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November 26, 2013

Docket Nos.: 50-348 50-321 50-424 NL-13-2340
50-364 50-366 50-425

U. S. Nuclear Regulatory Commission
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Joseph M. Farley Nuclear Plant – Units 1 and 2
Edwin I. Hatch Nuclear Plant – Units 1 and 2
Vogtle Electric Generating Plant – Units 1 and 2
Evacuation Time Estimates Update

Reference:
1. Southern Nuclear Operating Company Letter dated December 7, 2012, *Evacuation Time Estimate Update* (NL-12-2329, ADAMS Accession No. ML12346A411)

2. Southern Nuclear Operating Company Letter dated December 7, 2012, *Evacuation Time Estimate Update* (NL-12-2330, ADAMS Accession No. ML12346A412)

3. Southern Nuclear Operating Company Letter dated December 7, 2012, *Evacuation Time Estimate Update* (NL-12-2331, ADAMS Accession No. ML12346A413)

4. Southern Nuclear Operating Company Letter dated March 28, 2013, *Evacuation Time Estimate Update* (NL-13-0634, ADAMS Accession No. ML13088A036)

5. Southern Nuclear Operating Company Letter dated July 31, 2013, *Evacuation Time Estimate Update* (NL-13-1601, ADAMS Accession No. ML13214A045)

6. Southern Nuclear Operating Company Letter dated July 31, 2013, *Evacuation Time Estimate Update* (NL-13-1604, ADAMS Accession No. ML13214A049)

7. Southern Nuclear Operating Company Letter dated July 31, 2013, *Evacuation Time Estimate Update* (NL-13-1605, ADAMS Accession No. ML13214A043)

Ladies and Gentlemen:

By letters dated December 7, 2012 (References 1, 2, and 3), and as updated by Reference 4, Southern Nuclear Operating Company (SNC) submitted the Evacuation Time Estimate (ETE) Updates for Joseph M. Farley Nuclear Plant (FNP), Edwin I. Hatch Nuclear Plant (HNP), and Vogtle Electric Generating Plant (VEGP) Units 1 and 2. Based upon further discussion between SNC and the Nuclear Regulatory Commission (NRC), SNC revised the ETE Update to more closely align with the guidance provided in NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies", and submitted the revised ETE in References 5, 6, and 7. Specifically, the assumptions utilized for the ETE were modified to be consistent with the assumptions provided in NUREG/CR-7002. Subsequently, SNC discovered that when the ETE was originally performed, the calculation only included the protective action zones (PAZs) within the downwind plume sector and did not include PAZs within the two adjoining sectors in accordance with the guidance in NUREG/CR-7002. The methodology was adjusted and the ETEs were recalculated. The recalculated ETE values resulted in minor changes to the results submitted in References 1 through 7. The minor changes in the revised ETE data did not adversely impact the existing Protective Action Recommendation (PAR) strategies for FNP, HNP, or VEGP. Therefore, the existing PAR strategies remain unchanged.

The revised ETE Updates for FNP, HNP, and VEGP have been reviewed pursuant to 10 CFR 50.54(q). The changes have been determined to not reduce the effectiveness of the Emergency Plan.

Results of the ETE are included as the Enclosures to this letter. Enclosure 1 provides the ETE for FNP. Enclosure 2 provides the ETE for HNP. Enclosure 3 provides the ETE for VEGP. The Enclosures provided in this letter supersede the Enclosures provided in References 1 through 7, in their entirety.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Sincerely,

C. R. Pierce

C. R. Pierce
Regulatory Affairs Director

CRP/CLN/lac

Enclosures: 1. Evacuation Time Estimates for the Joseph M. Farley Nuclear Plant
2. Evacuation Time Estimates for the Edwin I. Hatch Nuclear Plant
3. Evacuation Time Estimates for the Vogtle Electric Generating Plant

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**Joseph M. Farley Nuclear Plant – Units 1 and 2**
**Edwin I. Hatch Nuclear Plant – Units 1 and 2**
**Vogtle Electric Generating Plant – Units 1 and 2**
**Evacuation Time Estimates Update**

**Enclosure 1**

**Evacuation Time Estimates for the Joseph M. Farley Nuclear Plant**

November 2012, Revised October 2013

# Evacuation Time Estimates for the Joseph M. Farley Nuclear Plant

IEM/TEC12-1002

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# EXECUTIVE SUMMARY

In order to ensure the safety of the public living in the vicinity of nuclear power plants in the nation, the U.S. Nuclear Regulatory Commission (NRC) requires the plants to update their evacuation times estimates (ETEs) within the 10-mile radius plume exposure pathway emergency planning zone (EPZ) as local conditions change (e.g., significant changes in population, change in the type of effectiveness of public notification system, etc.).

Southern Nuclear Operating Company (SNC) contracted IEM to estimate evacuation times for the 2012 populations within the 10-mile plume exposure pathway EPZ surrounding the Joseph M. Farley Nuclear Plant (FNP). This document describes the methods used to obtain population data and to estimate evacuation times. It also reports the estimated population figures, evacuation road network information, and ETEs.

In compliance with the guidelines outlined in the NRC's *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002), this report breaks down the population by geographic areas and protective action zones (PAZ).[1] As described in NUREG/CR-7002, three population segments have been analyzed in this report: permanent residents and transient population; transit dependent permanent residents, and school populations. No special facilities were found within the EPZ. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The total year 2012 permanent resident populations within the 10-mile EPZ for FNP are estimated to be 7,188. The transient population consists of workers employed within the area, recreational sportsmen, and visitors. The total transient population within the 10-mile EPZ is estimated to be 4,734, which includes 600 transient workers at FNP. The school populations identified in the FNP EPZ include six schools, which are a combination of both public and private. In these analyses, IEM contacted the schools within the EPZ area to collect current enrollment and staff figures. The total peak population for the schools in the 10-mile EPZ is estimated to be 3,225. Transit dependent permanent residents in the 10-mile EPZ are estimated to be 94. This study also considered the voluntary evacuees, who are also known as shadow evacuees and consist of 20% of the residents within 10 to 15 miles from FNP.

IEM used PTV Vision VISUM—a computer traffic simulation model—to perform the ETE analyses. For the analyses, the 10-mile plume exposure pathway EPZ was divided into 25 unique geographic areas based on two-mile, five-mile, and ten-mile radius rings, the 16 22.5-degree PAZs, as well as keyhole and staged evacuation logic. In order to represent the most realistic emergency scenarios, evacuations for the 25 geographic evacuation areas were modeled individually for the midweek daytime, midweek – weekend evening, and weekend daytime scenarios. Each of these scenarios was then considered under both normal and adverse weather conditions using the 2012 population

[1] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

projections. A total of 150 evacuation scenarios were considered as part of this study to represent different wind, temporal, and seasonal weather conditions.

Both 100% and 90% ETEs for each scenario were collected. The 100% ETEs for 2012 normal weather conditions ranged from 2 hours to 3 hours 20 minutes. The 100% ETEs for 2012 adverse weather conditions ranged from 2 hours 5 minutes to 3 hours 25 minutes. The 90% ETEs for 2012 normal weather conditions ranged from 1 hour 15 minutes to 1 hour 50 minutes. The 90% ETEs for 2012 adverse weather conditions ranged from 1 hour 20 minutes to 1 hour 50 minutes. The factors that contributed to the variations in ETEs between scenarios include differences in the number of evacuating vehicles, the capacity of the evacuation routes used, and the distance from the origin zones to the EPZ boundary.

Based on the data gathered and the results of the evacuation simulations, the existing evacuation strategy is functional for the 2012 conditions, given the lack of severe congestion or very high ETEs. However, the following recommendations will help emergency managers to improve the evacuation times from an event at FNP:

- ETEs can also be reduced by implementing additional measures that will shorten the elapsed time between the incident's occurrence and the time the public uses to take the required protective action—especially for the recreational area users, such as hunters and fishermen.
- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use traffic control points (TCPs) to facilitate flow in the high volume intersections where vehicles might otherwise have to slow down due to congestion.
- Work with local and state road/transportation departments to suggest improvements to the road infrastructure near the intersections of Ross Clark Circle with U.S. Hwy 84, Alabama Hwy 52 (AL-52), and Cottonwood Road (AL-53) may contribute to reduced congestion and lower ETEs.
- Consider routing evacuees from some zones in Alabama such as B-10 and C-10 to other roads in order to distribute traffic evenly and to reduce traffic congestion.
- The regional stakeholders should continue using and updating, as necessary, the existing regional evacuation plans.

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# 1.0 INTRODUCTION

The Joseph M. Farley Nuclear Plant, also known as Farley Nuclear Plant (FNP), is owned by Alabama Power and operated by Southern Nuclear Operating Company (SNC). In order to ensure the safety of the public living in the vicinity of FNP, the U.S. Nuclear Regulatory Commission (NRC) requires nuclear power plants in the nation to conduct evacuation studies for the population within the 10-mile radius plume exposure pathway emergency planning zone (EPZ) at regular intervals. This population evacuation study fulfills regulatory requirements outlined in the NRC *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002).[2]

SNC contracted IEM to perform a population evacuation study for the 10-mile radius plume exposure pathway EPZ surrounding FNP. This document presents the results of that study. It describes the assumptions and methodologies used by IEM to obtain population and evacuation network data and to perform evacuation time estimates (ETE) analyses. ETEs in this evacuation study incorporate the actual population numbers[3] for the year 2012. This document reports the updated population figures, evacuation road network information, and ETEs.

The study is consistent with the requirements specified in NUREG/CR-7002 guidelines. The study is intended to provide information for State and local officials, and FNP emergency management personnel to effectively plan for an accidental event at the plant.

## 1.1. Site Location

FNP is located on the western bank of the Chattahoochee River in the northeastern corner of Houston County, Alabama. The City of Blakely, Georgia is approximately 14 miles northeast of the plant and is the nearest significant population center from the plant. The City of Dothan, Alabama is approximately 15 miles west of the plant. Figure 1 shows the location of the FNP site.

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[2] NRC. *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002) guidelines. November 2011.

[3] SNC 2012 first-quarter population estimates


**Figure 1: Farley Nuclear Plant Site Location**

## 1.2. Emergency Planning Zone

The plume exposure pathway EPZ includes the majority of the 10-mile geographic area surrounding FNP. The land within the plume exposure pathway is divided by the Chattahoochee River. The FNP EPZ covers portions of Houston and Henry Counties in Alabama, and Early County in Georgia. The EPZ is primarily a rural farming and lumber harvesting area. Transient population in the EPZ is minimal with the exception of recreational users along the Chattahoochee River, and hunters.

The State of Alabama Radiological Emergency Preparedness Plan[4], the State of Georgia Radiological Emergency Plan (REP)[5], and the Joseph M. Farley Emergency Plan are the bases for the geographical and political boundaries for the EPZ. For evacuation and emergency response planning purposes, the 10-mile radius plume exposure pathway EPZ has been divided into 19 Emergency Response Planning Areas (ERPAs) known as protective action zones (PAZ).[6] The PAZ descriptions were obtained and verified from FNP's 2012 emergency information calendar[7], the county REPs[8], and discussions with both SNC and FNP representatives. The PAZs were selected based on existing political boundaries and prominent physical features—either natural (e.g., rivers and lakes) or man-made (e.g., roads and bridges)—to enhance direction and coordination of the public in the affected area. Figure 2 shows a map of the PAZs for FNP. Appendix A of this document contains boundary descriptions of the PAZs within the 10-mile plume exposure pathway EPZ of the plant.

[4] State of Alabama Radiological Emergency Preparedness Plan – Nuclear Power Plants – Alabama Emergency Management Agency. Revision 15 – July 2009.
[5] State of Georgia Radiological Emergency Plan – Annex B – Plant Farley. Georgia Emergency Management Agency. January 2009.
[6] Protective Action Zone is also referred to as "Zone" in this document.
[7] 2012 Joseph M. Farley Nuclear Plant Emergency Information Calendar.
[8] State of Georgia REP Plan, Blakely-Early County Emergency Management Agency Radiological Emergency Plan for Nuclear Incidents/Accidents Involving the Joseph M. Farley Nuclear Power Plant. January 2009.
Dothan-Houston County Emergency Management Agency Standard Operating Guidelines for Joseph M. Farley Nuclear Power Plant Incidents.

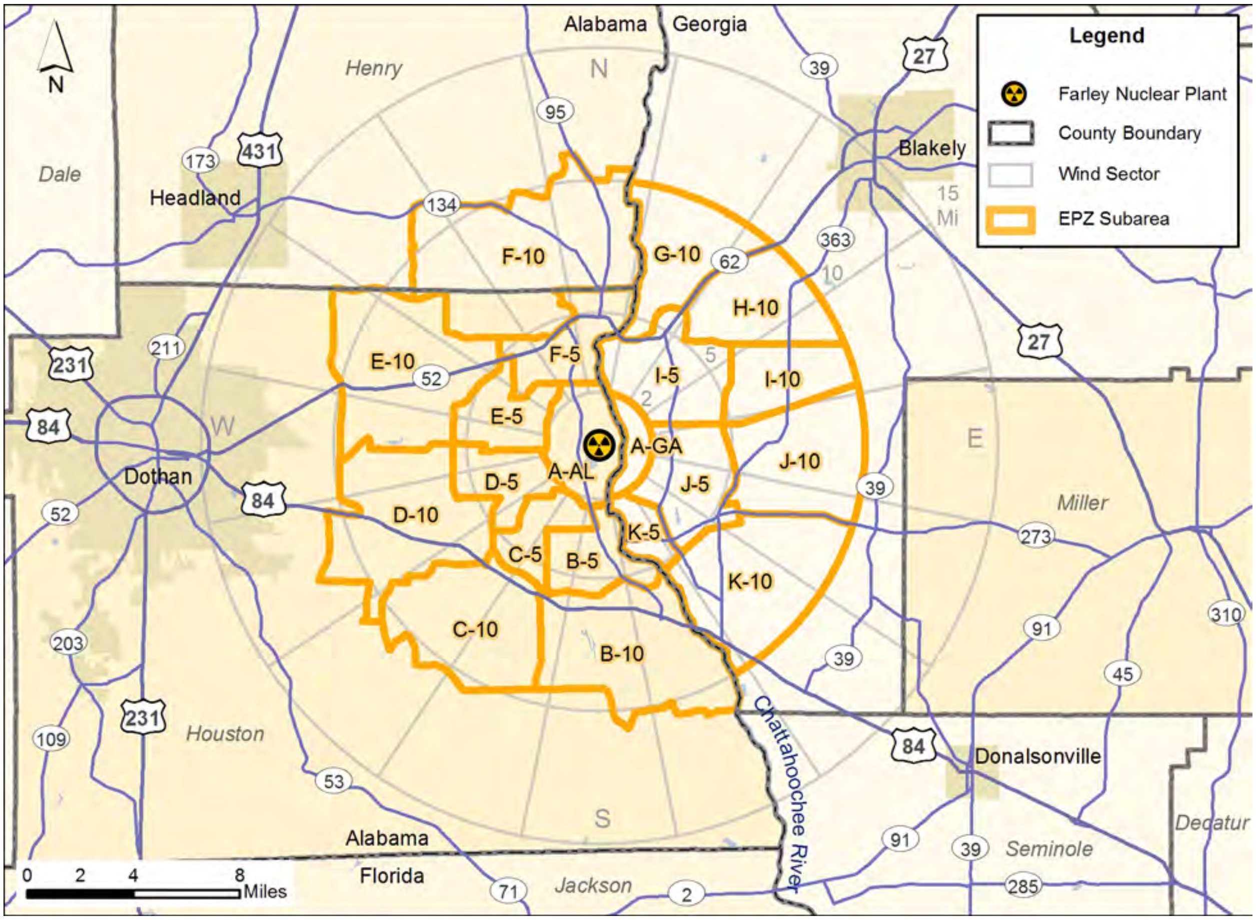


Figure 2: FNP EPZ Boundary and Protective Action Zones

## 1.3. Comparison with Previous ETE Study

Table 1 identifies information that is useful in comparing the 2008 and 2012 ETE studies. Note that the 2008 ETE study was modeled using both 2007 and 2010 estimated population data. For comparison purpose, Table 1 lists the information for the 2010 estimated population from the 2008 study, as well as the 2012 population from this study.

**Table 1: ETE Comparison Chart**

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Permanent Residents** | | |
| - Total Population | 10,358 | 7,188 |
| - Vehicle Occupancy Rate | 2.5 | 1.5-1.6 |

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Transit Dependent Population** | | |
| - Total Population | 0 | 94 |
| - Number of Buses | 0 | 245 |
| - Number of Ambulances | 0 | 36 |
| - Number of Special Equipped Vehicles[9] | 0 | 67 |
| **Transient Population** | | |
| - Total Population | 5,239 | 4,734[10] |
| **Special Facilities** [11] | | |
| - Total Population | 0 | 0 |
| - Number of Buses | N/A | N/A |
| - Other Transportation Resources | N/A | N/A |
| **Schools** | | |
| - Total Student Population | 3,002 | 2,952 |
| - Number of Buses | 57 | 52 |
| **Shadow Evacuation Percent Estimated** | 0 | 20% |
| **Special Event(s)** | | |
| - Population | N/A | N/A |
| - Location | N/A | N/A |
| - Duration | N/A | N/A |
| **Adverse Weather (rain, snow, ice, fog)** | Heavy Rain | Heavy Rain |
| **Evacuation Model - name and version** | VISUM 10 | VISUM11 |
| **Scenarios** | Combination of time (weekday, weeknight, weekend) and weather (adverse and normal) | Combination of time (weekday, weeknight, weekend) and weather (adverse and normal) |

[9] The number of special equipped vehicles includes both buses with lifts and special medical transport vehicles, per discussion with county emergency management agencies.
[10] Due to more available data received in 2012, the total population for the transient population has been adjusted to separate transient workers and resident workers. This separation decreases the total number of transient in the 2012 report.
[11] No special facilities, as defined in NUREG/CR-7002, were identified in the 10-mile EPZ.

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Assumptions** | • One evacuation vehicle per household for residents<br>• Mobilization time for resident and transient population are based on literature [12]<br>• No shadow evacuation considered | • Vehicle occupancy rates for residents are based on telephone survey<br>• Mobilization time for resident and transient population are based on telephone survey<br>• 20% of residents in 10-15 mile ring are shadow evacuees |

[12] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

# 2.0 ASSUMPTIONS AND METHODOLOGY

## 2.1. General Assumptions

IEM made the following general assumptions to model the population evacuation study:

- The ETEs include the times associated with warning diffusion, public mobilization, and travel time out of the EPZ. The ETE is measured from the time that instructions were first made available to the public within the EPZ (e.g., initial emergency alert system [EAS] broadcast). Mobilization of the public begins after initial notification.
- Following initial notification, all persons within the EPZ will evacuate. 100% ETE will be considered as the time when all evacuating vehicles are outside the EPZ. 90% ETE will be considered as the time when 90% of the evacuating vehicles are outside the EPZ.
- Existing lane utilization patterns will prevail during the course of the evacuation. There will be traffic control points (TCP) in the network to allow efficient flow of traffic toward the reception centers.
- Reception centers are modeled as defined in the 2012 emergency information calendar.
- Non-auto-owning households will evacuate with neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by State and county emergency management officials. This is also consistent with the 2012 emergency information calendar and county REPs.
- The major adverse weather condition in the area is considered as heavy rain. To model the population evacuation during adverse weather conditions, the free flow speeds are reduced by 15%, and the road capacities are reduced by 10%.
- The evacuation is ordered promptly and no early protective actions have been implemented.
- Schools receive initial notification the same time as the general public within the EPZ.
- A shadow evacuation of 20% of the permanent resident population was assumed to occur in areas outside of the evacuation area being assessed extending to 15 miles from the FNP. The vehicle occupancy rates and trip generation times of shadow evacuees are consistent with those of the residents within the EPZ.
- Information such as the number of vehicles by the residents during the evacuation and mobilization times are estimated based on a telephone survey on the residents within the EPZ.
- Located in a rural area, there is little pass-through traffic and the majority of the trips are home-work trips made by the local residents within the EPZ. Due to this nature, IEM assumed that minimum background traffic would exist after the evacuees start to

load into the roadway network. No significant impact of pass-through traffic on the ETEs is expected.

- Buses used to evacuate schools and special facilities are loaded to capacity.
- Shadow evacuation of 20% of the residents in 10-15 mile ring would occur when an evacuation order is issued.

## 2.2. Methodology

IEM used PTV Vision VISUM (version 11), a computer simulation model, to perform the ETEs for the FNP site.[13] PTV Vision is the leading software suite for transportation planning and operations analyses used in more than 70 countries. Detailed information on the evacuation time analysis methodology using PTV Vision is provided in Section 5.2. PTV Vision quality assurance and industry acceptance information is provided in Appendix D.

## 2.3. Sources of Data

The most up-to-date data sources were reviewed and analyzed to prepare appropriate input data for running the traffic simulation and providing the best ETEs. The data sources are explained below:

- Geographical and political boundaries for the EPZ were obtained from the State of Alabama and the State of Georgia REPs.
- The 19 PAZ descriptions were obtained and verified from State of Alabama REP Plan[14], State of Georgia REP Plan[15], FNP's 2012 emergency information calendar[16], the county REPs[17], and discussions with SNC and FNP representatives.
- The 2012 population estimates, as well as business location data, were obtained from the 2010 U.S. Census Bureau, the 2012 Plant Farley Tone Alert Radio (TAR) Database, and the population estimates obtained from Synergos Technologies, Inc.[18]
- The peak and average estimated employment level at the plant obtained from the SNC representatives reflects office or operations personnel.
- Roadway geometric data was obtained from PTV. PTV data is based on high-quality, regularly updated, NAVTEQ street network data. NAVTEQ networks are detailed and include neighborhood streets in every community in North America. This data was validated by IEM during a "ground truthing" field trip in April 2012.

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[13] PTV Vision can be found online at http://www.ptvamerica.com.
[14] State of Alabama Radiological Emergency Preparedness Plan – Nuclear Power Plants – Alabama Emergency Management Agency. Revision 15 – July 2009.
[15] State of Georgia Radiological Emergency Plan – Annex B – Plant Farley. Georgia Emergency Management Agency. January 2009.
[16] 2012 Joseph M. Farley Nuclear Plant Emergency Information Calendar.
[17] State of Georgia REP Plan, Blakely-Early County Emergency Management Agency Radiological Emergency Plan for Nuclear Incidents/Accidents Involving the Joseph M. Farley Nuclear Power Plant. January 2009.
Dothan-Houston County Emergency Management Agency Standard Operating Guidelines for Joseph M. Farley Nuclear Power Plant Incidents.
[18] Synergos Technologies, Inc. Online: http://www.synergos-tech.com.

- Roadway and intersection approach capacities were calculated using the concepts and procedures defined in the Highway Capacity Manual[19] published by the Transportation Research Board.
- Warning diffusion and mobilization times were based on the data presented in *Evaluating Protective Actions for Chemical Agent Emergencies*[20] published by the Oak Ridge National Laboratory. The data in this report was collected during evacuations executed in response to large-scale chemical spills, and explicitly incorporates the time required for communication of the warning (warning diffusion) and the time required for an individual to respond to the warning (mobilization). The data collected in this meta-study were based on transient and permanent populations. Section 5.1.1 provides more information on warning diffusion and mobilization time assumptions.
- Vehicle occupancy rates for the different population categories were derived based on telephone survey and discussions with the counties' and plant's emergency planning staffs. Section 3.0 provides more information on population and vehicle demand assumptions.
- Agencies participating in the study are provided below. These agencies participated in an initial briefing for the study and provided input regarding specifics for the data and assumptions for the ETE within their jurisdiction.
    - Alabama Emergency Management Agency
    - Dothan/Houston County Emergency Management Agency
    - Henry County Emergency Management Agency
    - Early County Emergency Management Agency
    - Georgia Emergency Management Agency

## 2.4. Scenarios Modeled

In accordance with NUREG/CR-7002 guidelines, ETEs for each of the evacuation areas (refer to Table 3) have been prepared for different temporal and weather conditions. Based on the discussion with the SNC emergency planning staff, estimates have been prepared for both normal and adverse weather conditions for midweek daytime, midweek – weekend night, and weekend daytime.

Normal weather refers to conditions where roads are clear and dry and visibility is not impaired. Adverse weather refers to rainy or snowy conditions where road capacities are reduced by 10% and speed limits are reduced by 15%.

Evacuation conditions are modeled for the populations of the year 2012. Table 2 presents the snapshot of the ETE scenarios that were modeled for the study.

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[19] Transportation Research Board, National Research Council. *Highway Capacity Manual*. Washington, D.C. 2000.
[20] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

**Table 2: ETE Scenarios Modeled***

| Scenario | Day | Time | Weather |
|---|---|---|---|
| 1 | Midweek | Daytime | Normal |
| 2 | Midweek | Daytime | Adverse |
| 3 | Midweek and Weekend | Night | Normal |
| 4 | Midweek and Weekend | Night | Adverse |
| 5 | Weekend | Daytime | Normal |
| 6 | Weekend | Daytime | Adverse |

** Per discussions with SNC emergency planning staff, special events and seasonal variation scenarios were not modeled. However, due to a potential for more recreational population during the fall months, peak recreational population numbers were used for the weekend scenarios (5 and 6).*

The various population components for different scenarios are summarized below:

- **Midweek Daytime – Normal Weather:** This situation represents a typical normal weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
    - Permanent residents within the EPZ will evacuate from their places of residence.
    - The plant site employment is at an estimated peak daytime level.
    - Workplaces are fully staffed at daytime levels.
    - Schools are in session.
    - Recreational activities, such as hunting and fishing, are at daytime levels.
- **Midweek Daytime – Adverse Weather:** This situation represents an adverse weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
    - Permanent residents within the EPZ will evacuate from their places of residence.
    - The plant site employment is at an estimated peak daytime level.
    - Workplaces are fully staffed at daytime levels.
    - Schools are in session.
- **Midweek and Weekend Evening – Normal Weather:** This situation reflects a typical normal weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:
    - Permanent residents within the EPZ will evacuate from their places of residence.
    - The plant site is staffed at an estimated peak nighttime level.
    - Workplaces are at nighttime levels.

- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Midweek and Weekend Evening – Adverse Weather:** This situation reflects an adverse weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is staffed at an estimated peak nighttime level.
- Workplaces are at nighttime levels.
- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Weekend Daytime – Normal Weather:** The normal weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

▪ **Weekend Daytime – Adverse Weather:** The adverse weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

## 2.5. Evacuation Areas Modeled

NUREG/CR-7002 recommends that the EPZ be subdivided into evacuation areas for performing the evacuation time estimate analyses.[21] As indicated in Table 3, each evacuation area includes one or more affected PAZ's to support the various evacuation logic including keyhole and staged evacuations. Based on the geography and political boundaries in the EPZ, 25 unique areas were defined by IEM for the FNP EPZ, in

[21] NUREG/CR-7002. Table 1-4, p.8.

agreement with the SNC personnel. As shown in the lower part of Table 3, separate evacuation areas are modeled for the 0-2 mile zone and the 2-5 mile zone to support protective action decision making for a staged evacuation.

## Table 3: Evacuation Areas for an Evacuation Keyhole With and Without the 2-Mile Zone

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | F-5 | I-5 | J-5 | K-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0–2 miles | X | | | | | | | | | | | | | | | | | | |
| A, B-5, C-5, D-5, E-5, F-5, I-5, J-5, K-5 | 0–5 miles | X | X | X | X | X | X | X | X | X | | | | | | | | | | |
| All Evacuation Zones | 0-10 miles, Full EPZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Evacuate 2 to 5 miles downwind | | | | | | | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (ERPAs) | | | | | | | | | | | | | | | | | | |
| | | A | B-5 | C-5 | D-5 | E-5 | F-5 | I-5 | J-5 | K-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 |
| K-5, B-5, C-5 | N | | X | X | | | | | | X | | | | | | | | | | |
| B-5, C-5, D-5 | NNE | | X | X | X | | | | | | | | | | | | | | | |
| B-5, C-5, D-5 | NE | | X | X | X | | | | | | | | | | | | | | | |
| C-5, D-5, E-5 | ENE | | | X | X | X | | | | | | | | | | | | | | |
| D-5, E-5 | E | | | | X | X | | | | | | | | | | | | | | |
| D-5, E-5, F-5 | ESE | | | | X | X | X | | | | | | | | | | | | | |
| E-5, F-5 | SE | | | | | X | X | | | | | | | | | | | | | |
| E-5, F-5, I-5 | SSE | | | | | X | X | X | | | | | | | | | | | | |
| F-5, I-5 | S | | | | | | X | X | | | | | | | | | | | | |
| F-5, I-5 | SSW | | | | | | X | X | | | | | | | | | | | | |
| I-5, J-5 | SW | | | | | | | X | X | | | | | | | | | | | |
| I-5, J-5 | WSW | | | | | | | X | X | | | | | | | | | | | |
| I-5, J-5 | W | | | | | | | X | X | | | | | | | | | | | |

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | F-5 | I-5 | J-5 | K-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-5, K-5 | WNW | | | | | | | | X | X | | | | | | | | | | |
| J-5, K-5, B-5 | NW | | X | | | | | | X | X | | | | | | | | | | |
| J-5, K-5, B-5 | NNW | | X | | | | | | X | X | | | | | | | | | | |
| **Evacuate 2-mile zone and 5-miles downwind** | | | | | | | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (ERPAs) | | | | | | | | | | | | | | | | | | |
| | | A | B-5 | C-5 | D-5 | E-5 | F-5 | I-5 | J-5 | K-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 |
| A, K-5, B-5, C-5 | N | X | X | X | | | | | | X | | | | | | | | | | |
| A, B-5, C-5, D-5 | NNE | X | X | X | X | | | | | | | | | | | | | | | |
| A, B-5, C-5, D-5 | NE | X | X | X | X | | | | | | | | | | | | | | | |
| A, C-5, D-5, E-5 | ENE | X | | X | X | X | | | | | | | | | | | | | | |
| A, D-5, E-5 | E | X | | | X | X | | | | | | | | | | | | | | |
| A, D-5, E-5, F-5 | ESE | X | | | X | X | X | | | | | | | | | | | | | |
| A, E-5, F-5 | SE | X | | | | X | X | | | | | | | | | | | | | |
| A, E-5, F-5, I-5 | SSE | X | | | | X | X | X | | | | | | | | | | | | |
| A, F-5, I-5 | S | X | | | | | X | X | | | | | | | | | | | | |
| A, F-5, I-5 | SSW | X | | | | | X | X | | | | | | | | | | | | |
| A, I-5, J-5 | SW | X | | | | | | X | X | | | | | | | | | | | |
| A, I-5, J-5 | WSW | X | | | | | | X | X | | | | | | | | | | | |
| A, I-5, J-5 | W | X | | | | | | X | X | | | | | | | | | | | |
| A, J-5, K-5 | WNW | X | | | | | | | X | X | | | | | | | | | | |
| A, J-5, K-5, B-5 | NW | X | X | | | | | | X | X | | | | | | | | | | |
| A, J-5, K-5, B-5 | NNW | X | | | | | | | X | X | | | | | | | | | | |

# 3.0 POPULATION AND VEHICLE DEMAND ESTIMATION

IEM identified three population segments[22] within the EPZ surrounding FNP, as specified in the NUREG/CR-7002 guidelines. These populations include the permanent residents and transient population, transit dependent permanent residents, and school populations. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The transient population is comprised of individuals working and/or visiting within the EPZ but not living there. For instance, the transient population consists of workers employed within the area, recreational sportsmen, and visitors to the area. The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). The school populations consist of students and staff, and may require additional consideration in the event of an evacuation. Populations at six schools in the FNP EPZ were identified.

FNP is located in a rural area of Alabama. There are no concentrated population centers, and there is minimal transient population within the 10-mile EPZ. The transient facilities include the five major employers, which includes the FNP, and the parks/hunter/boater recreational attraction sites. There are no special facility populations within the 10-mile EPZ. The majority of the population consists of permanent residents, workers, school students, and a varying number of recreational visitors who are mainly located on or around the Chattahoochee River.

IEM derived the 2012 permanent population estimates, as well as business location data, from 2010 Census, the 2012 Plant Farley TAR Database, the SNC 2012 first-quarter population estimates, and the population estimates obtained from Synergos Technologies, Inc. Local school data was obtained through contact with individual facilities. The recreational visitors' population figures were based on discussions with the FNP's emergency planning staff and contact with individual parks. After discussion with the appropriate facilities and the site emergency planning personnel, it was estimated that the 2010 school and recreational user information applies to the year 2012 since no major change in the land use pattern within the EPZ. These population estimates formed the basis for determining the evacuee demand used in the analyses for any given evacuation scenario. The populations from these sources were assigned to each applicable zone.

## 3.1. Permanent Residents

IEM used GIS software to process the geographic data and associated population counts for census blocks in each of the counties surrounding FNP. IEM then aggregated these populations over each zone to generate a permanent resident population count, which is comprised of the nighttime population.

[22] Special facilities, as defined in NUREG/CR-7002, were not identified in the 10-mile EPZ.

To calculate population by each zone and radial sector, census block populations were aggregated within each of the sectors. Since boundaries of the sectors do not follow census block boundaries, many of the blocks had to be divided into sub-areas based on sector boundaries. To do this, IEM overlaid the census blocks with the zones and 10-mile radius sectors. The blocks were then split into sub-areas and allocated the block population to the sub-areas based on an area ratio method. The populations of the block sub-areas within the sector boundaries were then aggregated for each radius sector. The area ratio method assigns each sub-area a portion of the block population based on the ratio of the area of each block part to the area of the entire block. For example, if a particular sub-area contains one-fourth the area of the total block area, the sub-area receives one-fourth of the block's total population. Figure 3illustrates this principle, in which one-fourth of the total area is located in the sub-area and it includes one-fourth of the population. The area ratio method assumes that the population within the block is evenly distributed, a reasonable assumption in most cases.

The populations of the block sub-areas within the sector boundaries were then aggregated for each sector. This method was also used in the few instances in which the zone boundaries did not follow block boundaries, making it necessary to split blocks along a particular zone boundary. Additionally, the permanent resident population is divided into auto-owning versus non-auto-owning populations.


**Figure 3: An Example of the Area Ratio Method Applied to a Census Block Divided into Sub-Areas**

### 3.1.1. Auto-Owning Population

IEM collected information for auto-owning population by conducting a telephone survey of the residents within the FNP EPZ. The survey indicates an average household size of 2.1 persons for the FNP EPZ. The collected data also indicate that more than 97% of the households within the EPZ have at least one vehicle per household. Additionally, the respondents indicated that each household would use an average of 1.5 to 1.6 vehicles during the evacuation depending on the day of the week and time of the day.

### 3.1.2. Non-Auto-Owning Population

The telephone survey indicates that 2-3% of the households within the EPZ do not own a vehicle. It is assumed that privately-owned vehicles of friends and/or relatives will be available to evacuate the majority of this population component. This assumption is used since it provides the most realistic representation of evacuation traffic generated from the non-auto-owning households. For an estimate of the vehicle demand associated with the non-auto-owning population, IEM assumed one vehicle would be made available to evacuate each household. This is based on the assumptions stated above that a family would use a vehicle from neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by county emergency management officials.

