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April 1, 2008

Mr. John Stephenson
Emergency Preparedness Supervisor
Progress Energy Crystal River EOF
8200 West Venable Street
Crystal River, FL 34429-5492

Ref: Revisions to the Levy Nuclear Plant Final ETE Report

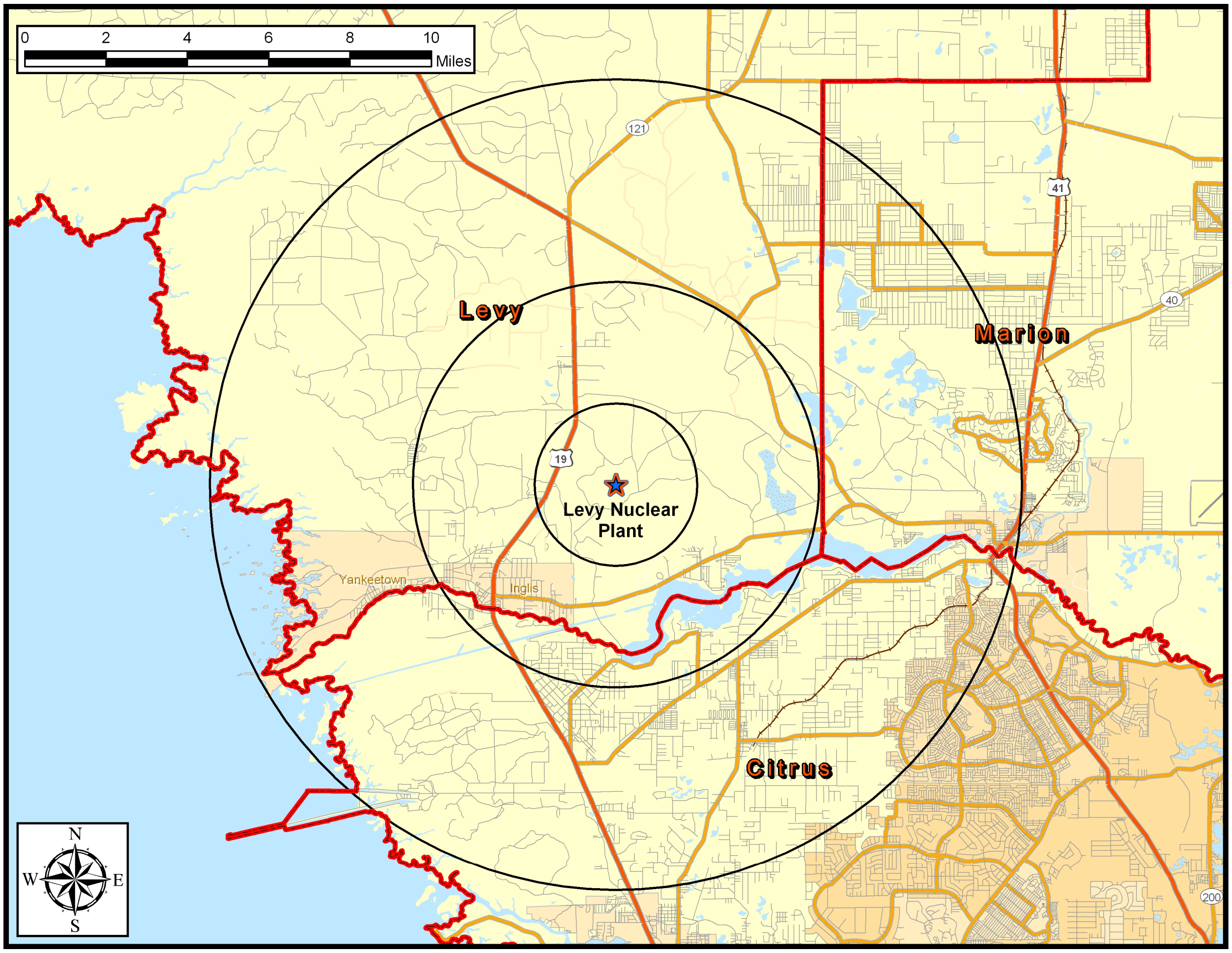
Dear John:

Enclosed is a PDF file containing the revised final version of the Levy Nuclear Plant ETE Report, marked Rev. 3. All cases were re-run due to the error in the input stream identified in the deficiency report e-mailed to you on March 5th. Changes have been made to the Executive Summary, Section 7, Section 8, Appendix I and Appendix J based on the changes in ETE in the new runs. The date of the report has been updated to April, 2008 on the Cover Page. We sincerely apologize for any inconvenience this may have caused.

Respectfully submitted,

Kevin Weinisch, P.E.
Senior Traffic Engineer

Levy Nuclear Plant
Development of Evacuation Time Estimates



Prepared for:

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April, 2008 **Final Report** **KLD TR – 414**

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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 Levy Nuclear Plant (LNP) located in Levy County, Florida. ETE are part of the required planning basis and provide LNP 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 February, 2007 and extended over a period of 7 months. The major activities performed are briefly described in chronological sequence:

- Attended "kick-off" meetings with Progress Energy personnel and emergency management personnel representing state and local governments.
- Reviewed prior ETE reports prepared for the Crystal River Nuclear Plant, which is located within 10 miles of the proposed LNP location.
- Accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of LNP, 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" area 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 State and county personnel prior to the survey.
- Data collection forms (provided to the counties at the kickoff meeting) were returned with data pertaining to employment, transients, and special facilities in each county.

- The traffic demand and trip-generation 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 8 Protective Action Zones (PAZ). These PAZ are then grouped within circular areas or “keyhole” configurations (circles plus radial sectors) that define a total of 13 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). One special scenario involving the completion of construction on Unit 2 when Unit 1 becomes operational in June 2016 at the LNP site was considered.
- The Planning Basis for the calculation of ETE is:
  - A rapidly escalating accident at LNP 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 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 143 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 13 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 11 Evacuation Scenarios (13 x 11 =143). 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 LNP, 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 LNP), 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 LNP site showing the layout of the 8 PAZ that comprise, in aggregate, the Emergency Planning Zone (EPZ).
- Table 3-1 presents the estimates of permanent resident population in each PAZ based on the 2000 Census data. Extrapolation to the year 2007 reflects population growth rates in each county obtained from the County Planning Departments.
- Table 6-1 defines each of the 13 Evacuation Regions in terms of their respective groups of PAZ.
- Table 6-2 lists the 11 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.

Conclusion

This report presents the methodological details supporting the results obtained and recommendations for consideration by local emergency responders.

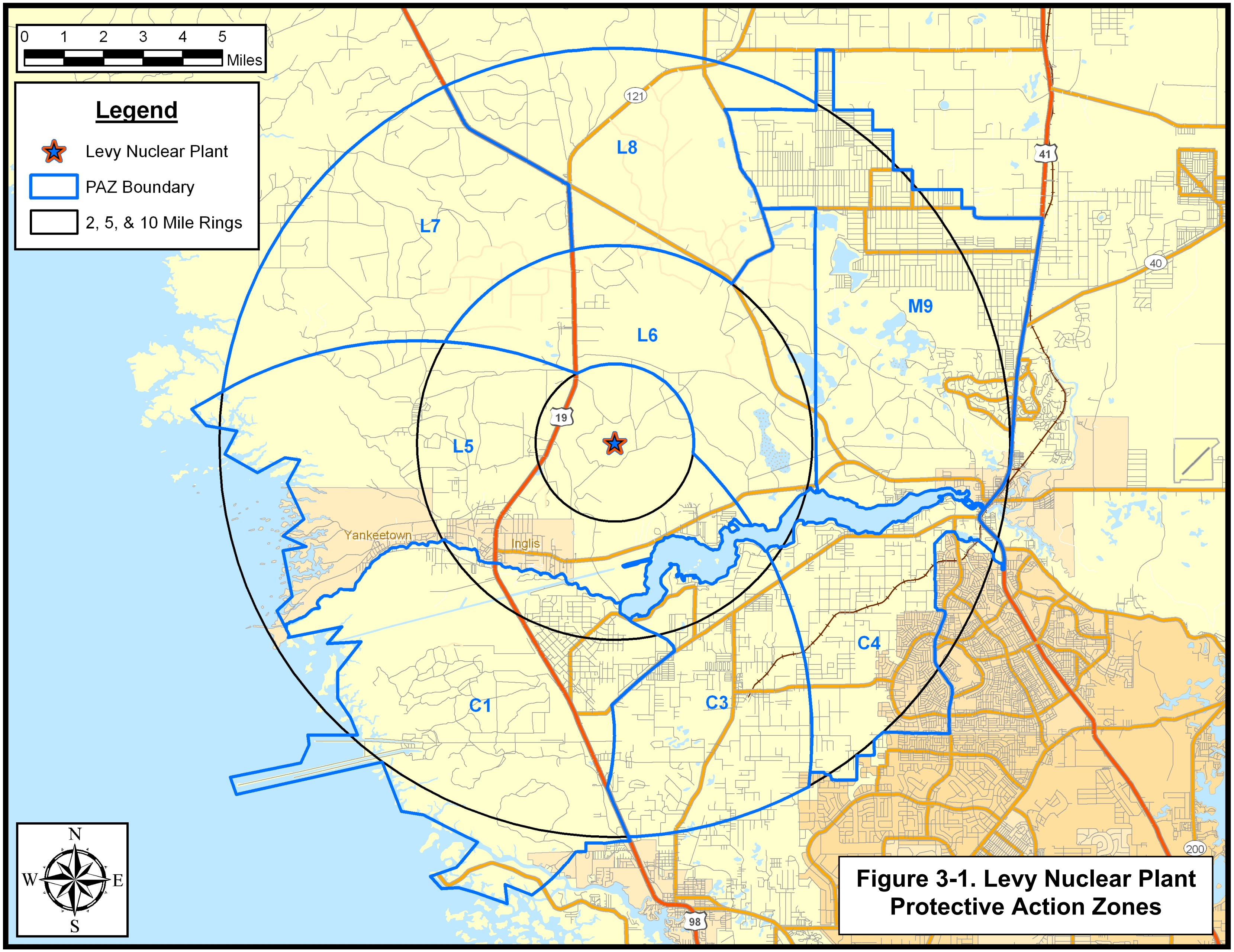


Figure 3-1. Levy Nuclear Plant Protective Action Zones

Table 3-1. EPZ Permanent Resident Population		
PAZ	**2000 Population**	**2007 Population**
C1	1,434	1,776
C3	4,422	5,476
C4	2,795	3,461
L5	3,004	3,601
L6	545	653
L7	14	17
L8	245	294
M9	5,866	7,480
TOTAL	**18,325**	**22,758**
	Population Growth:	**24%**

Table 6-1. Description of Evacuation Regions									
Region	Description	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
R01	2 mile ring				X				
R02	5-mile ring				X	X			
R03	Full EPZ	X	X	X	X	X	X	X	X
Evacuate 2 mile ring and 5 miles downwind									
Region	Wind Direction Towards:	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
Refer to R02	WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE				X	X			
Refer to R01	SSE, S, SSW, SW, WSW, W				X				
Evacuate 5 mile ring and downwind to EPZ boundary									
Region	Wind Direction Towards:	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
R04	N				X	X	X	X	X
R05	NNE, NE				X	X		X	X
R06	ENE, E			X	X	X			X
R07	ESE, SE		X	X	X	X			X
R08	SSE	X	X	X	X	X			
R09	S, SSW	X	X		X	X			
R10	SW, WSW	X			X	X			
R11	W	X			X	X	X		
R12	WNW				X	X	X		
R13	NW, NNW				X	X	X	X	

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	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	New Plant Construction

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

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

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

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

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bndry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)	Travel Time EPZ Bndry to RC (min)	ETE to R.C. (hr:min)
Levy County Schools								
Yankeetown School	90	5	9.7	12	**1:50**	20.7	25	**2:15**
Citrus County Schools								
Citrus Springs Elementary School	90	5	2.0	3	**1:40**	2.9	4	**1:45**
Marion County Schools								
Dunnellon Middle School	90	5	7.8	10	**1:45**	27.7	34	**2:20**
Dunnellon Christian Academy	90	5	7.6	10	**1:45**	27.7	34	**2:20**
Romeo Elementary School	90	5	0.3	1	**1:40**	27.7	34	**2:10**
				Average for EPZ:	**1:45**		**Average:**	**2:05**

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

Table 8-7A. Transit Dependent Evacuation Time Estimates - Good Weather														
		Single Wave					**Second Wave**							
Route Number	**Bus Number**	**Mobilization (min.)**	**Route Length (mi.)**	**Route Travel Time[1] (min)**	**Pickup Time (min)**	**ETE (hr:min)**	**Mobilization (min.)**	**Unload (min.)**	**Driver Rest (min.)**	**Return time to EPZ (min.)**	**Route Travel Time[2] (min.)**	**Pickup Time (min.)**	**ETE (hr:min)**
1	1,2	120	13.1	15	15	2:30	125	5	10	20	15	15	3:10
	3,4	120	15.6	17	15	2:35							
2	1	120	10	11	15	2:30	125	5	10	20	11	15	3:10
	2	150	10	11	15	3:00							
	3	180	10	11	15	3:30							
3	1	120	14.2	16	15	2:35	125	5	10	20	16	15	3:15
	2	150	14.2	16	15	3:05							
	3	180	14.2	16	15	3:35							
4	1	120	18.2	20	15	2:35	125	5	10	20	20	15	3:15
	2	150	18.2	20	15	3:05							
5	1	120	18.2	20	15	2:35	125	5	10	20	20	15	3:15
	2	150	18.2	20	15	3:05							
6	1	120	11.3	13	15	2:30	125	5	10	20	13	15	3:10
7	1	120	19.2	21	15	2:40	125	5	10	20	21	15	3:20
					Average for EPZ:	**2:50**						**Average for EPZ:**	**3:15**

[1] Average speed output by PC-DYNEV at 125 minutes for good weather is 53.9 mph.

[2] Average speed output by PC-DYNEV at 160 minutes (mobilization time + unload + driver rest + return time to EPZ) for good weather is 53.8 mph.

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained in preparing the Evacuation Time Estimates (ETE) for the proposed Levy Nuclear Plant (LNP), located in Levy County, Florida. 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 Levy County, Citrus County, and Marion 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 Progress Energy.
    - Attended meetings with emergency planners from the three EPZ Counties 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 census and state agencies.
    - Conducted a random sample telephone survey of EPZ residents.

- Conducted a data collection effort to identify and describe schools, special facilities, major employers, transportation providers, and other important sources of information.

2. Estimated distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the random sample telephone survey.
3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.
4. Defined a traffic management strategy. Traffic control is applied at specified Traffic Control Points (TCP) located within the Emergency Planning Zone (EPZ), and at Access Control Points (ACP) located outside the EPZ. Local and state police personnel have reviewed all traffic control plans.
5. Defined Evacuation Areas or Regions. The EPZ is partitioned into Protective Action Zones (PAZ) which serve as a basis for the ETE analysis presented herein. Evacuation "Regions" are comprised of contiguous PAZ 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.

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

- Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.
- 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 LNP.
- 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 Levy Nuclear Plant Location

The Levy Nuclear Plant is located approximately 85 miles north of Tampa, Florida and 9 miles northeast of the existing Crystal River Nuclear Plant. The Emergency Planning Zone (EPZ) consists of parts of three counties: Levy County, Citrus County, and Marion County. Figure 1-1 displays the area surrounding LNP. This map identifies the communities in the area and the major roads.

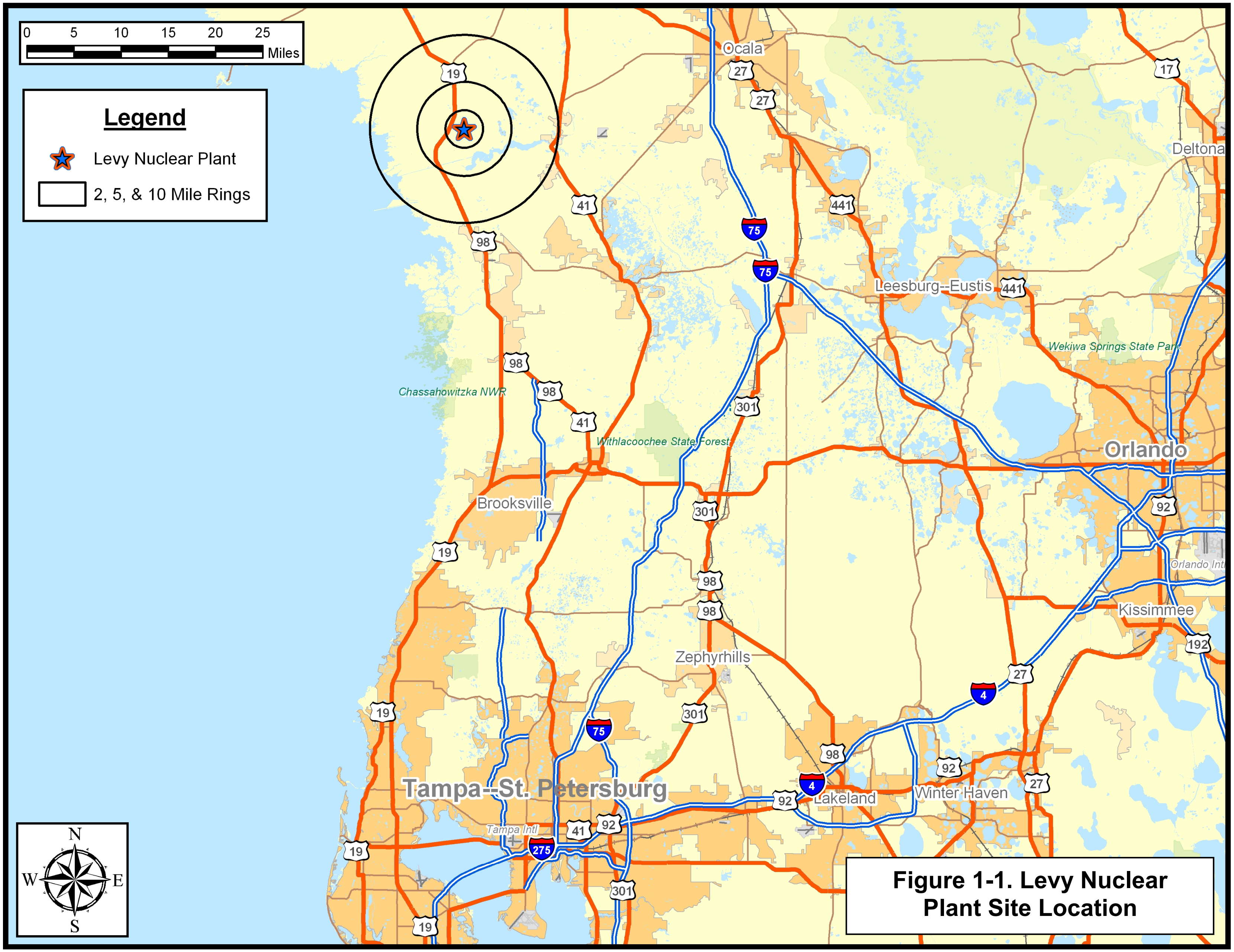


Figure 1-1. Levy Nuclear Plant Site Location

1.3 Preliminary Activities

KLD performed preliminary review activities as described below.

