APPENDIX I

Evacuation Sensitivity Studies

APPENDIX I: EVACUATION SENSITIVITY STUDIES

A sensitivity study was performed to determine whether changes in the estimated trip generation time have an effect upon the evacuation time estimate (ETE) for the entire EPZ. The case considered was Scenario 1, Region 3; a summer, midweek, midday, good weather evacuation for the entire EPZ. Table I-1 presents the time needed to clear the 2-Mile Region, the 5-Mile Region and the Entire EPZ for an evacuation of Region 3 under Scenario 1 conditions with varying trip generation times.

Table I-1. Evacuation Time Estimates for Trip Generation Sensitivity Study

Trip Generation Period	Time (hr:min) to Clear the Indicated Area for an Evacuation of Region R03		
	2-Mile Region	5-Mile Region	Entire EPZ
3 Hours	3:00	3:20	3:20
4 Hours (Base)	4:05	4:10	4:10
5 Hours	5:00	5:10	5:20

The results confirm the importance of accurately estimating the trip generation times. The evacuation time estimates closely mirror the values for the time the last evacuation trip is generated. As discussed in Section 7.2, congestion within the EPZ dissipates at 3 hours after the advisory to evacuate. Therefore, the ETE reflects mobilization time for all trip generation periods exceeding 3 hours. The results indicate that programs to educate the public and encourage them toward faster responses for a radiological emergency can reduce evacuation time.

A sensitivity study was conducted to determine the effect on ETE of changes in the percentage of people who decide to relocate from the Shadow Region. The movement of people in the Shadow Region has the potential to impede vehicles evacuating from an Evacuation Region within the EPZ.

The case considered was Scenario 1, Region 3; a summer, midweek, midday, good weather evacuation for the entire EPZ with the percent of shadow evacuation ranging from 15% to 60%. Table I-2 presents the evacuation time estimates for each of these cases. The ETE for all regions remain unchanged as the percentage of people who decide to relocate from areas within the Shadow Region increases from 15% to 60%, showing the insensitivity of the ETE to shadow evacuation. As discussed in Section 7.3, there is significant congestion in the Shadow Region near Raleigh; however, that congestion does not delay those evacuating from within the EPZ. There are a total of 171,271 people (74,692 vehicles) living in the Shadow Region. The "Shadow" footnote to Table 6-3 indicates that a percentage of employees in the Shadow Region are also assumed to evacuate; this percentage is small (less than 3%) relative to the number of residents. For simplicity, only the number of shadow residents evacuating has been provided in Table I-2.

Table I-2. Evacuation Time Estimates for Shadow Sensitivity Study

Shadow Data			**Time (hr:min) to Clear the Indicated Area for an Evacuation of Region R03**		
Percent Shadow Evacuation	**Number of Shadow Residents**	**Number of Shadow Resident Vehicles**	**2-Mile Region**	**5-Mile Region**	**Entire EPZ**
15	25,691	12,375	4:05	4:10	4:10
30 (Base)	51,381	24,750	4:05	4:10	4:10
60	102,763	49,500	4:05	4:10	4:10

A sensitivity study was conducted to determine the effects on ETE of changes in the average number of evacuating vehicles per household. The case considered was Scenario 1, Region 3. The value used as a base condition (1.33 evacuating vehicles per household) was obtained from the responses to the telephone survey of EPZ resident households. This number represents the average of all responses; vehicle usage ranged from zero vehicles to four vehicles per household.

A question was raised concerning the change in ETE which would result from assuming the following conditions:

- Households with less than two vehicles available (17% of households) will evacuate in one vehicle.
- Households with two or more available vehicles (83% of households) will evacuate in two vehicles.

This assumption results in an estimate of (0.17) x 1 veh + (0.83) x 2 vehs = 1.83 evacuating vehicles per household.

Table I-3 presents the evacuation time estimates for each of these cases. The ETE increases by 10 minutes for the entire EPZ as the vehicle utilization increases from 1.33 vehicles per household to 1.83 vehicles per household.

Table I-3. Evacuation Time Estimates for Evacuating Vehicles per Household Sensitivity Study

Evacuating Vehicles per Household	Time (hr:min) to Clear the Indicated Area for an Evacuation of Region R03		
	2-Mile Region	5-Mile Region	Entire EPZ
1.33 (Base) from Telephone Survey	4:05	4:10	4:10
1.83 (all households with 2 or more vehicles use 2 vehicles)	4:05	4:10	4:20

Sensitivity studies were conducted to determine the effect of traffic control tactics on the ETE. The case considered was Scenario 1, Region 3. The majority of the congestion experienced during the evacuation process is in Wake County between the 5 mile ring and the EPZ boundary. Based on discussions with the Department of Transportation (DOT) in Wake County, nearly all of the signals in the county are fully actuated and traffic responsive: the signal timing responds to changes in traffic demand. There are several preset signal settings which vary with time of day and are designed to service peak traffic demand. Most of the signals along North Carolina Highway 55, especially those in the City of Apex, can also be adjusted from the DOT office in Durham. Section 7.2 indicates that the approaches to US Highway 1 from North Carolina Highway 55 in Apex are congested during the evacuation. This information provided by the DOT supports the use of traffic responsive signal settings in developing the base case ETE, given that a fully actuated signal will adapt its timing to facilitate the flow of evacuation traffic.

Theoretically, the worst case scenario, in the event the traffic signals fail to operate properly, is that the signals present even amounts of green time to the competing traffic streams, a 50-50 signal cycle split. Sensitivity studies were performed to compare the ETE for a 50-50 signal cycle split and for a 75-25 signal cycle split (with the major evacuation route receiving 75% of the green time), with the ETE computed on the basis of traffic responsive signal settings. Table I-4 indicates that the worst case scenario (50-50 cycle split) adds 20 minutes to the ETE for an evacuation of the full EPZ for a summer, midweek, midday scenario, while the 75-25 split does not affect ETE.

These results indicate that if the signals fail to operate properly, the manning of all traffic control points outlined in Appendix G will at best reduce the ETE by 20 minutes. Regardless of signal operations, traffic control guides should man key intersections throughout the EPZ to serve as fixed point surveillance for accidents or other problems that may arise during the evacuation which could reduce capacity and extend the ETE. Traffic control guides also provide needed route guidance to those evacuees who may not be familiar with the area and the roadway system (i.e. transients), and to those residents who are uncertain of the proper direction of travel.

Table I-4. Evacuation Time Estimates for Signal Splits Sensitivity Study

Signal Cycle Split (major route – minor route)	Time (hr:min) to Clear the Indicated Area for an Evacuation of Region R03		
	2-Mile Region	5-Mile Region	Entire EPZ
50 – 50	4:10	4:20	4:30
75 – 25	4:05	4:10	4:10
Traffic Responsive	4:05	4:10	4:10

Peak Fest

The town of Apex (in sub-zone E) hosts Peak Fest every year on a Saturday in May from 9:00 am to 5:00 pm. The event requires Salem Street to be closed to vehicular traffic between Center St and NC Hwy 55. Based on data provided during a telephone conversation with a representative from the festival commission, Salem Street is closed from 8:00 a.m. to 6:00 p.m. to allow for setup and cleanup. There are police officers stationed at each street corner to divert traffic away from the festival area. Parking for the festival is located along the streets in Apex.

A sensitivity study was considered to assess the impact on the ETE of the additional transients the festival attracts into the EPZ. This "Special Event" is numbered Scenario 13 for this study.

Methodology

Since the event is held on a Saturday in May, it is appropriate to use Scenario 3 (summer, weekend, midday, good weather) as the base case for this study. The number of additional transient vehicles is estimated using the following data provided by the festival commission.

- Peak attendance for the event is on average 15,000 to 20,000 persons.
- Approximately half of the people travel more than 10 miles to attend the event; therefore it is assumed that 50% of the attendees, or 10,000 persons; are transients.
- Assuming 2.5 persons per vehicle, it is estimated that there will be an additional 4,000 transient vehicles for those attending the festival.

Given that the parking is located along the streets in Apex, it is reasonable to assume that these additional transient vehicles will travel southbound on NC Hwy 55 to access US Hwy 1, northbound on Center St to access US Hwy 1, and northbound on Old US Hwy 1 out of the EPZ. It is assumed that these transients will begin their evacuation trips within one hour of the advisory to evacuate: 10% will be ready to evacuate within 15 minutes, 50% will be ready to evacuate in the subsequent 15 minutes, 30% in the next 15 minutes and 10% in the final 15 minutes. It is further assumed that the street closure on Salem Street will be temporary and will re-open one hour after the advisory to evacuate.

Results

Table I-5 compares the 50th, 90th, 95th, and 100th percentile ETE for the Special Event with the ETE for the base case. The additional transient vehicles present for Peak Fest increase the ETE by 5, 10, 10 and 5 minutes for the 50th, 90th, 95th and 100th percentiles, respectively.

Table I-5: Scenario 3 (Base) and Scenario 13 (Peak Fest) ETE for Region 3				
Case	**ETE (hr:min) for Indicated Percentile**			
	50th Percentile	**90th Percentile**	**95th Percentile**	**100th Percentile**
Scenario 3, Region 3	1:10	2:15	2:30	4:05
Scenario 13, Region 3	1:15	2:25	2:40	4:10

Figure I-1 is a plot of vehicles evacuating over time after the advisory to evacuate for Region 3, under Scenario 13 (Peak Fest) and Scenario 3 (summer, weekend, midday, good weather) conditions.

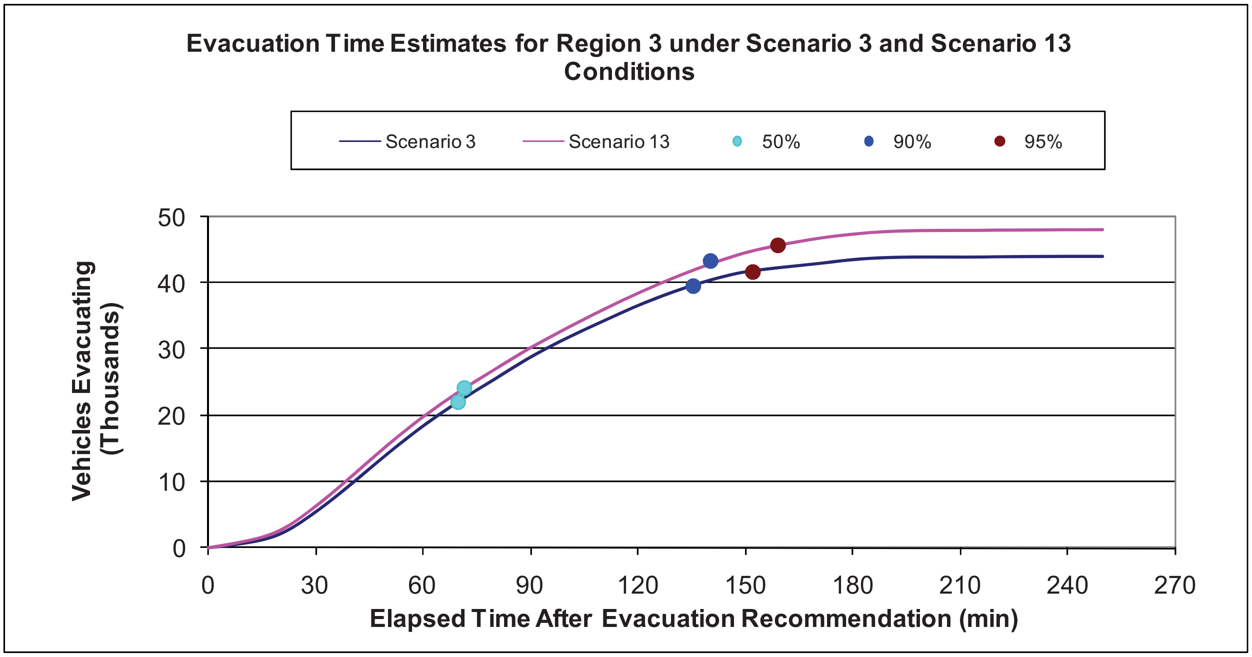


Figure I-1: Evacuation Plots for Scenario 3 (Base) and Scenario 13 (Peak Fest) for the Evacuation of the Entire EPZ (Region 3)

APPENDIX J

Evacuation Time Estimates for All Evacuation Regions and Scenarios
And
Evacuation Time Graphs for Region R03, for all Scenarios

APPENDIX J: EVACUATION TIME ESTIMATES FOR ALL EVACUATION REGIONS AND SCENARIOS
AND
EVACUATION TIME GRAPHS FOR REGION R03, FOR ALL SCENARIOS

This appendix presents the ETE Results for all 25 Regions and all 12 Scenarios (Tables J-1A through J-1D).

Plots of Evacuating Vehicles vs. Elapsed Time leaving the 2-mile and 5-mile circular areas around HNP and the entire EPZ for Region R03, for all 12 scenarios are presented. Each plot has points indicating the evacuation times corresponding to the 50th, 90th, and 95th percentiles of evacuated population.

J.1 Guidance on Using ETE Tables

Tables J-1A through J-1D present the ETE values for all 25 Evacuation Regions and all 12 Evacuation Scenarios. They are organized as follows:

Table	Contents
J-1A	ETE represents the elapsed time required for 50 percent of the population within a Region, to evacuate from that Region.
J-1B	ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region.
J-1C	ETE represents the elapsed time required for 95 percent of the population within a Region, to evacuate from that Region.
J-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
    - Ice
- Special Event (if any)
    - New Plant Construction

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

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

2. With the Scenario (and column in the Table) identified, now identify the **Evacuation Region**:
    - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: *towards* N, NNE, NE, …
    - Determine the distance that the Evacuation Region will extend from the Harris Nuclear Plant. The applicable distances and their associated candidate Regions are given below:
        - 2 Miles (Region R01)
        - 5 Miles (Regions R02 and R04 through R12)
        - to EPZ Boundary (Regions R03 and R13 through R25)
    - Enter Table J-2 and identify the applicable group of candidate Regions based on the wind direction and on the distance that the selected Region extends from HNP. 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 J-1 are labeled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number determined in Step 1.
    - Identify the row in this table that provides ETE values for the Region identified in Step 2.
    - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

<u>Example</u>

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

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

Table J-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 J-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 J-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 R14 in the first column of that row.

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

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

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
Region Wind Toward:	Midday		Midday		Evening	Region Wind Toward:	Midday			Midday		Evening	Region Wind Toward:	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather		Good Weather	Rain	Ice	Good Weather	Rain	Good Weather		New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	0:50	0:50	0:45	0:45	0:50	R01 2-mile ring	0:50	0:50	0:50	0:45	0:45	0:50	R01 2-mile ring	1:20
R02 5-mile ring	1:00	1:00	1:00	1:00	0:55	R02 5-mile ring	1:00	1:00	1:05	0:55	0:55	0:55	R02 5-mile ring	1:15
R03 Entire EPZ	1:25	1:30	1:10	1:15	1:10	R03 Entire EPZ	1:30	1:30	1:35	1:10	1:15	1:10	R03 Entire EPZ	1:35
2-Mile Ring and Downwind to 5 Miles														
R04 N, NW, NNW	1:00	1:05	1:05	1:05	0:55	R04 N, NW, NNW	1:00	1:00	1:05	0:55	0:55	0:55	R04 N, NW, NNW	1:15
R05 NNE	1:05	1:05	0:55	0:55	0:55	R05 NNE	1:05	1:05	1:05	0:55	0:55	0:55	R05 NNE	1:20
R06 NE, ENE	1:05	1:05	0:55	0:55	0:55	R06 NE, ENE	1:05	1:05	1:10	0:55	0:55	0:55	R06 NE, ENE	1:20
R07 E	1:05	1:05	0:55	0:55	0:55	R07 E	1:05	1:10	1:10	0:55	0:55	0:55	R07 E	1:20
R08 ESE	1:00	1:00	0:50	0:50	0:50	R08 ESE	1:00	1:00	1:00	0:50	0:50	0:50	R08 ESE	1:20
R09 SE	0:55	0:55	0:50	0:50	0:55	R09 SE	0:55	1:00	1:00	0:50	0:55	0:55	R09 SE	1:10
R10 SSE, S	0:55	0:55	0:50	0:50	0:55	R10 SSE, S	0:55	0:55	0:55	0:50	0:50	0:55	R10 SSE, S	1:10
R11 SSW, SW	0:55	0:55	0:50	0:50	0:55	R11 SSW, SW	0:55	0:55	0:55	0:50	0:50	0:55	R11 SSW, SW	1:10
R12 WSW, W, WNW	0:55	1:00	1:00	1:00	0:55	R12 WSW, W, WNW	0:55	0:55	0:55	0:50	0:55	0:55	R12 WSW, W, WNW	1:15
5-Mile Ring and Downwind to EPZ Boundary														
R13 N, NNE	1:20	1:25	1:05	1:05	1:05	R13 N, NNE	1:20	1:25	1:25	1:05	1:05	1:05	R13 N, NNE	1:30
R14 NE	1:25	1:30	1:10	1:15	1:10	R14 NE	1:25	1:30	1:35	1:10	1:15	1:10	R14 NE	1:40
R15 ENE, E	1:25	1:30	1:10	1:15	1:10	R15 ENE, E	1:30	1:30	1:35	1:10	1:15	1:10	R15 ENE, E	1:40
R16 ESE	1:20	1:25	1:10	1:10	1:05	R16 ESE	1:20	1:25	1:30	1:05	1:10	1:10	R16 ESE	1:30
R17 SE	1:15	1:20	1:05	1:10	1:05	R17 SE	1:20	1:20	1:25	1:05	1:05	1:05	R17 SE	1:30
R18 SSE	1:15	1:20	1:05	1:10	1:05	R18 SSE	1:20	1:20	1:25	1:05	1:05	1:05	R18 SSE	1:30
R19 S	1:10	1:10	1:00	1:00	0:55	R19 S	1:10	1:10	1:10	0:55	0:55	0:55	R19 S	1:20
R20 SSW	1:10	1:10	1:00	1:00	0:55	R20 SSW	1:10	1:15	1:15	0:55	0:55	0:55	R20 SSW	1:20
R21 SW	1:05	1:05	1:00	1:00	0:55	R21 SW	1:05	1:10	1:10	0:55	0:55	0:55	R21 SW	1:15
R22 WSW	1:05	1:05	1:00	1:00	0:55	R22 WSW	1:05	1:10	1:10	0:55	0:55	0:55	R22 WSW	1:15
R23 W, WNW	1:05	1:05	1:00	1:00	0:55	R23 W, WNW	1:05	1:05	1:10	0:55	0:55	0:55	R23 W, WNW	1:15
R24 NW	1:00	1:00	0:55	1:00	0:55	R24 NW	1:05	1:05	1:05	0:55	0:55	0:55	R24 NW	1:15
R25 NNW	1:20	1:20	1:05	1:05	1:00	R25 NNW	1:20	1:25	1:25	1:05	1:05	1:05	R25 NNW	1:30

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

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
	Midday		Midday		Evening		Midday			Midday		Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Ice	Good Weather	Rain	Good Weather	Region Wind Toward:	New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	1:40	1:40	1:25	1:25	1:50	R01 2-mile ring	1:40	1:40	1:40	1:30	1:30	1:55	R01 2-mile ring	2:30
R02 5-mile ring	1:55	1:55	2:20	2:25	1:45	R02 5-mile ring	1:55	2:00	2:00	1:40	1:40	1:45	R02 5-mile ring	2:30
R03 Entire EPZ	2:35	2:45	2:15	2:25	2:05	R03 Entire EPZ	2:35	2:45	3:00	2:10	2:20	2:05	R03 Entire EPZ	3:10
2-Mile Ring and Downwind to 5 Miles														
R04 N, NW, NNW	1:50	1:50	2:25	2:35	1:40	R04 N, NW, NNW	1:55	1:55	1:55	1:40	1:40	1:45	R04 N, NW, NNW	2:30
R05 NNE	1:55	1:55	1:40	1:45	1:45	R05 NNE	1:55	2:00	2:00	1:45	1:45	1:45	R05 NNE	2:30
R06 NE, ENE	2:00	2:00	1:45	1:45	1:45	R06 NE, ENE	2:00	2:00	2:00	1:45	1:45	1:45	R06 NE, ENE	2:30
R07 E	2:05	2:05	1:45	1:45	1:45	R07 E	2:05	2:05	2:05	1:45	1:45	1:45	R07 E	2:30
R08 ESE	2:10	2:10	1:35	1:35	1:55	R08 ESE	2:15	2:15	2:15	1:40	1:40	1:55	R08 ESE	2:30
R09 SE	1:50	1:55	1:40	1:40	1:45	R09 SE	1:55	1:55	1:55	1:40	1:40	1:45	R09 SE	2:20
R10 SSE, S	1:50	1:50	1:35	1:40	1:45	R10 SSE, S	1:50	1:50	1:55	1:40	1:40	1:45	R10 SSE, S	2:20
R11 SSW, SW	1:45	1:45	1:35	1:40	1:40	R11 SSW, SW	1:45	1:45	1:50	1:40	1:40	1:40	R11 SSW, SW	2:20
R12 WSW, W, WNW	1:50	1:50	2:30	2:40	1:40	R12 WSW, W, WNW	1:55	1:55	1:55	1:40	1:40	1:45	R12 WSW, W, WNW	2:20
5-Mile Ring and Downwind to EPZ Boundary														
R13 N, NNE	2:25	2:30	2:05	2:15	2:00	R13 N, NNE	2:30	2:35	2:40	2:00	2:05	2:00	R13 N, NNE	2:55
R14 NE	2:35	2:45	2:15	2:25	2:05	R14 NE	2:35	2:45	2:55	2:10	2:20	2:05	R14 NE	3:10
R15 ENE, E	2:35	2:45	2:15	2:25	2:05	R15 ENE, E	2:35	2:45	2:55	2:10	2:20	2:05	R15 ENE, E	3:10
R16 ESE	2:30	2:40	2:15	2:25	2:05	R16 ESE	2:35	2:40	2:55	2:05	2:15	2:05	R16 ESE	3:00
R17 SE	2:25	2:35	2:15	2:25	2:00	R17 SE	2:30	2:35	2:50	2:05	2:10	2:05	R17 SE	2:55
R18 SSE	2:25	2:35	2:15	2:25	2:00	R18 SSE	2:30	2:35	2:50	2:05	2:10	2:05	R18 SSE	2:55
R19 S	2:10	2:10	2:10	2:15	1:45	R19 S	2:15	2:15	2:15	1:45	1:45	1:50	R19 S	2:30
R20 SSW	2:15	2:15	2:15	2:20	1:50	R20 SSW	2:20	2:20	2:20	1:45	1:45	1:50	R20 SSW	2:35
R21 SW	2:05	2:05	2:15	2:20	1:45	R21 SW	2:10	2:10	2:10	1:45	1:45	1:50	R21 SW	2:30
R22 WSW	2:05	2:05	2:15	2:20	1:45	R22 WSW	2:10	2:10	2:10	1:45	1:45	1:50	R22 WSW	2:30
R23 W, WNW	2:00	2:05	2:10	2:20	1:45	R23 W, WNW	2:05	2:10	2:10	1:40	1:45	1:45	R23 W, WNW	2:30
R24 NW	2:00	2:00	2:10	2:20	1:45	R24 NW	2:05	2:05	2:05	1:40	1:40	1:45	R24 NW	2:30
R25 NNW	2:25	2:30	2:05	2:15	2:00	R25 NNW	2:30	2:35	2:40	2:00	2:05	2:00	R25 NNW	2:55

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

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
Region Wind Toward:	Midday		Midday		Evening	Region Wind Toward:	Midday			Midday		Evening	Region Wind Toward:	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather		Good Weather	Rain	Ice	Good Weather	Rain	Good Weather		New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	2:10	2:10	1:55	1:55	2:25	R01 2-mile ring	2:10	2:10	2:10	1:55	1:55	2:30	R01 2-mile ring	2:45
R02 5-mile ring	2:20	2:20	2:40	2:55	2:00	R02 5-mile ring	2:25	2:25	2:25	1:55	1:55	2:00	R02 5-mile ring	2:50
R03 Entire EPZ	2:55	3:00	2:30	2:40	2:30	R03 Entire EPZ	3:00	3:05	3:15	2:25	2:35	2:30	R03 Entire EPZ	3:25
2-Mile Ring and Downwind to 5 Miles														
R04 N, NW, NNW	2:15	2:15	2:45	2:55	1:55	R04 N, NW, NNW	2:20	2:20	2:20	1:50	1:55	1:55	R04 N, NW, NNW	2:50
R05 NNE	2:25	2:25	1:55	1:55	2:00	R05 NNE	2:25	2:25	2:25	1:55	1:55	2:00	R05 NNE	2:45
R06 NE, ENE	2:30	2:30	1:55	1:55	2:00	R06 NE, ENE	2:30	2:30	2:30	1:55	1:55	2:00	R06 NE, ENE	2:45
R07 E	2:30	2:30	1:55	1:55	2:10	R07 E	2:30	2:35	2:35	2:00	2:00	2:10	R07 E	2:45
R08 ESE	2:45	2:45	2:05	2:05	2:25	R08 ESE	2:45	2:50	2:50	2:15	2:15	2:25	R08 ESE	2:40
R09 SE	2:20	2:20	1:50	1:50	2:05	R09 SE	2:20	2:20	2:20	1:50	1:55	2:05	R09 SE	2:40
R10 SSE, S	2:10	2:15	1:50	1:50	2:00	R10 SSE, S	2:15	2:15	2:15	1:50	1:50	2:00	R10 SSE, S	2:40
R11 SSW, SW	2:05	2:05	1:50	1:50	1:55	R11 SSW, SW	2:05	2:05	2:05	1:50	1:50	1:55	R11 SSW, SW	2:40
R12 WSW, W, WNW	2:15	2:20	2:45	3:00	2:00	R12 WSW, W, WNW	2:25	2:25	2:25	1:50	1:50	2:05	R12 WSW, W, WNW	2:40
5-Mile Ring and Downwind to EPZ Boundary														
R13 N, NNE	2:55	2:55	2:35	2:40	2:25	R13 N, NNE	2:55	2:55	3:00	2:25	2:25	2:30	R13 N, NNE	3:10
R14 NE	2:55	3:00	2:35	2:40	2:30	R14 NE	2:55	3:00	3:15	2:25	2:35	2:30	R14 NE	3:25
R15 ENE, E	2:55	3:00	2:35	2:40	2:30	R15 ENE, E	2:55	3:00	3:15	2:25	2:35	2:30	R15 ENE, E	3:25
R16 ESE	2:55	2:55	2:35	2:45	2:25	R16 ESE	2:55	3:00	3:10	2:25	2:30	2:25	R16 ESE	3:20
R17 SE	2:50	2:55	2:35	2:45	2:25	R17 SE	2:55	3:00	3:10	2:20	2:30	2:25	R17 SE	3:15
R18 SSE	2:50	2:55	2:35	2:45	2:25	R18 SSE	2:55	3:00	3:10	2:20	2:30	2:25	R18 SSE	3:15
R19 S	2:40	2:40	2:35	2:45	2:15	R19 S	2:45	2:45	2:45	2:05	2:05	2:15	R19 S	2:55
R20 SSW	2:40	2:45	2:35	2:45	2:15	R20 SSW	2:45	2:45	2:45	2:05	2:05	2:20	R20 SSW	2:55
R21 SW	2:30	2:35	2:35	2:45	2:10	R21 SW	2:35	2:35	2:35	2:00	2:00	2:10	R21 SW	2:55
R22 WSW	2:30	2:35	2:35	2:45	2:10	R22 WSW	2:40	2:40	2:40	2:00	2:00	2:10	R22 WSW	2:55
R23 W, WNW	2:30	2:30	2:35	2:45	2:05	R23 W, WNW	2:35	2:35	2:35	2:00	2:00	2:10	R23 W, WNW	2:55
R24 NW	2:25	2:25	2:35	2:45	2:05	R24 NW	2:30	2:30	2:35	1:55	1:55	2:05	R24 NW	2:50
R25 NNW	2:55	2:55	2:30	2:35	2:25	R25 NNW	2:55	2:55	3:00	2:20	2:25	2:25	R25 NNW	3:10