### 3.1.3. Resident Population Summary

Table 4 shows the distribution of the 2012 total permanent resident population (including the shadow evacuation population in the 10 to 15 mile area) by sector and ring, while Figure 4 presents the same data for 2-5 mile, 5-10 mile, and 10-15 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 4: 2012 Permanent Resident Population Distributions by Sector and Ring**

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 14 | 14 |
| 2-3 | 86 | 100 |
| 3-4 | 258 | 358 |
| 4-5 | 649 | 1,007 |
| 5-6 | 850 | 1,857 |
| 6-7 | 857 | 2,714 |
| 7-8 | 1,294 | 4,008 |
| 8-9 | 1,308 | 5,316 |
| 9-10 | 1,752 | 7,068 |
| 10-11 | 2,213 | 9,281 |

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 11-12 | 2,409 | 11,690 |
| 12-13 | 2,539 | 14,229 |
| 13-14 | 3,573 | 17,802 |
| 14-15 | 7,322 | 25,124 |

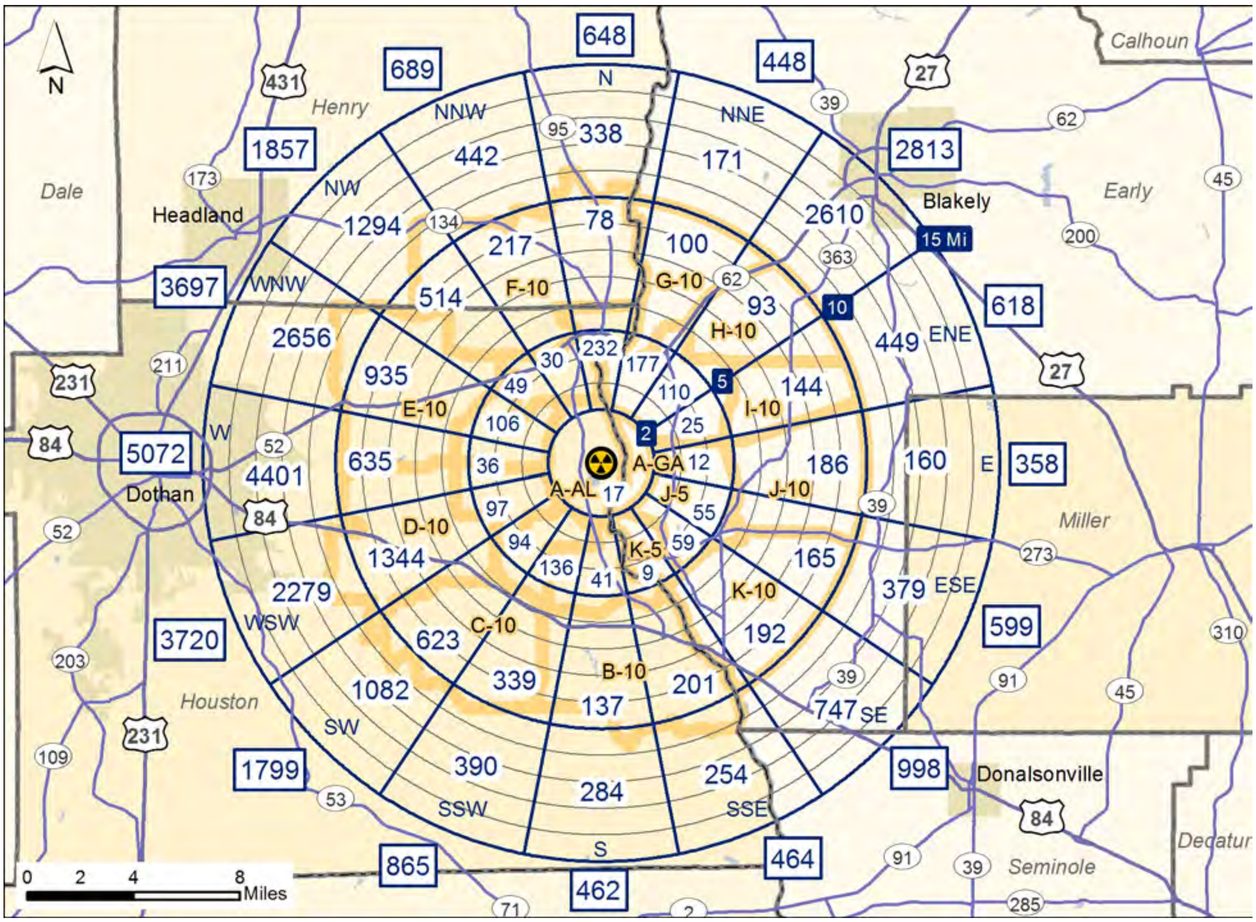


Figure 4: 2012 FNP Sector and Ring Permanent Resident Population Map

Table 5 shows the distribution of the permanent resident population by zone.

**Table 5: 2012 Permanent Resident Population Distributions by Zones**

| Zone | Permanent Resident Population |
|---|---|
| A-AL | 15 |
| A-GA | 2 |
| B-5 | 78 |
| B-10 | 294 |
| C-5 | 174 |
| C-10 | 818 |
| D-5 | 139 |
| D-10 | 1,690 |
| E-5 | 153 |
| E-10 | 1,560 |
| F-5 | 283 |
| F-10 | 592 |
| G-10 | 113 |
| H-10 | 127 |
| I-5 | 313 |
| I-10 | 95 |
| J-5 | 127 |
| J-10 | 267 |
| K-5 | 1 |
| K-10 | 347 |

## 3.2. Transient Populations

The transient population for the FNP EPZ area is derived from a combination of daytime populations, recreational populations, and employment data. The employment data was obtained from Synergos Technologies and combined with other contributors, such as the percentage of the population that is of working age, to daytime population estimations and assigned to population centroids in a manner similar to the permanent resident populations. The daytime populations incorporate employment and workforce information, such as county working-age population and unemployment statistics.

The recreational population shown for the FNP site considers users of parks and waterways, primarily boaters on the Chattahoochee River. Through conversations with FNP's emergency planning staff and with staff from the U.S. Fish and Wildlife Service's

Mobile office, IEM estimated there will be approximately 120 hunters/boaters throughout the EPZ on weekdays during the hunting season and approximately 575 hunters/boaters on peak weekends during the hunting season. In addition, there will be approximately 20 park visitors at parks during the weekdays, and 90 park visitors on the weekends.

A vehicle occupancy rate of 1.5 was used to estimate the number of vehicles used by recreational area users, such as hunters and fishermen.

Table 6 shows the distribution of the transient population by sector and ring, while Figure 5 presents the same data for 0-2 mile, 2-5 mile, and 5-10 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 6: Transient Population Distribution by Sector and Ring**

| Population Miles | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 608 | 608 |
| 2-3 | 74 | 683 |
| 3-4 | 484 | 1,167 |
| 4-5 | 235 | 1,402 |
| 5-6 | 463 | 1,865 |
| 6-7 | 513 | 2,378 |
| 7-8 | 784 | 3,162 |
| 8-9 | 603 | 3,765 |
| 9-10 | 764 | 4,529 |

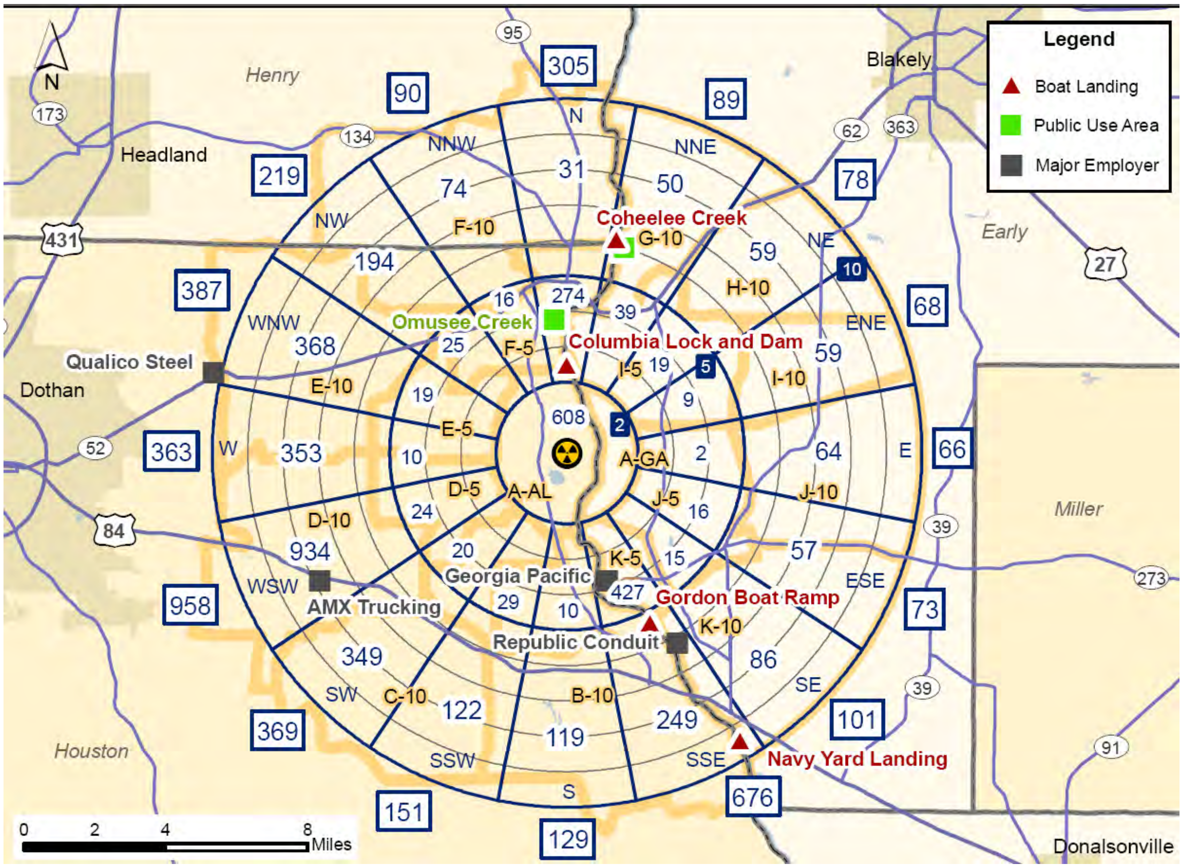


Figure 5: FNP Sector and Ring Transient Populations Map

Table 7 shows the distribution of the transient population by zone.

**Table 7: Transient Population Distribution by Zones**

| Zone | Transient Population |
|---|---|
| A-AL | 604 |
| A-GA | 4 |
| B-5 | 71 |
| B-10 | 251 |
| C-5 | 37 |
| C-10 | 332 |
| D-5 | 32 |
| D-10 | 1,280 |
| E-5 | 31 |
| E-10 | 711 |

| Zone | Transient Population |
|---|---|
| F-5 | 261 |
| F-10 | 189 |
| G-10 | 41 |
| H-10 | 74 |
| I-5 | 114 |
| I-10 | 37 |
| J-5 | 79 |
| J-10 | 95 |
| K-5 | 242 |
| K-10 | 248 |

### 3.2.1. Transient Facilities

The transient facilities consist of the five major employers, which includes the FNP site, and a few parks/hunter/boater recreational attraction sites. FNP is the largest employer in the EPZ, which has peak number of workers at 800 during the weekdays. The peak recreational population occurs on fall weekend periods during the hunting season (normally mid-September through early January). It is estimated that approximately one seventh to one fifth of peak recreational population is expected for the weekday scenarios and few visitors during the night. Table 8 shows the transient facilities' peak and average transient populations.

**Table 8: Peak and Average Transient Population**

| Facility Type | Facility Name | County | Zone | Peak Population | Average Population | Percent of Resident |
|---|---|---|---|---|---|---|
| Employer | Farley Nuclear Plant[23] | Houston | A-AL | 800 | 264 | 25% |
| Employer | Georgia-Pacific Paper | Early | K-5 | 320 | 250 | 25% |
| Employer | Maverick C & P | Early | J-5 | 60 | 31 | 25% |
| Employer | Republic Conduit | Early | K-10 | 112 | 52 | 20% |
| Employer | Qualico Steel | Houston | E-10 | 180 | 55 | 20% |
| Employer | AMX Trucking | Houston | D-10 | 100 | 49 | 20% |
| Boat Landing | Gordon Boat Camp | Houston | B-5 | 100 | 16 | 50% |
| Boat Landing | Navy Yard Landing | Early | K-10 | 50 | 8 | 50% |

[23] There are approximately 800 daytime employees and approximately 68 night and weekend employees. Approximately 600 employees may evacuate the facility during a daytime incident and it is possible that no one may evacuate during a nighttime or weekend incident.

| Facility Type | Facility Name | County | Zone | Peak Population | Average Population | Percent of Resident |
|---|---|---|---|---|---|---|
| Boat Landing | Columbia Lock and Dam | Early | I-5 | 100 | 16 | 50% |
| Boat Landing | Odom Creek Landing | Early | G-10 | 25 | 4 | 50% |
| Park | Omusee Public Use Area | Houston | F-5 | 75 | 86 | 80% |
| Park/Boat Landing | Coheelee Creek Public Use Area | Early | G-10 | 40 | 15 | 70% |

## 3.3. Transit Dependent Permanent Residents

The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). The transit dependent permanent resident population in the FNP EPZ was obtained from the county EMAs through SNC emergency planning staff. As shown in Table 9 there are 94 transit dependent permanent residents in the 10-mile EPZ. A roster of these individuals is maintained in the County EOCs. The EMA Directors maintain coordination with the County Departments of Family and Children Services on maintenance of the roster and dispatching emergency transportation to evacuate as needed.

**Table 9: Transit Dependent Permanent Residents**

| Transit Dependent Category | Houston County | Henry County | Early County |
|---|---|---|---|
| Wheelchair | 22 | 1 | 8 |
| Transportation | 44 | 2 | 13 |
| Immobile | 3 | 0 | 1 |

To evacuate the transit dependent permanent residents, the counties have 245 buses that will travel their regular routes to provide transportation to those individuals lacking personal transportation.[24] In addition, there are 49 lift-equipped buses, 36 ambulances, and 18 special transport vehicles. The special equipped vehicles will be dispatched by the EMA Directors directly to the homes of non-ambulatory individuals requiring special and or medical transportation means. The key information for evacuating the transit dependent population is shown in Table 10. The information shown includes the number of transit dependent permanent residents by category, number of evacuation vehicles by type and mobilization time, and evacuee loading time.

[24] State of Georgia REP Plan, Blakely-Early County Emergency Management Agency Radiological Emergency Plan for Nuclear Incidents/Accidents Involving the Joseph M. Farley Nuclear Power Plant. January 2009.
Dothan-Houston County Emergency Management Agency Standard Operating Guidelines for Joseph M. Farley Nuclear Power Plant Incidents.

**Table 10: Transit Dependent Permanent Resident Evacuation Information**

| Transit Dependent Category | Population | Number of Vehicles | Mobilization Time | Loading Time |
|---|---|---|---|---|
| Wheelchair | 31 | 67 | 15 min | 5 min |
| Transportation | 59 | 245 | 15 min | 2 min |
| Immobile | 4 | 36 | 10 min | 10 min |

## 3.4. Special Facility and School Populations

No special facilities, as defined in NUREG/CR-7002, were found within the EPZ; however, IEM identified six schools within the EPZ (Table 11). The key information for evacuating the populations at the school facilities is shown in Table 12. The information shown includes the enrollment, number of evacuation vehicles and its mobilization time, evacuee loading time and distance from the facility to the EPZ boundary.

Although the schools will require special consideration in an evacuation, it is estimated there are a sufficient number of evacuation vehicles available and no return trips are needed. The evacuation vehicles for the six schools will be dispatched from each county school bus depot as needed. All busses carrying students from the schools will check in at the Houston County Farm Center in Dothan, prior to their final destination. Figure 6 shows the location of these facilities.

**Table 11: School Locations**

| Facility Name | Address | City | County | Zone |
|---|---|---|---|---|
| Ashford Elementary School | 100 Barfield Street | Ashford | Houston | D-10 |
| Ashford High School | 607 Church Street | Ashford | Houston | D-10 |
| Houston County High School | 202 W Church Street | Columbia | Houston | F-5 |
| Webb Elementary School | 178 Depot Street | Webb | Houston | E-10 |
| Houston County Career and Technical Center | 801 Eighth Avenue | Ashford | Houston | D-10 |
| Ashford Academy | 1100 N Broadway Street | Ashford | Houston | D-10 |

## Table 12: School Evacuation Information

| School Name | Population | | Percent of Student Drivers | Number of Buses | Mobilization Time | Loading Time | Distance to EPZ Boundary |
|---|---|---|---|---|---|---|---|
| | Student | Staff | | | | | |
| Ashford Elementary School | 842 | 88 | 0% | 17 | 25 min | 15 min | 6 mi |
| Ashford High School | 814 | 66 | 20% | 13 | 25 min | 15 min | 6 mi |
| Houston County High School | 461 | 25 | 20% | 8 | 25 min | 15 min | 11 mi |
| Webb Elementary School | 501 | 33 | 0% | 10 | 25 min | 15 min | 1 mi |
| Houston County Career and Technical Center | 134 | 16 | 100% | 0 | N/A | N/A | 6 mi |
| Ashford Academy | 200 | 45 | 0% | 4 | 10 min | 30 min | 6.5 mi |

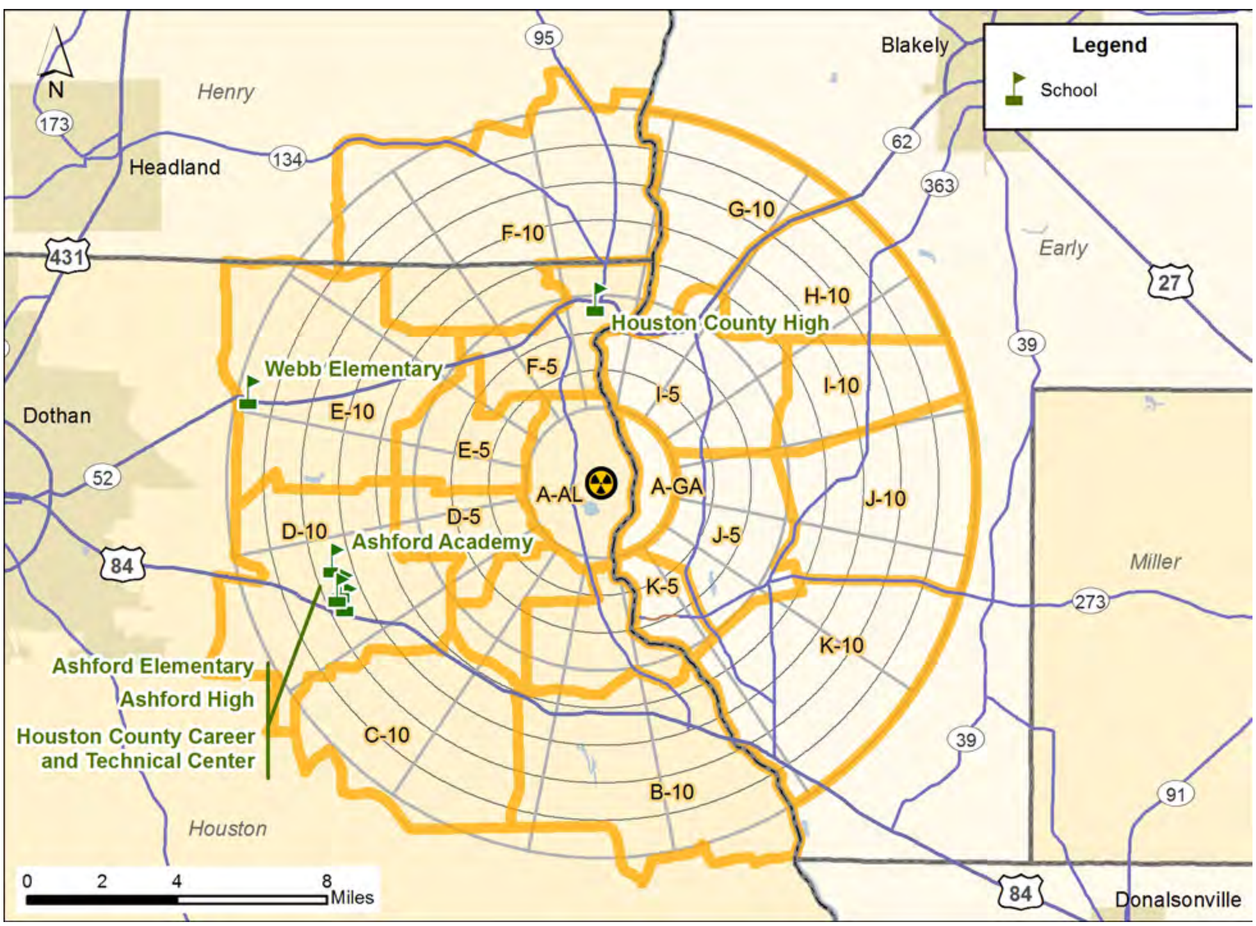


Figure 6: Map of Schools within the EPZ

## 3.5. Vehicle Occupancy Rate

Different vehicle occupancy rates (VOR) were used for the various categories of population (e.g., 1.5-1.6 vehicles per household for permanent residents; 1.5 people per vehicle for recreational area users). All workers were assumed to evacuate with a VOR of 1.25, whereas the recreational population was assumed to evacuate with a VOR of 1.5. After consultation with SNC emergency planners, students were assumed to evacuate via buses at a rate of 52 students per bus, with the remaining school population departing in their own cars (occupancy rate of 1.25). Table 13 shows the VORs by different population categories used for the evacuation modeling.

**Table 13: Vehicle Occupancy Rates by Population Categories**

| Population Category | Population Subtype | Vehicle Occupancy Rate |
|---|---|---|
| Permanent Residents | Auto-Owning Permanent | 1.5-1.6 |
| | Non-Auto-Owning Permanent | 2.1 |
| Transients | Work Force Transients | 1.25 |
| | Recreational Transients | 1.5 |
| School | Students | 52 |
| | Staff | 1.25 |

## 3.6. Summary of Demand Estimation

The total evacuation population and vehicles for different types and different scenarios are summarized in Table 14 and Table 15. There are more resident evacuees during the night and weekend because people do not need to commute to work or school at those times. Transient evacuees are at its peak level during the weekday because the majority is workers. There are also significant amount of transient population during the weekend, when the recreational population is at its peak level. The transient evacuees during the night are mainly the night shift workers of several industries within the EPZ. The shadow evacuees, who are assumed to be 20% of residents in the 10-15 mile ring, remain the same for weeknight and weekend. They are relatively less during the weekday because portion of the residents commute to work or school. As the vehicle occupancy rates for residents (including shadow evacuees) and transient population are determined by telephone survey and vary by scenario, the evacuation can be different for different scenarios, even if the population remains the same.

**Table 14: Population Summary Table**

| Scenario | Permanent residents | Transients | Schools | Transit Dependent | Shadow population |
|---|---|---|---|---|---|
| Weekday | 3,981 | 4,208 | 3,225 | 94 | 2,403 |
| Weeknight | 7,188 | 383 | - | 94 | 3,587 |
| Weekend | 7,188 | 1,003 | - | 94 | 3,587 |

**Table 15: Vehicle Summary Table**

| Scenario | Permanent residents | Transients | Schools | Transit-dependant | Shadow population |
|---|---|---|---|---|---|
| Weekday | 4,040 | 3,366 | 660 | --- | 2,030 |
| Weeknight | 4,467 | 292 | --- | --- | 2,229 |
| Weekend | 4,635 | 716 | --- | --- | 2,313 |

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# 4.0 EVACUATION ROADWAY NETWORK

The evacuation routes were modeled based on the information provided in the FNP 2012 emergency information calendar. Additional information regarding the evacuation routes was obtained from the past FNP ETE report and the county REPs. Maps and descriptions in both documents were used by IEM as the basis of network verification activity. IEM personnel also met with the FNP emergency response planning staff and county emergency preparedness officials regarding additional information and clarifications.

The 2012 emergency information calendar included a detailed description of the evacuation routes for each zone within the 10-mile radius plume exposure pathway EPZ. It provided descriptive information on recommended protective actions and the names and locations of reception centers for each PAZ. The map in the calendar clearly marks the evacuation routes and the direction of evacuation towards the respective reception centers. The reception centers are located well beyond the 10-mile EPZ.

IEM personnel drove along the designated evacuation routes in the direction of an evacuation, as marked on the 2012 emergency information calendar to collect complete and accurate information about the physical state of the roads. Any differences between information indicated in the calendar, NAVTEQ data, and existing field conditions were noted and were incorporated into the analyses, as necessary. Figure 7 shows the entire evacuation network (including the routes for shadow evacuees) that is modeled.

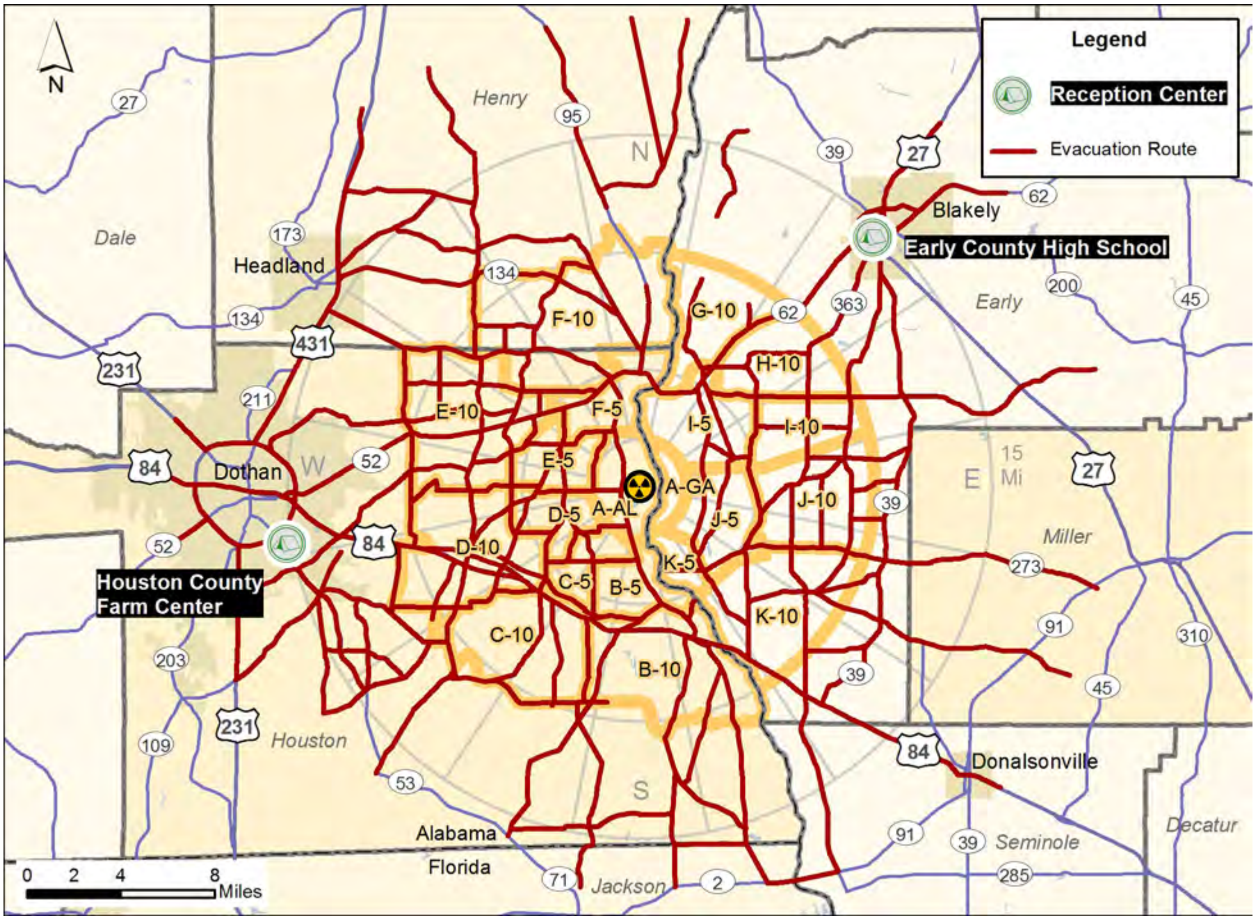


Figure 7: FNP Evacuation Network

## 4.1. Network Definition

IEM performed a complete review of the evacuation roadway network. The evacuation network was developed using published evacuation routes and GIS road network data representing roads available from NAVTEQ[25] and the Georgia Department of Transportation (GDOT) [26]. The high accuracy NAVTEQ street network GIS data, obtained for the PTV Vision simulation software, was used for field validation purposes and to build the digital evacuation network database. The GDOT data was used to supplement the NAVTEQ data where required. To ensure the accuracy of this data, the entire evacuation network, including those roads outside the 10-mile EPZ leading to the reception centers, was verified by traveling each route in the network in the direction of evacuation and collecting detailed information regarding the properties of each road

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[25] PTV America, Inc. "NAVTEQ Data for PTV VISION." Online: http://www.ptvamerica.com/navteq_tiles/index.html.

[26] Georgia Department of Transportation. Online: http://www.dot.state.ga.us. GDOT road network data was downloaded from the Georgia GIS Clearinghouse Web site: https://gis1.state.ga.us/index.asp. No such information was readily available on the Alabama Department of Transportation (ALDOT) website.

section using a Global Positioning System (GPS)-enabled device. The GPS allowed locating—with a high degree of precision—any sections that had changed in channelization, curvature, speed limits, or other necessary network information.

The specific network attributes that were collected during the field trip included number of lanes, speed, turns, traffic controls, pavement type and width, shoulder width, and any other information required to model the traffic capacity of each link in the network. The information collected during the field visit is listed as follows.

- *Land width* (in feet, field observation)
- *Shoulder width* (in feet, field observation)
- *Number of lanes* (field observation)
- *FFS* (in mph, field observation)
- *Speed limit* (in mph, field observation)
- *Intersection control method:* actuated signal, fixed timing signal, stop sign controlled, yield sign controlled, uncontrolled (field observation )
- Intersection layout (taking pictures)
- Toll gates and lane channelization (taking picture)
- *Access control*: whether road has full access control (field observation)
- *Median type*: divided or undivided cross section (road has divided cross section with >=4 ft median or curbed barrier median, note that two way left turn lanes can be considered as >4 ft median for evacuation scenarios) (field observation)
- *Pavement type*: whether the road is paved or not (field observation)
- *Terrain type*: level, rolling or mountainous area (field observation)
- *Separation line*: whether the two travel directions are separated by center lines (field observation)

## 4.2. Evacuation Route Descriptions

The evacuation network modeled for the ETE analyses covers Henry and Houston Counties in Alabama, and Early County in Georgia. The evacuation routes were originally developed by the Alabama and Georgia Emergency Management Agencies and county emergency officials. The evacuation route network is composed of three kinds of roads: highways, major arterial (roads connecting to highways), and minor arterial or connector roads (residential roads connecting to major arterial roads).

An example of a highway in the EPZ is U. S. Hwy 84. Examples of major arterials are Alabama State Road 95 (AL-95), Alabama State Road 52 (AL-52), Georgia State Road 62 (SR-62), and Georgia State Road 370 (SR-370). An example of a connector road is Bill Yance Road in Alabama. The connector roads, although not part of the evacuation routes described in the calendar, actually load the evacuee population onto the evacuation

routes. Figure 8 shows the evacuation routes in Alabama and Figure 9 shows the evacuation routes in Georgia.

Each evacuation route leads to one of two designated reception centers listed in Table 16 and shown graphically in both figures.