Literature Review

KLD Associates reviewed documentation by the federal government on the development of emergency plans and 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. 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.	

The data were then transcribed; this information was referenced while preparing the input stream for the IDYNEV System. Key highway locations were video archived.

Telephone Survey

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

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

Developing the Evacuation Time Estimates

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

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

Analytical Tools

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

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.

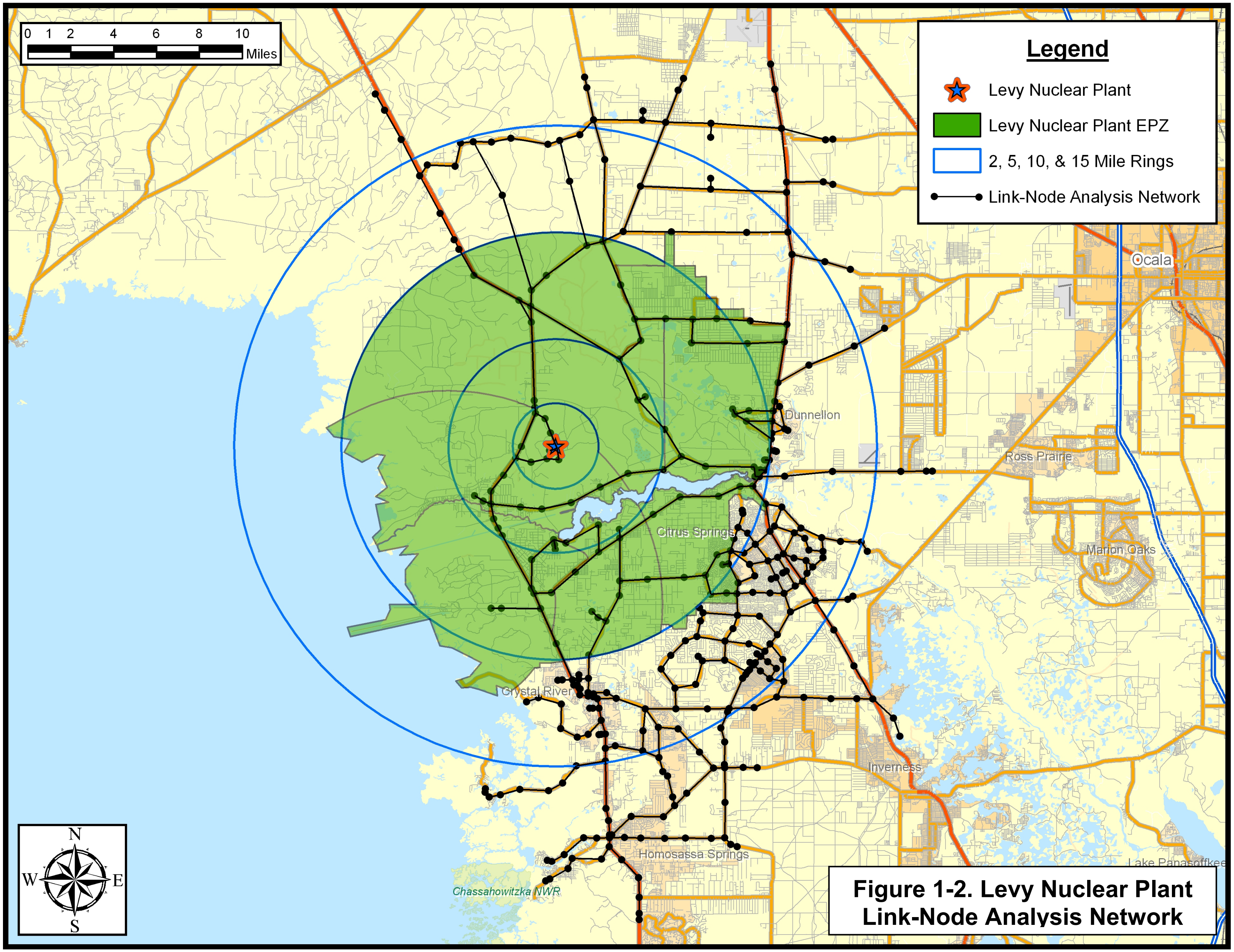


Figure 1-2. Levy Nuclear Plant Link-Node Analysis Network

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 LNP 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 LNP.

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 contains 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 ETE Study Overview

Table 1-1 presents an overview of this ETE study. The major factors that make this study and the ETE values obtained reliable can be summarized as follows:

- 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 highly detailed.
- Regions developed with guidance from NUREG/CR-6863.
- Traffic management plan included.

Table 1-1. Summary of ETE Study	
Topic	**Description**
Resident Population Basis	ArcGIS Software using 2000 US Census blocks; block centroid method used; population extrapolated to 2007. Permanent resident population inside the EPZ = 22,758
Resident Population Vehicle Occupancy	2.25 persons/household, 1.32 evacuating vehicles/household yielding: 1.70 persons/vehicle
Employee Population	Employees treated as separate population group. Employee estimates based on information provided by county emergency management offices about major employers in EPZ. 1.03 employees/vehicle based on phone survey results.
Voluntary evacuation from within EPZ in areas outside region to be evacuated	50 percent of population within the specified evacuation radius, but not within the area to be evacuated; 35 percent, in annular ring between the evacuation radius and the EPZ boundary (See Figure 2.1).
Shadow Evacuation	30% of people outside of the EPZ within the Shadow Region (See Figure 7-2).
Network Size	517 Links; 364 Nodes.
Roadway Geometric Data	Field surveys conducted in February, 2007. Major intersections were video archived. GIS shape-files of signal locations and roadway characteristics created during road survey. Road capacities based on 2000 HCM.
School Evacuation	Direct evacuation to designated Reception Center.
Transit Dependent Population	Defined as households with 0 vehicles + households with 1 vehicle with commuters who do not return home + households with 2 vehicles with commuters who do not return home. Telephone survey results used to estimate transit dependent population (See Table 8-1).

Table 1-1. Summary of ETE Study (cont.)	
Ridesharing	50 percent of transit dependent persons will ride out with a neighbor of friend.
Trip Generation for Evacuation	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 minutes and 5 hours. Residents without commuters returning leave between 15 minutes and 5 hours. Employees and transients leave between 15 minutes and 2 hours. All times measured from the Advisory to Evacuate.
Traffic and Access Control	Traffic and Access Control used in all scenarios to facilitate the flow of traffic outbound relative to LNP.
Weather	Normal or Rain. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain.
Modeling	IDYNEV System: TRAD and PC-DYNEV.
Special Events	One considered – new plant construction.
Evacuation Cases	13 Regions (central sector wind direction and each adjacent sector technique used as specified in NUREG/CR-6863) and 11 Scenarios producing 143 unique cases
Evacuation Time Estimates Reporting	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.	Winter Weekday Midday Good weather = 5:10 Winter Weekend Midday Good weather = 5:10

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 2007. County-specific projections are based upon growth rates obtained from the county planning departments. Estimates of employees who commute into the EPZ to work are based upon employment data obtained from county emergency management offices.
2. Population estimates at special facilities are based on available data from county emergency management offices.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000.
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 2.25 persons per household and 1.32 evacuating vehicles per household are used.
6. The relationship between persons and vehicles for special facilities is as follows:
   a. Parks/Recreational: 1 vehicle per family
   b. Employees: 1.03 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, and for the 2-mile, 5-mile and 10-mile distances. 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 Zones (PAZ) 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 PAZ) 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 PAZ 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“ (Appendix I).
6. A total of 11 “Scenarios” representing different seasons, time of day, day of week and weather are considered. One special event scenario is studied; the construction period of a new nuclear plant. These Scenarios are tabulated below:

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	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	New Plant Construction

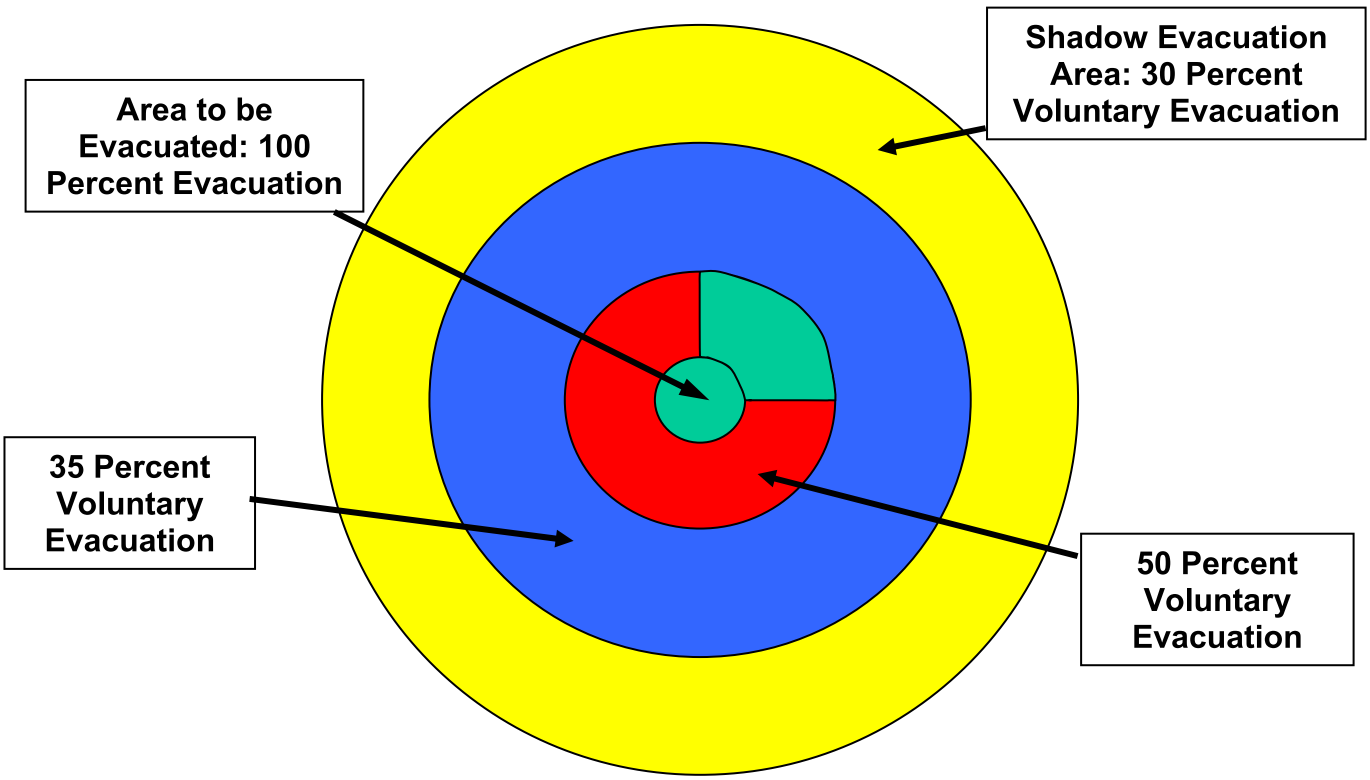


Figure 2-1. Voluntary Evacuation Methodology

7. The models of the IDYNEV System represent the state of the art, and have been recognized as such by the Atomic Safety and Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[1]).

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 PAZ 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. 59 percent of households in the EPZ will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.
4. A portion of the population outside the evacuated Region will elect to evacuate even though not advised to do so ("voluntary evacuation"). See Figure 2-1.
5. 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.
6. 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.
7. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. Their number and location will depend on the Region to be evacuated and personnel resources available. It is assumed that drivers will act rationally, travel in the directions identified in the plan (as documented in the public information

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

material), and obey all control devices and traffic guides.

8. 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.
   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.
9. It is reasonable to assume that some of transit-dependent people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. We assume that the percentage of people who rideshare is 50 percent. This assumption is based upon reported experience for other emergencies[2], which cites previous evacuation experience. The remaining transit-dependent portion of the general population will be evacuated to reception centers by bus.
10. An adverse weather scenario is also considered. Rain may occur for either winter or summer scenarios. In the case of rain, it is assumed that the rain begins prior to, or at about the same time as the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed. 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	90%	90%	No Effect
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

11. 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.

[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. DEMAND ESTIMATION

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

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

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

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

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

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

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

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

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. 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.

Analysis of the population characteristics of the Levy Nuclear Plant 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., boating, 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 Zone (PAZ) and by polar coordinate representation (population rose). The LNP EPZ has been subdivided into 8 PAZ 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 (2.25 persons/household) and the number of evacuating vehicles per household (1.32 vehicles/household) were adapted from the telephone survey results.

The rate of population change for each County in the EPZ was obtained by KLD from the county planning departments and applied to 2000 Census data to project population to 2007. The data in Table 3-1 show that the EPZ population has increased by 24 percent over the last 7 years.

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

<u>Construction</u>

A “special event” scenario (Scenario 11) which represents a typical winter, weekend, midday with construction workers on-site at the time of the emergency, is considered. Based on discussions with Progress Energy, there will be two units constructed at the proposed Levy site. The construction plans are offset slightly in that Unit 1 will be operational in June 2016, while construction will persist on Unit 2 which will be operational in June 2017. There will be 565 workers on site at Unit 1 when operational and 150 construction workers will remain at Unit 2, for a total of 715 additional people in the EPZ for this special event. An average vehicle occupancy of 1.03 workers per vehicle (adapted from telephone survey results) is used to convert workers to vehicles – 695 total vehicles. The existing roadway system is used for the construction scenario; no roadway improvements are considered. Permanent resident population and shadow population are extrapolated to 2016 for this scenario.

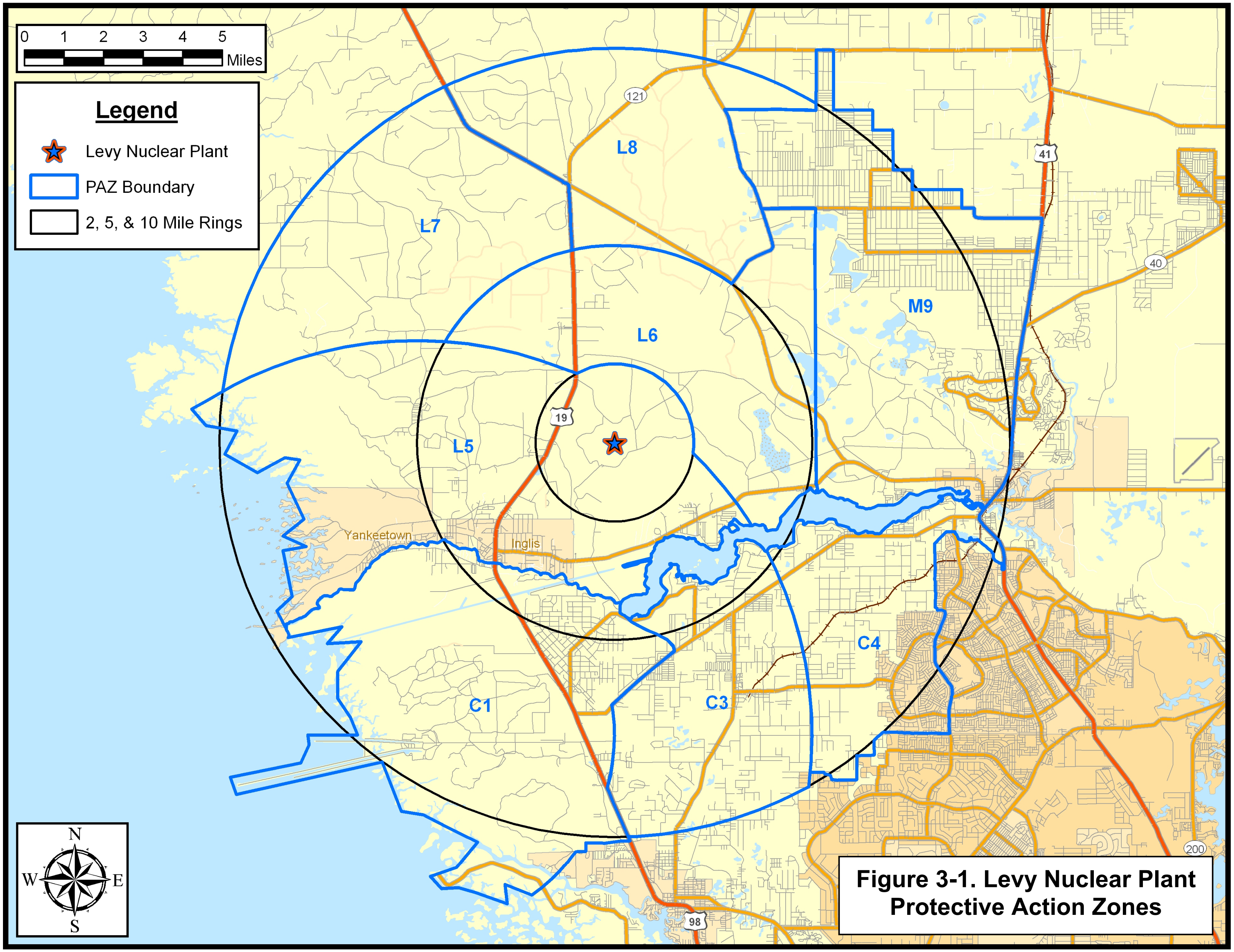
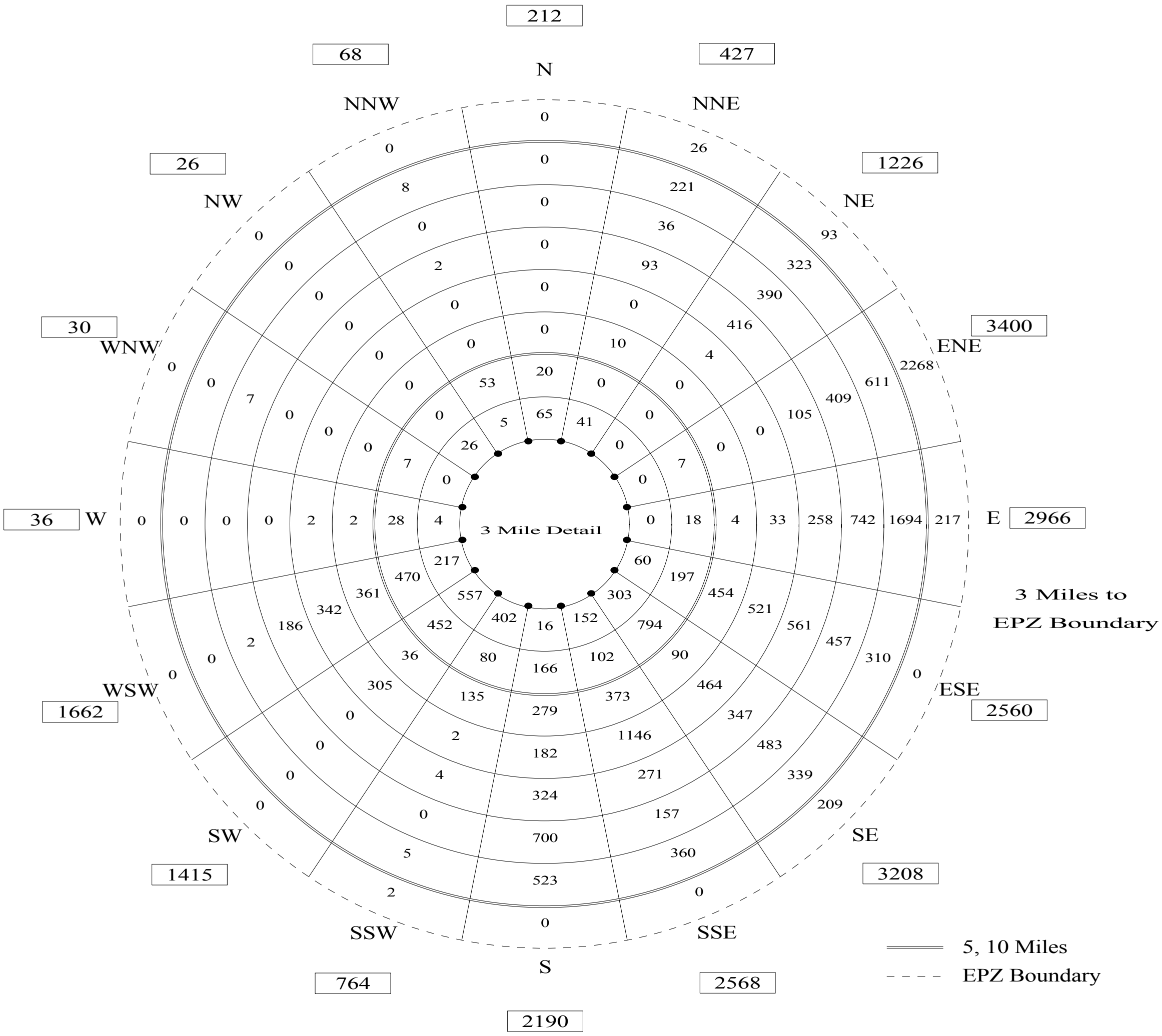


