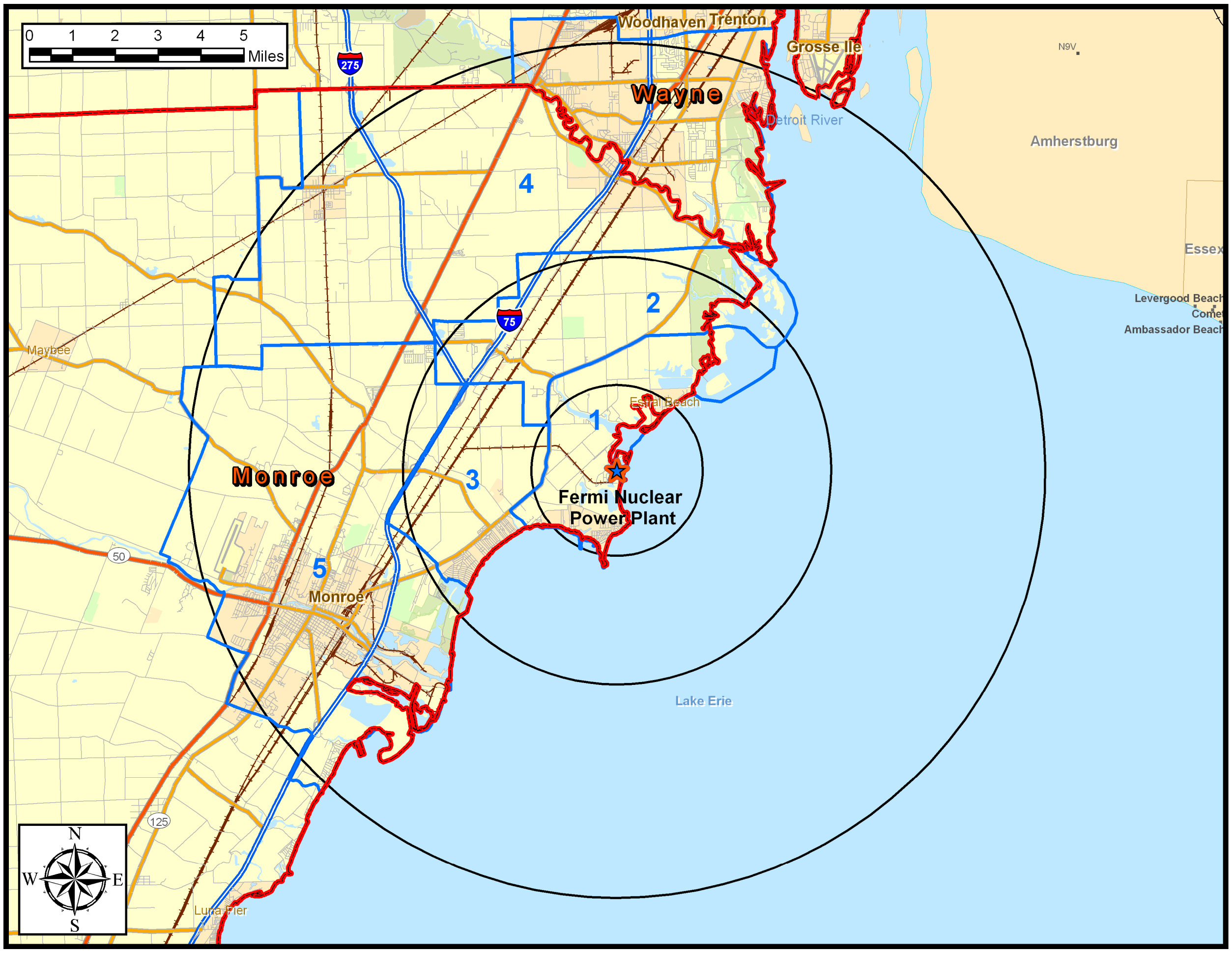
Fermi Nuclear Power Plant

Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Fermi Nuclear Power Plant (FNPP) located in Monroe County, Michigan. ETE are part of the required planning basis and provide FNPP and State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, all available prior documentation published by Federal Government agencies and relevant to ETE was reviewed. 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 January, 2008 and extended over a period of 5 months. The major activities performed are briefly described in chronological sequence:

- Attended “kick-off” meetings with Detroit Edison (DTE) personnel, Black and Veatch personnel and emergency management personnel representing state and local governments.
- Reviewed prior ETE reports prepared for the FNPP.
- Accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of FNPP, 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 Emergency Planning Zone (EPZ), plus a Shadow Region extending 15 miles radially from the plant.
- Designed and sponsored a telephone survey of residents within the EPZ to gather focused data needed for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by DTE and county personnel prior to the survey.
- A data collection survey was conducted to obtain data pertaining to employment, transients, and special facilities within the EPZ.
- The traffic demand and trip-generation rates of evacuating vehicles were estimated from the gathered data. The trip generation rates reflected the

estimated mobilization time (i.e., the time required by evacuees to prepare for the evacuation trip) computed using the results of the telephone survey of EPZ residents.

- Following Federal guidelines, the EPZ is subdivided into 5 Protective Action Areas (PAA). These PAA are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define a total of 7 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, Snow). Two special event scenarios were considered: the River Raisin Jazz Festival in St. Mary's Park in the City of Monroe, and the construction on Fermi 3 during refueling of Fermi 2 in the Year 2018.
- The Planning Basis for the calculation of ETE is:
    - A rapidly escalating accident at FNPP 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.
- If the emergency occurs while schools are in session, the ETE study assumes that the children will be evacuated by bus directly to specified host schools and 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 school children 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 98 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 7 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 14 Evacuation Scenarios (14 x 7 = 98). Separate ETE are calculated for transit-dependent evacuees, including school children 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. In addition, a portion of the population in the Shadow Region beyond the EPZ that extends a distance of 15 miles from FNPP, will also elect to evacuate. These voluntary evacuees could impede those 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 the plant), 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.

<u>Traffic Management</u>

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, which was reviewed with State and local law enforcement personnel, is also designed to control access into the EPZ after returning commuters have rejoined their families.

The plan is documented in the form of detailed schematics specifying: (1) the directions of evacuation travel to be facilitated, and other traffic movements to be discouraged; (2) the traffic control personnel and 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.

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 FNPP site showing the layout of the 5 PAA that comprise, in aggregate, the Emergency Planning Zone (EPZ). The 2008 estimates of permanent resident population within each PAA are also provided.
- Table 3-2 presents the estimates of permanent resident population in each PAA based on the 2000 Census data. Extrapolation to the year 2008 reflects population growth rates in each municipality obtained from the Census.
- Table 6-1 defines each of the 7 Evacuation Regions in terms of their respective groups of PAA.
- Table 6-2 lists the 14 Evacuation Scenarios.
- Tables 7-1C and 7-1D are compilations of 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 provides the ETE for medical facility residents in good weather.
- Table 8-11A provides the ETE for medical facility residents using folding wheelchairs in good weather.
- Table 8-12A provides the ETE for medical facility residents using rigid wheelchairs in good weather.
- Table 8-13A provides the ETE for ambulances evacuating bedridden medical facility residents in good weather.

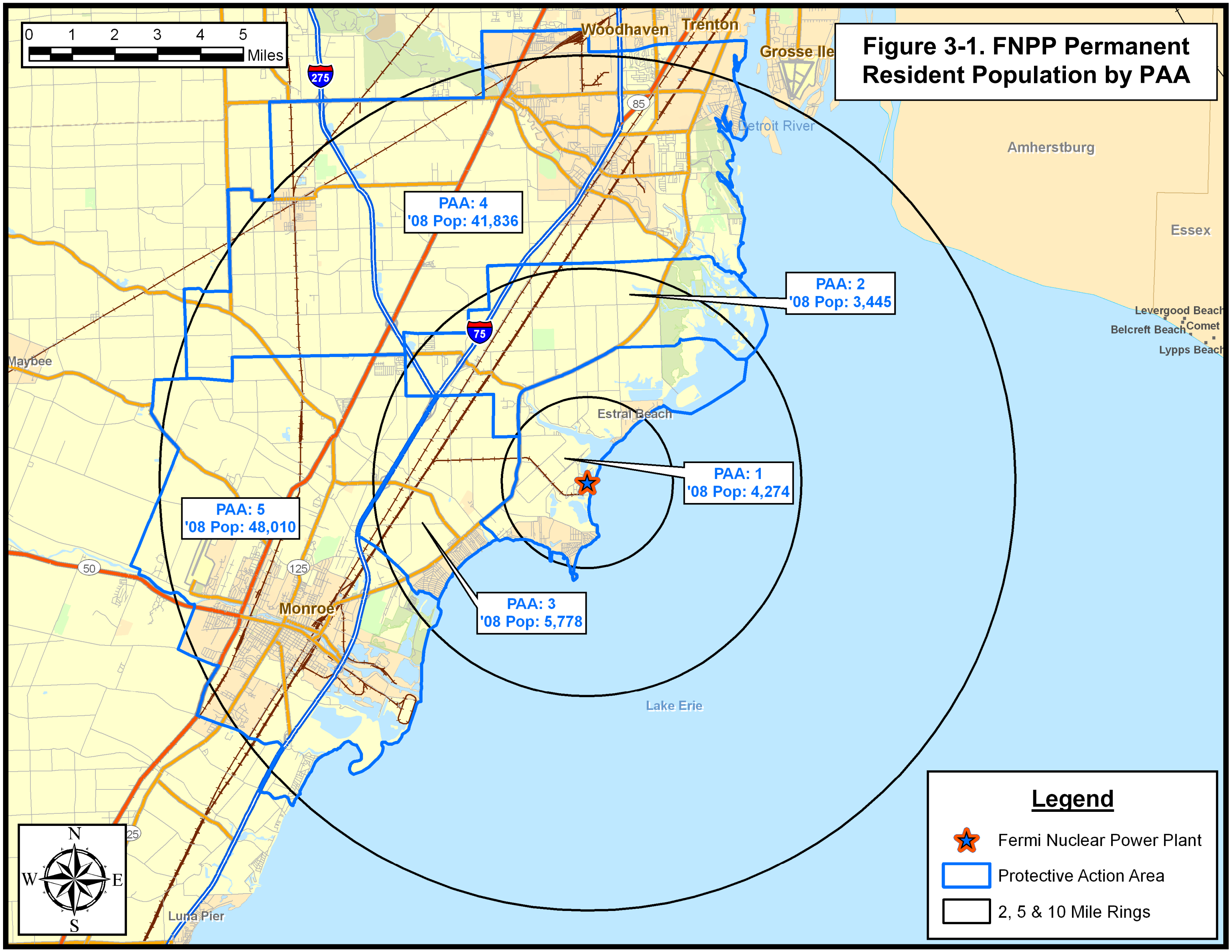

Figure 3-1. FNPP Permanent Resident Population by PAA
0 1 2 3 4 5 Miles
Woodhaven
Trenton
Grosse Ile
Detroit River
Amherstburg
Essex
Levergood Beach
Belcreft Beach
Comet
Lypps Beach
PAA: 4
'08 Pop: 41,836
PAA: 2
'08 Pop: 3,445
Maybee
Estral Beach
PAA: 1
'08 Pop: 4,274
PAA: 5
'08 Pop: 48,010
PAA: 3
'08 Pop: 5,778
Monroe
Lake Erie
Luna Pier
275
75
85
50
125
25
N
S
E
W
Legend
Fermi Nuclear Power Plant
Protective Action Area
2, 5 & 10 Mile Rings

Table 3-2. EPZ Permanent Resident Population		
PAA	**2000 Population**	**2008 Population**
1	3,723	4,274
2	2,576	3,445
3	5,628	5,778
4	33,723	41,836
5	47,049	48,010
TOTAL	**92,699**	**103,343**
Population Growth:		**11.5%**

Table 6-1. Description of Evacuation Regions						
		Protective Action Area				
Region	Description	1	2	3	4	5
R01	2-Mile Ring	X				
R02	5-Mile Ring	X	X	X		
R03	Full EPZ	X	X	X	X	X
Evacuate 2-Mile Ring and 5 Miles Downwind						
		Protective Action Area				
Region	Wind Direction From:	1	2	3	4	5
R04	SSE,S,SSW,SW,WSW	X	X			
	W,WNW,NW,NNW,N,NNE	Refer to Region R01				
R05	NE,ENE,E	X		X		
	ESE,SE	Refer to Region R02				
Evacuate 5-Mile Ring and Downwind to EPZ boundary						
		Protective Action Area				
Region	Wind Direction From:	1	2	3	4	5
R06	SSE,S,SSW,SW	X	X	X	X	
	WSW,W,WNW,NW,NNW,N	Refer to Region R02				
R07	NNE,NE,ENE	X	X	X		X
	E,ESE,SE	Refer to Region R03				

Table 6-2. Evacuation Scenario Definitions					
Scenarios	**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	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Weekend	Midday	Good	River Raisin Jazz Festival
14	Summer	Midweek	Midday	Good	New Plant Construction and Refueling

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	2:40	2:40	2:15	2:20	2:10	R1	2:40	2:40	3:20	2:10	2:20	2:55	2:10	R1	2:15	2:30
R2	2:20	2:20	1:50	2:00	2:10	R2	2:20	2:20	2:50	1:50	2:00	2:30	2:10	R2	1:50	2:30
R3	3:10	3:25	3:00	3:20	2:40	R3	3:10	3:20	3:55	2:50	3:00	3:40	2:40	R3	3:25	3:25
2-Mile Ring and Downwind to 5 Miles																
R4	2:00	2:00	1:40	1:45	2:00	R4	2:00	2:00	2:30	1:40	1:45	2:10	2:00	R4	1:40	2:20
R5	2:10	2:20	1:50	2:00	2:10	R5	2:10	2:20	2:50	1:50	2:00	2:30	2:10	R5	1:50	2:20
5-Mile Ring and Downind to EPZ Boundary																
R6	2:45	3:00	2:35	2:50	2:20	R6	2:45	3:00	3:25	2:25	2:40	3:10	2:20	R6	2:35	3:20
R7	3:10	3:30	3:05	3:30	2:50	R7	3:10	3:30	4:00	2:50	3:10	3:40	2:50	R7	3:30	3:15

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	4:00	4:00	4:00	4:00	4:00	R1	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R1	4:00	4:00
R2	4:00	4:00	4:00	4:00	4:00	R2	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R2	4:00	4:00
R3	4:05	4:10	4:05	4:10	4:05	R3	4:05	4:10	5:10	4:05	4:05	5:10	4:05	R3	4:30	4:10
2-Mile Ring and Downwind to 5 Miles																
R4	4:00	4:00	4:00	4:00	4:00	R4	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R4	4:00	4:00
R5	4:00	4:00	4:00	4:00	4:00	R5	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R5	4:00	4:00
5-Mile Ring and Downind to EPZ Boundary																
R6	4:05	4:10	4:05	4:10	4:00	R6	4:05	4:10	5:00	4:00	4:00	5:00	4:00	R6	4:05	4:10
R7	4:00	4:10	4:00	4:10	4:00	R7	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R7	4:30	4:00

Table 8-5A. School Evacuation Time Estimates - Good Weather									
School	**Driver Mobilization Time(min)**	**Loading Time (min)**	**Dist. to EPZ Boundary (mi.)**	**Average Speed (mph)**	**Travel Time to EPZ Bdry (min)**	**ETE (hr:min)**	**Dist. EPZ Bndry to H.S. (mi.)**	**Travel Time EPZ Bdry to H.S. (min)**	**ETE to H.S. (hr:min)**
Monroe County Schools									
North Elementary School	45	5	12.6	28.1	27	**1:20**	7.4	10	**1:30**
Neidermeier Elementary School	45	5	7.7	35.5	13	**1:05**	16.8	22	**1:25**
St. Charles School	45	5	11.1	19.6	34	**1:25**	5.9	8	**1:35**
Jefferson High School	45	5	7.9	18.3	26	**1:20**	7.4	10	**1:30**
Jefferson Middle School	45	5	7.6	18.3	25	**1:15**	7.4	10	**1:25**
Sodt Elementary School	45	5	9.2	17.3	32	**1:25**	7.4	10	**1:35**
Airport Senior High School	15	5	2.4	35.3	4	**0:25**	17.0	23	**0:50**
Carleton Country Day	15	5	1.3	38.1	2	**0:25**	17.0	23	**0:45**
Eyler Elementary School	45	5	2.3	46.2	3	**0:55**	17.2	23	**1:20**
Ritter Elementary School	45	5	6.9	37.9	11	**1:05**	17.3	23	**1:25**
St. Patrick School	45	5	1.5	44.4	2	**0:55**	16.5	22	**1:15**
Sterling Elementary School	45	5	2.6	38.6	4	**0:55**	16.8	22	**1:20**
Wager Junior High School	15	5	2.3	34.8	4	**0:25**	17.6	23	**0:50**
Cantrick Middle School	45	5	5.8	20.5	17	**1:10**	14.3	19	**1:30**
Christiancy Elementary School	45	5	4.2	19.4	13	**1:05**	6.3	8	**1:15**
Custer Elementary School #1	45	5	4.0	20.0	12	**1:05**	13.9	19	**1:25**
Custer Elementary School #2	45	5	4.0	20.0	12	**1:05**	13.9	19	**1:25**
Hollywood Elementary School	45	5	5.9	20.8	17	**1:10**	14.3	19	**1:30**
Holy Ghost Lutheran School	45	5	5.0	15.0	20	**1:10**	13.5	18	**1:30**
Hurd Elementary School	45	5	5.8	15.9	22	**1:15**	7.4	10	**1:25**
Lincoln Elementary School	45	5	4.8	19.2	15	**1:05**	15.0	20	**1:25**
Lutheran High School South	45	5	6.3	42.1	9	**1:00**	6.0	8	**1:10**
Manor Elementary School	45	5	3.7	11.6	19	**1:10**	15.1	20	**1:30**
Monroe Middle School	45	5	2.7	10.0	16	**1:10**	14.3	19	**1:25**
Monroe Senior High School	45	5	3.1	14.3	13	**1:05**	18.4	25	**1:30**
Orchard Center High School	45	5	4.7	18.8	15	**1:05**	7.3	10	**1:15**
Pathway Christian Academy/ Daycare	45	5	7.4	21.1	21	**1:15**	8.0	11	**1:25**
Raisinville Elementary School	45	5	2.9	14.5	12	**1:05**	18.4	25	**1:30**
Riverside Elementary School	45	5	6.1	19.3	19	**1:10**	14.9	20	**1:30**
S. Monroe Townsite Elementary School	45	5	3.8	13.4	17	**1:10**	15.1	20	**1:30**
St. John's School	45	5	2.8	10.4	16	**1:10**	6.4	9	**1:15**
St. Mary's Catholic Center High School	45	5	5.5	19.4	17	**1:10**	6.3	8	**1:15**
St. Mary's Parish School	45	5	5.5	19.4	17	**1:10**	6.3	8	**1:15**
St. Michael's School	45	5	5.6	19.8	17	**1:10**	6.8	9	**1:20**
Trinity Lutheran School	45	5	2.7	10.8	15	**1:05**	6.3	8	**1:15**
Waterloo Elementary School	45	5	3.0	12.0	15	**1:05**	18.7	25	**1:30**
Zion Lutheran School	45	5	6.9	20.7	20	**1:10**	6.3	8	**1:20**
Wayne County Schools									
Chapman Elementary School	60	5	3.5	17.5	12	**1:20**	10.7	14	**1:35**
David Oren Hunter Elementary School	60	5	1.7	34.0	3	**1:10**	10.7	14	**1:25**
Downriver High School	60	5	5.4	19.1	17	**1:25**	13.6	18	**1:40**
Ethel C. Bobcean Elementary School	60	5	3.5	16.2	13	**1:20**	8.7	12	**1:30**
Flat Rock / Gibraltar Head Start	60	5	3.7	15.9	14	**1:20**	8.7	12	**1:35**
Flat Rock Community High School	60	5	3.6	15.4	14	**1:20**	11.3	15	**1:35**
Hellen C. Shumate Junior High School	60	5	3.5	12.4	17	**1:25**	13.5	18	**1:40**
John M. Barnes Elementary	60	5	4.9	16.3	18	**1:25**	8.7	12	**1:35**
Oscar A. Carlson High School	60	5	3.5	12.4	17	**1:25**	13.5	18	**1:40**
Parsons Elementary School	60	5	3.2	14.6	13	**1:20**	13.5	18	**1:40**
Simpson Middle School	60	5	4.9	16.3	18	**1:25**	8.7	12	**1:35**
St. Mary's Rockwood Elementary School	60	5	3.2	17.5	11	**1:20**	10.7	14	**1:30**
Summit Academy/Summit Early Childhood Center	60	5	2.4	14.4	10	**1:15**	10.7	14	**1:30**
					Maximum for EPZ:	**1:25**		**Maximum:**	**1:40**
					Average for EPZ:	**1:10**		**Average:**	**1:25**

Table 8-7A. Transit-Dependent Evacuation Time Estimates - Good Weather

Route Number	Bus Number	Single Wave[4]						Second Wave[5]								
		Mobilization (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Head-way (min.)	Return to EPZ (min.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)
1	1	90	12.5	7.3	103	30	**03:45**	85	5	10	0	16	7.6	99	30	**04:05**
	8	114	12.5	9.0	83	30	**03:50**	85	5	10	24	16	11.0	68	30	**04:00**
2	1	90	8.9	10.3	52	30	**02:55**	85	5	10	0	16	7.7	69	30	**03:35**
	8	114	8.9	9.2	58	30	**03:25**	85	5	10	24	16	8.6	62	30	**03:55**
3	1	90	9.1	20.2	27	30	**02:30**	85	5	10	0	16	10.1	54	30	**03:20**
	8	114	9.1	9.5	57	30	**03:25**	85	5	10	24	16	8.5	64	30	**03:55**
4	1	90	9.4	10.8	52	30	**02:55**	85	5	10	0	16	8.4	67	30	**03:35**
	8	114	9.4	9.2	61	30	**03:25**	85	5	10	24	16	7.9	71	30	**04:05**
5	1	90	7.3	33.7	13	30	**02:15**	85	5	10	0	16	33.7	13	30	**02:40**
	3	99	7.3	33.7	13	30	**02:25**	85	5	10	9	16	33.7	13	30	**02:50**
6	1	90	10.2	24.5	25	30	**02:25**	85	5	10	0	16	24.5	25	30	**02:55**
	4	102	10.2	25.5	24	30	**02:40**	85	5	10	12	16	27.8	22	30	**03:00**
7	1	90	5.9	17.7	20	30	**02:20**	85	5	10	0	16	12.6	28	30	**02:55**
	3	99	5.9	13.6	26	30	**02:35**	85	5	10	9	16	14.2	25	30	**03:00**
						Maximum for EPZ:	**03:50**								**Maximum for EPZ:**	**04:05**
						Average for EPZ:	**02:55**								**Average for EPZ:**	**03:25**

4 Single wave ETE are applicable when school is not in session or when school is in session and there are sufficient bus resources available to service school children and the transit dependent general population simultaneously.

5 Second Wave ETE are applicable when there are not sufficient buses available to transport the transit dependent until the evacuation of the school children has been completed.

Table 8-8A. Special Facilities Evacuation Time Estimates - Good Weather

Special Facility	Single Wave						Second Wave							
	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County														
ALCC	60	6	7.2	42.8	10	**1:20**	85	5	10	16	6	42.8	10	**2:15**
Alterra	60	15	4.0	11.2	21	**1:40**	85	5	10	16	15	5.2	46	**3:00**
IHM Motherhouse	60	30	3.4	8.2	25	**1:55**	85	5	10	16	30	4.3	48	**3:15**
Lutheran Home	60	30	5.0	5.3	57	**2:30**	85	5	10	16	30	3.9	77	**3:45**
Maplewood Manor	60	30	7.0	41.6	10	**1:40**	85	5	10	16	30	41.6	10	**2:40**
Medlodge II	60	30	3.4	6.5	32	**2:05**	85	5	10	16	30	4.7	44	**3:10**
Mercy Memorial Hospital	60	30	5.4	6.7	48	**2:20**	85	5	10	16	30	4.6	71	**3:40**
Mercy Memorial Nursing Center	60	30	5.4	42.1	8	**1:40**	85	5	10	16	30	42.1	8	**2:35**
Tendercare of Monroe	60	30	4.1	7.5	32	**2:05**	85	5	10	16	30	4.7	52	**3:20**
Wayne County														
Marybrook Residence	60	10	4.6	17.5	16	**1:30**	85	5	10	16	10	8.1	34	**2:40**
					Maximum for EPZ:	**2:30**							**Maximum for EPZ:**	**3:45**
					Average for EPZ:	**1:50**							**Average for EPZ:**	**3:00**

Table 8-11A. Special Facilities Folding Wheelchair Evacuation Time Estimates - Good Weather

Special Facility	Single Wave							Second Wave							
	Mobilization (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County															
ALCC	60	3	15	7.2	42.8	10	**01:25**	85	5	10	16	15	42.8	10	**02:25**
IHM Motherhouse	60	6	30	3.4	8.2	25	**01:55**	85	5	10	16	30	4.3	48	**03:15**
Lutheran Home	60	4	20	5.0	6.9	44	**02:05**	85	5	10	16	20	4.1	73	**03:30**
Maplewood Manor	60	4	20	7.0	41.6	10	**01:30**	85	5	10	16	20	41.6	10	**02:30**
Medilodge II	60	3	15	3.4	10.2	20	**01:35**	85	5	10	16	15	4.6	45	**03:00**
Mercy Memorial Hospital	60	34	75	5.4	4.5	72	**03:30**	85	5	10	16	75	12.7	26	**03:40**
Tendercare of Monroe	60	6	30	4.1	7.5	32	**02:05**	85	5	10	16	30	4.7	52	**03:20**
						Maximum for EPZ:	**03:30**							**Maximum for EPZ:**	**03:40**
						Average for EPZ:	**02:00**							**Average for EPZ:**	**03:05**

Table 8-12A. Special Facilities Rigid Wheelchair Evacuation Time Estimates - Good Weather

Special Facility	Mobilization Time (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County							
ALCC	60	3	15	7.2	42.8	10	**1:25**
IHM Motherhouse	60	7	15	3.4	9.6	21	**1:40**
Lutheran Home	60	4	15	5.0	6.9	44	**2:00**
Maplewood Manor	60	4	15	7.0	41.6	10	**1:25**
Medilodge II	60	3	15	3.4	10.2	20	**1:35**
Mercy Memorial Hospital	60	35	15	5.4	8.1	40	**1:55**
Tendercare of Monroe	60	6	15	4.1	11.6	21	**1:40**
Wayne County							
Marybrook Residence	60	1	5	4.6	17.5	16	**1:25**
						Maximum for EPZ:	**2:00**
						Average for EPZ:	**1:40**

Table 8-13A. Evacuation Time Estimates for Ambulances - Good Weather

Facility	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County						
IHM Motherhouse	30	30	3.4	27.8	7	**01:10**
Lutheran Home	30	30	5.0	27.4	11	**01:15**
Maplewood Manor	30	30	7.0	41.6	10	**01:10**
Medilodge II	30	30	3.4	37.6	5	**01:05**
Mercy Memorial Hospital	30	30	5.4	25.8	13	**01:15**
Mercy Memorial Nursing Center	30	30	5.4	42.1	8	**01:10**
Tendercare of Monroe	30	30	4.1	38.6	6	**01:10**
					Maximum for EPZ:	**01:15**
					Average for EPZ:	**01:10**

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained in preparing the Evacuation Time Estimates (ETE) for the proposed Fermi Nuclear Power Plant (FNPP), located in Monroe County, Michigan. ETE are part of the required planning basis and provide State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, all available documentation published by Federal Government agencies and relevant to ETE was reviewed. 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.

We wish to express our appreciation to all the directors and staff members of the Monroe County and Wayne County emergency management agencies and local and state law enforcement and planning agencies, who provided valued guidance and contributed information contained in this report.

1.1 Overview of the ETE Determination 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 Detroit Edison.
    - Attended meetings with emergency planners from the two EPZ Counties and from the State to identify issues to be addressed.
    - Conducted a detailed field survey of the EPZ highway system and of area traffic conditions.
    - Obtained demographic data from the Census and from state and county 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 have reviewed all traffic control plans.

5. Defined Evacuation Areas or Regions. The EPZ is partitioned into Protective Action Areas (PAA) which serve as a basis for the ETE analysis presented herein. Evacuation "Regions" are comprised of contiguous PAA for which ETE are calculated. The configuration of these Regions reflects the fact that the wind can take any direction and that the radial extent of the impacted area depends on accident-related circumstances. Each Region, other than those that approximate circular areas, approximates a "key-hole" configuration within the EPZ as required by NUREG/CR-6863.

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, from data provided by local and state agencies and from the telephone survey.
   - Applied the procedures specified in the 2000 Highway Capacity Manual (HCM[1]) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.
   - Developed the 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 (HCM), 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 FNPP.
- 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 Evacuation Regions and Scenarios.
9. Documented ETE in formats responsive to the cited NUREG reports.
10. Calculated the ETE for all transit activities including those for special facilities (schools, health-related facilities, etc.) and for the transit-dependent population.

Steps 4, 7 and 8 are iterated as described in Appendix D.

1.2 The Fermi Nuclear Power Plant Location

The Fermi Nuclear Power Plant is located on the west bank of Lake Erie, approximately 24 miles northeast of Toledo, Ohio and 30 miles southwest of Detroit, Michigan. The Emergency Planning Zone (EPZ) consists of parts of two counties: Monroe County and Wayne County. Figure 1-1 displays the area surrounding FNPP.

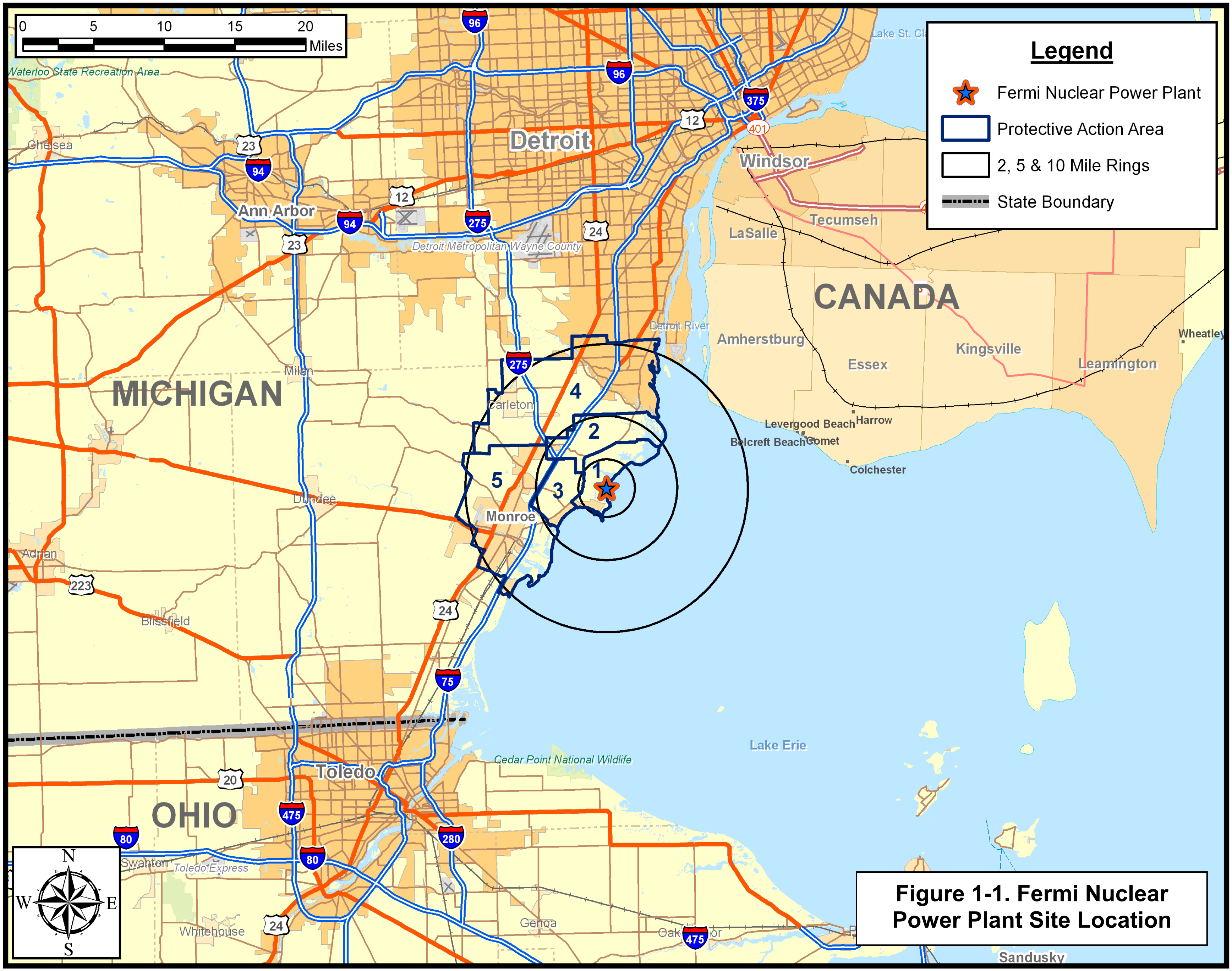


Figure 1-1. Fermi Nuclear Power Plant Site Location

1.3 Preliminary Activities

KLD performed preliminary review activities as described below.