**Table 16: Reception Centers**

| State | Reception Center | Address | Evacuation Routes Listed in 2012 Emergency Information Calendar |
|---|---|---|---|
| Alabama | Houston County Farm Center | 1701 E Cottonwood Road<br>Dothan, AL 36301 | Go west on U.S. Hwy 84 or AL-52 to Ross Clark Circle in Dothan. Then go south on Ross Clark Circle to Houston County Farm Center located at the intersection of Ross Clark Circle and Cottonwood Road (AL-53) |
| Georgia | Early County High School | 12020 Columbia Street<br>Blakely, GA 39823 | Go east to SR-39. Then go north to Blakely or take SR-62 into Blakely. |

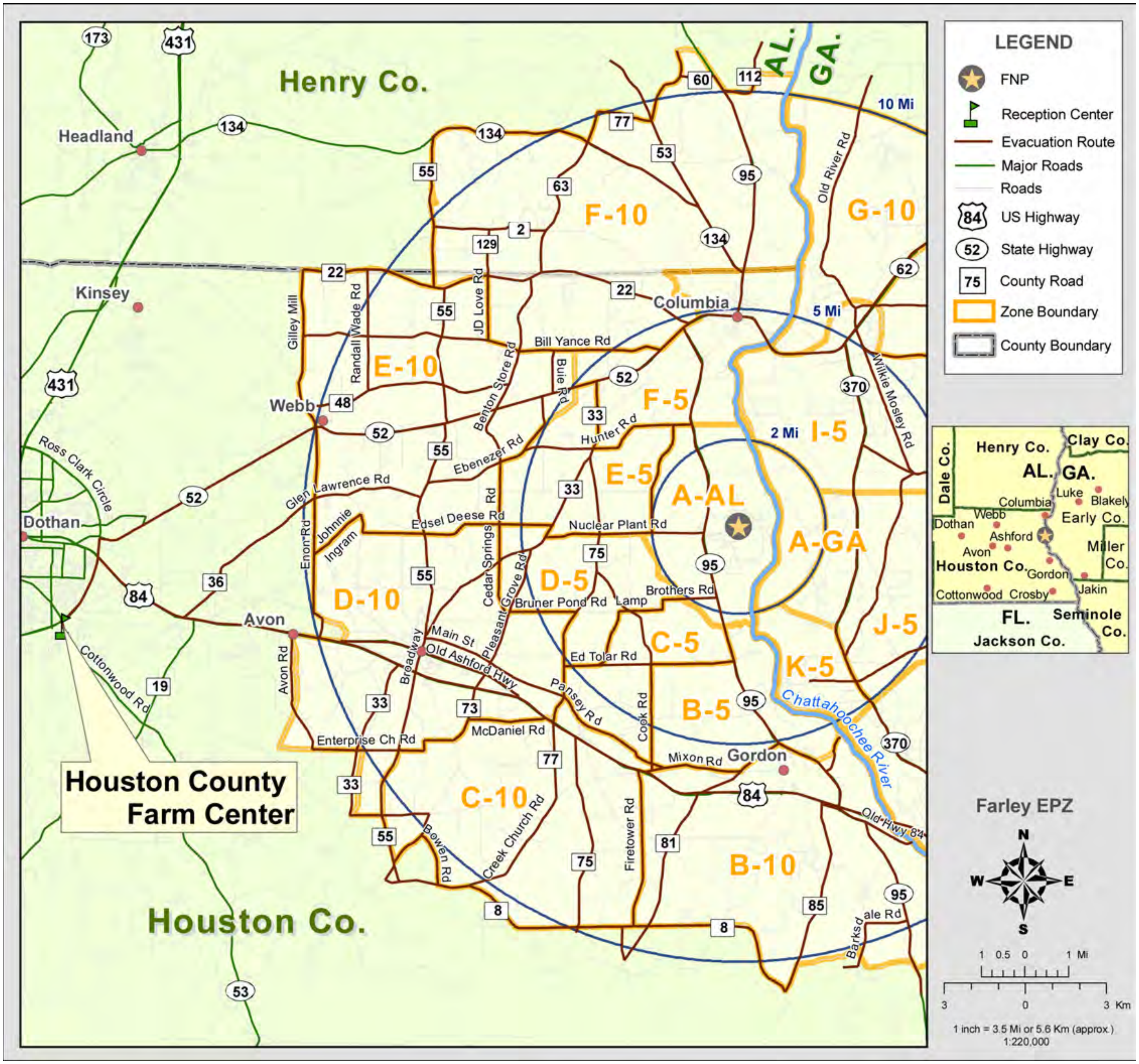


Figure 8: FNP Alabama Evacuation Routes

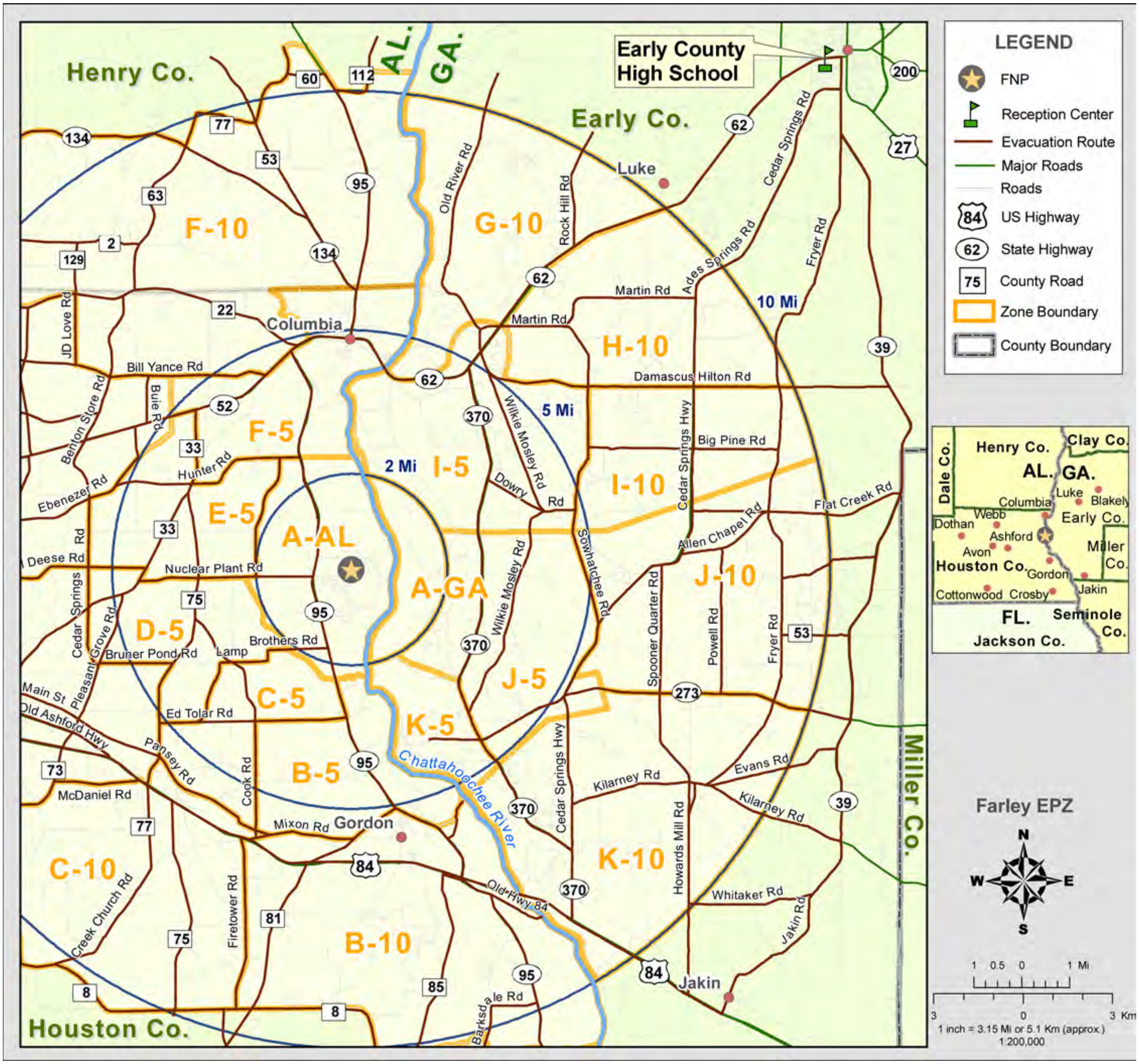


Figure 9: FNP Georgia Evacuation Routes

## 4.3. Evacuation Network Characteristics

The evacuation network, as modeled using the NAVTEQ street network data, contains 1,077 links[27] in the direction of evacuation and includes the connector roads. The total length of the modeled network, again in the direction of evacuation and all the way to the reception centers, is about 454 miles. Detailed information regarding the roads that make up the evacuation network is provided in Appendix B.

The state highways generally have a posted speed limit of 50–65 mph. The major and minor arterial or connector roads generally have a posted speed limit of 35-45 mph. On some of the roads, especially the highways, the posted speed limit decreases to 25 mph near city limit boundaries. Unpaved roads or dirt roads have randomly posted speed limits, so a speed limit of 20-25 mph was assumed for modeling purposes based on comfortable and safe driving speeds achieved by IEM personnel on these roads during field verification. Most of the links in the evacuation network (including some highways) generally have one lane available in the direction of evacuation. There are no interstates within the 10-mile plume exposure pathway EPZ. Two roads in the EPZ have network links with two lanes in the direction of evacuation— U.S. Hwy 84 west towards Ross Clark Circle in Dothan, Alabama, and U.S. Hwy 84 east toward Jakin, Georgia. AL-52 and GA SR-62 also have two lanes in the direction of evacuation along some sections (due to the presence of passing lanes). U.S. Hwy 84 has three lanes available in the direction of evacuation as it approaches Ross Clark Circle in Dothan.

Traffic control along the evacuation routes is mostly managed using stop signs. In Alabama, traffic lights were found along AL-95 (approaching center of Columbia), along AL-52 (approaching Dothan), along Ross Clark Circle (in Dothan), at the intersection of Broadway and Old U.S. Hwy 84 (in Ashford), and along U.S. Hwy 84 (approaching Dothan). In Georgia, a traffic light was found at the intersection of Church Street and Columbia Road in Blakely.

The number of intersections for different control types during the evacuation is listed in Table 17. There are 68 intersections that will be manned controlled and are modeled as actuated signal controlled, with varied cycle length. A few observed timing traffic signals in the network will be replaced by manned control during the evacuation.

**Table 17: Intersection Control Type**

| Control Type | Number of Intersections |
|---|---|
| Stop sign Control | 223 |
| Signal Control | 3 |
| Manned Control | 68 |

[27] A link is defined as a road section where its characteristics (e.g., speed limit and number of lanes) are constant. An intersection starts a new link or ends a link.

The key information for the ten highest volume intersections is listed in Table 18. Most of these intersections are not planned to be manned controlled, due to their relative distance from the FNP site. When minor roads intersect with the major roads, they are typically stop sign controlled. It is recommended to set up traffic control points at these intersections to facilitate the traffic flow from minor roads. Many of the ten highest volume intersection lie along U.S. Hwy 84, which serve as a backbone highway to transport evacuees in Appling County.

## Table 18: Information for Ten Highest Volume Intersections

| Location | Control Type | Cycle Length | Green Time | Evacuation Direction Turn | Turning Lane Queue Capacity (# vehicle)* |
|---|---|---|---|---|---|
| US-84 at CR-36 | Stop sign | N/A | N/A | Right turn from CR-36 to US-84; left turn from US-84 to CR-36 | 1 |
| US-84 at US-431 | Actuated Signal | Vary | 0 - 90 sec | Left turn from US-84 to US-431 | 7 |
| US-431 at SR-53 | Actuated Signal | Vary | 0 - 90 min | Left turn from US-431 to SR-53 | 22 |
| SR-53 at Houston County reception center | Manned | Vary | 0 - 5 min | Left and right turn from SR-53 to Houston County reception center | 0 |
| CR-36 at SR-53 | Stop sign | N/A | N/A | Left turn from CR-36 to SR-53 | 1 |
| Ross Clark Cir at US-431 | Actuated Signal | Vary | 0 - 45 sec | Left turn from Ross Clark Cir to US-431 | 0 |
| Bluffspring Road at US-84 | Stop sign | N/A | N/A | Right turn from Bluffspring Road toUS-84 | 0 |
| CR-57 at US-84 | Stop sign | N/A | N/A | Right turn from CR-57 Road toUS-84 | 0 |
| CR-55/N Broadway at US-84 | Stop sign | N/A | N/A | Right turn from CR-55 Road toUS-84 | 2 |
| Enon Road at SR-52 | Manned | Vary | 0 - 2 min | Enon Road at SR-52 | 2 |

* Queue capacity for turning lane of the evacuation direction

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# 5.0 EVACUATION TIME ESTIMATE METHODOLOGY

ETEs are developed using VISUM 11, one of the core components of the PTV Vision software suite. VISUM is used to estimate evacuation times for different scenarios (e.g., day vs. night or normal vs. adverse weather) for user-defined spatial networks. Information provided by PTV Vision includes evacuation or clearance times, operational characteristics (e.g., average evacuation speed, average distance traveled), points of congestion, and other data necessary to evaluate evacuation plans.

The evacuation network was defined based on the information provided in the 2012 Emergency Information Calendar. IEM subject matter experts drove the designated routes to ensure complete and accurate information about the state of the roads and to evaluate the appropriate selection of routes given the current conditions onsite.

Evacuation demand (in term number of vehicles) loaded onto the network is based on the data and methods described above in the Section 3.0. Loading times for the evacuation network are described below. Additional details about the methodology are included in the following sections.

## 5.1. Loading of the Evacuation Network

In the event of an emergency, the public notification will mark the beginning of the evacuation times. So, public behavior (how long it takes the population to learn of the emergency and begin to evacuate) will impact the ETEs. The loading time distributions, also known as “trip generation times,” described in this section are measured from the public notification, rather than from the occurrence of a hypothetical event.

### 5.1.1. Trip Generation Events and Activities

NUREG/CR-7002 requires planners estimate the amount of time for the public to begin evacuating. These elapsed times are represented as statistical distributions to reflect the variety of activities the public may undertake before evacuating. In addition, separate distributions are prepared for each population group, because, for example, a person evacuating from home will behave differently than someone who is at work, fishing, or in a nursing home, This is due to differences in their available alert systems and also systematic differences in their pre-evacuation preparations.

#### (i) Evacuation Events and Activities Series for Different Population Groups

The trip generation process consists of a series of events and activities. Each event occurs at an instant in time and is the outcome of an activity. Activities are undertaken over a period of time. As shown in Figure 10, Figure 11, and Figure 12, different population groups have different events and activity series for evacuation.

In these figures, circles represent events. Each event is coded by a number, which represents the following:

1. First notification of public
2. Individual's awareness of incident
3. Leave work/facilities
4. Arrive home
5. Leave home

An arrow indicates an activity. The following describe the activities that take place between each event:

- 1 → 2: Receive notification
- 2 → 3: Prepare to leave work/facilities
- 3 → 4: Travel home
- 2 → 5: Prepare to leave home

Transient evacuees, including travelers, boaters, hunters, and employees living outside the EPZ, will follow Series A as shown in Figure 10. They will be notified of the event and will leave their activities.

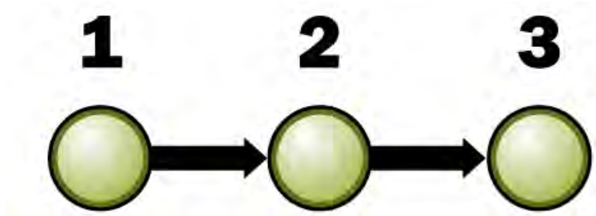


**Figure 10: Evacuation Events and Activity Series for Transients, Special Facilities (Series A)**

Households that do not have to wait for household members to return home will be notified of the emergency and leave home, following Series B, shown in Figure 11.

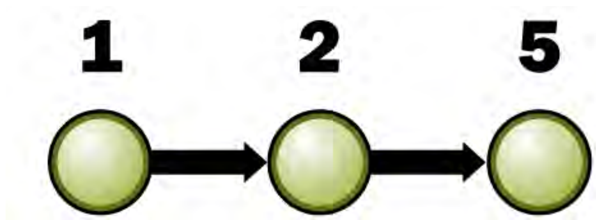


**Figure 11: Evacuation Events and Activity Series for Residences without Family Members Returning Home (Series B)**

The results of a phone survey suggest around 25% of residences have regular commuters who would wait for household members to return home before evacuating. This portion of the population will follow series C in Figure 12 to evacuate. Note the activities of the people at home (denoted with a subscript H) can be undertaken in parallel with those of the commuter (denoted with a subscript C). Specifically, an adult member of a household

can prepare to leave home while others are traveling home from work. In this instance, the household members would be able to evacuate sooner than a household that prepares to leave home after all members have returned home.

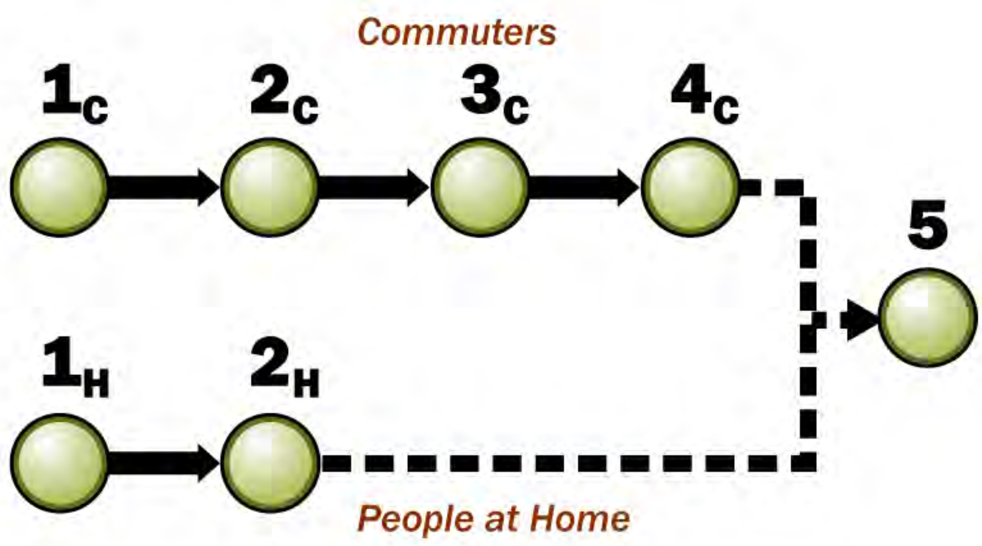


**Figure 12: Evacuation Events and Activity Series for Residences with Family Members Returning Home (Series C)**

### (ii) Calculation of Composite Distribution for Events and Activities Series in Evacuation

As indicated by NUREG/CR-7002, activities may be in sequence (i.e., an activity will be undertaken upon completion of a preceding event) or may be in parallel (i.e., two or more activities may take place over the same period of time). Given the assumption the time distribution of each activity is independent, the combined trip generation time required for individual activities undertaken in sequence would be the sum of the times required for each activity. On the other hand, the combined trip generation time required for individual activities undertaken in parallel would be the maximum of the times required for each activity. Table 19 shows the approach for estimating trip generation for different evacuation activity series.

**Table 19: Trip Generation Estimate for Different Evacuation Activity Series**

| Trip Generation Series | Composite Distribution Calculation |
|---|---|
| A | {1→2 + 2→3} |
| B | {1→2 + 2→5} |
| C | Max: {($1_C$→$2_C$ + $2_C$→$3_C$ + $3_C$→$4_C$), ($1_H$→$2_H$ + $2_H$→5)} |

### 5.1.2. Trip Generation Time Estimate

Trip generation consists of two phases of activities: notification (i.e., activity 1 → 2) and mobilization, which includes the rest of the activities. The notification process includes transmitting information and receiving and correctly interpreting the information that is transmitted. IEM adopted the time distribution for notification presented in *Evaluating Protective Actions for Chemical Agent Emergencies* (EPACAE).[28] This data was collected during evacuations executed in response to large-scale chemical spills and explicitly incorporates the time required for the communication of the warning. The data collected in this meta-study was based on transient, permanent, and special populations and is therefore appropriate to use as “general” notification curves for all three population types.

The underlying assumption in applying the EPACAE notification curves to a nuclear ETE study is the public perception of radiological emergencies is similar to that of a chemical event. These curves were developed from the empirical data collected from real-life evacuations in response to actual events, and no similar study developed specifically for radiological events is readily available. In the absence of such a study, empirical data from similar events was deemed to be more justifiable than estimating or hypothesizing about the public response to a nuclear event. IEM has successfully used this data for multiple ETE studies in the past, both for nuclear and chemical incidents or accident scenarios.

Since the EPACAE notification distribution of times depends on the warning system employed, IEM personnel incorporated the planned alert and notification systems (ANS) around the site, based on discussions with Southern Nuclear personnel. These discussions revealed the basic ANS within the FNP EPZ will include sirens, Emergency Alert Systems (EAS) (including local radio and television stations) and a rapid calling capability (RCC). The notification time distributions for these warning systems are shown in Figure 13. Any loss in capability of the ANS components would potentially increase the notification times and, as a result, ETEs.

[28] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

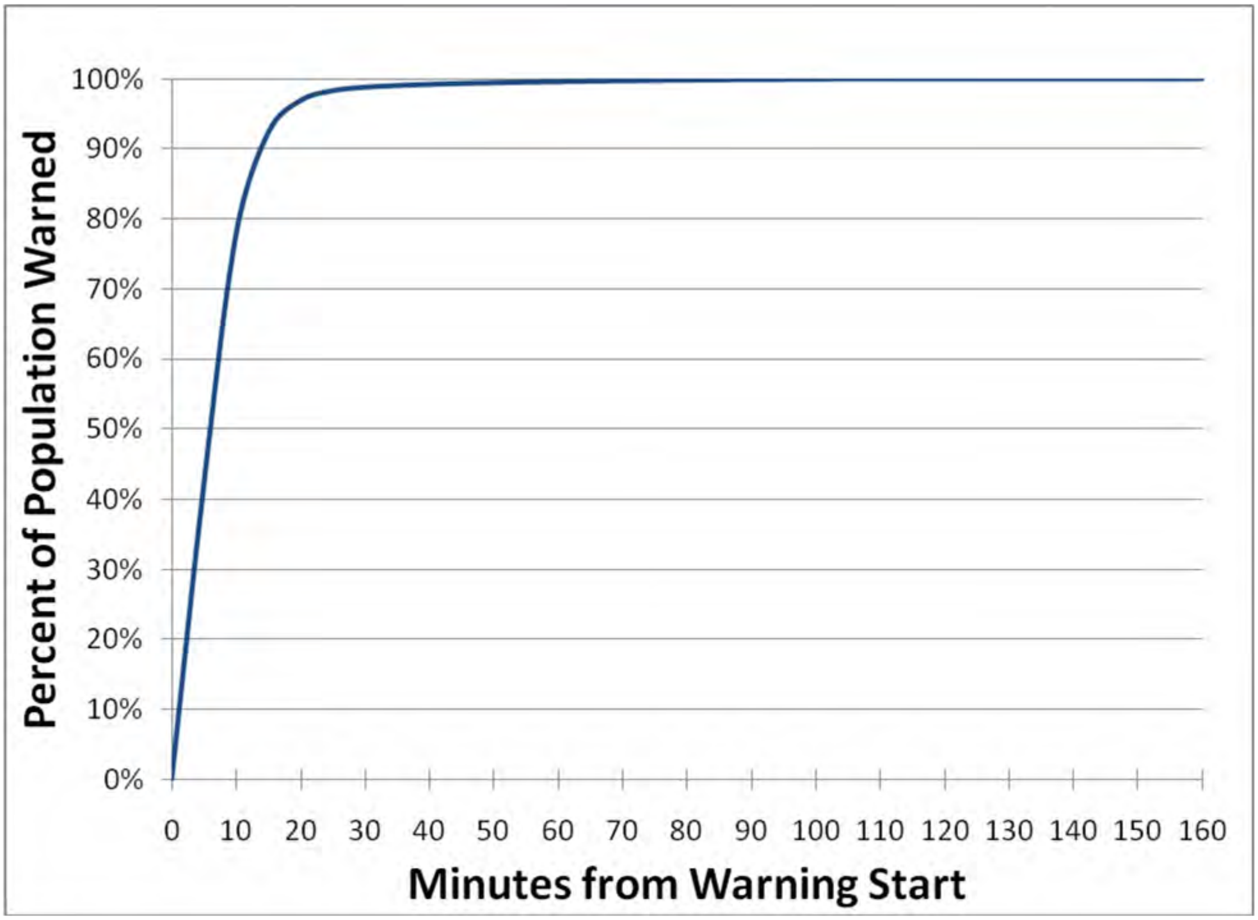


**Figure 13: Notification Times for Selected Alert and Notification Systems[29]**

Notification times for hunters, boaters, and park visitors were increased by 45 minutes to allow time for local emergency officials to patrol the forest, river, or park with loud speakers to warn visitors.

Generally, the information required to estimate the second phase of trip generation, the mobilization process, was obtained from a telephone survey of EPZ residents, supplemented by mobilization time estimated for similar sites. See Appendix C for details about the survey and its raw data.

Mobilization times will vary from one individual to the next depending on where they are, what they are doing, and related factors. Furthermore, some persons, including commuters, shoppers, and other travelers, will return home to join the other members of their households for evacuation upon receiving notification of an emergency. Therefore, the time elapsed for those people to travel home should be considered as part of the mobilization time before evacuation can begin.

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[29] *Ibid.*

Figure 14 presents the distribution of trip generation times (i.e., the combination of notification and mobilization times) for different population groups. These curves were obtained by applying the methodology described in Table 19 to the activities of each population group.

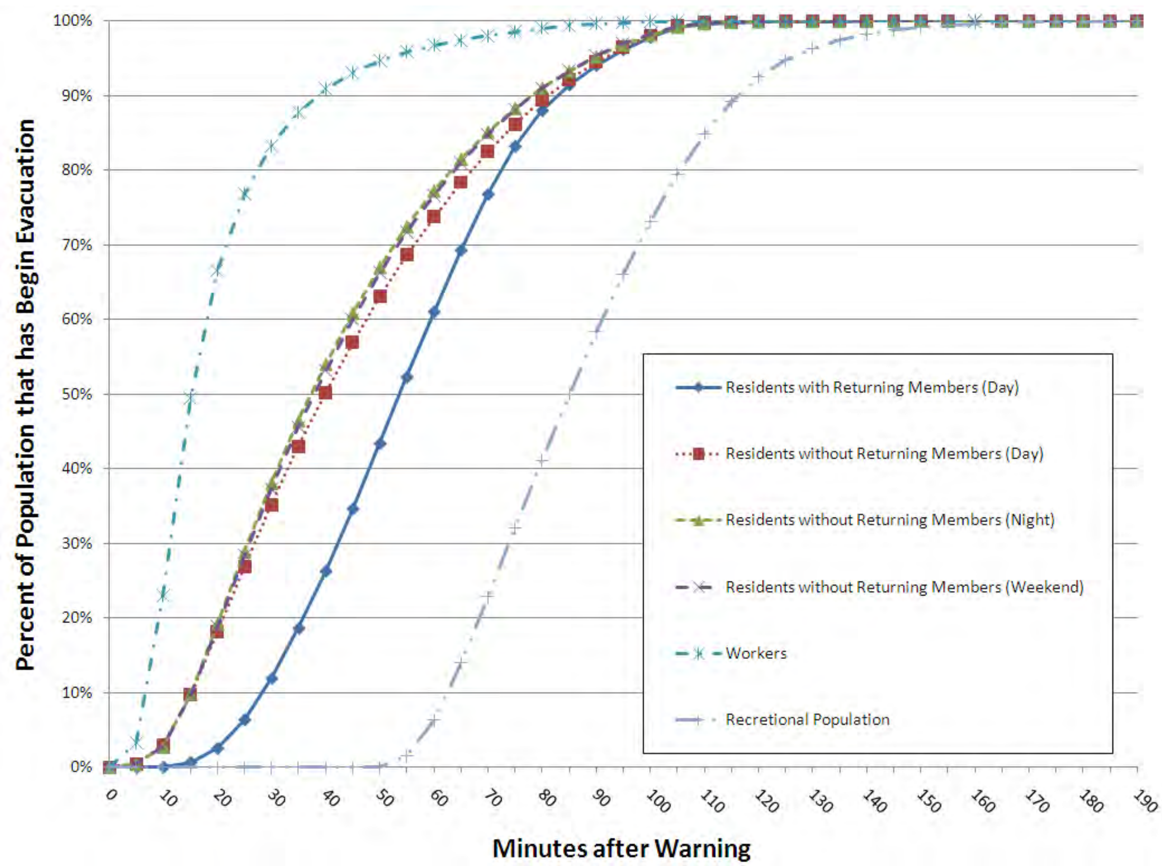


**Figure 14: Distribution of Trip Generation Times by Population Group**

## 5.1.3. Trip Generation Time for Transit Dependent Permanent Residents

As described in Section 3.3, the transit dependent permanent residents in the FNP EPZ are estimated at 94. Table 20 shows the assumptions for determining the trip generation time for evacuating the transit dependent population. The trip generation time for the transit dependent population was determined by consulting with relevant EMA personnel and the SNC planning staff.

**Table 20: Trip Generation Time for Transit Dependent Permanent Residents**

| Transit Dependent Category | County | Assumptions | Trip Generation Time |
|---|---|---|---|
| Wheelchair | Houston | Residents will evacuate by special equipped vehicles | 36 minutes |
| | Henry | Residents will evacuate by special equipped vehicles | 36 minutes |
| | Early | Residents will evacuate by special equipped vehicles | 36 minutes |
| Transportation | Houston | Residents will evacuate by school bus | 36 minutes |
| | Henry | Residents will evacuate by school bus | 36 minutes |
| | Early | Residents will evacuate by school bus | 46 minutes |
| Immobile | Houston | Residents will evacuate by ambulance | 46 minutes |
| | Henry | Residents will evacuate by ambulance | 46 minutes |
| | Early | Residents will evacuate by ambulance | 46 minutes |

### 5.1.4. Trip Generation Time for Schools

As described in Section 3.4, there are six schools within the FNP EPZ. IEM assumed that it will take 40 minutes (from the start of the notification) for loading the students onto evacuation vehicles and another 5 minutes for the school staff to be ready to leave. Table 21 shows the assumptions for determining the trip generation time for the school population. The trip generation times for the schools were determined by consulting with relevant personnel at the facilities.

**Table 21: Trip Generation Time for Population in Schools**

| Facility Category | Facility Name | Assumptions | Trip Generation Time |
|---|---|---|---|
| School Students | Ashford Elementary School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Ashford Elementary School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |
| School Students | Ashford High School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Ashford High School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |
| School Students | Houston County High School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Houston County High School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |

| Facility Category | Facility Name | Assumptions | Trip Generation Time |
|---|---|---|---|
| School Students | Webb Elementary School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Webb Elementary School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |
| School Students | Houston County Career and Technical Center | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Houston County Career and Technical Center | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |
| School Students | Ashford Academy | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Ashford Academy | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |

## 5.2. Evacuation Simulation

Evacuations were simulated using the population and vehicle demand data, evacuation network data, and loading distribution data discussed in the previous sections. VISUM 11 was used to simulate evacuations. Figure 15 describes the framework of the analysis and three of its main features: the demand model, the network model, and the impact model.

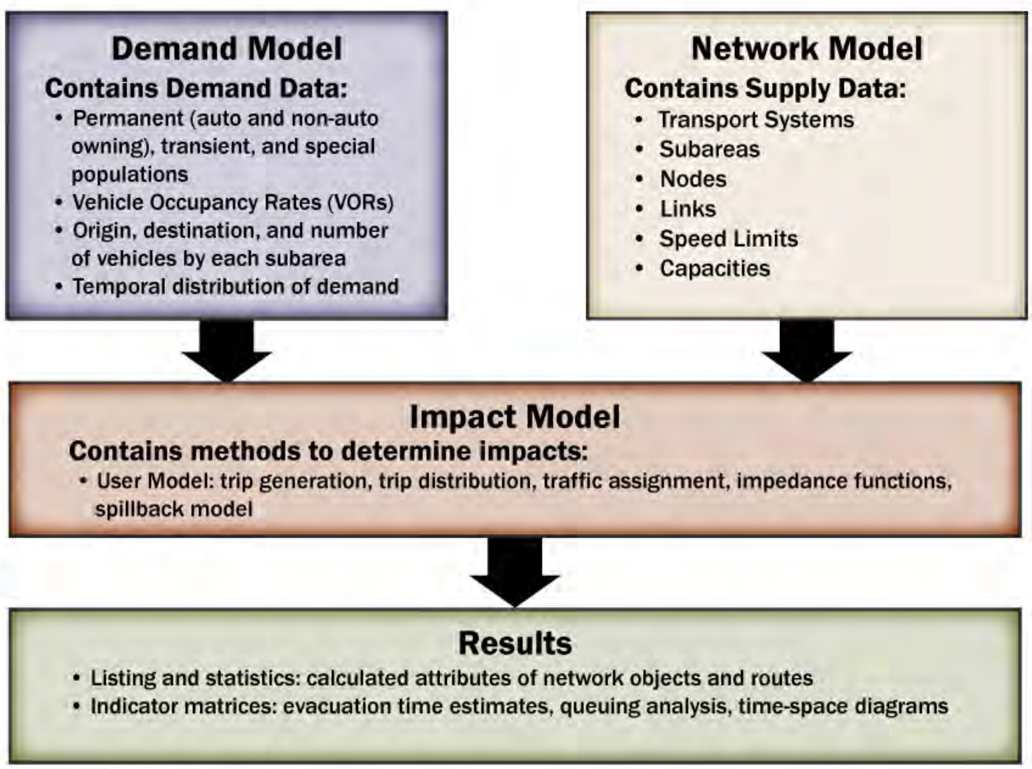


**Figure 15: ETEs Analysis Framework Using VISUM**

### 5.2.1. The Demand Model

The demand model contains the travel demand data. The total number of vehicles originating from a zone is calculated by dividing a population with its expected vehicle occupancy rate. The total number of vehicles originating from a zone is then distributed to different time intervals based on the loading distribution curve for the zone. The loading distribution curve for the zone depends on the warning system available for that zone. The travel demand is described by an origin-destination (OD) matrix. The OD matrix refers to a time interval and the total number of vehicles departing in that time interval.

### 5.2.2. The Network Model

The network model describes the relevant supply data of an evacuation network. The supply data consists of subareas, nodes, links, speed limits, and capacities. The subareas describe areas with particular boundaries based on demography, topography, land characteristics, access routes, and local jurisdictions. They represent the origin and destination of trips within the evacuation network. Nodes define positions of intersections in the evacuation network. Links connect nodes and, therefore, describe the road infrastructure. Every network object is described by its attributes (e.g., speed limits and capacities for the links). The travel time of a vehicle on a given link depends on the permitted speed and the capacity (i.e., the traffic volume a road can handle before the formation of a traffic jam) of the link. The roadway capacities used in the evacuation analysis were calculated using the field collected road attributes and capacity calculation methodology from the U.S. Federal Highway Administration.[30] The details of roadway capacity calculation method are presented as follows.

#### (i) Roadway Capacity Calculation Method

IEM estimated roadway capacity based on road type and free flow speed. Using the characteristics data field (e.g., access control, median type, number of lanes in one direction, pavement type), roadway is categorized into the following five types: 1) full access controlled road; 2) rural multilane highway; 3) urban multilane highway; 4) single lane road; 5) unpaved road. The classification method is shown in the flow chart below.

[30] U.S. Federal Highway Administration. “Highway Performance Monitoring System Field Manual, Appendix N - Procedures for Estimating Highway Capacity.” Online: http://www.fhwa.dot.gov/ohim/hpmsmanl/appn.htm.

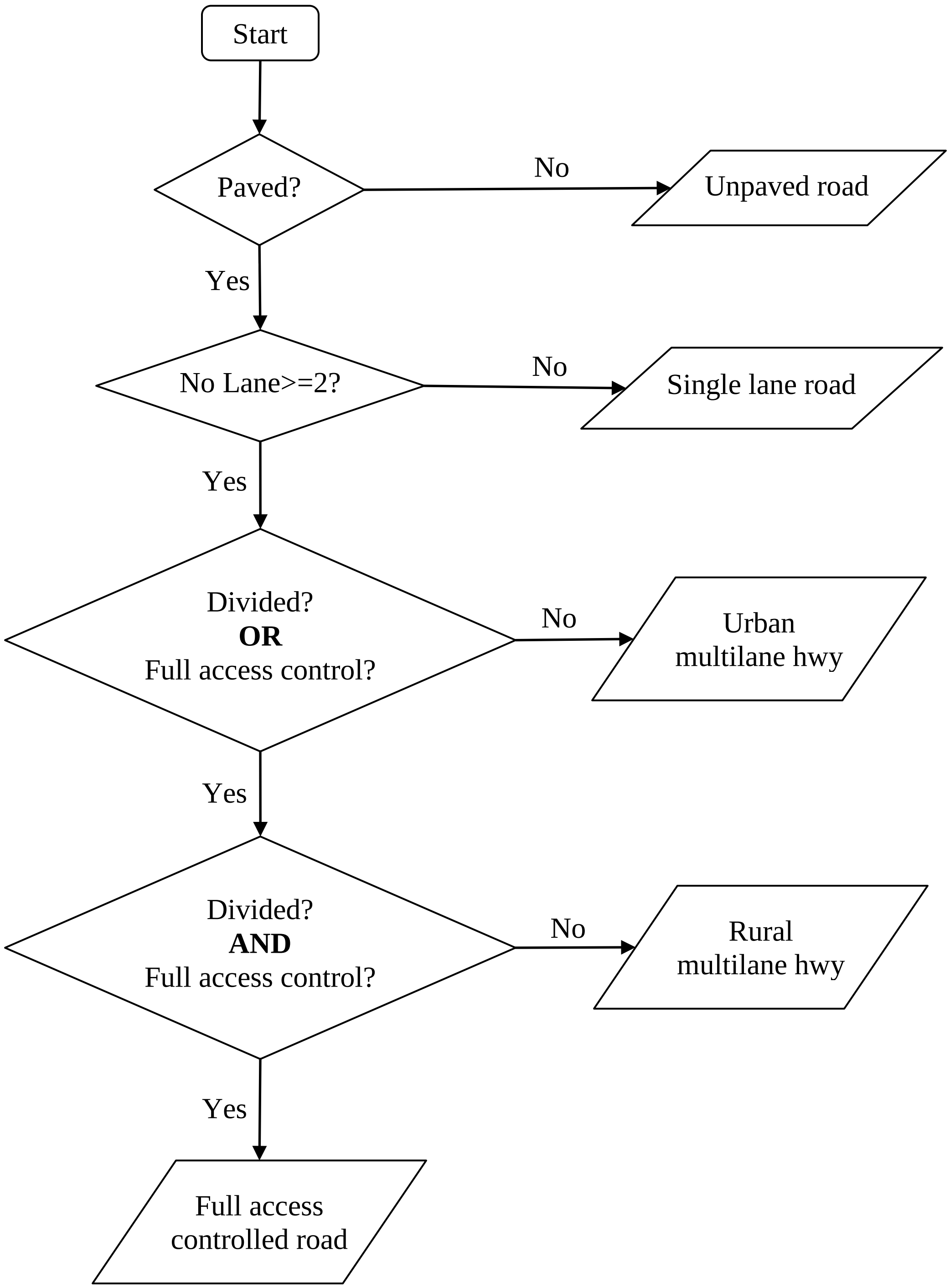


**Figure 16: Roadway Type Classification Method**

Once the roadway type is determined, the capacity (in vehicle per lane per hour) can be calculated for each road segment using the following method.