Figure 3-1. Levy Nuclear Plant Protective Action Zones

Table 3-1. EPZ Permanent Resident Population		
PAZ	**2000 Population**	**2007 Population**
C1	1,434	1,776
C3	4,422	5,476
C4	2,795	3,461
L5	3,004	3,601
L6	545	653
L7	14	17
L8	245	294
M9	5,866	7,480
TOTAL	**18,325**	**22,758**
	Population Growth:	**24%**

Table 3-2. Permanent Resident Population and Vehicles by PAZ		
PAZ	**2007 Population**	**2007 Vehicles**
C1	1,776	1,040
C3	5,476	3,214
C4	3,461	2,030
L5	3,601	2,112
L6	653	383
L7	17	11
L8	294	172
M9	7,480	4,388
TOTAL	**22,758**	**13,350**



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	159	0-2	159
2-3	453	0-3	612
3-4	1848	0-4	2460
4-5	2394	0-5	4854
5-6	1744	0-6	6598
6-7	3001	0-7	9599
7-8	2567	0-8	12166
8-9	3383	0-9	15549
9-10	4394	0-10	19943
10-EPZ	2815	0-EPZ	22758

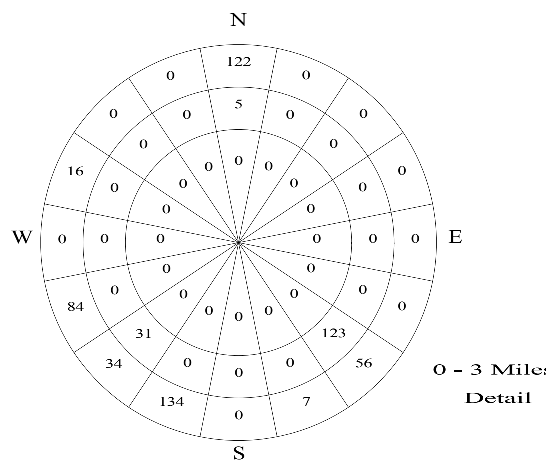
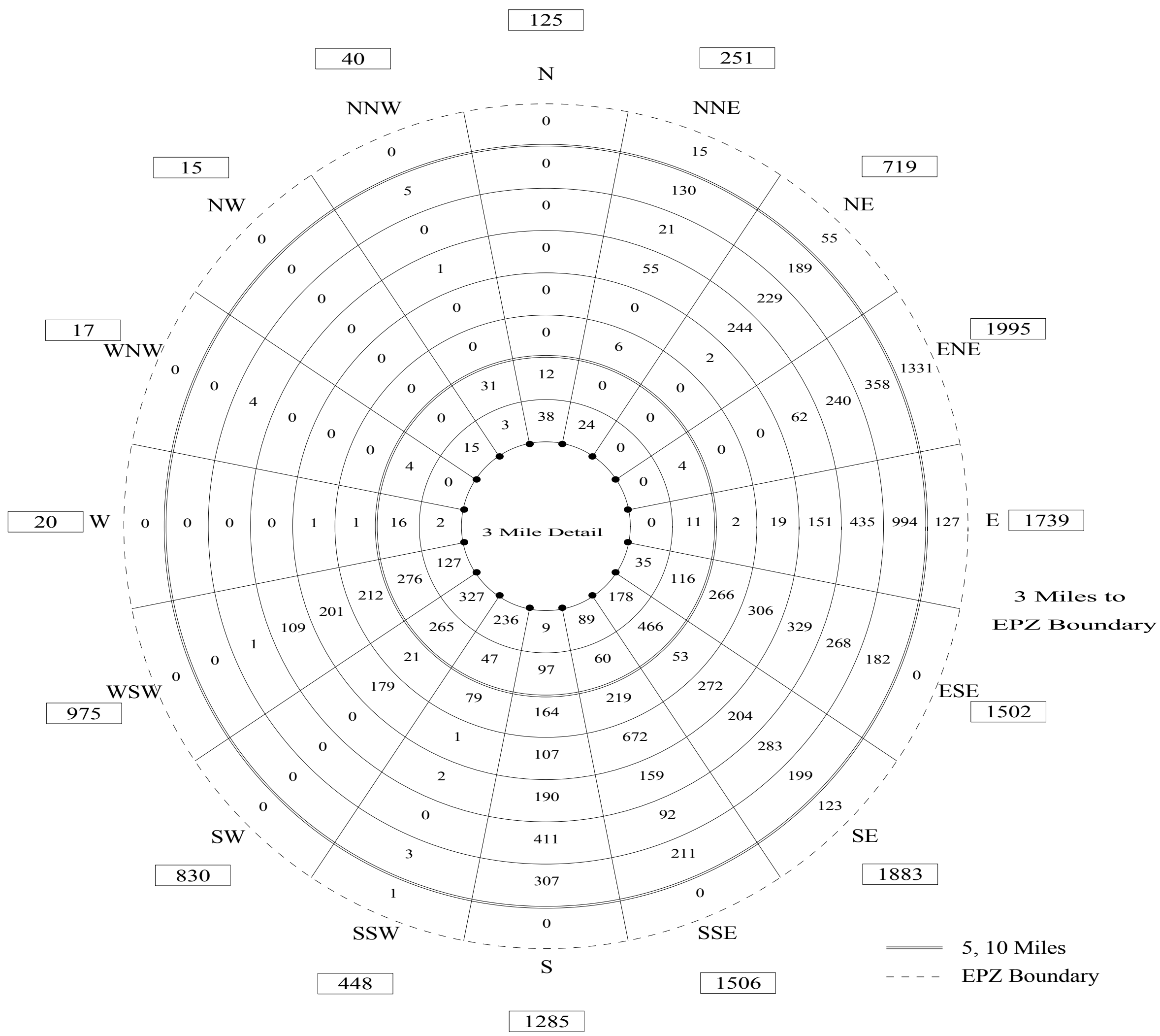


Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	93	0-2	93
2-3	266	0-3	359
3-4	1083	0-4	1442
4-5	1405	0-5	2847
5-6	1023	0-6	3870
6-7	1760	0-7	5630
7-8	1506	0-8	7136
8-9	1984	0-9	9120
9-10	2578	0-10	11698
10-EPZ	1652	0-EPZ	13350

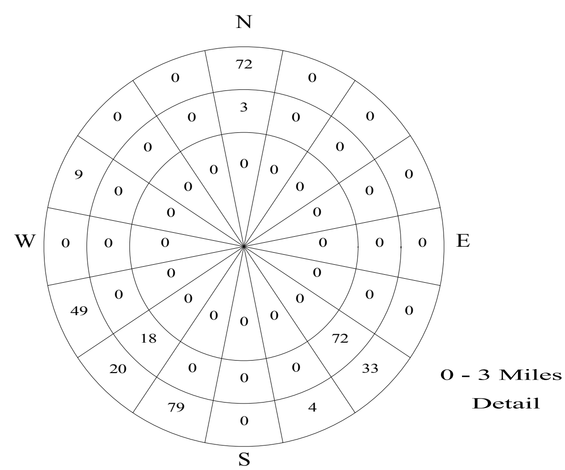


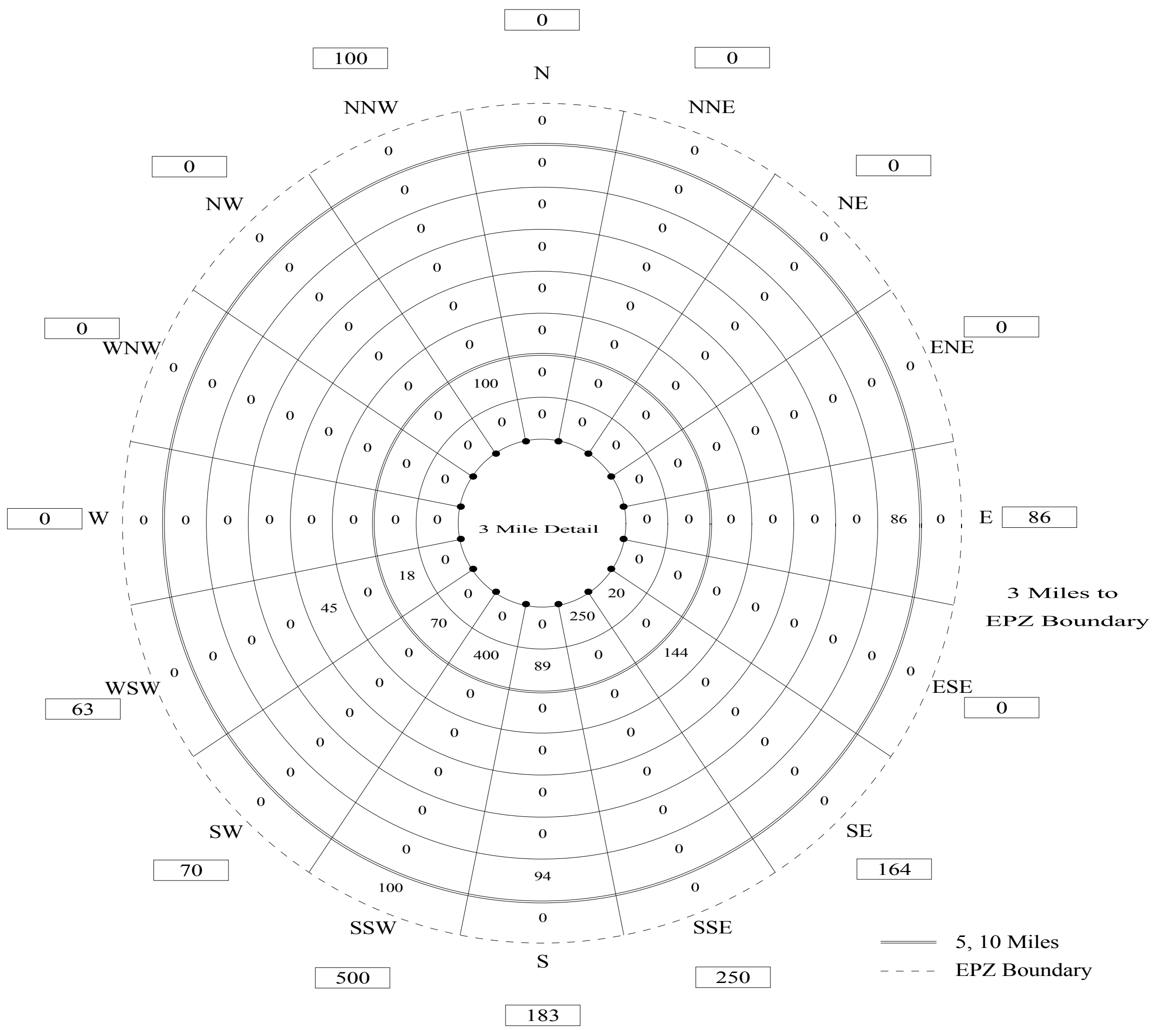
Figure 3-3. Permanent Resident Vehicles by Sector

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, boating). Transients may spend less than one day or stay overnight or longer at rented apartments, camping facilities, hotels and motels. There are several locations within the LNP EPZ that offer boating, fishing and camping facilities in and along Lake Rousseau and on the Gulf of Mexico.

A total of 1,416 people could be recreating in the EPZ during the peak season based on data obtained from the survey of the major recreational areas for LNP. This represents about 889 vehicles in the EPZ at an average occupancy rate of 1.63 persons/vehicle. The peak season is winter; 10-15% of transients are assumed to be present during off-peak times. See Appendix E for supporting data.

Figures 3-4 and 3-5 present transient population and transient vehicle data by sector.



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	270	0-4	270
4-5	677	0-5	947
5-6	144	0-6	1091
6-7	45	0-7	1136
7-8	0	0-8	1136
8-9	0	0-9	1136
9-10	180	0-10	1316
10-EPZ	100	0-EPZ	1416

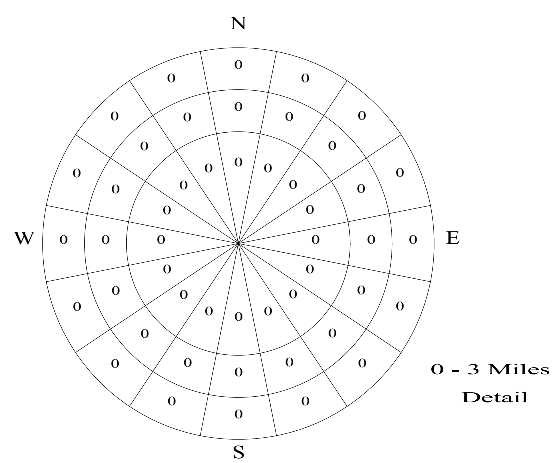
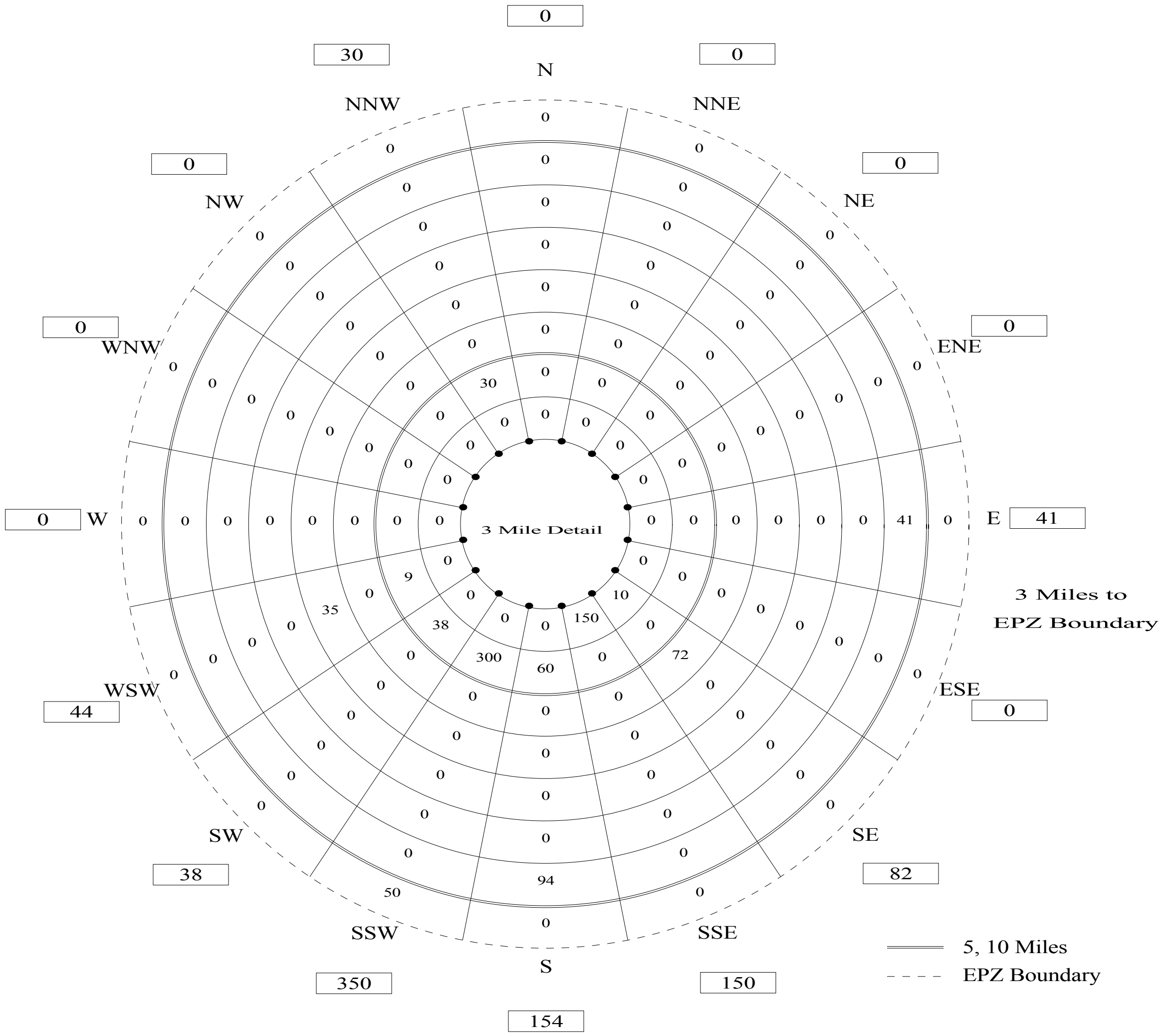


Figure 3-4. Transient Population by Sector



Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	160	0-4	160
4-5	437	0-5	597
5-6	72	0-6	669
6-7	35	0-7	704
7-8	0	0-8	704
8-9	0	0-9	704
9-10	135	0-10	839
10-EPZ	50	0-EPZ	889

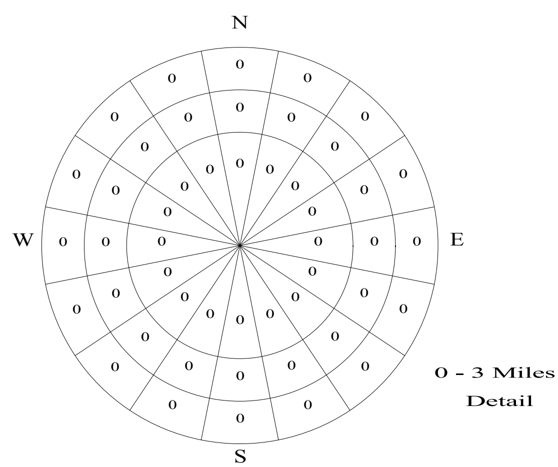


Figure 3-5. Transient Vehicles by Sector

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 (more than 50 total employees) in the EPZ was provided by the county emergency management offices. 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.