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

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
Region Wind Toward:	Midday		Midday		Evening	Region Wind Toward:	Midday			Midday		Evening	Region Wind Toward:	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather		Good Weather	Rain	Ice	Good Weather	Rain	Good Weather		New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	4:00	4:00	3:00	3:00	3:00	R01 2-mile ring	4:00	4:00	4:00	3:00	3:00	3:00	R01 2-mile ring	4:00
R02 5-mile ring	4:05	4:05	3:10	3:20	3:05	R02 5-mile ring	4:05	4:05	4:05	3:10	3:10	3:05	R02 5-mile ring	4:10
R03 Entire EPZ	4:10	4:10	4:05	4:05	4:05	R03 Entire EPZ	4:10	4:10	4:10	4:05	4:05	4:00	R03 Entire EPZ	4:15
2-Mile Ring and Downwind to 5 Miles														
R04 N, NW, NNW	4:05	4:05	3:05	3:20	3:05	R04 N, NW, NNW	4:05	4:05	4:05	3:05	3:05	3:05	R04 N, NW, NNW	4:05
R05 NNE	4:00	4:05	3:00	3:00	3:00	R05 NNE	4:00	4:05	4:05	3:00	3:00	3:00	R05 NNE	4:00
R06 NE, ENE	4:00	4:05	3:00	3:00	3:00	R06 NE, ENE	4:00	4:05	4:05	3:00	3:00	3:00	R06 NE, ENE	4:00
R07 E	4:00	4:05	3:00	3:05	3:00	R07 E	4:00	4:05	4:05	3:00	3:05	3:00	R07 E	4:00
R08 ESE	4:00	4:00	3:00	3:05	3:00	R08 ESE	4:00	4:00	4:00	3:00	3:05	3:00	R08 ESE	4:00
R09 SE	4:00	4:00	3:00	3:05	3:00	R09 SE	4:00	4:05	4:05	3:00	3:05	3:00	R09 SE	4:00
R10 SSE, S	4:00	4:00	3:05	3:05	3:00	R10 SSE, S	4:00	4:05	4:05	3:05	3:05	3:00	R10 SSE, S	4:00
R11 SSW, SW	4:00	4:00	3:05	3:05	3:00	R11 SSW, SW	4:00	4:00	4:00	3:05	3:05	3:00	R11 SSW, SW	4:00
R12 WSW, W, WNW	4:00	4:05	3:10	3:20	3:05	R12 WSW, W, WNW	4:05	4:05	4:05	3:10	3:10	3:05	R12 WSW, W, WNW	4:05
5-Mile Ring and Downwind to EPZ Boundary														
R13 N, NNE	4:05	4:05	4:00	4:00	4:00	R13 N, NNE	4:05	4:05	4:10	4:00	4:00	4:00	R13 N, NNE	4:10
R14 NE	4:05	4:05	4:00	4:00	4:00	R14 NE	4:05	4:05	4:10	4:00	4:00	4:00	R14 NE	4:10
R15 ENE, E	4:05	4:05	4:05	4:05	4:05	R15 ENE, E	4:05	4:05	4:10	4:00	4:00	4:00	R15 ENE, E	4:10
R16 ESE	4:10	4:10	4:05	4:05	4:05	R16 ESE	4:10	4:10	4:10	4:05	4:05	4:00	R16 ESE	4:10
R17 SE	4:10	4:10	4:05	4:05	4:00	R17 SE	4:10	4:10	4:10	4:00	4:00	4:00	R17 SE	4:10
R18 SSE	4:10	4:10	4:05	4:05	4:00	R18 SSE	4:10	4:10	4:10	4:00	4:00	4:00	R18 SSE	4:10
R19 S	4:10	4:10	3:50	3:50	3:50	R19 S	4:10	4:10	4:10	3:50	3:50	3:50	R19 S	4:10
R20 SSW	4:10	4:10	3:50	3:50	3:50	R20 SSW	4:10	4:10	4:10	3:50	3:50	3:50	R20 SSW	4:10
R21 SW	4:05	4:05	3:05	3:20	3:05	R21 SW	4:05	4:05	4:10	3:10	3:10	3:05	R21 SW	4:10
R22 WSW	4:05	4:10	3:10	3:25	3:05	R22 WSW	4:05	4:05	4:10	3:10	3:10	3:05	R22 WSW	4:10
R23 W, WNW	4:05	4:10	3:10	3:25	3:05	R23 W, WNW	4:05	4:05	4:10	3:10	3:10	3:05	R23 W, WNW	4:10
R24 NW	4:05	4:10	3:50	3:50	3:05	R24 NW	4:05	4:05	4:10	3:50	3:50	3:05	R24 NW	4:10
R25 NNW	4:05	4:10	4:00	4:00	4:00	R25 NNW	4:05	4:05	4:10	4:00	4:00	4:00	R25 NNW	4:10

Table J-2. Description of Evacuation Regions

Region	Description	Sub-Zone A	B	C	D	E	F	G	H	I	J	K	L	M	N
R01	2 mile ring	🟧													
R02	5-mile ring	🟧	🟧	🟧	🟧							🟧	🟧		
R03	Full EPZ	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧

Evacuate 2-mile ring and 5 miles downwind

Region	Wind Direction Towards:	Sub-Zone A	B	C	D	E	F	G	H	I	J	K	L	M	N
R04	N,NW,NNW	🟧	🟧										🟧		
R05	NNE	🟧	🟧												
R06	NE,ENE	🟧	🟧	🟧											
R07	E	🟧	🟧	🟧	🟧										
R08	ESE	🟧		🟧	🟧										
R09	SE	🟧		🟧	🟧							🟧			
R10	SSE,S	🟧			🟧							🟧			
R11	SSW, SW	🟧										🟧			
R12	WSW,W,WNW	🟧										🟧	🟧		

Evacuate 5-mile ring and downwind to EPZ boundary

Region	Wind Direction Towards:	Sub-Zone A	B	C	D	E	F	G	H	I	J	K	L	M	N
R13	N,NNE	🟧	🟧	🟧	🟧	🟧						🟧	🟧		🟧
R14	NE	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧		
R15	ENE, E	🟧	🟧	🟧	🟧	🟧	🟧	🟧				🟧	🟧		
R16	ESE	🟧	🟧	🟧	🟧		🟧	🟧	🟧			🟧	🟧		
R17	SE	🟧	🟧	🟧	🟧			🟧	🟧			🟧	🟧		
R18	SSE	🟧	🟧	🟧	🟧			🟧	🟧	🟧		🟧	🟧		
R19	S	🟧	🟧	🟧	🟧				🟧	🟧		🟧	🟧		
R20	SSW	🟧	🟧	🟧	🟧				🟧	🟧	🟧	🟧	🟧		
R21	SW	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧		
R22	WSW	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧	
R23	W,WNW	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧	
R24	NW	🟧	🟧	🟧	🟧							🟧	🟧	🟧	🟧
R25	NNW	🟧	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧

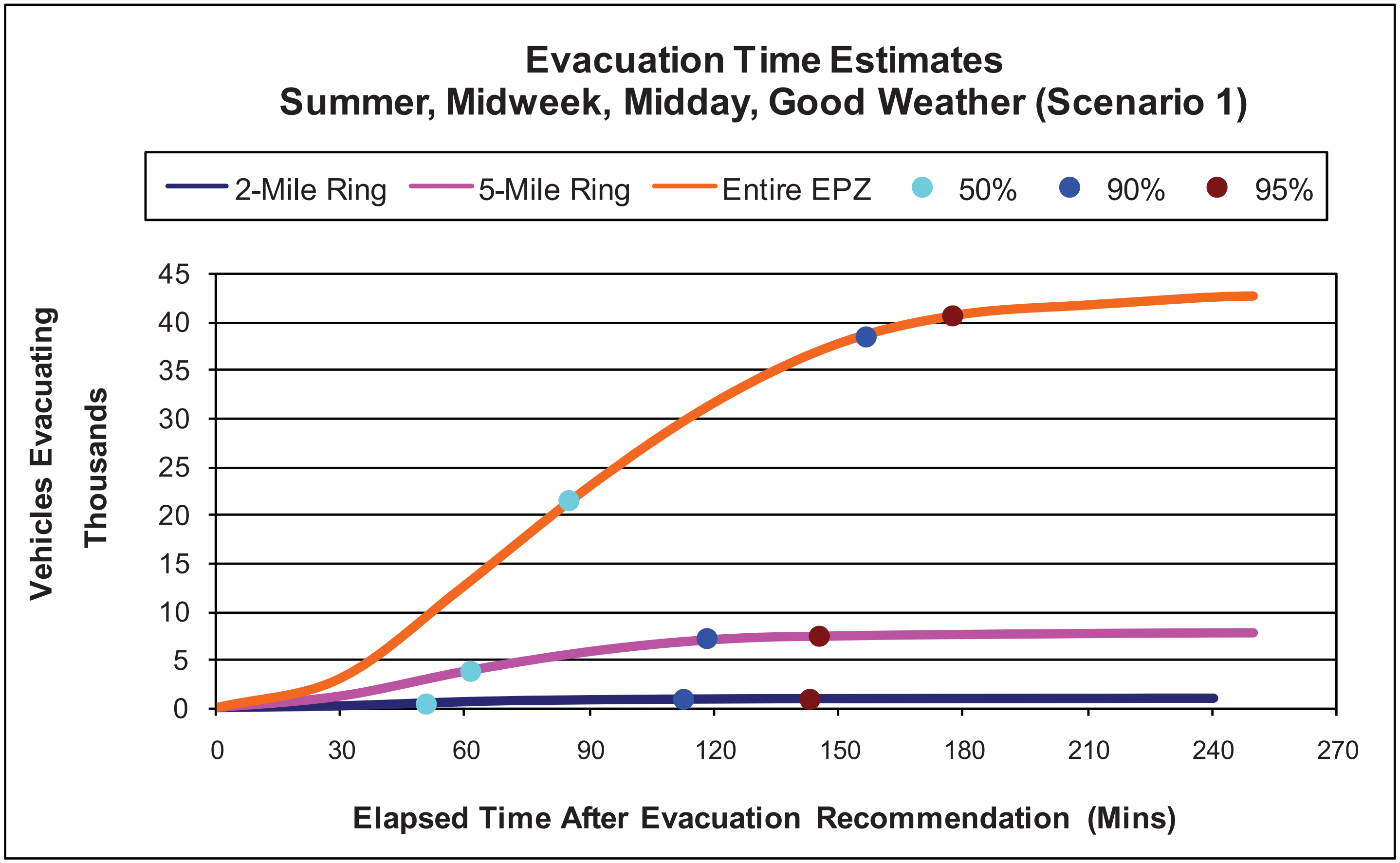


Figure J-1. Evacuation Time Estimates – Scenario 1 for Region R03 (Entire EPZ)

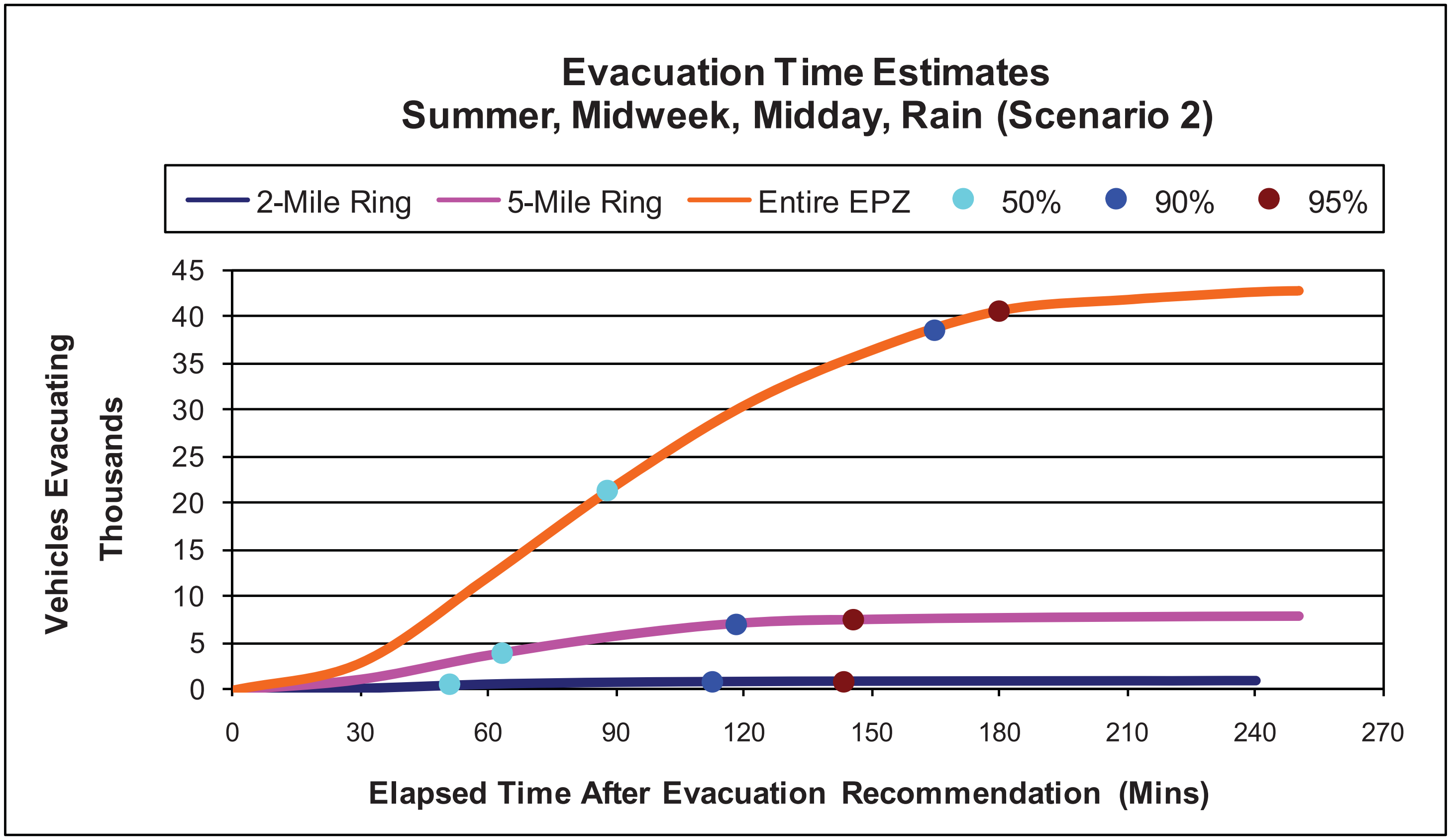


Figure J-2. Evacuation Time Estimates – Scenario 2 for Region R03 (Entire EPZ)

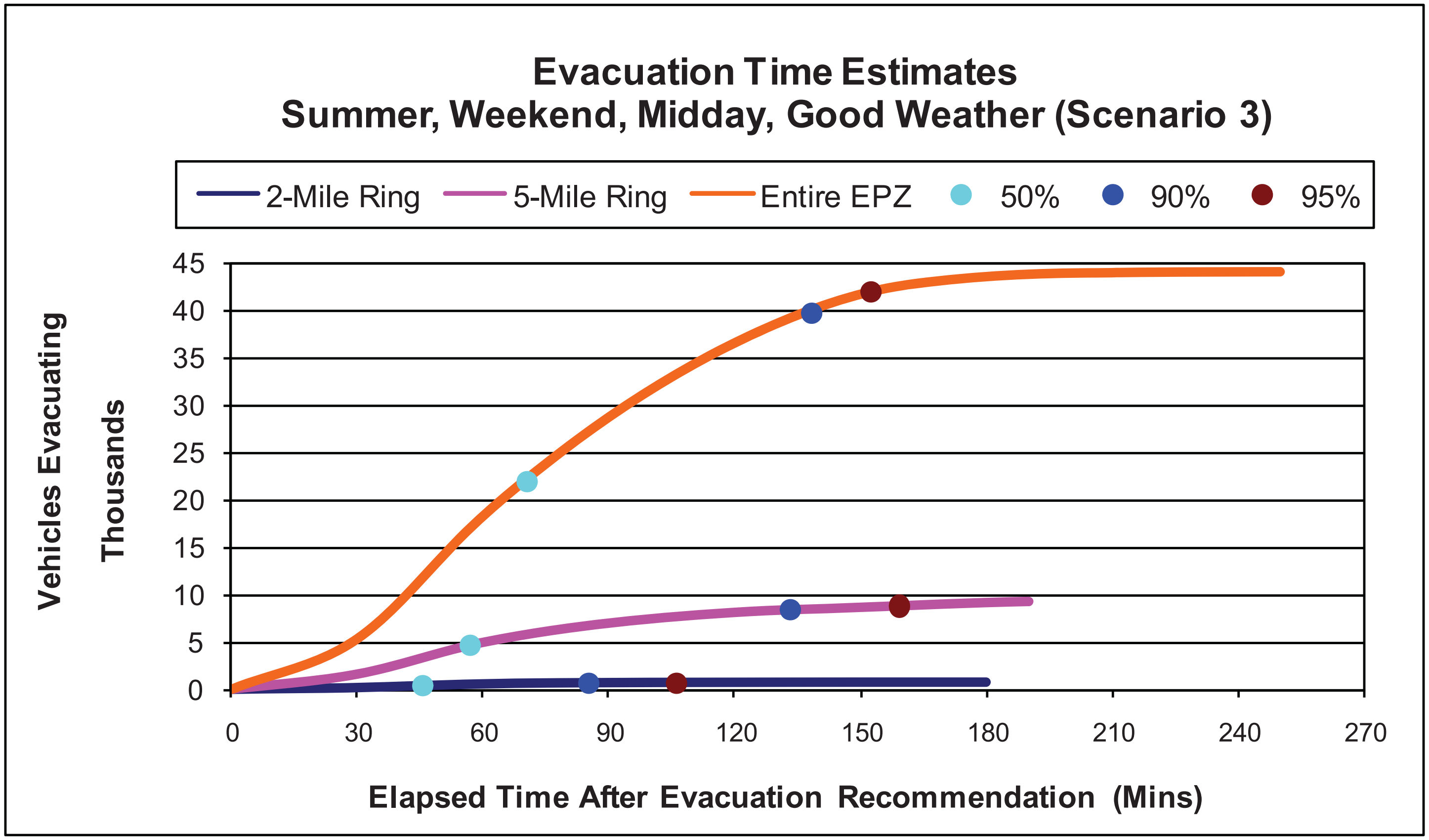


Figure J-3. Evacuation Time Estimates – Scenario 3 for Region R03 (Entire EPZ)

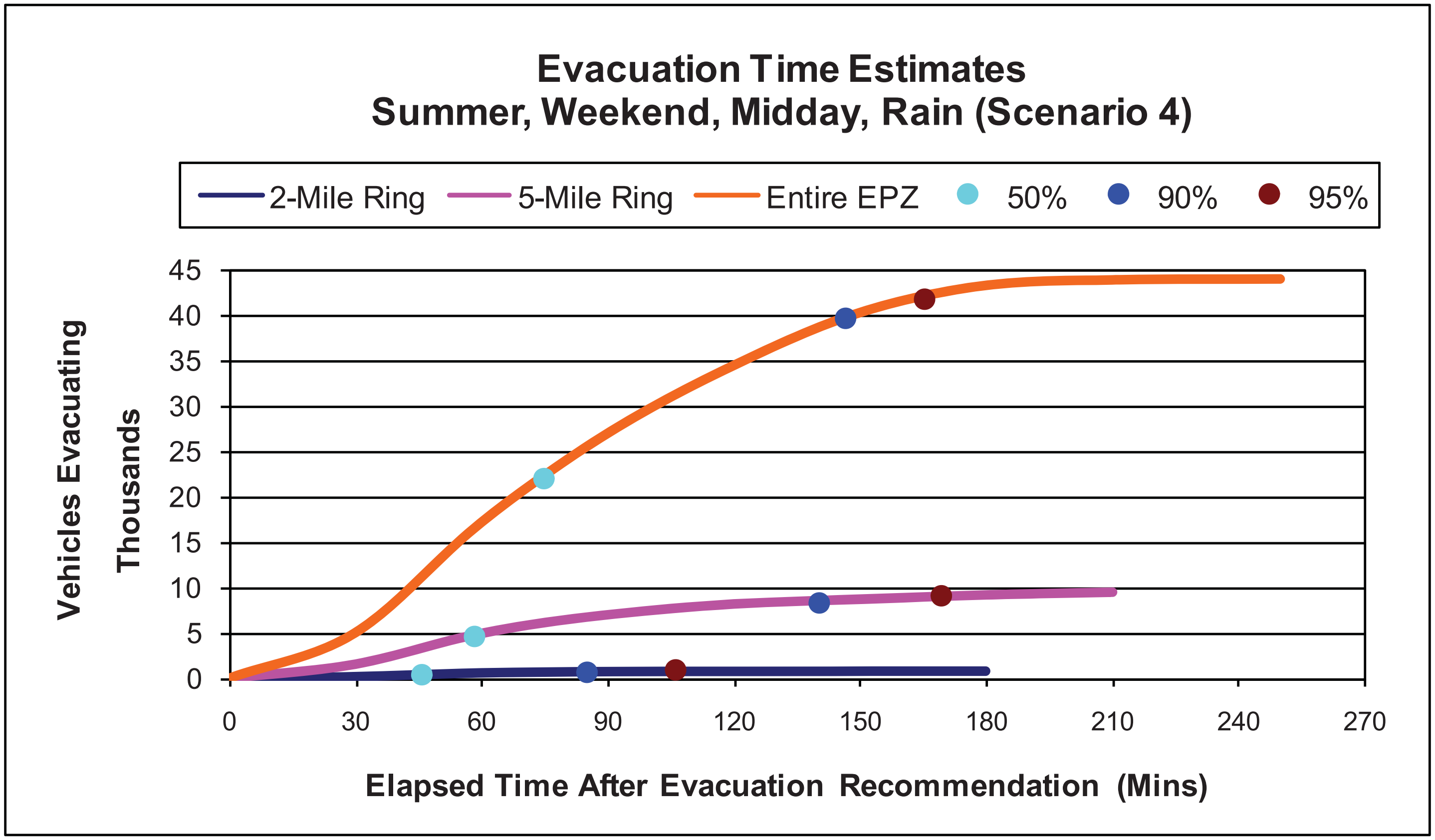


Figure J-4. Evacuation Time Estimates – Scenario 4 for Region R03 (Entire EPZ)

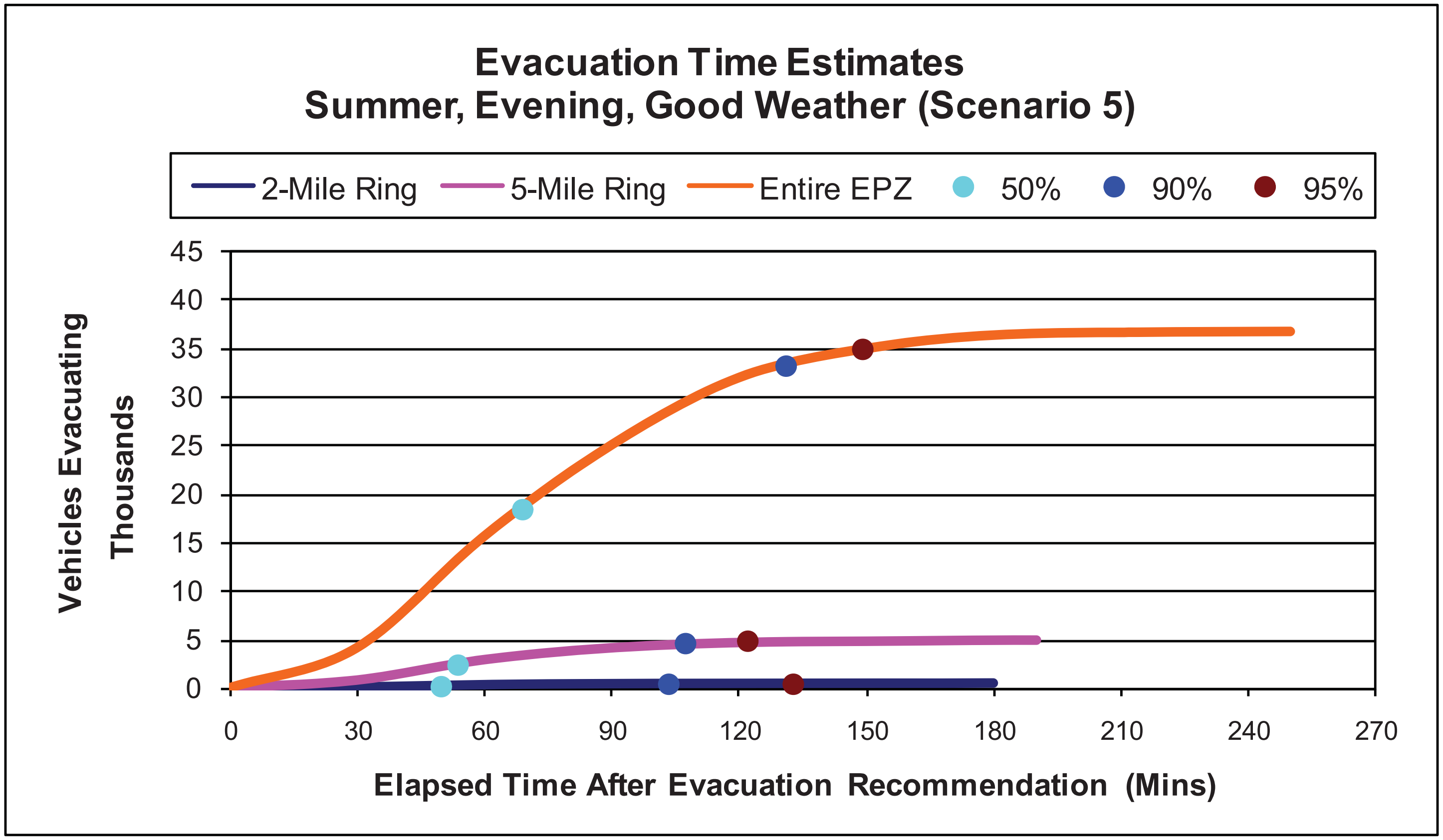


Figure J-5. Evacuation Time Estimates – Scenario 5 for Region R03 (Entire EPZ)

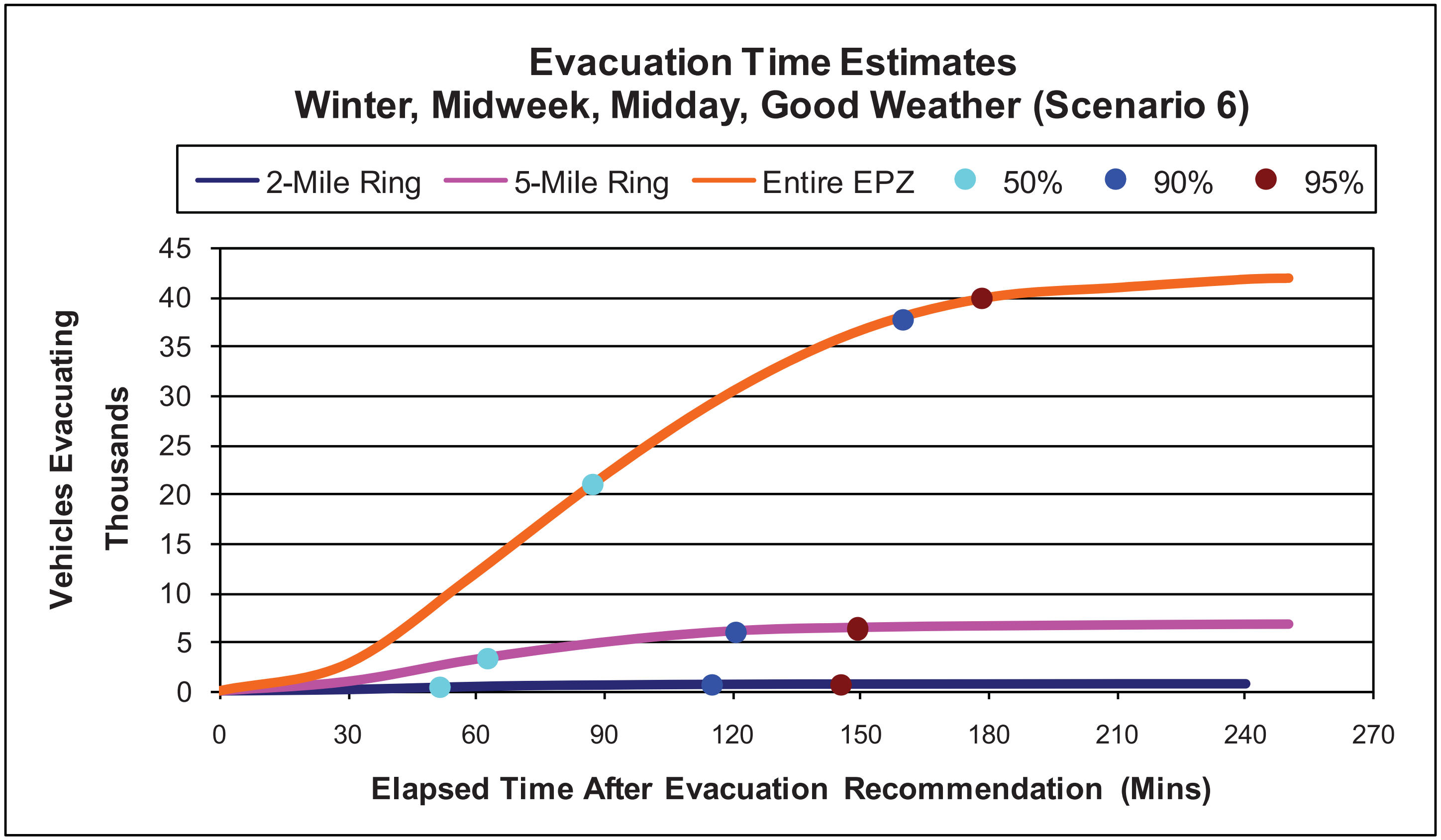


Figure J-6. Evacuation Time Estimates – Scenario 6 for Region R03 (Entire EPZ)