- Full access controlled road: Capacity = 1700 + *FFS* * 10 with maximum of 2400
- Rural multilane highway: Capacity = 1000 + *FFS* * 20 with maximum of 2200
- Urban multilane highway: Capacity = 1900
- Single lane road: Capacity = 1700 * $f_G$ - $V_{NP}$
- Unpaved road: Capacity = 800 * $f_G$ - $V_{NP}$

The unit for capacity of the above formula is pcplph (passenger car per lane per hour). One need is to multiply this value by number of lanes to obtain the capacity for all lanes in the unit of pcph (passenger car per hour). No heavy vehicle factor adjustment should be made to the adjustment because VISUM needs capacity as an input in passenger car units and heavy vehicles are modeled as different vehicle groups than the passenger cars. Peak hour factor (PHF) should not be considered for adjusting capacity in modeling, as modeling time step is typically less than 15 min (e.g., 5 min).

FFS *(definition: The desired speed of drivers in low volume conditions and in the absence of traffic control devices or other adverse conditions.)* is the key to estimate capacity and is a required input for modeling. It can be directly estimated in the field and is typically 5-10 mph higher than the speed limit.

$f_G$ and $V_{NP}$ are an adjustment factor for grades and an adjustment value for no passing zones. $f_G$ can be found from Table 22[31]. If no other information is available, one may assume the two-way flow rate is in the range 0-600 pcph.

**Table 22: Grade Adjustment Factors ($f_G$)**

| Two-Way Flow Rates (pcph) | Level | Rolling | Mountainous |
|---|---|---|---|
| 0-600 | 1.00 | 0.71 | 0.57 |
| >600-1,200 | 1.00 | 0.93 | 0.85 |
| >1,200 | 1.00 | 0.99 | 0.99 |

[31] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 6, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

$V_{NP}$ can be calculated as $V_{NP} = f_{NP} / 0.00776$, where $f_{NP}$ is the adjustment factor for no-passing zones on average travel speed and can be found in Table 23[32]. If no other information is available, one may assume the two-way flow rate is in the range 101-300 pcph, with a no passing zone percentage of 50% for separated roads and 90% for non-separated roads.

**Table 23: Adjustment ($f_{np}$) for Effect of No-Passing Zones on Average Travel Speed on Two-Way Segments**

| Two-Way Demand Flow Rate, $v_p$(pcph) | Reduction in Average Travel Speed (mph) No-Passing Zones (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 0-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 101-300 | 0.0 | 0.3 | 0.6 | 1.0 | 1.4 | 1.9 | 2.4 | 2.5 | 2.6 | 3.1 | 3.5 |
| 301-500 | 0.0 | 0.9 | 1.7 | 2.2 | 2.7 | 3.1 | 3.5 | 3.7 | 3.9 | 4.2 | 4.5 |
| 501-700 | 0.0 | 0.8 | 1.6 | 2.0 | 2.4 | 2.7 | 3.0 | 3.2 | 3.4 | 3.7 | 3.9 |
| 701-900 | 0.0 | 0.7 | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.6 | 2.7 | 2.9 | 3.0 |
| 901-1,100 | 0.0 | 0.6 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 2.2 | 2.4 | 2.6 |
| 1,101-1,300 | 0.0 | 0.4 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.1 |
| 1,301-1,500 | 0.0 | 0.3 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 |
| 1,501-1,700 | 0.0 | 0.3 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| 1,701-1,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 |
| 1,901-2,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 |
| 2,101-2,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 |

[32] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 8, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

| Two-Way Demand Flow Rate, $v_p$(pcph) | Reduction in Average Travel Speed (mph) No-Passing Zones (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 2,301-2,500 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 |
| 2,501-2,700 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 |
| 2,701-2,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 |
| 2,901-3,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 |
| 3,101-3,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| >3,300 | 0.0 | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

### (ii) Roadway Capacity Calculation Example

Link #9 (node 0017 to node 7791, shown in Figure 19 and

Table 33: Glossary of Terms for Roadway Links Inputs

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

) as a segment of GA-134 is a rural single lane road located in a level area with approximate 50% no-passing zones and the two-way traffic is estimated in a range of 101-300. Therefore, its capacity is estimated as 1700 * 1.0 – 1.9/0.00776 = 1455 pcph.

Another example is link #196 (node 0373 to 7496, shown in Figure 19 and

Table 33: Glossary of Terms for Roadway Links Inputs

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

) as a segment of U.S. Hwy 84 is a rural multi-lane highway with two lanes in each direction and free flow speed of 65 mph. Therefore, its capacity is estimated as 2 * *max* (2200, 1000 + 65 * 20) = 4400 pcph.

### 5.2.3. The Impact Model

The impact model takes its input data from the demand model and the network model. PTV Vision provides different impact models to analyze and evaluate the evacuation network. A user model simulates the behavior of travelers. It calculates traffic volumes and service indicators, such as travel time. The VISUM traffic assignment procedure chosen for this analysis simulates the movement of vehicles on the network as time passes in the evacuation and outputs volumes for each link at each time after analyzing the queuing behavior. This time-dynamic functionality allows for loading of the network via distributions, as when using a range of mobilization times.

The ETEs are measured by noting the time and counting the number of vehicles passes the boundary of the EPZ. VISUM displays the calculated results in graphic and tabular forms and allows graphical analysis of results. In this way, for example, routes per OD pair, traffic flow, and isochrones can be displayed and analyzed. Using the outputs from VISUM, IEM modeler was able to ensure that the traffic simulation model is in equilibrium, by checking whether the number of vehicles entering the roadway network is equal to the number of vehicles exiting the network.

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# 6.0 ANALYSIS OF EVACUATION TIMES

Evacuation times were estimated in order to give emergency planners in the area an approximate time required for evacuation of various parts of the footprint. The estimates were derived by using population (demand) data to determine the number of vehicles and then modeling the travel of the vehicles along the evacuation routes from their origin to their assigned reception center. Both 100% and 90% ETE were studied. The 100% ETE is the time between public notification and when the last evacuating vehicle exits the EPZ. On the other hand, 90% ETE is the time between public notification and when 90% of the evacuating vehicles exit the EPZ.

The ETEs are composed of two components. The first is loading (or "trip generation") time, which is the time required for residents within the area to prepare and then begin their evacuation. Loading times depend, in part, on how long it takes evacuees to receive the warning and is, thus, dependent on the warning systems in their area. The trip generation times estimated for the FNP EPZ are described in detail in Section 5.1. The second component of an ETE is travel time, which is the time between the resident's departure and when they cross the EPZ boundary. The travel time is determined via the evacuation model.

As a part of the analysis, zones in the study area were grouped to represent the different areas that might need to be evacuated during an incident, so that the decision makers could more effectively order evacuations based on the scenarios and potential wind direction. These areas are discussed in more detail in Section 1.2.

Each zone had been assigned a set of evacuation routes by State and local EMA planners, and these route restrictions were reflected in the modeling of the scenarios. These guidelines generally route evacuees based on the county these are located at the time of the incident. The evacuation routes are described in more detail in Section 4.2.

## 6.1. Summary of ETE Results for General Public

The evacuation time estimate results are displayed in Table 24 and Table 25. Evacuation times listed include warning diffusion, public mobilization, and travel time out of the EPZ. It is important to note that the evacuation time is the time from the moment at which public notification begins—not the start time of a hypothetical event.

## Table 24: 2012 100% ETEs in Minutes

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 125 | 125 | 120 | 125 | 125 | 125 |
| A, B-5, C-5, D-5, E-5, F-5, I-5, J-5, K-5 | 5-mile ring | 190 | 180 | 185 | 190 | 180 | 190 |
| All Evacuation Zones | 10-mile EPZ | 200 | 195 | 195 | 205 | 195 | 200 |
| **Evacuate 2 to 5 miles downwind** | | | | | | | |
| K-5, B-5, C-5 | N | 175 | 170 | 170 | 180 | 170 | 175 |
| B-5, C-5, D-5 | NNE | 140 | 135 | 150 | 145 | 135 | 150 |
| B-5, C-5, D-5 | NE | 140 | 135 | 150 | 145 | 135 | 150 |
| C-5, D-5, E-5 | ENE | 140 | 135 | 135 | 140 | 135 | 140 |
| D-5, E-5 | E | 135 | 135 | 135 | 135 | 135 | 135 |
| D-5, E-5, F-5 | ESE | 180 | 160 | 170 | 185 | 165 | 175 |
| E-5, F-5 | SE | 180 | 160 | 170 | 185 | 165 | 175 |
| E-5, F-5, I-5 | SSE | 180 | 160 | 175 | 185 | 165 | 180 |
| F-5, I-5 | S | 180 | 165 | 175 | 185 | 165 | 180 |
| F-5, I-5 | SSW | 180 | 165 | 175 | 185 | 165 | 180 |
| I-5, J-5 | SW | 145 | 135 | 150 | 145 | 140 | 155 |
| I-5, J-5 | WSW | 145 | 135 | 150 | 145 | 140 | 155 |
| I-5, J-5 | W | 145 | 135 | 150 | 145 | 140 | 155 |
| J-5, K-5 | WNW | 175 | 170 | 170 | 175 | 170 | 170 |
| J-5, K-5, B-5 | NW | 175 | 170 | 170 | 180 | 170 | 175 |
| J-5, K-5, B-5 | NNW | 175 | 170 | 170 | 180 | 170 | 175 |
| **Evacuate 2-mile zone and 5 miles downwind** | | | | | | | |
| A, K-5, B-5, C-5 | N | 175 | 170 | 170 | 180 | 170 | 175 |
| A, B-5, C-5, D-5 | NNE | 140 | 135 | 150 | 145 | 135 | 150 |
| A, B-5, C-5, D-5 | NE | 140 | 135 | 150 | 145 | 135 | 150 |
| A, C-5, D-5, E-5 | ENE | 140 | 135 | 135 | 140 | 135 | 140 |
| A, D-5, E-5 | E | 135 | 135 | 135 | 135 | 135 | 135 |
| A, D-5, E-5, F-5 | ESE | 180 | 160 | 170 | 185 | 165 | 175 |
| A, E-5, F-5 | SE | 180 | 160 | 170 | 185 | 160 | 175 |
| A,E-5, F-5, I-5 | SSE | 180 | 165 | 175 | 185 | 165 | 180 |
| A, F-5, I-5 | S | 180 | 165 | 175 | 185 | 165 | 180 |
| A, F-5, I-5 | SSW | 180 | 165 | 175 | 185 | 165 | 180 |

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A, I-5, J-5 | SW | 145 | 135 | 150 | 145 | 140 | 155 |
| A, I-5, J-5 | WSW | 145 | 135 | 150 | 145 | 140 | 155 |
| A, I-5, J-5 | W | 145 | 135 | 150 | 145 | 140 | 155 |
| A, J-5, K-5 | WNW | 175 | 170 | 170 | 175 | 170 | 170 |
| A, J-5, K-5, B-5 | NW | 175 | 170 | 170 | 180 | 170 | 175 |
| A, J-5, K-5, B-5 | NNW | 175 | 170 | 170 | 180 | 170 | 175 |

**Table 25: 2012 90% ETEs in Minutes**

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 95 | 90 | 90 | 95 | 90 | 90 |
| A, B-5, C-5, D-5, E-5, F-5, I-5, J-5, K-5 | 5-mile ring | 95 | 95 | 105 | 95 | 95 | 105 |
| All Evacuation Zones | 10-mile EPZ | 105 | 95 | 110 | 110 | 95 | 110 |
| Evacuate 2 to 5 miles downwind | | | | | | | |
| K-5, B-5, C-5 | N | 80 | 75 | 85 | 80 | 80 | 85 |
| B-5, C-5, D-5 | NNE | 80 | 80 | 85 | 85 | 80 | 85 |
| B-5, C-5, D-5 | NE | 80 | 80 | 85 | 85 | 80 | 85 |
| C-5, D-5, E-5 | ENE | 80 | 80 | 80 | 85 | 80 | 80 |
| D-5, E-5 | E | 80 | 75 | 80 | 80 | 80 | 80 |
| D-5, E-5, F-5 | ESE | 85 | 85 | 95 | 85 | 85 | 95 |
| E-5, F-5 | SE | 85 | 80 | 95 | 85 | 85 | 95 |
| E-5, F-5, I-5 | SSE | 85 | 85 | 95 | 85 | 85 | 95 |
| F-5, I-5 | S | 85 | 85 | 95 | 85 | 85 | 95 |
| F-5, I-5 | SSW | 85 | 85 | 95 | 85 | 85 | 95 |
| I-5, J-5 | SW | 80 | 75 | 85 | 85 | 80 | 85 |
| I-5, J-5 | WSW | 85 | 75 | 85 | 85 | 80 | 85 |
| I-5, J-5 | W | 85 | 75 | 85 | 85 | 80 | 85 |
| J-5, K-5 | WNW | 75 | 75 | 75 | 80 | 80 | 80 |
| J-5, K-5, B-5 | NW | 80 | 75 | 85 | 80 | 80 | 85 |
| J-5, K-5, B-5 | NNW | 80 | 75 | 85 | 80 | 80 | 85 |

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | |
| A, K-5, B-5, C-5 | N | 80 | 75 | 85 | 80 | 80 | 85 |
| A, B-5, C-5, D-5 | NNE | 80 | 80 | 85 | 85 | 80 | 85 |
| A, B-5, C-5, D-5 | NE | 80 | 80 | 85 | 85 | 80 | 85 |
| A, C-5, D-5, E-5 | ENE | 80 | 80 | 80 | 85 | 80 | 80 |
| A, D-5, E-5 | E | 80 | 75 | 80 | 80 | 80 | 80 |
| A, D-5, E-5, F-5 | ESE | 85 | 85 | 95 | 85 | 85 | 95 |
| A, E-5, F-5 | SE | 85 | 80 | 95 | 85 | 85 | 95 |
| A, E-5, F-5, I-5 | SSE | 85 | 85 | 95 | 85 | 85 | 95 |
| A, F-5, I-5 | S | 85 | 85 | 95 | 85 | 85 | 95 |
| A, F-5, I-5 | SSW | 85 | 85 | 95 | 85 | 85 | 95 |
| A, I-5, J-5 | SW | 80 | 75 | 85 | 85 | 80 | 85 |
| A, I-5, J-5 | WSW | 80 | 75 | 85 | 85 | 80 | 85 |
| A, I-5, J-5 | W | 80 | 75 | 85 | 85 | 80 | 85 |
| A, J-5, K-5 | WNW | 75 | 75 | 75 | 80 | 80 | 80 |
| A, J-5, K-5, B-5 | NW | 80 | 75 | 85 | 80 | 80 | 85 |
| A, J-5, K-5, B-5 | NNW | 80 | 75 | 85 | 80 | 80 | 85 |

## 6.2. Discussion of Scenario Results

### 6.2.1. General Trends

- The ETEs in both normal and adverse weather are mainly driven more by the warning system and available speeds rather than the roadway capacities because the vehicular demand is low compared to the available roadway capacities in most parts of the network.
- The ETEs for scenarios in adverse weather increased in a range of 0 to 5 minutes from the corresponding scenarios in normal weather. The adverse weather conditions have little impacts on ETEs, with no more than a 5 minute increase for all the scenarios. The increase is due more to the reduced speeds than to the reduced roadway capacities.
- For most areas, the weekday scenario produced the highest evacuation times. This is due to the increased amount of transients workers on the weekday. However, the weekend scenarios for some of the 0-5 mile and 2-5 mile areas that include evacuating zones B-5, F-5, or I-5 produced higher evacuation times than weekday and

weeknight. This is due to the high concentration of recreational transients in the areas (hunters and boaters) on the weekend. The recreational population has a higher warning and diffusion time than other populations – up to 2 hours 35 minutes, compared to 2 hours for permanent residents.

### 6.2.2. Evacuation Area: 0–2 Miles

The majority of the population in the Zone A evacuation area consists of employees of FNP. In addition, Zone A includes a small number of permanent residents, non-plant employees, and recreational visitors in the Georgia side of area for hunting and other activities along the Chattahoochee River. For the weekday scenario, the plant workforce was modeled to reflect 600 employees who would evacuate during an event, excluding another 200 emergency personnel, who will not evacuate. For the weeknight and weekend scenarios, the workforce for the plant was modeled such that all employees were emergency personnel and would remain during an event. For the weekend scenario, the recreational population was at its peak.

The evacuation times for the 2-mile radius under different scenarios vary very little, though the weekday appeared to be a little bit longer than others. The evacuation times are relatively low and were affected by the loading times and available speed limits, not by congestion in the network. Population west of the Chattahoochee River will evacuate to the Houston/Henry County Evacuation Center in Alabama, primarily using Pleasant Grove Road to US-84. Population east of the Chattahoochee River will primarily use SR-370 to SR-62 to exit the EPZ for the Early County reception center in Georgia.

### 6.2.3. Evacuation Area: 0–5 Miles

This area includes the entire 5-mile EPZ, consisting of zones A, B-5, C-5, D-5 E-5, F-5, I-5, J-5 and K-5. There are several evacuation routes leading out of the EPZ; however, a large portion of the evacuating population will converge on SR-62, SR-52 and US-84. The population from zones A-AL, B-5, C-5, D-5 and E-5 will converge on US-84 and travel south to the Houston/Henry County reception center. The population from zones E-5 and F-5 will converge on SR-52 and US-84 and travel south to the Houston/Henry County reception center. The population from zone I-5 as well as A-GA will primarily use State Route 62 to exit the EPZ and travel north to the Early County Reception Center. Population from zones J-5 and K-5 will primarily use State Route 273, State Route 370, Cedar Springs Hwy, and State Route 62 to exit EPZ and travel north to the Early County Reception Center.

Evacuation times for the entire 5-mile EPZ are similar to maximum evacuation times for all subzones for each scenario. The 100% ETEs for 0-5 mi scenarios are substantially longer than those for the 2-mile radius scenarios, whereas the 90% ETEs are merely slightly longer than the corresponding 2-mile ones. This is mainly due to the increased population, especially the recreational population in 2-5 mi ring. The evacuation times indicate that as the traffic converges for the evacuation of the entire 5-mile boundary, the road network will continue to provide sufficient capacity in both normal and adverse weather.

### 6.2.4. Evacuation Area: 0–10 Miles

The evacuation times of the entire 10-mile EPZ was slightly longer than those of 0-5 mile area, due to the additional evacuees from 5-10 mile area.

Zones A-AL, B-5, C-5, D-5, E-5, F-5, B-10, C-10, D-10, E-10, and F-10 will converge on SR-52 and US-84 and travel south to the Houston/Henry County reception center. Zones A-GA, I-5, G-10, H-10 and I-10 will evacuate to the Early County Reception Center and will primarily use the SR-62 to leave the EPZ. Zones J-5, K-5, J-10 and K-10 will evacuate to the Early County Reception Center, primarily using U.S. Hwy 1, County Road 364 (Cedar Crossing), and County Road 336 (Old River Road). Zones E-5, J-10 and K-10 evacuating to Toombs County will primarily use Cedar Springs Hwy, State Route 39, Ades Springs Road and State Route 62 to exit the EPZ.

Population for this area includes permanent residents, transient employees, FNP employees, recreational visitors to the Chattahoochee River, park visitors, and hunters. The area also includes Ashford Elementary School, Ashford High School, Houston County Career and Technical Center, Ashford Academy, Houston County High School, and Webb Elementary School. The population for these schools was only considered for the weekday scenario. Recreational activities were considered at peak levels for the weekend scenario.

These evacuation times are mainly influenced by three factors: 1) the higher warning and diffusion times for recreational population in the area; 2) possible moderate congestions on some such as Ross Clark Circle, US-84 and Alabama Hwy 52 (leading to Houston/Henry County reception center), and State Route 62 leading to Early County reception center; 3) larger evacuation population resulting in larger chance of having a few evacuees who need extensive long loading time.

## 6.3. ETE Results for Transit Dependent Permanent Residents

The ETEs for the transit dependent population are shown in Table 26. Note that the ETEs for the transit dependent population counts from the notification time of vehicles dispatched for this population group (assuming one hour earlier than the general public).

**Table 26: Transit Dependent Permanent Resident Evacuation Information**

| Transit Dependent Vehicle Category | ETE |
|---|---|

| | |
|---|---|
| Special Equipped Vehicle | 55 min |
| Bus | 55 min |
| Ambulance | 65 min |

## 6.4. ETE Results for School Population

The 100% ETEs, average travel speed and travel for the school populations for weekday, evacuating full EPZ under normal weather scenario are shown in Table 27Table 27: School Evacuation Times. Note that the ETEs for the schools count from the time when the schools are notified. The bus queue occurs due to several buses loading students simultaneously at the schools. Houston County High School has large number of evacuation vehicles and is located relatively farther away from the designated evacuation route than other schools. Therefore, it takes longer time to evacuate out of the EPZ. Because a large number of evacuation vehicles are expected in a short period from the schools in Ashford, AL, congestion occurs in the town.

**Table 27: School Evacuation Times**

| School Name | Outbound Travel Speed | Travel Time to EPZ Boundary | Bus Queue Length | ETE |
|---|---|---|---|---|
| Ashford Elementary School | 21 mph | 17 min | 850 | 75 min |
| Ashford High School | 15 mph | 24 min | 650 | 95 min |
| Houston County High School | 13 mph | 52 min | 400 | 120 min |
| Webb Elementary School | 10 mph | 6 min | 500 | 70 min |
| Houston County Career and Technical Center | 10 mph | 35 min | 0 | 95 min |
| Ashford Academy | 16 mph | 25 min | 200 | 85 min |

## 6.5. Example Model Output

Some example model outputs are presented as follows for the weekday, full EPZ, normal weather evacuation scenario. The total volumes and hourly percents at each exit roads are listed in Table 28. The highest exit traffic volume occurs on US Hwy 84, which is the back bone of the evacuation route to the Houston County Reception Center. The network wide average travel time from the origins to the reception centers is 30 minutes. The total number of vehicle exit the EPZ is 9,476 and is higher than the total number of vehicles (excluding shadow evacuees) loaded into the network, because some shadow evacuees would use the exit links to drive away from FNP. The mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ are plotted in Figure 17**Error! Reference source not found.**. The average speeds for the two evacuation routes leading to two designated evacuation routes are shown in Table 29.

**Table 28: Total Volumes and Hourly Percents at Exit Roads**

| Exit Road Name | Total Volume | Hour 1 Percent | Hour 2 Percent | Hour 3 Percent | Hour 4 Percent |
|---|---|---|---|---|---|
| GA-62 | 1,102 | 61.0% | 37.2% | 1.6% | 0.0% |
| GA-273 | 186 | 61.8% | 35.5% | 0.5% | 0.0% |
| GA-363 | 409 | 73.6% | 26.4% | 0.0% | 0.0% |
| Fryer Road | 189 | 57.1% | 41.8% | 1.1% | 0.0% |
| Watson Bridge Road | 2 | 100.0% | 0.0% | 0.0% | 0.0% |
| AL-52 | 2,669 | 42.9% | 56.0% | 1.1% | 0.0% |
| US Hwy 84 | 4,919 | 62.8% | 32.0% | 5.1% | 0.1% |

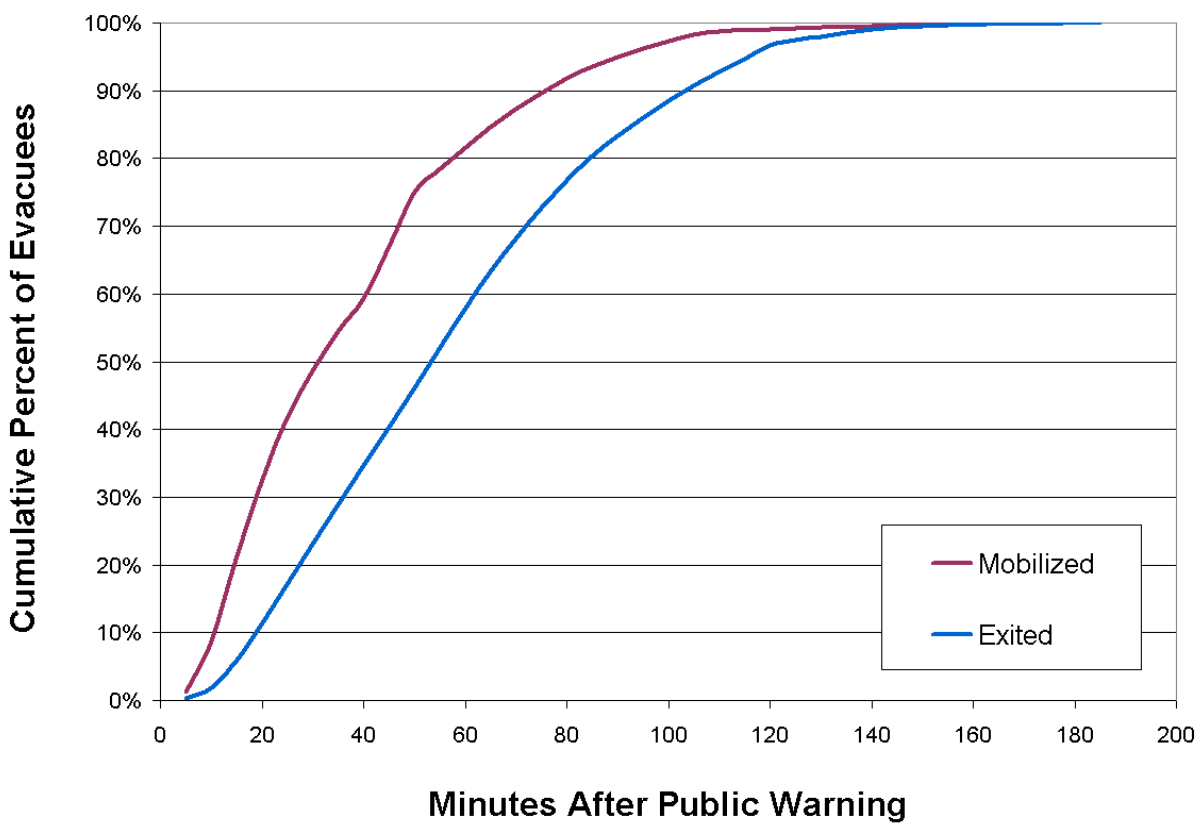


**Figure 17: Mobilization and Evacuation Curve**

**Table 29: Average Speed for Different Evacuation Routes**

| Evacuation Route | Average Speed (mph) |
|---|---|
| To Houston County Reception Center | 30 |
| To Early County Reception Center | 37 |

# 7.0 SUPPLEMENTAL ANALYSIS

The analyses related to confirmation of evacuation and potential mitigating measures to effectively manage the traffic flow were performed and are provided in the following sections.

## 7.1. Confirmation of Evacuation

The confirmation of evacuation process determines if the evacuation has been completed. The time required for confirmation of evacuation is dependent upon the method employed. The most time-consuming method typically employed is to use ground vehicles. The time required involves the driving time for each route selected.

Informing people to leave some standard signs on their doors or windows, such as tying a white cloth to the front doorknob of the house or to the mailbox (as mentioned in the 2012 emergency information calendar), when they leave their houses would help the authorities in the confirmation of evacuation. Presence of TCPs and Access Control Points (ACPs) at strategic locations within the evacuation network could provide real-time feedback regarding the progress of the evacuation process. All evacuees are recommended to register in at the designated county reception centers as they arrive. This procedure helps the authorities to account for the population within the designated county. This can be accounted as one of the means of confirmation of evacuation, only under the assumption that all the evacuees would actually report to the reception centers and nowhere else. Telephoning people at their homes could also be considered as a possible means of ensuring completion of evacuation.

As noted in the county REPs[33], evacuation confirmation will be accomplished by the county Sheriff's Department and supporting law enforcement agency personnel that will traverse roadways throughout the affected area to ensure that the residential population has evacuated their homes. Personnel from the Georgia Department of Natural Resources Law Enforcement Section, the Alabama Department of Conservation/Marine Police, and the county EMAs will ensure that hunters and fishermen within the 10-mile EPZ are notified and evacuated from the waterways and recreational areas. Additional assistance is available from other State agencies as requested.

The actual time associated with the confirmation process would depend on both the number of personnel and the amount of equipment available. These resources may change significantly under various emergency conditions.

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[33] State of Georgia REP Plan, Blakely-Early County Emergency Management Agency Radiological Emergency Plan for Nuclear Incidents/Accidents Involving the Joseph M. Farley Nuclear Power Plant. January 2009.
Dothan-Houston County Emergency Management Agency Standard Operating Guidelines for Joseph M. Farley Nuclear Power Plant Incidents.

## 7.2. Evacuation Traffic Management Locations and Other Potential Mitigating Measures

In order to efficiently promote smooth movement of traffic flow during an evacuation, several TCPs have been identified by the plant and county emergency response planning personnel. The TCPs are listed in Table 30 and shown graphically in Figure 18. The responsibility of supervising traffic controls during an evacuation will be shared between the State's and counties' emergency management and law enforcement agency personnel, as available. Each TCP will be manned and/or road blocks will be established to direct evacuees out of the EPZ and to deny access into the affected area. Also, route markers will be placed along the evacuation routes at critical intersections and road block locations to promote more efficient traffic flow out from the EPZ.