Literature Review

KLD Associates was provided with copies of documents describing past studies and analyses leading to the development of emergency plans and of the ETE. We also obtained supporting documents from a variety of sources, which contained information needed to form the database used for conducting evacuation analyses.

Field Surveys of the Highway Network

KLD personnel drove the entire highway system within the EPZ and for some distance outside. A personal computer equipped with Geographical information System (GIS) software was used during the field survey to acquire and record data. The characteristics of each section of highway were recorded. These characteristics include:

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

Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 20-5 in the HCM indicates that a reduction in lane width from 12 feet (the “base” value) to 10 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two lane highways. Exhibit 12-15 in the HCM shows no sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS. The highway terrain (level, rolling, and mountainous) is a far more important factor than lane and shoulder width when estimating capacity.

The data from the audio and video recordings were used to create detailed GIS shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the field survey; this information was referenced while preparing the input stream for the IDYNEV System.

As documented on page 20-3 of the HCM, the capacity of a two-lane highway is 1700 passenger cars per hour for each direction of travel. For freeway sections, a value of 2250 vehicles per hour per lane is assigned. The field survey has identified several segments which are characterized by adverse geometrics which are reflected in reduced values for both capacity and speed. These estimates reflect the service volumes for LOS E presented in HCM Exhibit 12-15. These links may be identified by reviewing Appendix K. Link capacity is an input to IDYNEV which calculates the ETE. The locations of these sections may be identified by reference to Figure 1-2 and the detailed maps in Appendix K, which are discussed under the "Development of Evacuation Time Estimates" heading below. Further discussion of roadway capacity is provided in Section 4 of this report.

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 HCM. The link-node representation of the physical highway network was developed using GIS mapping software. Figure 1-2 presents the link-node analysis network that was constructed to model the evacuation roadway network in the EPZ and Shadow Region. The detailed figures provided in Appendix K depict the analysis network with directional arrows shown and node numbers provided. The observations made during the field survey were used to calibrate the analysis network.

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).

IDYNEV 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 ETE is outlined in Appendix D. Appendix A is a glossary of terms.

For the reader interested in more details of the model than are provided in Appendices B, C and D, and in Highway Research Record No. 772 (discussed in Section 4 of this report), the following references are suggested:

- NUREG/CR-4873 – Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code
- NUREG/CR-4874 – The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code

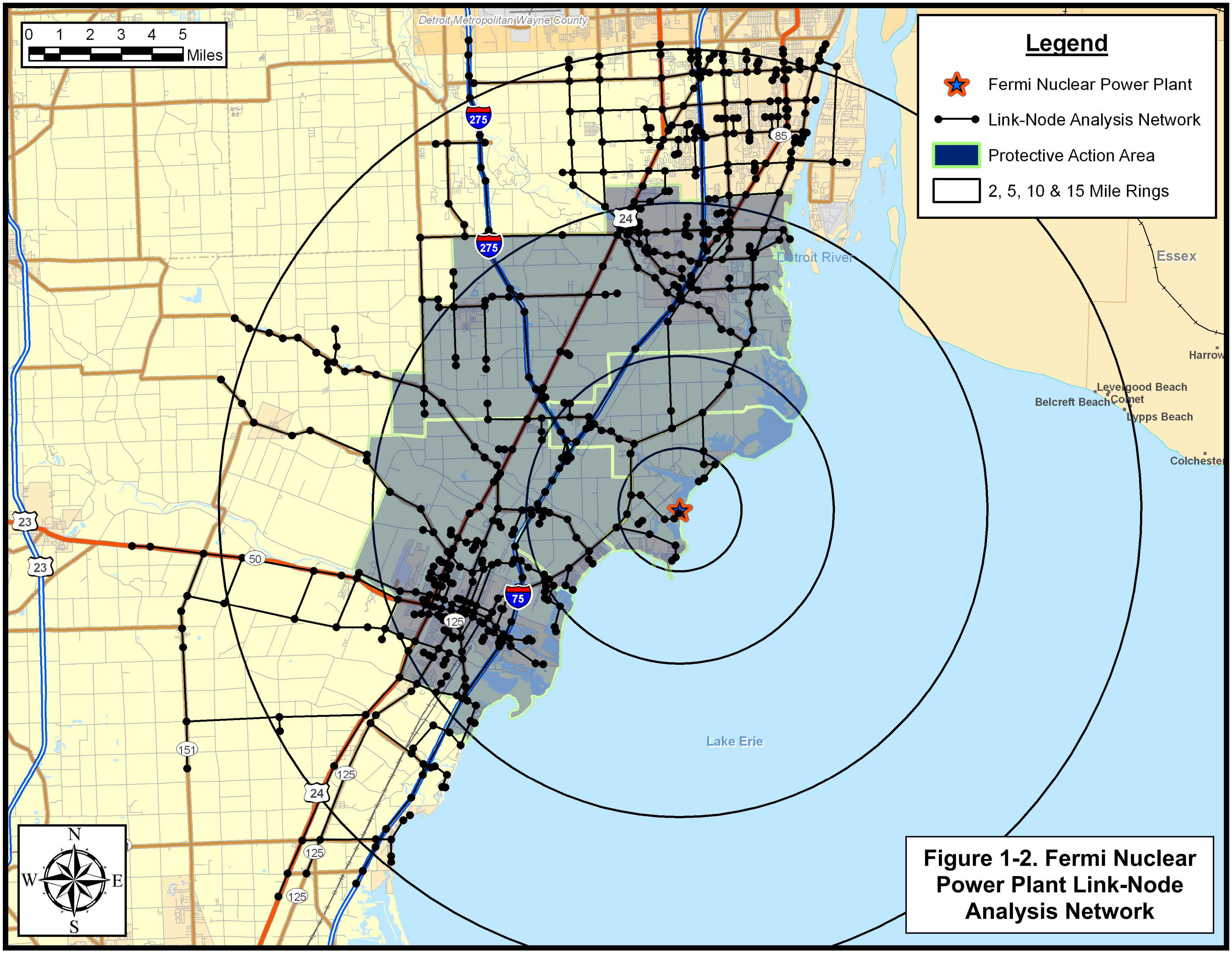


Figure 1-2. Fermi Nuclear Power Plant Link-Node Analysis Network

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 FNPP 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 FNPP.

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. The outputs of this model are the volume of traffic, expressed as vehicles/hour, that exit the Evacuation Region along the various highways (links) that cross the Region boundaries. These outputs are exported into a spreadsheet which documents the ETE. Section 7 presents a further description of this process along with the ETE Tables.

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.

1.4 Comparison with Prior ETE Study

Table 1-1 presents a comparison of the present ETE study with the 2003 ETE study. The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study can be summarized as follows:

- An increase in permanent resident population.
- Vehicle occupancy and Trip-generation rates are based on the results of a telephone survey of EPZ residents.
- Voluntary and shadow evacuations are considered.
- The highway representation is far more detailed. Link-node analysis network extends out to 15 miles from the plant. Capacities of exit links are significantly higher than in the previous study, resulting in shorter ETE.
- Highway free speed used on all roadways rather than maximum posted speed limit used in previous study, also contributing to shorter ETE.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Resident Population Basis	ArcGIS Software using 2000 US Census blocks; area ratio method used. Population = 92,645	ArcGIS Software using 2000 US Census blocks; block centroid method used; population extrapolated to 2008. Population = 103,343
Resident Population Vehicle Occupancy	2.75 persons per household based on Census data. 1 vehicle per household.	2.72 persons/household, 1.24 evacuating vehicles/household yielding: 2.19 persons/vehicle
Employee Population	Employees treated as separate population group. Employee estimates based on information provided by the counties, by Internet searches, and by direct phone calls to major employers. 1 employee/vehicle.	Employees treated as separate population group. Employee estimates based on information provided by the counties, by Internet searches, and by direct phone calls to major employers. 1.02 employees/vehicle based on phone survey results.
Voluntary evacuation from within EPZ in areas outside region to be evacuated	Not considered	50 percent of population within the circular portion of the region; 35 percent, in annular ring between the circle and the EPZ boundary. (See Figure 2-1)
Shadow Evacuation	Not considered.	30% of people outside of the EPZ within the shadow area. (See Figure 7-2)
Network Size	245 Nodes; Number of links not provided.	828 Links; 615 Nodes.

Table 1-1. ETE Study Comparisons (cont.)		
Roadway Geometric Data	Field surveys conducted. Date not provided.	Field surveys conducted in 2008. Major intersections were video archived. GIS shape-files of signal locations and roadway characteristics created during field survey. Road capacities based on HCM.
School Evacuation	Direct evacuation to designated Reception Center/Host School.	Direct evacuation to designated Reception Center/Host School.
Transit Dependent Population	Transit dependent population is mentioned; however, no estimate of this population is provided.	Defined as households with 0 vehicles.
Ridesharing	Assumed 100 percent of transit dependent population will ride out with neighbors or “designated public service vehicles”.	50 percent of transit dependent persons will ride out with a neighbor or friend.
Trip Generation for Evacuation	2 hours and 45 minutes for daytime – normal weather. 3 hours and 5 minutes for daytime – adverse weather. 1 hour and 15 minutes for nighttime scenarios. Trip generation rates based on assumptions for notification time, time to prepare to leave work, time to travel home from work, and time to prepare the home for departure.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 minutes and 4 hours. Households with no commuters leave between 15 minutes and 3 hours. Employees and transients leave between 15 minutes and 2 hours. All times measured from the Advisory to Evacuate.

Table 1-1. ETE Study Comparisons (cont.)		
Traffic and Access Control	11 critical intersections identified. No tactics provided.	Traffic and Access Control used in all scenarios to facilitate the flow of traffic outbound relative to the plant. Detailed schematics provided for each point.
Weather	Adverse. Capacity and speed reduced by 20% and 30% for summer and winter, respectively.	Normal, Rain, or Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain and 20% for snow.
Modeling	Evacuation Simulation Model (ESIM) – part of Oak Ridge Evacuation Modeling System (OREMS)	IDYNEV System: TRAD and PC-DYNEV.
Special Events	Midwest Waterfowl Decoy and Art Show at Pointe Mouille State Game Area.	Two considered. River Raisin Jazz Festival and Construction of a new unit at the Fermi Nuclear Power Plant site during refueling of the operational unit.
Evacuation Cases	11 Regions (ETE for individual PAA provided) and 8 Scenarios producing 88 unique cases	7 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 98 unique cases
Evacuation Time Estimates Reporting	ETE reported for 50^{th}, 75^{th}, 95^{th} and 100^{th} percentile population. Results presented by Region and Scenario	ETE reported for 50^{th}, 90^{th}, 95^{th}, and 100^{th} percentile population. Results presented by Region and Scenario.
Evacuation Time Estimates for the entire EPZ, 100^{th} percentile.	Full EPZ – Summer Weekday: Good weather = 5:12 Full EPZ – Winter Weekday: Good weather = 5:51	Full EPZ – Summer Weekday Good weather = 4:05 Full EPZ – Winter Weekday: Good weather = 4:05

2. STUDY ESTIMATES AND ASSUMPTIONS

This section presents the estimates and assumptions utilized in the development of the Evacuation Time Estimates (ETE).

2.1 Data Estimates

1. Population estimates are based upon Census 2000 data, projected to year 2008. Municipality-specific projections are based upon growth rates obtained from the Census website. Estimates of employees who commute into the EPZ to work are based upon employment data obtained from county emergency management offices, direct phone calls to major employers, and from previous ETE reports.
2. Population estimates at special facilities are based on available data from county emergency management offices and from direct phone calls to the facilities.
3. Roadway capacity estimates are based on field surveys and the application of the HCM.
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. The average values of 2.72 persons per household and 1.24 evacuating vehicles per household are used.
6. The relationship between persons and vehicles for special facilities is as follows:
   a. Parks/Recreational: 2.3 persons/vehicle based on data provided by Sterling State Park
   b. Employees: 1.02 employees per vehicle (telephone survey results)
7. ETE are presented for the evacuation of the 100th percentile of population for each Region and for each Scenario. ETE are presented in tabular format and graphically showing the values of ETE associated with the 50th, 90th and 95th percentiles of population. An Evacuation Region is defined as a group of Protective Action Areas (PAA) that is issued an Advisory to Evacuate.

2.2 Study Methodological Assumptions

1. The ETE is defined as the elapsed time from the Advisory to Evacuate issued to persons within a specific Region of the EPZ, and the time that Region is clear of the indicated percentile of people.
2. The ETE are computed and presented in a format compliant with the

guidance in the cited NUREG documentation. The ETE for each evacuation area ("Region" comprised of included PAA) 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/CR-6863. These Regions, as defined, display irregular boundaries reflecting the geography of the PAA 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 annular area between the circle defined by the central "key-hole" 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 annular area centered at the plant (the "Shadow Region"), it will be 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 the "Shadow Region". See Appendix I.
6. A total of 14 "Scenarios" representing different seasons, time of day, day of week and weather are considered. Two special event scenarios are studied; the River Raisin Jazz Festival in Monroe and the peak construction period of a new unit at the Fermi Nuclear Power Plant site while refueling at the operational unit. These Scenarios are detailed in Table 2-1.
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[1]). The models have continuously been refined and extended since those hearings and have been independently validated by a consultant retained by the NRC.

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

Table 2-1. Evacuation Scenario Definitions					
Scenarios	**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	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Weekend	Midday	Good	River Raisin Jazz Festival
14	Summer	Midweek	Midday	Good	New Plant Construction and Refueling

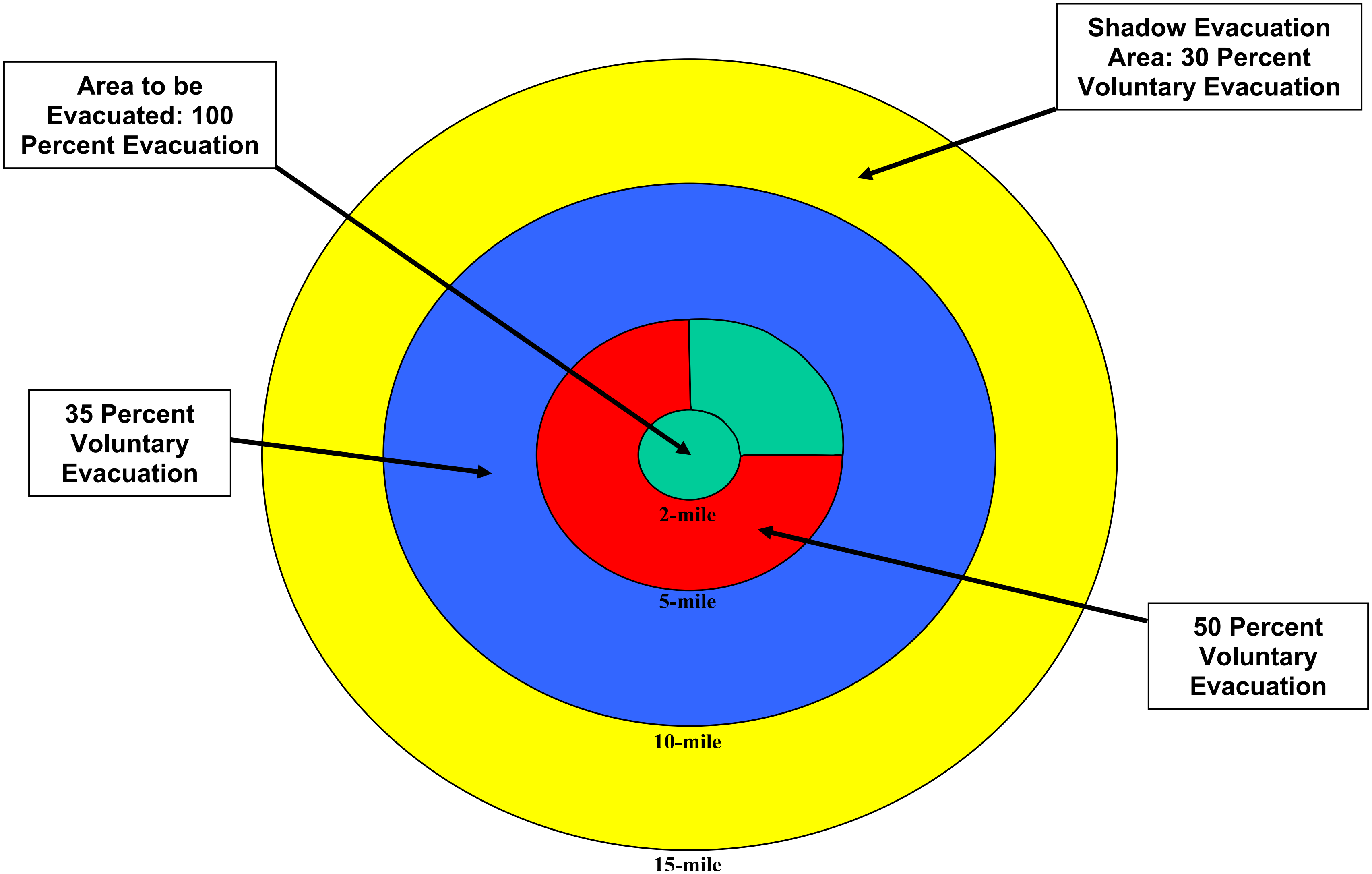


Figure 2-1. Voluntary Evacuation Methodology

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 of the Advisory to Evacuate.
   c. ETE are measured relative to the Advisory to Evacuate.
2. It is assumed that everyone within the group of PAA forming a Region that is issued an Advisory to Evacuate will, in fact, respond in general accord with the planned routes.
3. It is further assumed that:
   a. Schools may be evacuated prior to notification of the general public, if possible.
   b. All households in the EPZ with at least one commuter (62% of households according to telephone survey results, as documented in Figure F-6) will await the return of the commuter before beginning their evacuation trip.
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.

   The effect of heavy truck traffic on traffic operations during evacuation was determined to be immaterial; therefore the presence of truck traffic is not expressly considered in calculating ETE. However, the buses used to evacuate transit dependent persons from within the EPZ are represented within the modeling process as being equivalent to two passenger car units in calculating the ETE.

5. Access Control Points (ACP) will be staffed within approximately 90 minutes of the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no vehicles will enter the EPZ after this 90 minute mobilization time period.
6. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. The number and location of each TCP in the EPZ are predetermined and listed in the county plans. The specific TCP which will be manned will be determined using the specific circumstances of the evacuation. The objectives of the TCP are:
   a. Facilitate the movements of all (mostly evacuating) vehicles at the location.

b. Discourage inadvertent vehicle movements towards the power station.
c. Provide assurance and guidance to any traveler who is unsure of the appropriate actions or routing.
d. Act as local surveillance and communications center.
e. Provide information to the emergency operations center (EOC) as needed, based on direct observation or on information provided by travelers.

In calculating ETE, it is assumed that drivers will act rationally, travel in directions identified in the plan, and obey all control devices and traffic guides. These TCP serve many useful functions, but are not considered in specifying the inputs to the IDYNEV system used to calculate ETE. Consequently, the results presented in Section 7 and in Appendix J are conservative in that they do not reflect the presence of these TCP. The time needed to mobilize personnel or equipment to staff the TCP will not influence the ETE results.

The goal of the ETE modeling activity is to realistically represent the traffic environment during emergency evacuation conditions. Consistent with this objective of representing realistic driver behavior, it is assumed that all drivers will respond safely to traffic control regardless of whether that control is implemented by a traffic signal, a stop sign or by traffic control personnel at a TCP. The signal splits input to the model are adjusted to represent realistic human behavior during emergency evacuation based on traffic conditions but are not treated optimally as though there is expert traffic control personnel controlling the signal at all times. The outcome of this approach to developing ETE estimates is to produce realistic estimates of evacuation time.

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 and host schools.
   b. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
   c. Bus mobilization time is considered in ETE calculations.
   d. Analysis of the number of required “waves” of transit vehicles used for evacuation is presented.

8. It is reasonable to assume that some of transit-dependent people will rideshare 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[2]. The remaining transit-dependent portion of the general population will be evacuated to reception centers by bus.

9. Two types of adverse weather scenarios 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 the evacuation advisory is issued. Thus transient populations are not affected. That is, no weather-related reduction in the number of transients who may be present in the EPZ is assumed.

   Snow may occur in winter scenarios. Transient population reductions are not assumed for snow scenarios. Further, it is assumed that roads are passable and that the appropriate agencies are plowing the roads as they would normally.

   Adverse weather scenarios affect roadway capacity, free flow highway speeds and the time required to mobilize the general population. The factors assumed for the ETE study are:

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time
Rain[3]	90%	90%	No Effect
Snow[3]	80%	80%	Clear driveway before leaving home (Source: Telephone Survey)
*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 have the capacity 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 an average of 30 people per bus.

11. It is assumed that sufficient bus drivers are available for all buses servicing the EPZ.

[2] 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).

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

12. The transit needs for medical facilities were conservatively estimated assuming that no vehicle would service more than one facility.

13. It is assumed that half of the wheelchair bound persons in the EPZ use rigid wheelchairs while the other half use folding wheelchairs. Those wheelchair-bound persons using folding wheelchairs can be evacuated in a standard bus and their wheelchair can be folded and placed in the rear of the bus or in the seat adjacent to the seat they are sitting in. Those wheelchair-bound persons using rigid wheelchairs will need to be evacuated in specially equipped buses.

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[1] 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. Estimating counts of vehicles by 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.

[1] Double-counting is not considered in other COLA locations, which may lead to deviations in population estimates.

Analysis of the population characteristics of the Fermi Nuclear Power Plant (FNPP) 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.
- Commuter-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 Protective Action Area (PAA) and by polar coordinate representation (population rose). The FNPP EPZ has been subdivided into 5 PAA as shown in Figure 3-1.

<u>Permanent Residents</u>

The primary source for estimating permanent population is the latest U.S. Census data. The average household size (2.72 persons/household) and the number of evacuating vehicles per household (1.24 vehicles/household) were adapted from the telephone survey results.

The rate of population change for each municipality in the study area was obtained by KLD from Census data. These growth rates were applied to Year 2000 Census block point data using Geographical Information Systems (GIS) software to project population within the EPZ and within the Shadow Region to the Year 2008. Table 3-1 summarizes the rate of population change for each municipality while Table 3-2 shows that the EPZ population has increased by 11.5 percent over the last 8 years.

Permanent resident population and vehicle estimates for 2008 are presented in Table 3-3. Figures 3-2 and 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from FNPP. This “rose” was constructed using GIS software.

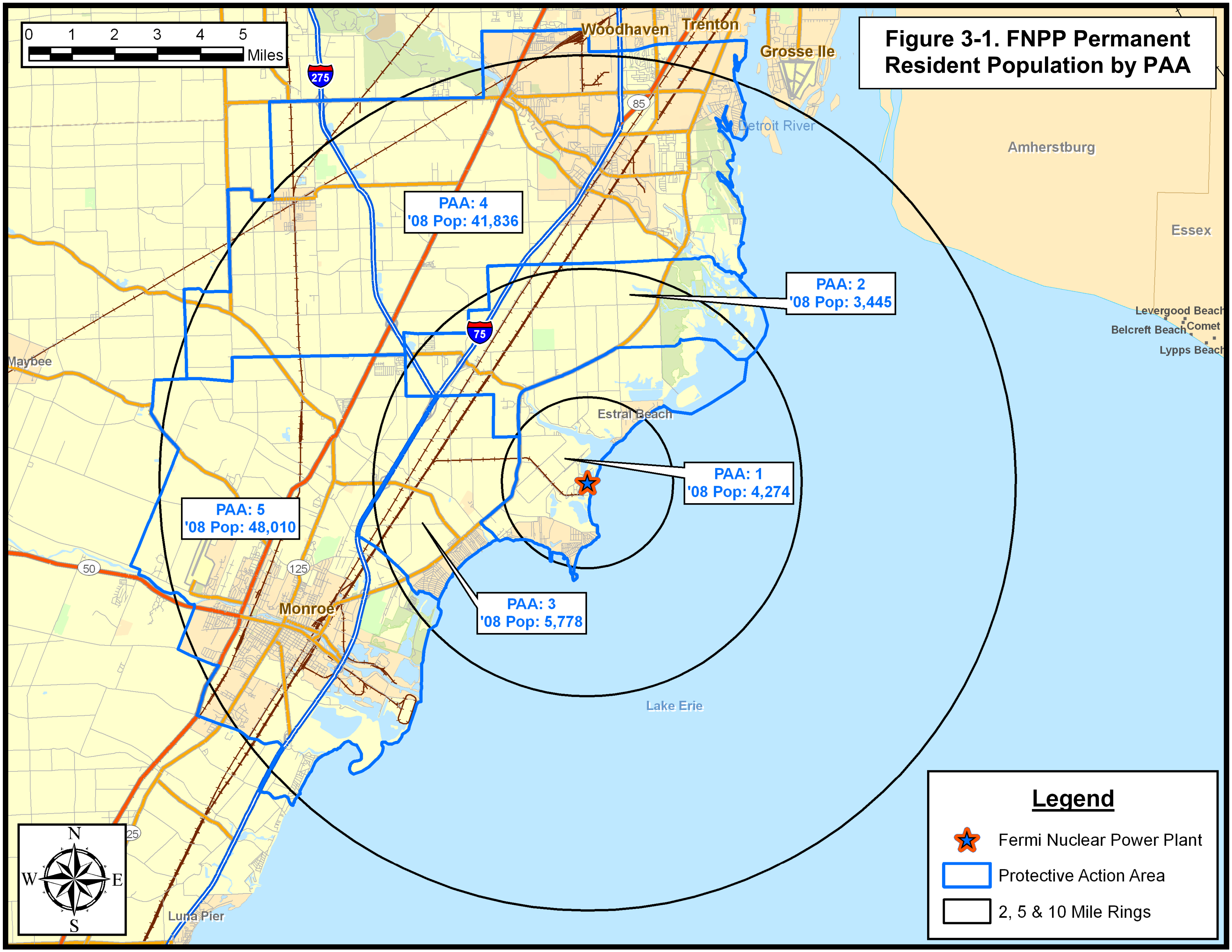


Figure 3-1. FNPP Permanent Resident Population by PAA
0 1 2 3 4 5 Miles
PAA: 4
'08 Pop: 41,836
PAA: 2
'08 Pop: 3,445
PAA: 1
'08 Pop: 4,274
PAA: 5
'08 Pop: 48,010
PAA: 3
'08 Pop: 5,778
Woodhaven
Trenton
Grosse Ile
Detroit River
Amherstburg
Essex
Levergood Beach
Comet
Belcreft Beach
Lypps Beach
Maybee
Estral Beach
Monroe
Lake Erie
Luna Pier
275
75
85
125
50
25
N
S
E
W
Legend
Fermi Nuclear Power Plant
Protective Action Area
2, 5 & 10 Mile Rings

Table 3-1. Yearly Rate of Population Change by Municipality[2]			
Municipality	2000 Census Population	2006[3] Census Population Estimate	Yearly Rate of Population Change
Monroe County			
Ash Township	7,610	9,086	3.00%
Berlin Township	6,924	8,613	3.70%
Erie Township	4,850	4,793	-0.20%
Exeter Township	3,727	3,928	0.88%
Frenchtown	20,777	21,192	0.33%
Ida Township	4,949	4,994	0.15%
LaSalle Township	5,001	5,018	0.06%
London Township	3,024	3,216	1.03%
Luna Pier City	1,483	1,543	0.66%
Monroe City	22,076	21,840	-0.18%
Monroe Township	13,491	14,180	0.83%
Raisinville Township	4,896	5,667	2.47%
Wayne County			
Brownstown Township	22,989	29,235	4.09%
Flat Rock City	8,488	9,560	2.00%
Gibraltar City	4,264	5,133	3.14%
Grosse Ile Township	10,894	10,504	-0.61%
Huron Township	13,737	15,983	2.56%
Riverview City	13,272	12,537	-0.95%
Rockwood City	3,442	3,360	-0.40%
Sumpter Township	11,856	11,822	-0.05%
Trenton City	19,584	19,068	-0.44%
Woodhaven City	12,530	13,381	1.10%

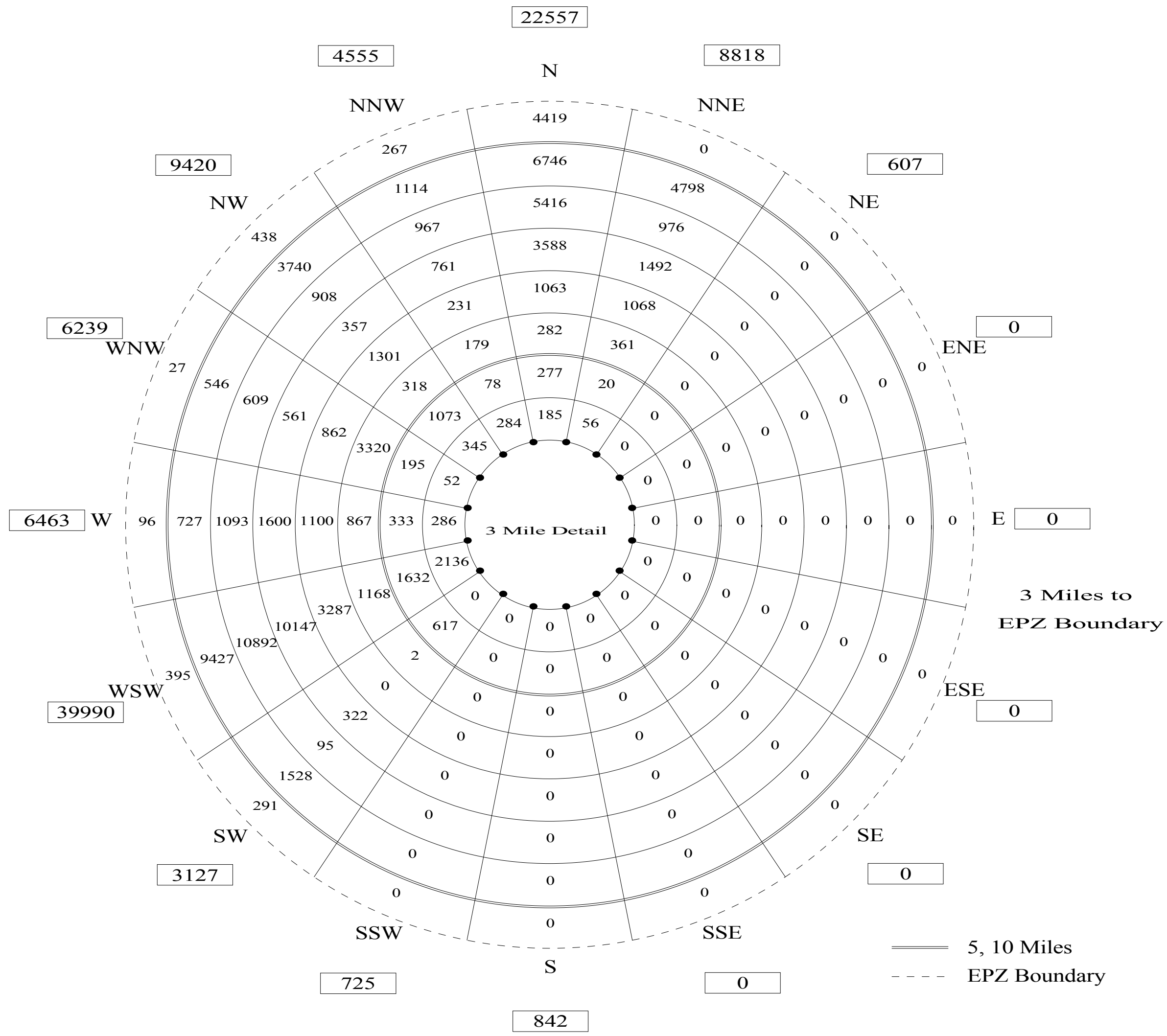
[2] County-specific growth rates are used in other COLA locations, which may lead to deviations in population estimates.