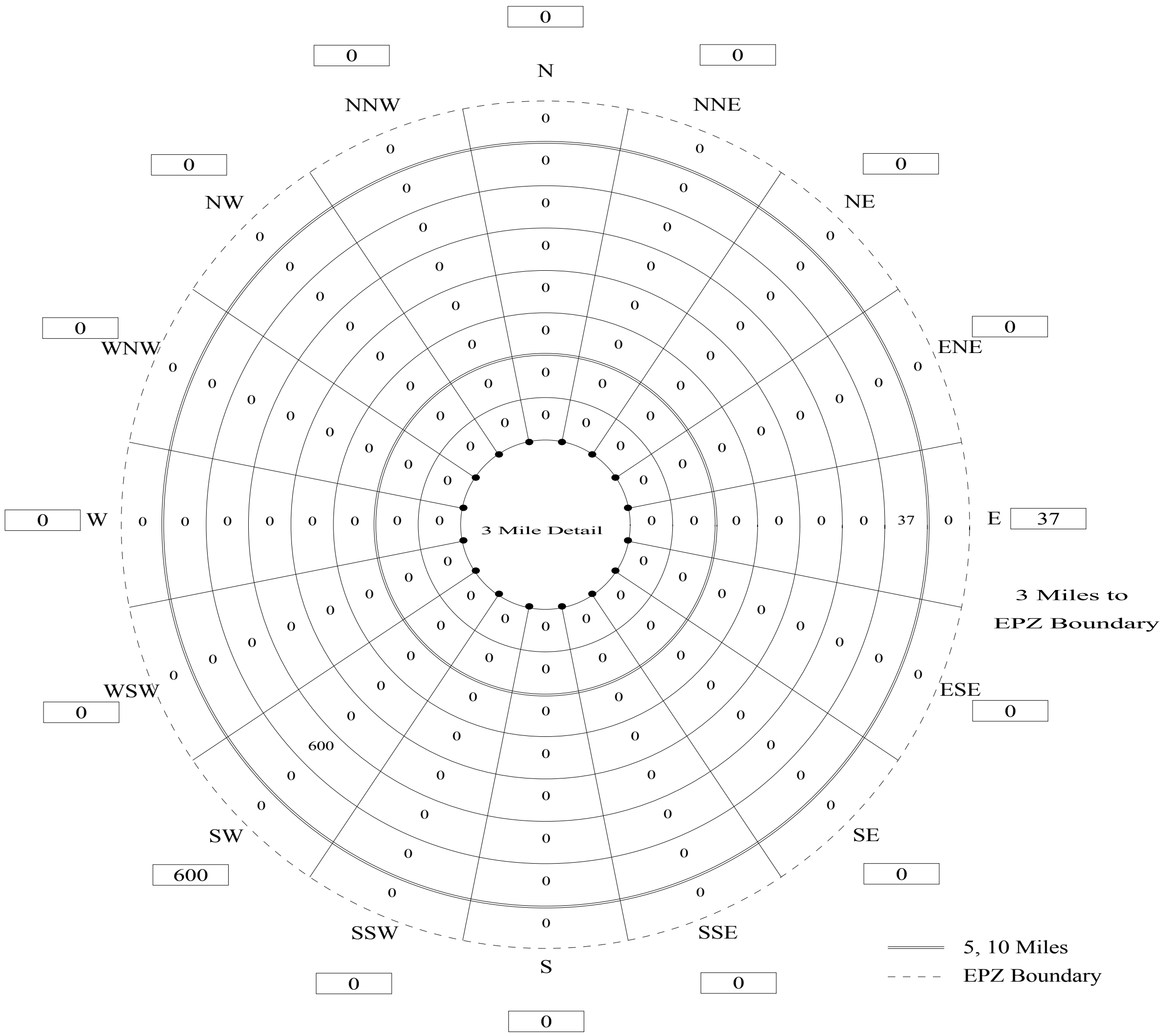
Three major employers were identified for the LNP EPZ:

1. The Crystal River Nuclear Plant
   - Total employment of 1,000 people.
   - Maximum shift employment of 800 people.
   - 75% of employees are non-EPZ residents; thus max shift is 600 non-EPZ employees.
   - Evening workforce is equal to 13% of daytime workforce.
2. Sweetbay Supermarket – Grocery Store
   - Total employment of 60 people.
   - Maximum shift employment of 25 people.
   - Assumed 50% of employees are non-EPZ residents.
3. Super Walmart – Grocery/Convenience Store
   - Assumed Total employment of 100 people.
   - Assumed Maximum shift employment of 50 people.
   - Assumed 50% of employees are non-EPZ residents.

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

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

Figures 3-6 and 3-7 present non-EPZ Resident employee data by sector.



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	0	0-4	0
4-5	0	0-5	0
5-6	0	0-6	0
6-7	0	0-7	0
7-8	0	0-8	0
8-9	600	0-9	600
9-10	37	0-10	637
10-EPZ	0	0-EPZ	637

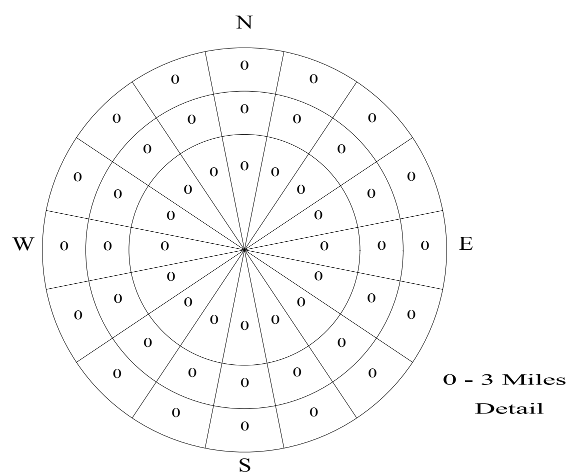
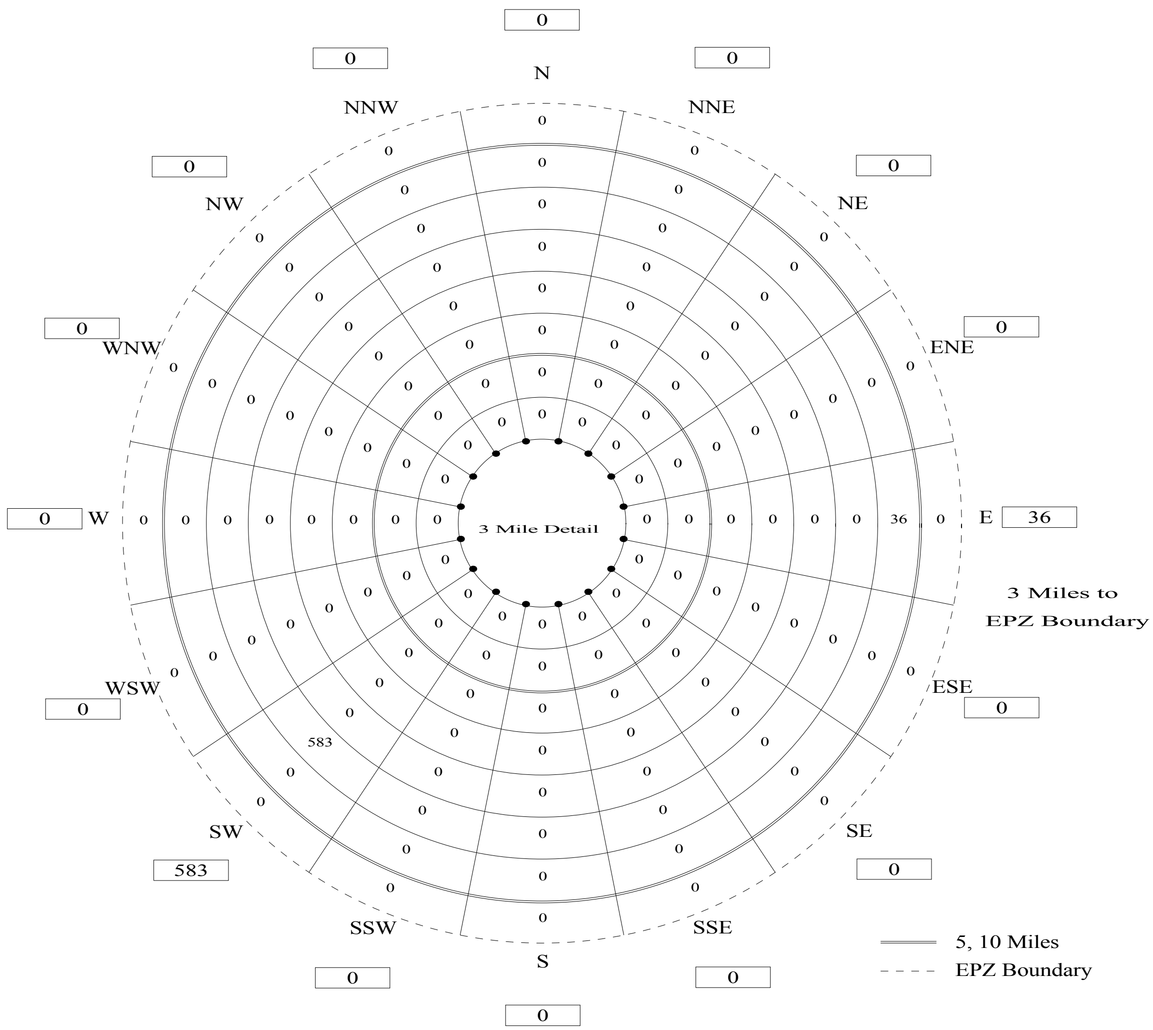


Figure 3-6. Employee Population by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	0	0-4	0
4-5	0	0-5	0
5-6	0	0-6	0
6-7	0	0-7	0
7-8	0	0-8	0
8-9	583	0-9	583
9-10	36	0-10	619
10-EPZ	0	0-EPZ	619

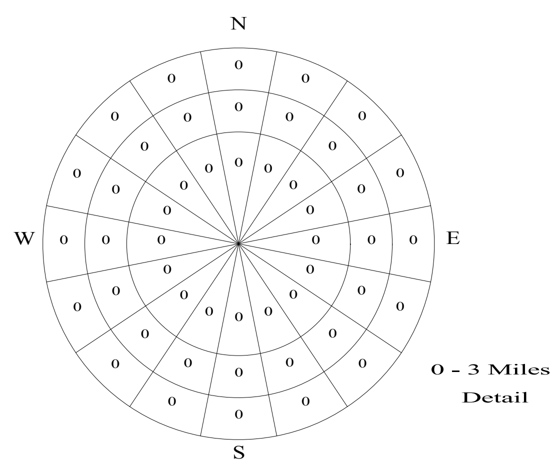


Figure 3-7. Employee Vehicles by Sector

Medical Facilities

There are three medical facilities in the LNP EPZ; a data request form was completed for each facility. 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 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

Pass-Through Demand

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major routes through the EPZ (e.g. US Hwy 19, US Hwy 41). It is assumed that this traffic will continue to enter the EPZ during the first 90 minutes following the Advisory to Evacuate. We estimate approximately 2,400 vehicles enter the EPZ as external-external trips during this period.

4. ESTIMATION OF HIGHWAY CAPACITY

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

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

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

Given the rural character of the EPZ within Levy and Marion Counties and the availability of well-maintained highways, congestion arising from evacuation is not likely to develop in those portions of the EPZ. The suburban character of the Citrus County portion of the EPZ will likely result in localized congestion. Estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Capacity Estimations on Approaches to Intersections

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

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

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

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

where:

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

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

$$h_m \geq h_{sat}$$

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.

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

Capacity Estimation Along Sections of Highway

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

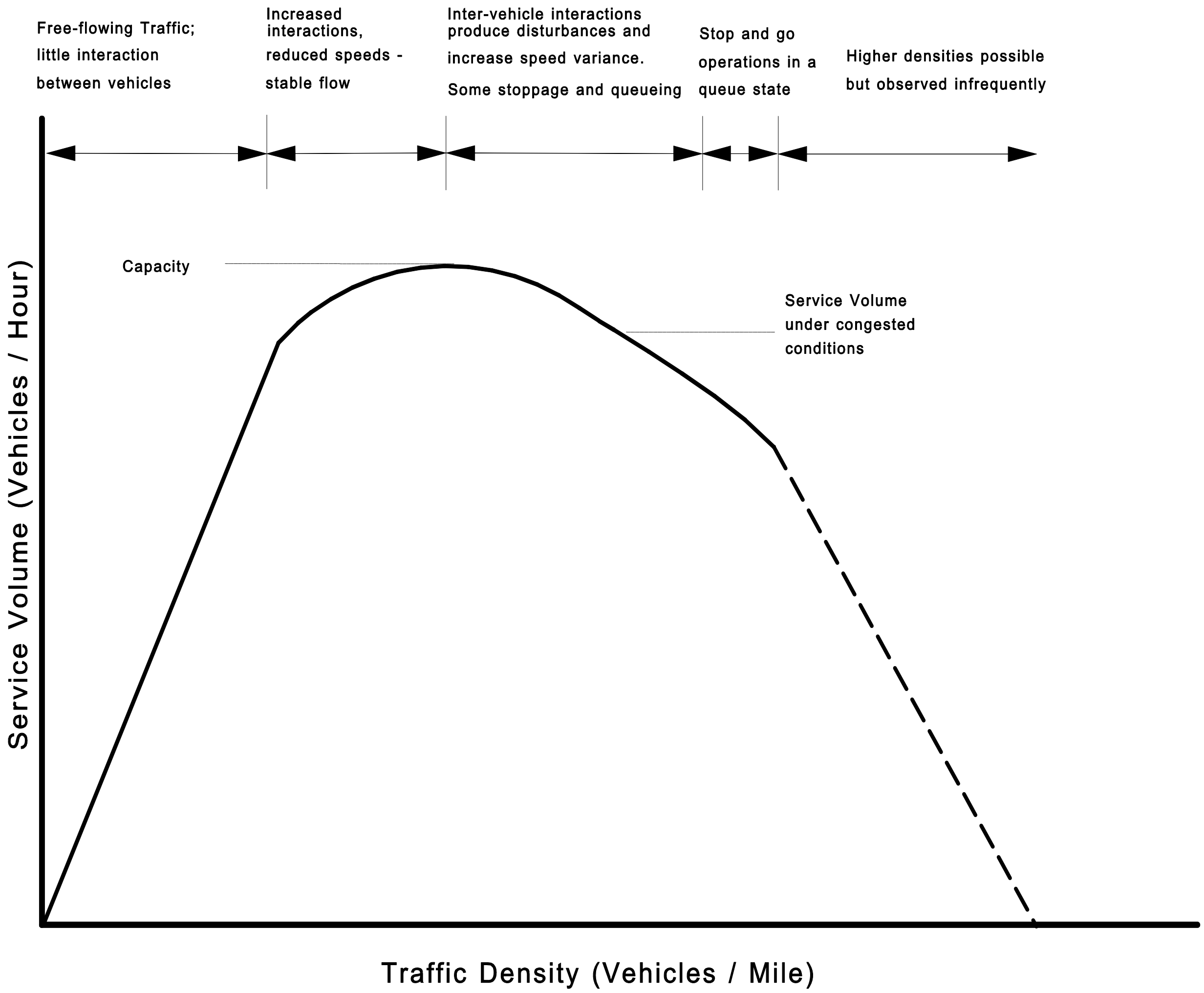


Figure 4-1. Fundamental Relationship Between Volume and Density

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

The value of V_F can be expressed as:

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

where R = Reduction factor which is less than unity.

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

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

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

Application to the Levy Nuclear Plant EPZ

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

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

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

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

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapter 20

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

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

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

Multi-Lane Highway

Ref: HCM Chapter 21

Exhibit 21-23 (in the HCM) presents a set of curves that indicates a per-lane capacity of approximately 2100 pc/h, for free-speeds of 55-60 mph. Based on observation, the multi-lane highways running north-south along the eastern and western parts of the EPZ (US Highway 19 and US Highway 41) service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand:capacity relationship and the impact of control at intersections.

Intersections

Ref: HCM Chapters 16, 17

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

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

5. ESTIMATION OF TRIP GENERATION TIME

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 Levy Nuclear Plant (LNP) 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 LNP 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 permanent resident population within the EPZ approximates 22,758 persons who are deployed over an area of approximately 314 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.