**Table 30: Traffic Control Points for the FNP EPZ**

| Map Location ID | Traffic Control Point/Post #[34] | Operation Control | Description | State |
|---|---|---|---|---|
| 1 | 48 | Houston County Sheriff | 3840 E. Cook Road and 1 Lamp Brothers Road | Alabama |
| 2 | 51 | Houston County Sheriff | 4185 Hunter Road and 10031 N. State Hwy 95 | Alabama |
| 3 | 53 | Houston County Sheriff | 3928 Ed Tolar Road and 4415 N. State Hwy 95 | Alabama |
| 4 | 54 | Houston County Sheriff | 2475 Nuclear Plant Road and 1 Macedonia Road | Alabama |
| 5 | 37 | Houston County Sheriff | North Main Street (AL-95) and State Hwy 134 (Henry County 53) | Alabama |
| 6 | 38 | Houston County Sheriff | 12412 N. State Hwy 95 and 16742 E. State Hwy 52 | Alabama |
| 7 | 39 | Houston County Sheriff | 517 Pea Market Road and 7841 Bill Yance Road | Alabama |
| 8 | 40 | Houston County Sheriff | 13832 E. State Hwy. 52 and 315 Jesse Road | Alabama |
| 9 | 41 | Houston County Sheriff | 3564 Cedar Springs Road and 1766 Ebenezer Road | Alabama |
| 10 | 42 | Houston County Sheriff | 2898 Cedar Springs Road and 1 King Road | Alabama |
| 11 | 43 | Houston County Sheriff | 2141 Cedar Springs Road and 3239 Edsel Deese Road | Alabama |

[34] Section C. Traffic Control Points. Received from SNC October 30, 2012.
State of Georgia REP Plan, Blakely-Early County Emergency Management Agency Radiological Emergency Plan for Nuclear Incidents/Accidents Involving the Joseph M. Farley Nuclear Power Plant. January 2009.

| Map Location ID | Traffic Control Point/Post #[34] | Operation Control | Description | State |
|---|---|---|---|---|
| 12 | 44 | Houston County Sheriff | 1308 Cedar Springs Road and 2465 N. County Road 33 | Alabama |
| 13 | 45 | Houston County Sheriff | 1 Cedar Springs Road and 1869 Pleasant Grove Road | Alabama |
| 14 | 46 | Houston County Sheriff | 2697 N. County 75 Road and 1530 Bruner Pond Road | Alabama |
| 15 | 47 | Houston County Sheriff | 1372 N. County 75 Road and 1 Ed Tolar Road | Alabama |
| 16 | 49 | Houston County Sheriff | 306 N. County 75 Road and 1 Liberty Road | Alabama |
| 17 | 50 | Houston County Sheriff | 6190 Pansey Road and 150 E. Cook Road | Alabama |
| 18 | 52 | Houston County Sheriff | 2195 N. County 81 Road and 2213 N. State Hwy 95 | Alabama |
| 19 | 36 | Henry County Sheriff | Henry Co. - State Hwy 95 and County Road 112 (1st Road N. of Foster Creek) | Alabama |
| 20 | 35 | Henry County Sheriff | Henry Co. - County Road 77 and County Road 53 | Alabama |
| 21 | 34 | Henry County Sheriff | Henry Co. - County Road 63 and County Road 77 (County Road 6) | Alabama |
| 22 | 33 | Houston County Sheriff | 7188 E. County Road 22 and 7160 N. County Road 55 | Alabama |
| 23 | 32 | Houston County Sheriff | 1245 Randall Wade Road and 2241 Bill Yance Road | Alabama |
| 24 | 30 | Houston County Sheriff | 4260 Enon Road and 7695 E. State Hwy 52 | Alabama |
| 25 | 29 | Houston County Sheriff | 2626 Enon Road and 4230 Glen Lawrence Road | Alabama |
| 26 | 28 | Houston County Sheriff | 1366 Enon Road | Alabama |
| 27 | 27 | Houston County Sheriff | 1 Broadway Avenue (County Road 55) and 7076 E. State Hwy 52 (Plan says 7076 E. US Hwy 84) | Alabama |
| 28 | 26 | Houston County Sheriff | 489 Battles Road and 1230 Broadway Avenue | Alabama |
| 29 | 25 | Houston County Sheriff | 1890 Silcox Road and 1 Enterprise Church Road | Alabama |
| 30 | 24 | Houston County Sheriff | 2208 S. County Road 33 and 1026 Enterprise Church Road | Alabama |
| 31 | 23 | Houston County Sheriff | 6220 Lucy Grade Road (County Road 24) and 3935 S. County 55 Road | Alabama |

| Map Location ID | Traffic Control Point/Post #[34] | Operation Control | Description | State |
|---|---|---|---|---|
| 32 | 22 | Houston County Sheriff | 1110 Antioch Church Road and 1221 Coot Adams Road | Alabama |
| 33 | 21 | Houston County Sheriff | 795 Bobby Hill (or Hall) Road (Creek Church Road) and 5096 S. Rocky Creek Road | Alabama |
| 34 | 20 | Houston County Sheriff | 4894 E. County Road 8 and 4565 S. County Road 75 | Alabama |
| 35 | 19 | Houston County Sheriff | 6526 E. County Road 8 and 3271 S. County Road 81 | Alabama |
| 36 | 18 | Houston County Sheriff | 8222 E. County Road 8 and 3435 S. Springhill Church Road | Alabama |
| 37 | 17 | Houston County Sheriff | 10616 E. County Road 8 and 4593 S. County Road 85 | Alabama |
| 38 | 15 | Houston County Sheriff | 3090 S. State Hwy 95 | Alabama |
| 39 | 16 | Houston County Sheriff | 2468 Barksdale Road | Alabama |
| 40 | 55 | Houston County Sheriff | 1 N. County Road 33 and 899 N. Broadway Street | Alabama |
| 41 | 56 | Houston County Sheriff | 399 Main Street and 799 N. Broadway Street | Alabama |
| 42 | 57 | Houston County Sheriff | 399 Church Street and 499 N. Broadway Street | Alabama |
| 43 | 58 | Houston County Sheriff | 1994 Old Hwy 84 and 299 N. Broadway Street | Alabama |
| 44 | 31 | Houston County Sheriff | 1 Wallace Buie Road and 635 Webb to Kinsey Road | Alabama |
| 45 | 1 | Early County Sheriff | Hwy 62 at Chattahoochee River (Early/Houston County Line) | Georgia |
| 46 | 2 | Early County Sheriff | Hwy 62 at Hwy 370 | Georgia |
| 47 | 3 | Early County Sheriff | Hwy 62 at County Road 25 (Martin Road) | Georgia |
| 48 | 4 | Early County Sheriff | Hwy 62 at County Road 145 (Rock Hill Road) | Georgia |
| 49 | 5 | Early County Sheriff | Hwy 62 (Columbia Road) at Reception Center (Early County High School) | Georgia |
| 50 | 6 | Early County Sheriff | Hwy 363 (Cedar Springs Road) at Chattahoochee Street | Georgia |
| 51 | 7 | Early County Sheriff | Hwy 363 (Cedar Springs Hwy) at County Road 25 (Martin Road) | Georgia |
| 52 | 8 | Early County Sheriff | Hwy 363 (Cedar Springs Hwy) at County Road 279 (Damascus Hilton Road) | Georgia |

| Map Location ID | Traffic Control Point/Post #[34] | Operation Control | Description | State |
|---|---|---|---|---|
| 53 | 9 | Early County Sheriff | Hwy 363 (Cedar Springs Hwy) at County Road 284 (Allen Chapel Road) | Georgia |
| 54 | 10 | Early County Sheriff | Hwy 370 at County Road 103 (Dowry Road) | Georgia |
| 55 | 11 | Early County Sheriff | Hwy 370 at Hwy 273 | Georgia |
| 56 | 12 | Early County Sheriff | County Road 50 (Spooner Quarter Road) at County Road 48 (Kilarney Road) | Georgia |
| 57 | 13 | Early County Sheriff | US Hwy 84 at Chattahoochee River (Early/Houston County Line) | Georgia |
| 58 | 14 | Early County Sheriff | US Hwy at Howards Mill Road | Georgia |
| 59 | 19B | Houston/Henry Sheriff | Intersection – Sherman Brunson Road and Billy Cherry Road | Alabama |
| 60 | 27B | Houston/Henry Sheriff | Jordan Avenue at Bluff Springs | Alabama |
| 61 | 27C | Houston/Henry Sheriff | Jordan Avenue at Crawford | Alabama |
| 62 | 33B | Houston/Henry Sheriff | Henry County –County Road 55 and County Road 49 | Alabama |
| 63 | 34B | Houston/Henry Sheriff | Henry County – Henry County 55 and County 6 | Alabama |
| 64 | 36B | Houston/Henry Sheriff | Henry County Road 79 | Alabama |
| 65 | 38B | Houston/Henry Sheriff | State Hwy 52 at County Road 22 | Alabama |
| 66 | 40B | Houston/Henry Sheriff | Hudson Road at Ebenezer Road | Alabama |
| 67 | 49B | Houston/Henry Sheriff | State Hwy 84 at County Road 75 | Alabama |
| 68 | 54B | Houston/Henry Sheriff | Goodson Road at Macedonia Church Road | Alabama |

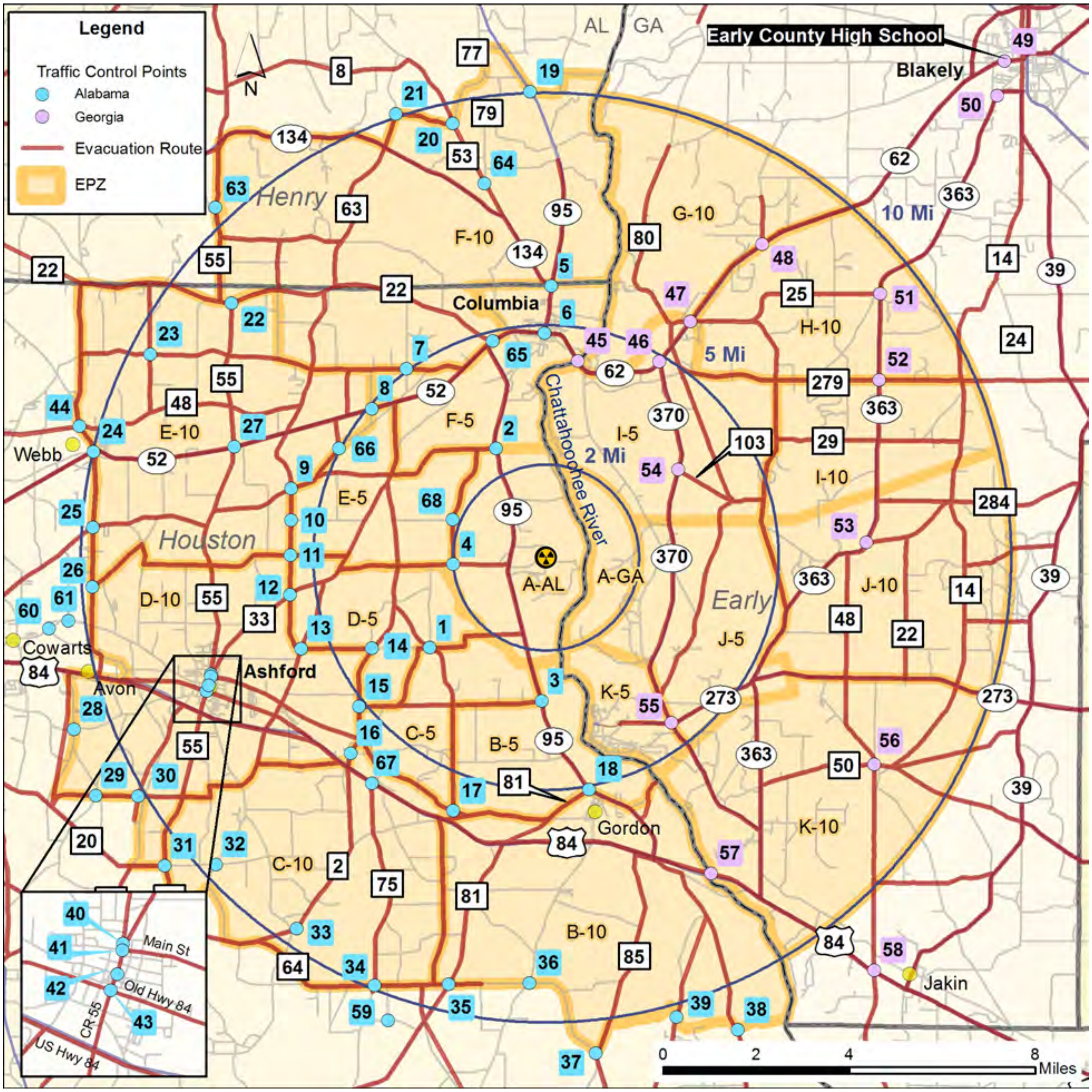


Figure 18: Traffic Control Points in and around the FNP EPZ

# 8.0 SENSITIVITY STUDY ON POPULATION CHANGE

ETEs vary with factors such as population, roadway networks and vehicle occupancy rates. In response to new federal regulations, IEM conducted a population sensitivity analysis for FNP to address the uncertainty in population data by estimating the anticipated impact of a population change on ETEs. This sensitivity analysis will provide a basis for decisions on future ETE update thresholds.

IEM increased the residential population (for both EPZ and shadow evacuees) to determine the population value that will cause ETE values to increase by 25 percent or 30 minutes, whichever is less for the scenario with the longest ETE. This scenario is evacuating the entire EPZ during the weekday under adverse weather conditions. The base ETE for this scenario is 200 minutes, and hence the threshold for triggering an ETE update is 30 minutes increase in ETE. IEM found that an increase of 30 minutes occurs with a permanent resident population increase of 161% or 6,409 people within the EPZ (along with the increase of shadow evacuees with the same percentage).

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# 9.0 CONCLUSION AND RECOMMENDATIONS

The ETEs developed for 25 evacuation areas within the 10-mile FNP EPZ measured the time from the public notification to when the last evacuating vehicle exited the EPZ boundary.

The 100% ETEs for the evacuation areas ranged from 120 minutes to 200 minutes for the normal scenarios, and from 125 minutes to 205 minutes for those occurring in adverse weather. The 90% ETEs for the evacuation areas ranged from 75 minutes to 110 minutes for the normal scenarios, and from 80 minutes to 110 minutes for those occurring in adverse weather. Variations in ETEs between scenarios generally correlated to differences in the number of evacuating vehicles, the capacity of the evacuation routes, the roadway conditions, or the distance from the origin zones to the EPZ boundary. For most cases, the weekend scenario produced the highest evacuation times due to the longer mobilization time for the higher number of recreational transients in the area (hunters and boaters) on the weekend.

The analysis shows that the capacity of the roadway network within the EPZ is adequate to accommodate the population for all scenarios. However, there are a few areas that could become congested during an evacuation. Several intersections where two heavily-traveled evacuation routes converge were identified from the models as possible congestion points. These potential traffic congestion points are listed in Table 31. The congestion points listed in the table are all outside of the EPZ, but the traffic congestion at these intersections might create a spillback toward and within the 10-mile EPZ. This spillback might put people at risk, so it is advisable that these intersections are controlled in a way to facilitate a smoother evacuation to reception centers. Providing an efficient and effective flow of traffic through these intersections will ensure that the evacuees in route to reception centers are outside of the EPZ before encountering the potential congestion points.

**Table 31: Potential Congestion Points for the FNP EPZ**

| Operation Control | Description |
|---|---|
| Houston County | SR-52/Columbia Hwy at US-431/SR-210/Ross Clark Cir |
| Houston County | US- 84/E Main Street at US-431/SR-210/Ross Clark Cir |
| Houston County | US-431/SR-210/Ross Clark Cir at SR-53/E Cottonwood Road |

In conclusion, based on the data gathered and the results of the evacuation study conducted, IEM believes that the existing evacuation strategy is functional for the year 2012 conditions, given the lack of severe congestion or very high ETEs.

## 9.1. Summary of Recommendations

The following recommendations will help emergency managers to improve the evacuation times from an event at FNP:

- ETEs can also be reduced by implementing additional measures that will shorten the elapsed time between the incident's occurrence and the time the public uses to take the required protective action—especially for the recreational area users, such as hunters and fishermen.
- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use TCPs to facilitate flow in the high volume intersections where vehicles might otherwise have to slow down due to congestion.
- Work with local and state road/transportation departments to suggest improvements to the road infrastructure near the intersections of Ross Clark Circle with U.S. Hwy 84, Alabama Hwy 52 (AL-52), and Cottonwood Road (AL-53), which may contribute to reduced congestion and lower ETEs.
- Consider routing evacuees from some zones in Alabama such as B-10 and C-10 to other roads in order to distribute traffic evenly and to reduce traffic congestion.
- The regional stakeholders should continue using and updating, as necessary, the existing regional evacuation plans.

# APPENDIX A: GEOGRAPHICAL BOUNDARIES OF EVACUATION ZONES

### Table 32: Geographical Boundaries of FNP EPZ Evacuation Zones

| Evacuation Zones | Zone Boundaries | | Landmark Descriptions |
|---|---|---|---|
| A-AL | North: | Hunter Road, then line due east to Chattahoochee River | Includes Farley Nuclear Plant |
| | West: | Macedonia Road and Jackson Creek | |
| | South: | Cedar Creek | |
| | East: | Chattahoochee River | |
| A-GA | North, South, East – 2 mile boundary | | |
| | West – Chattahoochee River | | |
| B-5 | North: | Cedar Creek and Ed Tolar Road | Gordon Boat Ramp |
| | West: | Cook Road | |
| | South: | Pansey Road, then Mixon Road, then County Road 81, then Main Street in Gordon, then Boat Landing Road | |
| | East: | Chattahoochee River | |
| B-10 | North: | Pansey Road, then Mixon Road, then County Road 81, then Main Street in Gordon, then Boat Landing Road | Includes town of Gordon |
| | West: | Fire Tower Road | |
| | South: | County Road 8, then County Road 85, then Greenhouse Road, then creek turning east to Chattahoochee River | |
| | East: | Chattahoochee River | |
| C-5 | North: | Lamp Brothers Road, Jackson Creek, and Cedar Creek | |
| | West: | County Road 75 | |
| | South: | Pansey Road and Ed Tolar Road | |
| | East: | Cook Road and Alabama Hwy 95 | |
| C-10 | North: | Pansey Road, then County Road 75, then U.S. Hwy 84, then McDaniel Road, then Cosby Road, then Meadows Road, then Garrett Road, then Buster Road | |
| | West: | County Road 55 | |
| | South: | Coot Adams Road, then Bowen Road, then County Road 8 | |
| | East: | Fire Tower Road, to U.S. Hwy 84, to Mixon Road | |

| Evacuation Zones | | Zone Boundaries | Landmark Descriptions |
|---|---|---|---|
| D-5 | North: | Nuclear Plant Road, then County Road 33, then Edsel Deese Road | |
| | West: | Cedar Springs Road | |
| | South: | Pleasant Grove Road, then Bruner Pond Road, then County Road 75, then Ed Tolar Road, then Paul Lamp Road and Lamp Brothers Road | |
| | East: | Jackson Creek | |
| D-10 | North: | Edsel Deese Road, then Ben Ivey Road, then Johnniee Ingram Road | Includes town of Ashford, Ingram Lake, and Enterprise Church |
| | West: | Enon Road, then Bluffspring Road, then Bluff Springs Road, then U.S. Hwy 84, then Broadway Avenue, becoming Avon Road | |
| | South: | Aspen Road becoming Enterprise Church Road, then County Road 33, then Lucy Grade Road, then County Road 55, then Buster Road, to Garrett Road, to Meadows Road, to Cosby Road, to McDaniel Road, to U.S. Hwy 84 | |
| | East: | County Road 75, to Bruner Pond Road, to Cedar Springs Road | |
| E-5 | North: | Hunter Road, then County Road 33, then Alabama Hwy 52, then Jesse Road, then Ebenezer Road | Hunters Cemetery |
| | West: | Cedar Springs Road | |
| | South: | Edsel Deese Road, to County Road 33, to Nuclear Plant Road | |
| | East: | Macedonia Road | |
| E-10 | North: | Bill Yance Road, to J D Love Road, to County Road 22 | Qualico Steel, Webb Elementary School |
| | West: | Gilley Mill Road, to Webb Kinsey Road, to Enon Road | |
| | South: | Ingram Road, to Ben Ivey Road, to Edsel Deese Road | |
| | East: | Cedar Springs Road, to Ebenezer Road, to Jesse Road | |
| F-5 | North: | Northern boundary of Columbia, to Omussee Creek, to Alabama Hwy 52, to Bill Yance Road | Includes town of Columbia, Omussee Creek State Park |
| | West: | Jesse Road, to Alabama Hwy 52, to County Road 33 | |
| | South: | Hunter Road, then line east to Chattahoochee River | |
| | East: | Chattahoochee River | |

| Evacuation Zones | Zone Boundaries | Landmark Descriptions |
|---|---|---|
| F-10 | North: County Road 112, Alabama Hwy 95, County Roads 277 and 77, then County Road 63, then Alabama Hwy 134<br>West: County Road 56/55<br>South: County Road 22, then J D Love Road, then Bill Yance Road, then Alabama Hwy 52, then Omussee Creek, then northern boundary of Columbia<br>East: Chattahoochee River | Spring Hill Church |
| G-10 | North: 10 mile boundary<br>West: Chattahoochee River<br>South and East: Georgia Hwy 62 | Includes Coheelee Creek Park and boat landing, and Camp E-TU-NAKE |
| H-10 | North and West: Georgia Hwy 62<br>South: County Road 1691<br>East: 10 mile boundary | |
| I-10 | North: County Road 1691<br>West: County Road 13<br>South: Power line from Farley Nuclear Plant<br>East: 10 mile boundary | |
| J-5 | North: Power line from Farley Nuclear Plant<br>West: 2 mile boundary<br>South: Georgia Hwy 370<br>East: 5 mile boundary, Georgia Hwy 363, and County Road 26 | |
| J-10 | North: Power line from Farley Nuclear Plant<br>West: County Road 26 and Georgia Hwy 363<br>South: Georgia Hwy 273/Cedar Springs Road<br>East: 10 mile boundary | Green Cemetery, Cedar Springs Church |
| K-5 | North: 2 mile boundary<br>West: Chattahoochee River<br>South/Southeast: 5 mile boundary<br>East/Northeast: Georgia Hwy 370 | Georgia Pacific |
| K-10 | North: Cedar Springs Road/Georgia Hwy 273<br>Northwest: 5 mile boundary<br>Southwest: Chattahoochee River<br>East/Southeast: 10 mile boundary | Navy Yard Landing, Republic Conduit |

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# APPENDIX B: EVACUATION NETWORK LINKS (DETAILED INFORMATION)

The detailed map for the evacuation network with legible values for nodes and links are provided in Figure 19 through Figure 22. In addition, detailed information for each roadway link is listed in

Table 33: Glossary of Terms for Roadway Links Inputs

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

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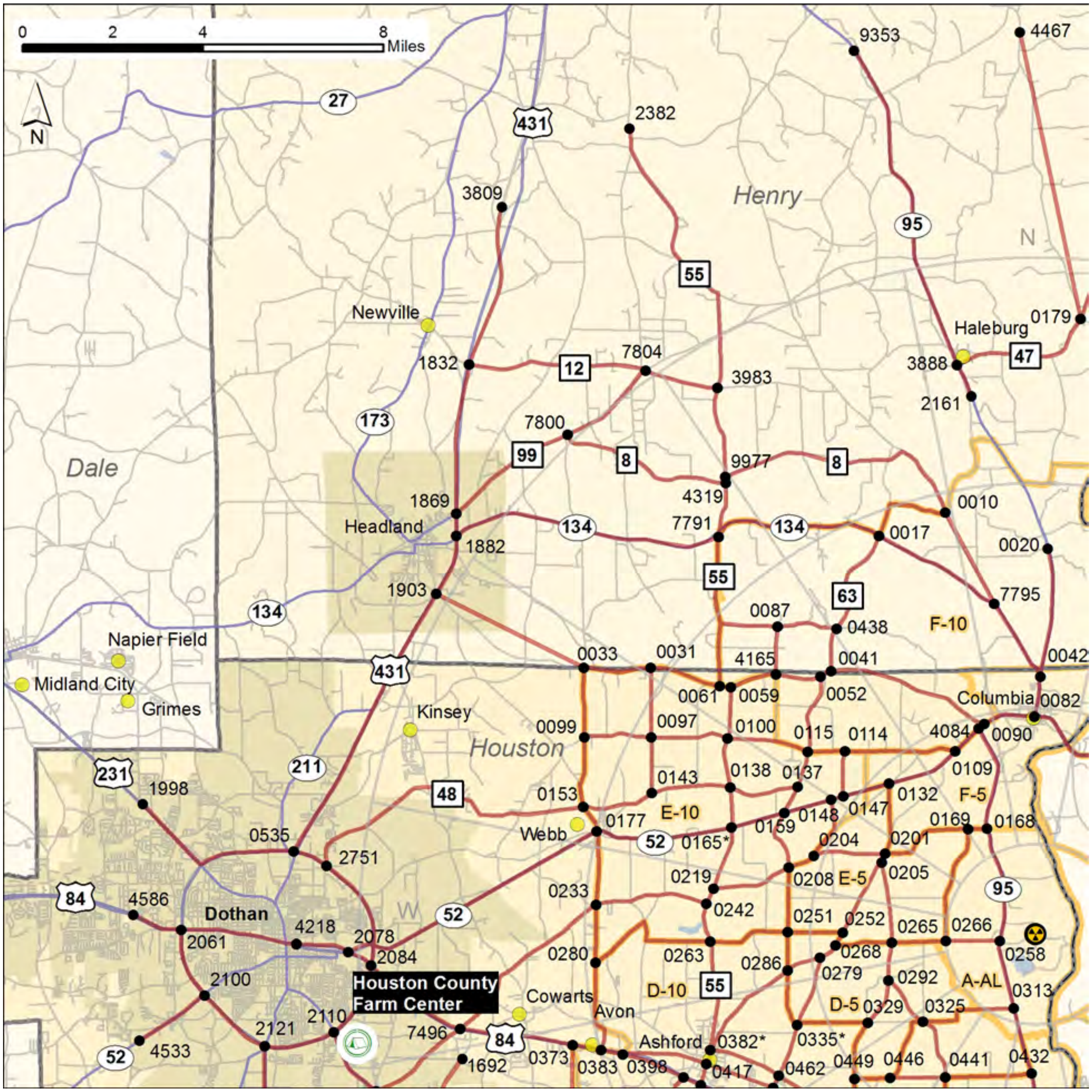