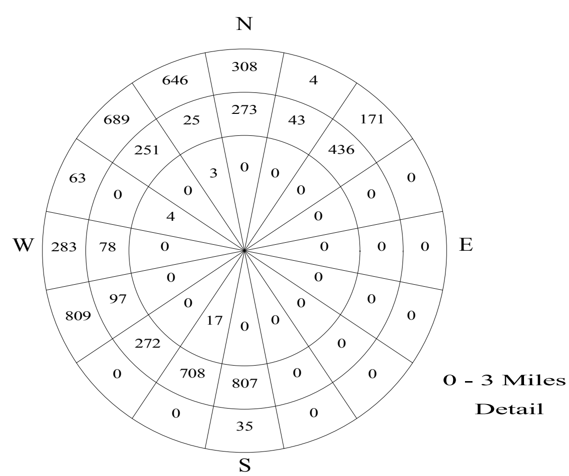
[3] The U.S. Census Bureau provides periodic population estimates between the major Census updates (every 10 years); the latest updates provided on the Census website are for 2006.

Table 3-2. EPZ Permanent Resident Population		
PAA	**2000 Population**	**2008 Population**
1	3,723	4,274
2	2,576	3,445
3	5,628	5,778
4	33,723	41,836
5	47,049	48,010
TOTAL	**92,699**[4]	**103,343**
Population Growth:		**11.5%**

Table 3-3. Permanent Resident Population and Vehicles by PAA		
PAA	**2008 Population**	**2008 Vehicles**
1	4,274	1,949
2	3,445	1,570
3	5,778	2,635
4	41,836	19,072
5	48,010	21,887
TOTAL	**103,343**	**47,113**

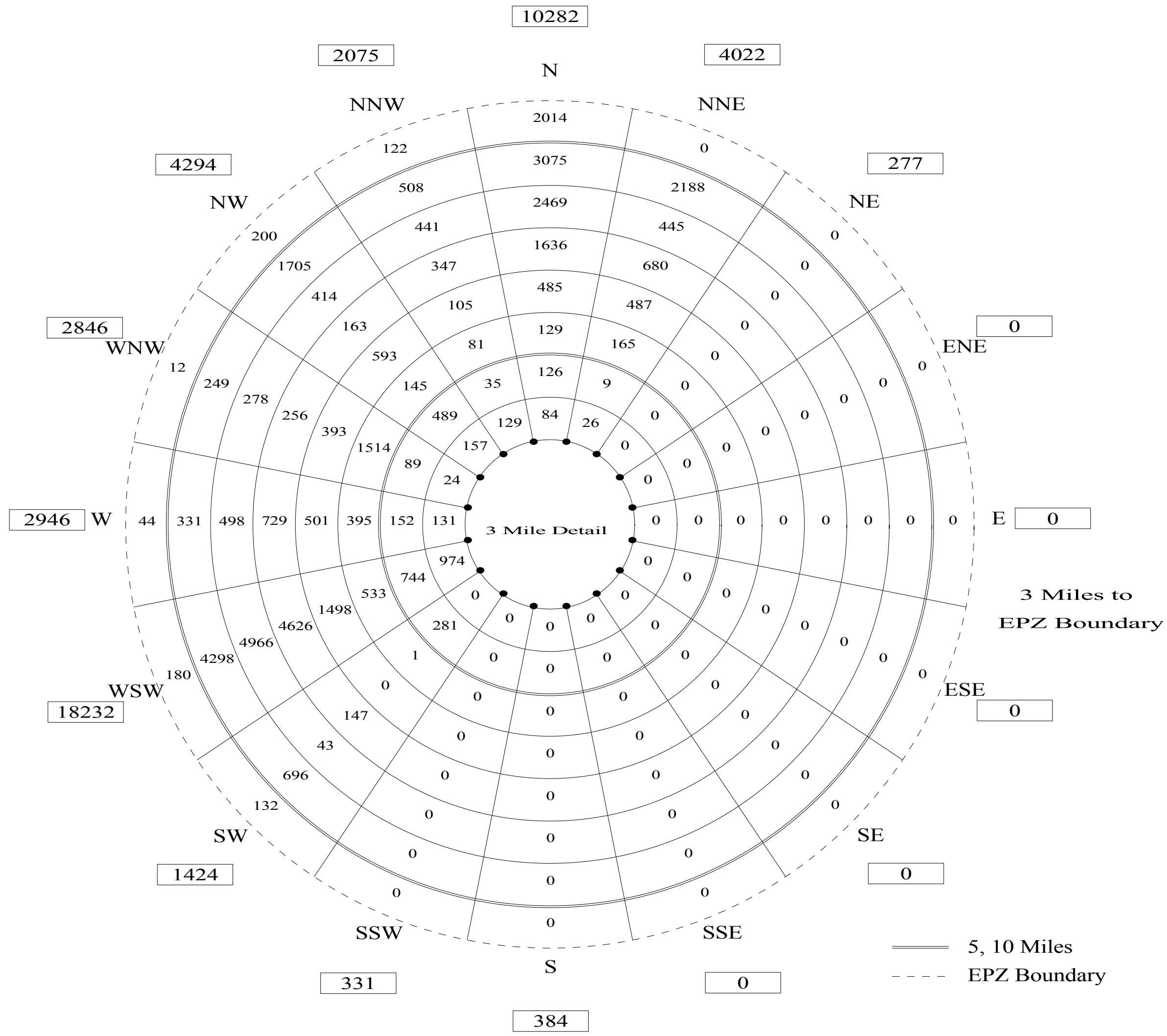
[4] The 10-mile boundary (as opposed to the EPZ boundary) is used in other COLA locations, which may lead to deviations in population estimates.





Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	24	0-1	24
1-2	2990	0-2	3014
2-3	3008	0-3	6022
3-4	3344	0-4	9366
4-5	4225	0-5	13591
5-6	6497	0-6	20088
6-7	8912	0-7	29000
7-8	18828	0-8	47828
8-9	20956	0-9	68784
9-10	28626	0-10	97410
10-EPZ	5933	0-EPZ	103343

Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	11	0-1	11
1-2	1364	0-2	1375
2-3	1371	0-3	2746
3-4	1525	0-4	4271
4-5	1925	0-5	6196
5-6	2963	0-6	9159
6-7	4062	0-7	13221
7-8	8584	0-8	21805
8-9	9554	0-9	31359
9-10	13050	0-10	44409
10-EPZ	2704	0-EPZ	47113

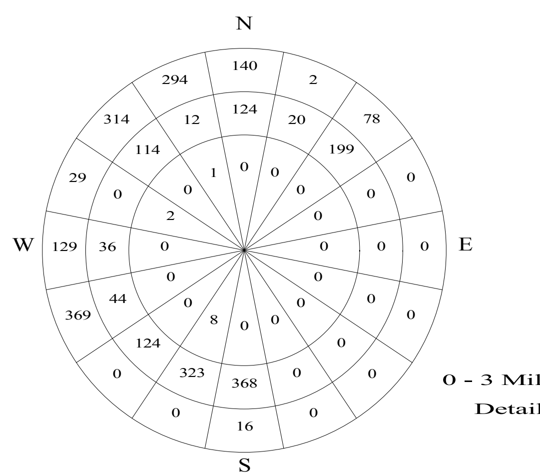


Figure 3-3. Permanent Resident Vehicles by Sector

Transient Population

Transient population groups are defined as those people who are not permanent residents and who enter the EPZ for a specific purpose (camping, shopping). Transients may spend less than one day or stay overnight or longer at camping facilities, hotels and motels. There are several locations within the FNPP EPZ that attract transients.

1. Sterling State Park

This 1,300 acre park, located in Monroe County, is the only State Park on Lake Erie. It features over one mile of beach, shore fishing, boating, wildlife viewing areas, picnicking areas, and 6 miles of trails for hiking and biking. The park also includes 256 campsites. Data provided by the park manager indicate that on average, there are 2.3 persons per vehicle entering the park. The park includes 1,900 parking spaces for daily visitors. We assume that during a typical peak season day, the parking lot is 75% full – 1,425 vehicles carrying 3,278 people.

We also assume that the campsites are 100% full during a peak day. Data provided by the park manager indicate 2 vehicles and 4 people per campsite on average. Thus, there are 1,024 people and 512 vehicles in the camping area of the park. There are 4,302 people and 1,937 vehicles in the park at peak times.

2. Lake Erie Metropark

This park includes parts of Monroe and Wayne Counties. Attractions at the park include a swimming pool, an 18-hole golf course, a museum, a nature center, boat launches, a marina and a children's playground. The park draws approximately 1,000 vehicles on a peak summer day. Assuming 2.3 persons per vehicle (based on the data provided at Sterling State Park) yields 2,300 people in the park on a peak day. Park officials indicated that the majority of the visitors to the park travel more than 10 miles to get there; therefore, we assume that all visitors to the park are not EPZ residents.

3. Pointe Mouillee State Game Area

This facility also includes parts of Monroe and Wayne Counties. It is owned and operated by the Michigan Department of Natural Resources and spans over 4,000 acres. It includes a boat ramp, hunting and fishing areas. It is considered the premier bird hunting area in the State of Michigan. It is open year round, with the best birding from early spring through September.

Several unsuccessful attempts were made to contact this facility and obtain updated information on visitation to this facility. We adapted the peak population of 2,000 people from the previous ETE study, evacuating in 870 vehicles (assumed 2.3 persons per vehicle).

4. Golf Courses

There are several golf courses within the EPZ. We conservatively assume that at most 50 non-EPZ residents will be golfing at these courses during peak times. We also assume 1 person per vehicle.

5. Marinas

There are several marinas within the FNPP EPZ. Appendix E details the data for each marina.

6. Major Retail

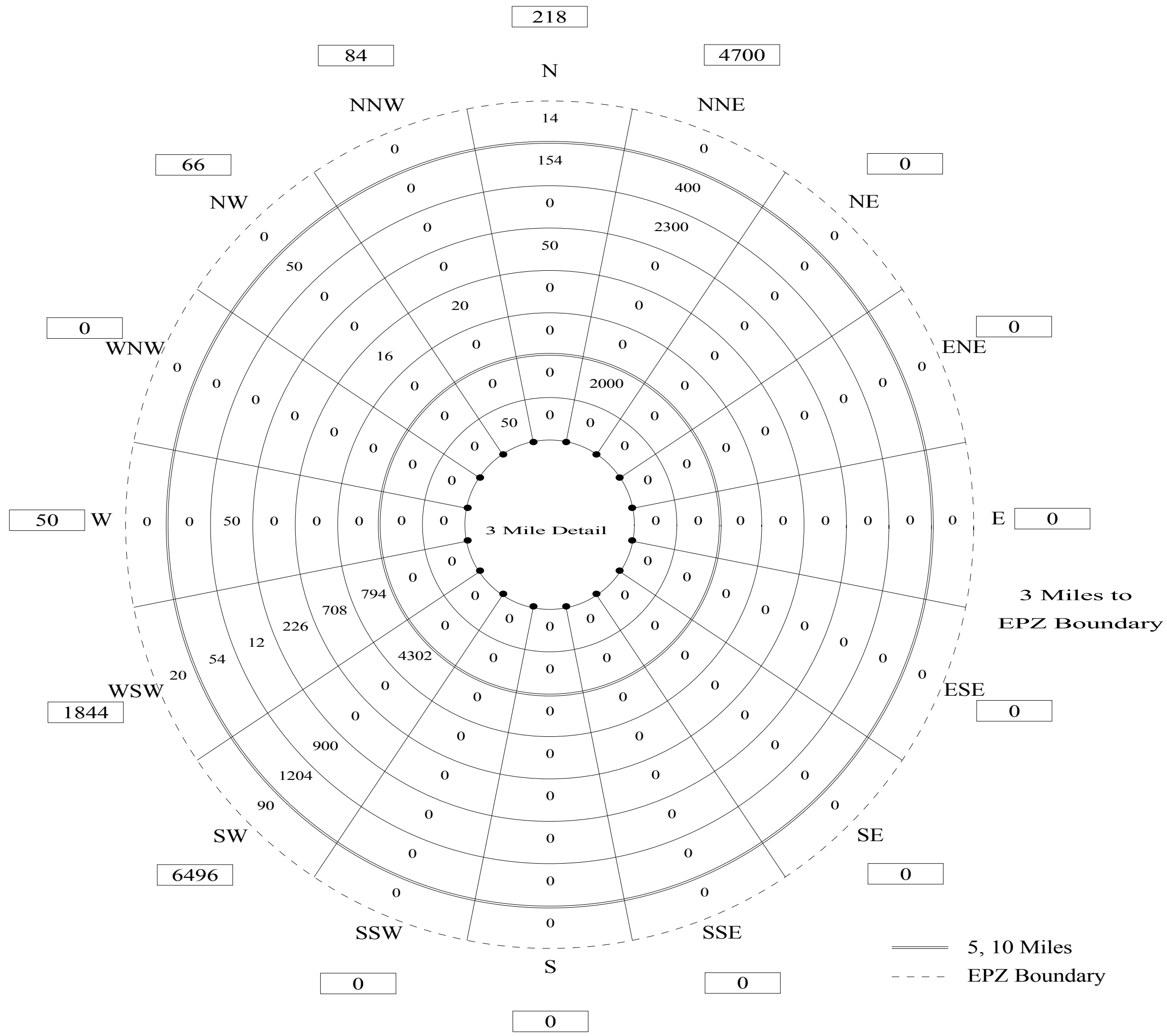
There are two major retail facilities within the FNPP EPZ. The Monroe Factory Shops (formerly Horizon Outlet Centers) includes 18 stores in total. The Gap, Van Heusen, Bass, and Reebok stores typically draw the largest customer base. Nearly all of the visitors to this facility are not from the area (most are Canadians). The parking lot capacity is approximately 400 vehicles and is full during peak times (typically around the 4th of July). We assume 2 persons per vehicle for a total transient population of 800 people during peak times.

The Frenchtown Square Mall, located in Monroe, features 75 stores – the largest of which are Target, Elder-Beerman, Sears, and Steve & Barry's. Discussions with human resources for the major stores indicated that the majority of the employees and shoppers were area residents. We conservatively assume that 400 non-EPZ residents will be shopping at the mall during peak times, evacuating in 200 vehicles (2 persons per vehicle).

There are a total of 13,458 transients in 6,405 vehicles within the FNPP EPZ during peak times. Appendix E presents the supporting data for these estimates, as well as maps of the major transient destinations within the EPZ. There are several small parks within the City of Monroe, in PAA 5. We assume that visitors to these parks live within the EPZ and have already been counted as permanent residents.

Table 3-4 summarizes the transient population and vehicles by PAA. Figures 3-4 and 3-5 present transient population and transient vehicle data by sector.

Table 3-4. Transient Population and Vehicles by PAA		
PAA	Transients	Transient Vehicles
1	44	22
2	2,050	920
3	0	0
4	3,004	1,402
5	8,360	4,061
TOTAL	**13,458**	**6,405**



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	14	0-2	14
2-3	30	0-3	44
3-4	50	0-4	94
4-5	2000	0-5	2094
5-6	5096	0-6	7190
6-7	744	0-7	7934
7-8	276	0-8	8210
8-9	3262	0-9	11472
9-10	1862	0-10	13334
10-EPZ	124	0-EPZ	13458

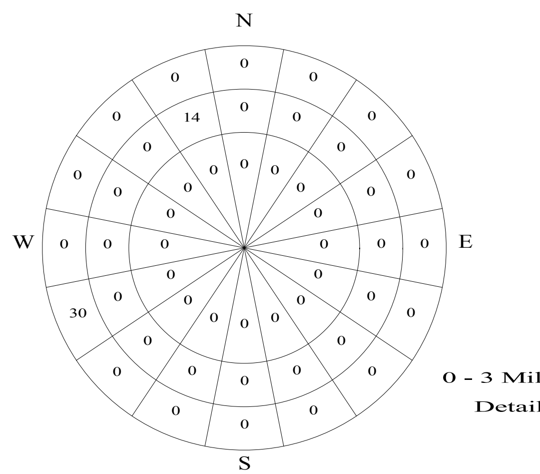
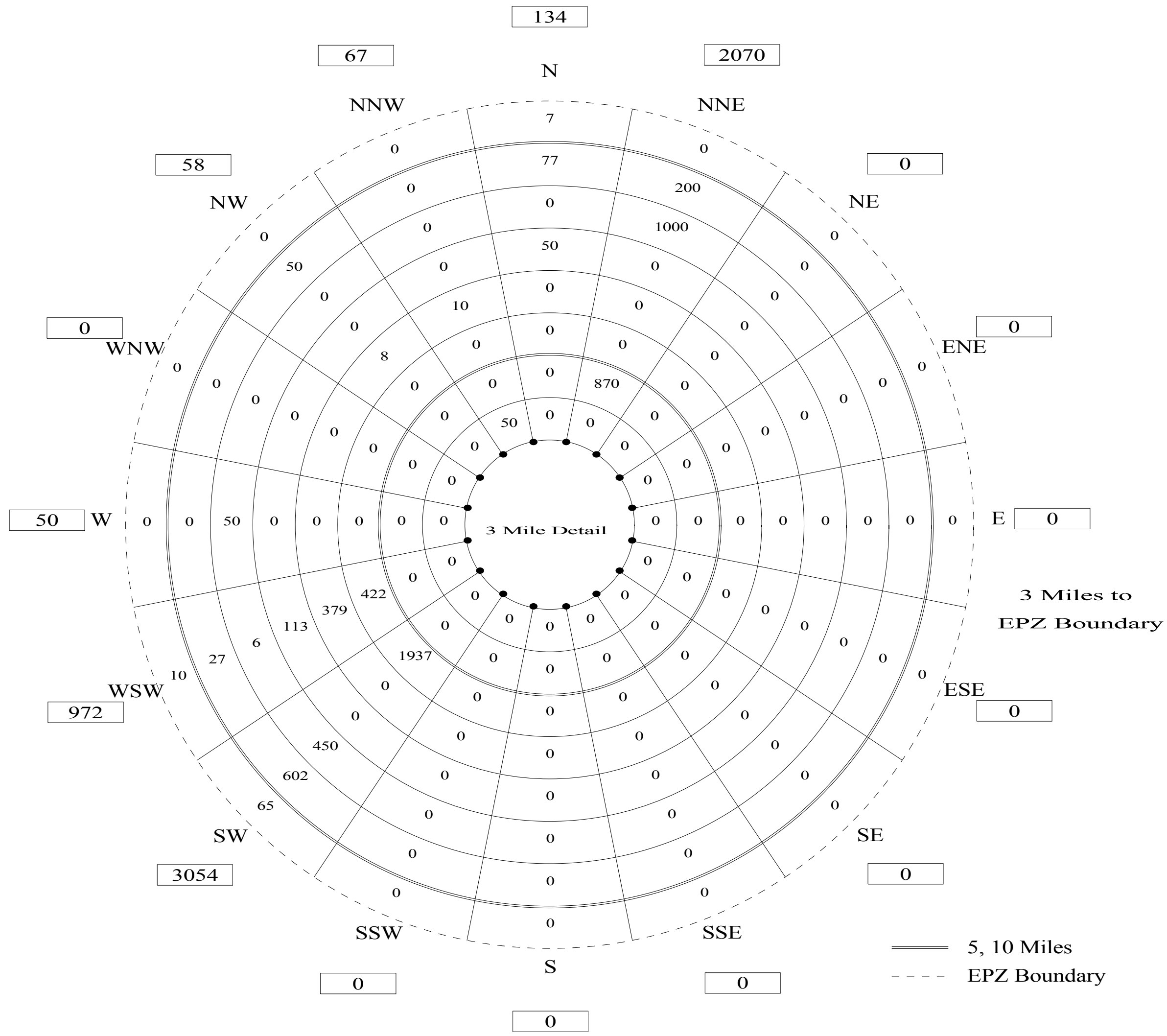


Figure 3-4. Transient Population by Sector



Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	7	0-2	7
2-3	15	0-3	22
3-4	50	0-4	72
4-5	870	0-5	942
5-6	2359	0-6	3301
6-7	397	0-7	3698
7-8	163	0-8	3861
8-9	1506	0-9	5367
9-10	956	0-10	6323
10-EPZ	82	0-EPZ	6405

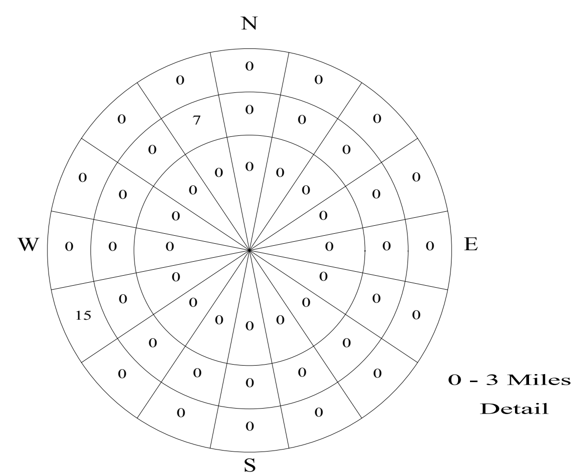


Figure 3-5. Transient Vehicles by Sector

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.

Data for major employers in the EPZ were obtained from the county emergency management offices, from Internet searches and from direct phone calls to major employers. The locations of these facilities were mapped using GIS software. The GIS map was overlaid with the evacuation analysis network and employees were loaded onto appropriate links.

Appendix E provides the data obtained for major employers within the EPZ as well as a map of the major employers.

Major employers were asked how many of their employees traveled more than 10 miles to work. This question was used to estimate the percentage of employees that were non-EPZ residents. On average, 39% of the employees at major employers within the EPZ are non-EPZ residents based on the data obtained.

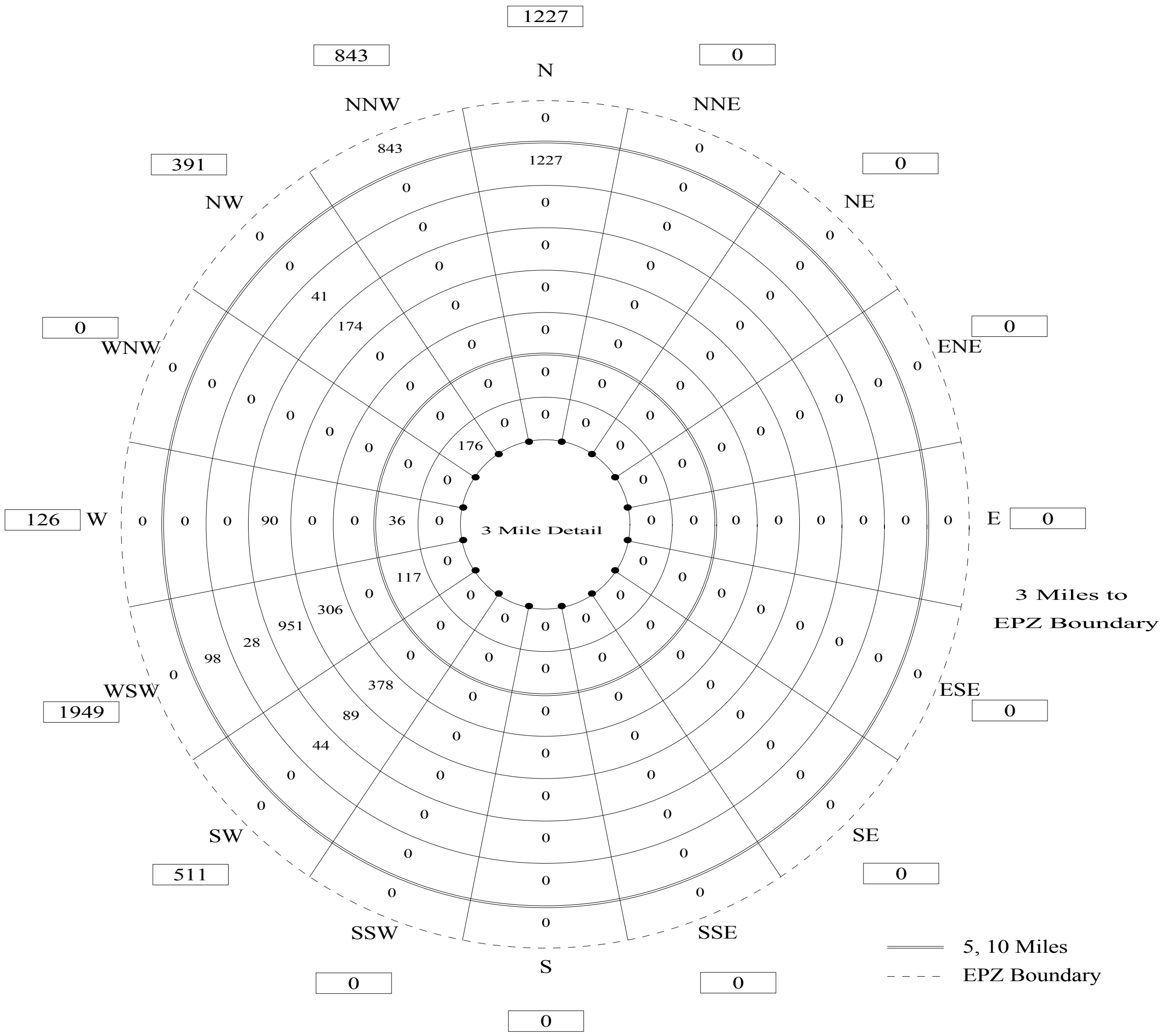
Phone surveys of the major chain stores (K-Mart, Target, Pet's Mart, Lowe's) in the City of Monroe indicated that nearly all of the employees were local residents. As a result, these facilities were not included in the major employers listed in Appendix E.

There are likely several smaller employment centers within the EPZ, but employees at such facilities are also most likely EPZ residents.

An occupancy of 1.02 persons per employee-vehicle (some carpooling) obtained from the telephone survey, was used to determine the number of evacuating employee vehicles.

There are a total of 5,047 employees commuting into the EPZ on a daily basis. These employees use 4,949 vehicles. Table 3-5 summarizes the employees commuting into the EPZ by PAA. Figures 3-6 and 3-7 present non-EPZ Resident employee data by sector.