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

Fundamental Considerations

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

Activities are undertaken over a period of time. Activities may be in "series" (i.e. to undertake an activity implies the completion of all preceding 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

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

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

Estimated Time Distributions of Activities Preceding Event 5

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

Time Distribution No. 1, Notification Process: Activity 1 → 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 → 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

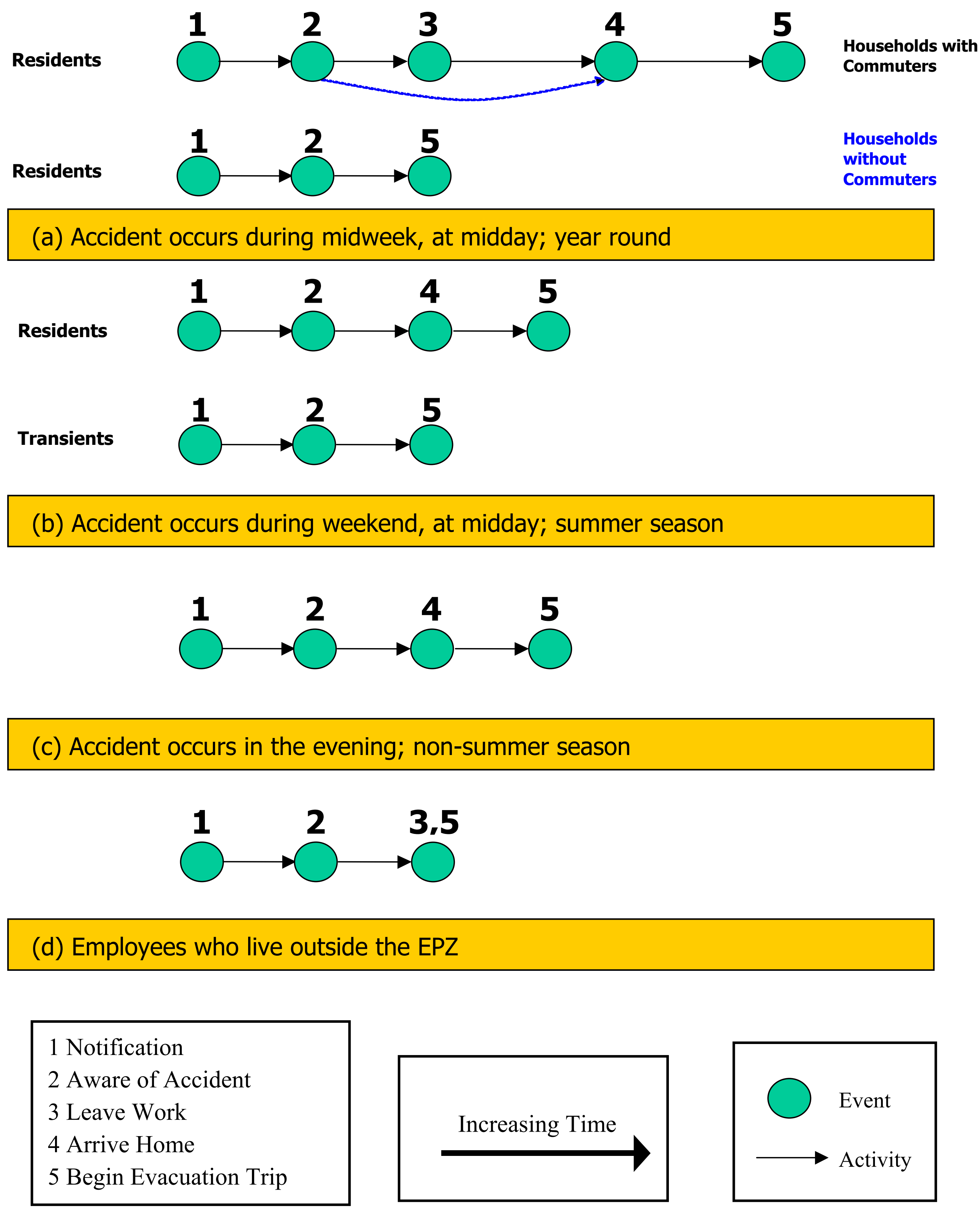


Figure 5-1. Events and Activities Preceding the Evacuation Trip

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 $\rightarrow$ 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	33
10	46
15	57
20	65
25	73
30	81
35	84
40	86
45	89
50	90
55	92
60	94
65	95
70	96
75	97
80	98
85	98
90	98
95	98
100	100

NOTE: The survey data was 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	18
10	37
15	50
20	61
25	70
30	77
35	82
40	85
45	90
50	92
55	92
60	94
65	95
70	96
75	96
80	96
85	97
90	97
95	97
100	97
105	97
110	98
115	99
120	100

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

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

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

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate	Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0	110	88
5	9	115	89
10	18	120	90
15	27	125	91
20	37	130	93
25	48	135	94
30	54	140	94
35	60	145	94
40	63	150	95
45	65	155	95
50	70	160	95
55	74	165	95
60	79	170	95
65	81	175	95
70	83	180	95
75	85	185	96
80	85	190	96
85	85	195	97
90	86	200	98
95	86	205	99
100	86	210	100
105	86		

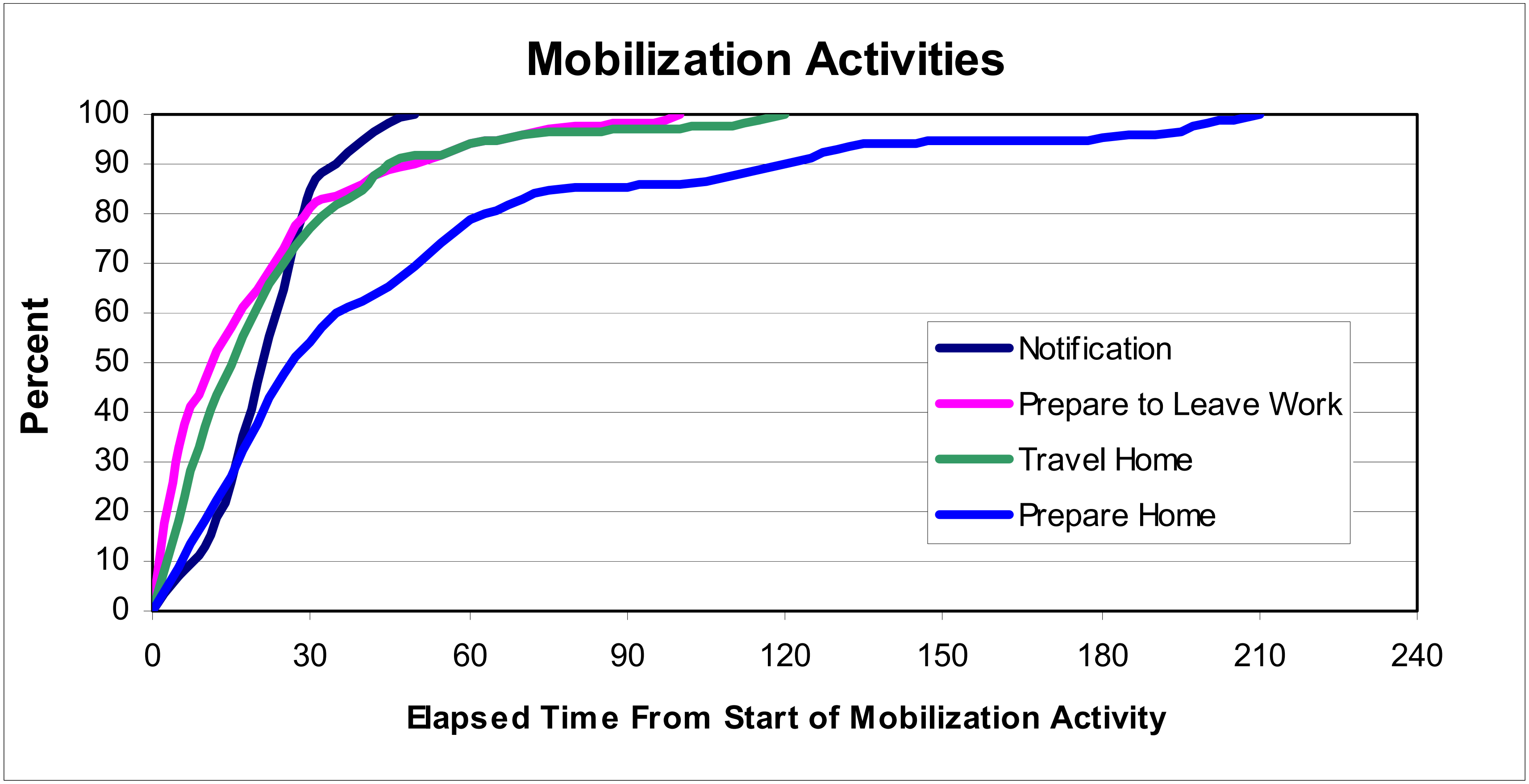


Figure 5-2. Evacuation Mobilization Activities

Calculation of Trip Generation Time Distribution

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

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

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

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

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 leaving home to begin the evacuation trip.
D	Time distribution of residents without commuters returning home to begin the evacuation trip.

Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, and D, properly displaced with respect to one another, are tabulated in Table 5-1 (Distribution B, Arrive Home, omitted for clarity).

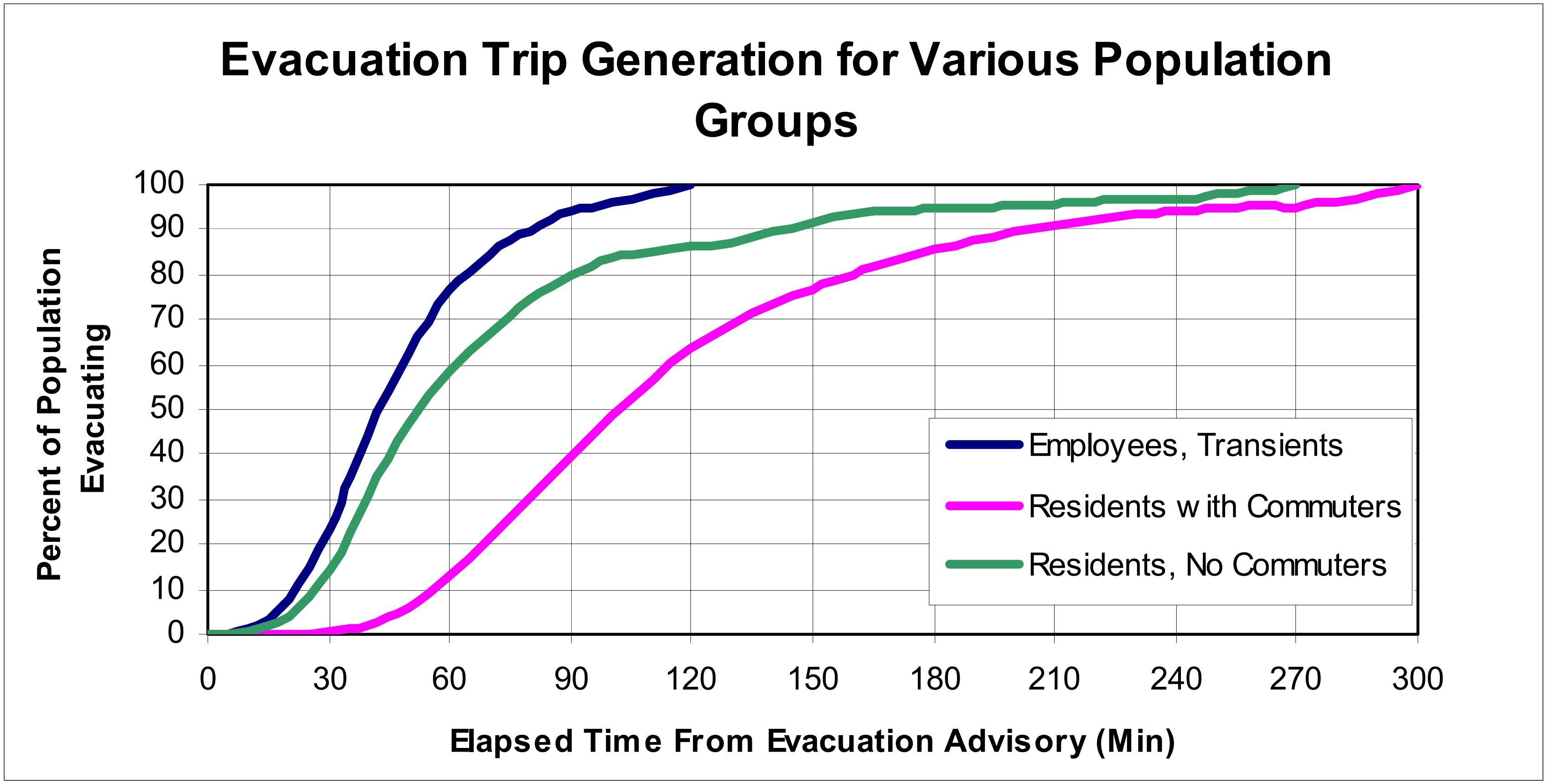


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-1. Trip Generation Histograms for the EPZ Population						
Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period				
		Residents With Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Employees (Distribution A)	Transients (Distribution A)
1	15	0	3	5	5
2	15	1	12	20	20
3	30	11	45	53	53
4	30	28	20	17	17
5	30	25	7	5	5
6	30	14	4	0	0
7	30	7	4	0	0
8	60	7	3	0	0
9	60	7	2	0	0
10	600	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 Zones (PAZ), 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 13 Regions were defined which encompass all the groupings of PAZ considered. These Regions are defined in Table 6-1. The PAZ configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a circular area centered at the Levy Nuclear Plant (LNP), and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from LNP, or to the EPZ boundary. The azimuth of the center sector defines the orientation of these Regions.

A total of 11 Scenarios were evaluated for all Regions. Thus, there are a total of 11 x 13 = 143 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	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
R01	2 mile ring				■				
R02	5-mile ring				■	■			
R03	Full EPZ	■	■	■	■	■	■	■	■
Evacuate 2 mile ring and 5 miles downwind									
Region	Wind Direction Towards:	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
Refer to R02	WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE				■	■			
Refer to R01	SSE, S, SSW, SW, WSW, W				■				
Evacuate 5 mile ring and downwind to EPZ boundary									
Region	Wind Direction Towards:	PAZ							
		C1	C3	C4	L5	L6	L7	L8	M9
R04	N				■	■	■	■	■
R05	NNE, NE				■	■		■	■
R06	ENE, E			■	■	■			■
R07	ESE, SE		■	■	■	■			■
R08	SSE	■	■	■	■	■			
R09	S, SSW	■	■		■	■			
R10	SW, WSW	■			■	■			
R11	W	■			■	■	■		
R12	WNW				■	■	■		
R13	NW, NNW				■	■	■	■	

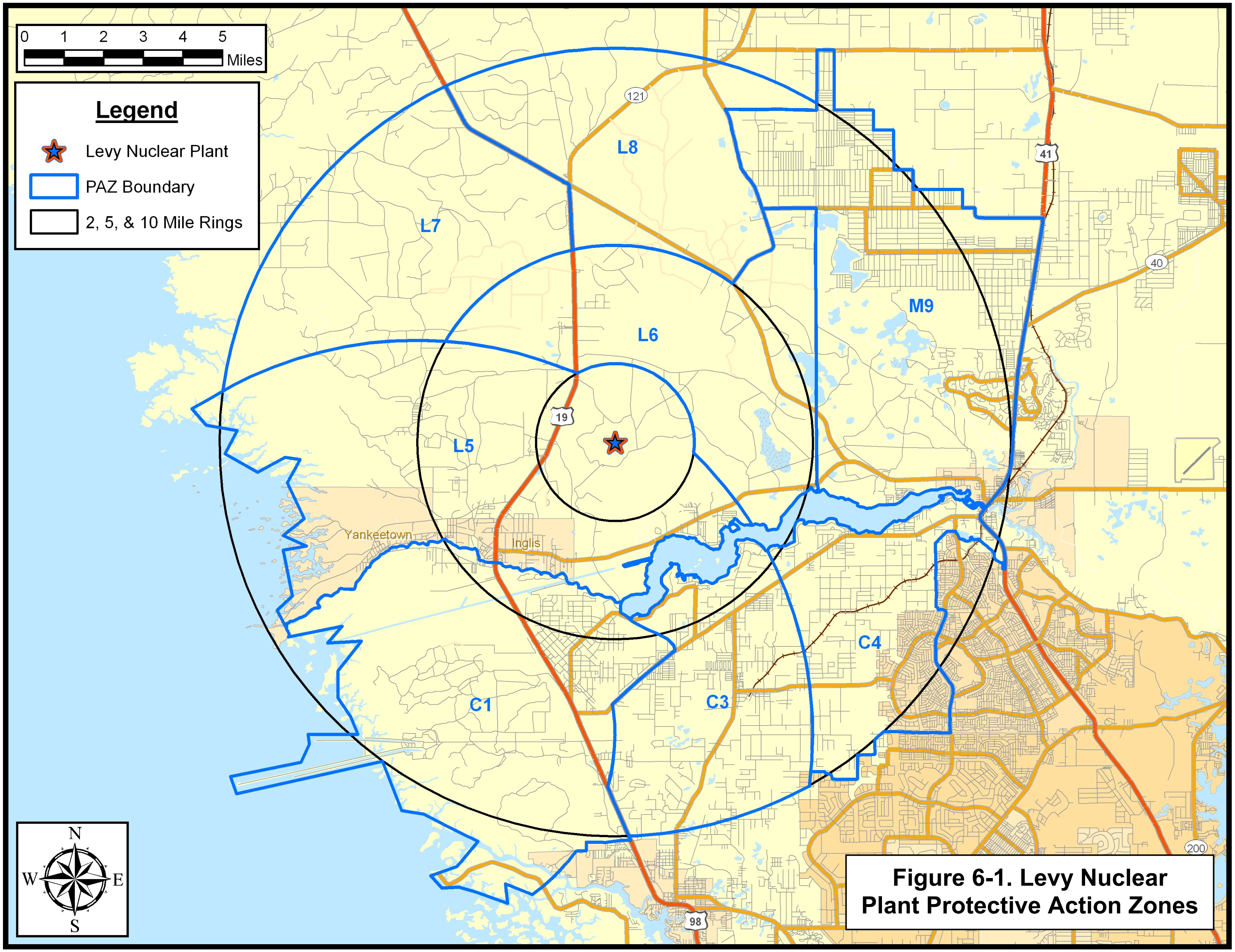


Figure 6-1. Levy Nuclear Plant Protective Action Zones

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	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	New Plant Construction

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

Scenarios	Residents With Commuters in Household	Residents With No Commuters in Household	Employees	Transients	Shadow	Special Event	School Buses	Transit Buses	External Through Traffic
1	45%	55%	96%	10%	31%	0%	10%	100%	100%
2	45%	55%	96%	10%	31%	0%	10%	100%	100%
3	10%	90%	75%	15%	31%	0%	0%	100%	100%
4	10%	90%	75%	15%	31%	0%	0%	100%	100%
5	10%	90%	10%	5%	30%	0%	0%	100%	60%
6	45%	55%	100%	50%	31%	0%	100%	100%	100%
7	45%	55%	100%	50%	31%	0%	100%	100%	100%
8	10%	90%	75%	100%	31%	0%	0%	100%	100%
9	10%	90%	75%	100%	31%	0%	0%	100%	100%
10	10%	90%	10%	50%	30%	0%	0%	100%	60%
11	10%	90%	75%	100%	31%	100%	0%	100%	100%

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

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

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

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

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

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

Special Events .... Additional vehicles in the Levy Nuclear Plant area during the completion of construction on Unit 2 in the Year 2017. Unit 1 will be operational in the Year 2016.