Figure 19: Detailed Roadway Nodes and Links – Northwest Quadrant


**Figure 20: Detailed Roadway Nodes and Links – Northeast Quadrant**

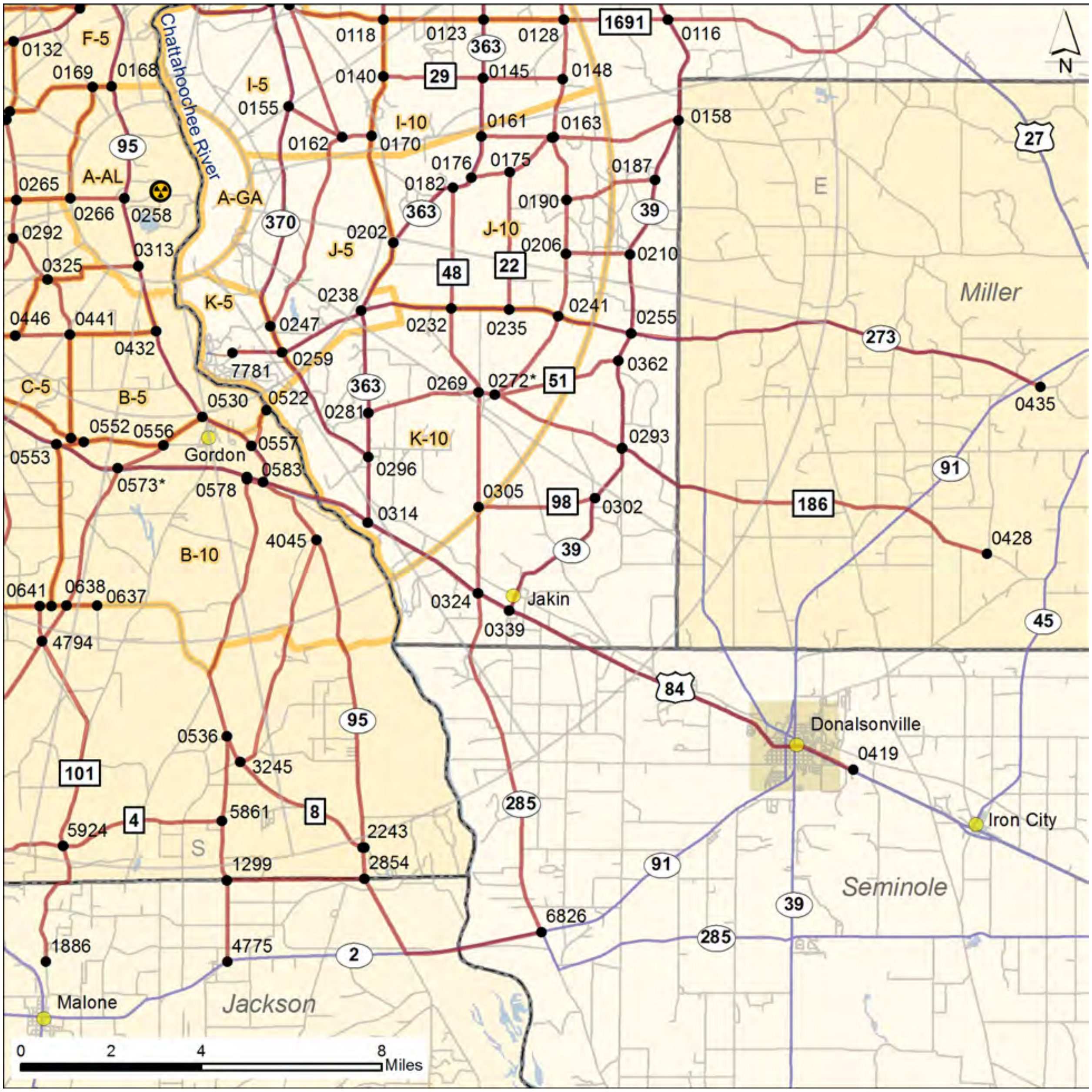


Figure 21: Detailed Roadway Nodes and Links – Southeast Quadrant

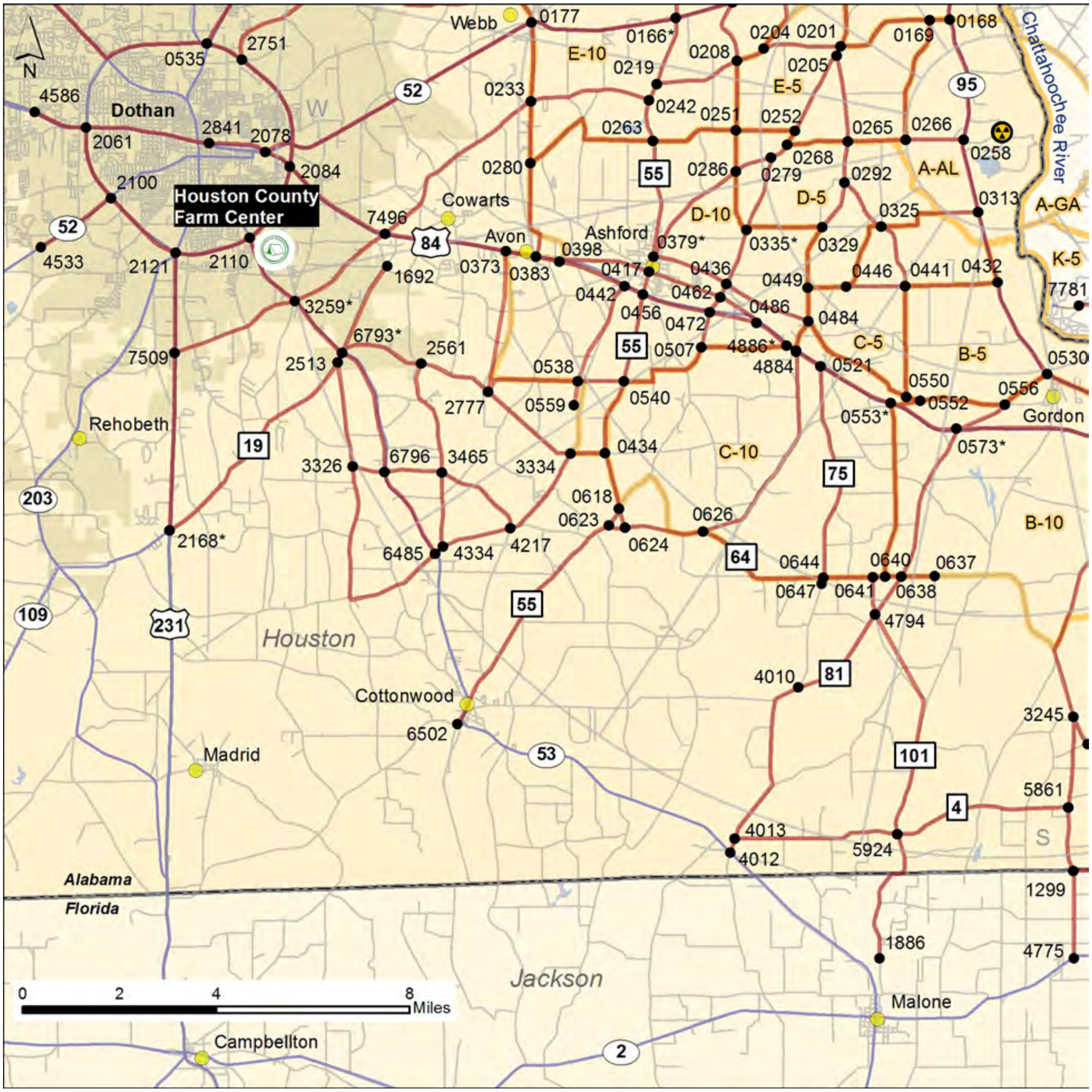


Figure 22: Detailed Roadway Nodes and Links – Southwest Quadrant

**Table 33: Glossary of Terms for Roadway Links Inputs**

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

**Table 34: Roadway Network Characteristics**

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0001 | 0018 | 0.671 | 11 | 1 | Single lane road | 1292 | 40 |
| 2 | 0001 | 0380 | 1.151 | 11 | 1 | Single lane road | 1292 | 40 |
| 3 | 0001 | 0410 | 0.699 | 11 | 1 | Single lane road | 1292 | 40 |
| 4 | 0001 | 0416 | 5.709 | 11 | 1 | Single lane road | 1292 | 40 |
| 5 | 0010 | 0017 | 2.012 | 11 | 1 | Single lane road | 1292 | 40 |
| 6 | 0010 | 7795 | 2.308 | 11 | 1 | Single lane road | 1292 | 40 |
| 7 | 0010 | 9977 | 3.711 | 11 | 1 | Single lane road | 1292 | 40 |
| 8 | 0017 | 0438 | 2.441 | 9 | 1 | Single lane road | 1292 | 40 |
| 9 | 0017 | 7791 | 3.826 | 12 | 1 | Single lane road | 1455 | 45 |
| 10 | 0017 | 7795 | 2.982 | 12 | 1 | Single lane road | 1455 | 45 |
| 11 | 0018 | 0032 | 0.923 | 12 | 1 | Single lane road | 1455 | 55 |
| 12 | 0018 | 0078 | 5.713 | 12 | 1 | Single lane road | 1455 | 45 |
| 13 | 0020 | 0042 | 2.870 | 12 | 1 | Single lane road | 1455 | 55 |
| 14 | 0031 | 0033 | 1.494 | 12 | 1 | Single lane road | 1455 | 55 |
| 15 | 0031 | 0059 | 1.593 | 12 | 1 | Single lane road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 16 | 0031 | 0097 | 1.542 | 12 | 1 | Single lane road | 1455 | 45 |
| 17 | 0032 | 0116 | 5.523 | 12 | 1 | Single lane road | 1455 | 55 |
| 18 | 0032 | 0128 | 5.808 | 12 | 1 | Single lane road | 1455 | 45 |
| 19 | 0033 | 0099 | 1.551 | 12 | 1 | Single lane road | 1455 | 45 |
| 20 | 0033 | 1903 | 3.665 | 12 | 1 | Single lane road | 1455 | 55 |
| 21 | 0034 | 0092 | 4.297 | 11 | 1 | Single lane road | 1292 | 40 |
| 22 | 0041 | 0052 | 0.272 | 12 | 1 | Single lane road | 1455 | 55 |
| 23 | 0041 | 0090 | 3.694 | 12 | 1 | Single lane road | 1455 | 55 |
| 24 | 0041 | 0438 | 0.970 | 12 | 1 | Single lane road | 1455 | 45 |
| 25 | 0042 | 0082 | 0.902 | 12 | 1 | Single lane road | 1455 | 45 |
| 26 | 0042 | 7795 | 1.925 | 12 | 1 | Single lane road | 1455 | 45 |
| 27 | 0047 | 0070 | 1.017 | 11 | 1 | Single lane road | 1292 | 40 |
| 28 | 0052 | 0115 | 1.777 | 12 | 1 | Single lane road | 1455 | 45 |
| 29 | 0052 | 4165 | 0.999 | 12 | 1 | Single lane road | 1455 | 45 |
| 30 | 0059 | 0061 | 0.254 | 12 | 1 | Single lane road | 1455 | 55 |
| 31 | 0059 | 0087 | 2.670 | 12 | 1 | Single lane road | 1455 | 45 |
| 32 | 0061 | 0100 | 1.135 | 12 | 1 | Single lane road | 1455 | 45 |
| 33 | 0061 | 4165 | 1.055 | 12 | 1 | Single lane road | 1455 | 45 |
| 34 | 0070 | 0089 | 2.298 | 12 | 1 | Single lane road | 1455 | 55 |
| 35 | 0070 | 0380 | 5.974 | 12 | 1 | Single lane road | 1455 | 55 |
| 36 | 0078 | 0086 | 3.165 | 10 | 1 | Single lane road | 1292 | 35 |
| 37 | 0078 | 0123 | 1.859 | 12 | 1 | Single lane road | 1455 | 45 |
| 38 | 0082 | 0090 | 1.165 | 12 | 1 | Single lane road | 1455 | 45 |
| 39 | 0082 | 0101 | 2.544 | 12 | 1 | Single lane road | 1455 | 55 |
| 40 | 0086 | 0089 | 1.311 | 11 | 1 | Single lane road | 1292 | 40 |
| 41 | 0086 | 0118 | 1.519 | 11 | 1 | Single lane road | 1292 | 35 |
| 42 | 0087 | 0438 | 1.348 | 10 | 1 | Single lane road | 1292 | 35 |
| 43 | 0089 | 0092 | 0.418 | 11 | 1 | Single lane road | 1292 | 40 |
| 44 | 0089 | 0098 | 0.654 | 12 | 1 | Single lane road | 1455 | 55 |
| 45 | 0090 | 4084 | 0.156 | 12 | 1 | Single lane road | 1455 | 55 |
| 46 | 0092 | 0098 | 0.459 | 11 | 1 | Single lane road | 1292 | 40 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 47 | 0097 | 0099 | 1.511 | 12 | 1 | Single lane road | 1455 | 45 |
| 48 | 0097 | 0100 | 1.717 | 12 | 1 | Single lane road | 1455 | 45 |
| 49 | 0097 | 0143 | 1.243 | 12 | 1 | Single lane road | 1455 | 45 |
| 50 | 0098 | 0101 | 0.434 | 12 | 1 | Single lane road | 1455 | 55 |
| 51 | 0098 | 0104 | 0.444 | 12 | 1 | Single lane road | 1455 | 45 |
| 52 | 0099 | 0153 | 1.566 | 12 | 1 | Single lane road | 1455 | 45 |
| 53 | 0100 | 0115 | 1.824 | 12 | 1 | Single lane road | 1455 | 45 |
| 54 | 0100 | 0138 | 1.117 | 12 | 1 | Single lane road | 1455 | 45 |
| 55 | 0101 | 0155 | 2.387 | 12 | 1 | Single lane road | 1455 | 55 |
| 56 | 0104 | 0118 | 2.163 | 12 | 1 | Single lane road | 1455 | 45 |
| 57 | 0104 | 0162 | 3.161 | 11 | 1 | Single lane road | 1292 | 35 |
| 58 | 0109 | 0114 | 2.472 | 12 | 1 | Single lane road | 1455 | 45 |
| 59 | 0109 | 0132 | 1.684 | 12 | 1 | Single lane road | 1455 | 55 |
| 60 | 0109 | 4084 | 0.724 | 12 | 1 | Single lane road | 1455 | 55 |
| 61 | 0114 | 0115 | 0.823 | 12 | 1 | Single lane road | 1455 | 45 |
| 62 | 0114 | 0147 | 1.001 | 12 | 1 | Single lane road | 1455 | 45 |
| 63 | 0115 | 0137 | 0.812 | 12 | 1 | Single lane road | 1455 | 45 |
| 64 | 0116 | 0128 | 2.307 | 12 | 1 | Single lane road | 1455 | 45 |
| 65 | 0116 | 0158 | 2.399 | 12 | 1 | Single lane road | 1455 | 55 |
| 66 | 0116 | 0431 | 0.747 | 12 | 1 | Single lane road | 1455 | 45 |
| 67 | 0118 | 0123 | 2.218 | 12 | 1 | Single lane road | 1455 | 45 |
| 68 | 0118 | 0140 | 1.265 | 11 | 1 | Single lane road | 1292 | 35 |
| 69 | 0123 | 0128 | 1.776 | 12 | 1 | Single lane road | 1455 | 45 |
| 70 | 0123 | 0145 | 1.295 | 12 | 1 | Single lane road | 1455 | 45 |
| 71 | 0128 | 0148 | 1.318 | 12 | 1 | Single lane road | 1455 | 45 |
| 72 | 0132 | 0147 | 1.046 | 12 | 1 | Single lane road | 1455 | 55 |
| 73 | 0132 | 0201 | 1.579 | 12 | 1 | Single lane road | 1455 | 45 |
| 74 | 0137 | 0138 | 1.556 | 10 | 1 | Unpaved | 800 | 25 |
| 75 | 0137 | 0159 | 0.651 | 12 | 1 | Single lane road | 1455 | 45 |
| 76 | 0138 | 0143 | 1.755 | 11 | 1 | Single lane road | 1292 | 40 |
| 77 | 0138 | 0165 | 0.876 | 12 | 1 | Single lane road | 1455 | 45 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 78 | 0140 | 0145 | 2.217 | 12 | 1 | Unpaved | 800 | 30 |
| 79 | 0140 | 0170 | 1.370 | 11 | 1 | Single lane road | 1292 | 35 |
| 80 | 0143 | 0153 | 1.614 | 11 | 1 | Single lane road | 1292 | 40 |
| 81 | 0145 | 0148 | 1.769 | 12 | 1 | Unpaved | 800 | 30 |
| 82 | 0145 | 0161 | 1.300 | 12 | 1 | Single lane road | 1455 | 45 |
| 83 | 0147 | 0148 | 0.281 | 12 | 1 | Single lane road | 1455 | 55 |
| 84 | 0148 | 0159 | 1.076 | 12 | 1 | Single lane road | 1455 | 50 |
| 85 | 0148 | 0163 | 1.319 | 12 | 1 | Single lane road | 1455 | 45 |
| 86 | 0148 | 0204 | 1.416 | 12 | 1 | Single lane road | 1455 | 45 |
| 87 | 0153 | 0177 | 0.639 | 12 | 1 | Single lane road | 1455 | 45 |
| 88 | 0153 | 2751 | 4.483 | 12 | 1 | Single lane road | 1455 | 55 |
| 89 | 0155 | 0162 | 1.367 | 10 | 1 | Unpaved | 800 | 30 |
| 90 | 0155 | 0247 | 5.032 | 12 | 1 | Single lane road | 1455 | 55 |
| 91 | 0158 | 0163 | 2.870 | 11 | 1 | Single lane road | 1292 | 35 |
| 92 | 0158 | 0187 | 1.432 | 12 | 1 | Single lane road | 1455 | 55 |
| 93 | 0159 | 0165 | 1.164 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 94 | 0159 | 0208 | 1.375 | 12 | 1 | Single lane road | 1455 | 45 |
| 95 | 0161 | 0164 | 1.568 | 9 | 1 | Unpaved | 800 | 30 |
| 96 | 0161 | 0176 | 0.950 | 12 | 1 | Single lane road | 1455 | 45 |
| 97 | 0162 | 0247 | 4.666 | 12 | 1 | Single lane road | 1455 | 45 |
| 98 | 0163 | 0164 | 0.033 | 11 | 1 | Single lane road | 1292 | 35 |
| 99 | 0163 | 0190 | 1.478 | 11 | 1 | Single lane road | 1292 | 35 |
| 100 | 0164 | 0175 | 1.242 | 12 | 1 | Unpaved | 800 | 30 |
| 101 | 0165 | 0166 | 0.051 | 12 | 1 | Single lane road | 1455 | 55 |
| 102 | 0166 | 0177 | 3.036 | 12 | 1 | Single lane road | 1455 | 55 |
| 103 | 0166 | 0219 | 1.441 | 12 | 1 | Single lane road | 1455 | 45 |
| 104 | 0168 | 0169 | 0.421 | 12 | 1 | Single lane road | 1455 | 45 |
| 105 | 0168 | 0258 | 2.563 | 12 | 1 | Single lane road | 1455 | 55 |
| 106 | 0168 | 4084 | 2.372 | 12 | 1 | Single lane road | 1455 | 55 |
| 107 | 0169 | 0201 | 2.091 | 12 | 1 | Single lane road | 1455 | 45 |
| 108 | 0169 | 0266 | 2.613 | 11 | 1 | Single lane road | 1292 | 40 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 109 | 0170 | 0162 | 0.658 | 10 | 1 | Unpaved | 800 | 30 |
| 110 | 0170 | 0202 | 2.459 | 11 | 1 | Single lane road | 1292 | 35 |
| 111 | 0175 | 0176 | 0.856 | 12 | 1 | Unpaved | 800 | 30 |
| 112 | 0175 | 0235 | 3.048 | 11 | 1 | Single lane road | 1292 | 35 |
| 113 | 0176 | 0182 | 0.511 | 12 | 1 | Single lane road | 1455 | 45 |
| 114 | 0177 | 0233 | 1.638 | 11 | 1 | Single lane road | 1292 | 40 |
| 115 | 0177 | 2078 | 3.365 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 116 | 0179 | 7960 | 5.993 | 12 | 1 | Single lane road | 1455 | 45 |
| 117 | 0182 | 0202 | 1.846 | 12 | 1 | Single lane road | 1455 | 45 |
| 118 | 0182 | 0232 | 2.687 | 12 | 1 | Single lane road | 1455 | 45 |
| 119 | 0187 | 0190 | 2.080 | 11 | 1 | Single lane road | 1292 | 35 |
| 120 | 0187 | 0210 | 1.783 | 12 | 1 | Single lane road | 1455 | 55 |
| 121 | 0190 | 0206 | 1.188 | 11 | 1 | Single lane road | 1292 | 35 |
| 122 | 0201 | 0204 | 1.600 | 12 | 1 | Single lane road | 1455 | 45 |
| 123 | 0201 | 0205 | 0.203 | 12 | 1 | Single lane road | 1455 | 45 |
| 124 | 0202 | 0238 | 1.695 | 12 | 1 | Single lane road | 1455 | 45 |
| 125 | 0204 | 0208 | 0.625 | 12 | 1 | Single lane road | 1455 | 45 |
| 126 | 0205 | 0252 | 1.797 | 12 | 1 | Single lane road | 1455 | 45 |
| 127 | 0205 | 0265 | 1.797 | 12 | 1 | Single lane road | 1455 | 45 |
| 128 | 0206 | 0210 | 1.422 | 10 | 1 | Unpaved | 800 | 30 |
| 129 | 0206 | 0241 | 1.413 | 11 | 1 | Single lane road | 1292 | 35 |
| 130 | 0208 | 0219 | 1.783 | 12 | 1 | Single lane road | 1455 | 45 |
| 131 | 0208 | 0251 | 1.431 | 12 | 1 | Single lane road | 1455 | 45 |
| 132 | 0210 | 0255 | 1.764 | 12 | 1 | Single lane road | 1455 | 55 |
| 133 | 0219 | 0242 | 0.369 | 12 | 1 | Single lane road | 1455 | 45 |
| 134 | 0232 | 0235 | 1.283 | 12 | 1 | Single lane road | 1455 | 55 |
| 135 | 0232 | 0238 | 2.022 | 12 | 1 | Single lane road | 1455 | 55 |
| 136 | 0232 | 0269 | 2.072 | 12 | 1 | Single lane road | 1455 | 45 |
| 137 | 0233 | 0280 | 1.285 | 12 | 1 | Single lane road | 1455 | 45 |
| 138 | 0233 | 7496 | 3.973 | 12 | 1 | Single lane road | 1455 | 45 |
| 139 | 0235 | 0241 | 1.115 | 12 | 1 | Single lane road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 140 | 0238 | 0259 | 2.000 | 12 | 1 | Single lane road | 1455 | 55 |
| 141 | 0238 | 0281 | 2.295 | 12 | 1 | Single lane road | 1455 | 45 |
| 142 | 0241 | 0255 | 1.667 | 12 | 1 | Single lane road | 1455 | 55 |
| 143 | 0241 | 0272 | 2.293 | 11 | 1 | Single lane road | 1292 | 35 |
| 144 | 0242 | 0233 | 2.516 | 12 | 1 | Single lane road | 1455 | 45 |
| 145 | 0242 | 0263 | 0.871 | 12 | 1 | Single lane road | 1455 | 45 |
| 146 | 0247 | 0259 | 0.635 | 12 | 1 | Single lane road | 1455 | 55 |
| 147 | 0251 | 0252 | 1.216 | 12 | 1 | Single lane road | 1455 | 45 |
| 148 | 0251 | 0263 | 1.813 | 12 | 1 | Single lane road | 1455 | 45 |
| 149 | 0251 | 0286 | 0.853 | 12 | 1 | Single lane road | 1455 | 45 |
| 150 | 0252 | 0268 | 0.325 | 12 | 1 | Single lane road | 1455 | 45 |
| 151 | 0255 | 0362 | 0.675 | 12 | 1 | Single lane road | 1455 | 55 |
| 152 | 0255 | 0435 | 1.056 | 12 | 1 | Single lane road | 1455 | 55 |
| 153 | 0258 | 0266 | 1.191 | 12 | 1 | Single lane road | 1455 | 45 |
| 154 | 0258 | 0313 | 1.540 | 12 | 1 | Single lane road | 1455 | 55 |
| 155 | 0259 | 0296 | 3.111 | 12 | 1 | Single lane road | 1455 | 55 |
| 156 | 0263 | 0280 | 3.284 | 12 | 1 | Single lane road | 1455 | 45 |
| 157 | 0263 | 0379 | 2.381 | 11 | 1 | Single lane road | 1292 | 40 |
| 158 | 0265 | 0268 | 1.263 | 12 | 1 | Single lane road | 1455 | 45 |
| 159 | 0265 | 0292 | 0.858 | 12 | 1 | Single lane road | 1455 | 45 |
| 160 | 0266 | 0265 | 1.197 | 12 | 1 | Single lane road | 1455 | 45 |
| 161 | 0268 | 0279 | 0.447 | 12 | 1 | Single lane road | 1455 | 45 |
| 162 | 0269 | 0272 | 0.357 | 12 | 1 | Single lane road | 1455 | 45 |
| 163 | 0269 | 0281 | 2.514 | 12 | 1 | Single lane road | 1455 | 45 |
| 164 | 0269 | 0305 | 2.547 | 12 | 1 | Single lane road | 1455 | 45 |
| 165 | 0272 | 0274 | 0.094 | 12 | 1 | Single lane road | 1455 | 45 |
| 166 | 0274 | 0293 | 2.996 | 12 | 1 | Single lane road | 1455 | 45 |
| 167 | 0279 | 0286 | 0.783 | 12 | 1 | Single lane road | 1455 | 45 |
| 168 | 0279 | 0330 | 1.533 | 12 | 1 | Single lane road | 1455 | 45 |
| 169 | 0280 | 0383 | 2.061 | 12 | 1 | Single lane road | 1455 | 45 |
| 170 | 0281 | 0296 | 0.974 | 12 | 1 | Single lane road | 1455 | 45 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 171 | 0286 | 0335 | 1.285 | 12 | 1 | Single lane road | 1455 | 45 |
| 172 | 0286 | 0379 | 2.467 | 12 | 1 | Single lane road | 1455 | 45 |
| 173 | 0292 | 0325 | 1.207 | 12 | 1 | Single lane road | 1455 | 45 |
| 174 | 0292 | 0329 | 1.072 | 12 | 1 | Single lane road | 1455 | 45 |
| 175 | 0293 | 0302 | 1.329 | 12 | 1 | Single lane road | 1455 | 45 |
| 176 | 0296 | 0314 | 1.450 | 12 | 1 | Single lane road | 1455 | 55 |
| 177 | 0302 | 0305 | 2.620 | 10 | 1 | Unpaved | 800 | 25 |
| 178 | 0302 | 0339 | 3.425 | 12 | 1 | Single lane road | 1455 | 45 |
| 179 | 0305 | 0324 | 1.911 | 12 | 1 | Single lane road | 1455 | 45 |
| 180 | 0313 | 0325 | 2.229 | 11 | 1 | Unpaved | 800 | 30 |
| 181 | 0313 | 0432 | 1.501 | 12 | 1 | Single lane road | 1455 | 55 |
| 182 | 0314 | 0324 | 2.914 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 183 | 0324 | 0339 | 0.791 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 184 | 0324 | 0376 | 1.969 | 12 | 1 | Single lane road | 1455 | 55 |
| 185 | 0325 | 0441 | 1.423 | 12 | 1 | Single lane road | 1455 | 45 |
| 186 | 0325 | 0446 | 1.624 | 12 | 1 | Single lane road | 1455 | 45 |
| 187 | 0329 | 0330 | 1.540 | 12 | 1 | Single lane road | 1455 | 45 |
| 188 | 0329 | 0449 | 1.335 | 12 | 1 | Single lane road | 1455 | 45 |
| 189 | 0330 | 0335 | 0.058 | 12 | 1 | Single lane road | 1455 | 45 |
| 190 | 0335 | 0436 | 1.197 | 12 | 1 | Single lane road | 1455 | 45 |
| 191 | 0339 | 0419 | 8.523 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 192 | 0362 | 0274 | 2.829 | 11 | 1 | Single lane road | 1292 | 35 |
| 193 | 0362 | 0293 | 1.952 | 12 | 1 | Single lane road | 1455 | 55 |
| 194 | 0373 | 0383 | 0.642 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 195 | 0373 | 2777 | 2.935 | 12 | 1 | Single lane road | 1455 | 45 |
| 196 | 0373 | 7496 | 1.214 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 197 | 0379 | 0382 | 0.052 | 12 | 1 | Single lane road | 1455 | 45 |
| 198 | 0380 | 0393 | 0.000 | 11 | 1 | Single lane road | 1292 | 35 |
| 199 | 0382 | 0417 | 0.324 | 11 | 1 | Single lane road | 1292 | 40 |
| 200 | 0382 | 0436 | 1.632 | 11 | 1 | Single lane road | 1292 | 35 |
| 201 | 0383 | 0398 | 0.492 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 202 | 0388 | 0428 | 0.000 | 12 | 1 | Single lane road | 1455 | 45 |
| 203 | 0391 | 0393 | 0.000 | 11 | 1 | Single lane road | 1292 | 30 |
| 204 | 0393 | 0410 | 0.000 | 11 | 1 | Single lane road | 1292 | 35 |
| 205 | 0398 | 0417 | 1.911 | 11 | 1 | Single lane road | 1292 | 40 |
| 206 | 0398 | 0442 | 1.438 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 207 | 0410 | 0420 | 0.000 | 11 | 1 | Single lane road | 1292 | 35 |
| 208 | 0417 | 0456 | 0.486 | 11 | 1 | Single lane road | 1292 | 40 |
| 209 | 0417 | 0462 | 1.564 | 12 | 1 | Single lane road | 1455 | 45 |
| 210 | 0432 | 0441 | 1.913 | 12 | 1 | Single lane road | 1455 | 45 |
| 211 | 0432 | 0530 | 2.186 | 12 | 1 | Single lane road | 1455 | 55 |
| 212 | 0436 | 0462 | 0.299 | 12 | 1 | Single lane road | 1455 | 45 |
| 213 | 0436 | 0484 | 1.870 | 12 | 1 | Single lane road | 1455 | 45 |
| 214 | 0441 | 0446 | 1.215 | 12 | 1 | Single lane road | 1455 | 45 |
| 215 | 0441 | 0550 | 2.292 | 12 | 1 | Single lane road | 1455 | 45 |
| 216 | 0442 | 0456 | 0.417 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 217 | 0442 | 0538 | 2.222 | 12 | 1 | Single lane road | 1455 | 55 |
| 218 | 0446 | 0449 | 0.791 | 12 | 1 | Single lane road | 1455 | 45 |
| 219 | 0449 | 0484 | 0.693 | 12 | 1 | Single lane road | 1455 | 45 |
| 220 | 0456 | 0472 | 1.439 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 221 | 0456 | 0540 | 1.845 | 12 | 1 | Single lane road | 1455 | 45 |
| 222 | 0462 | 0472 | 0.384 | 12 | 1 | Single lane road | 1455 | 45 |
| 223 | 0462 | 0486 | 0.946 | 12 | 1 | Single lane road | 1455 | 45 |
| 224 | 0472 | 0486 | 0.994 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 225 | 0472 | 0507 | 0.741 | 12 | 1 | Single lane road | 1455 | 45 |
| 226 | 0484 | 0514 | 0.678 | 12 | 1 | Single lane road | 1455 | 45 |
| 227 | 0484 | 0550 | 2.664 | 12 | 1 | Single lane road | 1455 | 45 |
| 228 | 0486 | 0502 | 0.795 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 229 | 0502 | 0507 | 1.786 | 12 | 1 | Single lane road | 1455 | 50 |
| 230 | 0502 | 0514 | 0.208 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 231 | 0507 | 0540 | 2.132 | 10 | 1 | Unpaved | 800 | 30 |
| 232 | 0514 | 0521 | 0.602 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 233 | 0514 | 0626 | 4.722 | 12 | 1 | Single lane road | 1455 | 45 |
| 234 | 0521 | 0553 | 1.641 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 235 | 0521 | 0644 | 4.500 | 12 | 1 | Single lane road | 1455 | 50 |
| 236 | 0522 | 0557 | 0.925 | 11 | 1 | Single lane road | 1292 | 40 |
| 237 | 0530 | 0556 | 1.080 | 12 | 1 | Single lane road | 1455 | 45 |
| 238 | 0530 | 0557 | 1.279 | 12 | 1 | Single lane road | 1455 | 45 |
| 239 | 0538 | 0540 | 0.962 | 12 | 1 | Single lane road | 1455 | 45 |
| 240 | 0538 | 0559 | 0.510 | 12 | 1 | Single lane road | 1455 | 45 |
| 241 | 0538 | 2777 | 1.861 | 12 | 1 | Single lane road | 1455 | 45 |
| 242 | 0540 | 0434 | 1.584 | 12 | 1 | Single lane road | 1455 | 45 |
| 243 | 0550 | 0552 | 0.299 | 12 | 1 | Single lane road | 1455 | 45 |
| 244 | 0550 | 0554 | 0.148 | 12 | 1 | Single lane road | 1455 | 45 |
| 245 | 0552 | 0554 | 0.304 | 12 | 1 | Single lane road | 1455 | 45 |
| 246 | 0552 | 0556 | 1.773 | 12 | 1 | Single lane road | 1455 | 45 |
| 247 | 0553 | 0558 | 0.149 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 248 | 0553 | 0640 | 3.635 | 12 | 1 | Single lane road | 1455 | 50 |
| 249 | 0554 | 0558 | 0.173 | 12 | 1 | Single lane road | 1455 | 45 |
| 250 | 0556 | 0572 | 1.061 | 12 | 1 | Single lane road | 1455 | 45 |
| 251 | 0557 | 0583 | 0.933 | 12 | 1 | Single lane road | 1455 | 55 |
| 252 | 0558 | 0573 | 1.356 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 253 | 0572 | 0573 | 0.091 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 254 | 0572 | 0578 | 2.805 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 255 | 0573 | 0638 | 3.327 | 12 | 1 | Single lane road | 1455 | 45 |
| 256 | 0578 | 0581 | 0.051 | 12 | 1 | Single lane road | 1455 | 45 |
| 257 | 0578 | 0583 | 0.371 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 258 | 0581 | 0536 | 5.993 | 12 | 1 | Single lane road | 1455 | 45 |
| 259 | 0581 | 4045 | 2.181 | 12 | 1 | Single lane road | 1455 | 45 |
| 260 | 0583 | 0314 | 2.525 | 12 | 1 | Single lane road | 1455 | 50 |
| 261 | 0618 | 0434 | 1.183 | 12 | 1 | Single lane road | 1455 | 45 |
| 262 | 0618 | 0624 | 0.409 | 9 | 1 | Unpaved | 800 | 25 |
| 263 | 0623 | 0624 | 0.352 | 12 | 1 | Single lane road | 1455 | 50 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 264 | 0623 | 4276 | 0.405 | 12 | 1 | Single lane road | 1455 | 45 |
| 265 | 0623 | 6502 | 2.802 | 12 | 1 | Single lane road | 1455 | 45 |
| 266 | 0624 | 0626 | 1.632 | 12 | 1 | Single lane road | 1455 | 50 |
| 267 | 0626 | 0644 | 2.904 | 12 | 1 | Single lane road | 1455 | 50 |
| 268 | 0637 | 0638 | 0.687 | 12 | 1 | Single lane road | 1455 | 50 |
| 269 | 0638 | 0640 | 0.330 | 12 | 1 | Single lane road | 1455 | 50 |
| 270 | 0638 | 4794 | 0.955 | 11 | 1 | Single lane road | 1292 | 40 |
| 271 | 0640 | 0641 | 0.254 | 12 | 1 | Single lane road | 1455 | 50 |
| 272 | 0641 | 0644 | 1.021 | 12 | 1 | Single lane road | 1455 | 50 |
| 273 | 0641 | 4794 | 0.785 | 11 | 1 | Single lane road | 1292 | 40 |
| 274 | 0644 | 0647 | 0.128 | 12 | 1 | Single lane road | 1455 | 45 |
| 275 | 0970 | 4199 | 2.712 | 11 | 1 | Single lane road | 1292 | 40 |
| 276 | 1299 | 5861 | 0.518 | 10 | 1 | Single lane road | 1292 | 35 |
| 277 | 1692 | 2449 | 0.474 | 10 | 1 | Single lane road | 1292 | 35 |
| 278 | 1832 | 1869 | 1.226 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 279 | 1832 | 3809 | 2.493 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 280 | 1832 | 7804 | 0.778 | 12 | 1 | Single lane road | 1455 | 45 |
| 281 | 1869 | 1882 | 0.501 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 282 | 1869 | 7800 | 2.128 | 12 | 1 | Single lane road | 1455 | 50 |
| 283 | 1882 | 1903 | 0.958 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 284 | 1882 | 7791 | 6.054 | 12 | 1 | Single lane road | 1455 | 50 |
| 285 | 1886 | 5924 | 1.793 | 10 | 1 | Single lane road | 1292 | 35 |
| 286 | 1903 | 0535 | 6.533 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 287 | 1998 | 0535 | 1.868 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 288 | 2007 | 7509 | 2.153 | 11 | 1 | Single lane road | 1292 | 40 |
| 289 | 2061 | 2100 | 0.718 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 290 | 2061 | 2841 | 0.718 | 12 | 2 | Multi-lane Hwy | 4400 | 65 |
| 291 | 2061 | 4586 | 1.200 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 292 | 2078 | 2084 | 0.263 | 12 | 3 | Multi-lane Hwy | 6600 | 55 |
| 293 | 2078 | 2841 | 0.940 | 12 | 3 | Multi-lane Hwy | 6600 | 60 |
| 294 | 2084 | 2110 | 0.196 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 295 | 2084 | 2751 | 2.613 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 296 | 2084 | 7496 | 1.452 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 297 | 2100 | 2121 | 0.826 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 298 | 2100 | 4533 | 1.581 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 299 | 2110 | 2121 | 0.724 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 300 | 2110 | 3260 | 1.298 | 12 | 1 | Single lane road | 1455 | 55 |
| 301 | 2121 | 7509 | 1.448 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 302 | 2161 | 3888 | 0.763 | 12 | 1 | Single lane road | 1455 | 45 |
| 303 | 2168 | 2169 | 0.017 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 304 | 2169 | 2513 | 0.348 | 10 | 1 | Single lane road | 1292 | 35 |
| 305 | 2169 | 7509 | 3.137 | 12 | 2 | Multi-lane Hwy | 4200 | 55 |
| 306 | 2243 | 3245 | 2.706 | 12 | 1 | Single lane road | 1455 | 45 |
| 307 | 2243 | 4045 | 6.980 | 12 | 1 | Single lane road | 1455 | 45 |
| 308 | 2243 | 6064 | 0.033 | 11 | 1 | Single lane road | 1292 | 35 |
| 309 | 2382 | 3983 | 4.911 | 10 | 1 | Single lane road | 1292 | 35 |
| 310 | 2449 | 2561 | 1.189 | 10 | 1 | Single lane road | 1292 | 35 |
| 311 | 2513 | 3326 | 2.185 | 10 | 1 | Single lane road | 1292 | 25 |
| 312 | 2561 | 2777 | 1.555 | 10 | 1 | Single lane road | 1292 | 25 |
| 313 | 2561 | 3465 | 1.351 | 10 | 1 | Single lane road | 1292 | 35 |
| 314 | 2751 | 0535 | 0.377 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 315 | 2777 | 3334 | 2.190 | 10 | 1 | Single lane road | 1292 | 35 |
| 316 | 2841 | 4218 | 0.005 | 11 | 1 | Single lane road | 1292 | 35 |
| 317 | 2854 | 1299 | 2.302 | 10 | 1 | Single lane road | 1292 | 35 |
| 318 | 2854 | 2243 | 0.692 | 12 | 1 | Single lane road | 1455 | 50 |
| 319 | 2854 | 6826 | 4.953 | 12 | 1 | Single lane road | 1455 | 55 |
| 320 | 3245 | 0536 | 0.619 | 12 | 1 | Single lane road | 1455 | 45 |
| 321 | 3245 | 4045 | 5.357 | 10 | 1 | Single lane road | 1292 | 35 |
| 322 | 3259 | 2007 | 0.017 | 11 | 1 | Single lane road | 1292 | 35 |
| 323 | 3259 | 3260 | 0.019 | 12 | 1 | Single lane road | 1455 | 50 |
| 324 | 3259 | 6793 | 0.411 | 12 | 1 | Single lane road | 1455 | 45 |
| 325 | 3259 | 7496 | 0.428 | 10 | 1 | Single lane road | 1292 | 35 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 326 | 3260 | 2007 | 0.019 | 11 | 1 | Single lane road | 1292 | 35 |
| 327 | 3334 | 0434 | 0.151 | 12 | 1 | Single lane road | 1455 | 45 |
| 328 | 3334 | 4217 | 1.671 | 10 | 1 | Single lane road | 1292 | 35 |
| 329 | 3465 | 4217 | 1.942 | 10 | 1 | Single lane road | 1292 | 25 |
| 330 | 3465 | 4334 | 1.550 | 10 | 1 | Single lane road | 1292 | 25 |
| 331 | 3888 | 0179 | 2.051 | 11 | 1 | Single lane road | 1292 | 40 |
| 332 | 3888 | 9353 | 6.129 | 12 | 1 | Single lane road | 1455 | 55 |
| 333 | 3983 | 9977 | 2.032 | 10 | 1 | Single lane road | 1292 | 35 |
| 334 | 4010 | 4013 | 1.892 | 12 | 1 | Single lane road | 1455 | 45 |
| 335 | 4010 | 4794 | 2.302 | 10 | 1 | Single lane road | 1292 | 35 |
| 336 | 4012 | 4013 | 0.295 | 12 | 1 | Single lane road | 1455 | 50 |
| 337 | 4013 | 5924 | 1.760 | 10 | 1 | Single lane road | 1292 | 35 |
| 338 | 4020 | 4794 | 0.955 | 11 | 1 | Single lane road | 1292 | 35 |
| 339 | 4165 | 0087 | 1.071 | 11 | 1 | Single lane road | 1292 | 40 |
| 340 | 4217 | 4334 | 1.451 | 11 | 1 | Single lane road | 1292 | 35 |
| 341 | 4319 | 9977 | 0.130 | 11 | 1 | Single lane road | 1292 | 35 |
| 342 | 4467 | 0179 | 6.492 | 12 | 1 | Single lane road | 1455 | 55 |
| 343 | 4775 | 1299 | 0.815 | 10 | 1 | Single lane road | 1292 | 35 |
| 344 | 4794 | 5924 | 4.887 | 11 | 1 | Single lane road | 1292 | 40 |
| 345 | 4884 | 2708 | 0.602 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 346 | 4884 | 4886 | 0.208 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 347 | 4884 | 7580 | 0.019 | 11 | 1 | Single lane road | 1292 | 35 |
| 348 | 4886 | 4887 | 0.794 | 12 | 2 | Multi-lane Hwy | 4400 | 60 |
| 349 | 4886 | 7578 | 0.020 | 11 | 1 | Single lane road | 1292 | 35 |
| 350 | 5861 | 0536 | 1.797 | 12 | 1 | Single lane road | 1455 | 45 |
| 351 | 5861 | 5924 | 2.030 | 10 | 1 | Single lane road | 1292 | 35 |
| 352 | 6485 | 3326 | 2.817 | 10 | 1 | Single lane road | 1292 | 35 |
| 353 | 6485 | 4334 | 0.214 | 11 | 1 | Single lane road | 1292 | 35 |
| 354 | 6485 | 6796 | 1.841 | 12 | 1 | Single lane road | 1455 | 45 |
| 355 | 6793 | 2449 | 0.091 | 11 | 1 | Single lane road | 1292 | 35 |
| 356 | 6793 | 2513 | 0.215 | 11 | 1 | Single lane road | 1292 | 35 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 357 | 6793 | 6796 | 0.364 | 12 | 1 | Single lane road | 1455 | 45 |
| 358 | 6796 | 3326 | 0.118 | 10 | 1 | Single lane road | 1292 | 35 |
| 359 | 6796 | 3465 | 1.201 | 11 | 1 | Single lane road | 1292 | 35 |
| 360 | 7781 | 0259 | 1.108 | 12 | 1 | Single lane road | 1455 | 45 |
| 361 | 7791 | 0087 | 3.210 | 10 | 1 | Single lane road | 1292 | 35 |
| 362 | 7791 | 4319 | 1.228 | 10 | 1 | Single lane road | 1292 | 35 |
| 363 | 7800 | 4319 | 3.556 | 10 | 1 | Single lane road | 1292 | 35 |
| 364 | 7800 | 7804 | 1.420 | 12 | 1 | Single lane road | 1455 | 50 |
| 365 | 7804 | 3983 | 1.644 | 10 | 1 | Single lane road | 1292 | 35 |

# APPENDIX C: TELEPHONE SURVEY

## Introduction

The development of evacuation time estimates (ETE) for the area surrounding the FNP requires the identification of travel patterns, available vehicles, and household size of the people who live or work in the area. Specific data is needed in developing ETEs in order to effectively quantify mobilization time and vehicle usage for residents responding to an evacuation advisory. A telephone survey was conducted to interview a sample of residents who live within the 10-mile EPZ of the proposed nuclear power plant site to acquire information required for the ETE study.

IEM secured the services of Survey Technology & Research Center (STR) in Allentown, Pennsylvania to conduct the telephone survey and provide data to IEM for analysis.

## Survey Instrument and Sampling Plan

A survey instrument/questionnaire was developed by IEM, and was reviewed and approved by Southern Nuclear project personnel. The approved survey questionnaire was used to interview a sample of residents who live or work within 10 miles of the site to acquire information required for the ETE study. To achieve a representative sample of households living in the emergency planning zone (EPZ), respondents were randomly selected to participate in the survey. STR fielded the telephone survey and provided data to IEM for analysis. Calls were conducted in the early evening hours from Wednesday, June 6, 2012 to Monday, June 11, 2012. Only residents 18 years of age and older were allowed to participate in the survey. Telephone calls were made during weekday evenings and on weekends in an attempt to reach households with both workers and non-workers. To ensure the highest quality of work was performed, a quality assurance plan was implemented in this survey process that included call-taker training, telephone monitoring by IEM, and extensive data quality control checks.

The sampling frame consisted of a list of households within the study area. The survey required over 550 completed surveys in order to achieve the desired margin of error of 4 percentage points or less. However, there were not enough telephone listings available in the databases used by STR to attain this sample size. Several efforts were made to get a more comprehensive listing. With the available telephone numbers, the survey effort produced a total of 251 completed surveys, resulting in a margin of error at 6.1% with 95% confidence level.