Table 3-5. Employees and Vehicles Commuting into the EPZ by PAA		
PAA	**Employees**	**Employee Vehicles**
1	449	440
2	176	173
3	153	150
4	2,285	2,242
5	1,984	1,944
TOTAL	**5,047**	**4,949**



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	449	0-1	449
1-2	0	0-2	449
2-3	0	0-3	449
3-4	176	0-4	625
4-5	153	0-5	778
5-6	0	0-6	778
6-7	684	0-7	1462
7-8	1304	0-8	2766
8-9	113	0-9	2879
9-10	1325	0-10	4204
10-EPZ	843	0-EPZ	5047

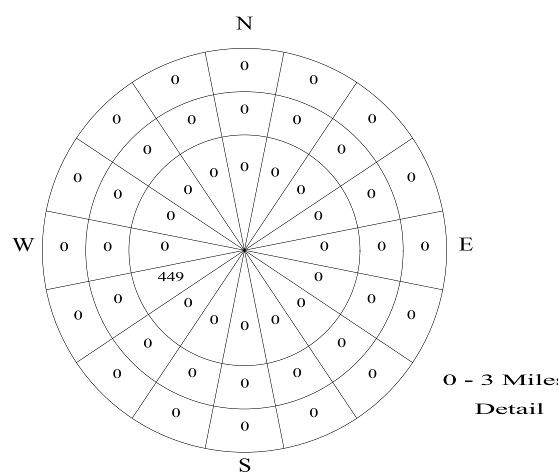
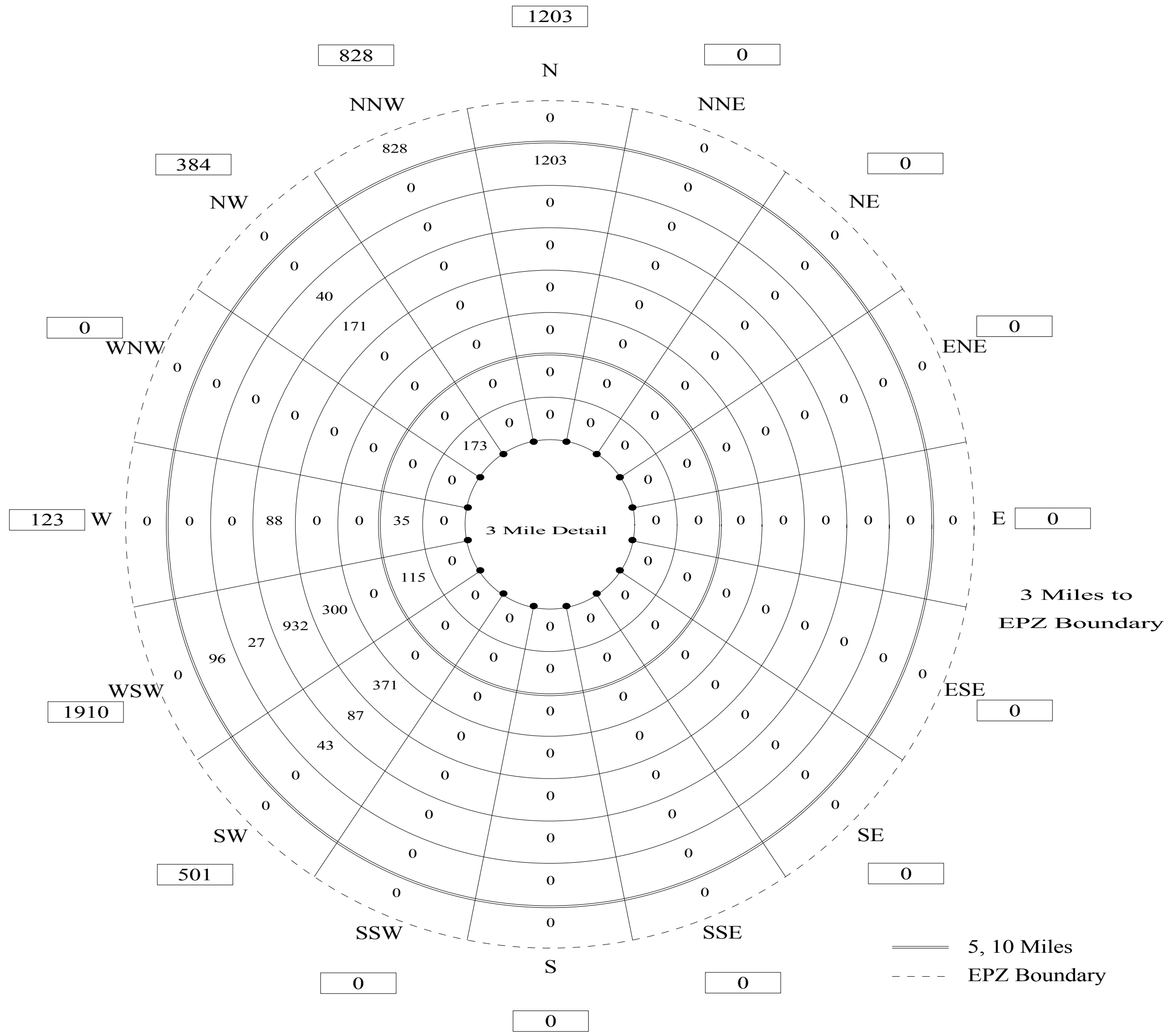


Figure 3-6. Employee Population by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	440	0-1	440
1-2	0	0-2	440
2-3	0	0-3	440
3-4	173	0-4	613
4-5	150	0-5	763
5-6	0	0-6	763
6-7	671	0-7	1434
7-8	1278	0-8	2712
8-9	110	0-9	2822
9-10	1299	0-10	4121
10-EPZ	828	0-EPZ	4949

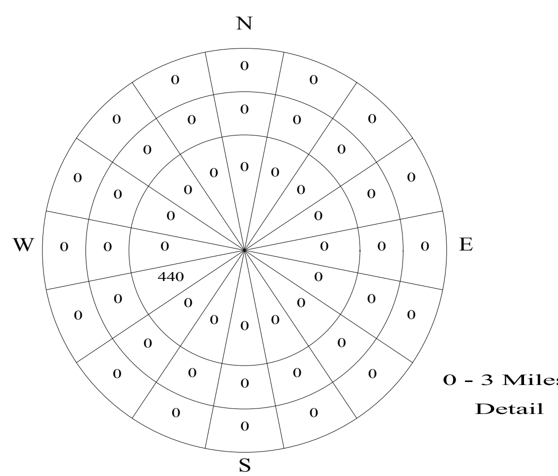


Figure 3-7. Employee Vehicles by Sector

Special Events

1. River Raisin Jazz Festival

A special event scenario (Scenario 13) is considered for the River Raisin Jazz Festival. The River Raisin Jazz Festival is held each summer at St. Mary's Park in the City of Monroe. This year's festival is scheduled for August 8th through 10th. The festival typically attracts as many as 50,000 people. Based on discussions with the director of the Monroe County Tourism & Convention Department, at most 20,000 people will be in the park for this event at any given time. He also indicated that 2/3 of these people are coming to the event from out of the area. Vehicle occupancies range from 1 to 4 persons per vehicle; we assume 3 people per vehicle. There are 1,300 public parking spaces available. People also park along local streets and in private parking lots. There are approximately 13,350 additional people (20,000 x 2/3) and 4,450 additional vehicles for this scenario. The additional vehicles are loaded on the analysis network on the links in the vicinity of St. Mary's Park.

2. Construction

A special event scenario (Scenario 14) which represents a typical summer, midweek, midday with construction workers at the FNPP site constructing the new unit (Fermi 3) when an emergency occurs at Fermi 2, is considered. Based on discussions with Black & Veatch, the peak construction will be in the Year 2018, with a workforce of 2,900 construction workers. The workforce will be split equally between two 10 hour shifts; thus there will be as many as 1,450 construction workers at a given time. We also assume that refueling of Fermi 2 will be occurring for this scenario. There are 1,500 additional workers needed for refueling, also split equally between two shifts. The average vehicle occupancy of 1.02 workers per vehicle is used to estimate the additional vehicle demand. A new access road from the FNPP site to Dixie Highway is considered in this study, based on the information provided. It is assumed that a traffic signal is present at the intersection of Dixie Highway and the new access road. Those workers present for construction of the new unit will use the existing access road (Enrico Fermi Drive), while the refueling workers and the Fermi 2 employees will use the new access road. There are a total of 1,425 vehicles loaded onto Enrico Fermi Drive for this scenario, and 1,175 vehicles (735 for refueling employees and 440 for those commuting into the EPZ to work at Fermi 2) loaded onto the new access road. There are a total of 2,160 additional vehicles for this special event. Permanent resident population and shadow population are extrapolated to 2018 for this scenario.

Medical Facilities

There are several medical facilities in the EPZ. Chapter 8 details the evacuation time estimate for the patients residing in these facilities. The number and type of evacuating vehicles that need to be provided depends on the state of health of the patients. Buses can transport up to 30 ambulatory patients or 15 wheelchair bound patients with folding wheelchairs; specially equipped buses, varies as shown in Table 8-10; ambulances, up to 2 bedridden patients or 1 wheelchair bound patient with a rigid wheelchair.

Pass-Through Demand

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate (ATE) is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major pass-through routes in the EPZ (Interstate 75 and Interstate 275). It is assumed that this traffic will continue to enter the EPZ during the first 90 minutes following the ATE. We estimate 3,000 vehicles per hour (1,000 vehicles per hour per lane) enter the EPZ northbound and southbound on I-75 and 1,500 vehicles per hour (500 vehicles per hour per lane) enter the EPZ southbound on I-275 as pass-through trips during this period. Thus there are a total of 7,500 vehicles per hour entering the EPZ as pass-through demand for the first 90 minutes following the ATE.

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 HCM)

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.

Another concept, closely associated with capacity, is “Service Volume” (SV). Service volume is defined as “The maximum hourly rate at which vehicles, bicycles or persons reasonably can be expected to traverse a point or uniform section of a roadway during an hour under specific assumed conditions while maintaining a designated level of service.” This definition is similar to that for capacity. The major distinction is that values of SV vary from one LOS to another, while capacity is the service volume at the upper bound of LOS E, only.

This distinction is illustrated in Exhibit 12-15 of the HCM. As indicated there, the SV varies with FFS, Terrain and LOS. However, the SV at LOS E (which approximates capacity) varies only with Terrain. This Exhibit was referenced when estimating capacity for two-lane rural highways within the EPZ and Shadow Region; such highways are predominant within the analysis network.

Other factors also influence capacity. These include, but are not limited to:

- Lane width
- Shoulder width
- Pavement Condition
- Weather conditions (rain, snow, fog, wind speed, ice)

These factors are considered during the field survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on FFS according to Exhibit 20-5 of the HCM. Consequently, lane and shoulder widths at the narrowest points were observed during the field survey and these observations were recorded, but no detailed measurements of lane or shoulder width were taken. The estimated FFS were measured using the survey vehicle’s speedometer and by observing local traffic.

As discussed in Section 2.3, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as 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 population density of the City of Monroe and the roadway grid system within the city, congestion arising from evacuation is likely to be significant within the city. As such, 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.

Rural highways generally consist of: (1) one or more uniform sections with limited access (driveways, parking areas) characterized by “uninterrupted” flow; and (2) approaches to at-grade intersections where flow can be “interrupted” by a control device or by turning or crossing traffic at the intersection. Due to these differences, separate estimates of capacity must be made for each section. Often, the approach to the intersection is widened by the addition of one or more lanes, to compensate for the lower capacity of the approach due to the factors there that can interrupt the flow of traffic. These additional lanes are recorded during the field survey and later entered as input to the IDYNEV system.

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 (Traffic Control Points, TCP) and the management procedures applied.

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:

$Q_{cap,m}$	=	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	=	Mean duration of GREEN time servicing vehicles that are executing movement, m, for each signal cycle; seconds
L	=	Mean "lost time" for each signal phase servicing movement, m; seconds
C	=	Duration of each signal cycle; seconds
P_m	=	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, and 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 HCM.

The above discussion is necessarily brief given the scope of this ETE report and the complexity of the subject of intersection capacity. In fact, the two longest chapters in the HCM (16 and 17), each well over 100 pages, address this topic. The factors, F_1, F_2, …, influencing saturation flow rate are indentified in equation (16-4) and Exhibit 16-7 of the HCM; Exhibit 10-12 identifies the required data and Exhibit 10-7 presents representative values of Service Volume.

Capacity Estimation Along Sections of Highway

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

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.

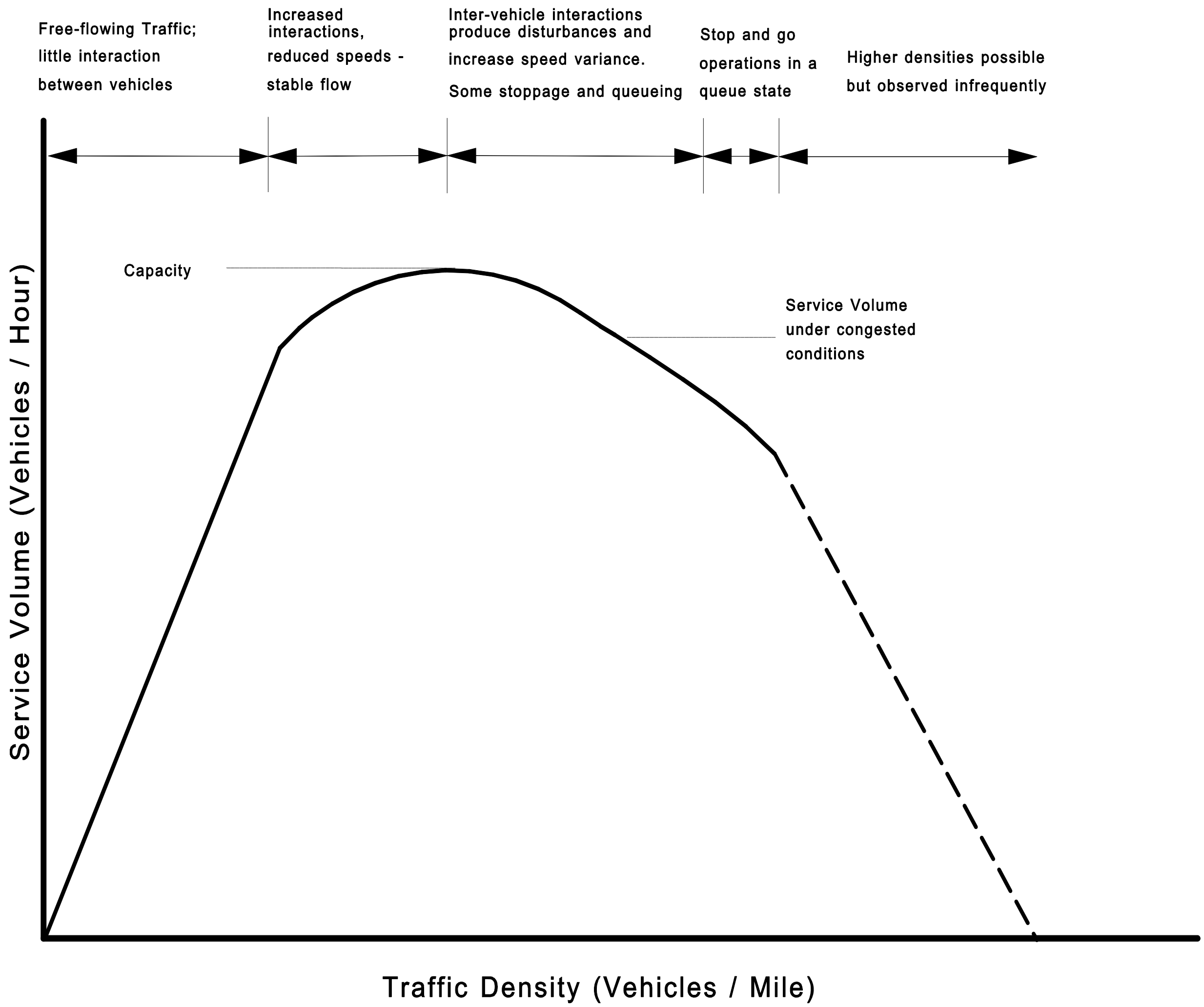


Figure 4-1. Fundamental Relationship Between Volume and Density

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; the 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.

We have employed a value of R=0.85. The advisability of such a capacity reduction factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at “bottlenecks” or “choke points” on a freeway system. Zhang and Levinson[2] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE and indicated in Appendix K for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90. The data collected in the cited reference indicates that the variation of QDF at a location is generally in the range of +/- 5% about the average QDF. That is, the lower tail of this distribution would be equivalent to a capacity reduction factor of 0.90 - 0.05 = 0.85 which is the figure adopted.

It is seen that a conservative view is taken in estimating the capacity at bottlenecks when congestion develops (this capacity, of course, is the QDF rate discussed above). One could argue that a more representative value for this capacity reduction factor could be 0.90 as discussed above. Given the emergency conditions, a conservative stance is justified. Therefore, a factor of 0.85 is applied only when flow breaks down, as determined by the simulation model.

[2] Lei Zhang and David Levinson, “Some Properties of Flows at Freeway Bottlenecks,” Transportation Research Record 1883, 2004.

Rural roads, like freeways, are classified as “uninterrupted flow” facilities. (This is in contrast with urban street systems which have closely spaced signalized intersections and are classified as “interrupted flow” facilities.) As such, traffic flow along rural roads is subject to the same effects as freeways in the event traffic demand exceeds the nominal capacity, resulting in queuing and lower QDF rates. As a practical matter, rural roads rarely break down at locations away from intersections. The breakdowns on rural roads which are experienced on this network occur at intersections where other model logic applies. Therefore, the application of a factor of 0.85 is appropriate on rural roads but rarely, if ever, activated.

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. Exhibit 12-15 in the HCM was referenced to estimate saturation flow rates. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction.

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 HCM. 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.

<u>Application to the Fermi Nuclear Power Plant EPZ</u>

As part of the development of the FNPP EPZ traffic network, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in the HCM.

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

- Two-lane roads: Local, State
- Multi-lane Highways (at-grade)
- Freeways (Interstate-75, Interstate-275)

Each of these classifications will be discussed.

<u>Two-Lane Roads</u>

Ref: HCM Chapters 12 and 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.

These HCM procedures utilize FFS as a "key step in the assessment of LOS". "The FFS is measured using the mean speed of traffic under low flow conditions." Lane and shoulder width moderately influence FFS as indicated in HCM Exhibit 20-5. Since FFS is observed directly during the field survey, the influences of pavement width, grade and horizontal curvature on FFS and on LOS are captured directly. Posted speeds may influence FFS but are not used in the HCM procedures. Finally, all simulation models which are designed to replicate actual traffic movements rely on FFS inputs—not posted speeds.

Multi-Lane Highway

Ref: HCM Chapters 12 and 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 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.

Chapter 12 presents the basic concepts underlying the procedures in Chapters 20 and 21.

Freeways

Ref: HCM Chapters 22-25

Chapter 22 of the HCM describes a procedure for integrating the results obtained in Chapters 23, 24 and 25, which compute capacity and LOS for freeway components. The discussion also references Chapter 31, which presents a discussion on simulation models. The simulation model, PC-DYNEV, automatically performs this integration process.

Chapter 23 of the HCM presents procedures for estimating capacity and LOS for "Basic Freeway Segments". Exhibit 23-3 of the HCM presents capacity vs. free speed estimates.

Free Speed:	55	60	65	70+
Per-Lane Capacity (pc/h):	2250	2300	2350	2400

The inputs to the simulation model are highway geometrics, free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships.

Chapter 24 of the HCM presents procedures for estimating capacity, speed, density and LOS. The simulation model contains logic that relates speed to the demand volume: capacity ratio. The value of capacity obtained from Exhibit 24-8 (of the HCM), depends on the "Type" and geometrics of the weaving segment and on the "Volume Ratio" (ratio of weaving volume to total volume).

Chapter 25 of the HCM presents procedures for estimating capacities of ramps and of "merge" areas. The capacity of a merge area "is determined primarily by the capacity of the downstream freeway segment". Values of this merge area capacity are presented in Exhibit 25-7 of the HCM, and depend on the number of freeway lanes and on the freeway free speed. The KLD simulation model logic simulates the merging operations of the ramp and freeway traffic. If congestion results from an excess of demand relative to capacity, then the model allocates service appropriately to the two entering traffic streams and produces LOS F conditions (The HCM does not address LOS F explicitly).

<u>Intersections</u>

Ref: HCM Chapters 10, 16 and 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, reflecting the complexity of these procedures. The simulation logic is likewise complex, but different; as stated on page 31-21 of the HCM:

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

Chapter 10 presents the basic concepts underlying the procedures in Chapters 16 and 17.

Simulation and Capacity Estimation

Chapter 31 of the HCM is entitled, “Simulation and other Models.” The lead sentence on the subject of Traffic Simulation Models is:

> Traffic simulation models use numerical techniques on a digital computer to create a description of how traffic behaves over extended periods of time for a given transportation facility or system…by stepping through time and across space, tracking events as the system state unfolds. Traffic simulation models focus on the dynamic of traffic flow.

In general terms, this description applies to the PC-DYNEV model, which is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM – they replace these procedures by describing the complex interactions of traffic flow and computing Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of these are: (1) FFS; and (2) saturation headway, h_{sat}. The first of these is estimated by direct observation during the field survey; the second is estimated using the concepts of the HCM, as described earlier. These parameters are listed in Appendix K, for each network link.

5. ESTIMATION OF TRIP GENERATION TIME

Federal Government 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 telephone survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

Background

In general, 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 (ETE) are measured relative to the Advisory to Evacuate.
d. Schools will be evacuated prior to the Advisory to Evacuate, if circumstances permit.

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

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

It is likely that a longer time will elapse between the various classes of an emergency at FNPP and that the Advisory to Evacuate is announced somewhat later than the siren alert.

For example, suppose one hour elapses 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 115,000 persons (permanent residents, employees commuting into the EPZ, and transients) who are deployed over an area of approximately 150 square miles and are 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 ETE 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 also differ from weekdays.

The information required to estimate trip generation is obtained from the telephone survey of EPZ residents. 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 activities) 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	No accident condition
2	Awareness of accident situation
3	Depart place of work or elsewhere, to return home
4	Arrive (or be at) home
5	Begin evacuation trip to leave the area

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

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
	Snow clearance	5

*If already at home, this is a null (no-time-consumed) activity.

These relationships are shown graphically in Figure 5-1.

An employee who lives outside the EPZ will follow sequence (c) in Figure 5-1. A household within the EPZ that has one or more commuters at work, and will await their return before beginning the evacuation trip will follow the first sequence of sequence (a) in Figure 5-1. A household within the EPZ that has no commuters at work will follow the second sequence of sequence (a) in Figure 5-1, regardless of day of week or time of day. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. For this study, we adopt the conservative posture that all activities will occur in sequence.

Households with no commuters on weekends or in the evening/night-time, will follow the applicable sequence of sequence (b) in Figure 5-1. Transients will always follow one of the sequences of sequence (b) in Figure 5-1. Some transients away from their residence could elect to evacuate immediately without returning to the residence, as indicated in the second sequence of sequence (b).

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

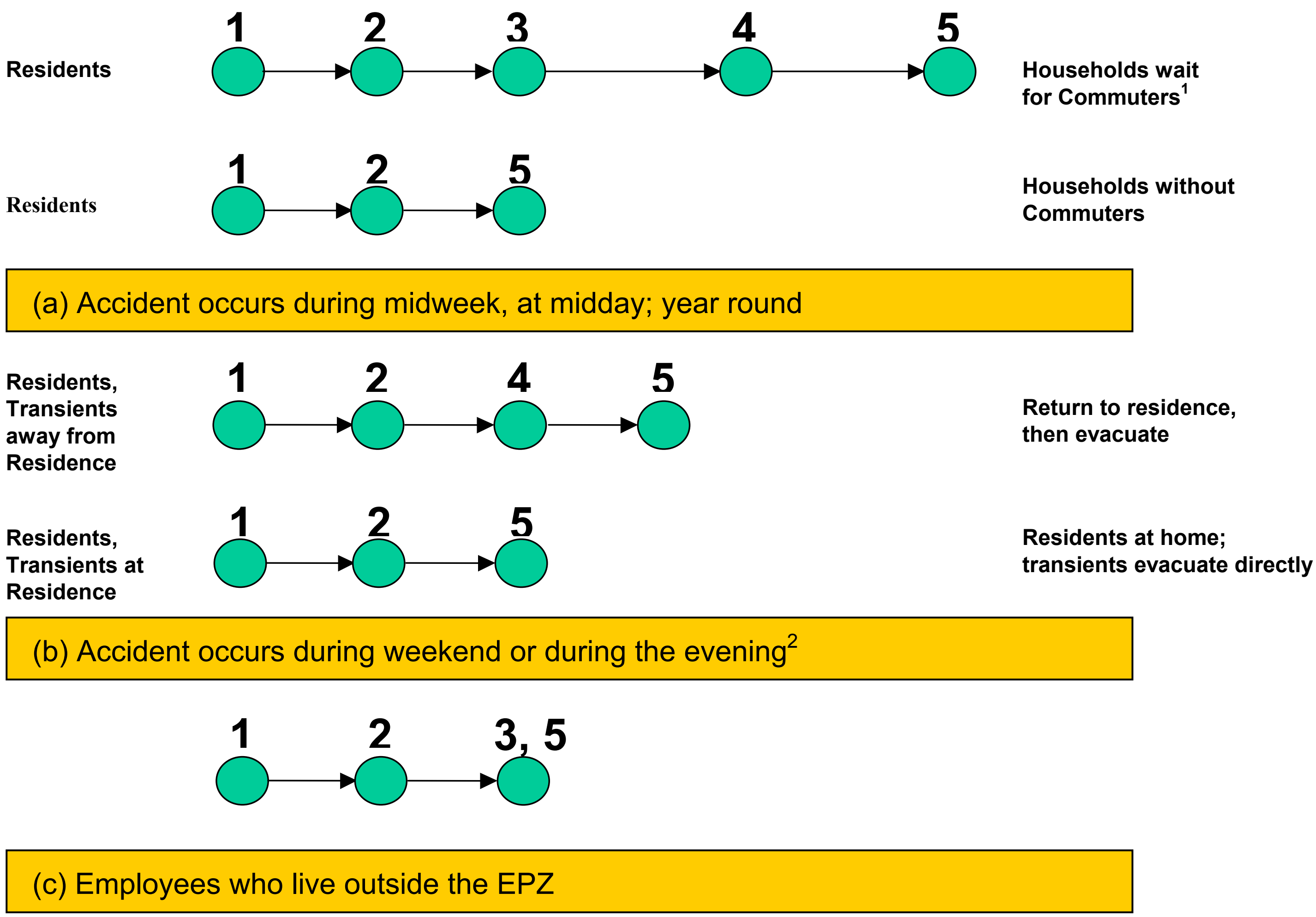
The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since we are operating on distributions – not scalar numbers.)

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 with the remainder notified within the following 20 minutes. The notification distribution is given below:

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

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



ACTIVITIES

1 → 2 Receive Notification
2 → 3 Prepare to Leave Work
2, 3 → 4 Travel Home
2, 4 → 5 Prepare to Leave to Evacuate

→ Activities Consume Time

EVENTS

1. Notification
2. Aware of situation
3. Depart work
4. Arrive home
5. Depart on evacuation trip

#

[1] Applies for evening and weekends also if commuters are at work.
[2] Applies throughout the year for transients.

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 or livestock would require additional time to secure their facility. The distribution of Activity 2 → 3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0
5	12
10	29
15	45
20	58
25	65
30	76
35	81
40	86
45	93
50	95
55	95
60	99
65	99
70	99
75	99
80	99
85	99
90	99
95	99
100	100

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

Distribution No. 3, Travel Home: Activity 3 $\rightarrow$ 4

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

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0
5	11
10	29
15	41
20	54
25	62
30	74
35	80
40	85
45	94
50	95
55	95
60	99
65	99
70	99
75	99
80	100

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

Distribution No. 4, Prepare to Leave Home: Activity 2, 4 $\rightarrow$ 5

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

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate	Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0	100	95
5	11	105	95
10	21	110	96
15	32	115	96
20	45	120	97
25	58	125	98
30	70	130	98
35	72	135	99
40	74	140	99
45	75	145	99
50	80	150	99
55	84	155	99
60	88	160	99
65	88	165	99
70	92	170	99
75	94	175	99
80	95	180	99
85	95	185	99
90	95	195	100
95	95		

Snow Clearance Time Distribution

Inclement weather scenarios involving snowfall must address the time lags associated with snow clearance. Discussions with local officials indicate that snow equipment is mobilized and deployed during the snowfall to maintain passable roads. The general consensus is that their efforts are generally successful for all but the most extreme blizzards when the rate of snow accumulation exceeds that of snow clearance over a period of many hours.

Consequently, it is reasonable to assume that the highway system will remain passable – albeit at a lower capacity – under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared to the extent needed to permit vehicles to gain access to the roadways. These clearance activities take time; this time must be incorporated into the trip generation time distributions. These data are provided by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate	Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0	75	96
5	16	80	97
10	32	85	97
15	49	90	97
20	60	95	98
25	70	100	98
30	81	105	98
35	83	110	98
40	84	115	99
45	86	120	99
50	88	125	99
55	90	130	99
60	92	135	99
65	94	140	100
70	95		

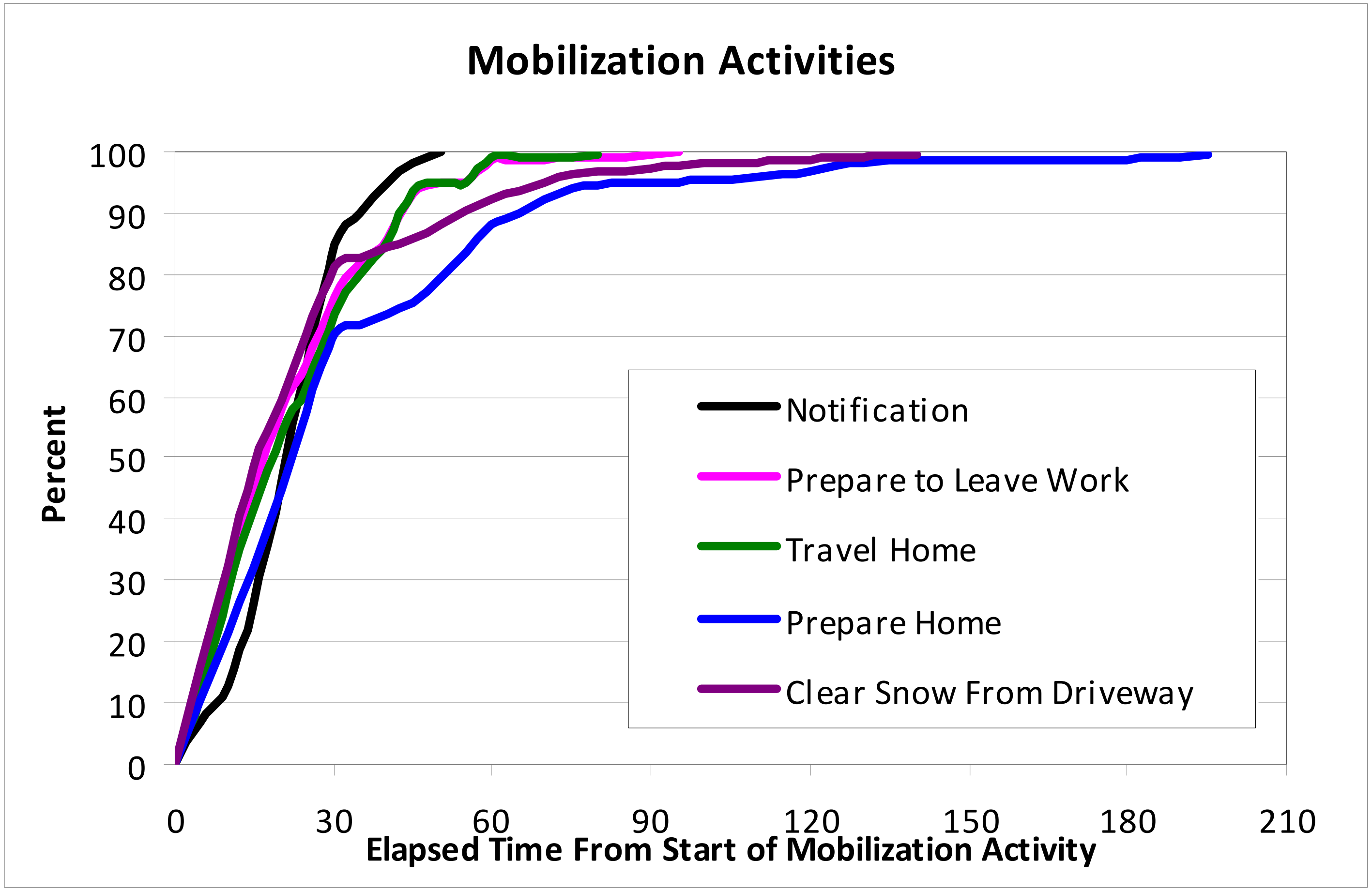


Figure 5-2. Evacuation Mobilization Activities

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, for households which await the return of a commuter, the work-to-home trip (Activity 3 $\rightarrow$ 4) must precede Activity 4 $\rightarrow$ 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.

Apply "Summing" Algorithm To:	Distribution Obtained	Event Defined
Distributions 1 and 2	Distribution A	Event 3
Distributions A and 3	Distribution B	Event 4
Distributions B and 4	Distribution C	Event 5
Distributions A and 4	Distribution D	Event 5
Distributions C and 5	Distribution E	Event 5
Distributions D and 5	Distribution F	Event 5

Distributions A through F are described below.

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ but live outside the EPZ, and to Transients within the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip.
D	Time distribution of residents with no commuters in the household to begin the evacuation trip.
E	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip after snow clearance activities.
F	Time distribution of residents with no commuters in the household, leaving to begin the evacuation trip after snow clearance activities.

As shown in Figure 5-2 and in Appendix F, the mobilization activity distributions include outliers – generally, these represent anomalous responses to the survey question. Following standard statistical practice, outliers were identified by (a) computing the estimated mean and standard deviation from the complete set of data, (b) computing value x_{LIMIT} as the mean plus 3.0 standard deviations, above which one expects 0.135% of the observations, (c) inspecting the gap between this limit value and the next-lowest observed value, (d) if that gap is sizable, classify the points above x_{LIMIT} as outliers and eliminate those points from the sample, (e) repeat the process from “a” to “d” until there are no outliers to consider.