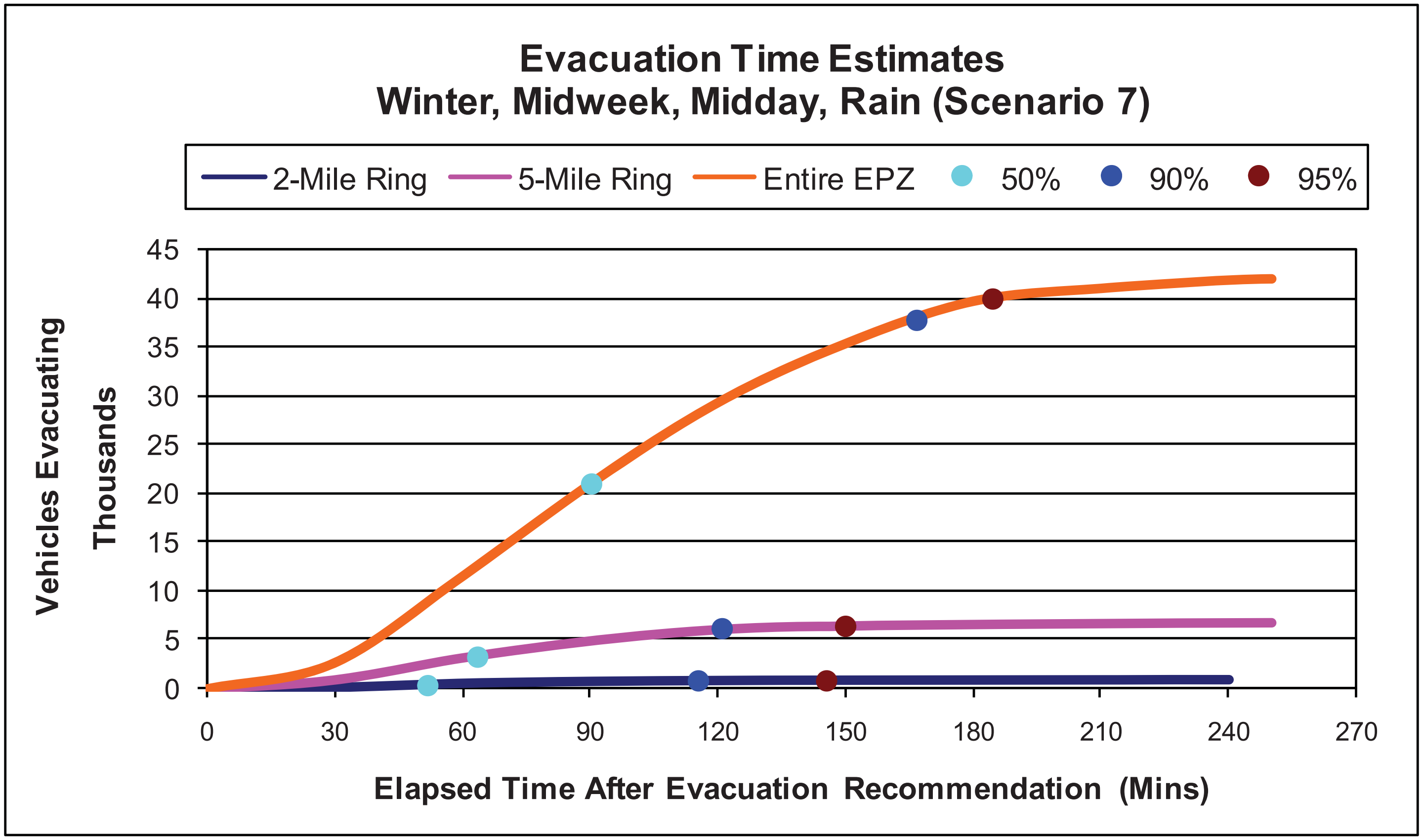


Figure J-7. Evacuation Time Estimates – Scenario 7 for Region R03 (Entire EPZ)

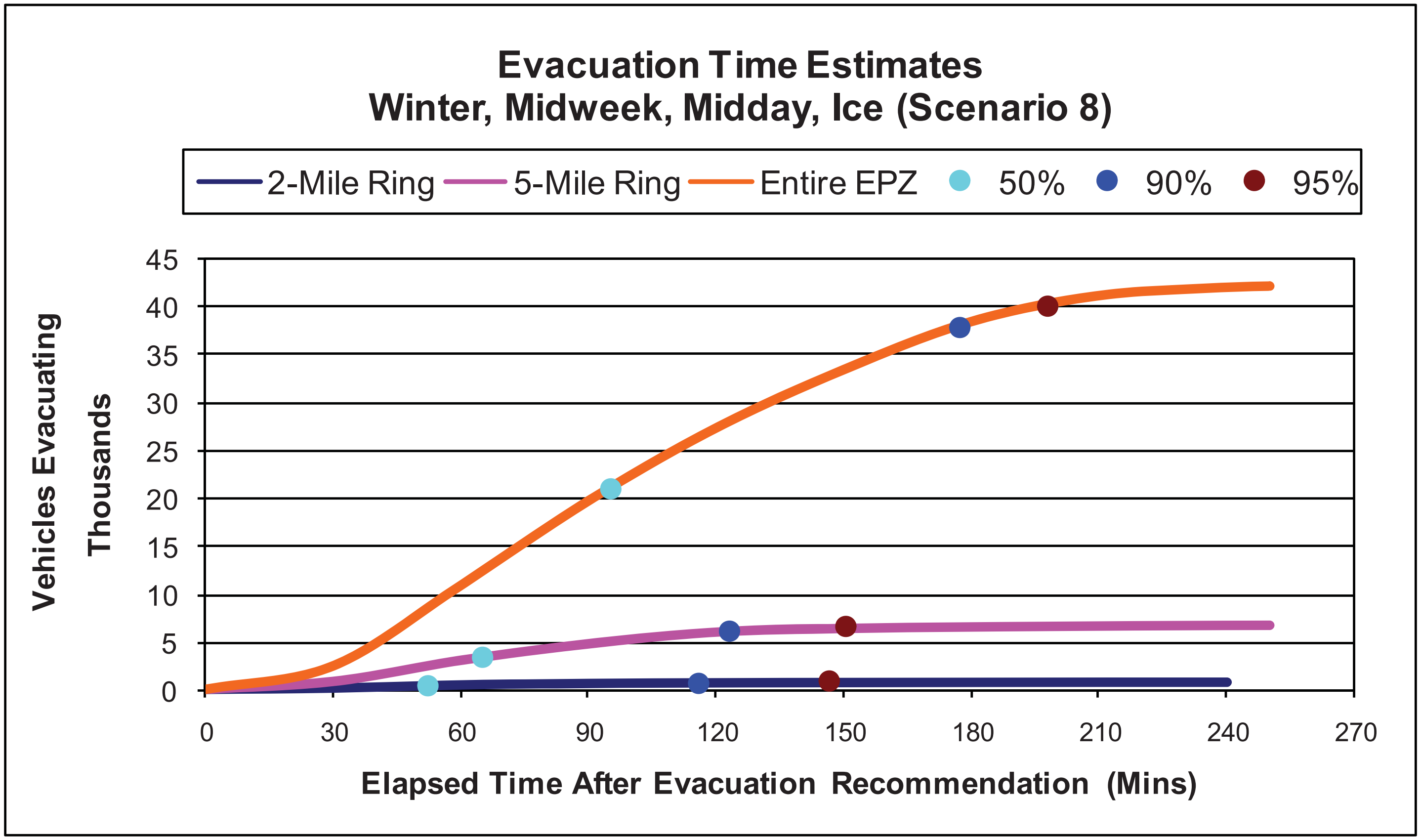


Figure J-8. Evacuation Time Estimates – Scenario 8 for Region R03 (Entire EPZ)

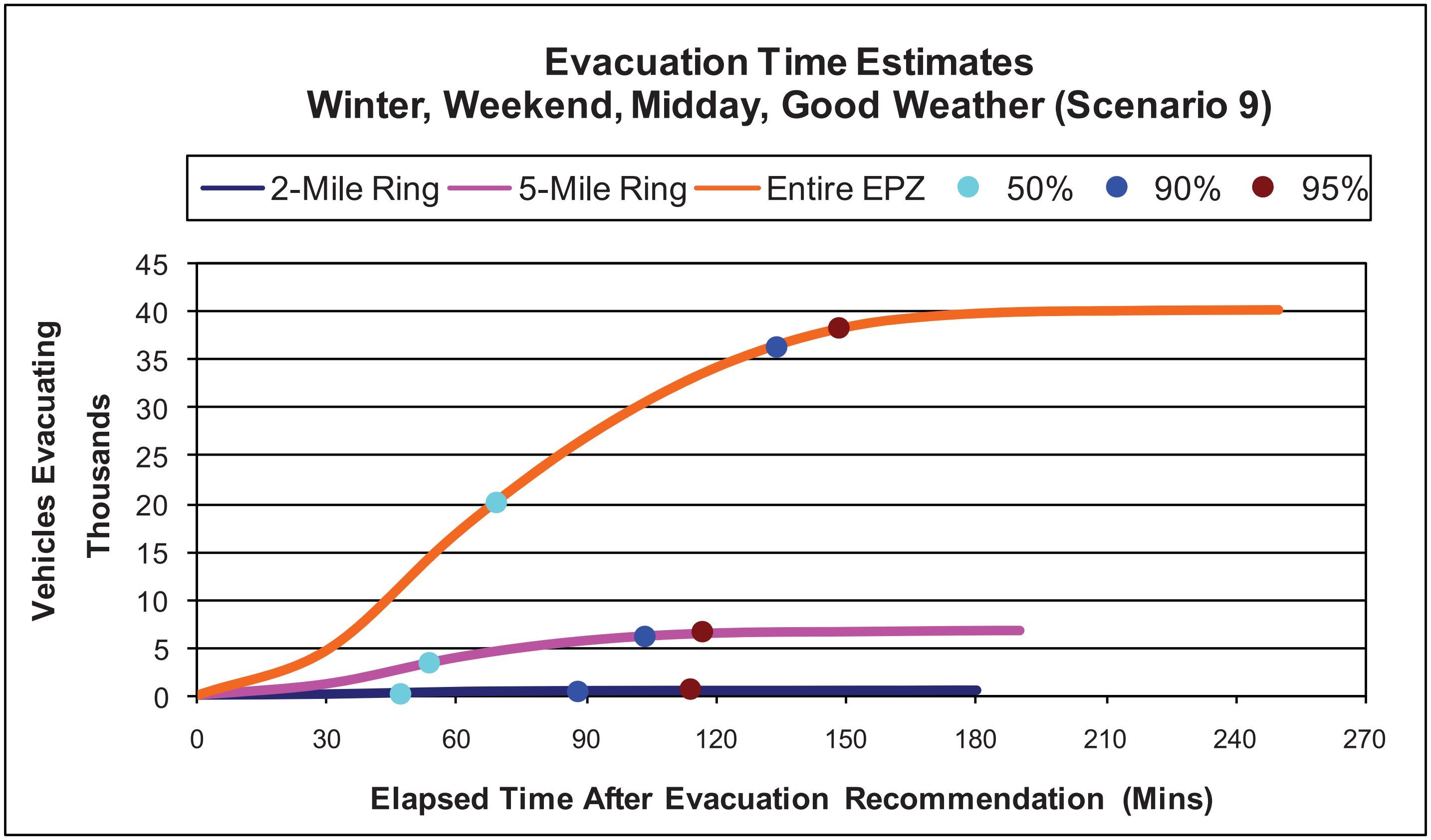


Figure J-9. Evacuation Time Estimates – Scenario 9 for Region R03 (Entire EPZ)

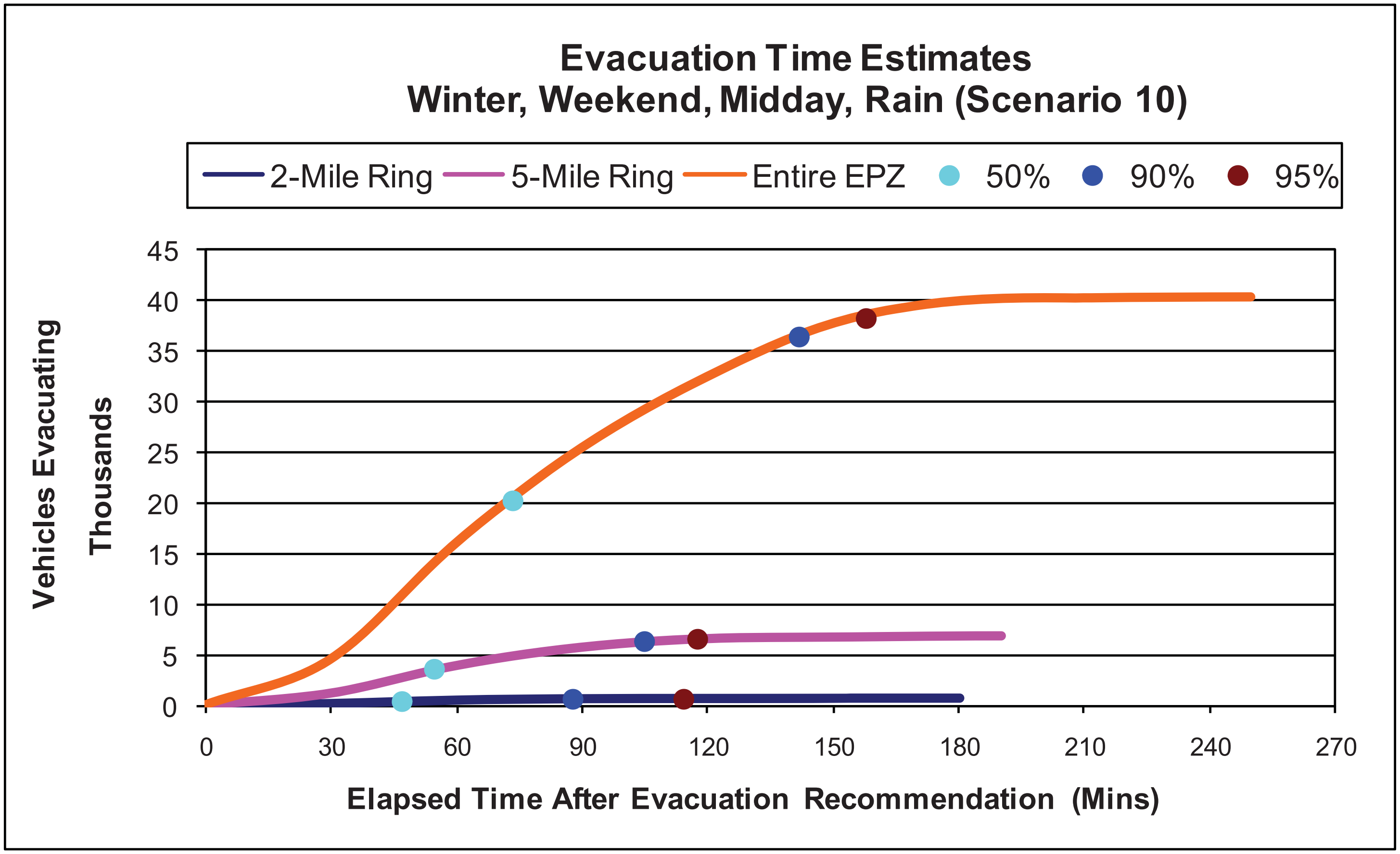


Figure J-10. Evacuation Time Estimates – Scenario 10 for Region R03 (Entire EPZ)

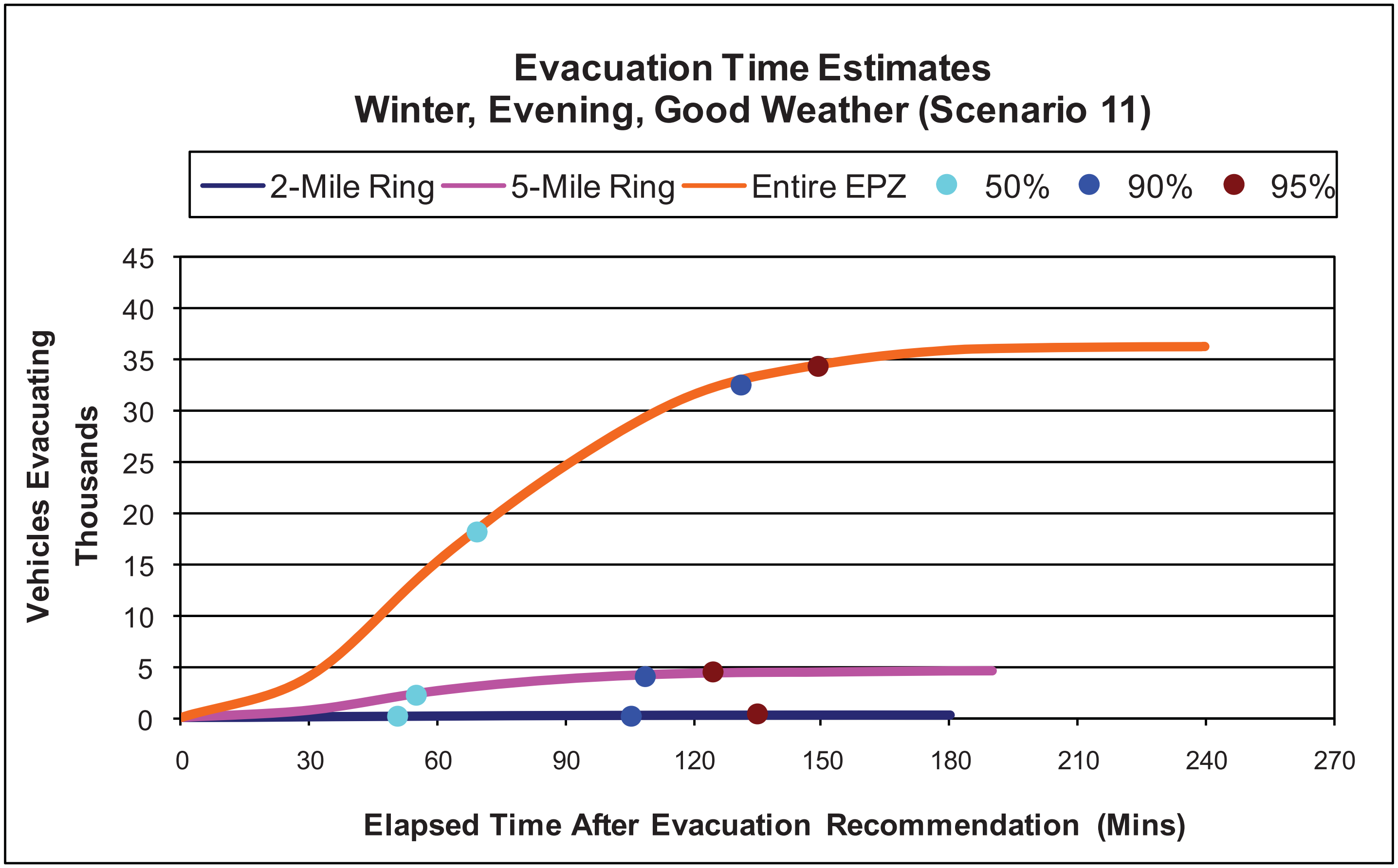


Figure J-11. Evacuation Time Estimates –
Scenario 11 for Region R03 (Entire EPZ)

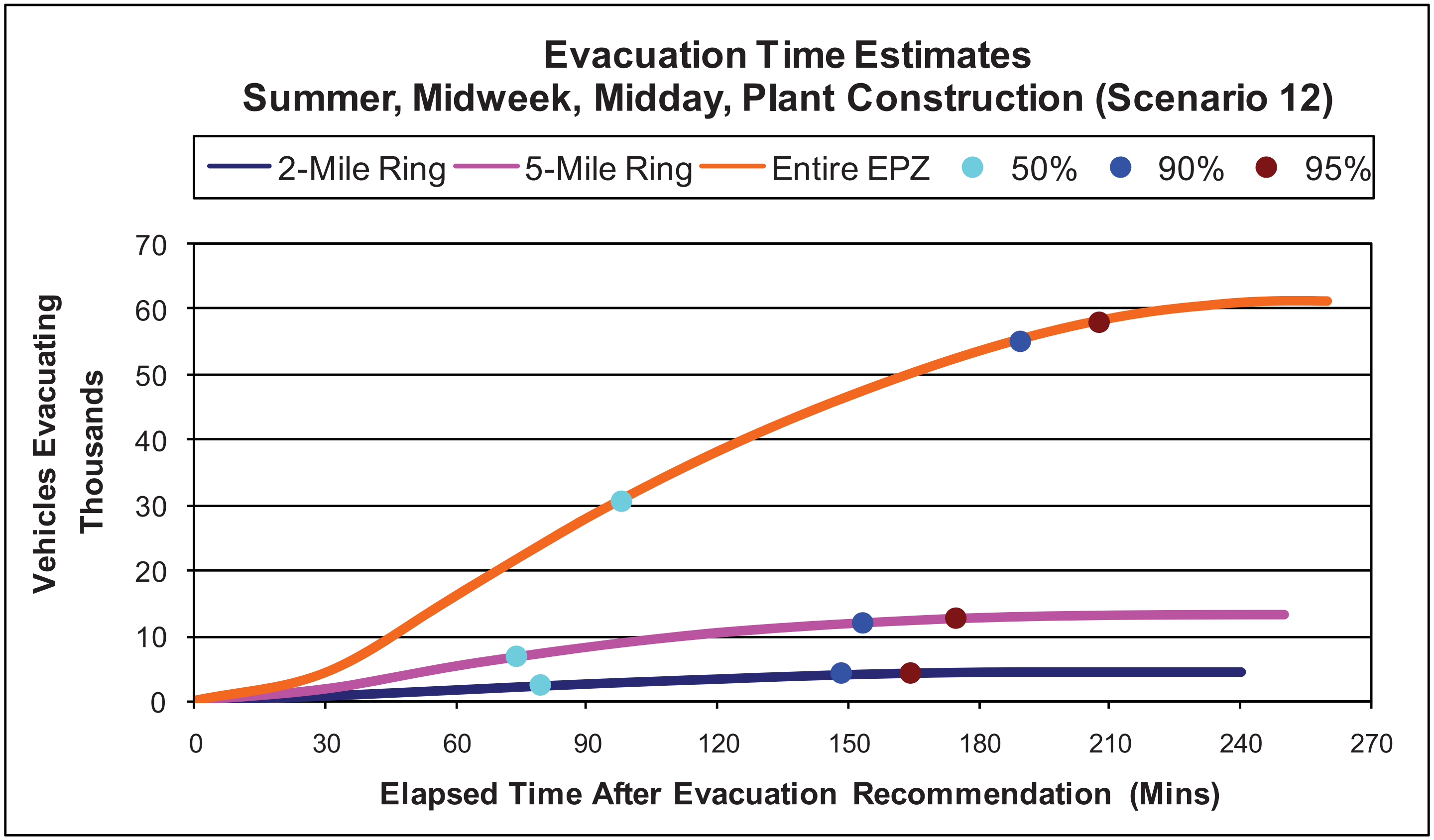


Figure J-12. Evacuation Time Estimates – Scenario 12 for Region R03 (Entire EPZ)

APPENDIX K

Evacuation Roadway Network Characteristics

APPENDIX K: EVACUATION ROADWAY NETWORK CHARACTERISTCS

Table K-1 lists the characteristics of each roadway section modeled in the ETE analysis. Each link is identified by its upstream and downstream node numbers. These node numbers can be cross-referenced to the electronic version of Figure 1-2 to identify the geographic location of each link. As mentioned in Section 1-3, the roadway characteristics were observed during the roadway survey; key roadway sections and intersections were video archived during the survey, including audio recordings of the comments made during the survey. A personal computer equipped with Geographical Information Systems (GIS) software was also used to note key observations during the survey. GIS shapefiles of the roadway characteristics and traffic control devices observed were created based on field observations and on the audio and video recordings.

The term, “Full Lanes” in Table K-1 identifies the number of lanes that extend throughout the length of the link. Many links have additional lanes on the immediate approach to an intersection (turn pockets); these have been recorded and entered into the I-DYNEV System input stream.

Table K-1. Evacuation Roadway Network Characteristics

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1	6	225	2	2250	65
2	3	24	1	1714	45
2	9	16	1	1714	40
3	5	30	1	1714	50
4	1	17	1	1714	50
5	17	56	2	2250	60
5	7	22	2	2250	60
6	1	225	2	2250	65
6	10	53	2	2250	65
7	5	22	2	2250	60
7	11	32	2	2250	60
8	626	16	1	1500	35
8	800	148	1	1895	60
9	11	22	1	1714	50
10	6	53	2	2250	65
10	575	49	2	2250	65
11	349	25	2	2250	60
11	7	32	2	2250	60
12	13	32	1	1714	40
13	19	33	1	1714	40
14	15	16	1	1714	40
14	17	21	1	1714	50
15	16	21	1	1714	50
16	17	37	2	2250	60
16	20	29	2	2250	60
17	16	37	2	2250	60
17	5	56	2	2250	60
18	1105	47	1	1714	40
19	14	38	2	1714	40
20	16	29	2	2250	60
21	33	80	2	1895	60
21	35	39	2	1895	60
22	592	33	2	2250	65
22	78	88	2	2250	65
23	22	14	1	1714	50
24	26	47	2	1895	60
24	30	43	2	1895	60
25	444	50	1	1714	40
25	26	34	2	1895	60
25	28	66	2	1895	55

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
26	25	34	2	1895	60
26	24	47	2	1895	60
27	28	40	2	1714	55
27	762	31	2	1714	55
28	25	66	2	1895	60
28	27	40	2	1714	55
29	28	22	1	1714	40
30	24	43	2	1895	60
30	31	50	2	1895	60
31	32	22	2	1895	60
31	30	50	2	1895	60
32	33	44	2	1895	60
32	31	22	2	1895	60
32	775	53	1	1714	45
33	21	80	2	1895	60
33	32	44	2	1895	60
34	597	124	4	2250	65
34	45	42	3	2250	65
35	438	21	1	1714	45
35	435	24	2	1895	60
35	21	39	2	1895	60
36	1032	75	1	1714	40
36	615	82	1	1714	40
37	720	18	2	1714	50
37	34	16	1	1714	50
38	615	43	1	1714	40
39	957	22	1	1500	30
40	1111	16	4	2250	60
40	355	21	4	2250	65
41	196	56	2	1895	55
41	225	47	2	1895	55
42	201	88	2	1895	50
42	202	24	2	1500	45
42	1045	26	1	1714	40
43	42	98	1	1500	50
44	43	31	1	1714	50
45	598	76	4	2250	65
45	34	42	3	2250	65
46	44	71	1	1714	50
47	46	53	1	1714	50
47	48	48	1	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
47	56	94	1	1714	45
48	47	48	1	1714	50
48	49	67	1	1714	50
49	48	67	1	1714	50
49	50	62	1	1714	50
50	49	62	1	1714	50
50	51	101	1	1714	50
51	50	101	1	1714	50
51	52	23	3	1714	45
52	790	14	2	1714	45
52	51	23	2	1714	50
53	791	77	1	1714	45
54	53	32	1	1714	45
55	54	44	1	1714	45
56	57	40	1	1714	45
57	58	59	1	1714	45
58	59	60	1	1714	45
59	736	45	1	1714	40
60	447	20	1	1714	45
60	692	15	1	1714	50
61	1042	23	2	1895	55
61	192	63	2	1895	50
62	301	26	1	1714	40
62	63	115	1	1714	40
63	396	25	1	1714	40
63	62	115	1	1714	40
64	396	37	1	1714	40
65	64	34	1	1714	40
66	65	28	1	1714	40
67	69	29	1	1714	45
68	445	8	2	1714	45
68	690	15	2	1714	50
69	389	22	1	1714	45
70	742	46	1	1714	40
71	690	35	2	2250	65
71	582	188	2	2250	65
71	68	21	1	1714	40
72	582	188	2	2250	65
72	73	188	2	2250	65
73	72	188	2	2250	65
73	76	183	2	2250	65

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
74	261	25	1	1714	50
74	769	118	1	1714	50
75	668	31	1	1714	45
75	73	14	1	1714	50
76	579	130	2	2250	65
76	73	183	2	2250	65
77	74	86	1	1714	50
78	630	55	2	2250	65
78	22	88	2	2250	65
79	78	9	1	1714	50
79	507	42	1	1714	50
80	81	27	1	1500	30
80	88	23	1	1500	30
81	82	54	1	1714	40
82	86	29	1	1714	40
83	84	40	2	2250	65
83	630	146	2	2250	65
84	83	40	2	2250	65
84	87	173	2	2250	65
85	84	23	1	1714	50
86	997	55	1	1714	40
87	84	173	2	2250	65
87	89	79	2	2250	65
88	91	25	1	1714	40
89	87	79	2	2250	65
89	92	118	2	2250	65
90	89	19	1	1714	50
90	941	35	1	1895	60
91	94	72	1	1714	40
92	93	98	2	2250	65
92	89	118	2	2250	65
93	92	98	2	2250	65
93	100	91	2	2250	65
94	95	57	1	1714	40
95	852	87	1	1714	40
96	80	86	1	1714	40
97	872	163	1	1714	40
98	99	149	1	1714	40
99	943	52	1	1714	40
100	93	91	2	2250	65
100	1123	67	2	2250	65

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
101	102	30	2	2000	60
101	108	100	2	2250	65
102	101	30	2	2250	65
102	104	22	2	2000	60
103	106	36	1	1714	40
104	102	22	2	2000	60
104	103	11	1	1714	40
104	654	107	2	2000	60
105	1123	8	2	2250	65
105	112	134	2	2250	65
106	141	87	1	1714	50
107	105	7	1	1714	50
108	101	100	2	2250	65
108	111	129	2	2250	65
109	110	21	2	1500	40
109	589	62	2	1500	40
109	629	10	1	1714	40
110	109	21	2	1500	40
110	557	22	2	1500	40
111	114	28	2	2250	65
111	113	21	1	1714	40
111	108	129	2	2250	65
112	105	134	2	2250	65
112	590	30	2	2250	65
113	114	18	1	1714	50
113	175	46	2	1895	60
114	111	28	2	2250	65
114	115	84	2	2250	65
115	114	84	2	2250	65
115	117	65	2	2250	65
116	119	43	2	1895	60
116	1011	31	2	1895	60
117	124	71	2	2250	65
117	115	65	2	2250	65
118	121	14	1	1714	50
118	125	49	1	1714	50
118	783	52	1	1714	50
119	1017	15	2	1714	45
119	120	83	2	1895	60
119	116	43	2	1895	60
120	119	83	2	1895	60