## Survey Results

1. How many people live in your home?

**Table 35: Household Size**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 23% |
| 2 | 53% |
| 3 | 11% |
| 4 | 8% |
| 5 or more | 4% |

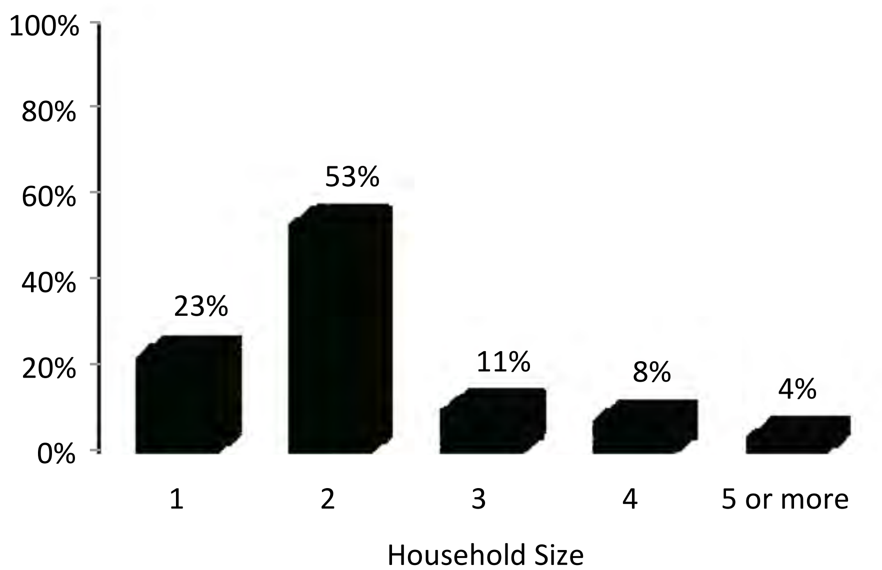


**Figure 23: Household Size**

2. If instructed to evacuate, how many cars would your family use to evacuate.
   a. During the day?

**Table 36: Percentage of Cars Used to Evacuate During the Day**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 63% |
| 2 | 28% |
| 3 or more | 6% |
| None | 3% |

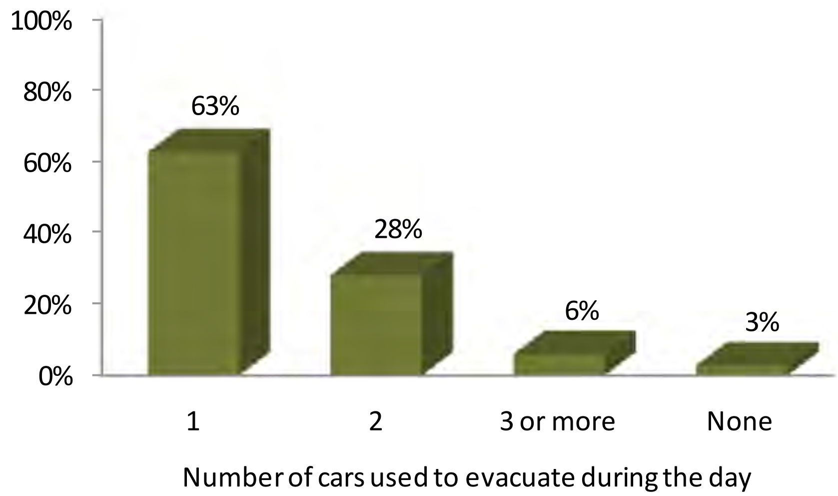


**Figure 24: Number of cars used to evacuate during the day**

b. At night?

**Table 37: Percentage of Cars Used to Evacuate at Night**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 69% |
| 2 | 23% |
| 3 or more | 6% |
| None | 2% |

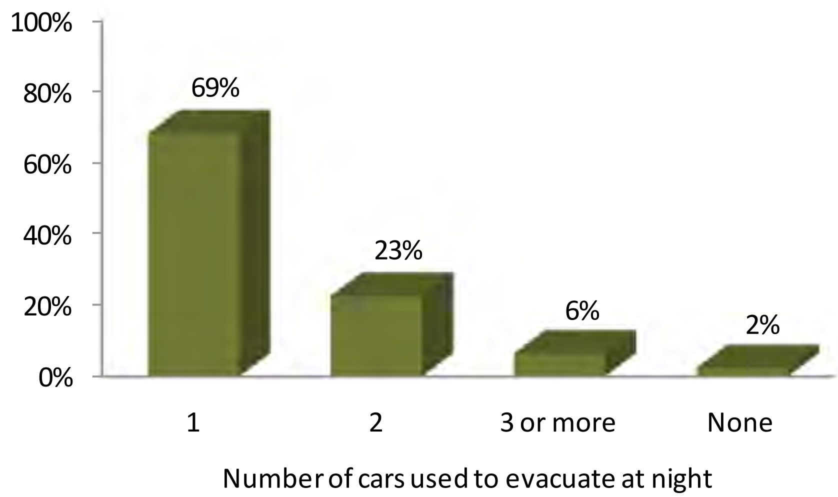


**Figure 25: Number of cars used to evacuate at night**

c. On most weekends?

**Table 38: Percentage of Cars Used to Evacuate on Weekends**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 63% |
| 2 | 27% |
| 3 or more | 7% |
| None | 2% |

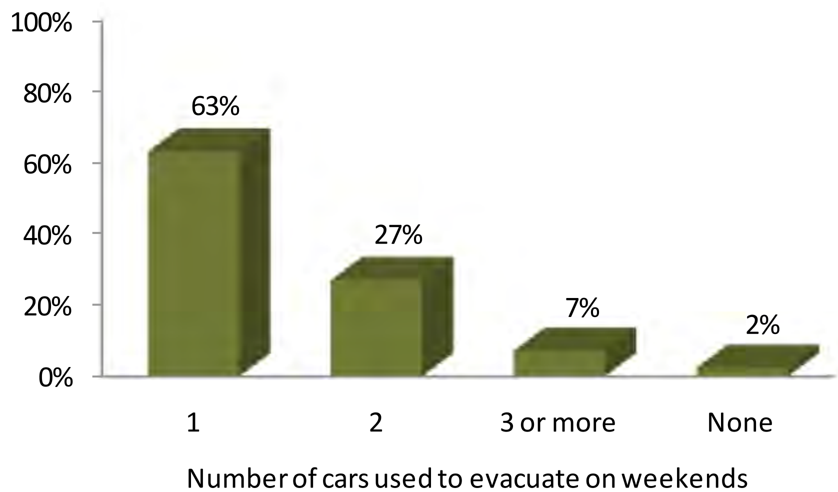


**Figure 26: Number of cars used to evacuate on weekends**

3. Does anyone in your family rely on public transportation in the event of an evacuation?

**Table 39: Percentage who rely on public transportation to evacuate**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 2% |
| 2 | <1% |
| 3 | 0% |
| 4 | <1% |
| 5 or more | 0% |
| None | 97% |

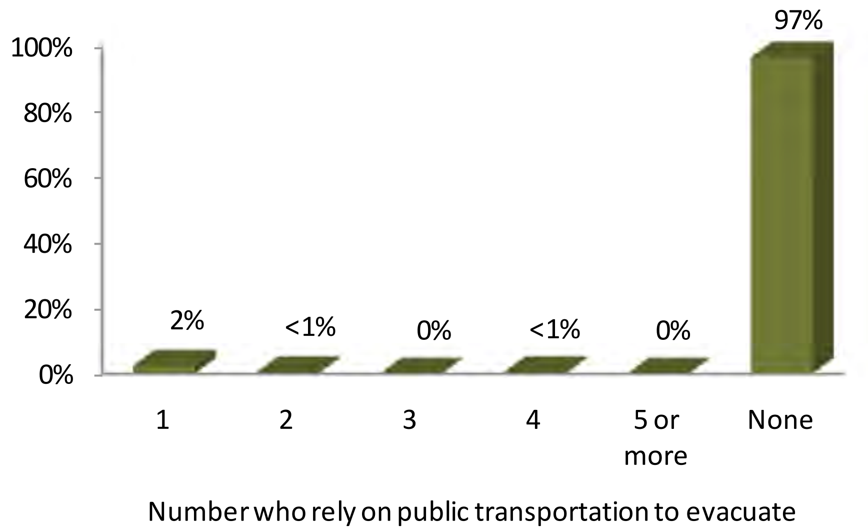


**Figure 27: Number who rely on public transportation to evacuate**

4. How many people in your family commute to a job, or to college, at least 4 times a week?

**Table 40: Percentage of Respondents who indicated there are commuters in the family**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 25% |
| 2 | 16% |
| 3 | 6% |
| 4 | 1% |
| 5 or more | 0% |
| None | 52% |

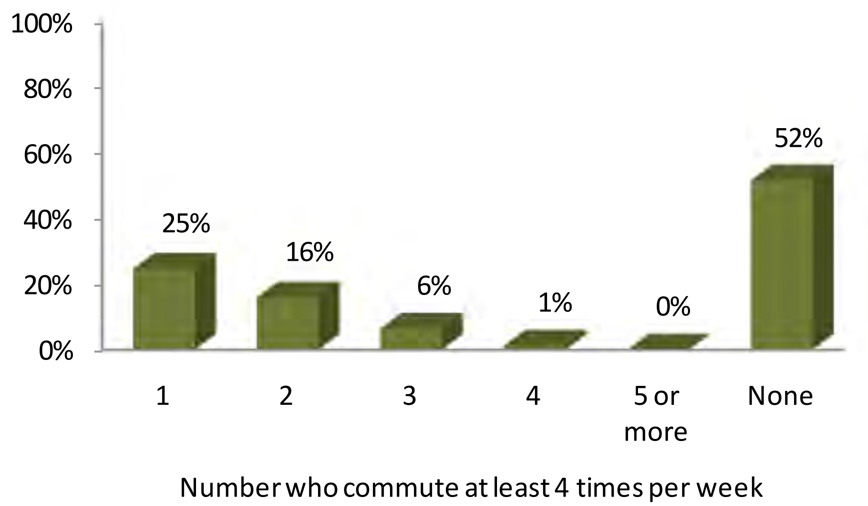


**Figure 28: Number who commutes at least 4 times per week**

5. How long would it take each family member who works to return home, including the preparation time to leave work and the travel time back home?

**Table 41: Time to Return Home from Work**

| Response | Percentage of Commuters (n=121) |
|---|---|
| 1-5 minutes | 5% |
| 6-10 minutes | 8% |
| 11-15 minutes | 8% |
| More than 15 minutes | 79% |

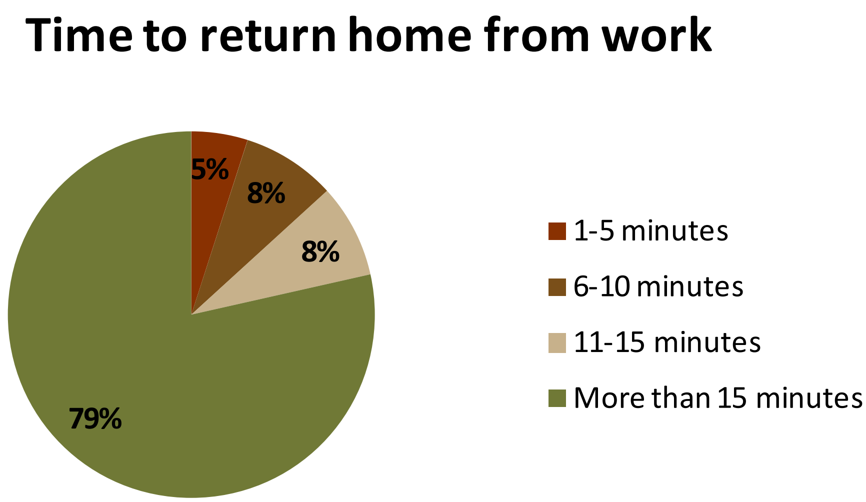


**Figure 29: Time to return home from work**

6. Would the people at home evacuate on their own or wait for family members to come home before evacuating?

**Table 42: Percentage who would Evacuate or Wait**

| Response | Percentage of Respondents (n=251) |
|---|---|
| Evacuate on own | 75% |
| Await the return of family members | 25% |

7. If you had to evacuate, how long would it take for the family to pack clothing, secure the house, load the car, and complete preparations…
   a. During the day?

**Table 43: Time to Complete Evacuation Preparations during the Day**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1-5 minutes | 6% |
| 6-10 minutes | 10% |
| 11-15 minutes | 8% |
| More than 15 minutes | 76% |

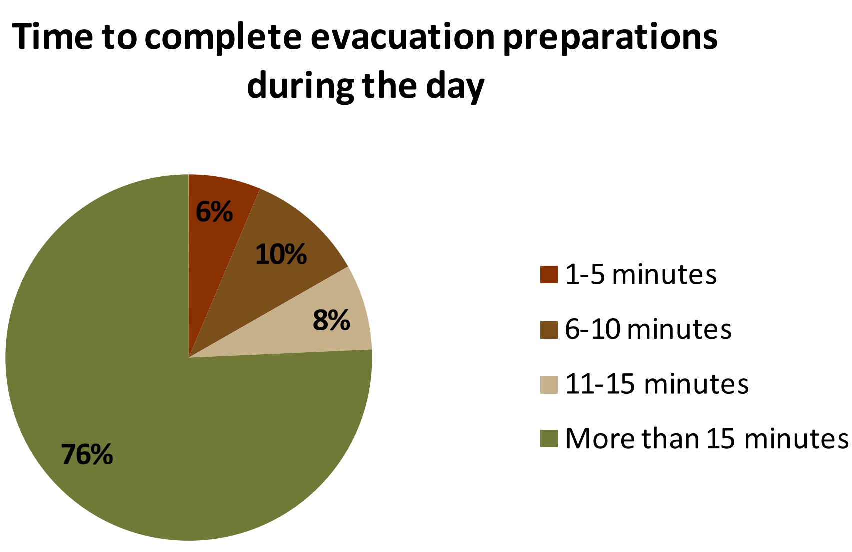


**Figure 30: Time to complete evacuations preparations during the day**

b. At night?

**Table 44: Time to Complete Evacuation Preparations at Night**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1-5 minutes | 4% |
| 6-10 minutes | 11% |
| 11-15 minutes | 10% |
| More than 15 minutes | 75% |

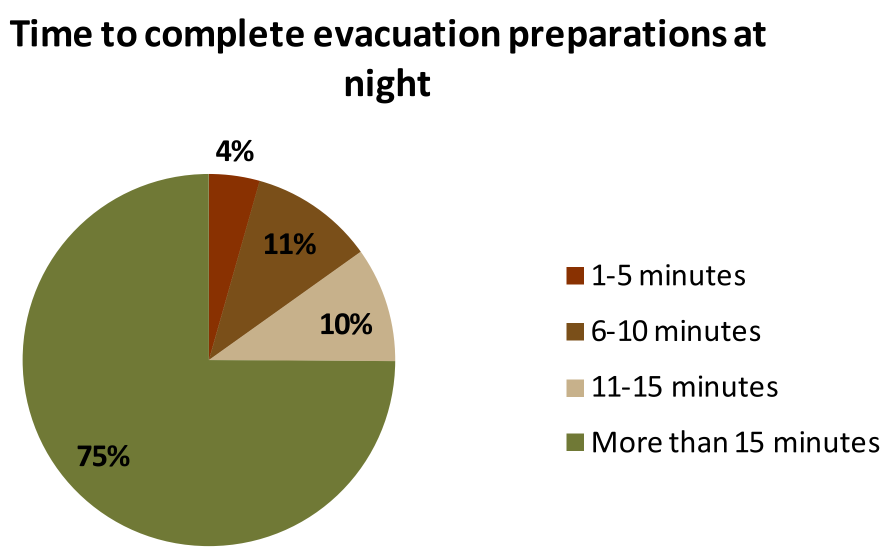


**Figure 31: Time to complete evacuation preparations at night**

c. On most weekends?

**Table 45: Time to Complete Evacuation Preparations on Weekends**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1-5 minutes | 5% |
| 6-10 minutes | 10% |
| 11-15 minutes | 10% |
| More than 15 minutes | 75% |

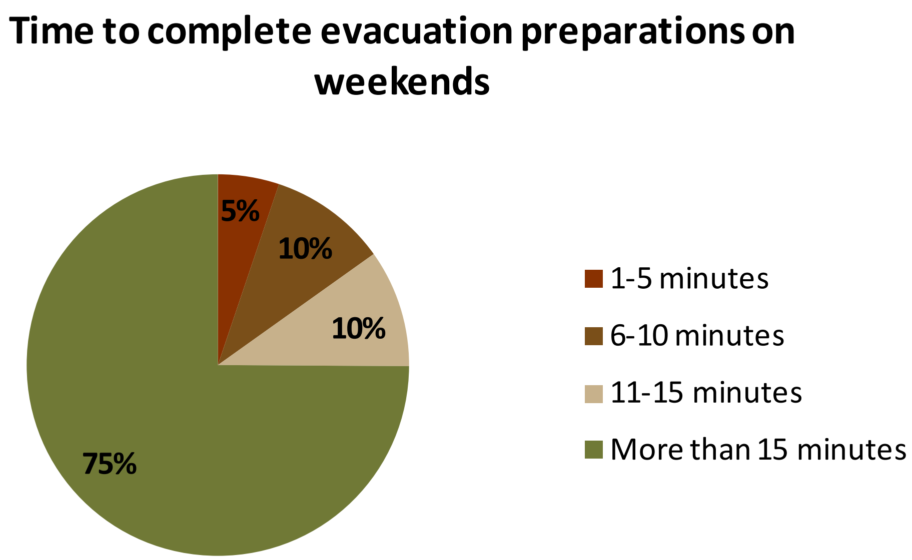


**Figure 32: Time to complete evacuation preparations on weekends**

8. Do any family members require assistance because they don't drive or cannot drive? If so, how many?

**Table 46: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=251) |
|---|---|
| 1 | 15% |
| 2 | 4% |
| 3 | 0% |
| 4 | <1% |
| 5 or more | 0% |
| None | 81% |

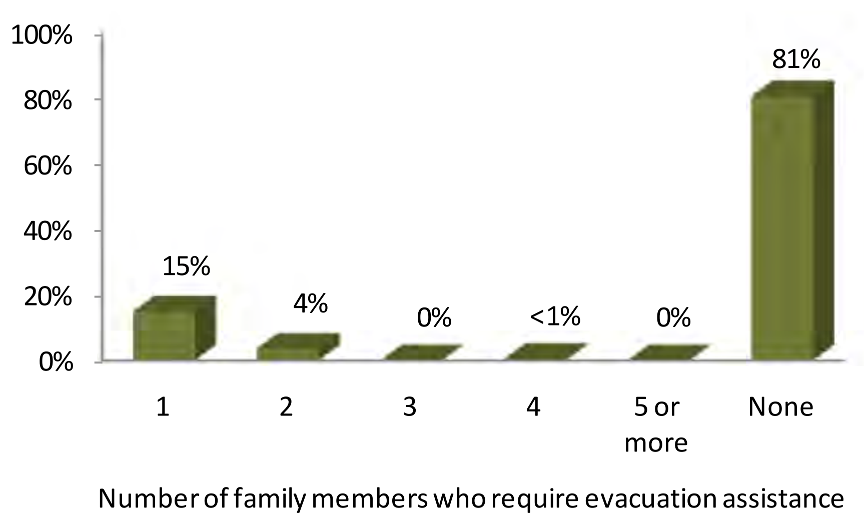


**Figure 33: Number of family members who require evacuation assistance**

9. What type of assistance is needed?

**Table 47: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=48) |
|---|---|
| Just a ride, no special accommodations | 75% |
| A wheelchair van | 4% |
| An ambulance with medical equipment and personnel to provide special medical attention. | 6% |
| An ambulance that can carry a stretcher, but no special medical attention is required. | 6% |
| Other | 8% |

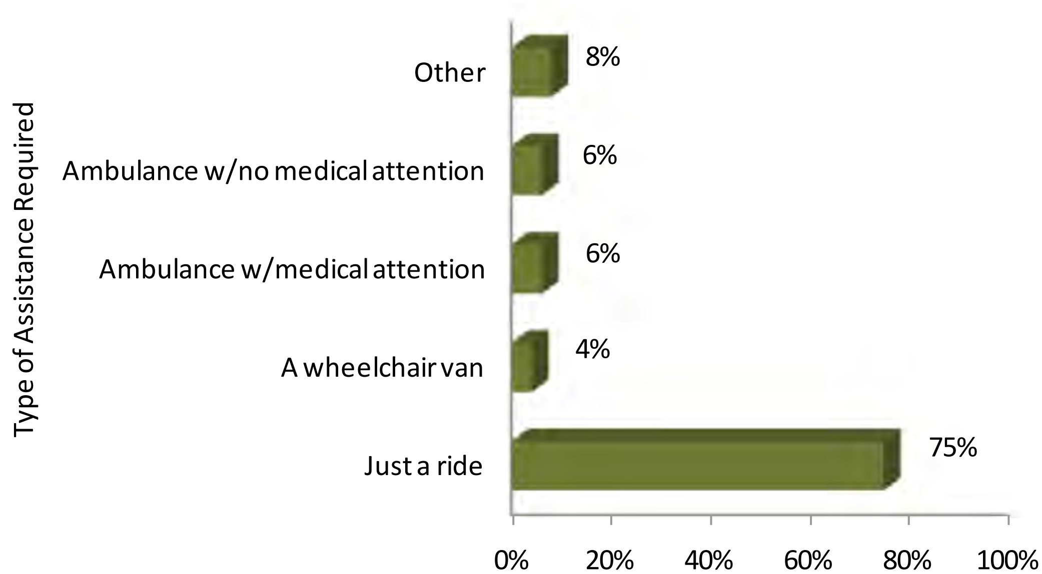


**Figure 34: Type of Evacuation Assistance Required**

Other types of assistance requested include:

- only hand or arm assistance
- son across the street needs help walking
- blind wife
- she has Alzheimer's and needs assistance

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# APPENDIX D: PTV VISION QUALITY ASSURANCE AND INDUSTRY ACCEPTANCE INFORMATION

March 28, 2006

traffic mobility logistics.

[redacted]

ıalyst/Modeler

a Blvd.
70809

PTV America, Inc.
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4384
Fax: 302-691-4740
www.ptvamerica.com

Akhil Chauhan
Transportation Ar
IEM, Inc.
8555 United Plaz
Baton Rouge, LA

**Quality Assurance and Industry Acceptance**

**RE: PTV Vision®**

n:

Dear Mr. Chauha

I am providing the following information concerning
and industry acceptance of the PTV Vision traffic

Per your request,
quality assurance

[redacted]

ıg software.

simulation and transportation plannir

search and development of the PTV
sis of the VISSIM simulation model is
models developed at the University
The first commercial release of
imulation model components have
and performance based on field data

PTV AG has performed extensive re
Vision software since 1992. The bas
the car-following and lane-changing
of Karlsruhe, Germany since 1974.
VISSIM was in 1993. The VISSIM s
been validated by PTV for accuracy
in Germany and the United States.

procedure is conducted before each
ase by PTV, ensuring consistency of

A comprehensive quality assurance
service pack and major software rele

[redacted]

traffic mobility logistics.

The following public agencies are currently using VISSIM:

- Arkansas State Highway Dept,

[redacted]

*PTV America, Inc.*
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302 654 4384
Fax: 302 691 4740
www.ptvamerica.com

- Colorado DOT,
- Florida DOT,
- Idaho DOT,
- Kansas DOT,
- Louisiana DOT,
- Michigan DOT,
- Missouri DOT,
- Nevada DOT,
- New Mexico DOT,
- NYSDOT,
- Ohio DOT,

[redacted]

- Oregon DOT,
- South Carolina DOT,
- UDOT,
- Washington DOT

ıg VISUM:

The following public agencies are currently usir

- AGFTC, Fort Edward NY
- BMPO, Bend OR
- BMTS, Binghamton NY
- CAMPO, Corvallis OR

[redacted]

D, El Paso TX
MPO, Farmington NM
ur D'Alene ID
MPO, Las Cruces NM
ene OR

- El Paso MP(
- Farmington I
- KMPO, Coe
- Las Cruces I
- LCOG, Euge

If you have any questions about the PTV Vision software, feel free to contact me at 302-654-4384.

Sincerely yours,

Kiel Ova, P.E., PTOE
Project Manager

traffic mobility logistics.

*PTV America, Inc.*
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4384
Fax: 302-691-4740
www.ptvamerica.com

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# APPENDIX E: ETE REVIEW CRITERIA CHECKLIST[35]

**Table 48: NUREG/CR-7002 ETE Review Criteria Checklist**

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **1.0** | **Introduction** | | |
| a. | The emergency planning zone (EPZ) and surrounding area should be described. | Yes | Section 1.1 Site Location<br>Section 1.2 Emergency Planning Zone |
| b. | A map should be included that identifies primary features of the site, including major roadways, significant topographical features, boundaries of counties, and population centers within the EPZ. | Yes | Figure 2: FNP EPZ Boundary and Protective Action Zones |
| c. | A comparison of the current and previous ETE should be provided and includes similar information as identified in Table 1-1, "ETE Comparison," of NUREG/CR-7002. | Yes | Section 1.3 ETE Comparison Chart |
| **1.1** | **Approach** | | |
| a. | A discussion of the approach and level of detail obtained during the field survey of the roadway network should be provided. | Yes | Section 2.2 Methodology<br>Section 2.4 Scenarios Modeled<br>Section 3.0 Population and Vehicle Demand Estimation (and sub-sections)<br>Section 4.0 Evacuation Roadway Network<br>Section 4.3 Evacuation Network Characteristics<br>Section 5.2 Evacuation Simulation |
| b. | Sources of demographic data for schools, special facilities, large employers, and special events should be identified. | Yes | Section 2.3 Sources of Data |

[35] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | Discussion should be presented on use of traffic control plans in the analysis. | Yes | Section 4.3 Evacuation Network Characteristics<br>Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures[36]<br>*(Because the FNP EPZ does not have any population centers, traffic control plans have not been produced. However, the sections listed above, discuss traffic control points)* |
| d. | Traffic simulation models used for the analyses should be identified by name and version. | Yes | Section 2.2 Methodology<br>Section 5.0 Evacuation Time Estimate Methodology |
| e. | Methods used to address data uncertainties should be described. | Yes | Section 8.0 Sensitivity Study on Population Change |
| **1.2** | **Assumptions** | | |
| a. | The planning basis for the ETE includes the assumption that the evacuation is ordered promptly and no early protective actions have been implemented. | Yes | Section 2.1 General Assumptions. |
| b. | Assumptions consistent with Table 1-2, "General Assumptions," of NUREG/CR-7002 should be provided and include the basis to support their use. | Yes | Section 2.1 General Assumptions |
| **1.3** | **Scenario Development** | | |
| a. | The ten scenarios in Table 1-3, Evacuation Scenarios, should be developed for the ETE analysis, or a reason should be provided for use of other scenarios. | Yes | Section 2.4 Scenarios Modeled<br>Table 2: ETE Scenarios Modeled |
| **1.3.1** | **Staged Evacuation** | | |
| a. | A discussion should be provided on the approach used in development of a staged evacuation. | Yes | Section 2.5 Evacuation Area Modeled |

[36] Because the FNP EPZ does not have any major population centers, traffic control plans have not been produced. However, Section 4.3 discusses traffic control points.

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **1.4** | **Evacuation Planning Areas** | | |
| a. | A map of the EPZ with emergency response planning areas (ERPAs) should be included. | Yes | Section 1.2 Emergency Planning Zone<br>Figure 2: FNP EPZ Boundary and Protective Action Zones |
| b. | A table should be provided identifying the ERPAs considered for each ETE calculation by downwind direction in each sector. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |
| c. | A table similar to Table 1-4, “Evacuation Areas for a Staged Evacuation Keyhole,” of NUREG/CR-7002 should be provided and includes the complete evacuation of the 2, 5, and 10 mile areas and for the 2 mile area/5 mile keyhole evacuations. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |
| **2.0** | **Demand Estimation** | | |
| a. | Demand estimation should be developed for the four population groups, including permanent residents of the EPZ, transients, special facilities, and schools. | Yes | Section 3.0 Population and Vehicle Demand Estimation (and sub-sections) |
| **2.1** | **Permanent Residents and Transient Population** | | |
| a. | The US Census should be the source of the population values, or another credible source should be provided. | Yes | Section 2.3 Sources of Data<br>Section 3.1 Permanent Residents |
| b. | Population values should be adjusted as necessary for growth to reflect population estimates to the year of the ETE. | Yes | Section 3.0 Population and Vehicle Demand Estimation |
| c. | A sector diagram should be included, similar to Figure 2-1, “Population by Sector,” of NUREG/CR-7002, showing the population distribution for permanent residents. | Yes | Figure 4: 2012 FNP Sector and Ring Permanent Resident Population Map |
| **2.1.1** | **Permanent Residents with Vehicles** | | |
| a. | The persons per vehicle value should be between 1 and 2 or justification should be provided for other values. | Yes | Section 3.1 Permanent Residents<br>Section 3.5 Vehicle Occupancy Rate |
| b. | Major employers should be listed. | Yes | Section 3.0 Population and Vehicle Demand Estimation<br>Section 3.2 Transient Populations |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **2.1.2** | **Transient Population** | | |
| a. | A list of facilities which attract transient populations should be included, and peak and average attendance for these facilities should be listed. The source of information used to develop attendance values should be provided. | Yes | Section 3.2 Transient Populations |
| b. | The average population during the season should be used, itemized and totaled for each scenario. | Yes | Section 3.2 Transient Populations.<br>Peak recreational population numbers were used for the fall weekend scenarios. Off-peak are estimated for other scenarios. |
| c. | The percent of permanent residents assumed to be at facilities should be estimated. | Yes | Section 3.2 Transient Populations |
| d. | The number of people per vehicle should be provided. Numbers may vary by scenario, and if so, discussion on why values vary should be provided. | Yes | Section 3.5 Vehicle Occupancy Rate |
| e. | A sector diagram should be included, similar to Figure 2-1 of NUREG/CR-7002, showing the population distribution for the transient population. | Yes | Figure 5: FNP Sector and Ring Transient Populations Map |
| **2.2** | **Transit Dependent Permanent Residents** | | |
| a. | The methodology used to determine the number of transit dependent residents should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| b. | Transportation resources needed to evacuate this group should be quantified. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| c. | The county/local evacuation plans for transit dependent residents should be used in the analysis. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | The methodology used to determine the number of people with disabilities and those with access and functional needs who may need assistance and do not reside in special facilities should be provided. Data from local/county registration programs should be used in the estimate, but should not be the only set of data. | Yes | Section 3.3 Transit Dependent Permanent Residents |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| e. | Capacities should be provided for all types of transportation resources. Bus seating capacity of 50% should be used or justification should be provided for higher values. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| f. | An estimate of this population should be provided and information should be provided that the existing registration programs were used in developing the estimate. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| g. | A summary table of the total number of buses, ambulances, or other transport needed to support evacuation should be provided and the quantification of resources should be detailed enough to assure double counting has not occurred. | Yes | Table 10: Transit Dependent Permanent Resident Evacuation Information |
| **2.3** | **Special Facility Residents** | | |
| a. | A list of special facilities, including the type of facility, location, and average population should be provided. Special facility staff should be included in the total special facility population. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| b. | A discussion should be provided on how special facility data was obtained. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| c. | The number of wheelchair and bed-bound individuals should be provided. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| d. | An estimate of the number and capacity of vehicles needed to support the evacuation of the facility should be provided. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| e. | The logistics for mobilizing specially trained staff (e.g., medical support or security support for prisons, jails, and other correctional facilities) should be discussed when appropriate. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| **2.4** | **Schools** | | |
| a. | A list of schools including name, location, student population, and transportation resources required to support the evacuation, should be provided. The source of this information should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 3.5 Vehicle Occupancy Rate |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | Transportation resources for elementary and middle schools are based on 100% of the school capacity. | Yes | Section 3.4 Special Facility and School Populations |
| c. | The estimate of high school students who will use their personal vehicle to evacuate should be provided and a basis for the values used should be provided. | Yes | Section 3.4 Special Facility and School Populations |
| d. | The need for return trips should be identified if necessary. | Yes | Section 3.4 Special Facility and School Populations |
| **2.5** | **Other Demand Estimate Considerations** | | |
| **2.5.1** | **Special Events** | | |
| a. | A complete list of special events should be provided and includes information on the population, estimated duration, and season of the event. | N/A | No special events were studied. |
| b. | The special event that encompasses the peak transient population should be analyzed in the ETE. | N/A | No special events were studied. |
| c. | The percent of permanent residents attending the event should be estimated. | N/A | No special events were studied. |
| **2.5.2** | **Shadow Evacuation** | | |
| a. | A shadow evacuation of 20 percent should be included for areas outside the evacuation area extending to 15 miles from the NPP. | Yes | Section 2.1 General Assumptions |
| b. | Population estimates for the shadow evacuation in the 10 to 15 mile area beyond the EPZ are provided by sector. | Yes | Section 3.1.3. Resident Population Summary |
| c. | The loading of the shadow evacuation onto the roadway network should be consistent with the trip generation time generated for the permanent resident population. | Yes | Section 2.1 General Assumptions |
| **2.5.3** | **Background and Pass Through Traffic** | | |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | The volume of background traffic and pass-through traffic should be based on the average daytime traffic. Values may be reduced for nighttime scenarios. | Yes | Section 2.1 General Assumptions<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |
| b. | Pass-through traffic should be assumed to have stopped entering the EPZ about two hours after the initial notification. | Yes | Section 2.1 General Assumptions<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |
| **2.6** | **Summary of Demand Estimation** | | |
| a. | A summary table should be provided that identifies the total populations and total vehicles used in the analysis for permanent residents, transients, transit dependent residents, special facilities, schools, shadow population, and pass-through demand used in each scenario. | Yes | Section 3.6 Summary of Demand Estimation |
| **3.0** | **Roadway Capacity** | | |
| a. | The method(s) used to assess roadway capacity should be discussed. | Yes | Section 5.2.2 The Network Model |
| **3.1** | **Roadway Characteristics** | | |
| a. | A field survey of key routes within the EPZ has been conducted. | Yes | Section 4.1 Network Definition |
| b. | Information should be provided describing the extent of the survey, and types of information gathered and used in the analysis. | Yes | Section 4.1 Network Definition |
| c. | A table similar to that in Appendix A, “Roadway Characteristics,” of NUREG/CR-7002 should be provided. | Yes | Table 34: Roadway Network Characteristics |
| d. | Calculations for a representative roadway segment should be provided. | Yes | Section 5.2.2 The Network Model |
| e. | A legible map of the roadway system that identifies node numbers and segments used to develop the ETE should be provided and should be similar to Figure 3-1, “Roadway Network Identifying Nodes and Segments,” of NUREG/CR-7002. | Yes | Appendix B: Evacuation Network Lines (Detailed Information)<br>Figure 19 through Figure 22 |
| **3.2** | **Capacity Analysis** | | |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | The approach used to calculate the roadway capacity for the transportation network should be described in detail and identifies factors that are expressly used in the modeling. | Yes | Section 5.2.2 The Network Model |
| b. | The capacity analysis identifies where field information should be used in the ETE calculation. | Yes | Section 5.2.2 The Network Model |
| **3.3** | **Intersection Control** | | |
| a. | A list of intersections should be provided that includes the total numbers of intersections modeled that are unsignalized, signalized, or manned by response personnel. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 17: Intersection Control Type |
| b. | Characteristics for the 10 highest volume intersections within the EPZ are provided including the location, signal cycle length, and turn lane queue capacity. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 18: Information for Ten Highest Volume Intersections |
| c. | Discussion should be provided on how time signal cycle is used in the calculations. | Yes | Section 4.3 Evacuation Network Characteristics |
| **3.4** | **Adverse Weather** | | |
| a. | The adverse weather condition should be identified and the effect of adverse weather on mobilization should be considered. | Yes | Section 2.1 General Assumptions<br>Section 2.4 Scenarios Modeled<br>Because there are few extreme weather conditions such as heavy snow at the FNP, no significant impacts of adverse weather on mobilization are expected. |
| b. | The speed and capacity reduction factors identified in Table 3-1, "Weather Capacity Factors," of NUREG/CR-7002 should be used or a basis should be provided for other values. | Yes | Section 2.1 General Assumptions |
| c. | The study identifies assumptions for snow removal on streets and driveways, when applicable. | N/A | Because there are few extreme weather conditions such as heavy snow at the FNP, no significant impacts of adverse weather on mobilization are expected. |
| **4.0** | **Development of Evacuation Times** | | |
| **4.1** | **Trip Generation Time** | | |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | The process used to develop trip generation times should be identified. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | When telephone surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance should be provided. | Yes | Appendix C: Telephone Survey |
| c. | Data obtained from telephone surveys should be summarized. | Yes | Appendix C: Telephone Survey |
| d. | The trip generation time for each population group should be developed from site specific information. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.1** | **Permanent Residents and Transient Population** | | |
| a. | Permanent residents are assumed to evacuate from their homes but are not assumed to be at home at all times. Trip generation time includes the assumption that a percentage of residents will need to return home prior to evacuating. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | Discussion should be provided on the time and method used to notify transients. The trip generation time discusses any difficulties notifying persons in hard to reach areas such as on lakes or in campgrounds. | Yes | Section 5.1.2 Trip Generation Time Estimate |
| c. | The trip generation time accounts for transients potentially returning to hotels prior to evacuating. | N/A | No Hotels were found within the EPZ |
| d. | Effect of public transportation resources used during special events where a large number of transients are expected should be considered. | N/A | No Special events are expected. |
| e. | The trip generation time for the transient population should be integrated and loaded onto the transportation network with the general public. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.2** | **Transit Dependent Residents** | | |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | If available, existing plans and bus routes are used in the ETE analysis. If new plans are developed with the ETE, they should have been agreed upon by the responsible authorities. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| b. | Discussion should be included on the means of evacuating ambulatory and non-ambulatory residents. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| c. | The number, location and availability of buses, and other resources needed to support the demand estimation are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | Logistical details, such as the time to obtain buses, brief drivers and initiate the bus route are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| e. | Discussion should identify the time estimated for transit dependent residents to prepare and then travel to a bus pickup point, and describes the expected means of travel to the pickup point. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| f. | The number of bus stops and time needed to load passengers should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| g. | A map of bus routes should be included. | N/A | There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| h. | The trip generation time for non-ambulatory persons includes the time to mobilize ambulances or special vehicles, time to drive to the home of residents, loading time, and time to drive out of the EPZ should be provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| i. | Information should be provided to support analysis of return trips, if necessary. | N/A | Round trips are not required. |
| **4.1.3** | **Special Facilities** | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| b. | Discussion should be provided on the inbound and outbound speeds. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| c. | The number of wheelchair and bed-bound individuals should be provided, and the logistics of evacuating these residents should be discussed. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| d. | Time for loading of residents should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| e. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| f. | If return trips are needed, the destination of vehicles should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| g. | Discussion should be provided on whether special facility residents are expected to pass through the reception center prior to being evacuated to their final destination. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| h. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| **4.1.4** | **Schools** | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation Time for Schools<br>Section 6.4 ETE Results for School Population. |
| b. | Discussion should be provided on the inbound and outbound speeds. | Yes | Section 6.4 ETE Results for Special Facility and School Population<br>No return trips are expected. |
| c. | Time for loading of students should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation for Schools<br>No return trips are expected. |
| d. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 3.4 Special Facility and School Populations<br>No return trips are expected. |
| e. | If return trips are needed, the destination of school buses should be provided. | N/A | No return trips are expected. |
| f. | If used, reception centers should be identified. Discussion should be provided on whether students are expected to pass through the reception center prior to being evacuated to their final destination. | Yes | Section 3.4 Special Facility and School. Populations |
| g. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No return trips are expected |
| **4.2** | **ETE Modeling** | | |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | General information about the model should be provided and demonstrates its use in ETE studies. | Yes | Section 5.2 Evacuation Simulation |
| b. | If a traffic simulation model is not used to conduct the ETE calculation, sufficient detail should be provided to validate the analytical approach used. All criteria elements should have been met, as appropriate. | N/A | A traffic simulation model was used for the ETE study. |
| **4.2.1** | **Traffic Simulation Model Input** | | |
| a. | Traffic simulation model assumptions and a representative set of model inputs should be provided. | Yes | Section 3.5 Vehicle Occupancy<br>Section 3.6 Summary of Demand Estimation<br>Section 5.1 Loading of the Evacuation Network<br>Section 5.2 Evacuation Simulation |
| b. | A glossary of terms should be provided for the key performance measures and parameters used in the analysis. | Yes | Appendix B: Evacuation Network Lines (Detailed Information) |
| **4.2.2** | **Traffic Simulation Model Output** | | |
| a. | A discussion regarding whether the traffic simulation model used must be in equilibration prior to calculating the ETE should be provided. | Yes | Section 5.2.3 The Impact Model |
| b. | The minimum following model outputs should be provided to support review:<br>1. Total volume and percent by hour at each EPZ exit mode.<br>2. Network wide average travel time.<br>3. Longest Queue length for the 10 intersections with the highest traffic volume.<br>4. Total vehicles exiting the network.<br>5. A plot that provides both the mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ.<br>6. Average speed for each major evacuation route that exits the EPZ. | Yes | Section 6.5 Example Model Output |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | Color coded roadway maps should be provided for various times (i.e., at 2, 4, 6 hrs., etc.) during a full EPZ evacuation scenario, identifying areas where long queues exist including level of service (LOS) "E" and LOS "F" conditions, if they occur. | N/A | No extensive LOS E or LOS F was observed. |
| **4.3** | **Evacuation Time Estimates for the General Public** | | |
| a. | The ETE should include the time to evacuate 90% and 100% of the total permanent resident and transient population. | Yes | Section 6.0 Analysis of Evacuation Times |
| b. | The ETE for 100% of the general public should include all members of the general public. Any reductions or truncated data should be explained. | Yes | Section 6.1 Summary of ETE Results for General Public |
| c. | Tables should be provided for the 90 and 100 percent ETEs similar to Table 4-3, "ETEs for Staged Evacuation Keyhole," of NUREG/CR-7002. | Yes | Section 6.1 Summary of ETE Results for General Public<br>Table 24: 100% ETEs in Minutes<br>Table 25: 90% ETEs in Minutes |
| d. | ETEs should be provided for the 100 percent evacuation of special facilities, transit dependent, and school populations. | Yes | Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>Section 6.4 ETE Results for School Populations |
| **5.0** | **Other Considerations** | | |
| **5.1** | **Development of Traffic Control Plans** | | |
| a. | Information that responsible authorities have approved the traffic control plan used in the analysis should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| b. | A discussion of adjustments or additions to the traffic control plan that affect the ETE should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| **5.2** | **Enhancements in Evacuation Time** | | |
| a. | The results of assessments for improvement of evacuation time should be provided. | Yes | Section 9.0 Conclusion and Recommendations |
| b. | A statement or discussion regarding presentation of enhancements to local authorities should be provided. | Yes | Section 9.0 Conclusion and Recommendations |