The data sets and distributions are then used to construct distributions for the total mobilization times under different scenarios (e.g. commuter returning, no commuter in household, no snow or snow in each). In general, these are additive, using weighting based upon the probability distributions of each element; Figure 5-3 presents the combined trip generation distributions designated A, C, D, E and F. These distributions are presented on the same time scale. (The use of strictly additive activities is a conservative approach, because it makes all activities sequential – preparation for departure follows the return of the commuter; snow clearance follows the preparation for departure, and so forth.

In practice, it is reasonable that some of these activities are done in parallel, at least to some extent – for instance, preparation to depart begins by a household member at home while the commuter is still on the road.)

Once the mobilization distributions are computed, they are not truncated, but rather used in their tabular/graphical form as direct inputs to later computations that lead to the ETE.

The final time period (10) is 600 minutes long. This time period is added to allow the analysis network to clear, in the event congestion persists beyond the trip generation period. Note that there are no trips generated during this final time period.

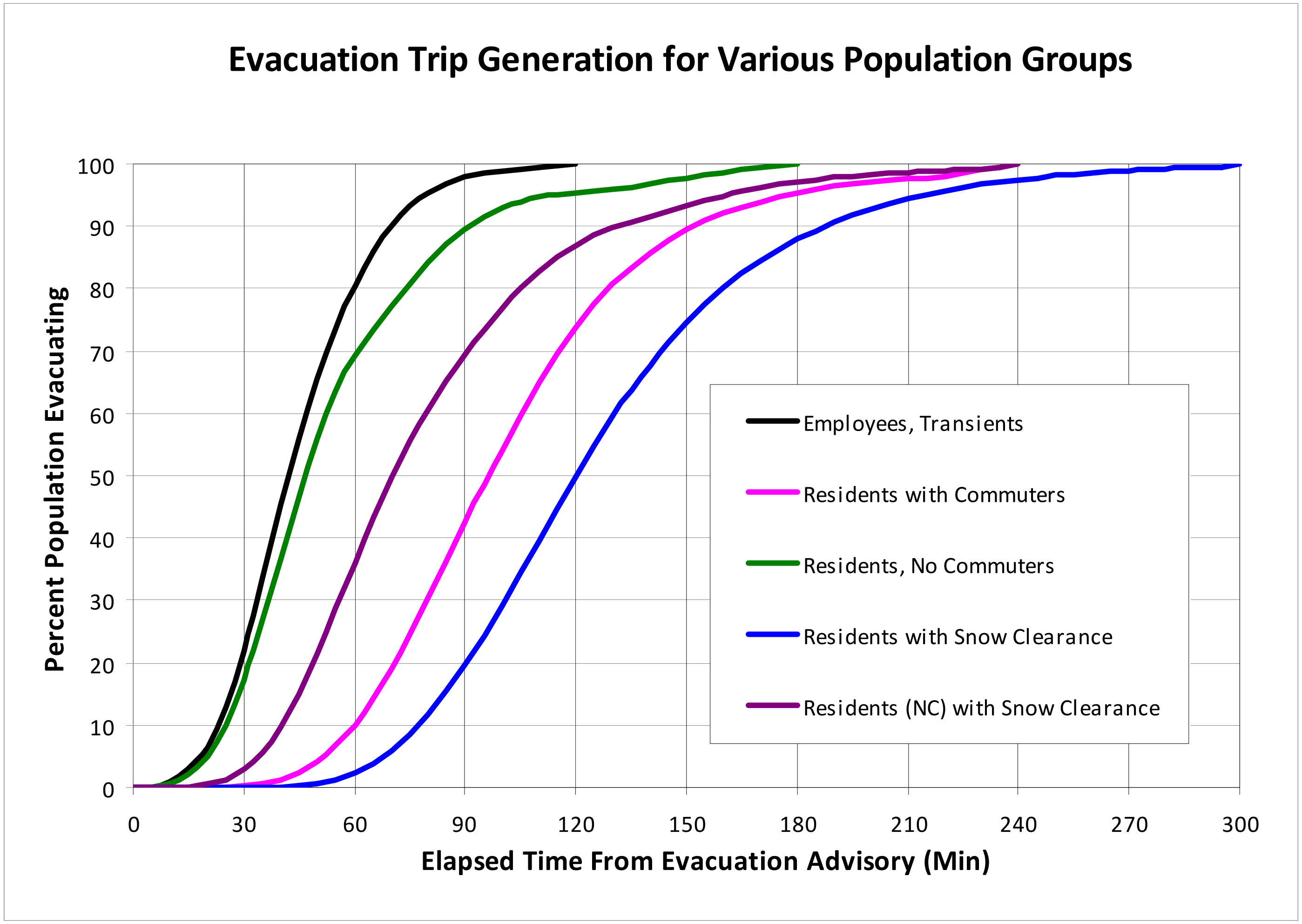


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-1. Trip Generation Histograms for the EPZ Population

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period					
		Employees (Distribution A)	Transients (Distribution B)	Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	15	3	3	0	2	0	0
2	15	19	19	0	15	0	3
3	30	59	59	10	52	2	33
4	30	17	17	32	21	18	33
5	30	2	2	32	5	30	18
6	30	0	0	16	3	25	6
7	30	0	0	5	2	13	4
8	60	0	0	5	0	10	2
9	60	0	0	0	0	2	1
10	600	0	0	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 Protective Action Areas (PAA), 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 7 Regions were defined which encompass all the groupings of PAA considered. These Regions are defined in Table 6-1. The PAA configurations, national, county and township boundaries are identified in Figure 6-1. Each keyhole sector-based area consists of a circular area centered at the Fermi Nuclear Power Plant (FNPP), and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from FNPP, or to the EPZ boundary. The azimuth of the center sector defines the orientation of these Regions.

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 14 x 7 = 98 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						
Region	Description	Protective Action Area				
		1	2	3	4	5
R01	2-Mile Ring	**X**				
R02	5-Mile Ring	**X**	**X**	**X**		
R03	Full EPZ	**X**	**X**	**X**	**X**	**X**
Evacuate 2-Mile Ring and 5 Miles Downwind						
Region	**Wind Direction From:**	**Protective Action Area**				
		1	**2**	**3**	**4**	**5**
R04	SSE,S,SSW,SW,WSW	**X**	**X**			
	W,WNW,NW,NNW,N,NNE	**Refer to Region R01**				
R05	NE,ENE,E	**X**		**X**		
	ESE,SE	**Refer to Region R02**				
Evacuate 5-Mile Ring and Downwind to EPZ boundary						
Region	**Wind Direction From:**	**Protective Action Area**				
		1	**2**	**3**	**4**	**5**
R06	SSE,S,SSW,SW	**X**	**X**	**X**	**X**	
	WSW,W,WNW,NW,NNW,N	**Refer to Region R02**				
R07	NNE,NE,ENE	**X**	**X**	**X**		**X**
	E,ESE,SE	**Refer to Region R03**				

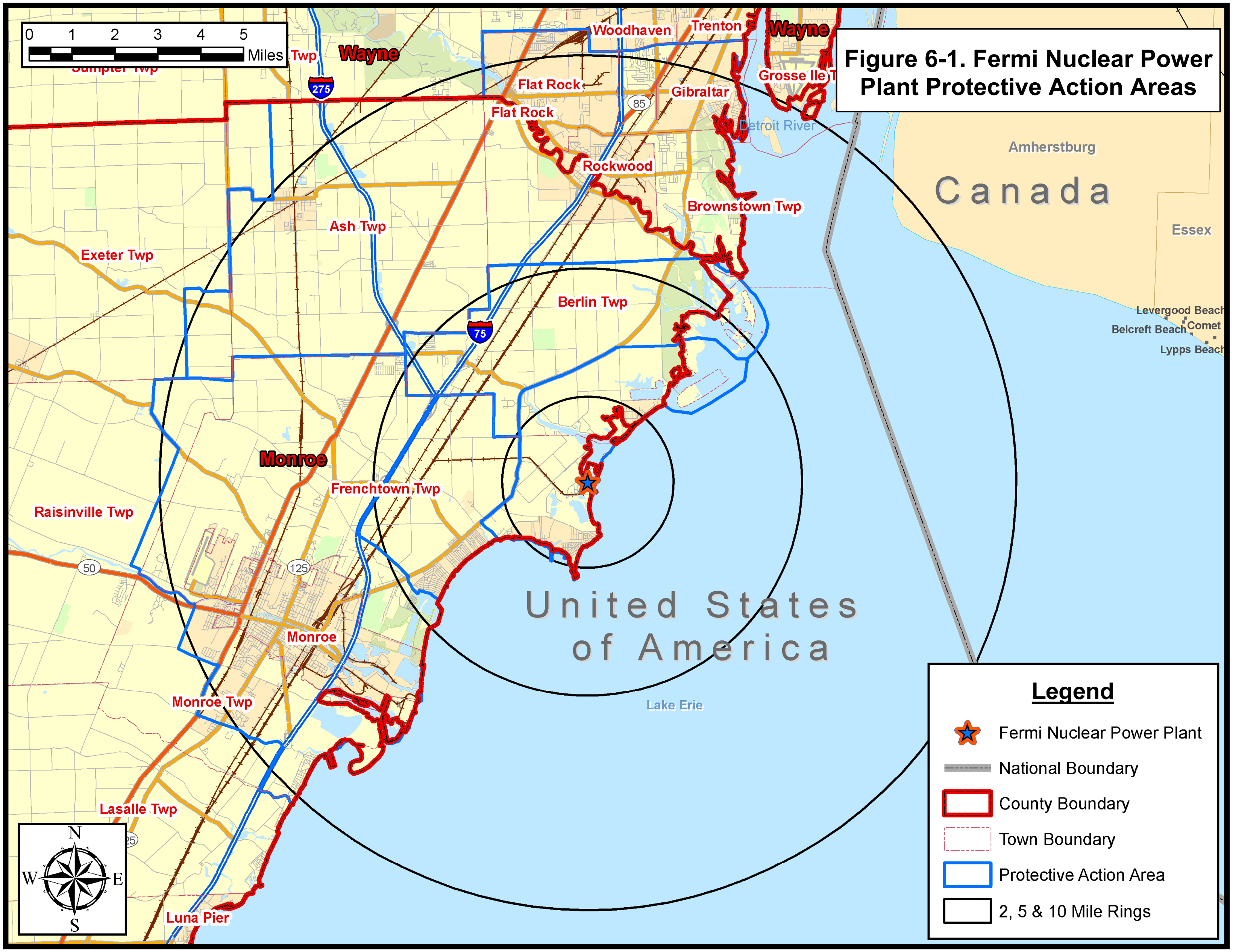


Figure 6-1. Fermi Nuclear Power Plant Protective Action Areas
0 1 2 3 4 5 Miles
Twp
Wayne
Woodhaven
Trenton
Wayne
Grosse Ile T
Flat Rock
Gibraltar
Flat Rock
Detroit River
Amherstburg
Canada
Rockwood
Brownstown Twp
Ash Twp
Exeter Twp
Essex
Berlin Twp
Levergood Beach
Belcreft Beach
Comet
Lypps Beach
Monroe
Frenchtown Twp
Raisinville Twp
Monroe
United States of America
Monroe Twp
Lake Erie
Lasalle Twp
Luna Pier
N
W
E
S
Legend
Fermi Nuclear Power Plant
National Boundary
County Boundary
Town Boundary
Protective Action Area
2, 5 & 10 Mile Rings

Table 6-2. Evacuation Scenario Definitions					
Scenarios	**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	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Weekend	Midday	Good	River Raisin Jazz Festival
14	Summer	Midweek	Midday	Good	New Plant Construction and Refueling

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

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

Scenarios	Residents With Commuters in Household	Residents With No Commuters in Household	Employees	Transients	Shadow	Special Event 1	Special Event 2	School Buses	Transit Buses	External Through Traffic
1	62%	38%	96%	40%	33%	0%	0%	10%	100%	100%
2	62%	38%	96%	40%	33%	0%	0%	10%	100%	100%
3	10%	90%	10%	100%	30%	0%	0%	0%	100%	100%
4	10%	90%	10%	100%	30%	0%	0%	0%	100%	100%
5	10%	90%	15%	25%	30%	0%	0%	0%	100%	40%
6	62%	38%	100%	15%	33%	0%	0%	100%	100%	100%
7	62%	38%	100%	15%	33%	0%	0%	100%	100%	100%
8	62%	38%	100%	15%	33%	0%	0%	100%	100%	100%
9	10%	90%	10%	25%	30%	0%	0%	0%	100%	100%
10	10%	90%	10%	25%	30%	0%	0%	0%	100%	100%
11	10%	90%	10%	25%	30%	0%	0%	0%	100%	100%
12	10%	90%	15%	10%	30%	0%	0%	0%	100%	40%
13	10%	90%	10%	100%	30%	100%	0%	0%	100%	100%
14	62%	38%	96%	40%	33%	0%	100%	10%	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 .

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 1, 2 .... Additional transient vehicles present for the River Raisin Jazz Festival and additional vehicles in the FNPP area during the construction on the new unit in the Year 2018 and the refueling of the operational 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), respectively.

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 90 minutes after the evacuation begins.

Table 6-4. Vehicle Estimates by Scenario

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Event 1	Special Event 2	School Buses*	Transit Buses*	External Traffic	Total Scenario Vehicles
1	29,283	17,830	4,751	2,562	15,258	-	-	77	84	7,500	77,345
2	29,283	17,830	4,751	2,562	15,258	-	-	77	84	7,500	77,345
3	2,928	44,185	495	6,405	14,006	-	-	-	84	7,500	75,603
4	2,928	44,185	495	6,405	14,006	-	-	-	84	7,500	75,603
5	2,928	44,185	742	1,601	14,078	-	-	-	84	3,000	66,618
6	29,283	17,830	4,949	961	15,316	-	-	766	84	7,500	76,689
7	29,283	17,830	4,949	961	15,316	-	-	766	84	7,500	76,689
8	29,283	17,830	4,949	961	15,316	-	-	766	84	7,500	76,689
9	2,928	44,185	495	1,601	14,006	-	-	-	84	7,500	70,799
10	2,928	44,185	495	1,601	14,006	-	-	-	84	7,500	70,799
11	2,928	44,185	495	1,601	14,006	-	-	-	84	7,500	70,799
12	2,928	44,185	742	641	14,078	-	-	-	84	3,000	65,658
13	2,928	44,185	495	6,405	14,006	4,450	-	-	84	7,500	80,053
14	34,003**	20,715**	4,751	2,562**	16,996	-	2,160	77	84	7,500	88,848

NOTE:
* School Buses and Transit Buses are expressed in vehicle equivalents (1 bus = 2 vehicles). Therefore actual number of buses are 1/2 the value shown.
**Permanent Resident population and Shadow population have been expanded (using municipality specific growth rates) to the Year 2018 when construction of the new unit will be at its peak.

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 7 Regions within the Fermi Nuclear Power Plant (FNPP) EPZ and the 14 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 from the PC-DYNEV simulation model outputs of vehicles exiting the specified evacuation areas. These data are generated at 10-minute intervals, then interpolated to the nearest 5 minutes.

7.1 Voluntary Evacuation and Shadow Evacuation

We define “voluntary evacuees” as people who are within the EPZ in Protective Action Areas (PAA) located outside the Evacuation Region, 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 FNPP addresses the issue of voluntary evacuees as discussed in Section 2.2 and displayed in Figure 7-1 (same as Figure 2-1). 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 from FNPP.

Traffic generated within this Shadow Evacuation Region, traveling away from the plant, has the 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, weekend, midday period under good weather conditions (Scenario 3).

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 at the indicated times are delineated in these Figures by a heavy red line; all others are lightly indicated. Congestion develops in areas with high population density and at traffic bottlenecks. Figure 7-3 presents the traffic congestion patterns at 30 minutes after the Advisory to Evacuate (ATE). The approach to I-275 from Carleton, I-75 northbound, the approach to I-75 from North Dixie Highway, and all major evacuation routes leading out of the City of Monroe (I-75 southbound, Michigan Highway 50 westbound, US-24 southbound and Michigan Highway 125 southbound) are congested at this time.

Figure 7-4 presents the traffic congestion patterns at the peak of congestion, 1 hour after the ATE. Congestion intensifies within the City of Monroe and within Carleton. Congestion propagates upstream along I-75 northbound and I-75 southbound. US Turnpike/Jefferson Ave is congested northbound traveling out of the EPZ. US Highway 24 northbound and the approaches to US 24 are also congested in Flat Rock.

The congestion patterns at 2 hours after the ATE are displayed in Figure 7-5. The patterns are similar to those at 1 hour, though the congestion in Carleton and northbound on US Turnpike/Jefferson Ave is beginning to dissipate. At 3 hours after the

ATE (Figure 7-6), all of the congestion in the northern portion of the EPZ has cleared. Congestion still persists on the major evacuation routes leaving the City of Monroe. Congestion is also observed leaving Sterling State Park and approaching I-75 southbound along Dixie Highway. The last path to clear is the approach to southbound I-75 from Laplaisance Rd in Monroe, which clears at 3 hours and 30 minutes after the ATE.

There is significant congestion within the City of Monroe; however, this congestion does not persist beyond the 4 hour mobilization time period (5 hours for snow scenarios). Therefore, the ETE is driven by the mobilization activities of the evacuating population. As a result, **it is recommended that the 95th percentile ETE (Table 7-1C) be used when making protective action decisions.**

7.3 Evacuation Rates

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.

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 within the EPZ.

7.4 Guidance on Using ETE Tables

Tables 7-1A through 7-1D present the ETE values for all 7 Evacuation Regions and all 14 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 (schools not in session)
     - Winter (also Autumn and Spring)
   - The Day of Week
     - Midweek (work-day)
     - Weekend, Holiday
   - The Time of Day
     - Midday (work and commuting hours)
     - Evening
   - Weather Condition
     - Good Weather
     - Rain
     - Snow
   - Special Event (if any)
     - River Raisin Jazz Festival
     - Construction of new unit

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, Spring and Autumn imply that public schools *are* in session.
- Time of Day: Midday implies the time over which most commuters are at work.

2. With the Scenario (and column in the Table) 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: *from* N, NNE, NE…
   - Determine the distance that the Evacuation Region will extend from the Fermi Nuclear Power Plant. The applicable distances and their associated candidate Regions are given below:
     - 2 Miles (Region R01)
     - 5 Miles (Regions R02, R04 and R05)
     - to EPZ Boundary (Regions R03, R06 and R07)
   - Enter Table 7-2 and identify the applicable group of candidate Regions based on the wind direction and on the distance that the selected Region extends from the FNPP. 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.

Example

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

- Sunday, August 10th at 4:00 AM.
- It is raining.
- Wind direction is *from* the southwest (SW).
- 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 From:”, identify the SW (southwest) azimuth and read REGION R06 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 R06. This data cell is in column (4) and in the row for Region R06; it contains the ETE value of **2:50**.

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	1:15	1:15	1:00	1:00	1:00	R1	1:15	1:15	1:35	1:00	1:00	1:25	1:00	R1	1:00	1:15
R2	1:05	1:05	1:00	1:00	1:00	R2	1:05	1:05	1:10	1:00	1:00	1:05	1:00	R2	0:55	1:05
R3	1:35	1:40	1:25	1:35	1:15	R3	1:35	1:40	2:00	1:20	1:30	1:50	1:15	R3	1:30	1:40
2-Mile Ring and Downwind to 5 Miles																
R4	1:00	1:00	0:55	0:55	0:55	R4	1:00	1:00	1:05	0:55	0:55	1:00	0:55	R4	0:55	1:05
R5	1:00	1:00	1:00	1:00	1:00	R5	1:00	1:00	1:10	1:00	1:00	1:05	1:00	R5	0:55	1:05
5-Mile Ring and Downind to EPZ Boundary																
R6	1:20	1:25	1:15	1:15	1:10	R6	1:20	1:25	1:40	1:10	1:15	1:30	1:10	R6	1:15	1:30
R7	1:30	1:35	1:20	1:25	1:15	R7	1:30	1:35	1:50	1:15	1:25	1:40	1:15	R7	1:25	1:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	2:20	2:20	2:00	2:10	2:00	R1	2:20	2:20	2:50	2:00	2:10	2:40	2:00	R1	2:00	2:10
R2	1:50	1:50	1:40	1:45	1:50	R2	1:50	1:50	2:20	1:40	1:45	1:55	1:50	R2	1:40	2:05
R3	2:50	3:05	2:45	3:00	2:25	R3	2:50	3:05	3:35	2:35	2:45	3:15	2:25	R3	3:00	3:05
2-Mile Ring and Downwind to 5 Miles																
R4	1:40	1:45	1:35	1:35	1:40	R4	1:40	1:45	2:00	1:35	1:35	1:45	1:40	R4	1:35	1:50
R5	1:45	1:50	1:40	1:45	1:50	R5	1:45	1:50	2:10	1:40	1:40	1:50	1:50	R5	1:40	2:00
5-Mile Ring and Downind to EPZ Boundary																
R6	2:30	2:45	2:20	2:35	2:10	R6	2:30	2:45	3:10	2:15	2:25	2:50	2:10	R6	2:20	3:05
R7	2:55	3:15	2:50	3:10	2:35	R7	2:55	3:10	3:45	2:40	2:55	3:25	2:35	R7	3:15	3:00

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
Region	Midday		Midday		Evening	Region	Midday			Midday			Evening	Region	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather		Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather		Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	2:40	2:40	2:15	2:20	2:10	R1	2:40	2:40	3:20	2:10	2:20	2:55	2:10	R1	2:15	2:30
R2	2:20	2:20	1:50	2:00	2:10	R2	2:20	2:20	2:50	1:50	2:00	2:30	2:10	R2	1:50	2:30
R3	3:10	3:25	3:00	3:20	2:40	R3	3:10	3:20	3:55	2:50	3:00	3:40	2:40	R3	3:25	3:25
2-Mile Ring and Downwind to 5 Miles																
R4	2:00	2:00	1:40	1:45	2:00	R4	2:00	2:00	2:30	1:40	1:45	2:10	2:00	R4	1:40	2:20
R5	2:10	2:20	1:50	2:00	2:10	R5	2:10	2:20	2:50	1:50	2:00	2:30	2:10	R5	1:50	2:20
5-Mile Ring and Downind to EPZ Boundary																
R6	2:45	3:00	2:35	2:50	2:20	R6	2:45	3:00	3:25	2:25	2:40	3:10	2:20	R6	2:35	3:20
R7	3:10	3:30	3:05	3:30	2:50	R7	3:10	3:30	4:00	2:50	3:10	3:40	2:50	R7	3:30	3:15

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Jazz Festival	Midweek Construction + Refueling
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)	(14)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile Region, 5-Mile Region, and EPZ																
R1	4:00	4:00	4:00	4:00	4:00	R1	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R1	4:00	4:00
R2	4:00	4:00	4:00	4:00	4:00	R2	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R2	4:00	4:00
R3	4:05	4:10	4:05	4:10	4:05	R3	4:05	4:10	5:10	4:05	4:05	5:10	4:05	R3	4:30	4:10
2-Mile Ring and Downwind to 5 Miles																
R4	4:00	4:00	4:00	4:00	4:00	R4	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R4	4:00	4:00
R5	4:00	4:00	4:00	4:00	4:00	R5	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R5	4:00	4:00
5-Mile Ring and Downind to EPZ Boundary																
R6	4:05	4:10	4:05	4:10	4:00	R6	4:05	4:10	5:00	4:00	4:00	5:00	4:00	R6	4:05	4:10
R7	4:00	4:10	4:00	4:10	4:00	R7	4:00	4:00	5:00	4:00	4:00	5:00	4:00	R7	4:30	4:00

Table 7-2. Description of Evacuation Regions						
		Protective Action Area				
Region	**Description**	**1**	**2**	**3**	**4**	**5**
R01	2-Mile Ring	X				
R02	5-Mile Ring	X	X	X		
R03	Full EPZ	X	X	X	X	X
Evacuate 2-Mile Ring and 5 Miles Downwind						
		Protective Action Area				
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**
R04	SSE,S,SSW,SW,WSW	X	X			
	W,WNW,NW,NNW,N,NNE	**Refer to Region R01**				
R05	NE,ENE,E	X		X		
	ESE,SE	**Refer to Region R02**				
Evacuate 5-Mile Ring and Downwind to EPZ boundary						
		Protective Action Area				
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**
R06	SSE,S,SSW,SW	X	X	X	X	
	WSW,W,WNW,NW,NNW,N	**Refer to Region R02**				
R07	NNE,NE,ENE	X	X	X		X
	E,ESE,SE	**Refer to Region R03**				

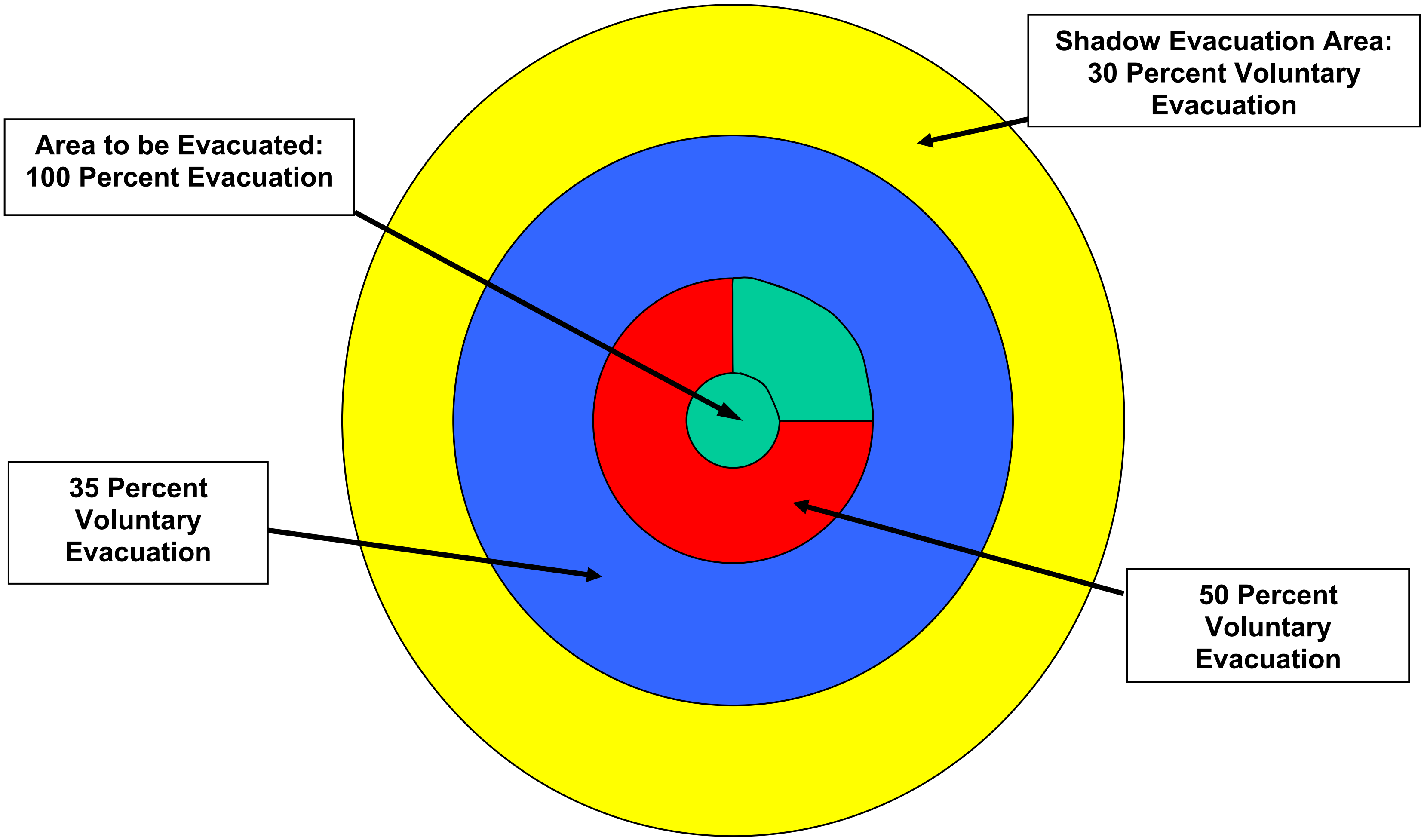


Figure 7-1. Assumed Evacuation Response

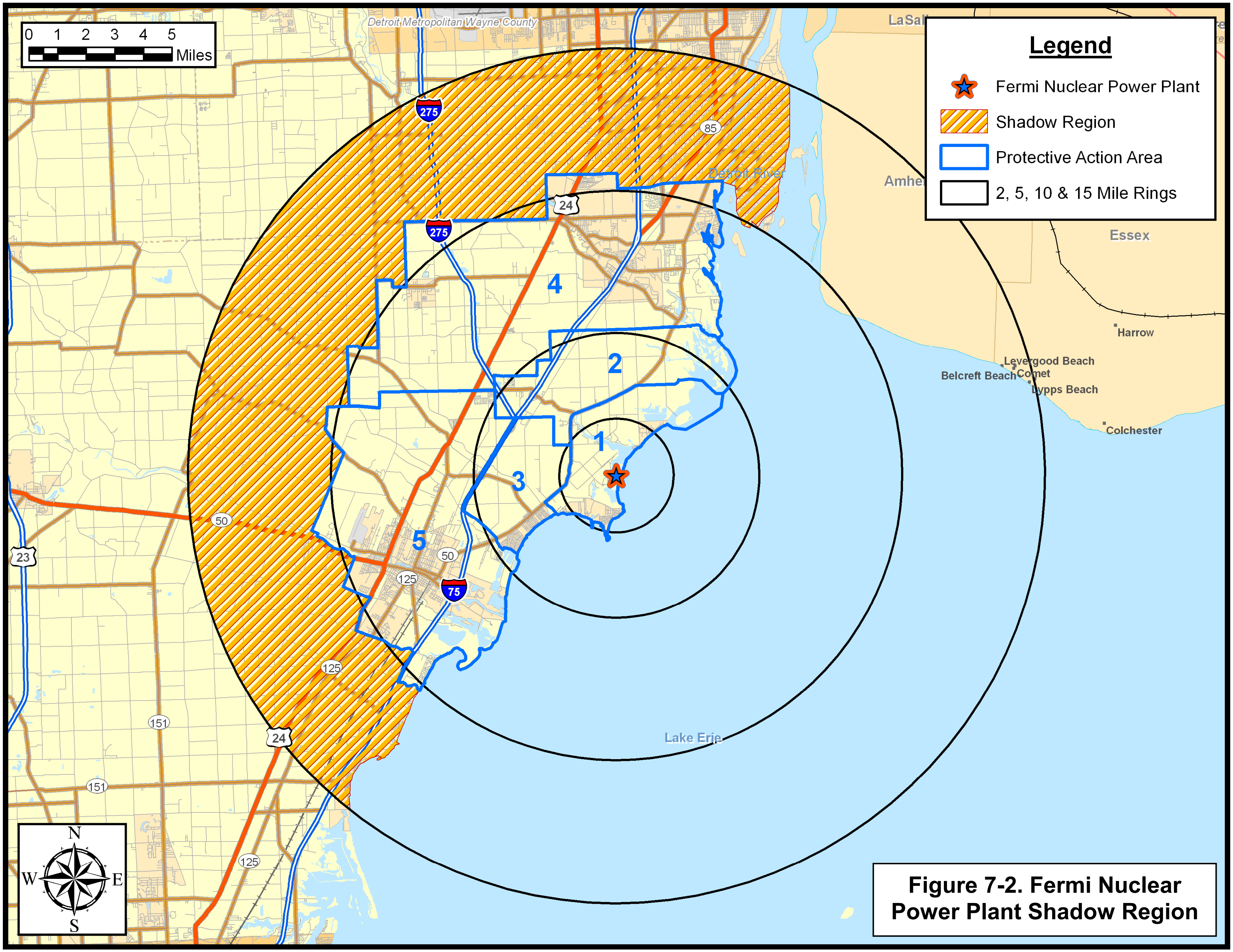


Figure 7-2. Fermi Nuclear Power Plant Shadow Region

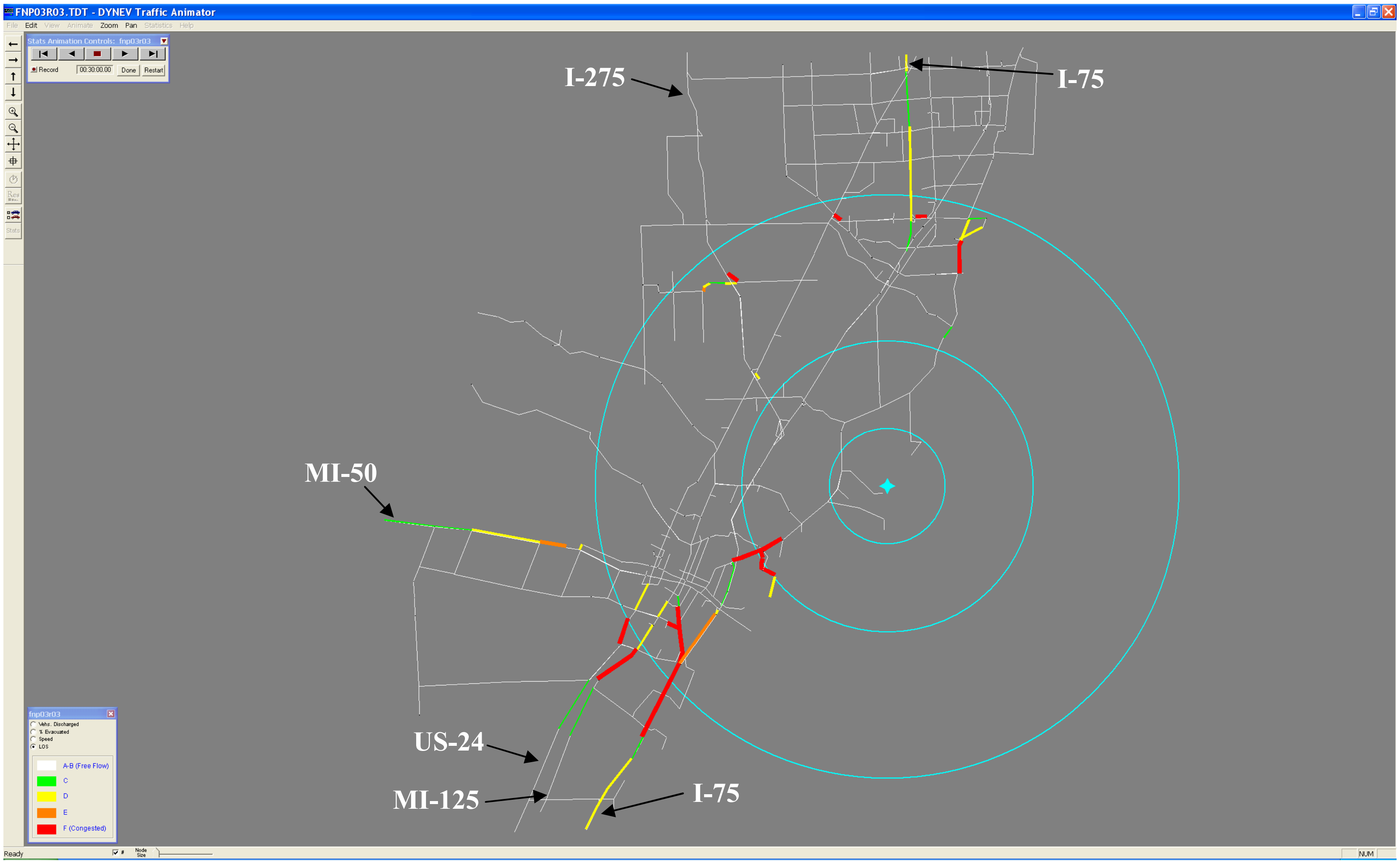


Figure 7-3. Congestion Patterns at 30 Minutes After the Advisory to Evacuate (Scenario 3, Region R03)