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
120	587	23	2	2000	60
120	1018	113	1	1714	45
120	1022	16	1	1714	45
121	124	25	2	2250	65
121	131	58	2	2250	65
122	587	35	2	2000	60
122	123	26	2	2000	60
123	122	26	2	2000	60
123	672	40	2	2000	60
124	117	71	2	2250	65
124	121	25	2	2250	65
125	118	49	1	1714	50
126	127	58	2	2000	60
126	326	27	1	1714	40
126	672	84	2	2000	60
127	126	58	2	2000	60
127	434	73	2	2000	60
128	641	67	2	2000	60
128	257	162	1	1714	60
128	433	166	2	2000	60
129	641	157	2	2000	60
129	130	64	2	2000	60
130	129	64	2	2000	60
130	466	45	2	2000	60
130	753	27	1	1714	55
131	121	58	2	2250	65
131	133	102	2	2250	65
132	136	15	1	1714	40
133	134	36	2	2250	65
133	131	102	2	2250	65
134	137	73	2	2000	60
134	133	36	2	2250	65
135	1025	93	2	2000	60
135	620	62	2	2000	60
136	134	18	1	1714	50
137	134	73	2	2000	60
138	785	14	1	1714	40
138	784	49	1	1714	40
139	785	22	1	1714	40
140	21	25	1	1714	40
141	233	157	1	1500	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
142	140	65	1	1714	40
143	795	6	1	1000	15
144	145	140	1	1714	50
144	782	20	1	1500	40
144	784	21	1	1714	40
145	132	132	1	1714	50
146	602	10	1	1500	40
147	142	86	1	1714	40
147	38	122	1	1714	40
147	150	108	1	1714	40
148	230	37	1	1714	40
148	149	125	1	1714	40
149	647	109	1	1895	60
149	148	125	1	1714	40
150	151	34	1	1714	40
151	1034	139	1	1714	50
151	153	97	1	1714	40
152	647	79	1	1895	60
152	995	82	1	1895	60
153	154	67	1	1714	40
154	155	30	1	1714	40
155	159	88	1	1714	50
155	893	82	1	1714	50
156	140	65	1	1714	40
157	643	68	1	1895	60
157	644	160	1	1895	60
158	156	77	1	1714	40
159	160	54	1	1714	50
160	161	59	1	1714	50
161	210	58	1	1714	50
162	163	123	1	1714	55
162	171	29	1	1714	45
163	164	22	1	1714	55
164	176	26	1	1714	55
165	162	203	1	1714	55
166	165	59	1	1714	55
167	166	25	1	1714	55
168	649	31	1	1500	40
169	167	76	1	1714	45
170	169	56	1	1200	45
171	172	33	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
172	173	64	1	1714	45
173	174	106	1	1714	40
174	974	8	1	1500	40
175	652	72	2	1895	60
176	211	103	1	1895	55
176	212	85	1	1895	55
177	155	51	1	1714	50
178	177	25	1	1714	40
179	178	39	1	1714	45
180	181	41	2	1895	60
181	793	43	2	1895	60
182	179	17	1	1714	45
183	182	50	1	1714	45
184	489	31	2	1895	60
185	613	30	2	1895	60
186	187	45	2	1895	60
187	188	34	2	1895	60
188	190	61	2	1714	50
189	183	59	1	1714	45
189	191	35	1	1714	45
191	194	76	1	1714	45
192	61	63	2	1895	50
192	193	25	2	1895	55
193	223	26	2	1895	50
193	731	42	1	1714	45
193	192	25	2	1895	50
194	195	60	1	1714	45
195	197	78	1	1714	45
196	41	56	2	1895	55
196	378	63	2	1895	55
197	198	59	1	1714	45
198	199	78	1	1714	45
199	200	87	1	1714	45
200	205	35	1	1714	45
201	985	8	2	1714	45
201	42	88	2	1500	45
201	388	124	2	1895	55
202	1099	139	1	1714	40
202	42	24	2	1500	45
202	226	83	2	1500	40
203	204	20	1	1500	35

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
203	1030	17	1	1500	40
204	203	20	1	1500	40
204	959	8	1	1500	35
205	213	78	1	1714	45
206	1100	29	1	1714	45
206	207	57	1	1714	45
207	206	57	1	1714	45
207	208	50	1	1714	45
208	207	50	1	1714	45
208	209	61	1	1895	60
209	210	49	1	1895	60
209	208	61	1	1895	60
210	211	98	1	1895	55
210	209	49	1	1895	60
211	210	98	1	1895	60
211	176	103	1	1895	55
212	176	85	1	1895	55
212	735	66	1	1895	55
213	214	35	1	1714	45
214	215	157	1	1714	45
215	219	43	1	1895	55
215	220	88	1	1895	55
216	735	88	1	1895	55
216	217	37	1	1895	55
217	219	101	1	1895	55
217	216	37	1	1895	55
218	594	69	1	1714	40
219	217	101	1	1895	55
219	215	43	1	1895	55
220	221	40	1	1895	55
220	215	88	1	1895	55
221	220	40	1	1895	55
221	222	51	1	1895	55
222	221	51	1	1895	55
223	224	39	2	1895	50
223	193	26	2	1895	55
224	223	39	2	1895	50
225	388	109	2	1895	55
225	41	47	2	1895	55
226	202	83	2	1500	40
226	1030	6	2	1500	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
227	218	65	1	1714	40
228	229	27	1	1500	40
228	957	39	1	1500	30
228	959	24	1	1500	35
229	228	27	1	1500	35
229	1100	50	1	1500	40
230	146	72	1	1500	40
230	148	37	1	1714	40
230	139	30	1	1714	40
231	227	154	1	1714	40
232	231	45	1	1714	40
233	143	18	1	1500	40
234	606	16	1	1500	40
235	239	52	1	1714	45
235	286	219	1	1895	60
235	668	62	1	1714	45
236	96	92	1	1714	40
237	236	77	1	1714	40
238	237	35	1	1714	40
239	241	53	1	1714	45
240	238	48	1	1714	40
241	243	37	1	1714	45
242	240	34	1	1714	40
243	244	42	1	1714	45
244	245	40	1	1714	45
245	246	35	1	1714	45
246	249	62	1	1714	45
247	242	133	1	1714	40
248	842	32	1	1714	40
249	251	65	1	1714	45
250	248	48	1	1714	40
251	128	67	1	1714	45
252	250	82	1	1714	40
253	252	77	1	1714	40
254	253	42	1	1714	40
255	254	43	1	1714	40
256	805	48	1	1714	45
257	633	43	1	1714	60
258	256	74	1	1714	50
259	258	47	1	1714	40
260	259	76	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
261	262	47	1	1714	40
261	770	26	1	1714	50
262	263	69	1	1714	40
263	265	50	1	1714	40
264	635	56	1	1714	60
265	267	41	1	1714	40
266	636	48	1	1714	60
267	268	60	1	1714	40
268	995	76	1	1714	40
269	637	29	1	1714	60
270	141	17	1	1714	40
271	270	73	1	1714	40
272	271	55	1	1714	40
273	272	26	1	1714	40
274	276	61	1	1714	60
275	273	82	1	1714	40
277	275	31	1	1714	40
278	8	191	1	1895	60
278	632	130	1	1895	60
279	277	30	1	1714	40
280	279	47	1	1714	40
281	280	57	1	1714	40
281	284	50	1	1714	40
282	283	45	1	1714	45
283	235	44	1	1714	40
284	285	44	1	1714	40
285	288	38	1	1714	40
286	287	94	1	1895	55
287	290	42	1	1895	55
288	289	84	1	1714	40
289	77	48	1	1714	40
290	293	81	1	1714	40
290	705	53	1	1895	55
291	292	63	1	1714	40
292	294	41	1	1500	35
292	757	40	1	1500	35
293	295	33	1	1714	40
294	702	37	1	1500	35
294	703	42	1	1200	30
294	319	19	1	1500	35
295	296	67	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
296	299	35	1	1714	40
297	298	25	1	1714	40
297	694	76	1	1714	40
297	703	23	1	1200	30
298	670	62	1	1714	45
298	297	25	1	1500	30
299	303	69	1	1714	40
299	434	81	1	1714	40
300	434	47	1	1714	40
300	1023	74	1	1714	40
301	1009	17	1	1714	45
301	62	26	1	1714	40
301	674	17	1	1714	40
302	300	14	1	1714	40
302	66	30	1	1714	40
303	304	78	1	1714	40
304	694	45	1	1714	40
305	1007	26	1	1714	45
305	1021	54	1	1714	45
306	299	43	1	1714	40
307	308	27	1	1714	45
308	309	33	1	1714	45
308	386	21	1	1714	45
309	312	12	1	1714	45
310	311	42	1	1714	45
311	698	19	1	1714	40
311	313	31	1	1714	45
312	385	20	2	1714	45
312	599	23	2	1714	45
312	310	12	1	1714	45
313	1104	39	1	1714	45
314	306	26	1	1714	40
315	314	40	1	1714	40
316	317	29	1	1714	40
316	677	28	1	1500	40
317	318	25	2	1714	40
318	1106	27	2	1714	40
319	320	40	1	1500	35
320	734	17	1	1500	35
321	330	18	2	1714	40
322	321	66	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
323	322	20	1	1714	40
324	323	71	1	1714	40
325	660	15	3	1714	40
325	126	18	1	1714	50
325	326	20	2	1895	60
326	327	17	2	1895	60
326	325	20	2	1895	60
327	396	63	2	1895	60
327	326	17	2	1895	60
328	324	21	1	1714	40
329	343	46	1	1714	40
329	331	41	1	1714	40
330	356	76	1	1714	40
330	569	49	2	1895	60
331	334	42	1	1714	40
332	335	19	2	1895	60
332	358	18	1	1714	40
334	337	40	1	1714	40
335	667	43	2	1895	60
336	1020	101	1	1714	45
337	340	31	1	1714	40
338	1008	13	2	1714	45
338	413	52	2	1714	50
338	339	20	2	1714	50
339	338	20	2	1714	50
339	707	35	2	1714	50
340	341	22	1	1714	40
341	567	54	1	1714	40
342	344	37	2	1714	50
342	586	30	1	1714	45
343	328	32	1	1714	40
344	345	27	2	1714	50
345	1076	22	2	1714	50
346	335	27	1	1714	40
347	346	133	1	1714	40
348	351	50	2	1714	50
349	11	25	2	2250	65
349	350	52	2	2250	65
350	374	16	2	2250	65
350	349	52	2	2250	60
351	410	24	2	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
351	381	46	2	1714	50
352	351	11	2	1714	50
353	352	28	2	1714	50
354	408	52	2	1714	50
354	423	80	2	1714	50
355	357	29	1	1714	50
355	361	23	3	2250	65
355	40	21	4	2250	65
356	696	17	1	1714	40
357	374	15	2	2250	65
357	359	36	2	2250	65
358	332	18	1	1714	40
358	663	22	1	1714	40
359	357	36	2	2250	65
360	362	41	1	1714	45
360	1001	35	2	1714	50
360	701	100	1	1714	45
361	355	23	2	2250	65
361	363	8	1	1500	40
361	375	29	2	2250	65
362	360	41	1	1714	45
362	364	61	1	1714	45
363	374	8	1	1714	50
364	362	61	1	1714	45
364	700	37	1	1714	50
365	366	21	2	1714	50
365	700	56	1	1714	50
366	367	29	2	1714	50
366	365	21	2	1714	50
367	366	29	2	1714	50
367	368	33	1	1714	50
368	367	33	1	1714	50
368	369	44	1	1714	50
369	368	44	1	1714	50
369	370	35	1	1714	50
370	369	35	1	1714	50
370	371	26	1	1714	50
371	370	26	1	1714	50
371	372	12	2	1714	40
372	371	12	2	1714	40
372	373	12	3	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
372	607	25	2	1500	40
373	970	18	2	1714	40
374	350	16	2	2250	65
374	357	15	2	2250	65
375	361	29	2	2250	65
376	372	14	3	1714	40
377	697	30	2	1714	50
377	699	51	2	1500	45
378	196	63	2	1895	55
378	387	30	2	1895	55
379	377	15	2	1714	45
380	377	24	2	1714	50
381	380	45	2	1714	50
382	967	23	1	1714	45
383	382	22	1	1714	45
384	383	27	1	1714	45
385	384	18	1	1714	45
385	67	12	1	1714	45
385	312	20	2	1714	45
386	385	31	1	1714	45
387	378	30	2	1895	55
387	1042	59	2	1895	55
388	201	124	2	1895	50
388	225	109	2	1895	55
389	390	65	1	1714	45
390	621	50	2	1714	45
390	391	54	2	1200	40
391	393	27	2	1714	40
392	975	52	1	1714	45
393	394	8	1	1200	30
393	395	17	1	1714	45
394	316	29	1	1500	40
395	712	71	2	1714	45
395	393	17	1	1714	40
396	399	88	2	1895	60
396	327	63	2	1895	60
396	63	25	1	1714	40
397	708	57	2	1714	45
397	709	16	2	1714	45
398	415	56	2	1714	45
398	712	32	2	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
398	397	25	2	1714	45
399	400	73	2	1895	60
400	330	29	2	1895	60
401	402	38	2	1714	50
402	404	33	2	1714	50
403	398	29	2	1714	45
404	405	36	2	1714	50
405	354	63	2	1714	50
405	1078	27	1	1714	40
406	865	9	1	1714	40
406	931	21	2	1714	40
407	421	16	2	1714	50
407	406	27	2	1714	40
408	353	24	2	1714	50
409	714	31	2	1714	50
410	412	35	2	1714	50
411	1069	8	1	1714	45
411	1014	27	2	1714	45
411	409	61	2	1714	50
412	414	51	2	1714	50
413	411	45	2	1714	50
414	418	13	2	1714	50
415	416	32	2	1714	45
416	687	40	2	1200	40
417	37	22	2	1714	50
418	420	28	2	1714	50
419	621	68	1	1714	40
419	1065	28	2	1714	50
420	368	19	2	1714	50
421	419	21	2	1714	50
422	861	28	2	1714	45
423	426	70	2	1714	50
424	226	9	1	1000	25
425	1029	15	1	1500	40
425	1031	14	2	1714	45
426	360	45	2	1714	50
427	700	94	1	1714	50
428	700	50	1	1714	50
429	430	35	1	1714	45
431	1032	60	2	1714	45
432	12	22	2	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
433	434	146	2	2000	60
433	128	166	2	2000	60
434	127	73	2	2000	60
434	433	146	2	2000	60
435	35	24	2	1895	60
435	615	181	2	1895	60
436	282	17	1	1714	45
437	436	101	1	1714	45
438	439	91	1	1714	45
439	441	41	1	1714	45
439	555	57	1	1714	45
439	775	30	1	1714	45
440	437	46	1	1714	45
441	439	41	1	1714	45
441	1036	10	1	1714	50
442	446	42	1	1714	45
442	440	50	1	1714	45
443	444	33	1	1714	50
444	25	50	1	1714	40
444	29	56	1	1714	50
444	55	89	1	1714	45
445	68	8	2	1714	45
445	762	79	2	1714	55
446	448	55	1	1714	45
447	449	54	1	1714	45
447	60	20	1	1714	45
448	450	43	1	1714	45
449	447	54	1	1714	45
449	1086	14	1	1714	45
450	452	44	1	1714	45
451	728	16	1	1714	45
452	75	96	1	1714	55
453	456	31	1	1500	50
453	455	51	1	1500	50
454	717	20	2	1714	45
454	729	31	1	1714	45
455	278	20	1	1500	50
456	457	26	1	1714	60
457	458	90	1	1714	60
458	460	69	1	1714	60
459	725	37	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
459	461	44	1	1714	45
459	565	12	1	1714	45
460	462	87	1	1714	60
461	463	48	1	1714	45
462	464	27	1	1714	60
463	465	25	1	1714	45
464	749	23	1	1714	60
465	792	18	2	1714	45
466	1024	52	2	2000	60
466	130	45	2	2000	60
467	655	43	1	1714	40
468	469	25	2	1714	45
469	681	37	2	1714	45
469	470	25	2	1714	45
469	422	53	2	1714	45
470	473	16	2	1714	45
471	467	53	1	1714	40
472	471	70	1	1714	40
473	474	61	1	1714	45
474	475	14	2	1714	50
474	481	39	1	1714	45
474	723	33	2	1714	50
475	720	28	2	1714	50
475	474	14	2	1714	50
476	477	54	1	1714	40
476	655	79	1	1714	40
477	476	54	1	1714	40
477	478	29	1	1714	40
478	480	28	1	1714	40
479	483	56	2	1714	45
480	482	105	1	1714	40
481	832	9	2	1714	45
482	486	63	1	1714	40
483	683	18	2	1714	45
483	484	18	3	1714	40
484	685	30	3	1714	40
484	483	18	3	1714	45
485	1040	26	1	1714	50
486	488	33	1	1714	40
487	485	31	1	1714	50
487	721	17	2	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
488	489	39	1	1714	40
489	185	45	2	1895	60
490	188	71	1	1895	60
491	490	22	1	1714	40
492	491	56	1	1714	40
493	492	37	1	1714	40
494	623	84	1	1714	40
494	493	45	1	1714	40
495	487	28	1	1714	50
496	495	20	1	1714	50
497	496	41	1	1714	50
498	494	40	1	1714	40
499	497	54	1	1714	50
500	499	57	1	1714	50
501	566	9	1	1714	45
501	726	33	1	1714	45
501	500	35	1	1714	50
502	498	55	1	1714	40
503	502	102	1	1714	40
504	503	29	1	1714	40
505	504	96	1	1714	40
506	501	15	1	1714	50
507	508	49	1	1714	50
508	513	42	1	1714	50
509	512	24	1	1714	50
510	509	33	1	1714	50
511	510	26	1	1714	50
511	527	37	1	1714	45
512	506	23	1	1714	50
513	514	84	1	1714	50
514	515	65	1	1714	40
514	516	129	1	1714	50
515	85	60	1	1714	40
516	521	188	1	1714	50
517	454	84	1	1714	45
518	517	46	1	1714	45
519	518	56	1	1714	45
520	519	14	1	1714	45
520	522	41	1	1714	45
521	523	40	1	1714	50
521	526	43	1	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
522	524	27	1	1714	45
523	90	42	1	1714	50
524	525	35	1	1714	45
525	511	85	1	1714	45
526	530	108	1	1714	50
527	528	37	1	1714	45
528	529	44	1	1714	45
529	619	75	1	1714	45
530	531	17	1	1714	40
531	533	6	1	1714	40
531	534	9	1	1714	40
532	535	91	1	1714	45
533	534	9	2	1895	60
533	536	76	2	1895	60
534	533	9	2	1895	60
534	645	84	2	1895	60
535	616	66	1	1714	45
536	533	76	2	1895	60
536	642	120	1	1895	60
537	539	22	2	1714	50
537	1058	102	1	1895	60
538	542	26	1	1714	45
538	541	74	1	1714	45
539	537	22	2	1714	50
539	1059	33	2	1714	50
539	1062	37	2	1714	50
540	543	44	2	1500	40
540	855	45	2	1714	50
541	733	63	1	1714	45
542	193	31	1	1714	40
543	540	44	2	1500	40
543	544	56	2	1500	40
544	543	56	2	1500	40
544	545	33	2	1500	40
545	544	33	2	1500	40
545	547	32	2	1500	40
546	538	73	1	1714	45
547	545	32	2	1500	40
547	549	29	2	1500	40
548	61	68	1	1714	40
548	546	40	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
549	547	29	2	1500	40
549	551	19	2	1500	40
550	548	177	1	1895	60
551	553	50	2	1500	40
551	549	19	2	1500	40
552	737	21	1	1714	45
553	551	50	2	1500	40
553	557	53	2	1500	40
554	551	23	1	1500	40
554	556	45	1	1500	40
555	715	86	1	1714	45
556	994	23	1	1500	40
556	554	45	1	1500	40
556	553	34	1	1500	40
557	553	53	2	1500	40
557	110	22	2	1500	40
558	554	63	1	1500	40
558	559	29	1	1500	40
559	560	29	1	1500	40
559	558	29	1	1500	40
560	556	43	1	1500	40
561	558	33	1	1500	40
562	1087	23	1	1714	40
562	563	51	1	1714	45
563	562	51	1	1714	45
563	564	26	1	1714	45
564	563	26	1	1714	45
564	565	21	1	1714	45
565	459	12	1	1714	45
565	564	21	1	1714	45
566	568	26	1	1714	45
567	332	122	2	1895	60
568	570	81	1	1714	45
569	567	54	2	1895	60
570	571	19	1	1714	45
571	572	41	1	1714	45
572	573	20	1	1714	45
572	1098	31	1	1714	40
573	574	36	1	1714	45
574	576	27	1	1714	45
575	10	49	2	2250	65

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
575	577	85	2	2250	65
576	578	19	1	1714	45
577	575	85	2	2250	65
577	579	42	2	2250	65
578	730	20	1	1714	45
579	76	130	2	2250	65
579	577	42	2	2250	65
580	1088	60	1	1714	45
581	60	52	1	1200	45
582	72	188	2	2250	65
582	71	188	2	2250	65
583	1011	30	2	1895	60
583	584	38	2	1895	50
584	583	38	2	1895	60
584	718	44	3	1895	50
585	1018	20	1	1714	45
585	1019	33	1	1714	40
586	588	30	1	1714	45
587	120	23	2	1895	60
587	122	35	2	2000	60
588	706	23	1	1714	45
589	109	62	2	1500	40
589	1102	126	2	1714	50
590	112	30	2	2250	65
591	593	26	1	1714	45
592	1	178	2	2250	65
592	22	33	2	2250	65
593	308	26	1	1714	45
594	738	132	1	1895	60
594	1056	123	1	1895	60
595	628	32	2	1895	60
595	596	38	2	1895	60
596	595	38	2	1895	60
596	645	36	2	1895	60
597	34	124	4	2250	65
597	1111	35	4	2250	60
598	45	76	4	2250	65
598	693	55	3	2250	65
599	379	19	2	1714	45
600	598	12	1	1714	50
601	692	35	2	2250	65

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
601	693	136	2	2250	65
602	796	14	1	1500	40
603	146	13	1	1500	40
604	168	23	1	1500	40
604	233	9	1	1500	40
605	168	21	1	1500	40
605	606	9	1	1500	40
606	144	34	1	1500	40
607	608	38	1	1500	35
608	609	29	1	1500	40
609	429	77	2	1714	40
609	677	10	1	1500	40
610	648	68	1	1714	50
611	113	30	2	1714	50
612	175	17	1	1714	40
613	186	36	2	1895	60
614	613	26	1	1714	40
615	431	28	2	1714	45
615	435	181	2	1895	60
616	538	41	1	1714	45
617	613	30	1	1714	40
618	655	43	2	2000	60
618	640	55	2	2000	60
619	532	37	1	1714	45
619	1097	159	1	1714	40
620	135	62	2	2000	60
620	655	39	2	2000	60
621	1064	27	2	1714	45
621	419	68	1	1714	40
622	862	56	1	1895	60
622	1056	77	1	1895	60
623	624	55	1	1714	40
624	625	42	1	1714	40
625	760	40	1	1714	50
626	10	17	1	1714	50
627	625	31	1	1714	40
628	100	22	1	1714	50
628	992	79	2	1714	50
628	595	32	2	1895	60
629	112	11	1	1714	50
630	78	55	2	2250	65

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
630	83	146	2	2250	65
631	327	20	1	1714	40
632	436	23	1	1895	60
633	264	48	1	1714	60
634	266	69	1	1714	60
635	634	45	1	1714	60
636	269	51	1	1714	60
637	639	31	1	1714	60
638	274	82	1	1714	60
639	638	41	1	1714	60
640	618	55	2	2000	60
640	654	55	2	2000	60
641	129	157	2	2000	60
641	128	67	2	2000	60
642	644	89	1	1895	60
642	536	120	1	1895	60
643	995	134	1	1895	60
643	157	68	1	1895	60
644	642	89	1	1895	60
644	157	160	1	1895	60
645	596	36	2	1895	60
645	534	84	2	1895	60
646	399	14	1	1714	40
647	152	79	1	1895	60
647	149	109	1	1895	60
648	611	27	1	1714	50
649	610	53	1	1500	40
650	180	51	2	1895	60
651	650	40	2	1895	60
652	651	39	2	1895	60
653	184	99	2	1895	60
654	640	55	2	2000	60
654	104	107	2	2000	60
655	620	39	2	2000	60
655	618	43	2	2000	60
655	476	79	1	1714	40
656	399	30	1	1714	40
657	400	18	1	1714	40
658	400	20	1	1714	40
659	740	74	1	1895	60
659	862	91	1	1895	60