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 Events	School Buses *	Transit Buses *	External Traffic	Total Scenario Vehicles
1	6,020	7,330	594	89	9,250	-	12	40	2,400	25,735
2	6,020	7,330	594	89	9,250	-	12	40	2,400	25,735
3	602	12,748	464	133	9,164	-	-	40	2,400	25,551
4	602	12,748	464	133	9,164	-	-	40	2,400	25,551
5	602	12,748	62	44	8,898	-	-	40	1,440	23,834
6	6,020	7,330	619	445	9,267	-	112	40	2,400	26,233
7	6,020	7,330	619	445	9,267	-	112	40	2,400	26,233
8	602	12,748	464	889	9,164	-	-	40	2,400	26,307
9	602	12,748	464	889	9,164	-	-	40	2,400	26,307
10	602	12,748	62	445	8,898	-	-	40	1,440	24,235
11	1,022**	21,645**	464	889	14,743**	695	-	40	2,400	41,898

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 County specific growth rates) to the Year 2017 when Unit 1 will be operational while Unit 2 construction is completed.

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 13 regions within the Levy Nuclear Plant EPZ and the 11 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 Zones (PAZ) 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 LNP 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 LNP.

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 winter, weekend, midday period under good weather conditions (Scenario 8).

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 red line; all others are lightly indicated. Congestion develops in areas with high population density and at traffic bottlenecks. The approaches to US Hwy 41 in Dunnellon, to US Hwy 19/98 in Crystal River and to US Hwy 19/98 in Inglis are congested at 1 hour after the Advisory to Evacuate (ATE) for Scenario 8, as indicated in Figure 7-3. Congestion is also exhibited northbound on US Hwy 41 and eastbound on State Highway 484 at this time. Congestion patterns are similar at 1 hour and 30 minutes after the ATE, as shown in Figure 7-4; however, congestion eastbound on Dunnellon Road is beginning to dissipate. Figure 7-5 indicates that most of the congestion in the EPZ has cleared by 2 hours after the ATE, while some congestion persists in the Rainbow Springs area along US Hwy 41. The roadway network is clear of congestion at 2 hours and 30 minutes after the ATE, as shown in Figure 7-6. The absence of congestion on network links implies that traffic demand there has decreased below the roadway capacity for a period of time sufficient to dissipate any traffic queues. It does not necessarily imply that traffic has completely cleared from these roadway sections.

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. There is no significant congestion within the EPZ and the ETE is driven by the mobilization activities of the EPZ population.

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 13 Evacuation Regions and all 11 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
    - Special Event (if any)
        - New Plant Construction

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

- The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenario (4) applies.

- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenario (9) 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: *towards* N, NNE, NE, …
   - Determine the distance that the Evacuation Region will extend from the Levy Nuclear Plant. The applicable distances and their associated candidate Regions are given below:
     - 2 Miles (Region R01)
     - 5 Miles (Region R02)
     - to EPZ Boundary (Regions R03 through R13)
   - 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 LNP. 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 *toward* the northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 95 percent of the population from within the impacted Region.

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

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1C, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of circumstances to Scenario 4.

2. Enter Table 7-2 and locate the group entitled “Evacuate 5-Mile Ring and Downwind to EPZ Boundary”. Under “Wind Direction Towards:”, identify the NE (northeast) azimuth and read REGION R05 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 R05. This data cell is in column (4) and in the row for Region R05; it contains the ETE value of **3:10**.

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

	Summer		Summer		Summer		Winter		Winter		Winter		Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	Scenario:	(11)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday
Region Wind Towards:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Towards:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Towards:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ													
R01 2-mile ring	1:15	1:15	1:05	1:10	1:05	R01 2-mile ring	1:15	1:15	1:05	1:10	1:05	R01 2-mile ring	1:25
R02 5-mile ring	1:15	1:20	1:05	1:10	1:05	R02 5-mile ring	1:15	1:20	1:05	1:10	1:05	R02 5-mile ring	1:15
R03 Entire EPZ	1:20	1:25	1:10	1:15	1:10	R03 Entire EPZ	1:20	1:25	1:10	1:15	1:10	R03 Entire EPZ	1:35
2-Mile Ring and Downwind to 5 Miles													
Same As R01 SSE, S, SSW, SW, WSW, W	1:15	1:15	1:05	1:10	1:05	Same As R01 SSE, S, SSW, SW, WSW, W	1:15	1:15	1:05	1:10	1:05	Same As R01 SSE, S, SSW, SW, WSW, W	1:25
Same As R02 WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE	1:15	1:20	1:05	1:10	1:05	Same As R02 WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE	1:15	1:20	1:05	1:10	1:05	Same As R02 WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE	1:15
5-Mile Ring and Downwind to EPZ Boundary													
R04 N	1:20	1:25	1:10	1:15	1:10	R04 N	1:20	1:25	1:10	1:15	1:10	R04 N	1:25
R05 NNE, NE	1:20	1:25	1:10	1:15	1:10	R05 NNE, NE	1:20	1:25	1:10	1:15	1:10	R05 NNE, NE	1:25
R06 ENE, E	1:20	1:25	1:10	1:15	1:10	R06 ENE, E	1:20	1:25	1:10	1:15	1:10	R06 ENE, E	1:25
R07 ESE, SE	1:20	1:25	1:10	1:15	1:10	R07 ESE, SE	1:20	1:25	1:10	1:15	1:10	R07 ESE, SE	1:15
R08 SSE	1:15	1:20	1:05	1:10	1:05	R08 SSE	1:15	1:20	1:05	1:10	1:05	R08 SSE	1:25
R09 S, SSW	1:15	1:20	1:05	1:10	1:05	R09 S, SSW	1:15	1:20	1:05	1:10	1:05	R09 S, SSW	1:15
R10 SW, WSW	1:15	1:20	1:05	1:10	1:05	R10 SW, WSW	1:15	1:20	1:05	1:10	1:05	R10 SW, WSW	1:15
R11 W	1:15	1:20	1:05	1:10	1:05	R11 W	1:15	1:20	1:05	1:10	1:05	R11 W	1:15
R12 WNW	1:20	1:20	1:10	1:10	1:10	R12 WNW	1:20	1:20	1:10	1:10	1:10	R12 WNW	1:20
R13 NW,NNW	1:20	1:25	1:10	1:10	1:10	R13 NW,NNW	1:20	1:25	1:10	1:10	1:10	R13 NW,NNW	1:20

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

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

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

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

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

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

Table 7-2. Description of Evacuation Regions									
		PAZ							
Region	**Description**	**C1**	**C3**	**C4**	**L5**	**L6**	**L7**	**L8**	**M9**
R01	2 mile ring				■				
R02	5-mile ring				■	■			
R03	Full EPZ	■	■	■	■	■	■	■	■
Evacuate 2 mile ring and 5 miles downwind									
		PAZ							
Region	**Wind Direction Towards:**	**C1**	**C3**	**C4**	**L5**	**L6**	**L7**	**L8**	**M9**
Refer to R02	WNW, NW, NNW, N, NNE, NE, ENE, E, ESE, SE				■	■			
Refer to R01	SSE, S, SSW, SW, WSW, W				■				
Evacuate 5 mile ring and downwind to EPZ boundary									
		PAZ							
Region	**Wind Direction Towards:**	**C1**	**C3**	**C4**	**L5**	**L6**	**L7**	**L8**	**M9**
R04	N				■	■	■	■	■
R05	NNE, NE				■	■		■	■
R06	ENE, E			■	■	■			■
R07	ESE, SE		■	■	■	■			■
R08	SSE	■	■	■	■	■			
R09	S, SSW	■	■		■	■			
R10	SW, WSW	■			■	■			
R11	W	■			■	■	■		
R12	WNW				■	■	■		
R13	NW, NNW				■	■	■	■	

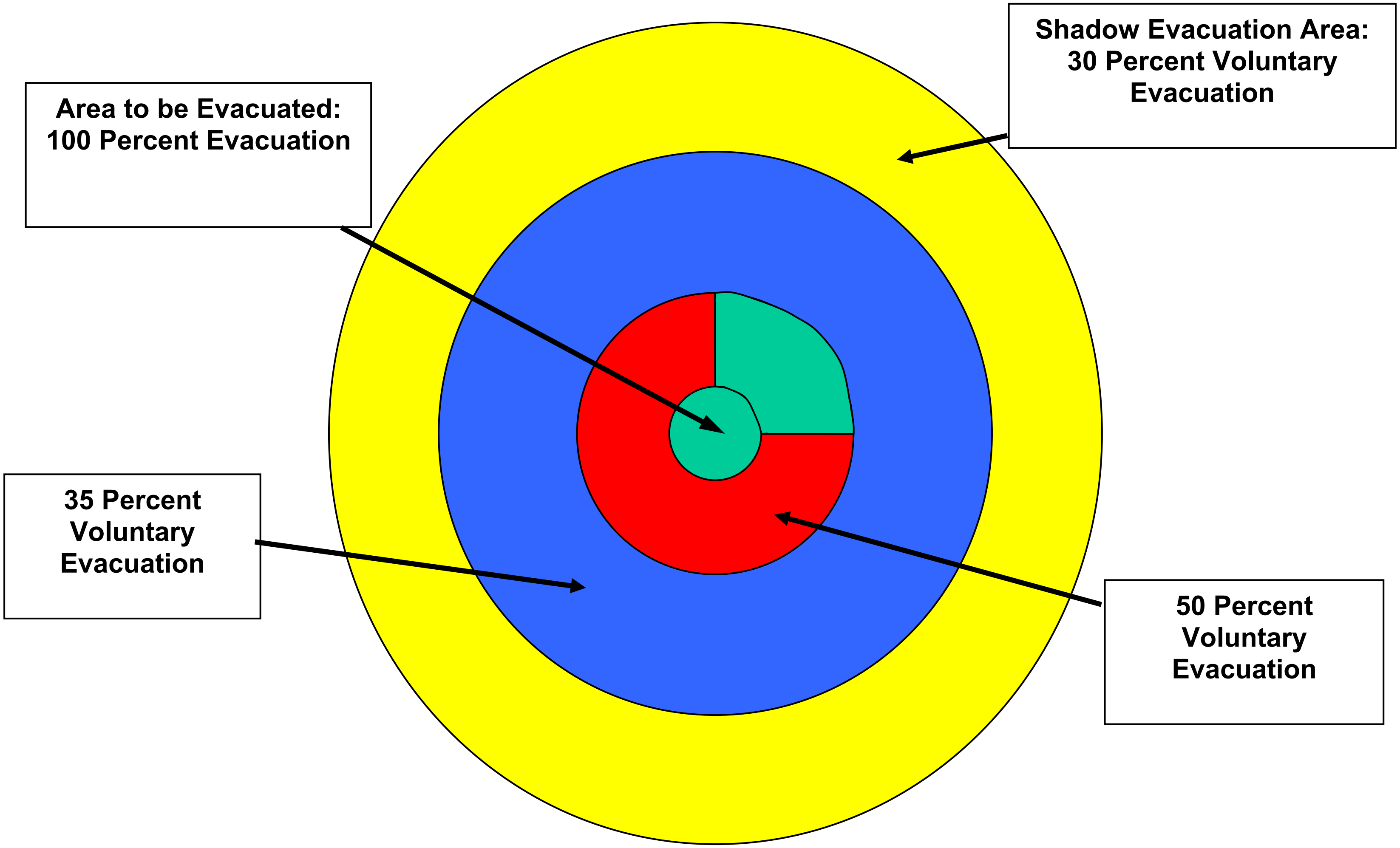


Figure 7-1. Assumed Evacuation Response

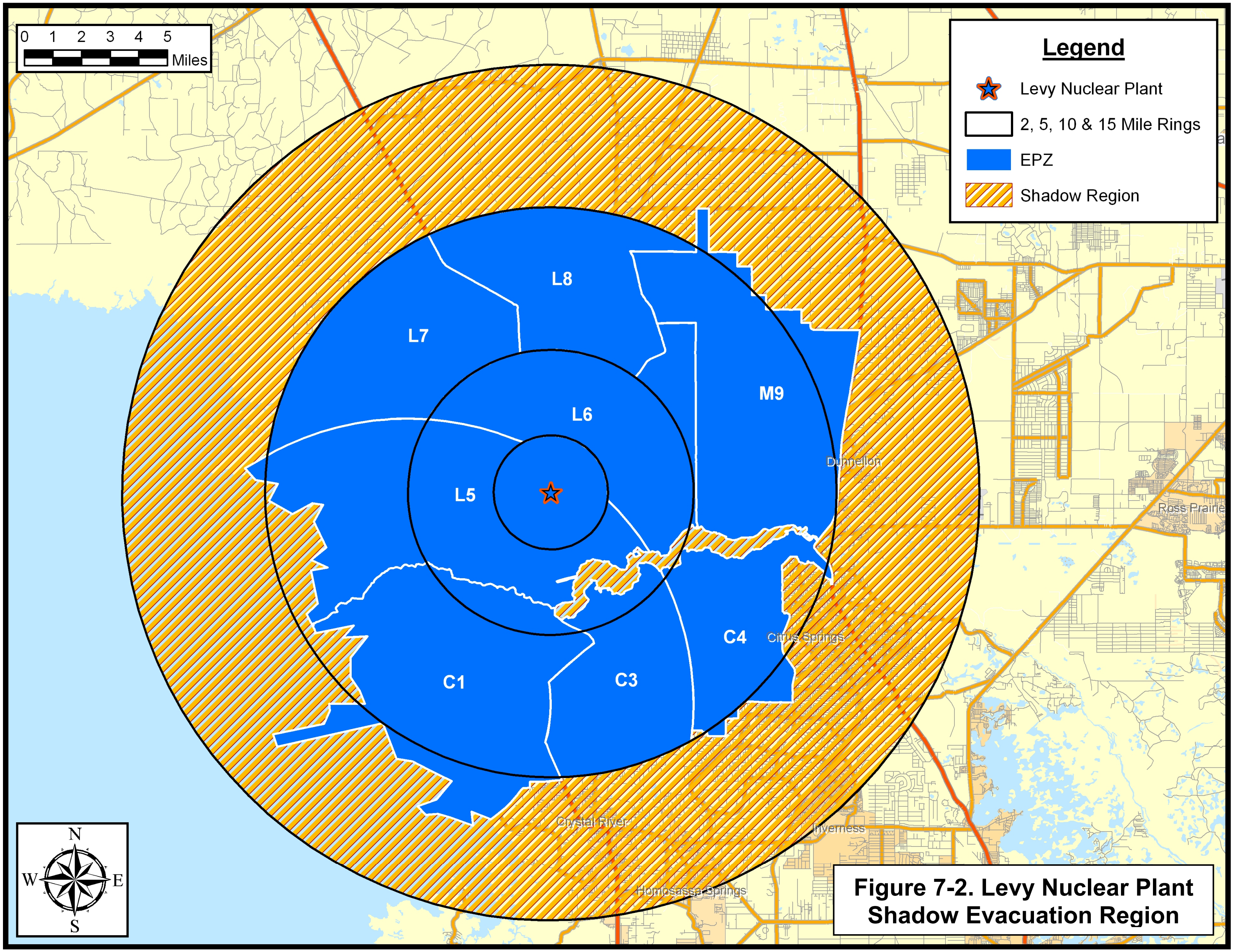


Figure 7-2. Levy Nuclear Plant Shadow Evacuation Region

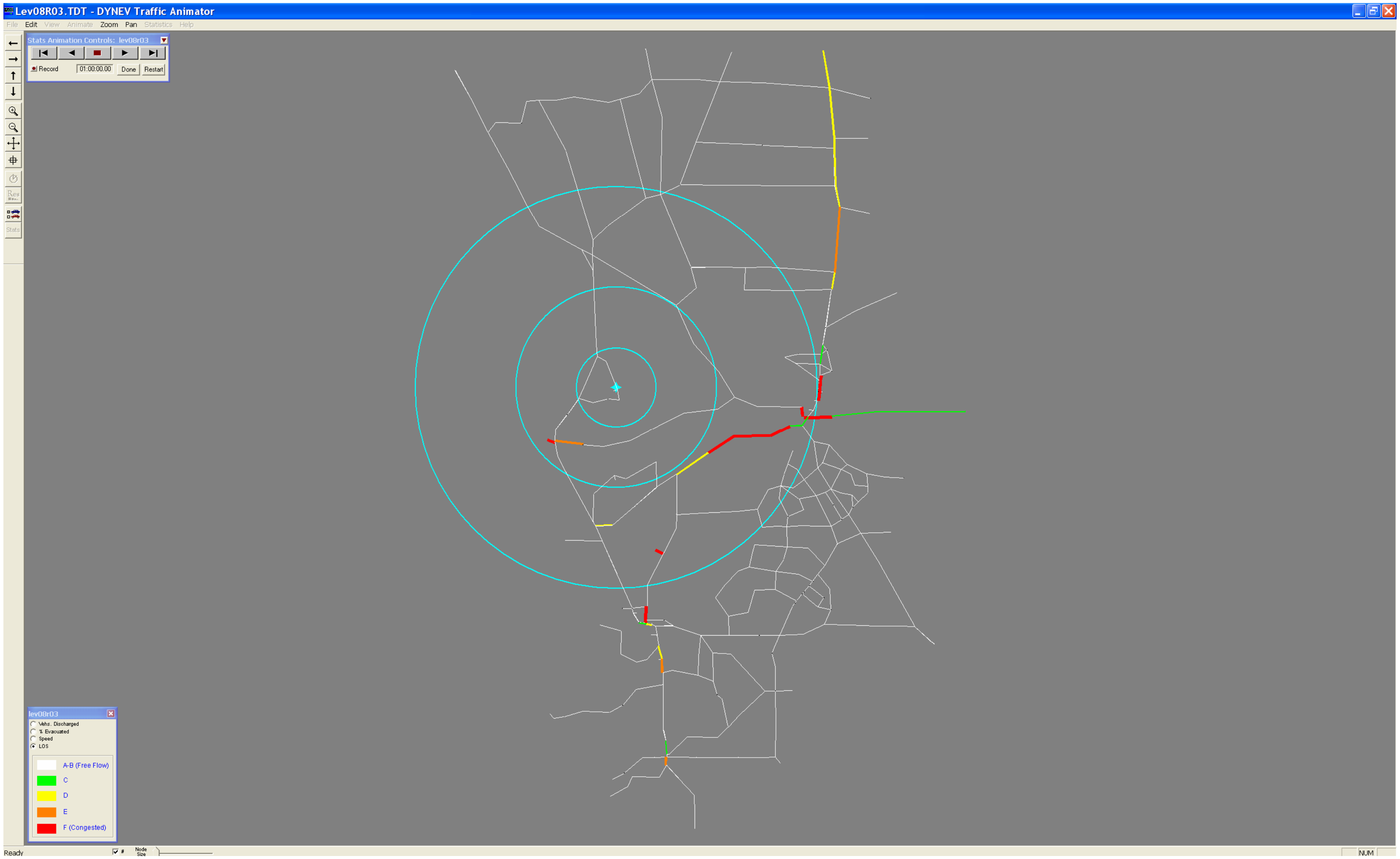


Figure 7-3. Congestion Patterns at 1 Hour After the Advisory to Evacuate (Scenario 8)