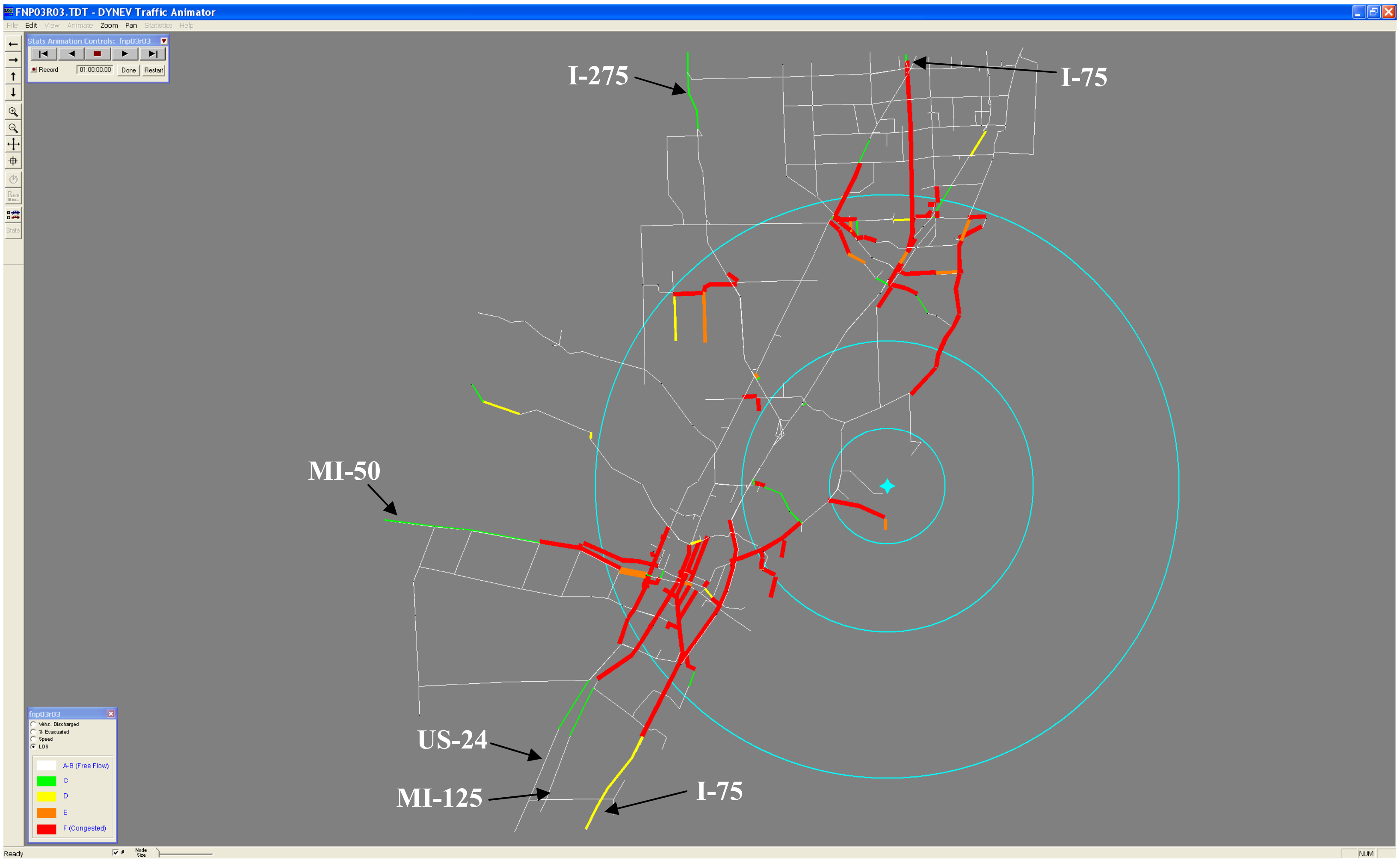


Figure 7-4. Congestion Patterns at 1 Hour After the Advisory to Evacuate (Scenario 3, Region R03)

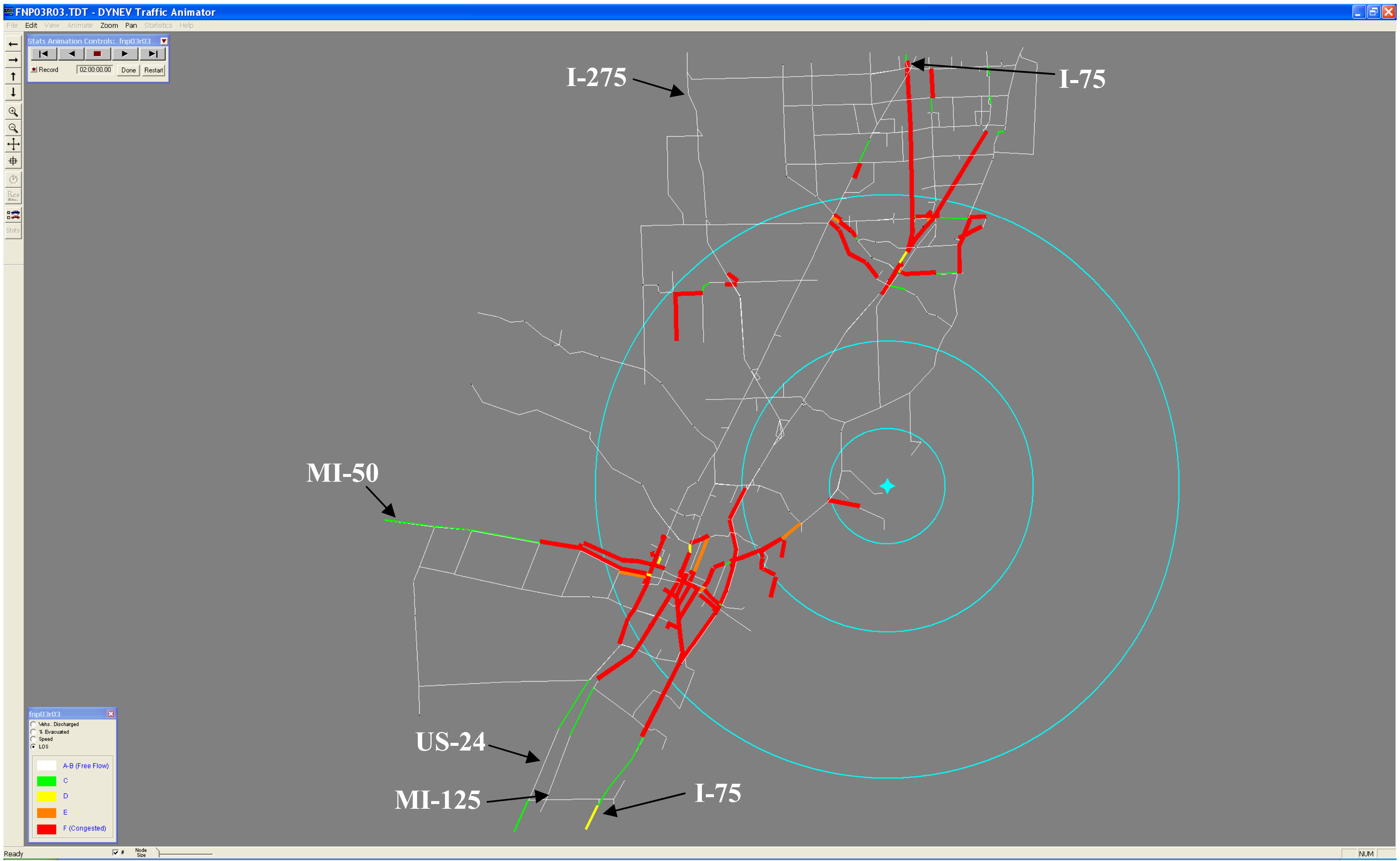


Figure 7-5. Congestion Patterns at 2 Hours After the Advisory to Evacuate (Scenario 3, Region R03)

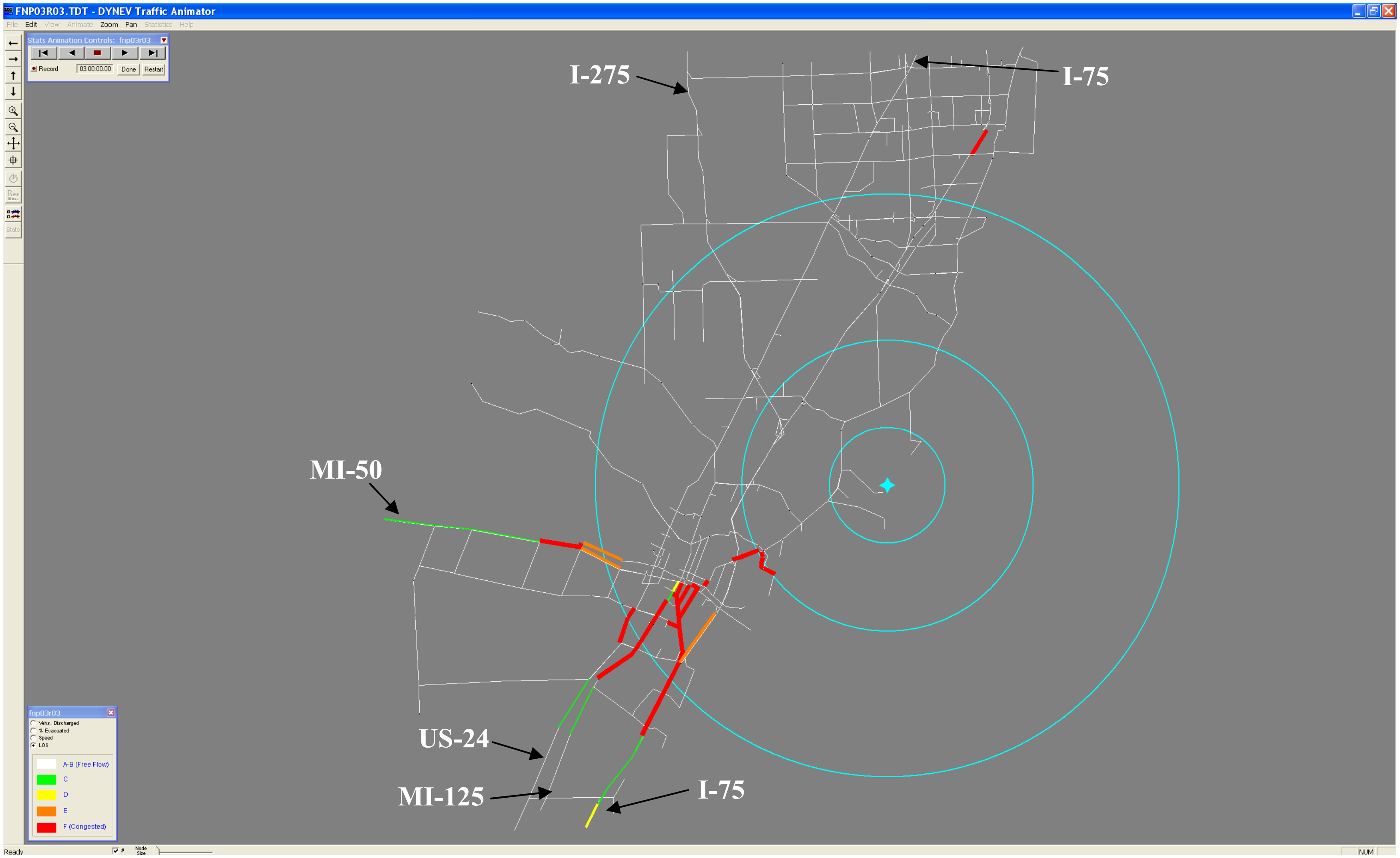


Figure 7-6. Congestion Patterns at 3 Hours After the Advisory to Evacuate (Scenario 3, Region R03)

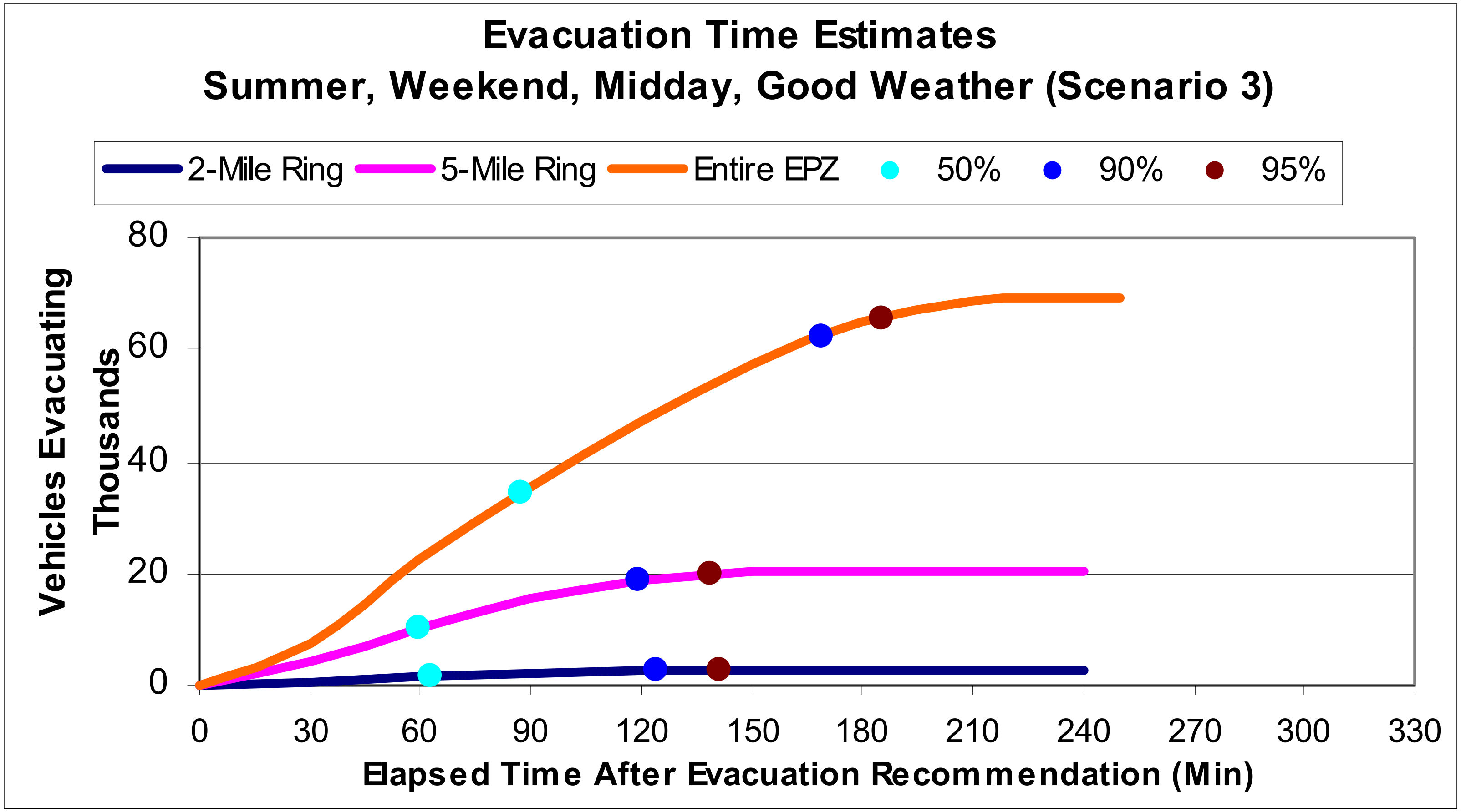


**Figure 7-7. Evacuation Time Estimates for FNPP
Summer, Weekend, Midday, Good Weather
Evacuation of Region R03 (Entire EPZ)**

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 larger 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 the county plans, it is estimated that bus mobilization time will range from 15 to 45 minutes extending from the Advisory to Evacuate to the time when buses arrive at their respective assignments for Monroe County, and 60 minutes for Wayne County.

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 members 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 to speed the evacuation of the school children 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 at school by their parents as 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 host schools

8.1 Transit-Dependent People - Demand Estimate

The telephone survey (see Appendix F) results for persons in households that do not have a vehicle were used to estimate the portion of the population requiring transit service.

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

- Estimates of persons requiring transit vehicles include school children. For those evacuation scenarios where children are at school when an evacuation is ordered, 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 1,253 people. Therefore, a total of 42 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 Fermi EPZ:

$P = 38{,}000 \text{ x } (0.042 \times 1.57)$
$P = 38{,}000 \text{ x } (0.06594) = 2{,}506$
$B = (0.5 \times P) \div 30 = 42$

These calculations are explained as follows:

- All members (1.57 avg.) of households (HH) with no vehicles (4.2%) will evacuate by public transit or ride-share. The term 38,000 (total households) x 0.042 x 1.87, accounts for these people.
- Households with 1 or more vehicles are assumed to have no need for transit vehicles.

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 that 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, 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. Some parents will likely pick up their children at school, although they are asked to pick children up at the host schools. Those buses originally allocated to evacuate school children 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.

Page C13, Annex C, Appendix 1, Attachment C of the Emergency Management Plan for Monroe County indicates that Monroe County School District has 315 vehicles, most of which are 64-78 passenger buses. As shown in Table 8-2A, 271 buses are needed to evacuate the schools within the Monroe County portion of the EPZ. Thus, there are sufficient buses to evacuate Monroe County schools in a single wave.

Item A under section IV of Annex M (page M-2) of the Wayne County Emergency Operations Plan states, "The RESA [Wayne County Regional Educational Services Agency] will provide the necessary transportation resources to provide for the emergency evacuation and/or transportation of school students, staff, and area residents as needed for the duration of the disaster situation." Based on telephone conversations with the school district transportation departments, there are 30 and 14 buses available for the Gibraltar and Flat Rock School Districts, respectively. As shown in Table 8-2B, 112 buses are needed for Wayne County. According to the transportation director for Wayne County RESA, school districts would call the Emergency Operations

Center (EOC) if additional bus resources are needed. The transportation director would then assign buses from neighboring school districts to assist in the evacuation. Therefore, it is assumed that the additional 68 buses needed (112 – 30 – 14) will be provided by neighboring school districts, through the EOC and RESA, so that Wayne County schools can be evacuated in a single wave. There are 1,440 buses available county-wide.

Table 8-3 presents a list of the host schools for the various school districts in the EPZ. Those students not picked up by their parents prior to the arrival of the buses, will be transported to these schools 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 May, 2008. Approximately 950 people have been identified as living in, or being treated in, these facilities. This census also indicates the number of wheelchair-bound people and the number of bed-ridden people. The transportation requirements for this group are also presented. The number of ambulance runs is determined by assuming that 2 patients can be accommodated per ambulance trip; the number of specially equipped bus runs is based on the data presented in Table 8-10; buses can transport 15 patients, and the number of bus runs estimated assumes 30 ambulatory patients per trip.

8.4 Evacuation Time Estimates for Transit-Dependent People

As discussed in Section 8.2, the available bus resources are sufficient in each county to service the school evacuation demand in a "single-wave", assuming drivers are available for all vehicles. In general, the buses will transport the evacuees to the appropriate host school and return to the EPZ for a second trip to service transit dependent people and other special facilities, if needed.

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 host schools 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 (Tables 8-7A and B). Of course, if the impacted Evacuation Region is other than R03 (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.

For each county, transit resources will be assigned to schools as a first priority. When these 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 along the pick-up routes.

ETE 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.

<u>Activity: Mobilize Drivers (A→B→C)</u>

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses have arrived at the facility to be evacuated. Based on the existing county plans, drivers will require 45 minutes to mobilize in Monroe County (some exceptions apply) and 60 minutes to mobilize in Wayne County. Mobilization time is assumed to be 10 minutes longer when raining to account for slower travel times.

<u>Activity: Board Passengers (C→D)</u>

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM Page 27-10). 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 30 minutes in good weather, and 40 minutes in rain.

<u>Activity: Travel to EPZ Boundary (D→E)</u>

<u>School Evacuation</u>

The UNITES software discussed in Section 1.3 was used to define bus routes along the most likely path from a school being evacuated to the EPZ boundary, traveling toward the appropriate relocation school. This is done in UNITES by interactively selecting the series of nodes from the school to the EPZ boundary. The bus route is given an identification number and is written to the IDYNEV input stream. UNITES computes the route length and PC-DYNEV outputs the average speed for each 10 minute interval for each bus route input. The travel times to the EPZ boundary are computed from the route length and the speeds output by the model (at the mobilization plus loading time). The bus routes input are documented in Table 8-9.

As shown in the figures in Appendix K, not all roadways are modeled, and some are modeled in one direction. Due to this, it is not possible to model full bus routes for some schools to the EPZ boundary. Generated speeds are used for the portion of the route that is modeled in the UNITES software, and free flow speeds of 35 mph (30 mph in rain) are applied to the un-modeled portion of the route.

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 Host School (H.S.). The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B→C, C→D, and D→E (For example: 45 min. + 5 + 27 = 1:20 (rounded to nearest 5 minutes) for North Elementary School, with good weather). The evacuation time to the Host School is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

<u>Evacuation of Transit-Dependent Population</u>

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 Section 5, about 90 percent of the evacuees (residents without commuters) will complete their mobilization when the first buses will begin their routes, 90 minutes after the Advisory to Evacuate (ATE).

Those buses servicing the transit-dependent evacuees will travel along their routes picking up those passengers who need transportation, then proceed out of the EPZ. Table 8-6 details the proposed bus routes to service the transit dependent people in the Fermi EPZ, while Figure 8-2 maps the proposed bus pick-up routes. *These routes were designed solely for estimating ETE for the transit-dependent population within the EPZ. It is not an indication that these routes must be used in the event of an emergency at the Fermi Nuclear Power Plant.*

The aforementioned bus route feature in UNITES was used to specify the transit dependent evacuation bus routes to the IDYNEV input stream. The average speed along the route output by PC-DYNEV was used to calculate the route travel time; Tables 8-7A and 8-7B provide the ETE for the buses servicing the transit-dependent population in good weather and rain, respectively. The routes input to UNITES are documented in Table 8-9.

Routes 1 through 4 service the City of Monroe, which accounts for nearly half of the EPZ population. The transit dependent population is expected to be highest in this area, thus the majority of the buses are allocated to the City of Monroe. The buses on these routes have been spaced at 3 minute headways with the first bus arriving at the route at 90 minutes after the ATE and the last bus arriving at 114 minutes after the ATE. The use of bus headways is intended to provide a more robust service by servicing those transit-dependent persons that may need more time to mobilize.

Table 8-7 presents the transit-dependent population evacuation time estimates for each route obtained using the above procedures. For example, the ETE for the first bus traversing Route 6 is computed as 90 + 25 + 30 = 2:25 for good weather. Here, 25 minutes is the time to travel 10.2 miles at 24.5 mph (average speed output by PC-DYNEV). The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers.

Activity: Travel to Host Schools (E→F)

The distances from the EPZ boundary to the host school are also measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ to the host school. 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. EPZ schools were routed to the appropriate host school depending on what district the EPZ school is in.

Activity: Passengers Leave Bus (F→G)

Passengers can deboard within 5 minutes. The bus driver takes a 10 minute break.

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 buses that evacuated the schools. Thus, the mobilization time for the second wave is the average time that buses arrive at the host schools (See Table 8-5). The travel time back to the EPZ is the average of the travel time to the host school from Table 8-5 - 16 minutes for good weather and 18 minutes for rain. The bus then travels its route and picks up transit-dependent evacuees along the route. The route-specific average speed output by PC-DYNEV at the time the buses begin the second wave is used to compute the route travel time.

The Second Wave ETE for Bus Route Number 6 is computed as follows for good weather:

- Bus arrives at host school at 1:25 in good weather (average of "ETE to H.S (min)" column in Table 8-5A).
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to EPZ: 16 minutes (average of travel time to host school in Table 8-5A).
- Bus completes pick-ups along route and departs EPZ: 30 minutes + (10.2 miles @ 24.5 mph) = 55 minutes.
- Bus exits EPZ at time 1:25 + 0:15 + 0:16 + 0:55 = 2:55 (rounded up to the nearest 5 minutes) after the Advisory to Evacuate.

ETE for single wave and second wave evacuations are provided in Tables 8-7A and B. Single wave ETE are applicable when school is not in session or when school is in session and there are sufficient bus resources available to service school children and the transit dependent general population simultaneously. In the event there are not sufficient buses available to transport the transit dependent until the evacuation of the school children has been completed, the second wave ETE will apply. The ETE for the transit-dependent population approximate, on average, the ETE for the 100th percentile of the general population.

Evacuation of Ambulatory Persons from Special Facilities

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

- Buses are assigned on the basis of 30 patients to allow for staff to accompany the patients.
- The passenger loading time will be longer at approximately one minute per patient to account for the time to move patients from inside the facility to the vehicles. For those facilities with more than 30 ambulatory patients, it is assumed that buses load concurrently and that loading time is equal to 30 minutes for the entire facility.

It is estimated that mobilization time averages 1 hour. In the event there is a shortfall of transit vehicles for a single wave evacuation, then buses used to evacuate schools will have to return to evacuate the special facilities for a "second wave" evacuation. The aforementioned bus route feature in the UNITES software was used to define bus routes along the most likely path from a special facility being evacuated to the EPZ boundary. Buses are routed west towards the medical host facilities as shown in Figure 8-3. The average speed along the route output by PC-DYNEV was used to calculate the route travel time; Tables 8-8A and 8-8B provide the ETE for a single and two wave evacuation for buses evacuating ambulatory persons from special facilities in good weather and rain, respectively. The routes input to UNITES for these facilities are documented in Table 8-9.

Evacuation of Wheelchair Bound Persons from Special Facilities

Table 8-4 indicates that 9 standard bus runs and 27 specially equipped bus runs are needed to evacuate all of the wheelchair bound population within the entire EPZ. As stated in Section 2.3, it is assumed that half of the wheelchair bound persons in the EPZ use rigid wheelchairs while the other half use folding wheelchairs. Those wheelchair-bound persons using folding wheelchairs can be evacuated in a standard bus and their wheelchair can be folded and placed in the rear of the bus or in the seat adjacent to the seat they are sitting in. Those wheelchair-bound persons using rigid wheelchairs will need to be evacuated in specially equipped buses. Loading times are estimated at 5 minutes per wheelchair bound person as staff will have to assist them in boarding the bus. For those facilities with more than 15 (wheelchair bus capacity) wheelchair bound persons, it is assumed that buses load concurrently and that the loading time is equal to 75 minutes (15 x 5) for the entire facility. According to Table 8-10, there are 36 specially equipped buses available with a total wheelchair capacity of 99; thus, average capacity is 2.75 wheelchairs per vehicle. Based on a loading time of 5 minutes per person, a loading time of 15 minutes, on average, will be used for these vehicles.

A mobilization time of 1 hour is estimated for standard buses and specially equipped buses needed to evacuate ambulatory and wheelchair bound persons from special facilities, with an additional 10 minutes needed in rain. The route travel time is computed using the aforementioned UNITES bus route feature and the route-specific speed output by DYNEV at the time the transit vehicle leaves the facility being evacuated. If there are not sufficient buses to evacuate schoolchildren and ambulatory patients and wheelchair bound patients from special facilities concurrently, a second wave evacuation will be needed. Those buses returning to perform a second wave evacuation of wheelchair bound and ambulatory patients would be the buses that evacuated the schoolchildren. As such, the mobilization time for these buses would be the sum of the time to arrive at the reception center, unload the bus, allow time for driver rest and return to the EPZ (all of which are taken from Table 8-5).