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
660	325	15	3	1895	60
660	665	19	2	1714	50
661	996	100	1	1895	60
661	1053	111	1	1895	60
662	1053	45	1	1895	60
662	666	185	1	1895	60
663	358	22	1	1714	40
663	701	20	1	1714	45
664	739	44	1	1895	60
664	1058	67	1	1895	60
665	669	19	2	1714	50
665	660	19	2	1714	50
666	662	185	1	1895	60
668	75	31	1	1714	55
668	235	62	1	1714	50
669	710	24	1	1714	50
669	665	19	2	1714	50
670	298	62	1	1714	40
670	671	9	2	1714	45
671	123	10	1	1714	50
671	673	6	2	1714	45
671	670	9	2	1714	40
672	126	84	2	2000	60
672	123	40	2	2000	60
673	671	6	2	1714	45
673	336	35	1	1714	45
673	1009	8	2	1714	45
674	401	99	1	1714	50
674	675	38	1	1714	40
675	676	28	1	1714	40
676	1020	30	1	1714	40
677	18	32	1	1714	40
678	665	33	1	1714	40
679	600	7	1	1714	40
680	600	12	1	1714	40
681	469	37	2	1714	45
681	680	11	2	1714	40
682	665	13	4	1714	40
682	684	19	1	1714	40
683	1041	34	1	1714	45
684	660	14	4	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
685	1039	24	3	1714	45
685	484	30	3	1714	40
686	1039	20	3	1714	45
686	999	6	2	1714	45
687	1109	18	2	1200	40
688	998	17	2	1200	30
689	40	11	1	1714	50
690	759	19	4	2250	65
690	71	35	2	2250	65
690	758	10	1	1714	40
691	759	34	2	2250	65
691	692	75	2	2250	65
692	691	75	2	2250	65
692	601	35	2	2250	65
693	598	55	3	2250	65
693	601	136	2	2250	65
694	710	26	1	1714	50
694	297	76	1	1500	30
694	702	41	1	1714	45
695	316	11	1	1200	40
695	609	32	2	1500	40
696	354	42	2	1200	40
697	311	33	2	1714	50
698	382	17	1	1714	40
699	968	23	2	1500	45
700	428	50	1	1714	50
700	427	94	1	1714	50
700	364	37	1	1714	45
700	365	56	1	1714	50
701	360	100	1	1714	45
701	663	20	1	1714	40
702	294	37	1	1500	35
702	694	41	1	1714	45
703	585	23	1	1714	40
703	297	23	1	1714	40
704	581	50	1	1714	45
705	1010	35	1	1895	55
706	591	20	1	1714	45
707	342	23	2	1714	50
708	432	54	2	1714	40
709	2	55	2	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
710	669	24	1	1714	50
710	694	26	1	1714	45
711	710	53	1	1714	40
712	397	22	2	1714	45
712	398	32	2	1714	45
712	395	71	2	1714	45
713	407	29	2	1714	45
714	713	28	2	1714	50
715	716	78	1	1714	45
716	52	14	2	1714	45
717	459	82	1	1714	45
718	679	19	1	1714	40
718	719	14	3	1895	50
719	681	19	3	1714	45
720	475	28	2	1714	50
720	37	18	2	1714	50
721	722	18	2	1714	50
721	487	17	2	1714	50
722	830	34	2	1714	50
722	721	18	2	1714	50
723	830	19	2	1714	50
723	474	33	2	1714	50
724	726	40	1	1714	45
724	725	44	1	1714	45
725	724	44	1	1714	45
725	459	37	1	1714	45
726	724	40	1	1714	45
726	501	33	1	1714	45
727	454	44	1	1714	45
728	727	23	1	1714	45
729	511	102	1	1714	45
730	580	80	1	1714	45
731	732	32	1	1714	45
733	1093	62	1	1714	45
734	758	42	2	1714	45
735	212	66	1	1895	55
735	216	88	1	1895	55
736	550	47	1	1714	50
736	41	43	1	1714	40
736	552	19	1	1714	45
737	225	16	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
738	594	132	1	1895	60
738	996	123	1	1895	60
739	664	44	1	1895	60
739	740	95	1	1895	60
740	739	95	1	1895	60
740	659	74	1	1895	60
741	4	176	1	1714	50
742	741	25	1	1714	50
742	744	45	1	1714	50
743	745	115	1	1714	50
744	743	37	1	1714	50
745	746	18	1	1714	50
746	747	28	1	1714	50
747	748	52	1	1714	50
748	462	14	1	1714	50
749	750	59	1	1714	60
750	751	66	1	1714	60
751	752	60	1	1714	60
752	130	77	1	1714	50
753	754	39	1	1714	55
754	755	100	1	1714	55
755	756	94	1	1714	55
756	766	108	1	1714	55
757	319	23	1	1500	35
757	320	34	1	1500	35
758	68	13	3	1714	45
758	71	27	1	1714	40
759	690	19	2	2250	65
759	691	34	3	2250	65
760	761	102	1	1714	50
762	445	79	2	1714	45
762	27	31	2	1714	55
763	445	20	1	1714	40
764	765	96	1	1714	55
765	625	87	1	1714	50
766	764	60	1	1714	55
767	23	37	1	1714	50
768	774	78	1	1714	50
769	767	76	1	1714	50
770	771	37	1	1714	50
771	772	95	1	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
772	773	77	1	1714	50
773	768	73	1	1714	50
774	776	117	1	1714	50
775	32	53	1	1714	45
775	439	30	1	1714	45
776	230	22	1	1714	40
777	555	65	1	1714	40
778	777	56	1	1714	40
779	778	20	1	1714	40
779	780	20	1	1714	40
780	781	18	1	1714	40
781	789	92	1	1714	40
782	144	20	1	1500	40
782	783	136	1	1714	50
783	118	52	1	1714	50
783	782	136	1	1714	50
784	144	21	1	1500	40
784	138	49	1	1714	40
785	786	57	1	1714	50
785	138	14	1	1714	40
786	785	57	1	1714	40
786	787	31	1	1714	50
787	786	31	1	1714	50
787	788	73	1	1714	50
788	787	73	1	1714	50
789	47	69	1	1714	40
790	520	46	1	1714	50
791	52	14	2	1714	45
792	794	22	2	1714	45
792	815	87	1	1714	45
793	653	53	2	1895	60
794	468	34	2	1714	45
795	168	5	1	1500	30
795	234	6	1	1000	15
796	143	7	1	1000	15
797	798	20	1	1895	60
798	801	37	1	1714	50
798	803	52	1	1895	60
799	797	53	1	1895	60
800	799	147	1	1895	60
801	802	40	1	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
802	4	62	1	1714	50
803	804	76	1	1895	60
804	256	29	1	1714	45
805	23	41	1	1714	40
805	806	57	1	1714	45
806	79	34	1	1714	50
807	866	15	1	1895	60
808	810	16	1	1895	60
809	808	29	1	1895	60
810	811	31	1	1895	60
811	839	52	1	1895	60
811	939	59	1	1714	55
812	813	27	1	1714	55
813	814	38	1	1714	55
814	816	45	1	1714	55
815	829	44	1	1714	45
816	817	33	1	1714	55
817	818	95	1	1714	55
818	819	43	1	1714	55
819	820	57	1	1714	55
820	821	19	1	1714	55
821	822	28	1	1714	55
822	823	33	1	1714	55
823	824	32	1	1714	55
824	825	30	1	1714	55
825	848	24	1	1714	45
825	826	44	1	1500	40
826	834	43	1	1500	40
827	828	58	1	1714	60
828	835	28	1	1714	60
829	830	50	1	1714	45
830	722	34	2	1714	50
830	723	19	2	1714	50
830	832	51	1	1714	40
831	838	29	1	1714	60
832	1037	50	2	1714	45
832	479	40	2	1714	45
833	837	19	1	1714	40
834	827	14	1	1500	40
835	831	41	1	1714	60
836	561	17	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
837	836	27	1	1714	40
838	833	32	1	1714	40
839	840	80	1	1895	60
840	841	105	1	1895	60
841	842	29	1	1895	60
842	843	32	1	1895	60
843	844	115	1	1895	60
844	845	40	1	1895	60
845	846	63	1	1895	60
846	847	60	1	1895	60
847	852	44	1	1895	60
848	850	110	1	1714	45
849	792	23	1	1714	40
850	851	22	1	1714	45
851	847	37	1	1714	40
852	853	90	1	1714	50
853	856	35	1	1714	50
854	1061	39	1	1714	40
855	540	45	2	1500	40
855	1027	43	1	1200	50
855	1062	73	2	1714	50
856	854	84	1	1714	50
856	1112	20	1	1714	50
857	468	10	1	1714	40
858	468	22	1	1714	40
858	470	27	1	1500	30
859	584	29	1	1714	40
860	583	20	1	1714	40
861	407	47	2	1714	45
862	659	91	1	1895	60
862	622	56	1	1895	60
863	861	16	1	1714	40
864	861	30	1	1714	40
865	421	25	1	1714	40
866	809	174	1	1895	60
867	868	41	1	1895	60
868	876	32	1	1895	60
869	867	39	1	1895	60
870	869	30	1	1895	60
871	870	52	1	1895	60
872	873	43	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
872	871	70	1	1895	60
873	874	46	1	1714	40
874	875	34	1	1895	60
875	807	69	1	1714	50
876	877	49	1	1895	60
877	878	25	1	1895	60
878	879	27	1	1895	60
879	880	67	1	1714	45
880	881	52	1	1714	45
881	883	55	1	1714	45
882	889	83	1	1895	60
883	888	26	1	1714	45
884	885	26	1	1714	45
885	886	27	1	1714	45
886	882	49	1	1895	60
887	884	31	1	1714	45
888	887	20	1	1714	45
889	890	29	1	1714	40
890	891	46	1	1714	40
891	892	63	1	1714	50
892	177	49	1	1714	50
893	894	134	1	1714	50
894	228	44	1	1200	25
895	902	28	1	1714	50
896	895	82	1	1714	50
897	900	19	1	1714	50
898	897	105	1	1714	50
898	899	52	1	1714	50
899	797	94	1	1714	50
900	896	40	1	1714	50
901	807	43	1	1714	50
902	901	38	1	1714	50
903	913	138	1	1714	50
903	904	21	1	1714	50
904	806	59	1	1714	50
905	903	89	1	1714	50
906	905	33	1	1714	50
907	906	53	1	1714	50
908	907	59	1	1714	50
908	909	130	1	1714	50
909	910	73	1	1500	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
910	911	91	1	1500	40
911	912	38	1	1500	40
912	808	36	1	1714	40
913	915	97	1	1714	50
914	916	73	1	1714	50
915	914	74	1	1714	50
916	918	61	1	1714	50
917	919	46	1	1714	50
918	917	51	1	1714	50
919	921	48	1	1714	50
920	406	22	1	1714	40
921	922	25	1	1714	50
922	98	47	1	1714	40
922	923	35	1	1714	50
923	925	32	1	1714	50
924	926	19	1	1714	50
925	924	50	1	1714	50
926	938	15	1	1714	50
927	928	56	1	1714	50
928	929	22	1	1714	50
929	930	20	1	1714	50
930	932	54	1	1714	50
931	390	46	2	1200	40
932	933	21	1	1714	50
933	934	32	1	1714	50
934	935	33	1	1714	50
935	936	37	1	1714	50
936	937	19	1	1714	50
937	561	17	1	1714	50
938	927	18	1	1714	50
939	812	39	1	1714	55
940	941	97	1	1895	60
940	942	74	1	1895	60
941	940	97	1	1895	60
941	90	35	1	1714	50
942	940	74	1	1895	60
942	943	37	1	1895	60
943	944	44	1	1895	60
943	942	37	1	1895	60
944	945	32	1	1895	60
945	947	26	1	1895	60

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
946	931	26	1	1714	40
947	949	28	1	1895	60
948	951	22	1	1895	60
949	950	14	1	1895	60
950	1122	13	1	1500	40
950	948	25	1	1895	60
951	952	25	1	1895	60
952	953	15	1	1714	40
953	955	18	1	1714	40
954	559	19	1	1500	40
955	954	38	1	1714	40
956	931	23	1	1714	40
957	228	39	1	1500	35
957	958	30	1	1500	30
957	226	47	1	1500	30
958	229	39	1	1200	30
959	228	24	1	1500	35
959	204	8	1	1500	35
960	962	31	1	1714	45
960	961	176	1	1714	45
961	1046	39	1	1714	40
961	1044	78	1	1714	45
961	960	176	1	1714	45
962	960	31	1	1714	45
962	963	54	1	1714	45
963	962	54	1	1714	45
963	964	52	1	1714	45
964	965	149	1	1714	45
964	963	52	1	1714	45
965	966	61	1	1714	45
965	964	149	1	1714	45
966	969	20	1	1500	40
966	965	61	1	1714	45
967	1104	13	1	1714	45
968	376	60	2	1500	45
969	973	59	1	1500	40
969	966	20	1	1500	40
969	974	19	1	1500	40
969	975	44	1	1500	40
970	429	51	2	1714	40
971	974	16	1	1500	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
971	979	31	1	1500	40
972	982	18	2	1714	40
973	969	59	1	1500	40
973	1101	70	1	1714	50
974	969	19	1	1500	40
974	971	16	1	1500	40
975	969	44	1	1500	40
975	392	52	1	1714	45
976	983	96	1	1714	40
976	977	79	1	1714	55
977	978	81	1	1714	55
977	976	79	1	1714	55
978	977	81	1	1714	55
979	980	52	1	1714	40
979	971	31	1	1500	40
980	981	38	1	1714	40
980	979	52	1	1714	40
981	980	38	1	1714	40
981	984	34	1	1714	40
982	367	39	2	1714	40
983	976	96	1	1714	40
983	984	59	1	1714	40
984	981	34	1	1714	40
984	983	59	1	1714	40
985	1044	10	1	1714	45
985	201	8	3	1714	45
985	986	93	1	1714	45
986	987	62	1	1714	45
986	985	93	1	1714	45
987	988	102	1	1714	45
987	986	62	1	1714	45
988	990	35	1	1714	45
988	987	102	1	1714	45
989	991	45	1	1714	45
990	991	61	1	1714	45
990	988	35	1	1714	45
991	990	61	1	1714	45
991	989	45	1	1714	45
992	994	166	1	1714	50
992	628	79	2	1895	60
993	1121	48	2	2250	60

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
994	556	23	1	1500	40
994	992	166	1	1714	50
995	152	82	1	1895	60
995	643	134	1	1895	60
996	661	100	1	1895	60
996	738	123	1	1895	60
997	622	7	1	1714	40
998	689	6	1	1200	30
999	686	6	2	1714	40
999	688	5	2	1200	30
1000	366	19	2	1714	40
1001	360	35	1	1714	50
1001	1002	37	1	1714	50
1002	1001	37	1	1714	50
1003	356	16	1	1714	40
1004	1003	10	1	1714	40
1005	1004	32	1	1714	40
1006	408	24	1	1714	40
1007	338	14	2	1714	45
1008	307	73	1	1714	45
1009	301	17	1	1714	40
1009	673	8	2	1714	45
1010	291	35	1	1714	40
1011	116	31	2	1895	60
1011	583	30	2	1895	60
1012	119	69	1	1714	40
1013	1011	10	1	1714	40
1014	411	27	2	1714	45
1014	1015	30	2	1714	45
1015	1014	30	2	1714	45
1015	1016	29	1	1714	45
1016	1017	24	2	1714	45
1016	1015	29	1	1714	45
1017	119	15	2	1714	45
1017	1016	24	1	1714	45
1018	120	113	1	1714	45
1018	585	20	1	1714	40
1018	1012	88	1	1714	40
1019	704	24	1	1200	45
1020	305	19	1	1714	45
1021	305	54	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1021	1022	38	1	1714	45
1022	1021	38	1	1714	45
1022	120	16	1	1714	45
1023	631	19	1	1714	40
1023	127	8	1	1714	40
1024	1025	180	2	2000	60
1024	466	52	2	2000	60
1025	135	93	2	2000	60
1025	1024	180	2	2000	60
1026	853	36	1	1714	40
1026	1058	81	1	1714	40
1028	204	35	1	1500	35
1029	1028	27	1	1500	40
1030	203	17	1	1500	40
1030	226	6	2	1500	40
1031	424	52	1	1200	30
1032	1033	18	2	1714	45
1033	425	22	2	1200	45
1034	1033	63	1	1714	45
1035	441	23	1	1714	40
1036	443	114	1	1714	50
1037	1038	23	2	1714	45
1038	1039	48	2	1714	45
1039	685	24	3	1714	45
1039	686	20	2	1714	45
1040	483	15	3	1714	45
1042	387	59	2	1895	55
1042	61	23	2	1895	55
1043	1042	12	1	1500	30
1044	985	10	3	1714	45
1044	961	78	1	1714	45
1045	1046	68	1	1714	40
1045	42	26	1	1714	40
1045	170	105	1	1714	45
1046	961	39	1	1714	45
1046	1045	68	1	1714	40
1047	1048	66	1	1714	40
1047	1049	44	1	1714	40
1047	1050	113	1	1714	40
1048	961	59	1	1714	45
1049	987	43	1	1714	45

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1050	1051	42	1	1714	40
1051	1052	56	1	1714	40
1052	964	72	1	1714	40
1053	662	45	1	1895	60
1053	661	111	1	1895	60
1054	1053	123	1	1714	40
1055	1054	149	1	1714	40
1056	594	123	1	1895	60
1056	622	77	1	1895	60
1057	1026	58	1	1714	40
1057	664	63	1	1714	40
1058	664	67	1	1895	60
1058	537	102	1	1895	60
1059	1060	90	2	1714	50
1059	539	33	2	1714	50
1060	1059	90	2	1714	50
1061	1062	66	1	1714	40
1061	855	44	1	1200	40
1062	855	73	2	1714	50
1062	539	37	2	1714	50
1063	728	21	1	1714	40
1064	403	31	2	1714	45
1065	417	27	2	1714	55
1066	1065	28	1	1714	40
1067	1066	30	1	1714	40
1068	1067	42	1	1200	40
1068	403	39	1	1200	40
1069	1070	47	1	1714	45
1070	1071	42	1	1714	45
1071	1072	25	1	1714	45
1072	1073	17	1	1714	45
1073	1074	15	1	1714	45
1074	389	13	1	1714	45
1075	714	13	1	1714	40
1076	1077	19	1	1714	40
1076	348	33	2	1200	50
1077	1078	18	1	1714	40
1077	1076	19	1	1714	40
1078	1077	18	1	1714	40
1078	405	27	1	1714	40
1079	344	20	1	1714	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1080	414	17	1	1714	40
1081	972	29	2	1714	40
1081	1082	76	2	1714	40
1082	1083	15	2	1714	40
1083	426	14	2	1714	40
1084	423	36	1	1714	40
1085	402	28	1	1714	40
1086	1087	7	1	1714	40
1086	451	44	1	1714	45
1086	449	14	1	1714	45
1087	1086	7	1	1714	40
1087	562	23	1	1714	45
1088	1089	85	1	1714	45
1089	1094	24	1	1714	45
1090	1089	23	1	1714	45
1091	1090	56	1	1714	45
1092	1091	43	1	1714	45
1093	1092	36	1	1714	45
1095	529	89	1	1714	40
1095	1096	74	1	1714	40
1096	1097	84	1	1714	40
1097	548	159	1	1714	45
1098	619	90	1	1714	40
1099	202	139	1	1714	40
1099	1100	65	1	1714	40
1100	229	50	1	1500	40
1100	206	29	1	1714	45
1100	1099	65	1	1714	40
1101	973	70	1	1714	50
1102	1103	113	2	1895	60
1102	589	126	2	1500	40
1103	1102	113	2	1895	60
1104	695	35	2	1714	40
1105	12	26	1	1895	55
1106	1105	19	1	1714	40
1106	432	28	2	1714	40
1107	415	22	1	1714	40
1108	416	27	1	1714	40
1109	999	17	3	1714	45
1109	1110	11	1	1500	30
1110	1111	11	1	1714	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1111	40	16	4	2250	65
1111	597	35	4	2250	65
1112	1113	31	2	2250	60
1113	1114	40	2	2250	60
1114	1115	102	2	2250	60
1115	1116	78	2	2250	60
1116	1117	62	2	2250	60
1117	1119	57	2	2250	60
1118	993	58	2	2250	60
1119	1118	72	2	2250	60
1120	107	8	1	1500	40
1120	1124	22	2	2250	60
1121	1120	21	2	2250	60
1121	1123	17	1	1714	50
1122	1118	11	1	1714	50
1123	105	8	2	2250	65
1123	100	67	2	2250	65
1125	158	79	1	1714	40
1126	1125	55	1	1714	40
1127	32	35	1	1714	40
1128	1127	83	1	1714	40
1129	1128	88	1	1714	40
1130	1129	85	1	1714	40

APPENDIX L

Sub-Zone Boundaries

APPENDIX L: SUB-ZONE BOUNDARIES

Sub-Zone A:

Wake County: This portion of the sub-zone includes the Harris Plant and the central portion of the Harris Lake. It is bordered by Old US 1 and New Hill-Holleman Rd. The lake forms the border to the south.

Chatham County: This portion of the sub-zone includes the Chatham County area west of the Harris Plant and is bordered by Old US 1, Christian Chapel Road, and the Chatham-Wake county line.

Sub-Zone B:

Wake County: This sub-zone includes the communities of New Hill and Bonsal and the areas around the following roads: Old US Hwy. 1, Humie-Olive Rd., New Hill-Olive Chapel Rd., Friendship Rd., US Highway 1, Shearon Harris Rd., and New Hill-Holleman Rd.

Sub-Zone C:

Wake County: This sub-zone includes the community of Holleman's Crossroads, the northeast portion of Harris Lake, and the areas surrounding Avent Ferry Rd. and New Hill Rd.

Sub-Zone D:

Wake County: This portion of the sub-zone includes the southeastern portion of Harris Lake and the area surrounding Cass Holt Rd. The sub-zone is bordered by Bartley Holleman Rd., Rex Rd., Buckhorn-Duncan Rd., and the Wake-Harnett/Wake-Chatham county lines.

Harnett County: This portion of the sub-zone includes the areas surrounding Rollins Mill Rd., Hobby Rd., and Auger Hole Rd. This portion of the sub-zone is bordered by the Harnett-Lee county line, Harnett-Wake county line and areas north of NC Hwy 42.

Sub-Zone E:

Wake County: This sub-zone includes the town of Apex, the community of Friendship, and the areas surrounding US Hwy. 1, Old US Hwy. 1, US Hwy. 64, NC Hwy. 55, Tingen Rd., and Olive Chapel Rd. The sub-zone is bordered by the Wake-Chatham county line, the community of Green Level, SR 1010, Kildaire Farm Rd., Sunset Lake Rd., and Woods Creek Rd.

Sub-Zone F:

Wake County: This sub-zone includes the town of Holly Springs, Sunset Lake and Bass Lake, and the areas surrounding NC Hwy. 55 Bypass, Holly Springs Rd., Avent Ferry Rd., Bass Lake Rd., and Cass-Holt Rd.

Sub-Zone G:

Wake County: This sub-zone includes the town of Fuquay-Varina and the areas surrounding NC Hwy. 42, NC Hwy. 55, US Hwy. 401, Piney Grove-Wilbon Rd., Bass Lake Rd., James Slaughter Rd., and Sunset Lake Rd. The sub-zone extends south to the Wake-Harnett county line and east along Kenneth Creek.

Sub-Zone H:

Harnett County: This sub-zone includes the community of Duncan, Camp Agape, Raven Rock Park, the areas surrounding Avents Creek and the following roads: NC Hwy. 42, Rawls Church Rd., Baptist Grove Rd., Christian Light Rd., Cokesbury Rd., and River Rd. This sub-zone is bordered by the Chatham-Harnett-Wake county lines, Avents Creek, Christian Light Rd., Hector Creek, Rawls Church Rd., and US Hwy 401.

Sub-Zone I:

Lee County: This sub-zone is bordered by the Cape Fear River and the Lee-Harnett county line. It includes the areas surrounding Poplar Springs Church Rd., Buckhorn Rd., and NC Hwy. 42 and where Lower Moncure Rd. intersects RH Lane Rd.

Sub-Zone J:

Lee County: This sub-zone is bordered by the Deep River and Cape Fear River, and includes areas surrounding Lower Moncure Rd., Lees Chapel Rd., Rod Sullivan Rd., Deep River Rd., Lower River Rd., Ferrell Rd., and US Hwy. 1.

Sub-Zone K:

Chatham County: This sub-zone includes the communities of Merry Oaks and Corinth, the southern portion of Harris Lake and the areas surrounding the following roads: Old US Hwy. 1, Christian Chapel Rd., Moncure-Flat Wood Rd., Corinth Rd., and NC Hwy. 42. This sub-zone is bordered by the Chatham-Wake county line (on the south side), Christian Chapel road (on the east side), the Chatham-Harnett county line, the Cape Fear River, the Haw River, and US Hwy. 1.

Sub-Zone L:

Chatham County: This sub-zone includes the eastern portion of Jordan Lake and the areas around the following roads: Olive Chapel Rd., Tody Goodwin Rd., Farrington Rd., Poole Rd. east, East Goodwin Rd. New Elam Rd., Pea Ridge Rd., W.H.Jones Rd., and Old US Hwy. 1. This sub-zone is bordered by the Chatham-Wake county line, the eastern shore of Jordan Lake, US Hwy. 1 and the Haw River.

Sub-Zone M:

Chatham County: This sub-zone includes the communities of Haywood, Moncure, Hank’s Chapel, and Griffin’s Crossroads; Jordan Lake; and the areas surrounding the following roads: North Pea Ridge Rd., Gum Springs Church Rd., Clark Poe Rd., Moncure-Pittsboro Rd., Jordan Dam Rd., Mt. View Church Rd., and Providence Church Rd. This sub-zone is bordered by US Hwy. 64, the eastern shore of Jordan Lake, the Haw River and the Deep River. Also included are all areas north and east from the point where the Rocky River enters the Deep River to US Hwy. 64 at Griffin’s Crossroads.

Sub-Zone N:

Chatham County:	This sub-zone includes the northern portion of Jordan Lake and the areas surrounding the following roads: Farrington Rd., Horton Pond Rd., and NC Hwy. 751. This sub-zone is bordered by US Hwy. 64, the Chatham-Wake county line, Green Level Rd., and Hollands Chapel Rd. Also, all areas east of the Farrington Rd. and Hollands Chapel Rd. intersection to US Hwy. 64 at Wilsonville Crossroads.

APPENDIX M

FSAR Tables

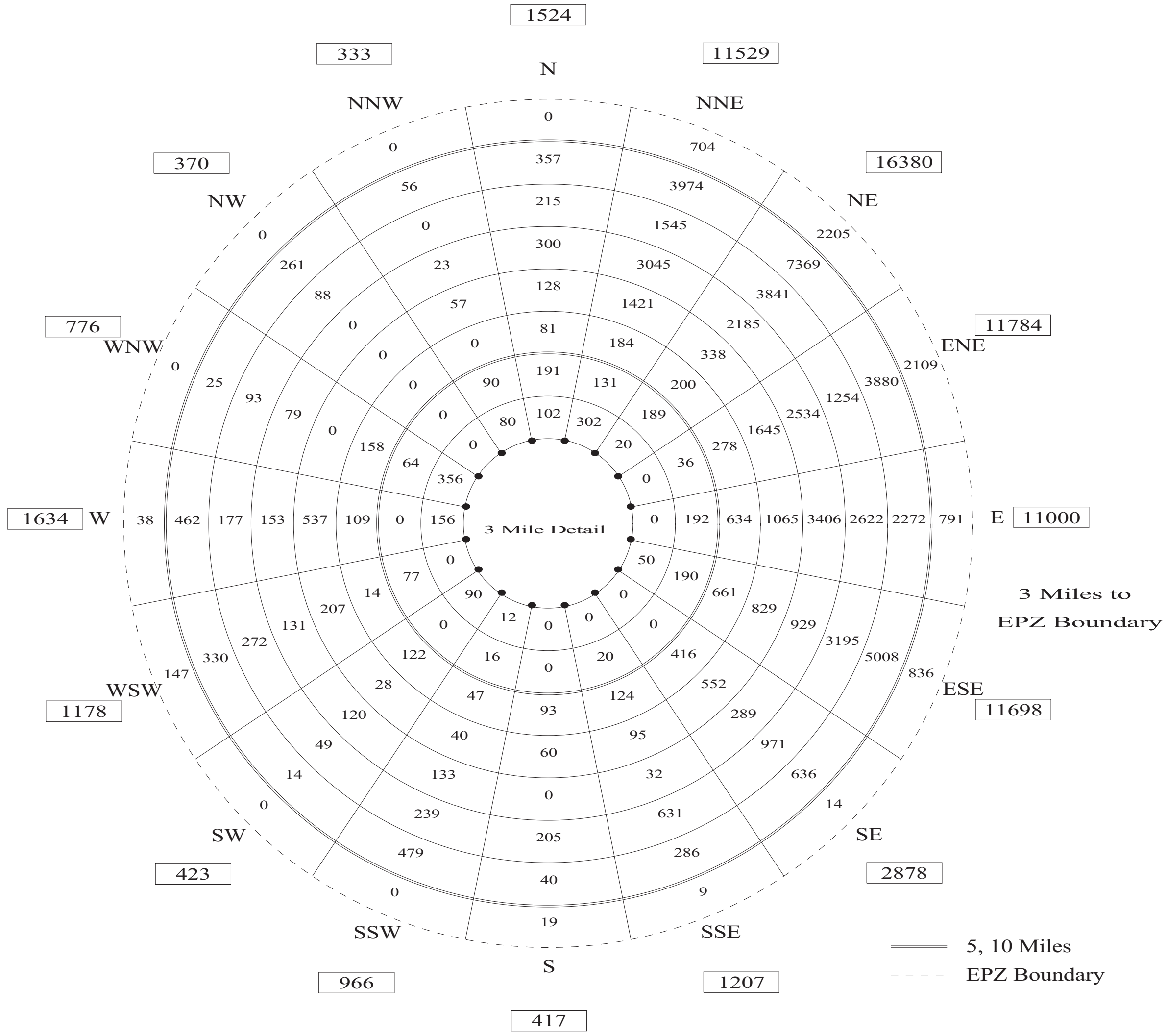
APPENDIX M: FSAR Tables

This appendix presents the tables and figures needed for the Final Safety Analysis Report (FSAR) for the Harris Nuclear Plant.

Table M-1. Population Data by Sub-Zone
Summer, Weekend, Midday, Good Weather (Scenario 3*)

Sub-Zone	Permanent Residents	Transients	Employees	Special Facility	Total
A	180	305	219	44	704
B	1,397	0	0	0	1,397
C	416	0	0	0	416
D	319	458	0	0	777
E	32,879	454	963	239	34,296
F	13,534	0	125	49	13,659
G	15,497	18	281	260	15,796
H	3,444	0	0	0	3,444
I	947	0	4	0	951
J	1,348	0	0	94	1,348
K	763	458	213	0	1,434
L	874	5,625	68	0	6,567
M	1,778	4,351	0	0	6,129
N	721	3,162	0	0	3,883
TOTAL	**74,097**	**14,831**	**1,873**	**686**	**90,801**

* This is based on the "Harris Nuclear Plant, Development of Evacuation Time Estimates, February, 2009". Table 6-4 of the report indicates that the largest number of vehicles evacuating occurs in Scenario 3. The total resident population (Table 3-1), total transient population (Table 3-3), and total non-EPZ employees (Table 3-4) were multiplied by the percentages in Table 6-3 to generate the appropriate columns in Table M-1. The special facility column was generated from data provided in Table 8-4.