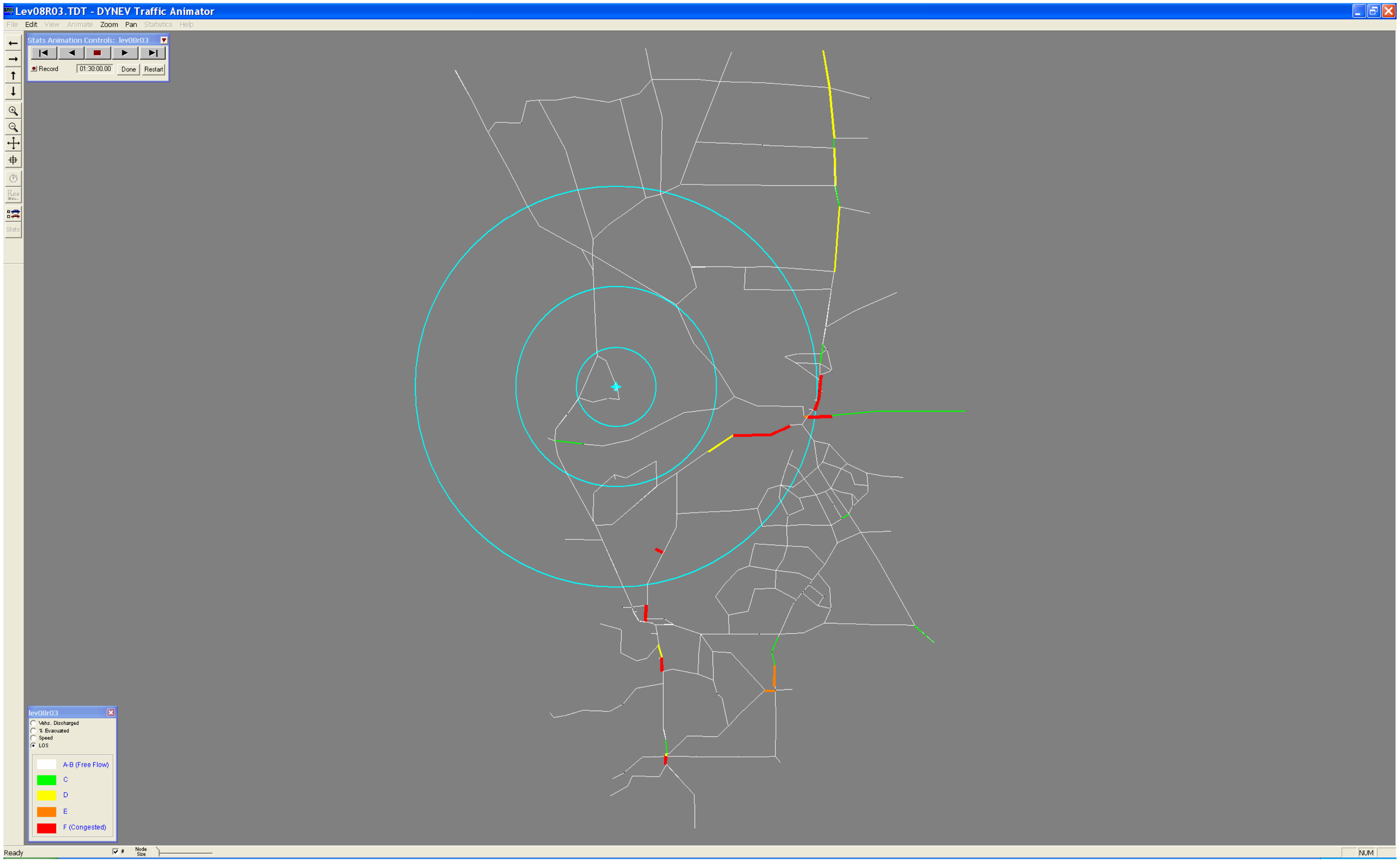


Figure 7-4. Congestion Patterns at 1 Hour, 30 Minutes After the Advisory to Evacuate (Scenario 8)

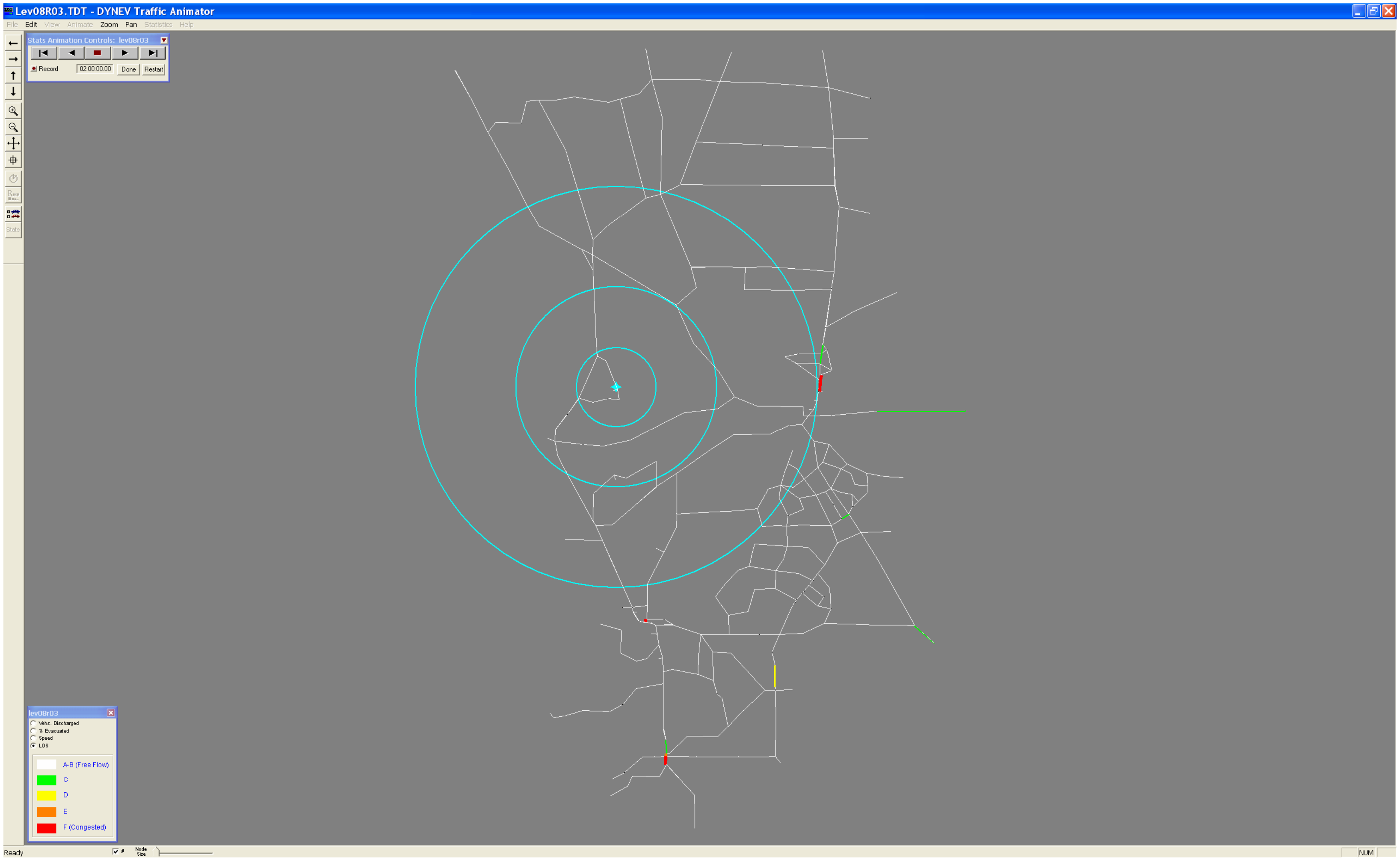


Figure 7-5. Congestion Patterns at 2 Hours After the Advisory to Evacuate (Scenario 8)

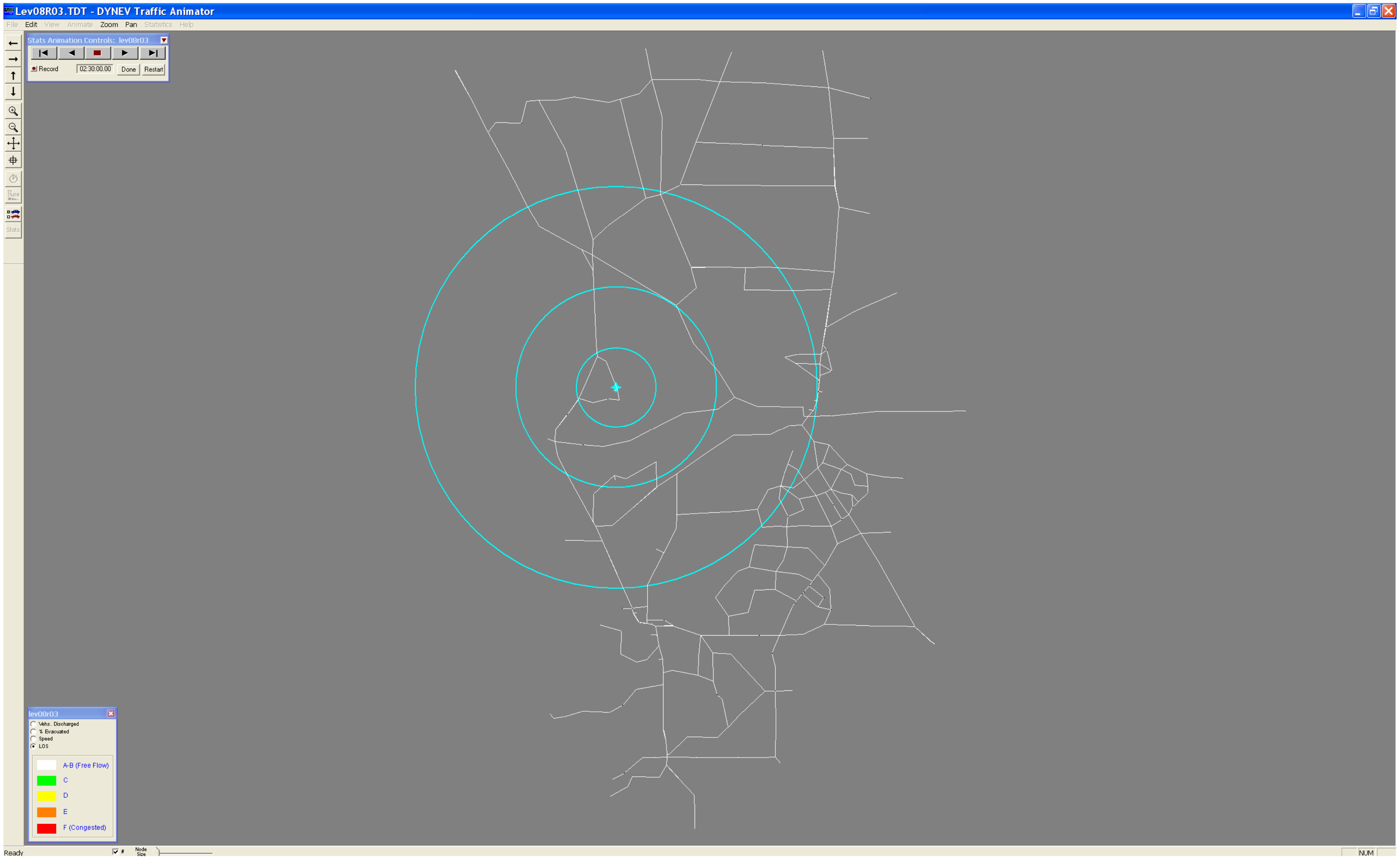


Figure 7-6. Congestion Patterns at 2 Hours, 30 Minutes After the Advisory to Evacuate (Scenario 8)

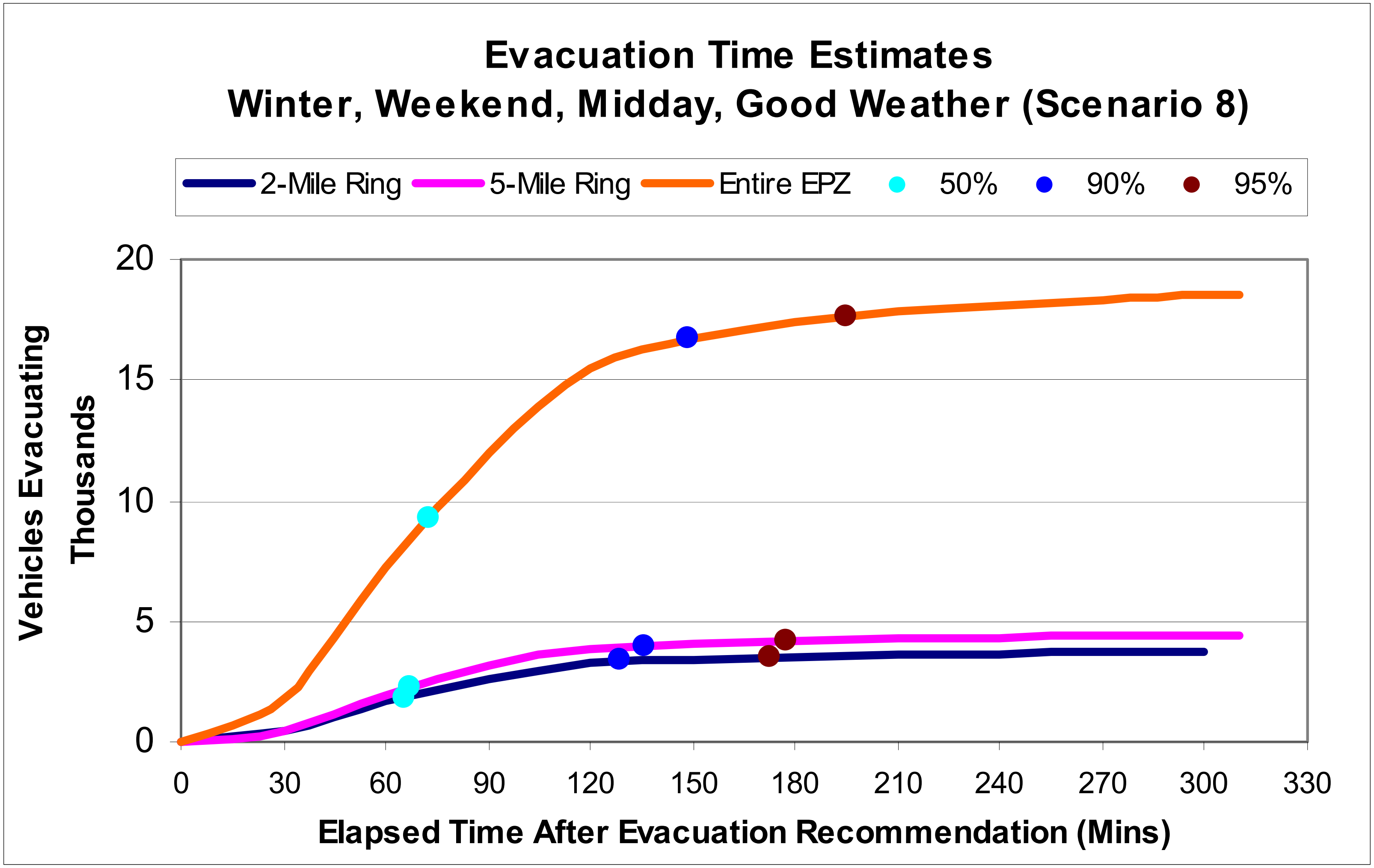


Figure 7-7. Evacuation Time Estimates for LNP
Winter, Weekend, Midday, Good Weather
Evacuation of Region R03 (Entire EPZ)

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 experience at other suburban plants, it is estimated that bus mobilization time will average approximately 90 minutes extending from the Advisory to Evacuate to the time when buses arrive at their respective assignments.

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 or reception centers 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 school reception centers

8.1 Transit-Dependent People - Demand Estimate

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

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

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

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

- Estimates of persons requiring transit vehicles include 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 582 people. Therefore, a total of 20 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 Levy EPZ:

$$P = 10{,}150 \times (0.045 \times 1.40 + 0.349 \times (1.70 - 1) \times 0.45 \times 0.41 + 0.421 \times (2.45 - 2) \times (0.45 \times 0.41)^2)$$
$$P = 10{,}150 * (0.1147) = 1164$$
$$B = (0.5 \times P) \div 30 = 20$$

These calculations are explained as follows:

- All members (1.4 avg.) of households (HH) with no vehicles (4.5%) will evacuate by public transit or ride-share. The term 10,150 (total households) x 0.045 x 1.40, accounts for these people.
- The members of HH with 1 vehicle away (34.9%), who are at home, equal (1.70-1). The number of HH where the commuter will not return home is equal to (10,150 x 0.349 x 0.45 x 0.41), given that 45% of the households in the EPZ have at least one commuter, 41% of which will not wait for the commuter to return before evacuating. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (42.1%), who are at home, equal (2.45 – 2). The number of HH where neither commuter will return home is equal to 10,150 x 0.421 x $(0.45 \times 0.41)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

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 (approximately one hour after the Advisory to Evacuate), to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. Some parents will likely pick up their children at school, although they are asked to pick children up at the reception centers. 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.

Table 8-3 presents a list of the reception centers for each school in the EPZ. Those students not picked up by their parents prior to the arrival of the buses, will be transported to these centers where they will be subsequently retrieved by their respective families.

8.3 Special Facility Demand

Table 8-4 presents the census of special facilities in the EPZ as of July, 2007. Approximately 127 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 wheelchair van runs assumes 4 wheelchairs per trip; wheelchair 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

The available resources expressed in terms of bus-seats, are sufficient in each county to service the evacuation demand in a “single-wave”, assuming drivers are available for all vehicles. In general, the buses will transport the evacuees to the appropriate reception centers and return to the EPZ for a second trip 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 reception center after completing its first evacuation trip, to complete a “second wave” of providing transport service to evacuees. For this reason, the ETE will be calculated for both a one wave transit evacuation and for two waves (Table 8-7). 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 at the pick-up points.

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.

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses have arrived at the facility to be evacuated. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities. Mobilization time is slightly longer – 100 minutes – when raining.

Activity: Board Passengers (C→D)

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

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

The distance from a school to the EPZ boundary is measured using Geographical Information Systems (GIS) software along the most likely route out of the EPZ. The travel times to the EPZ boundary are based on evacuation speeds computed by the model (PC-DYNEV). The average speed for an evacuation of the full EPZ (Region 3) under Scenario 6 (winter, midweek, midday, good weather) conditions at 90 minutes (mobilization time) is 49.4 mph, while the average speed for an evacuation of the full EPZ under Scenario 7 conditions (Rain) is 38.7 mph. The travel time from the EPZ boundary to the Reception Center was computed assuming an average speed of 50 mph and 40 mph for good weather and rain, respectively. Based on discussions with the EPZ counties, there are adequate buses to evacuate the school children in a single wave.