Tables 8-11A and 8-11B provide single-wave and two-wave ETE for buses evacuating wheelchair bound patients in folding wheelchairs for good weather and for rain, respectively. Tables 8-12A and 8-12B provide single-wave ETE for specially equipped buses evacuating wheelchair bound patients using rigid wheelchairs for good weather and for rain, respectively. As shown in Table 8-10, there are sufficient specially equipped bus resources available to evacuate those using rigid wheelchairs in a single wave.

The ETE for the ambulatory and wheelchair bound patients at special facilities, on average, do not exceed the 100^{th} percentile ETE of the general population.

Emergency Medical Services (EMS) Vehicles

The previous discussion focused on transit operations for ambulatory persons residing at medical facilities within the Evacuation Region. It is also necessary to provide transit services to non-ambulatory persons who do not – or cannot – have access to private vehicles. Based on the data provided in Table 8-4, a total of 21 ambulance runs (assuming 2 people per ambulance) are needed to evacuate all of the bed ridden patients in the EPZ, all of which are at facilities within the City of Monroe in Monroe County. These ambulances will be provided by EMS providers within the EPZ and neighboring cities. Annex K to Attachment A (page K-6 and K-7) of the Monroe County Emergency Management Plan indicates that 69 total ambulances are available to Monroe County; 29 of which are available within 25 miles of the City of Monroe, the remainder of which are in Lansing, Michigan, approximately 50 miles from the City of Monroe. Although it is indicated in Table 8-4 that no ambulances are needed for Wayne County, the county has access to approximately 60 ambulances from several different ambulance companies and fire departments.

It is reasonable to assume that ambulances will travel at approximately 50 mph from neighboring cities, given that they are traveling counter to the evacuation flow and that they are emergency vehicles which always have right of way. It is estimated that at most 30 minutes (25 miles at 50 mph) will be needed to mobilize ambulances and travel to the medical facilities. Mobilization time is 5 minutes longer in rain. Loading times are conservatively estimated as 30 minutes. As with the buses transporting ambulatory patients, the average speed along the route output by PC-DYNEV was used to calculate the route travel time; Tables 8-13A and 8-13B provide the ETE for a single wave evacuation for ambulances evacuating bedridden persons from special facilities in good weather and rain, respectively. The routes input to UNITES for these facilities are documented in Table 8-9. All ETE are rounded up to the nearest 5 minutes.

8.5 Evacuation of Homebound Special Needs Population

It is the responsibility of the Off-site Response Organizations (ORO) to compile an “Evacuation Registry” for the people within the EPZ. The back flap of the 2007-2008 “Emergency Preparedness for Monroe and Wayne Counties” public information booklet provides registration cards for homebound (not in a special facility) special needs population, including “wheelchair disabled” persons and those persons “confined to bed.” The findings of the recent NRC public telephone survey[1] indicate that special needs registration data are not reliable, as approximately two-thirds of special needs people do not register with their local emergency response agency.

The National Organization on Disability (NOD) discusses locating people with special needs in neighborhoods in the United States at the below listed site:

(www.nod.org/index.cfm?fuseaction=Feature.showFeature&FeatureID=1100)

Additionally, privacy concerns can impede the efforts of ORO agencies; confidentiality must be assured to encourage caretakers to register.

Given these limitations, the ETE for the homebound special needs population was computed as follows:

- Estimate that 15% of non-institutionalized transit-dependent persons have a disability. This is based on the 2006 American Community Survey (ACS), U.S. Census Bureau.
- Disabilities include Sensory (4.3%); Physical (4.4%); Mental (5.8%); Self-care (3.0%). (Note: This adds to more than 15% due to multiple disabilities)
- Assume caretakers are available to the extent that one-fifth of persons with disabilities can evacuate with transit dependent persons without disabilities,

[1] Jones, J., et. al. Review of NUREG-0654, Supplement 3, “Criteria for Protective Action Recommendations for Severe Accidents” - Focus Groups and Telephone Survey, NUREG/CR-6953, Vol. 2, Sandia National Laboratories, Pages viii, ix and 33.

using transit vehicles on routes. This leaves 12% of this population to be picked up at home. As shown in Table 8-1, it is estimated that there are 1,253 transit-dependent persons in the EPZ, which includes homebound special needs persons.

- Estimate population requiring transit pickup:
  a. 8% of this population for bus service (0.08 x 1253 = 100 persons and 100 caretakers);
  b. 3% of this population for specially equipped bus service (40 persons plus 40 caretakers), and
  c. 1% of this population for ambulance service (13 persons with 13 caretakers).
- Standard buses will be used to transport those wheelchair bound persons with folding wheelchairs, while specially equipped buses will be used to transport those wheelchair bound persons with rigid wheelchairs. It is assumed that half of the wheelchair bound persons use folding wheelchairs and half use rigid. Thus, 20 persons plus 20 caretakers will be evacuated using standard buses and 20 persons plus 20 caretakers will be evacuated using specially equipped buses. Wheelchair bus capacity is 15 persons plus wheelchairs, while specially equipped bus capacity is 4 persons plus wheelchairs plus 4 caretakers.
- The vehicle requirements would be:
  a. Bus Service - 10 bus trips, 20 persons per trip, or 10 stops per trip
  b. Wheelchair Bus Service – 3 bus trips, 7 persons plus wheelchairs plus 7 caretakers per trip, or 7 stops per trip
  c. Specially Equipped Bus Service - 5 bus trips, 4 persons plus wheel chairs plus 4 caretakers per trip, or 4 stops per trip
  d. Ambulance Service - 7 ambulance trips, 2 persons plus caretakers per trip, or 2 stops per trip
- The associated ETE depends in part on the time after the ATE that the vehicles become available. It is reasonable to expect that the buses that have evacuated the school children for the midweek, winter scenarios will return to the EPZ to transport the special needs persons in a single wave. In good weather these buses will arrive at the host schools at an average ETE of 1:25 (1 hr 25 min) (see Table 8-5A). Allowing 30 minutes for the buses to unload, for the drivers to rest and for the return trip to the EPZ, the first pick-up should occur at 1:55 (1 hr 55 min).
  a. Bus Service - Estimating travel at 15 mph over a one-mile distance separating stops (4 minutes travel time), on average, and one minute to board two persons, yields 5 minutes per stop. Since there are 9 stops after the first, a total of 45 minutes are required to complete the pickup of 20 persons. The last pick-up is completed at 1:55 + 0:45 = 2:40 (2 hr 40 min). Adding travel time to the EPZ boundary (5 miles @ 15 mph) yields an ETE = **<u>3:00</u>** (3 hr).

     For rain, the average ETE to host schools is 1:50 (1 hr 50 min) (see Table 8-5B), assume 10 additional minutes needed for unloading, driver rest and return trip to EPZ, and allowing 6 minutes per stop at 12 mph yields an ETE of:

1:50 + 40 + 9 x 6 + 5mi @ 12 mph = **3:50** (3 hr 50 min)

b. Wheelchair Bus Service - Compared with the 10 bus trips analyzed above, these 3 buses are estimated to spend six (6) minutes at each stop to board a non-ambulatory person and to secure a wheel chair. This yields 10 minutes per stop, or 6 x 10 + 6 minutes from the bus arrival at the first stop until completion of boarding at the seventh and last stop. Then the ETE is estimated at 1:55 + 1:06 + 0:20 (5 miles @ 15 mph) = **3:20** (3 hr 20 min). For rain, allowing 12 minutes per stop, the ETE is 1:50 + 0:40 + 6 x 12 + 6 + 5mi @ 12mph = **4:15** (4 hr 15 min).

c. Specially Equipped Bus Service – These 5 specially equipped buses are also assumed to travel at 15 mph over a one-mile distance separating stops (4 minutes travel time) and are estimated to spend 6 minutes at each stop to board a non-ambulatory person and to secure a wheel chair. This yields a total of 40 minutes for the 4 stops serviced by each specially equipped bus. The vehicles servicing these people will be resources from Bedford Schools (see Table 8-10). It is estimated that 60 minutes will be needed to mobilize these resources. The ETE for these vehicles is estimated at 1:00 + 0:40 + 5mi @ 15mph = **2:00** (2 hr). For rain, allowing 12 minutes per stop, the ETE is 1:00 + 0:48 + 5 mi @ 12mph = **2:15** (2 hr 15 min).

d. Ambulance Service - Allowing about 15 minutes at each stop and assuming that the ambulances are those that completed their first trip at 1:10 (see average ETE in Table 8-13A), the ETE is estimated at 1:10 + 0:15 + 0:15 + 0:15 + 0:15 + 0:20 + 0:20 = **2:50** (2 hr 50 min). Here, 15 minutes are estimated to unload the ambulance at the host facility, 15 minute rest for driver, 15 minutes to return to EPZ and travel to first stop, 15 minutes to load patient, 20 minutes for second stop and 20 minutes to leave the EPZ. For rain, the ETE would be about **3:30** (3 hr 30 min).

- In general, the ETE for the special needs population is within that for 100% of the general population.
- For the 10 bus trips servicing the ambulatory population, assuming 20 persons per trip and for the 3 bus trips servicing the wheelchair bound population, assuming 14 persons plus wheel chairs per trip analyzed above, the ETE values presented will be reduced by 55 minutes (1:55 - 1:00 mobilization) if there is no need to evacuate school children.

8.6 Evacuation of Inmates at Correctional Facilities

There are two correctional facilities within the Fermi 3 EPZ – Monroe City Jail Facility #1 and Facility #2 – as indicated in Table E-8. Based on discussions with the Monroe County Sheriff Department, school buses provided by the Monroe County School

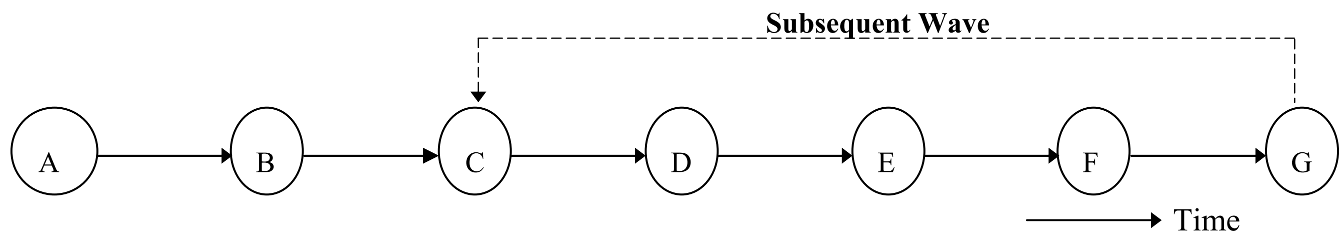
System would be used to transport prisoners from these facilities. As indicated in Table E-8, there are 343 inmates at these facilities. Assuming a bus capacity of 30 inmates, 12 buses would be needed. Mobilization time of buses would be 30 minutes to 1 hour, according to the sheriff's department. Monroe County has verbal agreements with Lucas County, Washtenaw County, Lenawee County and Wayne County to house these displaced inmates in the event of an evacuation. The following jails are located within these counties:

- Mound Correctional Facility in Wayne County, Michigan
- Ryan Correctional Facility in Wayne County, Michigan
- Gus Harrison Correctional Facility in Lenawee County, Michigan
- Huron Valley Complex in Washtenaw County, Michigan
- Toledo Correctional Institution in Lucas County, Ohio

It is assumed that loading time is 1 minute per passenger to account for additional security measures that will be taken, for a total loading time of 30 minutes per bus.

The ETE for the inmates at the Monroe City Jail is computed as follows:

- Mobilization time is 60 minutes.
- Loading time is 30 minutes.
- Lucas County is located to the south of the City of Monroe; Lenawee County is located to the west; Washtenaw is located to the northwest; and Wayne County is located to the north. Therefore, evacuation to any of these counties would require leaving the EPZ southbound to avoid traveling closer to Fermi 3.
- Facility #1 would evacuate southbound on State Highway 125 to depart the EPZ – a 2.5 mile route.
- Facility #2 would evacuate southbound on Laplaisance Rd. to access Interstate-75 southbound and depart the EPZ – a 2.5 mile route.
- A travel speed of 20 mph is used for buses evacuating these facilities to account for congestion within the City of Monroe.
- Therefore, estimated travel time to the EPZ boundary is 7.5 minutes.
- ETE = 60 + 30 + 7.5 or 1:40 (1 hr 40 min) when rounded to the nearest 5 minutes.



Event

A	Advisory to Evacuate
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Pick-up Route
D	Bus Departs for Host School
E	Bus Exits Region
F	Bus Arrives at Host School
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 Host School 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	2008 EPZ Population	Survey Average Household Size With 0 Vehicles	Estimated Number of Households	Survey Percent Households With 0 Vehicles	Survey Percent Households With Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent of Population Requiring Public Transit
Fermi Nuclear Power Plant	103,343	1.57	38,000	4.2%	62%	2,506	50%	1,253	1.2%

Table 8-2A. Monroe County Schools				
PAA	School Name	District	Enrollment	Bus Runs Required
1	North Elementary School	Jefferson	425	7
2	Neidermeier Elementary School	Airport	306	5
2	St. Charles School	Private	194	4
3	Jefferson High School	Jefferson	775	16
3	Jefferson Middle School	Jefferson	365	8
3	Sodt Elementary School	Jefferson	344	5
4	Airport Senior High School	Airport	1,050	21
4	Carleton Country Day*	Airport	114	3
4	Eyler Elementary School	Airport	300	5
4	Ritter Elementary School	Airport	300	5
4	St. Patrick School*	Airport	134	3
4	Sterling Elementary School	Airport	313	5
4	Wager Junior High School	Airport	740	15
5	Cantrick Middle School	Monroe	554	12
5	Christiancy Elementary School	Monroe	262	4
5	Custer Elementary School #1	Monroe	650	10
5	Custer Elementary School #2	Monroe	294	5
5	Hollywood Elementary School	Monroe	237	4
5	Holy Ghost Lutheran School*	Monroe	100	2
5	Hurd Elementary School	Jefferson	420	6
5	Lincoln Elementary School	Monroe	271	4
5	Lutheran High School South*	Airport	36	1
5	Manor Elementary School	Monroe	406	6
5	Monroe Middle School	Monroe	941	19
5	Monroe Senior High School	Monroe	2,130	43
5	Orchard Center High School	Monroe	175	4
5	Pathway Christian Academy/ Daycare	Monroe	138	3
5	Raisinville Elementary School	Monroe	425	7
5	Riverside Elementary School	Monroe	162	3
5	S. Monroe Townsite Elementary School	Monroe	138	2
5	St. John's School*	Monroe	211	5
5	St. Mary's Catholic Center High School*	Monroe	411	9
5	St. Mary's Parish School*	Monroe	248	5
5	St. Michael's School*	Monroe	185	4
5	Trinity Lutheran School*	Monroe	220	5
5	Waterloo Elementary School	Monroe	250	4
5	Zion Lutheran School*	Monroe	62	2
		Total	**14,286**	**271**

*Denotes Private School which evacuates with the schools of the public school district listed.

Table 8-2B. Wayne County Schools				
PAA	**School Name**	**District**	**Enrollment**	**Bus Runs Required**
4	Chapman Elementary School	Gibraltar	503	8
4	David Oren Hunter Elementary School	Gibraltar	422	7
4	Downriver High School	Gibraltar	62	2
4	Ethel C. Bobcean Elementary School	Flat Rock	483	7
4	Flat Rock / Gibraltar Head Start*	Gibraltar	175	3
4	Flat Rock Community High School	Flat Rock	568	12
4	Hellen C. Shumate Junior High School	Gibraltar	895	18
4	John M. Barnes Elementary	Flat Rock	429	7
4	Oscar A. Carlson High School	Gibraltar	1,074	22
4	Parsons Elementary School	Gibraltar	447	7
4	Simpson Middle School	Flat Rock	431	9
4	St. Mary's Rockwood Elementary School*	Gibraltar	220	4
4	Summit Academy/Summit Early Childhood Center	Flat Rock	403	6
		Total	**6,112**	**112**

*Denotes Private School which evacuates with the schools of the public school district listed.

Table 8-3. Host Schools	
School District	**Host School**
MONROE COUNTY	
Jefferson (Monroe)	Mason Senior High, Erie, MI
St. Charles (Newport)	St. Stephen School, New Boston, MI
Airport (Carleton)	Milan Senior High, Milan, MI
Monroe (Monroe)	Bedford Senior High, Temperance, MI
WAYNE COUNTY	
Gibraltar	Harry. S. Truman High School, Taylor, MI
Flat Rock	
St. Mary's (Rockwood)	

Table 8-4. Special Facility Transit Demand

PAA	Facility Name	Municipality	Capacity	Current Census	Ambulatory Patients	Wheel - chair Bound	Bed Ridden	Ambu- lance Runs	Wheel- chair Bus Runs[2]	Wheel- chair Van Runs[3]	Bus Runs[4]
Monroe County											
5	ALCC	Monroe	21	12	6	6	0	0	1	2	1
5	Alterra	Monroe	20	15	15	0	0	0	0	0	1
5	IHM Motherhouse	Monroe	210	192	177	13	2	1	1	2	6
5	Lutheran Home	Monroe	115	115	106	8	1	1	1	3	4
5	Maplewood Manor	Monroe	120	110	101	8	1	1	1	2	4
5	Medilodge II	Monroe	103	92	85	6	1	1	1	1	3
5	Mercy Memorial Hospital	Monroe	168	168	69	69	30	15	3	14	3
5	Mercy Memorial Nursing Center	Monroe	70	60	59	0	1	1	0	0	2
5	Tendercare of Monroe	Monroe	192	175	161	12	2	1	1	2	6
Wayne County											
4	Marybrook Residence	Flat Rock	12	11	10	1	0	0	0	1	1
		EPZ Totals:	**1,031**	**950**	**789**	**123**	**38**	**21**	**9**	**27**	**31**

[2] It is assumed that half of the wheelchair bound residents use folding wheelchairs and can be evacuated using a standard bus with a capacity of 15 wheelchair bound persons.

[3] It is assumed that half of the wheelchair bound residents use rigid wheelchairs and must be evacuated using a specially equipped bus or ambulance. The capacity of these transit vehicles varies as indicated in Table 8-10. The assignment of available vehicles to these facilities is provided in Table 8-10.

[4] The estimated bus runs can accommodate up to 40 patients each if population increases.

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Table 8-5A. School Evacuation Time Estimates - Good Weather									
Monroe County Schools									
North Elementary School	45	5	12.6	28.1	27	**1:20**	7.4	10	**1:30**
Neidermeier Elementary School	45	5	7.7	35.5	13	**1:05**	16.8	22	**1:25**
St. Charles School	45	5	11.1	19.6	34	**1:25**	5.9	8	**1:35**
Jefferson High School	45	5	7.9	18.3	26	**1:20**	7.4	10	**1:30**
Jefferson Middle School	45	5	7.6	18.3	25	**1:15**	7.4	10	**1:25**
Sodt Elementary School	45	5	9.2	17.3	32	**1:25**	7.4	10	**1:35**
Airport Senior High School	15	5	2.4	35.3	4	**0:25**	17.0	23	**0:50**
Carleton Country Day	15	5	1.3	38.1	2	**0:25**	17.0	23	**0:45**
Eyler Elementary School	45	5	2.3	46.2	3	**0:55**	17.2	23	**1:20**
Ritter Elementary School	45	5	6.9	37.9	11	**1:05**	17.3	23	**1:25**
St. Patrick School	45	5	1.5	44.4	2	**0:55**	16.5	22	**1:15**
Sterling Elementary School	45	5	2.6	38.6	4	**0:55**	16.8	22	**1:20**
Wager Junior High School	15	5	2.3	34.8	4	**0:25**	17.6	23	**0:50**
Cantrick Middle School	45	5	5.8	20.5	17	**1:10**	14.3	19	**1:30**
Christiancy Elementary School	45	5	4.2	19.4	13	**1:05**	6.3	8	**1:15**
Custer Elementary School #1	45	5	4.0	20.0	12	**1:05**	13.9	19	**1:25**
Custer Elementary School #2	45	5	4.0	20.0	12	**1:05**	13.9	19	**1:25**
Hollywood Elementary School	45	5	5.9	20.8	17	**1:10**	14.3	19	**1:30**
Holy Ghost Lutheran School	45	5	5.0	15.0	20	**1:10**	13.5	18	**1:30**
Hurd Elementary School	45	5	5.8	15.9	22	**1:15**	7.4	10	**1:25**
Lincoln Elementary School	45	5	4.8	19.2	15	**1:05**	15.0	20	**1:25**
Lutheran High School South	45	5	6.3	42.1	9	**1:00**	6.0	8	**1:10**
Manor Elementary School	45	5	3.7	11.6	19	**1:10**	15.1	20	**1:30**
Monroe Middle School	45	5	2.7	10.0	16	**1:10**	14.3	19	**1:25**
Monroe Senior High School	45	5	3.1	14.3	13	**1:05**	18.4	25	**1:30**
Orchard Center High School	45	5	4.7	18.8	15	**1:05**	7.3	10	**1:15**
Pathway Christian Academy/ Daycare	45	5	7.4	21.1	21	**1:15**	8.0	11	**1:25**
Raisinville Elementary School	45	5	2.9	14.5	12	**1:05**	18.4	25	**1:30**
Riverside Elementary School	45	5	6.1	19.3	19	**1:10**	14.9	20	**1:30**
S. Monroe Townsite Elementary School	45	5	3.8	13.4	17	**1:10**	15.1	20	**1:30**
St. John's School	45	5	2.8	10.4	16	**1:10**	6.4	9	**1:15**
St. Mary's Catholic Center High School	45	5	5.5	19.4	17	**1:10**	6.3	8	**1:15**
St. Mary's Parish School	45	5	5.5	19.4	17	**1:10**	6.3	8	**1:15**
St. Michael's School	45	5	5.6	19.8	17	**1:10**	6.8	9	**1:20**
Trinity Lutheran School	45	5	2.7	10.8	15	**1:05**	6.3	8	**1:15**
Waterloo Elementary School	45	5	3.0	12.0	15	**1:05**	18.7	25	**1:30**
Zion Lutheran School	45	5	6.9	20.7	20	**1:10**	6.3	8	**1:20**
Wayne County Schools									
Chapman Elementary School	60	5	3.5	17.5	12	**1:20**	10.7	14	**1:35**
David Oren Hunter Elementary School	60	5	1.7	34.0	3	**1:10**	10.7	14	**1:25**
Downriver High School	60	5	5.4	19.1	17	**1:25**	13.6	18	**1:40**
Ethel C. Bobcean Elementary School	60	5	3.5	16.2	13	**1:20**	8.7	12	**1:30**
Flat Rock / Gibraltar Head Start	60	5	3.7	15.9	14	**1:20**	8.7	12	**1:35**
Flat Rock Community High School	60	5	3.6	15.4	14	**1:20**	11.3	15	**1:35**
Hellen C. Shumate Junior High School	60	5	3.5	12.4	17	**1:25**	13.5	18	**1:40**
John M. Barnes Elementary	60	5	4.9	16.3	18	**1:25**	8.7	12	**1:35**
Oscar A. Carlson High School	60	5	3.5	12.4	17	**1:25**	13.5	18	**1:40**
Parsons Elementary School	60	5	3.2	14.6	13	**1:20**	13.5	18	**1:40**
Simpson Middle School	60	5	4.9	16.3	18	**1:25**	8.7	12	**1:35**
St. Mary's Rockwood Elementary School	60	5	3.2	17.5	11	**1:20**	10.7	14	**1:30**
Summit Academy/Summit Early Childhood Center	60	5	2.4	14.4	10	**1:15**	10.7	14	**1:30**
					Maximum for EPZ:	**1:25**		**Maximum:**	**1:40**
					Average for EPZ:	**1:10**		**Average:**	**1:25**

Table 8-5B. School Evacuation Time Estimates - Rain									
School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Monroe County Schools									
North Elementary School	55	10	12.6	13.3	57	**2:05**	7.4	11	**2:15**
Neidermeier Elementary School	55	10	7.7	30.8	15	**1:20**	16.8	25	**1:45**
St. Charles School	55	10	11.1	11.7	57	**2:05**	5.9	9	**2:15**
Jefferson High School	55	10	7.9	10.8	44	**1:50**	7.4	11	**2:00**
Jefferson Middle School	55	10	7.6	10.6	43	**1:50**	7.4	11	**2:00**
Sodt Elementary School	55	10	9.2	9.9	56	**2:05**	7.4	11	**2:15**
Airport Senior High School	25	10	2.4	35.3	4	**0:40**	17.0	26	**1:05**
Carleton Country Day	25	10	1.3	25.4	3	**0:40**	17.0	26	**1:05**
Eyler Elementary School	55	10	2.3	46.2	3	**1:10**	17.2	26	**1:35**
Ritter Elementary School	55	10	6.9	32.0	13	**1:20**	17.3	26	**1:45**
St. Patrick School	55	10	1.5	29.6	3	**1:10**	16.5	25	**1:35**
Sterling Elementary School	55	10	2.6	30.8	5	**1:10**	16.8	25	**1:35**
Wager Junior High School	25	10	2.3	34.8	4	**0:40**	17.6	26	**1:05**
Cantrick Middle School	55	10	5.8	13.9	25	**1:30**	14.3	21	**1:55**
Christiancy Elementary School	55	10	4.2	12.0	21	**1:30**	6.3	9	**1:35**
Custer Elementary School #1	55	10	4.0	14.1	17	**1:25**	13.9	21	**1:45**
Custer Elementary School #2	55	10	4.0	14.1	17	**1:25**	13.9	21	**1:45**
Hollywood Elementary School	55	10	5.9	14.2	25	**1:30**	14.3	21	**1:55**
Holy Ghost Lutheran School	55	10	5.0	5.8	52	**2:00**	13.5	20	**2:20**
Hurd Elementary School	55	10	5.8	10.9	32	**1:40**	7.4	11	**1:50**
Lincoln Elementary School	55	10	4.8	11.1	26	**1:35**	15.0	23	**1:55**
Lutheran High School South	55	10	6.3	37.9	10	**1:15**	6.0	9	**1:25**
Manor Elementary School	55	10	3.7	5.6	39	**1:45**	15.1	23	**2:10**
Monroe Middle School	55	10	2.7	7.3	22	**1:30**	14.3	21	**1:50**
Monroe Senior High School	55	10	3.1	9.3	20	**1:25**	18.4	28	**1:55**
Orchard Center High School	55	10	4.7	11.8	24	**1:30**	7.3	11	**1:40**
Pathway Christian Academy/ Daycare	55	10	7.4	10.6	42	**1:50**	8.0	12	**2:00**
Raisinville Elementary School	55	10	2.9	5.8	30	**1:35**	18.4	28	**2:05**
Riverside Elementary School	55	10	6.1	13.1	28	**1:35**	14.9	22	**1:55**
S. Monroe Townsite Elementary School	55	10	3.8	10.4	22	**1:30**	15.1	23	**1:50**
St. John's School	55	10	2.8	6.4	26	**1:35**	6.4	10	**1:45**
St. Mary's Catholic Center High School	55	10	5.5	12.7	26	**1:35**	6.3	9	**1:40**
St. Mary's Parish School	55	10	5.5	10.3	32	**1:40**	6.3	9	**1:50**
St. Michael's School	55	10	5.6	11.2	30	**1:35**	6.8	10	**1:45**
Trinity Lutheran School	55	10	2.7	7.3	22	**1:30**	6.3	9	**1:40**
Waterloo Elementary School	55	10	3.0	4.9	37	**1:45**	18.7	28	**2:10**
Zion Lutheran School	55	10	6.9	10.1	41	**1:50**	6.3	9	**1:55**
Wayne County Schools									
Chapman Elementary School	70	10	3.5	13.1	16	**1:40**	10.7	16	**1:55**
David Oren Hunter Elementary School	70	10	1.7	34.0	3	**1:25**	10.7	16	**1:40**
Downriver High School	70	10	5.4	15.4	21	**1:45**	13.6	20	**2:05**
Ethel C. Bobcean Elementary School	70	10	3.5	11.7	18	**1:40**	8.7	13	**1:55**
Flat Rock / Gibraltar Head Start	70	10	3.7	11.7	19	**1:40**	8.7	13	**1:55**
Flat Rock Community High School	70	10	3.6	12.0	18	**1:40**	11.3	17	**1:55**
Hellen C. Shumate Junior High School	70	10	3.5	9.1	23	**1:45**	13.5	20	**2:05**
John M. Barnes Elementary	70	10	4.9	12.3	24	**1:45**	8.7	13	**2:00**
Oscar A. Carlson High School	70	10	3.5	9.1	23	**1:45**	13.5	20	**2:05**
Parsons Elementary School	70	10	3.2	9.1	21	**1:45**	13.5	20	**2:05**
Simpson Middle School	70	10	4.9	12.3	24	**1:45**	8.7	13	**2:00**
St. Mary's Rockwood Elementary School	70	10	3.2	12.8	15	**1:35**	10.7	16	**1:55**
Summit Academy/Summit Early Childhood Center	70	10	2.4	11.1	13	**1:35**	10.7	16	**1:50**
					Maximum for EPZ:	**2:05**		**Maximum:**	**2:20**
					Average for EPZ:	**1:35**		**Average:**	**1:50**

Table 8-6. Summary of Transit Dependent Bus Routes

Route Number	Number of Buses	Route Description	Length (mi.)
1	8	Eastbound on Stoney Creek Rd to Michigan Highway 125. South on Michigan Highway 125 through Monroe and out of the EPZ.	12.5
2	8	Eastbound on Bluebush Rd to US Highway 24. South on US Highway 24 through Monroe and out of the EPZ.	8.9
3	8	Eastbound on Bluebush Rd to US Highway 24. South on US Highway 24 to North Custer Rd. West on North Custer Rd through Monroe and out of the EPZ.	9.1
4	8	Northbound on Interstate 75. Exit for Front Street. West on Front Street through Monroe and out of the EPZ.	9.4
5	3	Southbound on Interstate 275. Exit for Carleton-Rockwood Rd. West on Carleton-Rockwood Rd, through Carleton to Exeter Rd. North on Exeter Rd out of the EPZ.	7.3
6	4	Southbound on US Highway 24 to East Huron River Dr. East on East Huron River Dr to Jefferson Ave. North on Jefferson Ave out of the EPZ.	10.2
7	3	Southbound on Allen Road to Gibraltar Rd. West on Gibraltar Rd to US Highway 24. North on US Highway 24 out of the EPZ.	5.9