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	87	0-2	87
2-3	446	0-3	533
3-4	1168	0-4	1701
4-5	1196	0-5	2897
5-6	3121	0-6	6018
6-7	7002	0-7	13020
7-8	13359	0-8	26379
8-9	15397	0-9	41776
9-10	25449	0-10	67225
10-EPZ	6872	0-EPZ	74097

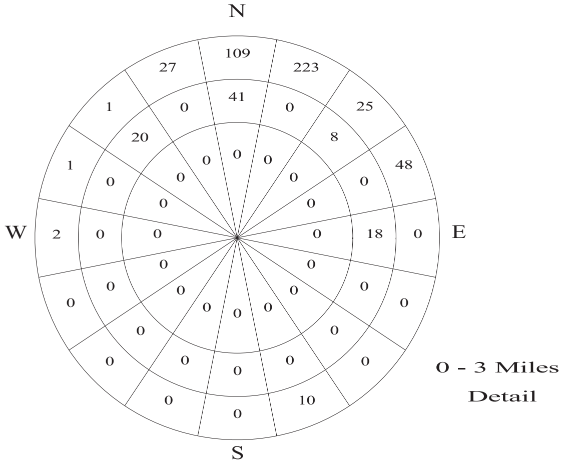
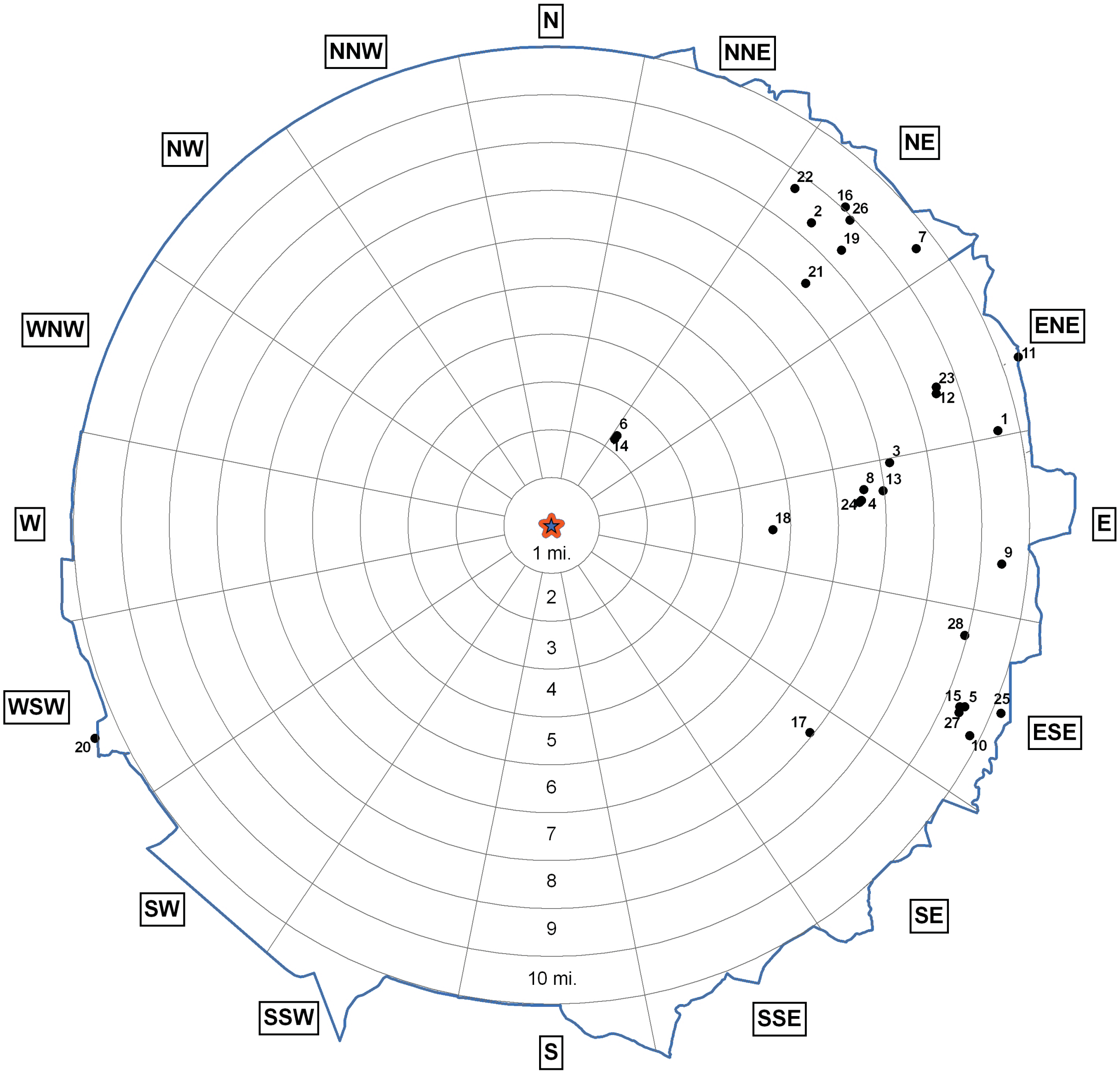


Figure M-1. Permanent Residents by Sector

Figure M-2. Hospital and Family Care Facilities Located in the HNP 10-Mile EPZ



Number	FACILITY	Number	FACILITY
1	Adams Care Home	15	Kinton Sunset Ret. Community
2	Atwater Rest Home	16	Mason Street Group Home
3	Autumn Green Adult Care Home	17	Mims Family Care Home
4	Avent Ferry Home	18	Murchison Adult Family Living
5	Brighton Manor	19	Rex Rehab & Nursing Ctr
6	Brown's Family Care Home	20	Sanford Health & Rehab
7	Buck Jones Rd Home	21	Seagroves Family Home
8	Country Lane Group Home	22	Spring Arbor of Apex
9	Evans-Watson Home	23	St. Mark's Manor
10	Fuquay Varina Home-Elderly	24	Trotter's Bluff
11	Harrison Home	25	VOCA Creekway
12	Herbert Reid Home	26	VOCA Olive Home
13	Hickory Street Group Home	27	WakeMed Center
14	James' Rest Home	28	Windsor Point

Table M-2. HNP Plume Exposure EPZ Evacuation Time Estimates

Time to Clear the Indicated Area of 100 Percent of The Affected Population

	Summer		Summer		Summer		Winter			Winter		Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend		Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	Scenario:	(12)
Region Wind Toward:	Midday		Midday		Evening	Region Wind Toward:	Midday			Midday		Evening	Region Wind Toward:	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather		Good Weather	Rain	Ice	Good Weather	Rain	Good Weather		New Plant Construction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 2-mile ring	4:00	4:00	3:00	3:00	3:00	R01 2-mile ring	4:00	4:00	4:00	3:00	3:00	3:00	R01 2-mile ring	4:00
R02 5-mile ring	4:05	4:05	3:10	3:20	3:05	R02 5-mile ring	4:05	4:05	4:05	3:10	3:10	3:05	R02 5-mile ring	4:10
R03 Entire EPZ	4:10	4:10	4:05	4:05	4:05	R03 Entire EPZ	4:10	4:10	4:10	4:05	4:05	4:00	R03 Entire EPZ	4:15
2-Mile Ring and Downwind to 5 Miles														
R04 N, NW, NNW	4:05	4:05	3:05	3:20	3:05	R04 N, NW, NNW	4:05	4:05	4:05	3:05	3:05	3:05	R04 N, NW, NNW	4:05
R05 NNE	4:00	4:05	3:00	3:00	3:00	R05 NNE	4:00	4:05	4:05	3:00	3:00	3:00	R05 NNE	4:00
R06 NE, ENE	4:00	4:05	3:00	3:00	3:00	R06 NE, ENE	4:00	4:05	4:05	3:00	3:00	3:00	R06 NE, ENE	4:00
R07 E	4:00	4:05	3:00	3:05	3:00	R07 E	4:00	4:05	4:05	3:00	3:05	3:00	R07 E	4:00
R08 ESE	4:00	4:00	3:00	3:05	3:00	R08 ESE	4:00	4:00	4:00	3:00	3:05	3:00	R08 ESE	4:00
R09 SE	4:00	4:00	3:00	3:05	3:00	R09 SE	4:00	4:05	4:05	3:00	3:05	3:00	R09 SE	4:00
R10 SSE, S	4:00	4:00	3:05	3:05	3:00	R10 SSE, S	4:00	4:05	4:05	3:05	3:05	3:00	R10 SSE, S	4:00
R11 SSW, SW	4:00	4:00	3:05	3:05	3:00	R11 SSW, SW	4:00	4:00	4:00	3:05	3:05	3:00	R11 SSW, SW	4:00
R12 WSW, W, WNW	4:00	4:05	3:10	3:20	3:05	R12 WSW, W, WNW	4:05	4:05	4:05	3:10	3:10	3:05	R12 WSW, W, WNW	4:05
5-Mile Ring and Downwind to EPZ Boundary														
R13 N, NNE	4:05	4:05	4:00	4:00	4:00	R13 N, NNE	4:05	4:05	4:10	4:00	4:00	4:00	R13 N, NNE	4:10
R14 NE	4:05	4:05	4:00	4:00	4:00	R14 NE	4:05	4:05	4:10	4:00	4:00	4:00	R14 NE	4:10
R15 ENE, E	4:05	4:05	4:05	4:05	4:05	R15 ENE, E	4:05	4:05	4:10	4:00	4:00	4:00	R15 ENE, E	4:10
R16 ESE	4:10	4:10	4:05	4:05	4:05	R16 ESE	4:10	4:10	4:10	4:05	4:05	4:00	R16 ESE	4:10
R17 SE	4:10	4:10	4:05	4:05	4:00	R17 SE	4:10	4:10	4:10	4:00	4:00	4:00	R17 SE	4:10
R18 SSE	4:10	4:10	4:05	4:05	4:00	R18 SSE	4:10	4:10	4:10	4:00	4:00	4:00	R18 SSE	4:10
R19 S	4:10	4:10	3:50	3:50	3:50	R19 S	4:10	4:10	4:10	3:50	3:50	3:50	R19 S	4:10
R20 SSW	4:10	4:10	3:50	3:50	3:50	R20 SSW	4:10	4:10	4:10	3:50	3:50	3:50	R20 SSW	4:10
R21 SW	4:05	4:05	3:05	3:20	3:05	R21 SW	4:05	4:05	4:10	3:10	3:10	3:05	R21 SW	4:10
R22 WSW	4:05	4:10	3:10	3:25	3:05	R22 WSW	4:05	4:05	4:10	3:10	3:10	3:05	R22 WSW	4:10
R23 W, WNW	4:05	4:10	3:10	3:25	3:05	R23 W, WNW	4:05	4:05	4:10	3:10	3:10	3:05	R23 W, WNW	4:10
R24 NW	4:05	4:10	3:50	3:50	3:05	R24 NW	4:05	4:05	4:10	3:50	3:50	3:05	R24 NW	4:10
R25 NNW	4:05	4:10	4:00	4:00	4:00	R25 NNW	4:05	4:05	4:10	4:00	4:00	4:00	R25 NNW	4:10

Table M-3. Schools Located in the HNP EPZ

Harris EPZ: Schools (As of March 2007)			
School	**Sub -zone**	**Direction**	**Distance (miles)**
CHATHAM COUNTY			
Moncure Elementary School	M	W	6.9
WAKE COUNTY			
Apex High School	E	NE	8.8
Apex Middle School	E	NE	10.1
Baucom Elementary School	E	NE	9.1
Hope Montessori	E	NE	10.3
Lufkin Rd Middle School	E	NE	9.3
Olive Chapel Elementary School	E	NE	7.8
Salem Elementary School	E	NE	10.3
Salem Middle School	E	NE	10.3
St. Mary Magdalene Catholic School	E	NE	7.7
Apex Elementary School	E	NE	8.3
Community Partners Charter High School	F	E	7.0
Holly Grove Elementary School	F	E	6.0
Holly Ridge Elementary School	F	E	8.0
Holly Ridge Middle School	F	E	8.0
Holly Springs Elementary School	F	E	7.4
Holly Springs High School	F	E	6.0
Southern Wake Montessori School	F	E	7.2
The New School Montessori Center	F	E	9.6
Fuquay-Varina High School	G	E	9.2
Fuquay-Varina Middle School	G	SE	9.7
Lincoln Heights Elementary School	G	SE	8.8

Table M-4. Transients by Sub-Zone for the HNP EPZ

Sub-Zone	Transients	Transient Vehicles
A	305	100
B	**No Transients**	
C		
D	458	300
E	454	227
F	**No Transients**	
G	18	9
H	**No Transients**	
I		
J		
K	458	300
L	5,625	2,213
M	4,351	1,864
N	3,162	1,240
TOTAL	**14,831**	**6,253**

Table M-5. Non-EPZ Employees by Sub-Zone for the HNP EPZ

Sub-Zone	Total Non-EPZ Employees	Employee Vehicles
A	467	432
B	**No employment**	
C		
D		
E	2,048	1,896
F	267	247
G	597	554
H	**No employment**	
I	8	7
J	**No employment**	
K	453	419
L	144	133
M	**No employment**	
N		
TOTAL	**3,984**	**3,688**

The population was estimated for the Harris Nuclear Plant (HNP) 50-mile ingestion pathway using Geographical Information Systems (GIS) software. The software was used to construct a population rose by drawing the 16 major wind directions (N, NNE, NE…) emanating from the HNP site coupled with concentric rings drawn every mile out to 10 miles, and every 5 miles from 10 to 50 miles. The population rose was then overlaid with the US Census "blockpop" layer file for the year 2000. The "blockpop" layer file indicates the number of people living in a census block. The software was then used to identify the number of people living in each sector of the rose by county for the year 2000 using the census layer file. Population growth rates from April, 2000 to July, 2005 were obtained from the US Census website for each county. These growth rates were used to extrapolate the 2000 population to projection years of 2010, 2020, and 2027. Tables M-6 through M-9 present the population estimates for the HNP 50-mile ingestion pathway for the years 2000, 2010, 2020, and 2027, respectively. Table M-10 compares the cumulative populations for each of the projection years. Finally, Table M-11 compares the projected population density within 30 miles of HNP between 2000 and 2027.

Table M-6. Fifty-Mile Ingestion Pathway Population for HNP EPZ – Year 2000

Year 2000 Population - Harris Nuclear Plant																	
	Direction																
Distance (mi.)	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**RING TOTAL**
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1-2	33	0	6	0	14	0	0	0	0	0	0	0	0	0	16	0	**69**
2-3	87	177	20	38	0	0	0	8	0	0	0	0	2	1	1	22	**356**
3-4	81	240	16	0	0	40	0	0	0	10	73	0	126	288	0	65	**939**
4-5	152	104	150	29	153	151	0	17	0	13	0	62	0	52	0	73	**956**
5-6	65	146	159	221	504	526	342	105	76	38	99	11	88	128	0	0	**2,508**
6-7	103	1,130	269	1,308	847	659	461	80	51	32	23	168	435	0	0	46	**5,612**
7-8	242	2,422	1,738	2,015	2,709	739	236	27	0	113	102	111	124	64	0	19	**10,661**
8-9	173	1,229	3,055	997	2,085	2,541	816	532	173	203	42	231	143	75	71	0	**12,366**
9-10	289	3,161	5,856	3,086	1,807	3,983	521	241	34	407	12	281	387	20	211	45	**20,341**
10-15	1,358	24,991	53,046	21,767	9,155	8,002	4,356	1,603	1,177	3,049	2,423	2,416	799	3,220	2,681	2,785	**142,828**
15-20	24,111	2,078	51,290	54,000	16,788	6,760	8,250	5,773	3,545	4,568	23,416	4,696	1,286	2,001	2,300	33,367	**244,229**
20-25	84,346	21,742	108,508	67,665	12,233	9,077	7,615	2,866	4,129	6,821	5,902	1,709	2,194	1,497	2,728	37,633	**376,665**
25-30	73,773	21,722	54,383	33,268	19,283	5,969	19,371	4,264	12,824	6,619	4,583	1,033	3,908	8,306	4,596	7,547	**281,449**
30-35	22,616	4,357	21,325	15,721	11,465	11,618	8,827	3,127	50,461	3,267	8,030	2,227	2,486	4,591	9,618	13,876	**193,612**
35-40	6,024	14,163	15,362	14,762	12,806	10,263	5,366	7,812	99,126	261	12,549	5,371	4,638	8,768	29,438	17,008	**263,717**
40-45	6,789	6,128	11,056	11,120	8,706	6,514	4,777	8,955	96,490	6,503	27,541	3,830	9,350	8,038	59,854	5,544	**281,195**
45-50	7,008	5,502	9,014	8,837	8,131	6,950	4,454	8,262	32,111	13,731	6,598	5,586	35,670	21,131	18,300	4,455	**195,740**
TOTAL	**227,250**	**109,292**	**335,253**	**234,834**	**106,686**	**73,792**	**65,392**	**43,672**	**300,197**	**45,635**	**91,393**	**27,732**	**61,636**	**58,180**	**129,814**	**122,485**	**2,033,243**

Table M-7. Fifty-Mile Ingestion Pathway Population for HNP EPZ – Year 2010 (Projected)

Year 2010 Projected Population - Harris Nuclear Plant																	
Distance (mi.)	**Direction**																**RING TOTAL**
	N	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1-2	45	0	8	0	19	0	0	0	0	0	0	0	0	0	22	0	**94**
2-3	119	242	27	52	0	0	0	11	0	0	0	0	3	1	1	30	**486**
3-4	111	328	22	0	0	55	0	0	0	13	97	0	168	385	0	87	**1,266**
4-5	208	142	205	40	209	207	0	22	0	17	0	83	0	69	0	97	**1,299**
5-6	88	200	217	302	689	719	447	133	101	51	132	15	118	171	0	0	**3,383**
6-7	139	1,545	368	1,789	1,158	901	592	101	65	43	31	224	581	0	0	61	**7,598**
7-8	324	3,312	2,377	2,756	3,705	1,011	312	34	0	141	128	139	166	85	0	25	**14,515**
8-9	234	1,681	4,178	1,364	2,851	3,475	1,037	673	218	254	53	289	191	100	95	0	**16,693**
9-10	387	4,323	8,009	4,220	2,471	5,447	686	305	43	509	15	352	495	27	282	60	**27,631**
10-15	1,822	34,178	72,547	29,769	12,521	10,874	5,510	2,027	1,489	3,826	3,032	3,032	1,064	4,299	3,580	3,719	**193,289**
15-20	27,958	2,642	70,145	73,851	22,963	9,108	10,434	7,301	4,484	5,738	29,303	5,906	1,717	2,672	3,070	36,647	**313,939**
20-25	96,895	27,034	148,398	92,540	16,837	12,527	9,640	3,625	5,222	8,607	7,386	2,178	2,930	1,999	3,136	39,425	**478,379**
25-30	85,466	26,109	74,375	45,498	26,654	8,254	24,949	4,870	15,402	8,339	5,452	1,293	5,218	11,059	5,179	7,906	**356,023**
30-35	25,928	5,477	29,123	21,508	15,854	16,066	11,039	3,195	50,942	3,860	9,452	2,687	3,188	5,878	10,974	14,621	**229,792**
35-40	6,703	17,042	20,137	20,170	17,709	14,192	6,460	8,026	100,070	307	14,772	6,314	5,177	9,838	33,587	18,786	**299,290**
40-45	7,449	7,371	14,218	13,884	11,917	8,962	5,308	9,214	98,447	9,216	32,425	4,508	10,438	8,932	68,212	6,171	**316,672**
45-50	7,622	6,528	11,320	10,368	9,936	8,118	4,859	8,635	34,173	19,459	7,817	6,005	39,802	23,453	20,514	4,753	**223,362**
TOTAL	**261,498**	**138,154**	**455,674**	**318,111**	**145,493**	**99,916**	**81,273**	**48,172**	**310,656**	**60,380**	**110,095**	**33,025**	**71,256**	**68,968**	**148,652**	**132,388**	**2,483,711**

Table M-8. Fifty-Mile Ingestion Pathway Population for HNP EPZ – Year 2020 (Projected)

Year 2020 Projected Population - Harris Nuclear Plant																	
Distance (mi.)	Direction																RING TOTAL
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1-2	57	0	10	0	24	0	0	0	0	0	0	0	0	0	28	0	**119**
2-3	151	307	35	66	0	0	0	14	0	0	0	0	3	2	2	37	**617**
3-4	141	416	28	0	0	69	0	0	0	17	122	0	210	481	0	109	**1,593**
4-5	264	180	260	50	265	262	0	26	0	22	0	104	0	87	0	122	**1,642**
5-6	111	253	276	383	875	913	552	161	126	63	165	18	147	214	0	0	**4,257**
6-7	175	1,961	467	2,270	1,470	1,144	723	122	78	53	38	279	727	0	0	77	**9,584**
7-8	407	4,203	3,016	3,497	4,701	1,282	388	41	0	170	153	167	207	107	0	32	**18,371**
8-9	294	2,133	5,301	1,730	3,618	4,409	1,258	814	264	305	63	347	239	125	119	0	**21,019**
9-10	485	5,485	10,162	5,355	3,136	6,911	852	369	52	612	18	422	603	33	352	75	**34,922**
10-15	2,285	43,365	92,047	37,771	15,886	13,747	6,664	2,452	1,800	4,602	3,641	3,647	1,329	5,379	4,479	4,652	**243,746**
15-20	31,807	3,207	89,000	93,703	29,138	11,455	12,619	8,830	5,422	6,909	35,191	7,117	2,148	3,343	3,840	39,927	**383,656**
20-25	109,443	32,327	188,287	117,415	21,441	15,978	11,667	4,384	6,315	10,393	8,870	2,647	3,665	2,501	3,542	41,217	**580,092**
25-30	97,158	30,496	94,367	57,728	34,026	10,540	30,527	5,476	17,980	10,060	6,322	1,553	6,528	13,812	5,761	8,266	**430,600**
30-35	29,240	6,596	36,921	27,295	20,244	20,514	13,252	3,263	51,422	4,452	10,875	3,145	3,890	7,164	12,329	15,368	**265,970**
35-40	7,381	19,920	24,913	25,577	22,612	18,122	7,555	8,241	101,014	353	16,995	7,258	5,716	10,907	37,736	20,564	**334,864**
40-45	8,110	8,612	17,382	16,649	15,129	11,412	5,840	9,474	100,404	11,928	37,307	5,184	11,526	9,825	76,572	6,796	**352,150**
45-50	8,234	7,553	13,627	11,899	11,740	9,286	5,263	9,007	36,234	25,187	9,035	6,424	43,936	25,776	22,728	5,050	**250,979**
TOTAL	**295,743**	**167,014**	**576,099**	**401,388**	**184,305**	**126,044**	**97,160**	**52,674**	**321,111**	**75,126**	**128,795**	**38,312**	**80,874**	**79,756**	**167,488**	**142,292**	**2,934,181**

Table M-9. Fifty-Mile Ingestion Pathway Population for HNP EPZ – Year 2027 (Projected)

Year 2027 Projected Population - Harris Nuclear Plant																	
Distance (mi.)	**Direction**																**RING TOTAL**
	N	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1-2	66	0	12	0	28	0	0	0	0	0	0	0	0	0	32	0	**138**
2-3	173	353	40	76	0	0	0	16	0	0	0	0	4	2	2	44	**710**
3-4	161	478	32	0	0	80	0	0	0	19	139	0	240	549	0	124	**1,822**
4-5	303	207	299	58	305	301	0	29	0	25	0	118	0	99	0	139	**1,883**
5-6	128	291	317	440	1,004	1,048	626	180	143	72	189	21	168	244	0	0	**4,871**
6-7	201	2,252	536	2,606	1,688	1,313	814	137	87	61	44	317	829	0	0	88	**10,973**
7-8	465	4,826	3,463	4,015	5,398	1,473	441	46	0	190	171	186	236	122	0	36	**21,068**
8-9	336	2,449	6,087	1,987	4,155	5,063	1,413	912	296	341	71	388	272	143	135	0	**24,048**
9-10	554	6,299	11,668	6,149	3,601	7,936	967	413	58	683	20	472	679	38	402	86	**40,025**
10-15	2,609	49,796	105,698	43,372	18,242	15,758	7,472	2,749	2,018	5,145	4,068	4,077	1,515	6,135	5,108	5,306	**279,068**
15-20	34,500	3,602	102,199	107,599	33,461	13,099	14,148	9,900	6,079	7,728	39,312	7,964	2,450	3,812	4,379	42,222	**432,454**
20-25	118,227	36,031	216,210	134,827	24,664	18,393	13,085	4,915	7,081	11,643	9,909	2,975	4,180	2,852	3,828	42,472	**651,292**
25-30	105,343	33,568	108,362	66,289	39,186	12,139	34,432	5,900	19,784	11,264	6,930	1,735	7,445	15,739	6,170	8,517	**482,803**
30-35	31,559	7,381	42,379	31,346	23,317	23,628	14,801	3,311	51,759	4,868	11,871	3,466	4,381	8,064	13,278	15,889	**291,298**
35-40	7,857	21,936	28,256	29,362	26,044	20,872	8,320	8,391	101,675	386	18,551	7,918	6,093	11,657	40,641	21,809	**359,768**
40-45	8,572	9,482	19,595	18,585	17,377	13,125	6,212	9,656	101,775	13,827	40,725	5,658	12,288	10,451	82,422	7,235	**376,985**
45-50	8,663	8,271	15,241	12,970	13,004	10,104	5,546	9,268	37,678	29,196	9,888	6,717	46,829	27,402	24,278	5,259	**270,314**
TOTAL	**319,717**	**187,222**	**660,394**	**459,681**	**211,474**	**144,332**	**108,277**	**55,823**	**328,433**	**85,448**	**141,888**	**42,012**	**87,609**	**87,309**	**180,675**	**149,226**	**3,249,520**

Table M-10. Cumulative Population Estimates and Projections between Zero and Fifty Miles of HNP

Year	Miles from Site										
	0-1	0-2	0-3	0-4	0-5	0-10	0-EPZ	0-20	0-30	0-40	0-50
2000	0	69	425	1,364	2,320	53,808	59,285	440,865	1,098,979	1,556,308	2,033,243
2010	0	94	580	1,846	3,145	72,965	80,433	580,193	1,414,595	1,943,677	2,483,711
2020	0	119	736	2,329	3,971	92,124	101,585	719,526	1,730,218	2,331,052	2,934,181
2027	0	138	848	2,670	4,553	105,538	116,395	817,060	1,951,155	2,602,221	3,249,520

Table M-11. Estimated and Projected Population Density within Fifty Miles of HNP (People per Square Mile)

Year	Miles from Site										
	0-1	0-2	0-3	0-4	0-5	0-10	0-EPZ	0-20	0-30	0-40	0-50
2000	0	5.49	15.03	27.14	29.54	171.28	186.69	350.83	388.68	309.62	258.88
2010	0	7.48	20.51	36.73	40.04	232.25	253.28	461.70	500.31	386.68	316.24
2020	0	9.47	26.03	46.33	50.56	293.24	319.89	572.58	611.94	463.75	373.59
2027	0	10.98	29.99	53.12	57.97	335.94	366.53	650.20	690.08	517.70	413.74

Table M-12. Emergency Planning Zone Population*

Sub-Zone	Permanent Residents	Peak Transients	Peak Employees	Total
A	180	305	467	952
B	1,397	0	0	1,397
C	416	0	0	416
D	319	458	0	777
E	32,879	454	2,048	35,381
F	13,534	0	267	13,801
G	15,497	18	597	16,112
H	3,444	0	0	3,444
I	947	0	8	955
J	1,348	0	0	1,348
K	763	458	453	1,674
L	874	5,625	144	6,643
M	1,778	4,351	0	6,129
N	721	3,162	0	3,883
TOTAL	**74,097**	**14,831**	**3,984**	**92,912**

*Based on study by KLD Associates, Inc. (February, 2009)

Table M-13. Emergency Planning Zone Permanent Resident Population by County

County	Year			
	2000	**2010**	**2020**	**2027**
Chatham	3,427	4,577	5,722	6,531
Harnett	2,978	3,768	4,555	5,105
Lee	1,949	2,439	2,930	3,272
Wake	50,931	69,649	88,378	101,487
Total	**59,285**	**80,433**	**101,585**	**116,395**

APPENDIX N

ETE for Construction and Build-Out Scenarios

APPENDIX N: ETE FOR CONSTRUCTION AND BUILD-OUT SCENARIOS

This appendix presents evacuation time estimates (ETE) for the suggested roadway configurations and employee estimates detailed in the Harris Advanced Reactor Traffic Impact Analysis and Conceptual Design for Impacted Roads (TIA) report, June 2008. The ETE for these cases are compared with the base case – a summer, midweek, midday scenario with construction workers on site (Scenario 12 from the main body of this report) to quantify the impact on ETE of the roadway improvements suggested in the TIA report.

As discussed on page 3-2 of the ETE report, the ETE analysis considers a “special event” scenario (Scenario 12) which represents a typical summer, mid-week, midday with construction workers on-site at the time of the emergency at the existing site. The construction activity was not yet determined at the time the ETE study was conducted, so it was conservatively assumed that a single shift of 3,500 construction workers would be on site. Furthermore, the ETE study assumed an average vehicle occupancy of 1.08 workers per vehicle (limited carpooling). On this basis, it was estimated that 3,241 vehicles used by workers would evacuate the construction site. The peak construction period indicated by Progress Energy was 2015 to 2017; the ETE analysis uses 2016 as the peak construction year. There are 697 employees at the existing unit during peak times, 64% of whom are non-EPZ residents. Using the vehicle occupancy of 1.08 workers per vehicle, based on the telephone survey, an estimated 413 vehicles would be used by plant employees to evacuate.

The TIA report assumes that 70% of the construction workforce (reported as 3,150 workers) will be present during the peak shift. The report also assumes an average vehicle occupancy of 1.80 workers per vehicle (extensive carpooling). Therefore, there are 1,240 vehicles used by workers evacuating the construction site in the TIA report, including some 15 vehicles from vendors. Table 4.1 of the TIA report indicates that 200 employee vehicles arrive at the plant during the peak hour.

The following cases are considered:

1. Base case (ETE) – No roadway changes, ETE report employee and construction worker estimates, 2016 population estimates.
2. Base case (TIA) – No roadway changes, TIA report employee and construction worker estimates, 2015 population estimates.
3. Plan A – The existing intersection on New Hill Holleman Road at US 1 is upgraded to better accommodate the increased traffic volumes, TIA report employee and construction worker estimates, 2015 population estimates.

4. Plan B – A new interchange is constructed, TIA report employee and construction estimates, 2015 population estimates. Five “Options” are proposed in the TIA, with varying intersection design and geometry; each option was simulated.
5. Build-out case – Post construction employee estimates, 2019 population estimates, all traffic is routed to a new interchange (the existing main driveway on Shearon Harris Road is no longer used).

The ETE report predated the TIA report and different traffic demand estimates were applied. It was decided to analyze the ETE impact of the candidate configurations defined in the TIA report using those demand estimates presented in the TIA, rather than the demand estimates of the ETE report.

Base Case (ETE)

The trips servicing existing employees (413 vehicles) are generated onto the main driveway and continue onto New Hill Holleman Road. The construction worker trips (3,241 vehicles) are generated onto the existing access road, north of the main driveway, which was used during construction of the existing facility. These vehicles travel both north and south on Shearon Harris Road to access either New Hill Holleman Road or Old US 1.

