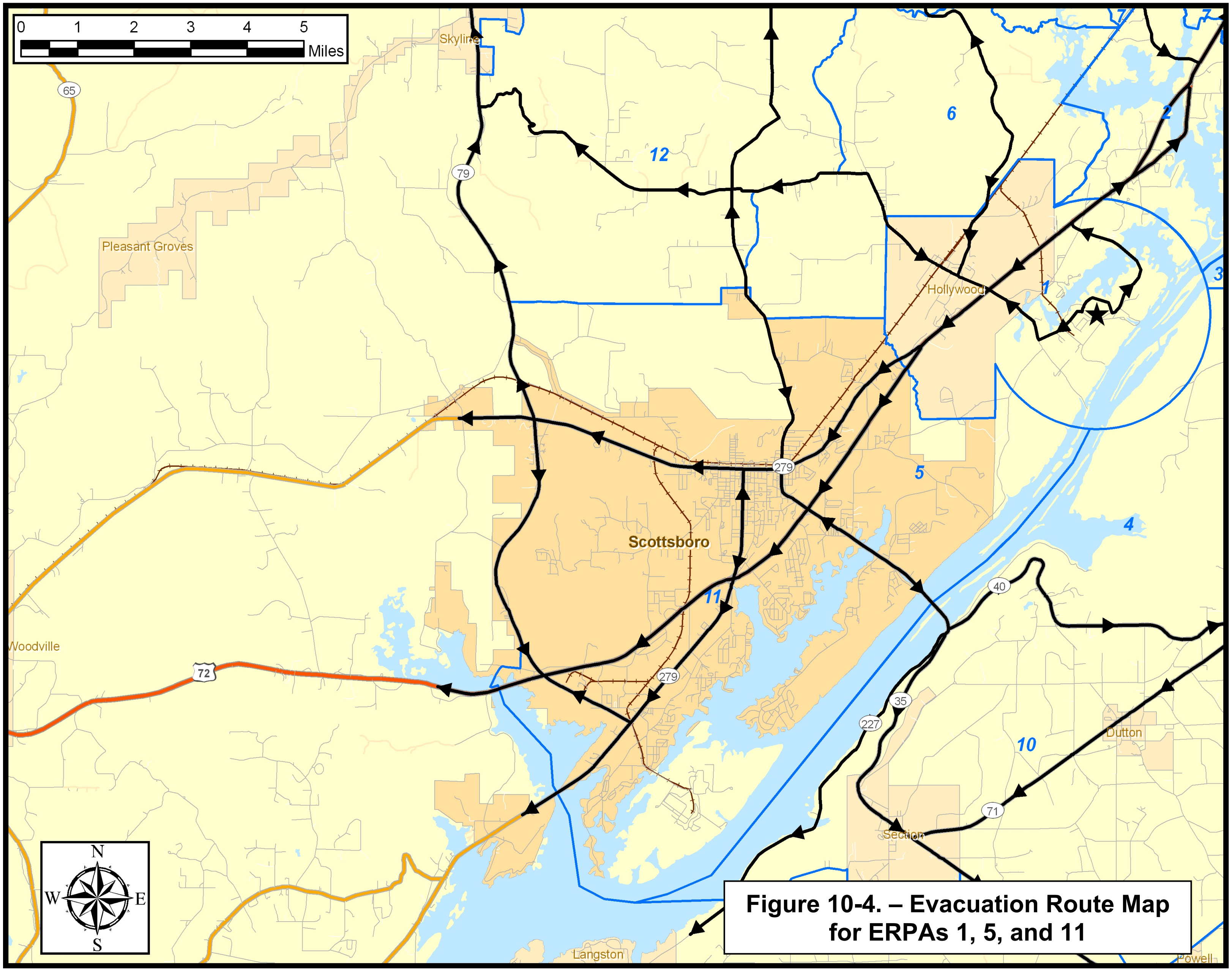


Figure 10-4. – Evacuation Route Map for ERPAs 1, 5, and 11

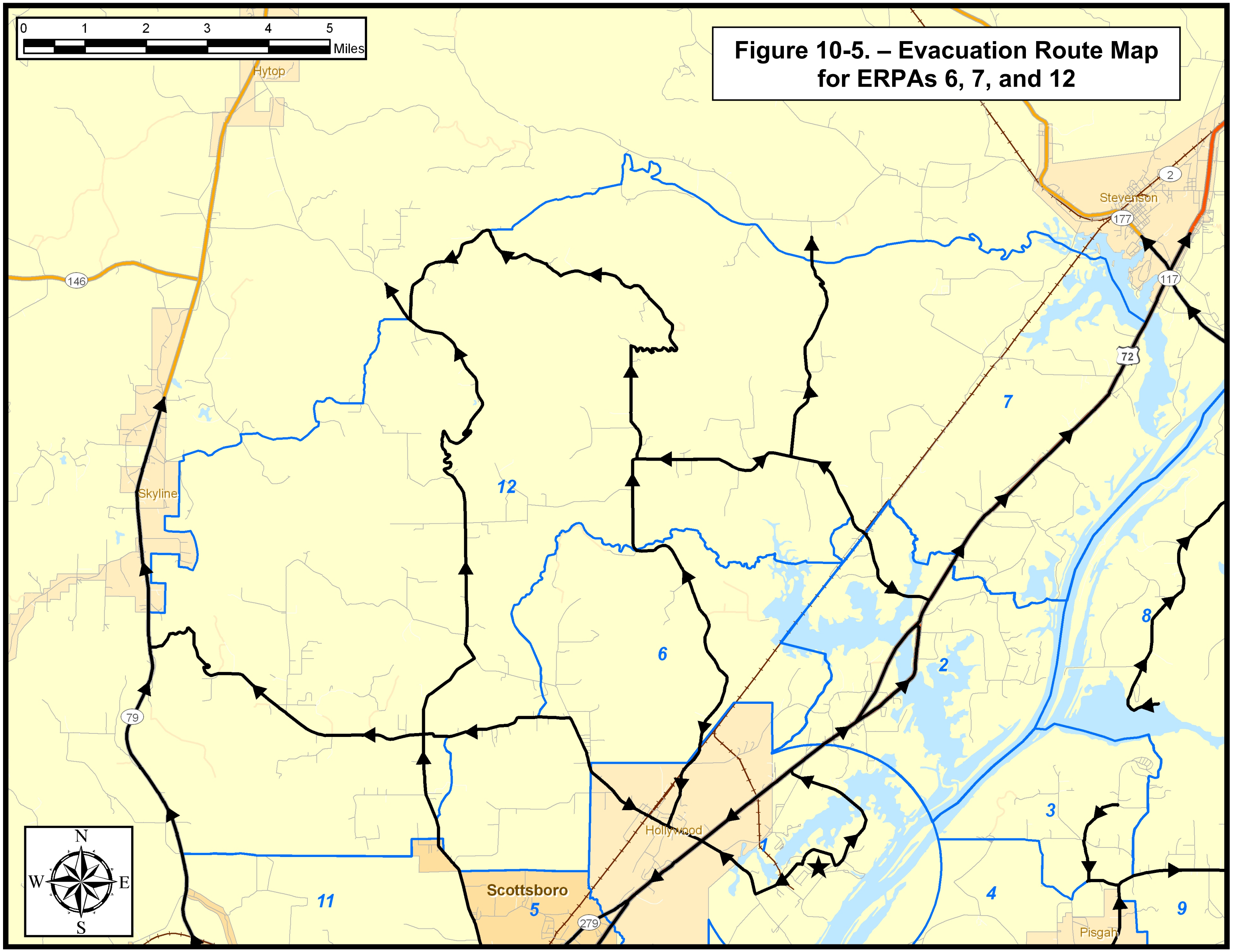


Figure 10-5. – Evacuation Route Map
for ERPAs 6, 7, and 12
0
1
2
3
4
5
Miles
Hytop
Skyline
Stevenson
Hollywood
Scottsboro
Pisgah
146
79
2
177
117
72
279
12
6
7
2
8
3
4
9
11
5
1
N
S
W
E

11. SURVEILLANCE OF EVACUATION OPERATIONS

There is a need for surveillance of traffic operations during the evacuation. There is also a need to clear any blockage of roadways arising from accidents or vehicle disablement. Surveillance can take several forms.