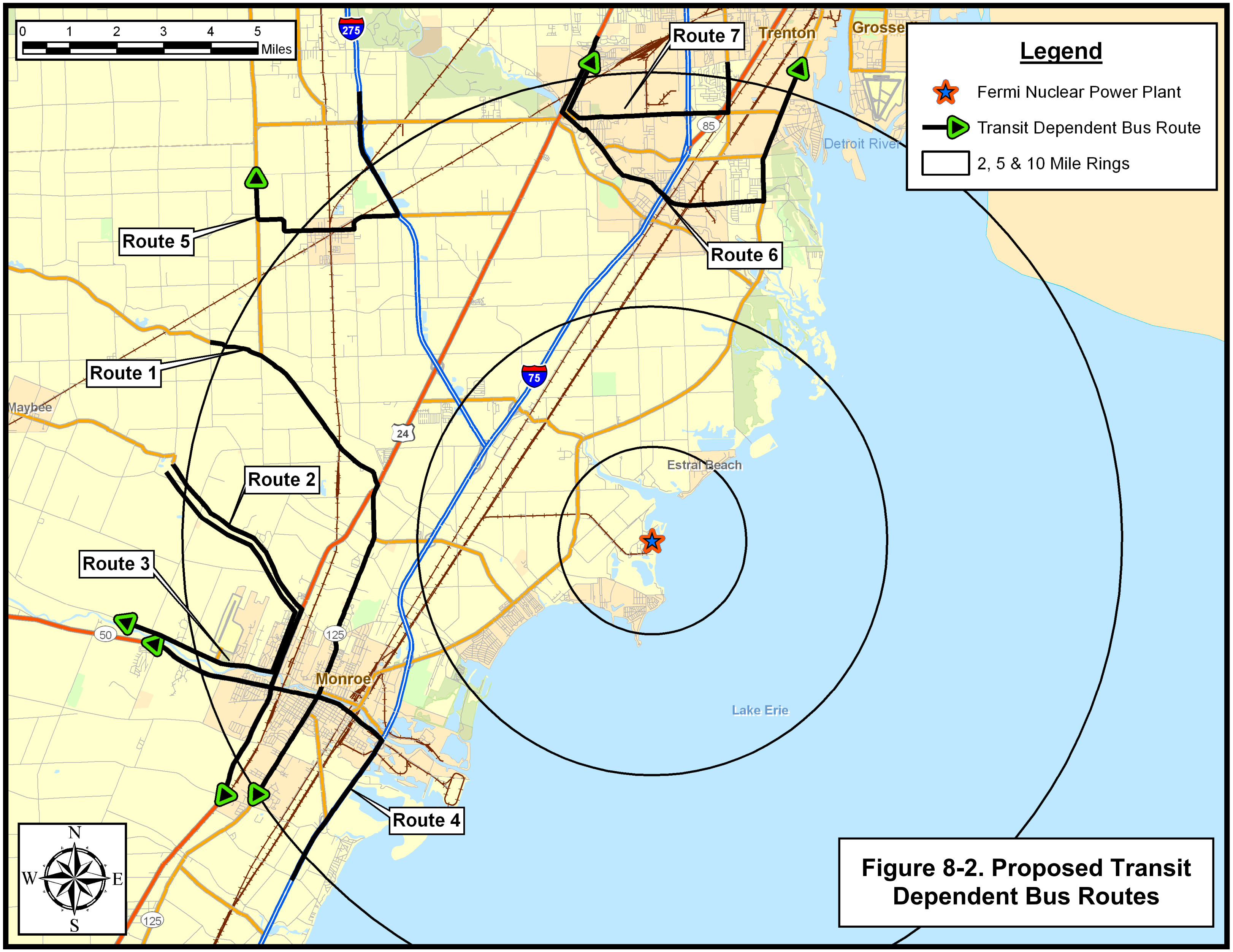


Figure 8-2. Proposed Transit Dependent Bus Routes

Table 8-7A. Transit-Dependent Evacuation Time Estimates - Good Weather

Route Number	Bus Number	Single Wave[4] Mobilization (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)	Second Wave[5] Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Head-way (min.)	Return to EPZ (min.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)
1	1	90	12.5	7.3	103	30	**03:45**	85	5	10	0	16	7.6	99	30	**04:05**
	8	114	12.5	9.0	83	30	**03:50**	85	5	10	24	16	11.0	68	30	**04:00**
2	1	90	8.9	10.3	52	30	**02:55**	85	5	10	0	16	7.7	69	30	**03:35**
	8	114	8.9	9.2	58	30	**03:25**	85	5	10	24	16	8.6	62	30	**03:55**
3	1	90	9.1	20.2	27	30	**02:30**	85	5	10	0	16	10.1	54	30	**03:20**
	8	114	9.1	9.5	57	30	**03:25**	85	5	10	24	16	8.5	64	30	**03:55**
4	1	90	9.4	10.8	52	30	**02:55**	85	5	10	0	16	8.4	67	30	**03:35**
	8	114	9.4	9.2	61	30	**03:25**	85	5	10	24	16	7.9	71	30	**04:05**
5	1	90	7.3	33.7	13	30	**02:15**	85	5	10	0	16	33.7	13	30	**02:40**
	3	99	7.3	33.7	13	30	**02:25**	85	5	10	9	16	33.7	13	30	**02:50**
6	1	90	10.2	24.5	25	30	**02:25**	85	5	10	0	16	24.5	25	30	**02:55**
	4	102	10.2	25.5	24	30	**02:40**	85	5	10	12	16	27.8	22	30	**03:00**
7	1	90	5.9	17.7	20	30	**02:20**	85	5	10	0	16	12.6	28	30	**02:55**
	3	99	5.9	13.6	26	30	**02:35**	85	5	10	9	16	14.2	25	30	**03:00**
						Maximum for EPZ:	**03:50**								**Maximum for EPZ:**	**04:05**
						Average for EPZ:	**02:55**								**Average for EPZ:**	**03:25**

4 Single Wave ETE are applicable when school is not in session or when school is in session and there are sufficient bus resources available to service school children and the transit dependent general population simultaneously.

5 Second Wave ETE are applicable when there are not sufficient buses available to transport the transit dependent until the evacuation of the school children has been completed.

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

		Single Wave[6]						Second Wave[7]								
Route Number	Bus Number	Mobilization (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Head-way (min.)	Return to EPZ (min.)	Average Speed (mph)	Route Travel Time (min.)	Pickup Time (min.)	ETE (hr:min)
1	1	100	12.5	7.0	107	40	**04:10**	110	5	10	0	18	7.8	96	40	**04:40**
	8	124	12.5	6.9	108	40	**04:35**	110	5	10	24	18	8.8	85	40	**04:55**
2	1	100	8.9	7.5	71	40	**03:35**	110	5	10	0	18	6.2	86	40	**04:30**
	8	124	8.9	6.5	82	40	**04:10**	110	5	10	24	18	7.9	68	40	**04:35**
3	1	100	9.1	11.1	49	40	**03:10**	110	5	10	0	18	9.6	57	40	**04:00**
	8	124	9.1	9.7	56	40	**03:40**	110	5	10	24	18	10.9	50	40	**04:20**
4	1	100	9.4	9.4	60	40	**03:20**	110	5	10	0	18	8.2	69	40	**04:15**
	8	124	9.4	8.1	70	40	**03:55**	110	5	10	24	18	8.7	65	40	**04:35**
5	1	100	7.3	29.2	15	40	**02:35**	110	5	10	0	18	29.2	15	40	**03:20**
	3	109	7.3	29.2	15	40	**02:45**	110	5	10	9	18	29.2	15	40	**03:30**
6	1	100	10.2	21.1	29	40	**02:50**	110	5	10	0	18	22.7	27	40	**03:30**
	4	112	10.2	22.7	27	40	**03:00**	110	5	10	12	18	29.1	21	40	**03:40**
7	1	100	5.9	11.4	31	40	**02:55**	110	5	10	0	18	14.8	24	40	**03:30**
	3	109	5.9	12.6	28	40	**03:00**	110	5	10	9	18	15.4	23	40	**03:35**
						Maximum for EPZ:	**04:35**								**Maximum for EPZ:**	**04:55**
						Average for EPZ:	**03:25**								**Average for EPZ:**	**04:05**

6 Single Wave ETE are applicable when school is not in session or when school is in session and there are sufficient bus resources available to service school children and the transit dependent general population simultaneously.

7 Second Wave ETE are applicable when there are not sufficient buses available to transport the transit dependent until the evacuation of the school children has been completed.

Figure 8-3. Fermi Nuclear Power Plant Host Medical Facilities

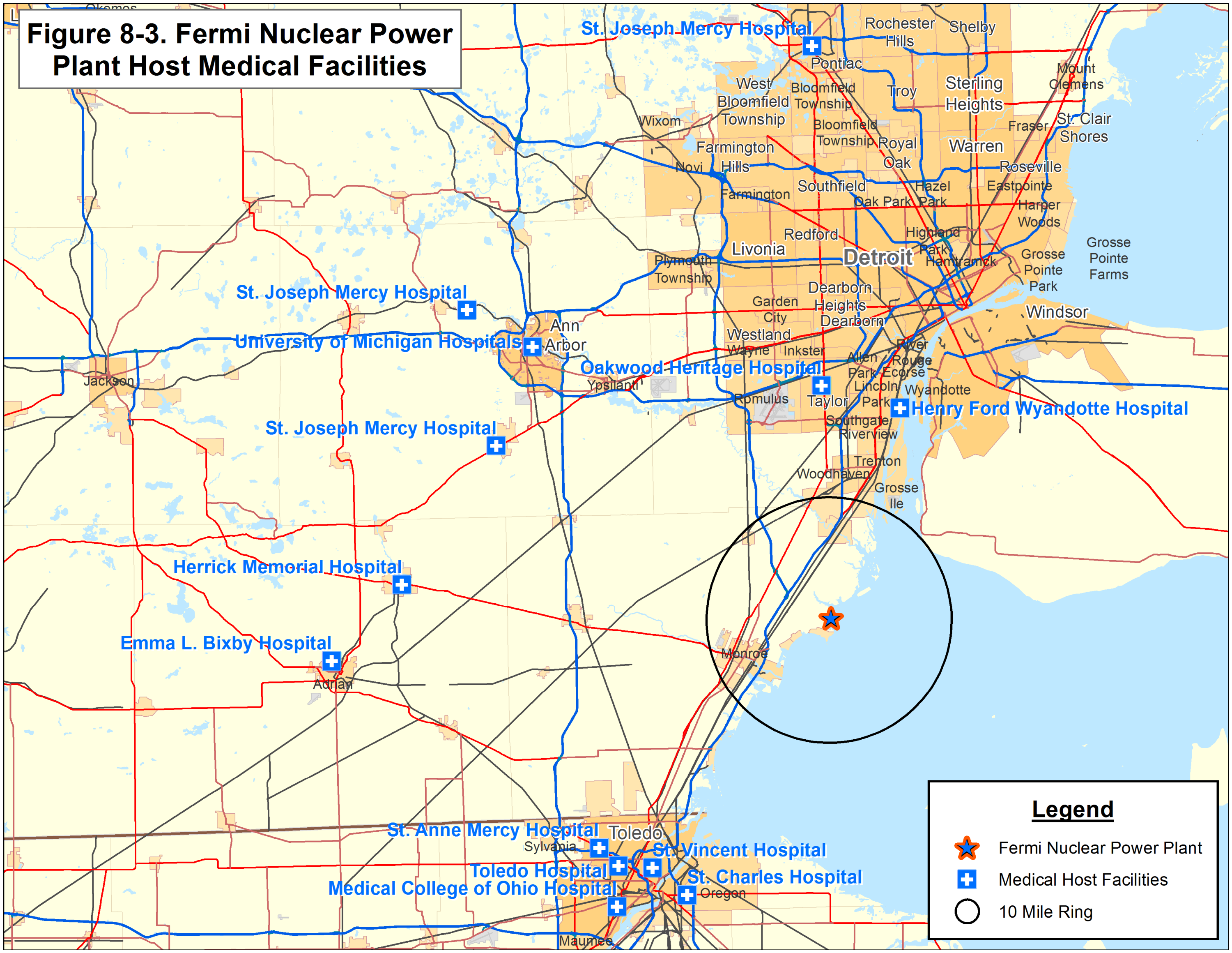


Table 8-8A. Special Facilities Evacuation Time Estimates - Good Weather

Special Facility	Single Wave						Second Wave							
	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County														
ALCC	60	6	7.2	42.8	10	**1:20**	85	5	10	16	6	42.8	10	**2:15**
Alterra	60	15	4.0	11.2	21	**1:40**	85	5	10	16	15	5.2	46	**3:00**
IHM Motherhouse	60	30	3.4	8.2	25	**1:55**	85	5	10	16	30	4.3	48	**3:15**
Lutheran Home	60	30	5.0	5.3	57	**2:30**	85	5	10	16	30	3.9	77	**3:45**
Maplewood Manor	60	30	7.0	41.6	10	**1:40**	85	5	10	16	30	41.6	10	**2:40**
Medlodge II	60	30	3.4	6.5	32	**2:05**	85	5	10	16	30	4.7	44	**3:10**
Mercy Memorial Hospital	60	30	5.4	6.7	48	**2:20**	85	5	10	16	30	4.6	71	**3:40**
Mercy Memorial Nursing Center	60	30	5.4	42.1	8	**1:40**	85	5	10	16	30	42.1	8	**2:35**
Tendercare of Monroe	60	30	4.1	7.5	32	**2:05**	85	5	10	16	30	4.7	52	**3:20**
Wayne County														
Marybrook Residence	60	10	4.6	17.5	16	**1:30**	85	5	10	16	10	8.1	34	**2:40**
					Maximum for EPZ:	**2:30**							**Maximum for EPZ:**	**3:45**
					Average for EPZ:	**1:50**							**Average for EPZ:**	**3:00**

Table 8-8B. Special Facilities Evacuation Time Estimates - Rain

Special Facility	Single Wave						Second Wave							
	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County														
ALCC	70	6	7.2	38.7	11	**01:30**	110	5	10	18	6	38.7	11	**02:40**
Alterra	70	15	4.0	6.3	38	**02:05**	110	5	10	18	15	5.7	42	**03:20**
IHM Motherhouse	70	30	3.4	4.5	46	**02:30**	110	5	10	18	30	4.0	52	**03:45**
Lutheran Home	70	30	5.0	3.8	79	**03:00**	110	5	10	18	30	3.8	80	**04:15**
Maplewood Manor	70	30	7.0	37.5	11	**01:55**	110	5	10	18	30	37.5	11	**03:05**
Medlodge II	70	30	3.4	4.3	47	**02:30**	110	5	10	18	30	5.2	39	**03:35**
Mercy Memorial Hospital	70	30	5.4	4.7	69	**02:50**	110	5	10	18	30	4.4	74	**04:10**
Mercy Memorial Nursing Center	70	30	5.4	38.0	8	**01:50**	110	5	10	18	30	38.0	8	**03:05**
Tendercare of Monroe	70	30	4.1	4.5	54	**02:35**	110	5	10	18	30	5.0	49	**03:45**
Wayne County														
Marybrook Residence	70	10	4.6	12.1	23	**01:45**	110	5	10	18	10	8.3	33	**03:10**
					Maximum for EPZ:	**03:00**							**Maximum for EPZ:**	**04:15**
					Average for EPZ:	**02:15**							**Average for EPZ:**	**03:30**

Table 8-9: Bus Route Descriptions (Page 1 of 2)		
Bus Route Number	**Description**	**Nodes Traversed from Route Start to EPZ Boundary**
1	Transit Route 1	58, 107, 319, 106, 105, 7, 104, 79, 78, 101, 100, 99, 98, 97
2	Transit Route 2	525, 660, 60, 61, 62, 258, 64, 75, 74, 135, 73
3	Transit Route 3	528, 526, 618, 617, 616, 632, 508
4	Transit Route 4	211, 184, 181, 325, 78, 324, 76, 215, 64, 65, 66, 67
5	Transit Route 5	270, 457, 271, 232, 584, 234, 580, 237, 582, 583, 535
6	Transit Route 6	545, 40, 641, 547, 42, 171, 656
7	Transit Route 7	47, 649, 49, 50, 51, 347, 350, 115, 116, 659, 117
8	North Elementary School	444, 441, 278, 280, 279, 23, 24, 296, 297, 451, 452, 298, 453, 300, 209, 302, 305, 307
9	Neidermeier Elementary School	226, 109, 534
10	St. Charles School	36, 462, 35, 34, 33, 32, 162, 85, 84, 298, 453, 300, 209, 302, 305, 307
11	Jefferson High School, Jefferson Middle School	35, 34, 33, 32, 162, 85, 84, 298, 453, 300, 209, 302, 305, 307
12	Sodt Elementary School	34, 33, 32, 162, 85, 84, 298, 453, 300, 209, 302, 305, 307
13	Airport Senior High School, Wager Junior High School, Sterling Elementary School, St. Patrick School	109, 534
14	Carleton Country Day School	237, 582, 583, 535
15	Eyler Elementary School	341, 243
16	Ritter Elementary School	342, 56, 231
20	Cantrick Middle School, Hollywood Elementary School	201, 570, 190, 81, 63, 299, 300, 209, 302, 305, 307
21	Christiancy Elementary School	320, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
22	Custer Elementary School #1, Custer Elementary School #2	514, 513, 217, 304, 305, 307
25	Holy Ghost Lutheran School	508, 67, 66, 65, 64, 75, 74, 135, 73
26	Hurd Elementary School	33, 32, 162, 85, 84, 298, 453, 300, 209, 302, 305, 307
27	Lincoln Elementary School	211, 569, 301, 303, 302, 305, 307
28	Lutheran High School South	332, 108, 335, 222, 223, 226, 109, 534
29	Manor Elementary School	204, 527, 258, 64, 75, 74, 135, 73
30	Monroe Middle School	101, 519, 177, 182, 520, 217, 304, 305, 307
31	Monroe Senior High School	505, 500, 74, 135, 73
32	Orchard Center High School	210, 175, 569, 301, 303, 302, 305, 307
33	Pathway Christian Academy/Daycare	60, 531, 105, 7, 104, 79, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
34	Raisinville Elementary School	508, 67, 66, 65, 64, 75, 74, 135, 73
35	Riverside Elementary School	79, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
36	S. Monroe Townsite Elementary School	518, 520, 217, 304, 305, 307
37	St. John's School	78, 101, 519, 177, 182, 520, 217, 304, 305, 307
38	St. Mary's Catholic Center High School	79, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
39	St. Mary's Parish School	104, 79, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
40	St. Michael's School	211, 569, 301, 303, 302, 305, 307
41	Trinity Lutheran School	325, 519, 177, 182, 520, 217, 304, 305, 307
42	Waterloo Elementary School	66, 65, 64, 75, 74, 135, 73
43	Zion Lutheran School	113, 105, 7, 104, 79, 80, 190, 81, 63, 299, 300, 209, 302, 305, 307
44	Chapman Elementary School	169, 292, 447, 293, 448, 604, 290, 288, 287
45	David Oren Hunter Elementary School	602, 552, 208
46	Downriver High School	549, 40, 545, 546, 170, 292, 447, 293, 448, 604, 290, 288, 287
47	Ethel C. Bobcean Elementary School Flat Rock Community High School Flat Rock/Gibraltar Head Start	49, 649, 47, 289, 291, 290, 288, 287
50	Hellen C. Shumate Junior High School Oscar A. Carlson High School	547, 42, 43, 160, 159, 252, 288, 287

Table 8-9: Bus Route Descriptions (Page 2 of 2)		
Bus Route Number	**Description**	**Nodes Traversed from Route Start to EPZ Boundary**
51	John M. Barnes Elementary School Simpson Middle School	374, 49, 649, 47, 289, 291, 290, 288, 287
53	Parson's Elementary School	387, 42, 43, 160, 159, 252, 288, 287
55	St. Mary's Rockwood Elementary School	170, 292, 447, 293, 448, 604, 290, 288, 287
56	Summit Academy/Summit Early Childhood Center	649, 47, 289, 291, 290, 288, 287
57	ALCC	319, 106, 105, 531, 60, 660, 525, 68, 69, 630, 70
58	Alterra	529, 62, 258, 64, 65, 66, 67
59	IHM Motherhouse	322, 323, 618, 617, 616, 632, 508, 67
60	Lutheran Home	105, 7, 104, 79, 322, 323, 618, 617, 616, 632, 508, 67
61	Maplewood Manor	319, 107, 58, 108, 335, 222, 223, 226, 109, 534
62	Medilodge II	527, 258, 64, 65, 66, 67
63	Mercy Memorial Hospital	113, 320, 80, 79, 322, 323, 618, 617, 616, 632, 508, 67
64	Mercy Memorial Nursing Center	105, 531, 60, 660, 525, 68, 69, 630, 70
65	Tendercare of Monroe	61, 62, 258, 64, 65, 66, 67
66	Marybrook Residence	649, 47, 289, 252, 288, 287

Table 8-10. Wheelchair Transit Resources Available

Vehicle Source	Total Vehicles	Wheelchair Capacity of each Vehicle	Total Wheelchair Capacity	Assignment
Monroe County (Specially Equipped Buses)				
Airport Schools	3	Various	12	Maplewood Manor (2), Medilodge II (1)
Jefferson Schools	3		9	Mercy Memorial Hospital
Bedford Schools	5		22	Homebound Special Needs
Mason Schools	2		3	ALCC
Dundee Schools	2		6	Tendercare of Monroe
Summerfield Schools	3		4	Lutheran Home
Monroe Schools	10		24	Mercy Memorial Hospital
Whiteford Schools	1		2	Mercy Memorial Hospital
Ida Schools	2		7	IHM Motherhouse
TOTAL	**31**		**89**	
Wayne County (Ambulances Provided by Private Ambulance Companies)				
East Side Med Star	6	1	6	Marybrook Residence (1), Surplus (5)
Community	13		13	Surplus
Concord	16		16	
HealthLink	5		5	
HVA	6		6	
Rapid Response	8		8	
Medic One	9		9	
Superior	6		6	
Universal (Macomb)	10		10	
Star EMS	3		3	
TOTAL	**82**		**82**	
Toledo, Ohio (Specially Equipped Buses)				
ProMedica	5	2	10	Surplus
TOTAL	**5**		**10**	
EPZ TOTAL	**118**		**181**	

Table 8-11A. Special Facilities Folding Wheelchair Evacuation Time Estimates - Good Weather

Special Facility	Single Wave							Second Wave							
	Mobilization (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County															
ALCC	60	3	15	7.2	42.8	10	**01:25**	85	5	10	16	15	42.8	10	**02:25**
IHM Motherhouse	60	6	30	3.4	8.2	25	**01:55**	85	5	10	16	30	4.3	48	**03:15**
Lutheran Home	60	4	20	5.0	6.9	44	**02:05**	85	5	10	16	20	4.1	73	**03:30**
Maplewood Manor	60	4	20	7.0	41.6	10	**01:30**	85	5	10	16	20	41.6	10	**02:30**
Medilodge II	60	3	15	3.4	10.2	20	**01:35**	85	5	10	16	15	4.6	45	**03:00**
Mercy Memorial Hospital	60	34	75	5.4	4.5	72	**03:30**	85	5	10	16	75	12.7	26	**03:40**
Tendercare of Monroe	60	6	30	4.1	7.5	32	**02:05**	85	5	10	16	30	4.7	52	**03:20**
						Maximum for EPZ:	**03:30**							**Maximum for EPZ:**	**03:40**
						Average for EPZ:	**02:00**							**Average for EPZ:**	**03:05**

Table 8-11B. Special Facilities Folding Wheelchair Evacuation Time Estimates - Rain

Special Facility	Single Wave							Second Wave							
	Mobilization (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)	Arrive at RC (min.)	Unload (min.)	Driver Rest (min.)	Return to EPZ (min.)	Loading Time (min.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County															
ALCC	70	3	15	7.2	38.7	11	**01:40**	110	5	10	18	15	38.7	11	**02:50**
IHM Motherhouse	70	6	30	3.4	4.5	46	**02:30**	110	5	10	18	30	4.0	52	**03:45**
Lutheran Home	70	4	20	5.0	4.4	68	**02:40**	110	5	10	18	20	3.4	89	**04:15**
Maplewood Manor	70	4	20	7.0	37.5	11	**01:45**	110	5	10	18	20	37.5	11	**02:55**
Medilodge II	70	3	15	3.4	5.6	36	**02:05**	110	5	10	18	15	5.3	39	**03:20**
Mercy Memorial Hospital	70	34	75	5.4	5.1	63	**03:30**	110	5	10	18	75	12.4	26	**04:05**
Tendercare of Monroe	70	6	30	4.1	4.3	57	**02:40**	110	5	10	18	30	5.0	49	**03:45**
						Maximum for EPZ:	**03:30**							**Maximum for EPZ:**	**04:15**
						Average for EPZ:	**02:25**							**Average for EPZ:**	**03:35**

Table 8-12A. Special Facilities Rigid Wheelchair Evacuation Time Estimates - Good Weather

Special Facility	Mobilization Time (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County							
ALCC	60	3	15	7.2	42.8	10	**1:25**
IHM Motherhouse	60	7	15	3.4	9.6	21	**1:40**
Lutheran Home	60	4	15	5.0	6.9	44	**2:00**
Maplewood Manor	60	4	15	7.0	41.6	10	**1:25**
Medilodge II	60	3	15	3.4	10.2	20	**1:35**
Mercy Memorial Hospital	60	35	15	5.4	8.1	40	**1:55**
Tendercare of Monroe	60	6	15	4.1	11.6	21	**1:40**
Wayne County							
Marybrook Residence	60	1	5	4.6	17.5	16	**1:25**
						Maximum for EPZ:	**2:00**
						Average for EPZ:	**1:40**

Table 8-12B. Special Facilities Rigid Wheelchair Evacuation Time Estimates - Rain

Special Facility	Mobilization Time (min.)	Wheelchair Passengers	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County							
ALCC	70	3	15	7.2	38.7	11	**1:40**
IHM Motherhouse	70	7	15	3.4	5.8	36	**2:05**
Lutheran Home	70	4	15	5.0	4.4	68	**2:35**
Maplewood Manor	70	4	15	7.0	37.5	11	**1:40**
Medilodge II	70	3	15	3.4	5.6	36	**2:05**
Mercy Memorial Hospital	70	35	15	5.4	5.5	59	**2:25**
Tendercare of Monroe	70	6	15	4.1	6.4	38	**2:05**
Wayne County							
Marybrook Residence	70	1	5	4.6	12.1	23	**1:40**
						Maximum for EPZ:	**2:35**
						Average for EPZ:	**2:00**

Table 8-13A. Evacuation Time Estimates for Ambulances - Good Weather

Facility	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County						
IHM Motherhouse	30	30	3.4	27.8	7	**01:10**
Lutheran Home	30	30	5.0	27.4	11	**01:15**
Maplewood Manor	30	30	7.0	41.6	10	**01:10**
Medilodge II	30	30	3.4	37.6	5	**01:05**
Mercy Memorial Hospital	30	30	5.4	25.8	13	**01:15**
Mercy Memorial Nursing Center	30	30	5.4	42.1	8	**01:10**
Tendercare of Monroe	30	30	4.1	38.6	6	**01:10**
					Maximum for EPZ:	**01:15**
					Average for EPZ:	**01:10**

Table 8-13B. Evacuation Time Estimates for Ambulances - Rain

Facility	Mobilization (min.)	Loading Time (min.)	Route Length (mi.)	Average Speed (mph)	Route Travel Time (min.)	ETE (hr:min)
Monroe County						
IHM Motherhouse	35	30	3.4	17.7	12	**01:20**
Lutheran Home	35	30	5.0	17.4	17	**01:25**
Maplewood Manor	35	30	7.0	37.5	11	**01:20**
Medilodge II	35	30	3.4	34.0	6	**01:15**
Mercy Memorial Hospital	35	30	5.4	13.3	24	**01:30**
Mercy Memorial Nursing Center	35	30	5.4	38.0	8	**01:15**
Tendercare of Monroe	35	30	4.1	34.9	7	**01:15**
					Maximum for EPZ:	**01:30**
					Average for EPZ:	**01:20**

9. TRAFFIC MANAGEMENT STRATEGY

This section presents the current traffic control and 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 (preferably, not necessarily, law enforcement officers).
- Traffic Control Devices to assist these personnel in the performance of their tasks. These devices should comply with the guidance of the Manual of Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA) of the U.S.D.O.T. All state and most county transportation agencies have access to the MUTCD (also available online). Applicable devices include, with reference to the MUTCD:
    - Traffic Barriers: Chapter 6F, section 6F.61, 62 and Figure 6F-4.
    - Traffic Cones: Chapter 3F and section 6F.56.
    - Signs: Chapter 2I
- A plan that defines all necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

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, or other evacuees.
- 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 describing traffic control, which are presented in Appendix G, are based on data collected during field surveys, upon large-scale maps, and on overhead photos.
2. Computer analysis of the evacuation traffic flow environment.
   This analysis identifies the best routing and those locations that experience pronounced congestion.
3. Consultation with emergency management and enforcement personnel.
   Trained personnel who are experienced in controlling traffic and are aware of the likely evacuation traffic patterns have extensively reviewed these control tactics.
4. Prioritization of TCPs.
   Application of traffic control at some TCPs will have a more pronounced influence on expediting traffic movements than at other TCPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located far from the power plant. Thus, during the mobilization of personnel to respond to the emergency situation, those TCPs which are assigned a higher priority should be manned earlier. These priorities have been developed in conjunction with county emergency management representatives and law enforcement personnel.

The control tactic at each TCP is presented in each schematic that appears in Appendix G.

The use of Intelligent Transportation Systems (ITS) technologies can reduce manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) can be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. DMS can also be placed outside of the EPZ to warn motorists to avoid using routes that may conflict with the flow of evacuees away from the nuclear power plant. Highway Advisory Radio (HAR) can be used to broadcast information to evacuees en route through their vehicle stereo systems. Automated Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins his trip, while on board navigation systems (GPS units), cell phones, and pagers can be used to provide information en route. These are only several examples of how ITS technologies can benefit the evacuation process.

Chapter 2I of the MUTCD presents guidance on Emergency Management signing. Specifically, the Evacuation Route sign, EM-1 on page 2I-3, with the word "Hurricane" removed, could be installed selectively within the EPZ, if considered advisable by local and state authorities. Similar comments apply to sign EM-3 which identifies TCP locations.

As discussed in Section 2.3, these TCP are not credited in calculating the ETE results. Access control points (ACP) are deployed near the periphery of the EPZ to divert "through" trips. The ETE calculations reflect the assumptions that all "external-external" trips are interdicted after 90 minutes have elapsed after the advisory to evacuate (ATE).

All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCP.

Study assumption 5 and 6 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

10. EVACUATION ROUTES

Evacuation routes are composed of two distinct components:

- Routing from a Protective Action Area (PAA) 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 Fermi Nuclear Power 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.

Table 10-1 lists the details – Name, Facility type and Location for all the designated reception centers. Figure 10-1 maps each of the reception centers. The major evacuation routes for the two counties within the EPZ are presented in Figures 10-2 and 10-3.

Table 10-1 Reception Center Details – Name, Type and Location

Reception Center	Facility Type	Street Address	City	State	ZIP	County
Dundee High School	Reception Center	130 Viking Dr.	Dundee	Michigan	48131	Monroe
Ida Public School	Reception Center	3145 Prairie St.	Ida	Michigan	48140	Monroe
Summerfield High School	Reception Center	17555 Ida West Rd.	Petersburg	Michigan	49270	Monroe
Whiteford High School	Reception Center	6655 Consear Rd.	Ottawa Lake	Michigan	49267	Monroe
St. Stephen School	Host School	18800 Huron River Dr.	New Boston	Michigan	48164	Monroe
Milan Senior High School	Host School	920 North St.	Milan	Michigan	48160	Monroe
Bedford Senior High School	Reception Center & Host School	8285 Jackman Rd.	Temperance	Michigan	48182	Monroe
Mason High School	Reception Center & Host School	2400 Lakeside Rd	Erie	Michigan	48133	Monroe
Harry S. Truman High School	Reception Center & Host School	1211 Beech Daly Rd.	Taylor	Michigan	48180	Wayne

Figure 10-1. Fermi Nuclear Power Plant Reception Centers and Host Schools

Figure 10-2. Evacuation Routes for PAA 1,3 and 5