Base Case (TIA)

The trips servicing existing employees (200 vehicles) are generated onto the main driveway and continue onto New Hill Holleman Road. The construction worker trips (1,240 vehicles) are generated onto the existing access road, north of the main driveway, which was used during construction of the existing facility. These vehicles travel both north and south on Shearon Harris Road to access either New Hill Holleman Road or Old US 1.

Plan A – Improve Existing Intersection on US 1

To simulate this scenario, the analysis network (see Figure 1-2 of the ETE report) was modified to include the roadway improvements detailed in the TIA report. The proposed improvements relevant to evacuating traffic are:

- **New Hill Holleman Road at US 1.** Widen the overpass from two lanes to four lanes, providing left-turn lanes in both directions to access the on-ramps to US 1, and install a traffic signal at the intersection with southbound US 1 ramps. Construct an exclusive northbound right-turn lane on New Hill Holleman Road that extends to Friendship Road.
- **Shearon Harris Road at Construction Driveway.** Construct an exclusive eastbound right-turn lane on the Construction Driveway with 150 feet of storage.

- **Shearon Harris Road at Proposed Service Road.** It is planned that the service road will be functional by the time construction starts on the new units. There will be separate left and right-turn lanes on the service road at Shearon Harris Road.

The existing employee trips (200 vehicles) are generated onto the main driveway and continue onto New Hill Holleman Road. The construction worker trips (1,240 vehicles) are loaded on both the existing construction access road and the new service road.

<u>Plan B – Build a New Interchange with US 1</u>

Five different alternatives are under consideration for the interchange placement and design. The following roadway improvements are recommended in the TIA report for all alternatives:

- **Shearon Harris Road at Construction Driveway.** Construct an exclusive eastbound right-turn lane on the Construction Driveway with 150 feet of storage.

- **Shearon Harris Road at Proposed Service Road.** It is planned that the service road will be functional by the time construction starts on the new units. There will be separate left and right-turn lanes on the service road at Shearon Harris Road.

For the proposed interchange on US 1, five options are under consideration; Option 1 is considered the most promising. Briefly, the Options are as follows:

- **Option 1**. Convert the existing Shearon Harris Road overpass to a diamond interchange.

- **Option 2**. Convert the existing Shearon Harris Road overpass to a modified partial cloverleaf interchange.

- **Option 3**. Build a new trumpet interchange approximately 4,000 feet southwest of the Shearon Harris Road overpass.

- **Option 4**. Build a new trumpet interchange approximately 1,000 feet northeast of the railroad overpass.

- **Option 5**. Build a new diamond interchange approximately 1,000 feet northeast of the railroad overpass.

As was done for Plan A, the existing employee trips (200 vehicles) are generated onto the main driveway and continue onto New Hill Holleman Road. The construction worker trips (1,240 vehicles) are generated onto both the existing construction access road and the new service road.

Build-out case – Build a New Interchange with US 1

Once the new reactors are on-line, the existing main driveway on Shearon Harris Road will likely be closed and all traffic will use the service road. The aforementioned Option 1 interchange was modeled with population estimates projected out to 2019 and an estimated 405 employee vehicles.

Results

The ETE results based on the TIA demand estimates and suggested roadway improvements were developed for the three regions (Regions R01 – 2-mile ring, R02 – 5-mile ring and R03 – Entire EPZ) for a typical summer mid-week, mid-day with good weather. These ETE are shown in Table N-1 and compared with the ETE obtained for Scenario 12 in the ETE report. There is little difference (nothing greater than 5 minutes) in ETE among the alternatives for all evacuation regions; however, there are differences when compared with the Base Case (ETE), reflecting the differences in estimated demand discussed earlier. As discussed in the main body of this report, the ETE are determined by, and are closely related to resident mobilization time.

Comparison of the base cases for an evacuation of the entire EPZ (Region R03) based on the demand estimates presented in the ETE and the TIA reports indicates that the ETE are the same for the 50th percentile; however, the ETE are longer by 10 minutes for the 90th and 95th percentiles and by 5 minutes for the 100th percentile for the ETE base case. The ETE for the 2-mile ring (Region R01) differ by 35, 60 and 55 minutes for the 50th, 90th and 95th percentiles, respectively. The ETE are longer for the more conservative vehicle demand estimated in the ETE report, as shown by comparison of the second and third columns of Table N-1. This is most pronounced for Region R01 as there are approximately three times as many vehicles evacuating in the ETE base case using the same roadways as the TIA base case. In addition, the ETE base case assumes 2016 as the peak construction year versus 2015 for the TIA base case; thus, the number of evacuating vehicles is greater as the vehicle estimates have been extrapolated an additional year.

The ETE for Region R01 for the 50th, 90th and 100th percentiles is unchanged (relative to the TIA base case) for each of the 6 proposed roadway improvements, as evidenced by comparison of columns 4 through 9 of Table N-1 with column 3. The ETE for the 95th percentile do show some 5-minute variations for Region R01. The ETE for all percentiles for Regions R02 and R03 are unaffected by the proposed roadway improvements. Therefore, from an ETE standpoint, none of the proposed improvements has a significant impact.

The final column of Table N-1 provides the ETE for the Year 2019 ("build-out") when construction at the HNP site will be complete and all units are operational. All vehicles (except external traffic) have been extrapolated to 2019 using the same methodology presented on pages 3-2 and 3-3 of the main body of this report. It is assumed that the main driveway along Shearon Harris Rd will be closed at that time in favor of a service road running parallel to US Route 1 which will service traffic accessing the HNP site. As the results indicate, the ETE for the 100th percentile are identical to those for the ETE base case for all regions. The ETE for all regions at all percentiles for the "build-out" case are longer than the TIA base case, which is explained by increased demand due to population growth between 2015 and 2019. The ETE for Regions R01 and R02 for the "build-out" case are shorter than the ETE base case at the 50th, 90th and 95th percentiles, despite the increased demand from 2016 to 2019. The heavy construction demand (3,241 vehicles) over-saturates the roadways servicing the HNP site for the ETE base case, thereby prolonging congestion at the HNP site and extending the ETE for the lesser percentiles for Regions R01 and R02. The animation of the evacuation indicates that the HNP site is the last congested area to clear for Regions R01 and R02; therefore, the ETE for these regions is dictated by the evacuation of the HNP site. The ETE for the Entire EPZ (Region R03), however, are longer for the "build-out" case than for the ETE base case for the 50th, 90th and 95th percentiles. The increased demand in the "build-out" case resulting from population growth from 2016 to 2019 outweighs the increased construction demand at the HNP site in the ETE base case for the Entire EPZ, resulting in longer ETE at lesser percentiles.

Figures N-1 through N-9 are plots of evacuated vehicles versus elapsed time after the evacuation recommendation. Figure N-1 indicates more vehicles evacuating than Figures N- 2 through N-8, and the points representing the ETE for the 50th, 90th and 95th percentiles of population are shifted towards longer times. As discussed above, these differences are a reflection of the differences in evacuating vehicle demand. Figures N-2 through N-8, all of which depict evacuation scenarios for 2015 are essentially identical. Figure N-9, for conditions in 2019, is similar to Figure N-1.

The results indicate that the ETE is unaffected by any of the roadway improvements suggested in the TIA report. The only significant changes in ETE observed in Table N-1 are a result of the differences in estimated demand between the ETE report and the TIA report.

Table N-1: ETE for Traffic Mitigation Measures Under Consideration[1]

Region Evacuated	BASE CASE (ETE)	BASE CASE (TIA)	PLAN A Construction Volumes, No New Interchange	PLAN B Construction Volumes, New Interchange Option 1	PLAN B Construction Volumes, New Interchange Option 2	PLAN B Construction Volumes, New Interchange Option 3	PLAN B Construction Volumes, New Interchange Option 4	PLAN B Construction Volumes, New Interchange Option 5	Build-Out Volumes, New Interchange Option 1
Time to Clear the Indicated Area of 100 Percent of The Affected Population									
R01 2-mile ring	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00
R02 5-mile ring	4:10	4:05	4:05	4:05	4:05	4:05	4:05	4:05	4:10
R03 Entire EPZ	4:15	4:10	4:10	4:10	4:10	4:10	4:10	4:10	4:15
Time to Clear the Indicated Area of 95 Percent of The Affected Population									
R01 2-mile ring	2:45	1:50	1:50	1:55	1:55	1:55	1:55	1:55	2:30
R02 5-mile ring	2:50	2:20	2:20	2:20	2:20	2:20	2:20	2:20	2:30
R03 Entire EPZ	3:25	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:35
Time to Clear the Indicated Area of 90 Percent of The Affected Population									
R01 2-mile ring	2:30	1:30	1:30	1:30	1:30	1:30	1:30	1:30	2:00
R02 5-mile ring	2:30	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:10
R03 Entire EPZ	3:10	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:15
Time to Clear the Indicated Area of 50 Percent of The Affected Population									
R01 2-mile ring	1:20	0:45	0:45	0:45	0:45	0:45	0:45	0:45	0:50
R02 5-mile ring	1:15	1:05	1:00	1:00	1:00	1:00	1:00	1:00	1:05
R03 Entire EPZ	1:35	1:35	1:35	1:35	1:35	1:35	1:35	1:35	1:40

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[1] The ETE presented are for an evacuation during a typical summer, mid-week, mid-day, good weather scenario during construction (Scenario 12 from the main body of this report).

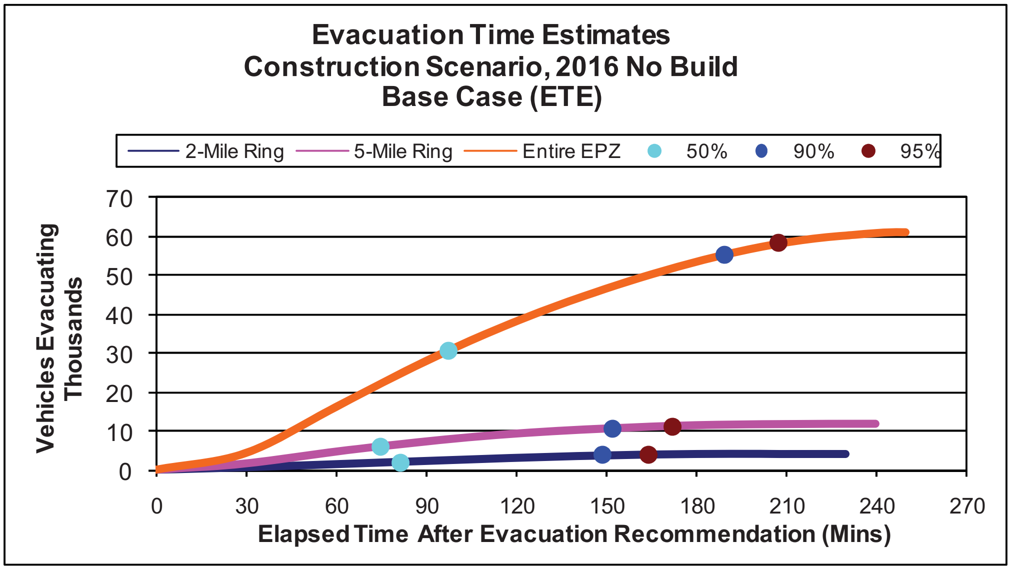


Figure N-1: ETE Plot for Construction Scenario, 2016, Base Case (ETE)

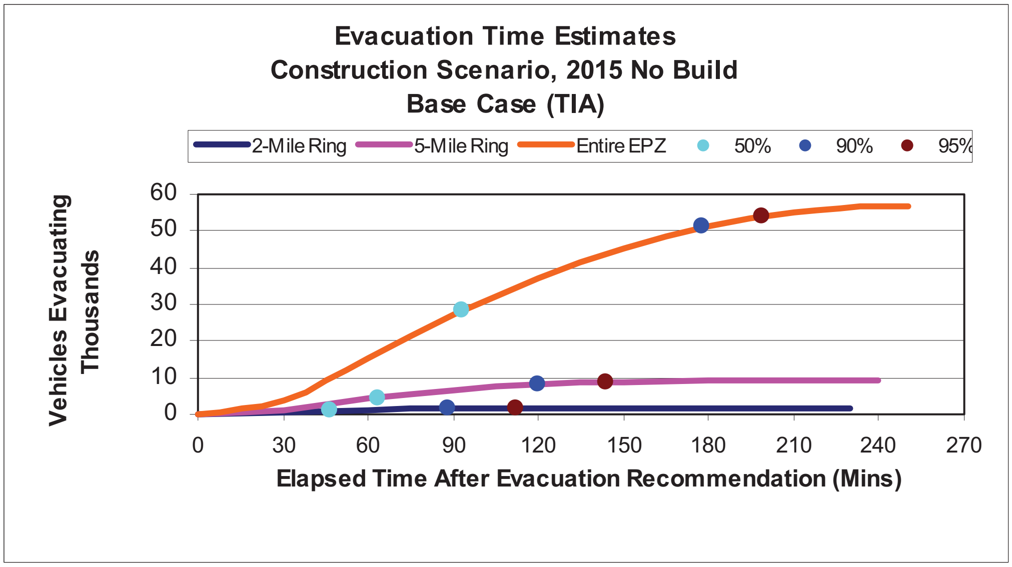


Figure N-2: ETE Plot for Construction Scenario, 2015, Base Case (TIA)

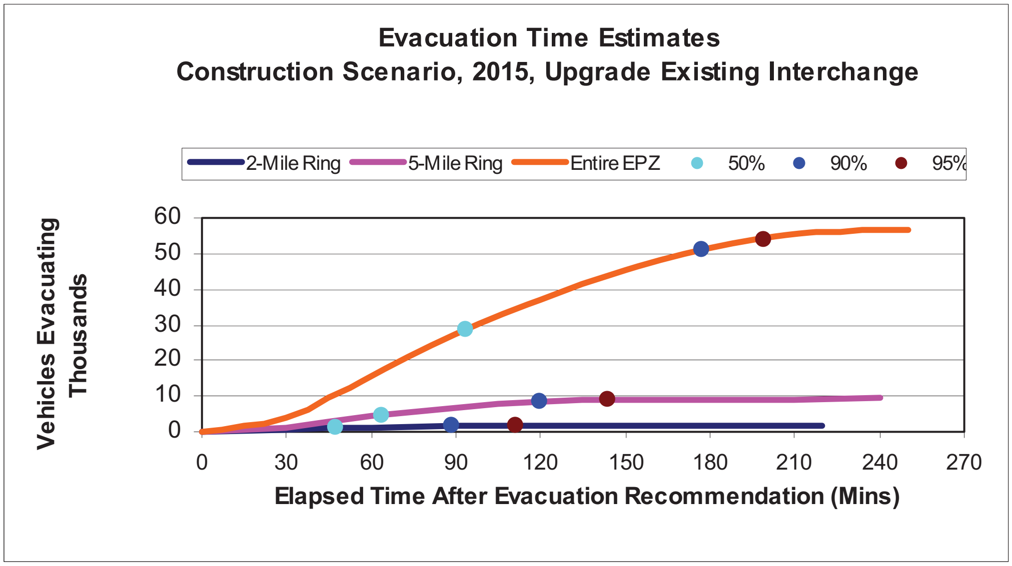


Figure N-3: ETE Plot for Construction Scenario, 2015, Plan A

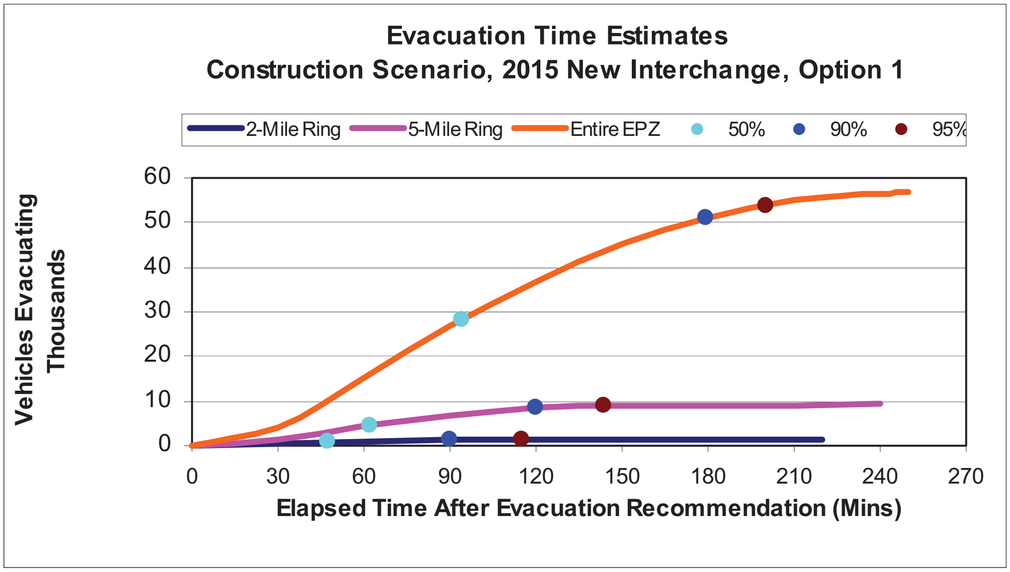


Figure N-4: ETE Plot for Construction Scenario, 2015, Plan B, Option 1

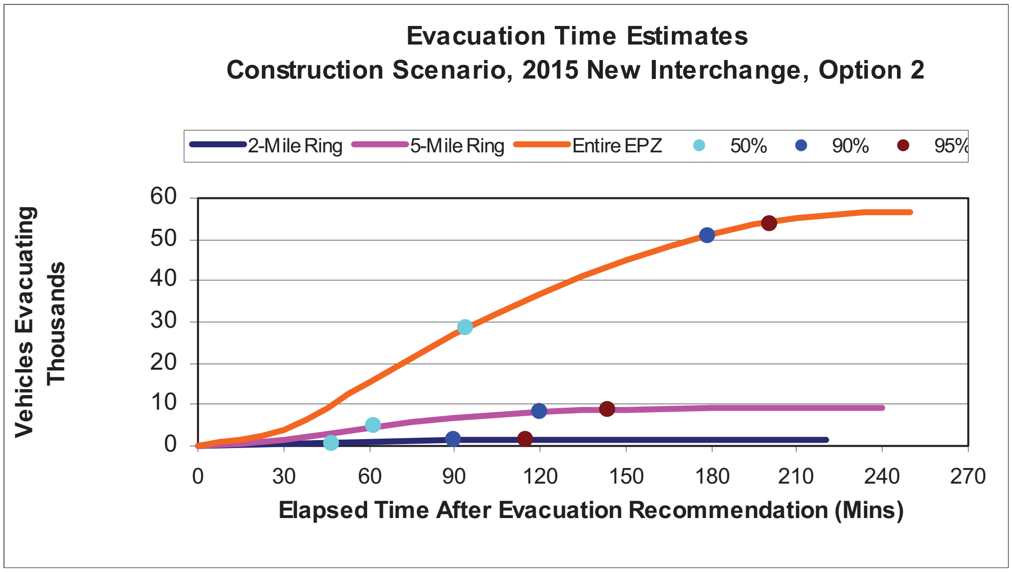


Figure N-5: ETE Plot for Construction Scenario, 2015, Plan B, Option 2

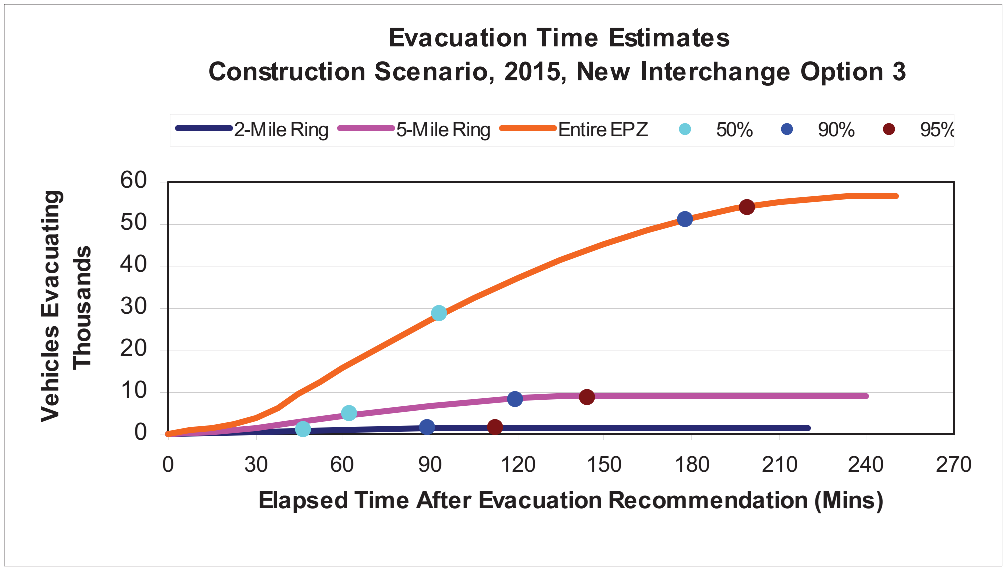


Figure N-6: ETE Plot for Construction Scenario, 2015, Plan B, Option 3

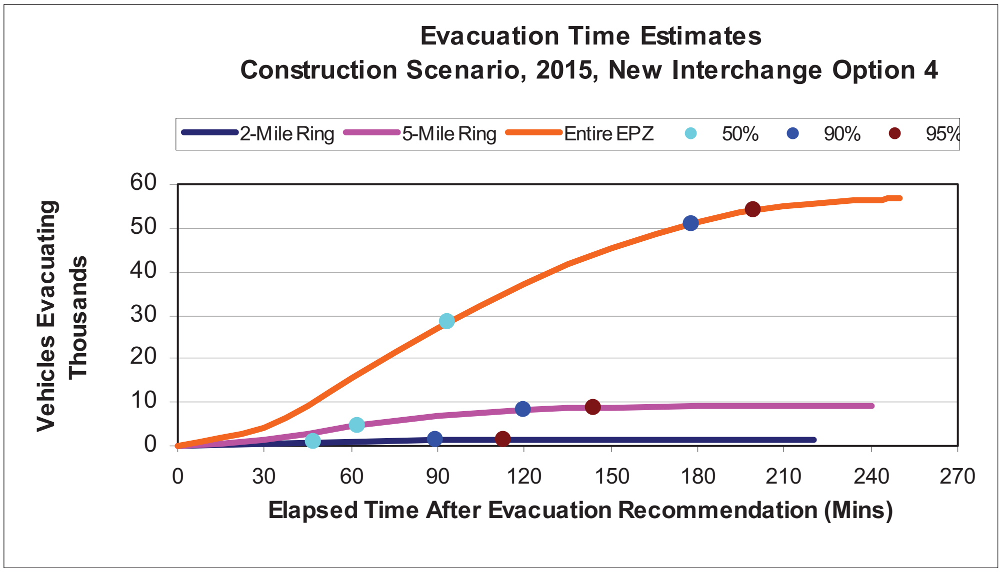


Figure N-7: ETE Plot for Construction Scenario, 2015, Plan B, Option 4

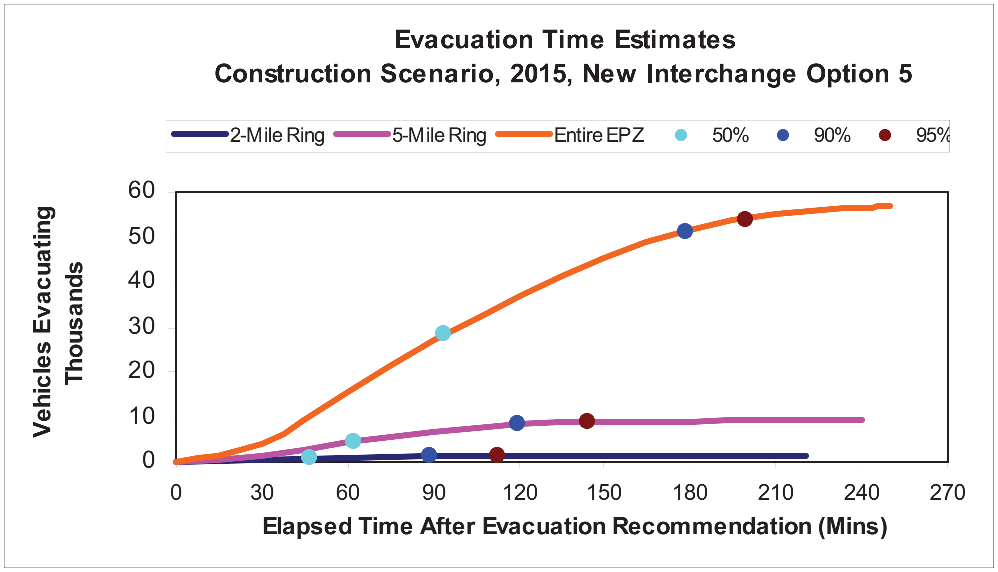


Figure N-8: ETE Plot for Construction Scenario, 2015, Plan B, Option 5

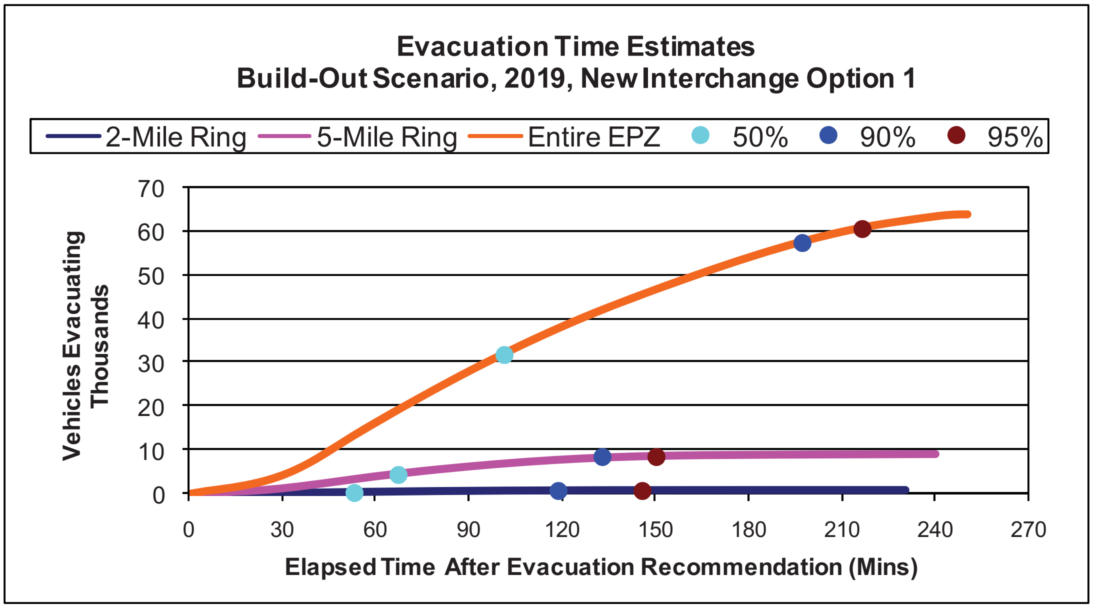


Figure N-9: ETE Plot for Build-Out Scenario, 2019, Option 1

APPENDIX O

Procedure for Estimating Mobilization Time Based upon Survey Data

APPENDIX O: PROCEDURE FOR ESTIMATING MOBILIZATION TIME BASED UPON SURVEY DATA

The mobilization time data is obtained from a telephone survey, often with N = 500 to 1000 samples. The cumulative distribution or cumulative histogram can be plotted from the survey results.

Experience shows that the best fit pattern to the data is often a cumulative exponential distribution, shifted by T_0 minutes. For instance, refer to Figure 1, which shows a hypothetical case in which:

> The population begins to leave only after t = T_0 = 20 minutes, and then follows the exponential distribution, and almost all are gone by T_0 + T_1 = 320 minutes.

Because this single-regime model is the most common in practice, this procedure addresses this case first. It also lays the basis for the additional cases.