1. Traffic control personnel, located at Traffic Control and Access Control points, provide fixed-point surveillance.
2. Ground patrols may be undertaken along well-defined paths to ensure coverage of those highways that serve as major evacuation routes.
3. Aerial surveillance of evacuation operations may also be conducted using helicopter or fixed-wing aircraft.
4. Cellular phone calls from motorists may also provide direct field reports of road blockages.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. It is the responsibility of the Counties to support a communication system that can receive messages from the field and be in a position to respond to any reported problems in a timely manner. This coverage should quickly identify, and expedite the response to any blockage caused by a disabled vehicle.

Tow Vehicles

In a low-speed traffic environment, any vehicle disablement is likely to arise due to a low-speed collision, mechanical failure or exhausting its fuel supply. In any case, the disabled vehicle can be pushed onto the shoulder, thereby restoring traffic flow. Past experience in other emergencies indicates that evacuees who are leaving an area often perform activities such as pushing a disabled vehicle to the side of the road without prompting.

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Tow trucks may be deployed at strategic locations within, or just outside, the EPZ. These locations should be selected so that:

- They permit access to key, heavily loaded, evacuation routes.
- Responding tow trucks would most likely travel counter-flow relative to evacuating traffic.

12. CONFIRMATION TIME

It is necessary to confirm that the evacuation process is effective in the sense that the public is complying with the Advisory to Evacuate. Although Jackson County and DeKalb County may use their own procedures for confirmation, we suggest an alternative or complementary approach.

The procedure we suggest employs a stratified random sample and a telephone survey. The size of the sample is dependent on the expected number of households that do not comply with the Advisory to Evacuate. We believe it is reasonable to assume, for the purpose of estimating sample size that at least 80 percent of the population within the EPZ will comply with the Advisory to Evacuate. On this basis, an analysis could be undertaken (see Table 12-1) to yield an estimated sample size of approximately 300.

The confirmation process should start at about 4 hours after the Advisory to Evacuate, which is after the mobilization activities are completed. At this time, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Table 12-1, approximately 8-1/2 person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of ERPA), then the confirmation process will extend over a time frame of about 85 minutes. Thus, the confirmation should be completed well before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the Evacuation Region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

Should the number of telephone responses (i.e., people still at home) exceed 20 percent, then the telephone survey should be repeated after an hour's interval until the confirmation process is completed.

TABLE 12-1
ESTIMATED NUMBER OF TELEPHONE CALLS REQUIRED
FOR CONFIRMATION OF EVACUATION

Problem Definition

Estimate number of phone calls, n, needed to ascertain the proportion, F of households that have not evacuated.

Reference: Burstein, H., Attribute Sampling, McGraw Hill, 1971

Given:

No. of households plus other facilities, N, within the EPZ (est.) = 12,500
Est. proportion, F, of households that will not evacuate = 0.20
Allowable error margin, e: 0.05
Confidence level, α: 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

$$p = F + e = 0.25; \; q = 1 - p = 0.75$$

$$n = \frac{A^2 pq + e}{e^2} = 308$$

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 301$$

Thus, some 300 telephone calls will confirm that approximately 20 percent of the population has not evacuated. If only 10 percent of the population does not comply with the Advisory to Evacuate, then the required sample size, n_F = 212.

Est. Person Hours to complete 300 telephone calls

Assume: Time to dial using touch-tone (random selection of listed numbers): 30 seconds
Time for 8 rings (no answer): 48 seconds
Time for 4 rings plus short conversation: 60 sec.
Interval between calls: 20 sec.

Person Hours: 300[30+20+0.8(48)+0.2(60)]/3600 = 8.4