Tables 8-5A (good weather) and 8-5B (rain) present the following evacuation time estimates (rounded up to the nearest 5 minutes) for schools in the EPZ: (1) The elapsed time from the Advisory to Evacuate until the bus exits the EPZ; and (2) The elapsed time until the bus reaches the School Reception Center. The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B→C, C→D, and D→E (For example: 90 min. + 5 + 10 = 1:45 for Dunnellon Middle School, with good weather). The evacuation time to the School Reception Center is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

Evacuation of Transit-Dependent Population

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As indicated in Section 5, about 90 percent of the evacuees will complete their mobilization when the first buses will begin their routes, 120 minutes after the Advisory to Evacuate.

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ. Table 8-6 details the proposed bus routes to service the transit dependent people in the Levy EPZ, while Figure 8-2 maps the proposed bus pick-up routes. The travel distance along the respective pick-up routes within the EPZ is measured using GIS software. The average speed output by the PC-DYNEV model at the mobilization time is used to estimate the route travel time. Routes 2 through 5 which circulate through the major population centers within the EPZ have multiple buses spaced at 30 minute headways; each subsequent bus arrives at the route 30 minutes after the previous bus. The use of bus headways is designed to service 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 Route 6 is computed as 120 + 13 + 15 = 2:30 for good weather. Here, 13 minutes is the time to travel 11.3 miles at 53.9 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 School Reception Centers (E→F)

The distances from the EPZ boundary to the reception centers are also measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ to the relocation 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.

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 reception center (See Table 8-5). The travel time back to the EPZ is estimated as 20 minutes for good weather and 25 minutes for rain. The bus then travels its route and picks up transit-dependent evacuees along the route. The average speed output by PC-DYNEV at the time the buses begin the second wave is used to compute the route travel time. Multiple buses will likely not be needed for the second wave evacuation. Thus, only a single bus will be sent for a second wave evacuation, as Table 8-7 indicates. The additional buses at the reception center may be needed for a second wave evacuation of special facilities as detailed in the following section.

The travel times for Bus Route Number 6 are computed as follows for good weather:

- Bus arrives at reception center at 2:05 in good weather (average of "ETE to RC (min)" column in Table 8-5A).
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to EPZ: 20 minutes (assumed).
- Bus completes pick-ups along route and departs EPZ: 15 minutes + (11.3 miles @ 53.8 mph) = 35 minutes.
- Bus exits EPZ at time 2:05 + 0:15 + 0:20 + 0:35 = 3:15 after the Advisory to Evacuate.

The ETE estimates for the second wave are given in Table 8-7. The ETE for the transit-dependent population does not extend beyond the ETE for 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 25-30 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.

As is done for the schools, it is estimated that mobilization time averages 90 minutes. In the event there is a shortfall of transit vehicles for a "first-wave" evacuation, then buses used to evacuate schools will have to return to evacuate the special facilities. The school ETE to the Reception Centers is approximately 2:05 on average, and about 20 minutes of additional inbound travel time to the special facility from the reception area would be required. It follows, therefore, that about one hour would have to be added to the calculated ETE for special facilities, in the event they are evacuated as a “second wave.”

Table 8-4 indicates that the medical facilities are 7.5 miles from the plant, on average. Thus, buses evacuating these facilities will have to travel approximately 2.5 miles. We will conservatively estimate the travel distance out of the EPZ as 5 miles. The average travel speed at 90 minutes after the Advisory to Evacuate is 49.4 mph, thus the travel time out of the EPZ for buses evacuating special facilities is 6 minutes. The ETE for Crystal Gem Manor Assisted Living, with 43 patients, is provided as an example:

ETE: 90 + 43 x 1 + 6 = 139 min. or 2:20 rounded up. 3:20 for “second wave”.

Table 8-4 indicates that 2 wheelchair bus runs and 2 wheelchair van runs are needed for the entire EPZ. Wheelchair buses and vans are often scarce; however, regular buses can be used to transport wheelchair bound patients. Patients would occupy the front portion of the bus and their wheelchairs would be folded and stacked in the back of the bus. Loading times are estimated at 5 minutes per wheelchair bound person as staff will have to assist them in boarding the bus. For example, the ETE for the wheelchair bound at Seven Rivers Regional Medical Center is:

ETE: 90 + 33 x 5 + 6 = 4:25 (rounded up to the nearest 5 minutes).

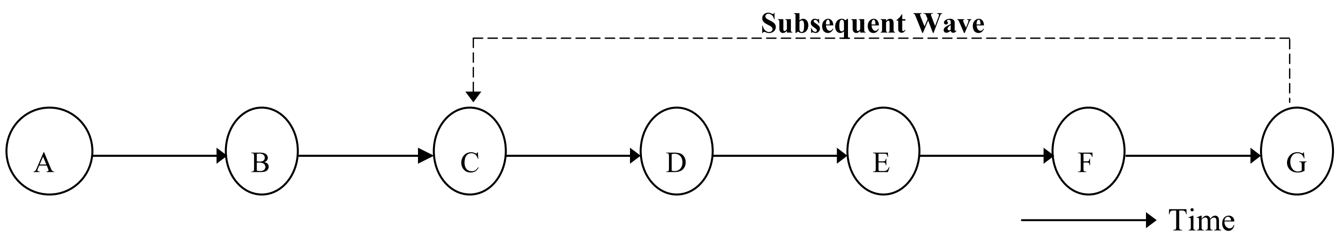
Thus, the ETE for special facilities do not exceed the general population ETE.

<u>Emergency Medical Services (EMS) Vehicles</u>

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 10 ambulance runs are needed to evacuate all of the bed ridden patients in the EPZ, assuming 2 people per ambulance. These ambulances will be provided by EMS providers within the EPZ. Additional ambulances will be provided by Crystal River and other neighboring cities if needed.

It is estimated that 30 minutes will be needed to mobilize ambulances and travel to the medical facilities. Loading times are conservatively estimated as 30 minutes. As with the buses transporting ambulatory patients, ambulances will have to travel 5 miles, on average, to leave the EPZ. The average speed output by the model at 1 hour for Region 3, Scenario 6 is 51.3 mph as much of the EPZ has not yet mobilized; thus, travel time out of the EPZ is 6 minutes.

The ETE for ambulances is: 30 + 30 + 6 = 1:10 (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 Reception Center
E	Bus Exits Region
F	Bus Arrives at School Reception Center
G	Bus Available for “Second Wave” Evacuation Service

Activity

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

Figure 8-1. Chronology of Transit Evacuation Operations

Table 8-1. Transit Dependent Population Estimates														
Facility Name	2007 EPZ Population	Survey Average Household Size With Indicated No. of Vehicles			Estimated Number of Households	Survey Percent Households With			Survey Percent Households With Commuters	Survey Percent Households With Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent of Population Requiring Public Transit
		0	1	2		0 Veh-icle	1 Veh-icle	2 Veh-icle						
Levy Nuclear Plant	22,758	1.40	1.70	2.45	10,150	4.5%	34.9.%	42.1%	45%	41%	1164	50%	582	2.6%

Table 8-2. School Population Demand Estimates							
PAZ	**Distance (miles)**	**Dire-ction**	**School Name**	**Municipality**	**Enroll-ment**	**Staff**	**Bus Runs Required**
Levy County							
L5	5	WSW	Yankeetown School	Yankeetown	329	51	5
Citrus County							
C4	9.9	SW	Citrus Springs Elementary	Citrus Springs	875	55	13
Marion County							
M9	9.4	E	Dunnellon Middle School	Dunnellon	1,100	110	22
M9	9.4	E	Dunnellon Christian Academy	Dunnellon	263	33	4
M9	11.9	ENE	Romeo Elementary School	Dunnellon	810	105	12
				Marion County Total:	2,173	248	38
				EPZ Total:	**3,377**	**354**	**56**

Table 8-3. School Relocation Schools		
Facility	**PAZ**	**Relocation School**
Middle Schools		
Dunnellon Middle School	M9	Bronson High School
Elementary Schools		
Citrus Springs Elementary	C4	Citrus Springs Middle School
Dunnellon Christian Academy	M9	Bronson High School
Romeo Elementary	M9	Bronson High School
Yankeetown School	L5	First United Methodist Church

Table 8-4. Special Facility Transit Demand													
PAZ	**Distance (miles)**	**Direction**	**Facility Name**	**Municipality**	**Capacity**	**Current Census**	**Ambulatory Patients**	**Wheelchair Bound**	**Bed-ridden**	**Ambulance Runs**	**Wheelchair Bus Runs**	**Wheelchair Van Runs**	**Bus Runs**
Citrus County													
C1	8.2	S	Seven Rivers Regional Medical Center	Crystal River	128	80	27	33	20	10	2	1	1
C1	8.0	S	Crystal Gem Manor Assisted	Crystal River	70	43	43	0	0	0	0	0	2
C3	6.8	SSE	Richard Hoffman Adult Family Care Home	Dunnellon	5	4	2	2	0	0	0	1	1
EPZ Total:					**203**	**127**	**72**	**35**	**20**	**10**	**2**	**2**	**4**

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

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bndry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)	Travel Time EPZ Bndry to RC (min)	ETE to R.C. (hr:min)
Levy County Schools								
Yankeetown School	90	5	9.7	12	**1:50**	20.7	25	**2:15**
Citrus County Schools								
Citrus Springs Elementary School	90	5	2.0	3	**1:40**	2.9	4	**1:45**
Marion County Schools								
Dunnellon Middle School	90	5	7.8	10	**1:45**	27.7	34	**2:20**
Dunnellon Christian Academy	90	5	7.6	10	**1:45**	27.7	34	**2:20**
Romeo Elementary School	90	5	0.3	1	**1:40**	27.7	34	**2:10**
				Average for EPZ:	**1:45**		**Average:**	**2:05**

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

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bndry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)	Travel Time EPZ Bndry to RC (min)	ETE to R.C. (hr:min)
Levy County Schools								
Yankeetown School	100	10	9.7	16	**2:10**	20.7	32	**2:40**
Citrus County Schools								
Citrus Springs Elementary School	100	10	2.0	4	**1:55**	2.9	5	**2:00**
Marion County Schools								
Dunnellon Middle School	100	10	7.8	13	**2:05**	27.7	42	**2:45**
Dunnellon Christian Academy	100	10	7.6	12	**2:05**	27.7	42	**2:45**
Romeo Elementary School	100	10	0.3	1	**1:55**	27.7	42	**2:35**
				Average for EPZ:	**2:05**		**Average:**	**2:30**

Table 8-6. Summary of Transit Dependent Bus Routes

Route Number	Number of Buses	Route Description	Length (mi.)
1	6	West on CR 488 (6 buses), buses split with 3 buses continuing west on CR 488 and then SB on US Hwy 19/98 out of the EPZ and 3 buses going south on CR 495 out of the EPZ.	13.1, 15.6
2	4	Buses will circulate in Citrus Springs picking up passengers along local roads, then proceed out of the EPZ.	10.0
3	4	Buses will circulate in Dunnellon picking up passengers along local roads, then proceed out of the EPZ northbound on US Hwy 41.	14.2
4	2	Buses will circulate in Yankeetown picking up passengers along local roads, then proceed out of the EPZ southbound on US Hwy 19/98.	18.2*
5	2	Buses will circulate in Inglis picking up passengers along local roads, then proceed out of the EPZ southbound on US Hwy 19/98.	18.2*
6	1	West on Rainbow Lakes Blvd, north on Soundview Dr, west on Sea Cliff Ave, north on NW Ridgewood Rd, and then east on 27th St out of the EPZ.	11.3
7	1	West on CR 40, northwest on CR 336, and then north on US Hwy 19/98 out of the EPZ.	19.2

*Circulating portion of route is assumed to be 10 miles long.

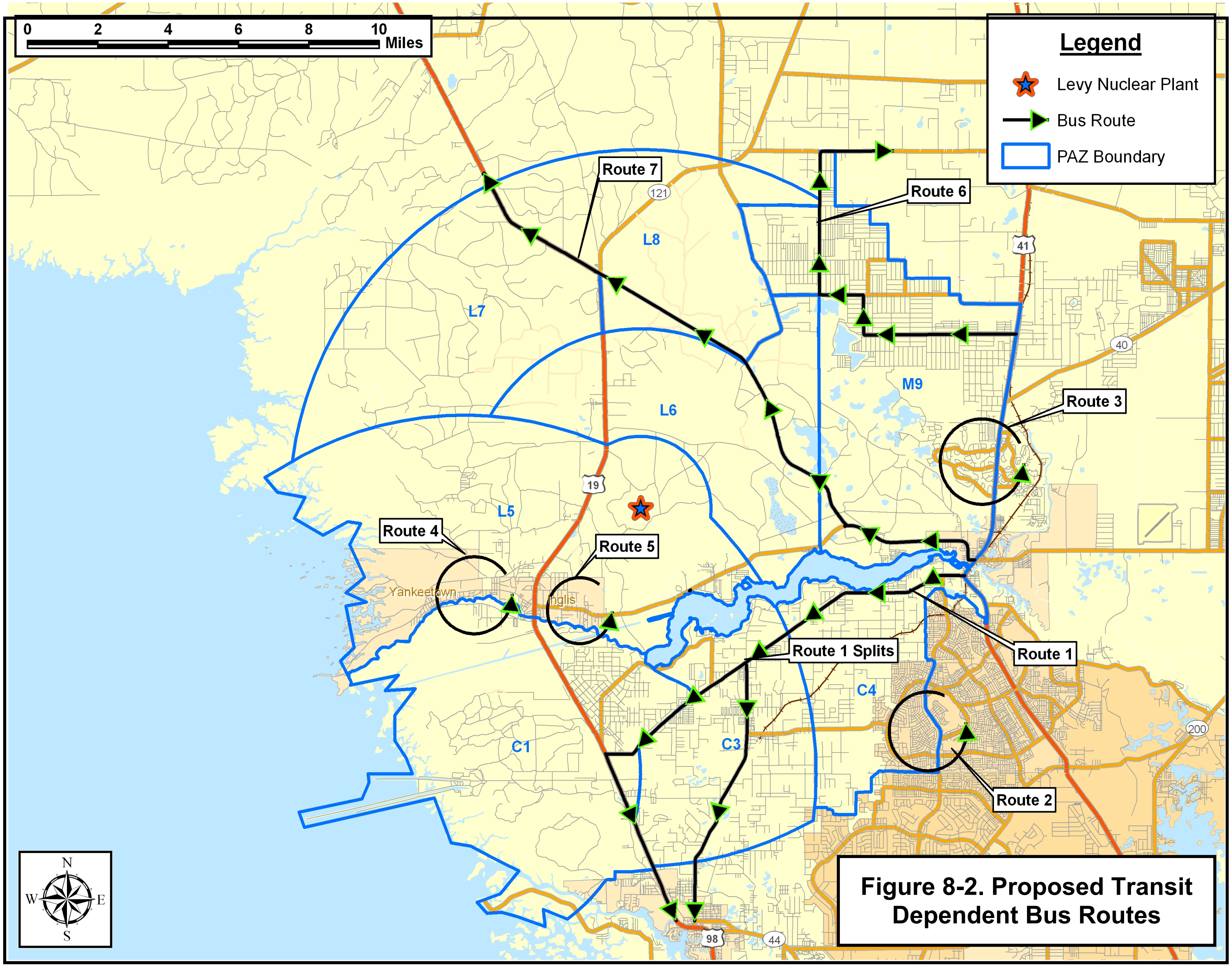


Figure 8-2. Proposed Transit Dependent Bus Routes

Table 8-7A. Transit Dependent Evacuation Time Estimates - Good Weather														
		Single Wave					Second Wave							
Route Number	Bus Number	Mobilization (min.)	Route Length (mi.)	Route Travel Time[1] (min)	Pickup Time (min)	ETE (hr:min)	Mobilization (min.)	Unload (min.)	Driver Rest (min.)	Return time to EPZ (min.)	Route Travel Time[2] (min.)	Pickup Time (min.)	ETE (hr:min)
1	1,2	120	13.1	15	15	2:30	125	5	10	20	15	15	3:10
	3,4	120	15.6	17	15	2:35							
2	1	120	10	11	15	2:30	125	5	10	20	11	15	3:10
	2	150	10	11	15	3:00							
	3	180	10	11	15	3:30							
3	1	120	14.2	16	15	2:35	125	5	10	20	16	15	3:15
	2	150	14.2	16	15	3:05							
	3	180	14.2	16	15	3:35							
4	1	120	18.2	20	15	2:35	125	5	10	20	20	15	3:15
	2	150	18.2	20	15	3:05							
5	1	120	18.2	20	15	2:35	125	5	10	20	20	15	3:15
	2	150	18.2	20	15	3:05							
6	1	120	11.3	13	15	2:30	125	5	10	20	13	15	3:10
7	1	120	19.2	21	15	2:40	125	5	10	20	21	15	3:20
					Average for EPZ:	**2:50**						**Average for EPZ:**	**3:15**

[1] Average speed output by PC-DYNEV at 125 minutes for good weather is 53.9 mph.

[2] Average speed output by PC-DYNEV at 160 minutes (mobilization time + unload + driver rest + return time to EPZ) for good weather is 53.8 mph.

Table 8-7B. Transit Dependent Evacuation Time Estimates - Rain														
		Single Wave					Second Wave							
Route Number	Bus Number	Mobilization (min.)	Route Length (mi.)	Route Travel Time[3] (min.)	Pickup Time (min.)	ETE (hr:min)	Mobilization (min.)	Unload (min.)	Driver Rest (min.)	Return time to EPZ (min.)	Route Travel Time[4] (min.)	Pickup Time (min.)	ETE (hr:min)
1	1,2	120	13.1	20	20	2:40	150	5	10	25	16	20	3:50
	3,4	120	15.6	23	20	2:45							
2	1	120	10	15	20	2:35	150	5	10	25	12	20	3:45
	2	150	10	15	20	3:05							
	3	180	10	15	20	3:35							
3	1	120	14.2	21	20	2:45	150	5	10	25	18	20	3:50
	2	150	14.2	21	20	3:15							
	3	180	14.2	21	20	3:45							
4	1	120	18.2	27	20	2:50	150	5	10	25	22	20	3:55
	2	150	18.2	27	20	3:20							
5	1	120	18.2	27	20	2:50	150	5	10	25	22	20	3:55
	2	150	18.2	27	20	3:20							
6	1	120	11.3	17	20	2:40	150	5	10	25	14	20	3:45
7	1	120	19.2	29	20	2:50	150	5	10	25	24	20	3:55
					Average for EPZ:	3:00						Average for EPZ:	3:50

[3] Average speed output by PC-DYNEV at 120 minutes for a rain scenario is 40.3 mph.

[4] Average speed output by PC-DYNEV at 180 minutes (mobilization time + unload + driver rest + return time to EPZ) for a rain scenario is 48.6 mph.