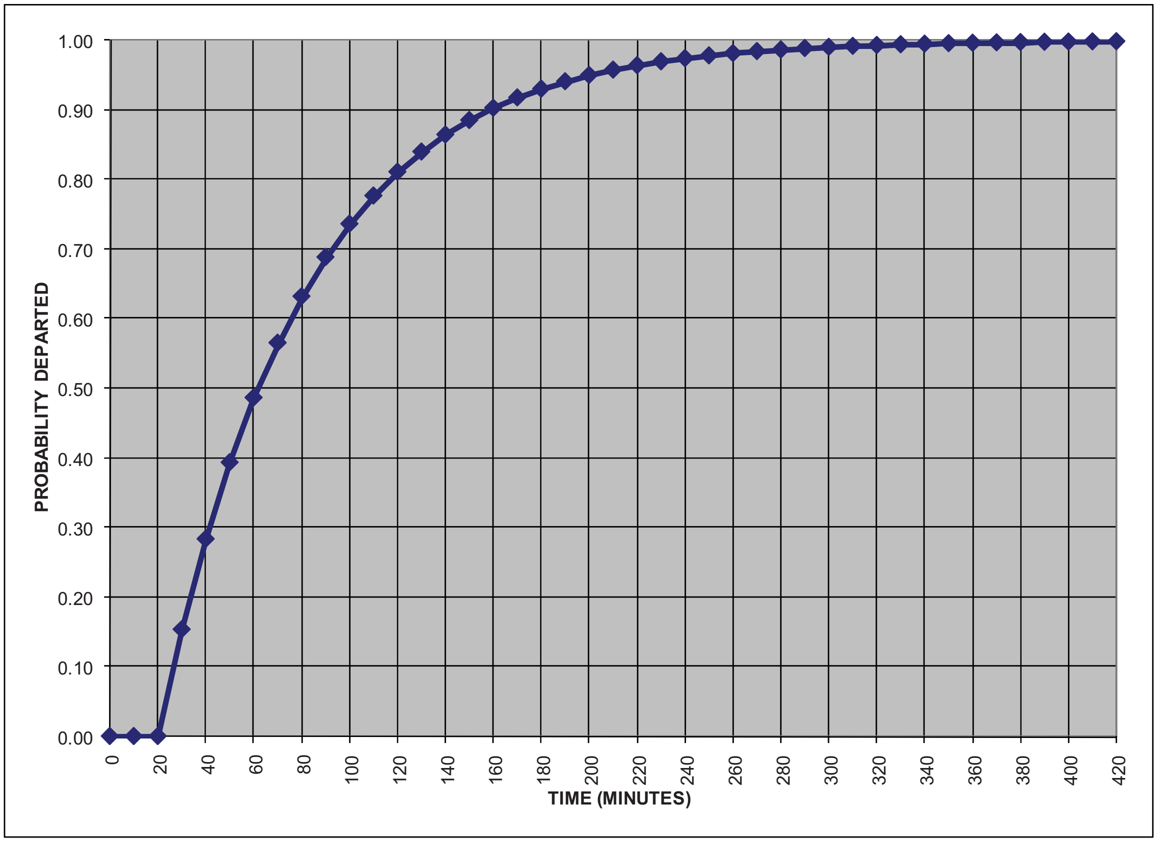


Figure 1: Common Representation of Underlying Behavior

The form of the relation shown in Figure 1 is

$$\left.\begin{array}{ll} P_R(\text{departure time} \le t) = F(t) = \{1 - e^{-(t-T_0)/\tau}\} & \text{for } t \ge T_0 \\ \\ = 0 & \text{for } t < T_0 \end{array}\right\} \qquad (1)$$

where P_R indicates the cumulative probability of a departure, “t” is any given time and “τ” is a constant referred to as the “time constant”.

The relation can also be read as “the percentage of vehicles departed by time ‘t’”.

The relation can also be expressed as shown in Figure 2, namely as the probability density function of a departure at time “t”. In this form, the relation is

$$f(t) = (1 / \square)\, e^{-(t-T_0)/\tau} \quad \text{for } t \ge T_0 \qquad , = 0 \text{ else} \qquad (2)$$

This can be read as “the relative probability of departing <u>at</u> time ‘t’”. The probability of departing in the interval {t, t + Δt} is approximately $p(t) \simeq f(t)\,\Delta t$.

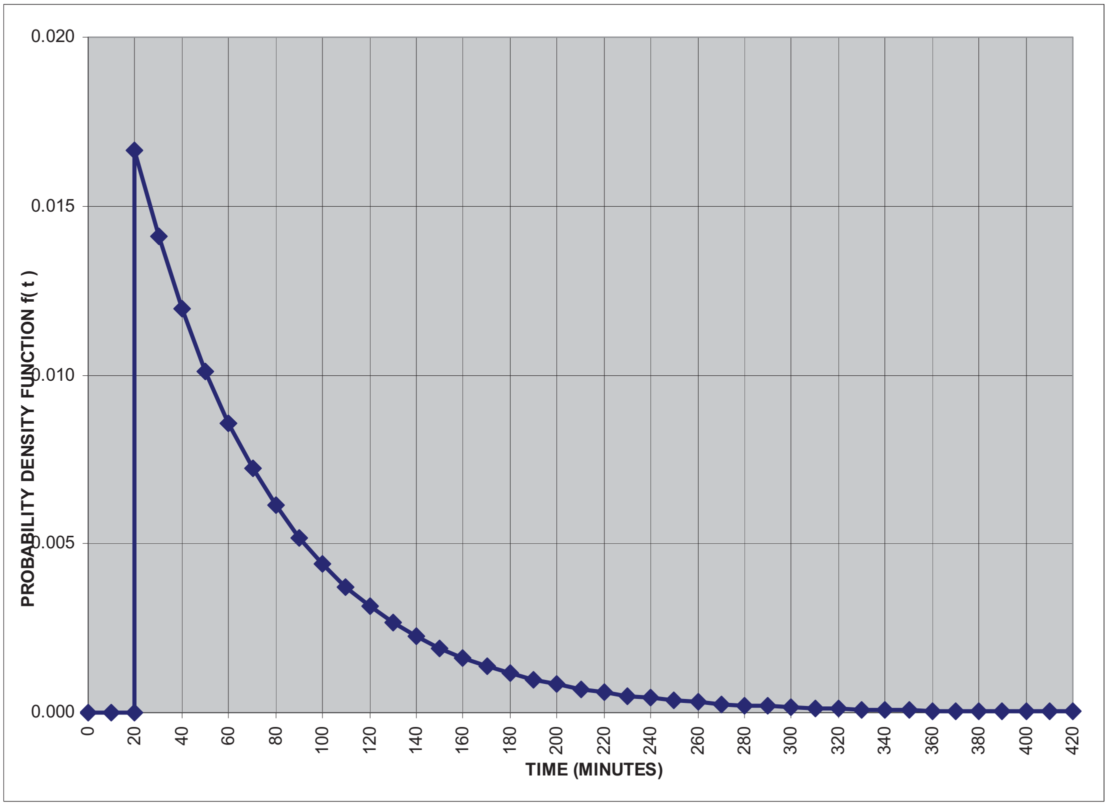


Figure 2: The probability density function f(t) Related to Figure 1

Estimating T_0

The problem of estimating these curves from data is divided into two estimations: (1) estimate the time T_0 and (2) estimate the parameter τ. There are various methods for doing this. Based upon the sample sizes and the number of sampling intervals used in the survey, it has proven effective to

- Select a value of T_0
- Estimate τ based upon methods described in this document
- Iterate as needed

In practice, the choice of T_0 has been clear from the plot of the survey results.

For the remainder of this document, given an initial choice of T_0, you are to shift all the data (or data categories) by subtracting $T_{0.}$ The net effect of this is to create a version of Figure 2 with the curve starting at t = 0 rather than t = T_0.

Time Constant and Settling Time

In linear systems, it is common to say that the exponential curve has essentially settled to zero when either four or five time constants have passed. In fact,

$e^{-(4t/\tau)} = e^{-4} = 0.018$ or 1.8% of the original signal strength

$e^{-(5t/\tau)} = e^{-5} = 0.007$ or 0.7% of the original signal strength

Focus on the purpose of the analysis, which is to estimate “τ”. The (shifted) Figure 2 curve is idealized. When inspecting data and conceptually sketching a curve through the cumulative plot of the data, it is quite feasible to identify the “4τ” level of 98.2% of the data to the left (i.e. 1.8% remaining) whereas identifying the “5τ” level with 99.3% of the data generally proves elusive due to the presence of outliers in the data. Therefore, while recognizing that the curve truly settles in 5τ, this procedure calibrates τ based upon the 98.2% level.

> **Therefore, as a key element of this procedure is to identify “τ”, you will seek to establish the point at which the 1.8% threshold is passed in plots such as Figure 2, or the 98.2% threshold is passed in plots such as Figure 1 (shifted, in both cases).**
>
> **The identification may be done by reference to the cumulative data plot (usually aggregated by category, from the survey) or by reference to a smooth exponential curve through that data.**
>
> **Given that you are working with the curve up to the 4τ time, it can be truncated (brought to 100%) at any point thereafter.**

For clarity:

Time constant is the constant "τ" shown in Equations 1 and 2. If the exponential relation is written in the form e^{-At}, then $\tau = 1 / A$.

Settling time is generally taken as five time constants. If the exponential relation is written in the form e^{-At}, then the settling time to the 1.8% level is 4 / A.

In either Figures 1 or 2, it is easy to estimate by inspection that the settling time to the 4τ level is about 260 seconds from the graph, including the T_0 component. Therefore, the "time constant" is $\tau = (260\text{-}20)/4 = 60$ and $A = 1/60$. A later section in this document will give guidance by which to estimate "τ", for more difficult cases.

Note that the exponential curve never reaches zero, but approaches zero asymptotically. The concept behind using this curve is that "essentially everyone" has departed by five time constants. In the ETE application, this defines the 100th percentile.

Other percentiles (50th, 90th, 95th) can be found on the basis of entering Figure 1 on the vertical at the desired percentile and reading the corresponding time "t". The same can be achieved by solving Equation 1 for "t", given the percentile set on the left hand side of Equation 1.

From basic probability theory, it is known that the mean of the exponential distribution equals "1 / A" or "τ" (that is, one time constant). Let us formalize the procedure as:

Method 1 is estimating the settling time to the 4τ level by inspection as described above, and arriving at the estimated time constant "τ".

Method 2 for estimating the time constant is making it equal to the:

{ (estimated mean mobilization time) - T_0 },

computed from the observations (i.e. samples) obtained. It may be necessary to do this by using the centers of the categories, given the method of data collection and recording.

With the analytic form of the curve thus determined, the curve can be plotted on the same display as the data, and any major anomalies can be identified.

A "major anomaly" would be a cumulative analytic curve that has the data systematically lying to one side or the other of the analytic curve, which is drawn in the form of Equation 1. This would imply that the shifted exponential form is not a satisfactory representation of the data.

As an example, consider the hypothetical data shown in Table 1, along with the computation of the estimated mean and estimated variance contained therein.

Table 1: Estimation of {(Mean Mobilization Time) – T_0}

	minutes CATEGORIES			FROM CATEGORY OBSERVATIONS	
Cat #	FROM	TO	Observed	EST MEAN	EST STD
1	0	30	228	3420	51300
2	30	60	149	6705	301725
3	60	90	88	6600	495000
4	90	120	47	4935	518175
5	120	150	42	5670	765450
6	150	180	12	1980	326700
7	180	210	8	1560	304200
8	210	240	5	1125	253125
9	240	270	6	1530	390150
10	270	END	5	1425	406125
			590	34950	3811950

590	observations	6472	est variance
59.2	deduced mean	80.4	est std
		6.5	for conf bound on mean

With 95% confidence, mean is estimated		
to be between	52.7	minutes
and	65.7	minutes

The estimated time constant is therefore 59.2 minutes, given the particular sample used for this computation.

Note that the 95% confidence bound range on this estimate of the mean is from 52.7 to 65.7 minutes. A hypothesis that the mean is any value in this range would not be rejected[1].

Because the data tends to be aggregated into groups due to the survey (stated ranges are checked by the interviewer, rather than interviewee estimate of minutes, it is not necessarily true that Method 1 is markedly better than Method 2. Rather, the two results should be compared for "reasonableness".

Should there be a clear anomaly, one can expect the underlying hypothesis to be rejected in the next section.

---

[1] Indeed, for this illustration within this procedure, the true mean of the distribution that generated the "data" was 60 minutes. Normally, of course, this would not be known and the above estimate would be the best available.

A Goodness-of-Fit Test for the Hypothesized Curve

The hypothesis to be tested is that the underlying probability density function (pdf) is as described in Equation 2, with the constant “τ” or “A” determined by Methods 1 or 2 or an alternative method (described herein). **In practice, one is to use Method 1 as the preferred method.** *Should an analyst recommend another choice, it is to be discussed with the senior analyst and the quality control (QC) Officer.*

The statistical test to be used is chi-square goodness-of-fit test. A level of significance of $\alpha = 0.05$ will be used.

The procedure calls for the data to be divided into at least 5 categories, generally such that the shape of the curve to be calibrated is retained. More than 5 categories are preferred. The category widths need not be equal.

A number of standard statistical packages (e.g. SPSS, StatGraphics, MiniTab) contain the chi-square goodness of fit test. It can also be done on a spreadsheet.

Refer to Table 2, which shows the results of a hypothetical set of survey data. The KLD spreadsheet accompanying this procedure was used. Note that:

1) There are at least five categories and at least 5 samples per category;
2) The last category is open-ended;
3) The categories are selected such that the “expected” bars do not obscure the fact that they represent the exponential distribution;
4) While the “observed” differs from the “expected”, it is within the range of natural variability for the number of samples and categories, so that the conclusion *in this illustration* is “**do not reject the hypothesis**”.

With that decision reached, one then proceeds to use the exponential distribution as descriptive of the phenomenon being modeled (e.g. the mobilization times) for the purpose of identifying where the sample distribution may be truncated.

Table 2: Chi-Square Test on the Mobilization Distribution Above T_0

CHI-SQUARE TEST ON EXPONENTIAL DISTRIBUTION OF MOBILIZATION TIMES

time constant = **60** minutes LEVEL OF SIGNIFICANCE = **0.05**

	CATEGORIES		PROB WITH
Cat #	FROM	TO	EXP DIST
1	0	**30**	0.393
2	30	**60**	0.239
3	60	**90**	0.145
4	90	**120**	0.088
5	120	**150**	0.053
6	150	**180**	0.032
7	180	**210**	0.020
8	210	**240**	0.012
9	240	**270**	0.007
10	270	END	0.011

	Expected	Observed	CHI-SQ	
1	232	**228**	0.074	
2	141	**149**	0.477	
3	85	**88**	0.079	
4	52	**47**	0.445	
5	31	**42**	3.564	
6	19	**12**	2.613	
7	12	**8**	1.095	
8	7	**5**	0.576	
9	4	**6**	0.719	
10	7	**5**	0.369	
		590	**10.011**	COMPUTED

Decision Point = **16.919**
with α above and df = {#categories - 1}

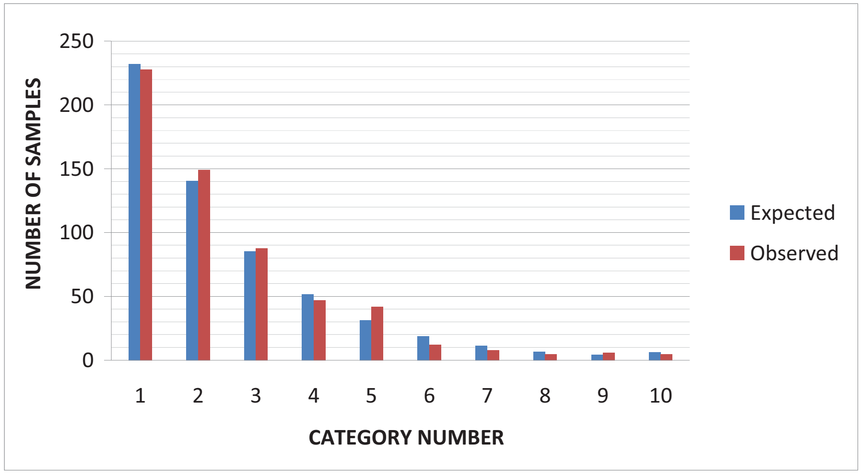
HYPOTHESIS: UNDERLYING DISTRIBUTION IS EXPONENTIAL, WITH PARAMETERS SHOWN

CONCLUSION

DO NOT REJECT HYPOTHESIS

implication: use the exponential relation

Notes	
1	# categories ≥ 5, # samples per category ≥ 5
2	categories need not be equal span (range)
3	expected distribution should follow hypothesized curve, namely exponential (do not aggregate too much, particularly where curve changes quickly)
4	this spreadsheet starts with 10 categories, with the first nine each 1/2 of a time constant wide. The user can modify the red bold category ends, and can change the number of categories



Another Graphical Display, Involving the Natural Logarithm

It is interesting that if one takes the natural logarithm of both sides of Equation 2, the result is a linear relation, namely

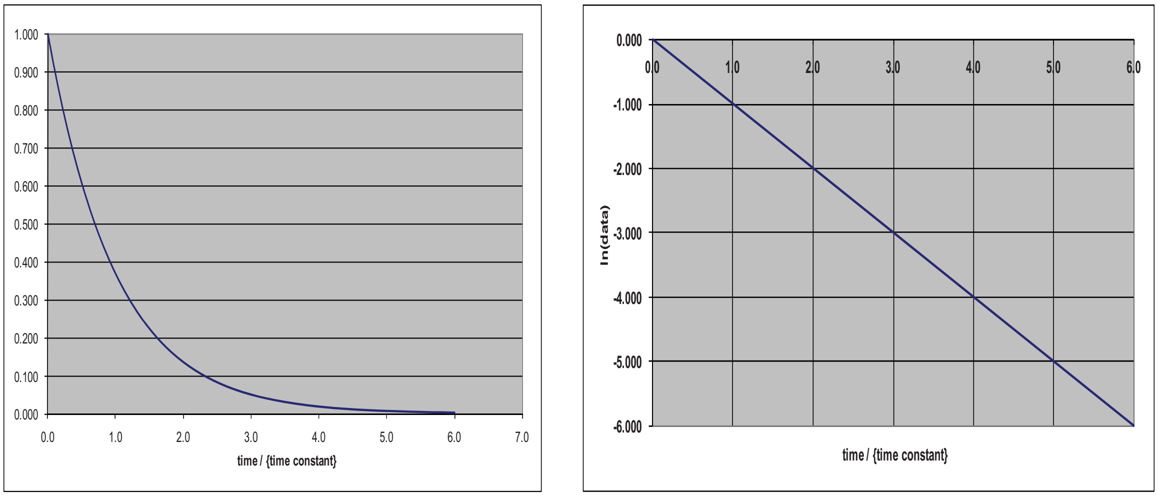
$$\ell n\{ f(t) \} = - \{ t / \tau \} + \ell n \{ 1 / \tau \}$$

or (3)

$$\ell n\{ f(t) \} = a + b\, t$$

where “b” is actually “ – A” or “ -1 / τ ”

Refer to Figure 3 for an illustration of how Equation 2 and 3 would plot, normalized to (t/τ), which is the same as saying plotting for $\tau = 1$ just for illustration[2].



a) f(t) versus t/τ

b) $\ell n\{ f(t) \}$versus t/τ

Figure 3: Plot of Exponential Function

Figure 4 shows the logarithmic plot of the “data” from Table 1, with the trend line from the data. The “trend line” obtained in Excel is in fact the same as that resulting from a linear regression. If one does the regression using Data Analysis tools in Excel, the result is

Estimated time constant = 60.2 ± 11.7 minutes

For present purposes, let us define the use of the regression line in this format as **Method 3** for arriving at an estimate of the time constant.

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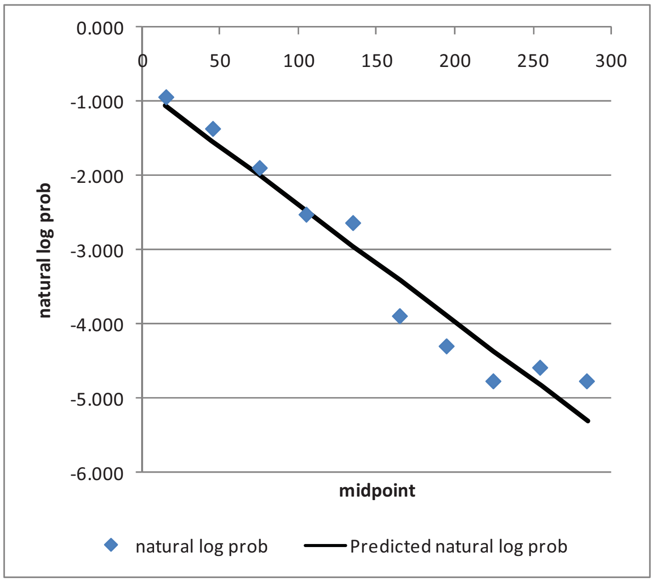
[2] At one time, it was common to use semi-log paper to plot this, with the scale on the paper taking care of the logarithmic conversion.



midpoint	natural log prob
15	-0.951
45	-1.376
75	-1.903
105	-2.530
135	-2.642
165	-3.895
195	-4.301
225	-4.771
255	-4.588
285	-4.771

Figure 4: Plot of the Table 1 "Data" in Logarithm Form for the Percent by Category

This is rather consistent with the Method 2 estimate of 59.2 ± 6.5 minutes.

Comparing the three "methods" side-by-side, Figure 5 shows a negligible difference in the results, at least on a visual scale. The analyst is to use Method 1, but as this illustration demonstrates, the other methods yield comparable results, with no more than ± 2% on the 50th percentile and ± 1% at the 90th, 95th, or 99th percentiles. This is well within the natural variability of the statistics, given the number of samples and the inherent variability in the population. Consider Table 3, as an illustration.

Table 3: Percentile Results, for Different Methods

Percentiles indicated, in minutes			
	Method 1	Method 2	Method 3
50th	42	41	42
90th	138	136	139
95th	180	178	180
99th	271	271	273

Note: Add T_0 = 20 minutes for actual mobilization times

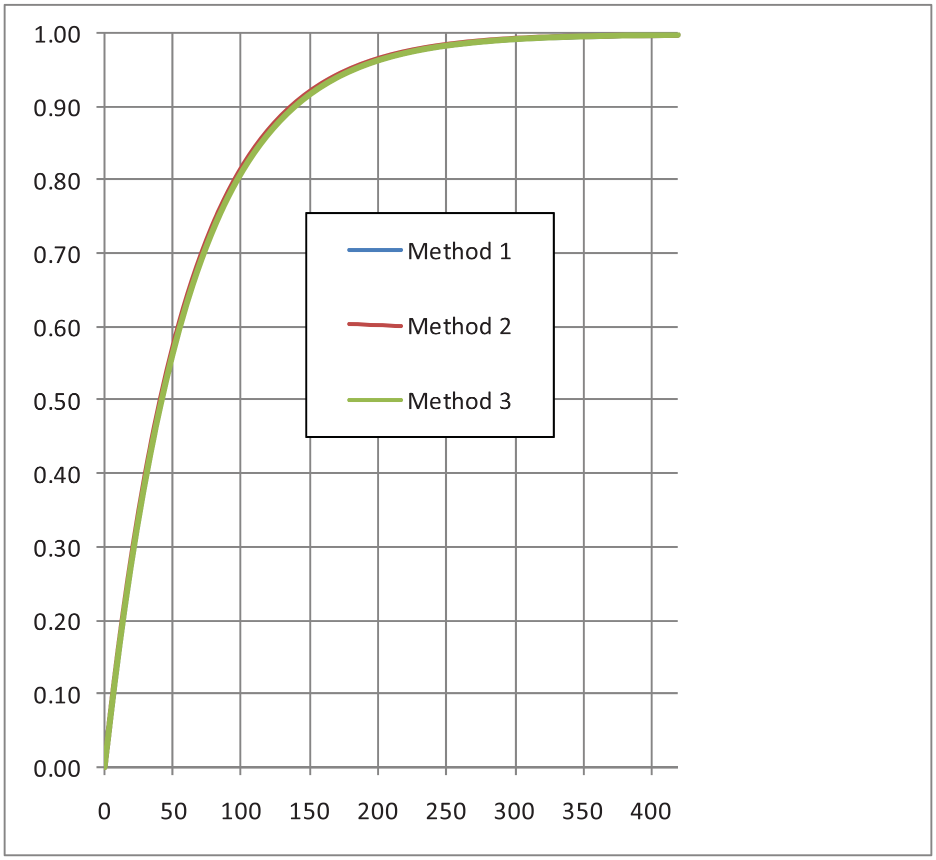


Figure 5: Comparison of Three Methods of Estimating τ

Insights and Guidance for the Analyst

1) Method 1 is to be used as the default method. If another method is considered, it must be discussed with the senior analyst and reviewed by the QC officer.

2) Given the natural variability in the data and the survey sample sizes, any differences shown herein are within the expected variability of the results.

3) Table 3 illustrates the variability that may arise, in terms of percentile values of the mobilization distribution. As shown in Figure 3, the numbers that appear somewhat different in Table 3 have little practical impact in Figure 5.

4) All of the analysis and methods have focused on the most common model of a homogeneous population mobilizing. If there were more complex models (see the next section), the problem can be subdivided into "regimes" and the above techniques applied within each regime. Because

this is not as common, the analyst should review such cases with the senior analyst and QC officer when they occur.

5) Note that the “outlying” points typical of survey responses may shift the mean somewhat, but not in a major way. The methods used do not depend on the outliers as much as on the 98.2% level or the mean. That is, good estimates of the major percentiles can be obtained from the underlying curve, as illustrated in Figure 5.

6) In reviewing work, the analyst may find that the mobilization curve is not continued past the 95th percentile or that it is sketched unevenly (poorly) past that point. Fortunately, as cited in #5, the time constant τ (whether estimated by Methods 1, 2, or 3) is the prime determinant of the curve and of the key percentiles.

7) The goodness-of-fit test is intended to assure that the hypothesis of an underlying exponential distribution is plausible. If it is not, the analyst can expect the result of “reject hypothesis” in the analysis illustrated in Table 2.

8) Indeed, if the data in the Figure 4 display is done at the time of the goodness-of-fit test, the analyst can then expect the data to not appear randomly distributed about the trend line. In particular, a range that has the values on only one side – notably toward the end – may represent a more complex underlying model.

The conclusion in #8 occurs infrequently, and the senior analyst should then be involved, with a review by the QC officer expected.

Other Model Forms

Three variations may occur, as illustrated in Figures 6, 7, and 8:

- Figure 6 shows a 2-regime model in which there are two distinct groups *that can be discerned* in the data. For instance, Group 1 may start to leave immediately and follow the basic model pattern. Group 2 may start some time later (due to returning home, etc) and then follow a shifted exponential, perhaps with a different time constant. The curve may also be shifted at t = 0.
- Figure 7 shows a 3-regime model in which there are three distinct groups *that can be discerned* in the data. The curve may also be shifted at t = 0.
- Figure 8 shows a delayed curve with a smooth rise (shown compared to the dashed basic model with $T_0 = 0$).

If and when the data displays these unexpected multi-regime patterns, the senior analyst is to be involved, and a special analysis is to be documented and submitted to the QC officer.

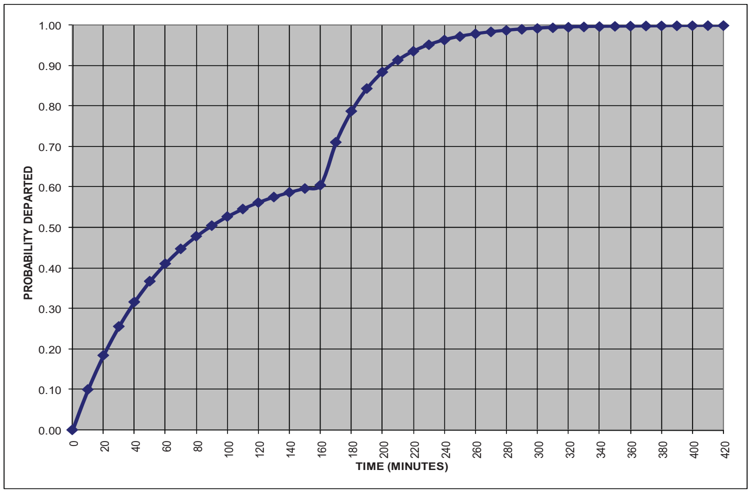


Figure 6: 2-Regime Model

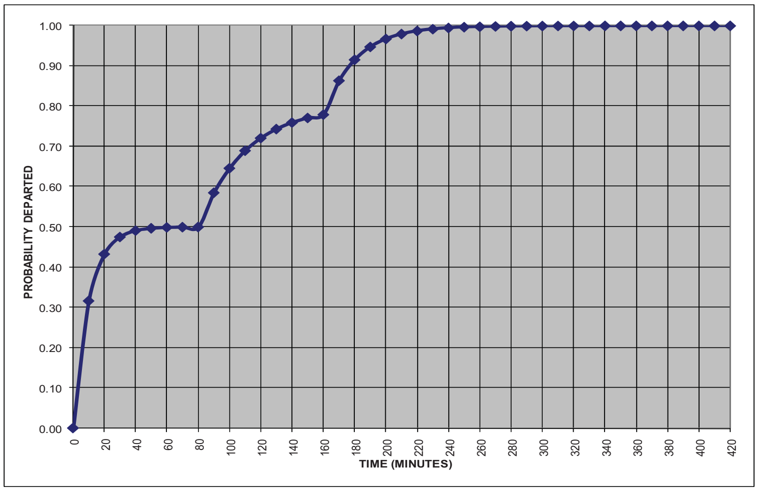


Figure 7: 3-Regime Model

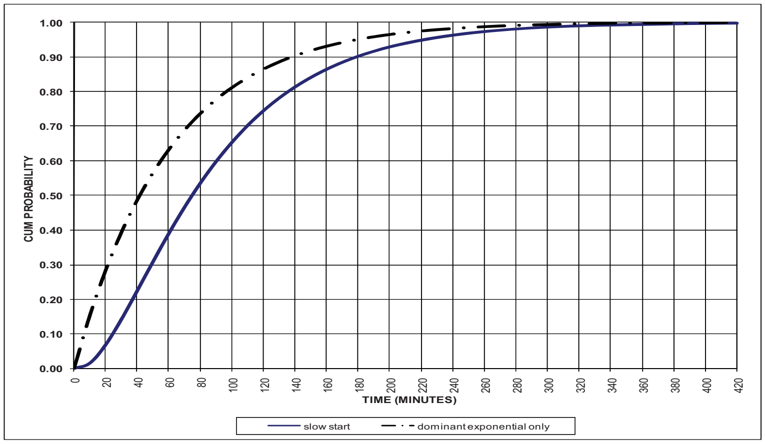


Figure 8: Delayed Initiation Model, Compared to Basic Model