| | Review of ETE for Joseph M. Farley Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **5.3** | **State and Local Review** | | |
| a. | A list of agencies contacted and the extent of interaction with these agencies should be discussed. | Yes | Section 2.3 Sources of Data |
| b. | Information should be provided on any unresolved issues that may affect the ETE. | Yes | The ETE has been reviewed and no unresolved issues were found. |
| **5.4** | **Reviews and Updates** | | |
| a. | A discussion of when an updated ETE analysis is required to be performed and submitted to the NRC. | Yes | Section 8.0 Sensitivity Study on Population Change |
| **5.5** | **Reception Centers and Congregate Care Center** | | |
| a. | A map of congregate care centers and reception centers should be provided. | Yes | Figure 7: FNP Evacuation Network |
| b. | If return trips are required, assumptions used to estimate return times for buses should be provided. | N/A | No return trips are expected |
| c. | It should be clearly stated if it is assumed that passengers are left at the reception center and are taken by separate buses to the congregate care center. | N/A | The congregate care centers are located adjacent to the reception centers. No separate buses are required. |

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**Joseph M. Farley Nuclear Plant – Units 1 and 2**
**Edwin I. Hatch Nuclear Plant – Units 1 and 2**
**Vogtle Electric Generating Plant – Units 1 and 2**
**Evacuation Time Estimates Update**

**Enclosure 2**

**Evacuation Time Estimates for the Edwin I. Hatch Nuclear Plant**

November 2012, Revised October 2013

# Evacuation Time Estimates for the Edwin I. Hatch Nuclear Plant

IEM/TEC12-1001

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# EXECUTIVE SUMMARY

In order to ensure the safety of the public living in the vicinity of nuclear power plants in the nation, the U.S. Nuclear Regulatory Commission (NRC) requires the plants to update their evacuation times estimates (ETEs) within the 10-mile radius emergency planning zone (EPZ) as local conditions change (e.g., significant changes in population, change in the type of effectiveness of public notification system, etc.).

Southern Nuclear Operating Company (SNC) contracted IEM to estimate evacuation times for the 2012 populations within the 10-mile plume exposure pathway EPZ surrounding the Edwin I. Hatch Nuclear Plant (HNP). This document describes the methods used to obtain population data and to estimate evacuation times. It also reports the estimated population figures, evacuation road network information, and ETEs.

In compliance with the guidelines outlined in the NRC's *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002), this report breaks down the population by geographic areas and protective action zones (PAZ).[1] As described in NUREG/CR-7002, four population segments have been identified in this report: permanent residents and transient population; transit dependent permanent residents; special facility residents; and school populations. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The total year 2012 permanent resident populations within the 10-mile EPZ for HNP are estimated to be 8,609. The transient population consists of workers employed within the area, recreational sportsmen, and visitors. The total transient population within the 10-mile EPZ is estimated to be 1,841, which includes 657 workers at HNP. The populations of two public schools and one state-sponsored special facility in the HNP EPZ were identified. In these analyses, the study team contacted the schools and the special facility within the EPZ area to collect current enrollment and staff figures. The total peak population for the schools is estimated at 977, and the special facility is estimated to be 66. Transit dependent permanent residents in the 10-mile EPZ are estimated to be 74. This study also considered the voluntary evacuees, who are also known as shadow evacuees that reside within 10 to 15 miles from HNP.

IEM used PTV Vision VISUM—a computer traffic simulation model—to perform the ETE analyses. For the analyses, the 10-mile plume exposure pathway EPZ was divided into 17 unique geographic areas based on two-mile, five-mile, and ten-mile radius rings, the 16 22.5-degree PAZs, as well as keyhole and staged evacuation logic. In order to represent the most realistic emergency scenarios, evacuations for the 17 geographic evacuation areas were modeled individually for the midweek daytime, midweek – weekend evening, and weekend daytime scenarios. Each of these scenarios was then considered under both normal and adverse weather conditions using the 2012 population estimations. A total of 102 evacuation scenarios were considered to represent different wind, temporal, seasonal and weather conditions.

[1] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

Both 100% and 90% ETEs for each scenario were collected. The 100% ETEs for 2012 normal weather conditions ranged from 2 hour 50 minutes to 3 hours 35 minutes. The 100% ETEs for 2012 adverse weather conditions ranged from 2 hour 55 minutes to 3 hours 55 minutes. The 90% ETEs for 2012 normal weather conditions ranged from 1 hour 35 minutes to 2 hours 45 minutes. The 90% ETEs for 2012 adverse weather conditions ranged from 1 hour 40 minutes to 3 hours. The factors that contributed to the variations in ETEs between scenarios include differences in the number of evacuating vehicles, the capacity of the evacuation routes used, and the distance from the origin zones to the EPZ boundary.

Based on the data gathered and the results of the evacuation simulations, the existing evacuation strategy is functional for the 2012 conditions, given the lack of severe congestion or very high ETEs. However, the following recommendations will help emergency managers to improve the evacuation times from an event at HNP:

- ETEs can also be reduced by implementing additional measures that will shorten the elapsed time between the incident's occurrence and the time the public uses to take the required protective action—especially for the recreational area users, such as hunters and fishermen.
- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use traffic control points (TCP) to facilitate flow in populated areas where vehicles might otherwise have to slow down due to congestion and intersection control.
- Alter Evacuation Route 1, use SR-15 to get to CR-337 (Lyons-Center Road) instead of using CR-115 (Aimwell Road Ext). SR-15 is a straight wide road and has a major intersection with U.S. Hwy 1. CR-115 (Aimwell Road Ext) is paved but is a minor road and has a couple major curves.
- Developing comprehensive regional evacuation plans and/or working with local and state road/transportation departments to suggest improvements to the road infrastructure can contribute to a more successful evacuation.

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# 1.0 INTRODUCTION

The Edwin I. Hatch Nuclear Plant, also known as Hatch Nuclear Plant (HNP), is jointly owned by Georgia Power, Oglethorpe Power Corporation, Municipal Electrical Authority of Georgia, and the City of Dalton. The plant is operated by Southern Nuclear Operating Company (SNC). In order to ensure the safety of the public living in the vicinity of HNP, the U.S. Nuclear Regulatory Commission (NRC) requires nuclear power plants in the nation to conduct evacuation studies for the population within the 10-mile radius plume exposure pathway emergency planning zone (EPZ) at regular intervals. This population evacuation study fulfills regulatory requirements outlined in the NRC *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002).[2]

SNC contracted IEM to perform a population evacuation study for the 10-mile radius plume exposure pathway EPZ surrounding HNP. This document presents the results of that study. It describes the assumptions and methodologies used by IEM to obtain population and evacuation network data and to perform evacuation time estimates (ETE) analyses. ETEs in this evacuation study incorporate the actual population numbers[3] for the year 2012. This document reports the updated population figures, evacuation road network information, and ETEs.

The study is consistent with the requirements specified in NUREG/CR-7002 guidelines. The study is intended to provide information for State and local officials, and HNP emergency management personnel to effectively plan for an accidental event at the plant.

## 1.1. Site Location

HNP is located on the southern bank of the Altamaha River along U.S. Hwy 1 in Appling County, Georgia. The City of Baxley is approximately 11 miles south of the plant and is the nearest significant population center from the plant. The City of Hazlehurst is approximately 15 miles west; the City of Reidsville is approximately 18 miles east; and the cities of Vidalia and Lyons are approximately 20 miles north of the plant. The plant is approximately 75 miles west-southwest of Savannah, Georgia.
Figure 1shows the location of the HNP site.

[2] NRC. *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002) guidelines. November 2011.
[3] SNC 2012 first-quarter population estimates


**Figure 1: Hatch Nuclear Plant Site Location**

## 1.2. Emergency Planning Zone

The plume exposure pathway EPZ includes the majority of the 10-mile geographic area surrounding HNP. The land within the plume exposure pathway is divided almost equally by the Altamaha River. The HNP EPZ covers portions of Appling, Toombs, Jeff Davis, and Tattnall counties in Georgia. The EPZ is primarily a rural farming and lumber harvesting area with no concentrated population centers. The transient population in the EPZ is minimal with the exception of recreational users along the Altamaha River and hunters at both the Bullard Creek Wildlife Management Area (WMA) and the Moody Forest Natural Area.

The State of Georgia Radiological Emergency Plan (REP)[4] and the HNP Emergency Plan are the bases for the geographical and political boundaries for the EPZ. For evacuation and emergency response planning purposes, the 10-mile radius plume exposure pathway EPZ has been divided into 16 Emergency Response Planning Areas (ERPAs) known as protective action zones (PAZ).[5] The PAZ descriptions were obtained and verified from HNP's 2012 emergency information calendar[6], the county REPs[7], and discussions with both SNC and HNP representatives. The PAZs were selected based on existing political boundaries and prominent physical features—either natural (e.g., rivers and lakes) or man-made (e.g., roads and bridges)—to enhance direction and coordination of the public in the affected area. Figure 2 shows a map of the PAZs for HNP. Appendix A of this document contains boundary descriptions of the PAZs within the 10-mile plume exposure pathway EPZ of the plant.

[4] State of Georgia REP – Annex A – Plant Hatch. Georgia Emergency Management Agency. July 2011
[5] Protective Action Zone is also referred to as "Zone" in this document.
[6] 2012 Edwin I. Hatch Nuclear Plant Emergency Information Calendar.
[7] State of Georgia REP Plan, Appling County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Jeff Davis County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Tattnall County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Toombs County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidents involving Edwin I. Hatch Nuclear Power Plant. July 2011.

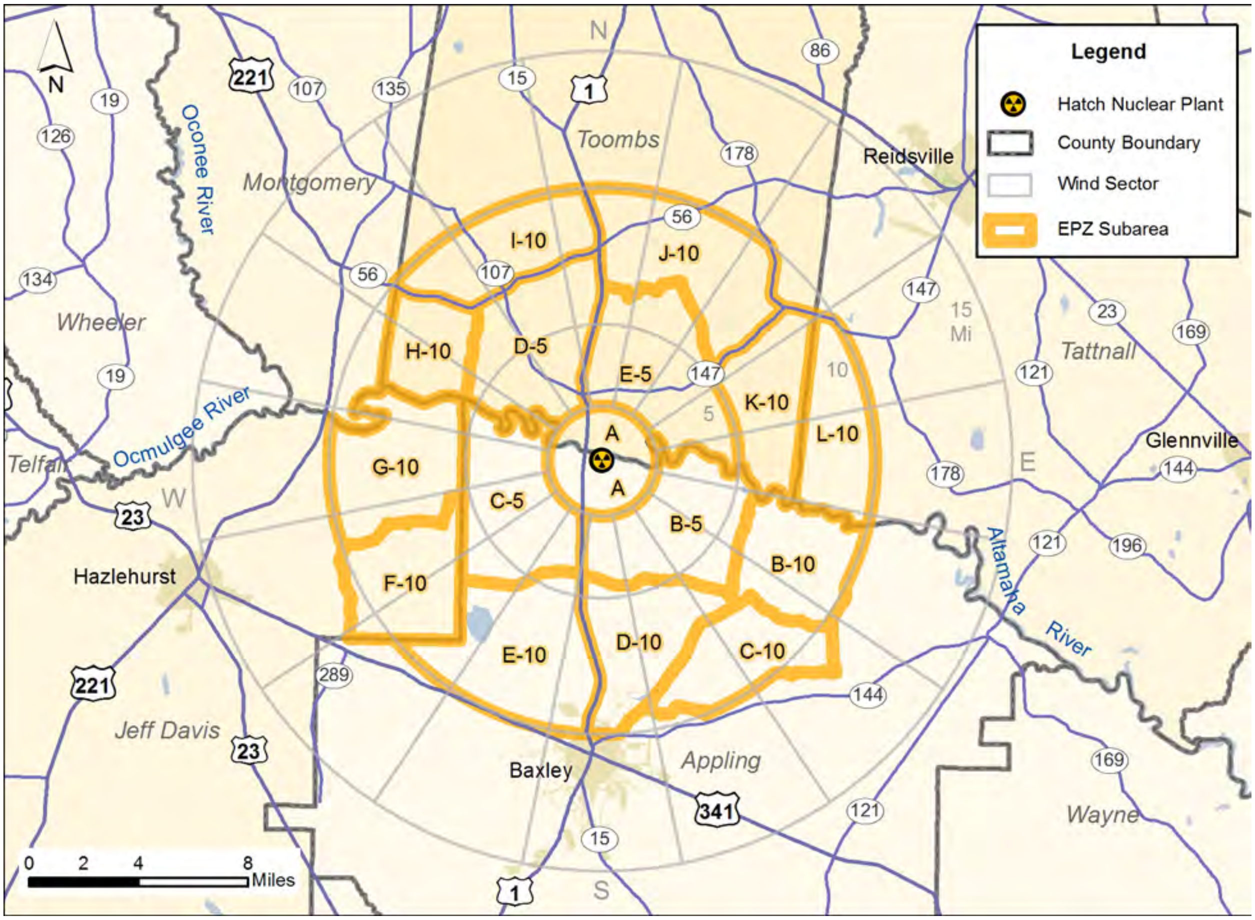


Figure 2: HNP EPZ Boundary and Protective Action Zones

## 1.3. Comparison with Previous ETE Study

Table 1 identifies information that is useful in comparing the 2007 and 2012 ETE studies. Note that the 2007 ETE study was modeled using both 2007 and 2010 estimated population data. For comparison purposes, Table 1 lists the information for the 2010 estimated population from the 2007 study, as well as the 2012 population from this study.

**Table 1: ETE Comparison Chart**

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| Permanent Residents | | |
| - Total Population | 7,988 | 8,609 |
| - Vehicle Ratio | 2.6 | 1.7-1.8 |

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| Transit Dependent Population | | |
| - Total Population | 0 | 74 |
| - Number of Buses | 0 | 139 |
| - Number of Ambulances | 0 | 21 |
| - Number of Special Equipped Vehicles | 0 | 7 |
| Transient Population | | |
| - Total Population | 1,600 | 1,841 |
| Special Facilities | | |
| - Total Population | 72 | 66 |
| - Number of Buses | 2 | 2 |
| - Other Transportation Resources | Private vehicles | Private vehicles |
| Schools | | |
| - Total Student Population | 927 | 830 |
| - Number of Buses | 19 | 19 |
| Shadow Evacuation Percent Estimated | 0 | 20% |
| Special Event(s) | | |
| - Population | N/A | N/A |
| - Location | N/A | N/A |
| - Duration | N/A | N/A |
| Adverse Weather (rain, snow, ice, fog) | Heavy rain | Heavy rain |
| Evacuation Model - name and version | VISUM10 | VISUM11 |
| Scenarios | Combination of time (Weekday, Weeknight, Weekend) and weather (adverse and normal) | Combination of time (Weekday, Weeknight, Weekend) and weather (adverse and normal) |
| Assumptions | • One evacuation vehicle per household for residents<br>• Mobilization time for resident and transient population are based on literature[8]<br>• No shadow evacuation considered | • Vehicle occupancy rates for residents are based on telephone survey<br>• Mobilization time for resident and transient population are based on telephone survey<br>• 20% of residents in 10-15 mile ring are shadow evacuees |

[8] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

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# 2.0 ASSUMPTIONS AND METHODOLOGY

## 2.1. General Assumptions

IEM made the following general assumptions to model the population evacuation study:

- The ETEs include the times associated with warning diffusion, public mobilization, and travel time out of the EPZ. The ETE is measured from the time that instructions were first made available to the public within the EPZ (e.g., initial emergency alert system [EAS] broadcast). Mobilization of the public begins after initial notification.
- Following initial notification, all persons within the EPZ will evacuate. 100% ETE will be considered as the time when all evacuating vehicles are outside the EPZ. 90% ETE will be considered as the time when 90% of the evacuating vehicles are outside the EPZ.
- Existing lane utilization patterns will prevail during the course of the evacuation. There will be traffic control points (TCP) in the network to allow efficient flow of traffic toward the reception centers.
- Reception centers are modeled as defined in the 2012 emergency information calendar.
- Non-auto-owning households will evacuate with neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by State and county emergency management officials. This is also consistent with the 2012 emergency information calendar and county REPs.
- The major adverse weather condition in the area is considered as heavy rain. To model the population evacuation during adverse weather conditions, the free flow speeds are reduced by 15%, and the road capacities are reduced by 10%.
- The evacuation is ordered promptly and no early protective actions have been implemented.
- Schools and special facilities receive initial notification the same time as the rest of the EPZ.
- A shadow evacuation of 20% of the permanent resident population was assumed to occur in areas outside of the evacuation area being assessed extending to 15 miles from the HNP. The vehicle occupancy rates and trip generation times of shadow evacuees are consistent with those of the residents within the EPZ.
- Information such as the number of vehicles by the residents during the evacuation and mobilization times are estimated based on a telephone survey on the residents within the EPZ.
- Located in a rural area, there is little pass-through traffic and the majority of the trips are home-work trips made by the local residents within the EPZ. Due to this nature, IEM assumed that minimum background traffic would exist after the evacuees start to

load into the roadway network. No significant impact of pass-through traffic on the ETEs is expected.

- Buses used to evacuate schools and special facilities are loaded to capacity.
- Shadow evacuation of 20 percent of the residents in 10-15 mile ring would occur when an evacuation order is issued.

## 2.2. Methodology

IEM used PTV Vision VISUM (version 11), a computer simulation model, to perform the ETEs for the HNP site.[9] PTV Vision is the leading software suite for transportation planning and operations analyses used in more than 70 countries. Detailed information on the evacuation time analysis methodology using PTV Vision is provided in Section 5.2. PTV Vision quality assurance and industry acceptance information is provided in Appendix D.

## 2.3. Sources of Data

The most up-to-date data sources were reviewed and analyzed to prepare appropriate input data for running the traffic simulation and providing the best ETEs. The data sources are explained below:

- Geographical and political boundaries for the EPZ were obtained from the State of Georgia REP.
- The 16 PAZ descriptions were obtained and verified from the State of Georgia REP[10], HNP's 2012 emergency information calendar[11], the county REPs[12], and discussions with SNC and HNP representatives.
- The 2012 population estimates, as well as business location data, were obtained from the 2010 U.S. Census Bureau, the 2012 Plant Hatch Tone Alert Radio (TAR) Database, and the population estimates from Synergos Technologies, Inc.[13]
- The peak and average estimated employment level at HNP obtained from the SNC representatives reflects office or operations personnel.
- Roadway geometric data was obtained from PTV. PTV data is based on high-quality, regularly updated, NAVTEQ street network data. NAVTEQ networks are detailed

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[9] PTV Vision can be found online at http://www.ptvamerica.com.

[10] State of Georgia Radiological Emergency Plan – Annex B – Plant Farley. Georgia Emergency Management Agency. January 2009.

[11] 2012 Edwin I. Hatch Nuclear Plant Emergency Information Calendar.

[12]State of Georgia REP Plan, Appling County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011
State of Georgia REP Plan, Jeff Davis County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Tattnall County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Toombs County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.

[13] Synergos Technologies, Inc. Online: http://www.synergos-tech.com.

and include neighborhood streets in every community in North America. This data was validated by IEM during a “ground truthing” field trip in April 2012.

- Roadway and intersection approach capacities were calculated using the concepts and procedures defined in the Highway Capacity Manual[14] published by the Transportation Research Board.
- Warning diffusion and mobilization times were based on the data presented in *Evaluating Protective Actions for Chemical Agent Emergencies*[15] published by the Oak Ridge National Laboratory. The data in this report was collected during evacuations executed in response to large-scale chemical spills, and explicitly incorporates the time required for communication of the warning (warning diffusion) and the time required for an individual to respond to the warning (mobilization). The data collected in this meta-study were based on transient and permanent populations. Section 5.1.1 of this report provides more information on warning diffusion and mobilization time assumptions.
- Vehicle occupancy rates for the different population categories were derived based on telephone survey and discussions with the counties’ and plant’s emergency planning staffs. Section 3.0 provides more information on population and vehicle demand assumptions.
- Agencies participating in the study are provided below. These agencies participated in an initial briefing for the study and provided input regarding specifics for the data and assumptions for the ETE within their jurisdiction.
  - Georgia Emergency Management Agency
  - Appling County Emergency Management Agency
  - Toombs County Emergency Management Agency
  - Tattnall County Emergency Management Agency
  - Jeff Davis County Emergency Management Agency

## 2.4. Scenarios Modeled

In accordance with NUREG/CR-7002 guidelines, ETEs for each of the evacuation areas (refer to Table 3) have been prepared for different temporal and weather conditions. Based on the discussion with the SNC emergency planning staff, estimates have been prepared for both normal and adverse weather conditions for midweek daytime, midweek – weekend night, and weekend daytime.

Normal weather refers to conditions where roads are clear and dry and visibility is not impaired. Adverse weather refers to rainy or snowy conditions where road capacities are reduced by 10% and speed limits are reduced by 15%.

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[14] Transportation Research Board, National Research Council. *Highway Capacity Manual*. Washington, D.C. 2000.
[15] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

Evacuation conditions are modeled for the populations of the year 2012. Table 2 presents the snapshot of the ETE scenarios that were modeled for the study.

**Table 2: ETE Scenarios Modeled***

| Scenario | Day | Time | Weather |
|---|---|---|---|
| 1 | Midweek | Daytime | Normal |
| 2 | Midweek | Daytime | Adverse |
| 3 | Midweek and Weekend | Night | Normal |
| 4 | Midweek and Weekend | Night | Adverse |
| 5 | Weekend | Daytime | Normal |
| 6 | Weekend | Daytime | Adverse |

** Per discussions with SNC emergency planning staff, special events and seasonal variation scenarios were not modeled. However, due to a potential for more recreational population during the fall months, peak recreational population numbers were used for the weekend scenarios (5 and 6).*

The various population components for different scenarios are summarized below:

- **Midweek Daytime – Normal Weather:** This situation represents a typical normal weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.
  - The plant site employment is at an estimated peak daytime level.
  - Workplaces are fully staffed at daytime levels.
  - Schools are in session.
  - Recreational activities, such as hunting and fishing, are at daytime levels.
- **Midweek Daytime – Adverse Weather:** This situation represents an adverse weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.
  - The plant site employment is at an estimated peak daytime level.
  - Workplaces are fully staffed at daytime levels.
  - Schools are in session.
- **Midweek and Weekend Evening – Normal Weather:** This situation reflects a typical normal weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.

- The plant site is staffed at an estimated peak nighttime level.
- Workplaces are at nighttime levels.
- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Midweek and Weekend Evening – Adverse Weather:** This situation reflects an adverse weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is staffed at an estimated peak nighttime level.
- Workplaces are at nighttime levels.
- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Weekend Daytime – Normal Weather:** The normal weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

▪ **Weekend Daytime – Adverse Weather:** The adverse weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

## 2.5. Evacuation Areas Modeled

NUREG/CR-7002 recommends that the EPZ be subdivided into evacuation areas for performing the evacuation time estimate analyses.[16] As indicated in Table 3, each evacuation area includes one or more affected PAZ's to support the various evacuation logic including keyhole and staged evacuations. Based on the geography and political boundaries in the EPZ, 17 unique areas were defined by IEM for the HNP EPZ, in agreement with the SNC personnel. As shown in the lower part of Table 3, separates evacuation areas are modeled for the 0-2 mile zone and the 2-5 mile zone to support protective action decision making for a staged evacuation.

[16] NUREG/CR-7002. Table 1-4, p.8.

## Table 3: Evacuation Areas for a Staged Evacuation Keyhole

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 | L-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0–2 miles | X | | | | | | | | | | | | | | | |
| A, B-5, C-5, D-5, E-5 | 0–5 miles | X | X | X | X | X | | | | | | | | | | | |
| All 16 Evacuation Zones | 0-10 miles, Full EPZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Evacuate 2 to 5 miles downwind | | | | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (ERPAs) | | | | | | | | | | | | | | | |
| | | A | B-5 | C-5 | D-5 | E-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 | L-10 |
| B-5, C-5 | N | | X | X | | | | | | | | | | | | | |
| B-5, C-5 | NNE | | X | X | | | | | | | | | | | | | |
| C-5 | NE | | | X | | | | | | | | | | | | | |
| C-5 | ENE | | | X | | | | | | | | | | | | | |
| C-5, D-5 | E | | | X | X | | | | | | | | | | | | |
| C-5, D-5 | ESE | | | X | X | | | | | | | | | | | | |
| C-5, D-5 | SE | | | X | X | | | | | | | | | | | | |
| D-5, E-5 | SSE | | | | X | X | | | | | | | | | | | |
| D-5, E-5 | S | | | | X | X | | | | | | | | | | | |
| D-5, E-5 | SSW | | | | X | X | | | | | | | | | | | |
| E-5 | SW | | | | | X | | | | | | | | | | | |
| E-5, B-5 | WSW | | X | | | X | | | | | | | | | | | |
| E-5, B-5 | W | | X | | | X | | | | | | | | | | | |

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 | L-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E-5, B-5 | WNW | | X | | | X | | | | | | | | | | | |
| B-5 | NW | | X | | | | | | | | | | | | | | |
| B-5 | NNW | | X | | | | | | | | | | | | | | |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (ERPAs) | | | | | | | | | | | | | | | |
| | | A | B-5 | C-5 | D-5 | E-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 | I-10 | J-10 | K-10 | L-10 |
| A, B-5, C-5 | N | X | X | X | | | | | | | | | | | | | |
| A, B-5, C-5 | NNE | X | X | X | | | | | | | | | | | | | |
| A, C-5 | NE | X | | X | | | | | | | | | | | | | |
| A, C-5 | ENE | X | | X | | | | | | | | | | | | | |
| A, C-5, D-5 | E | X | | X | X | | | | | | | | | | | | |
| A, C-5, D-5 | ESE | X | | X | X | | | | | | | | | | | | |
| A, C-5, D-5 | SE | X | | X | X | | | | | | | | | | | | |
| A, D-5, E-5 | SSE | X | | | X | X | | | | | | | | | | | |
| A, D-5, E-5 | S | X | | | X | X | | | | | | | | | | | |
| A, D-5, E-5 | SSW | X | | | X | X | | | | | | | | | | | |
| A, E-5 | SW | X | | | | X | | | | | | | | | | | |
| A, E-5, B-5 | WSW | X | X | | | X | | | | | | | | | | | |
| A, E-5, B-5 | W | X | X | | | X | | | | | | | | | | | |
| A, E-5, B-5 | WNW | X | X | | | X | | | | | | | | | | | |
| A, B-5 | NW | X | X | | | | | | | | | | | | | | |
| A, B-5 | NNW | X | X | | | | | | | | | | | | | | |

# 3.0 POPULATION AND VEHICLE DEMAND ESTIMATION

IEM identified four population segments[17] within the EPZ surrounding HNP, as specified in the NUREG/CR-7002 guidelines. These populations include the permanent residents and transient population, transit dependent permanent residents, special facility residents, and school populations. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The transient population is comprised of individuals working and/or visiting within the EPZ but not living there. For instance, the transient population consists of workers employed within the area, recreational sportsmen, and visitors to the area. The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). Populations at two public schools and one state-sponsored facility (categorized as a special facility) in the HNP EPZ were identified. The schools and special facility populations may require additional consideration in the event of an evacuation.

HNP is located in a rural area of Georgia. There are no concentrated population centers, and there is minimal transient population within the 10-mile EPZ. The transient facilities include the various employers, the HNP, and the parks/hunter/boater recreational attraction sites. The majority of the population consists of permanent residents, workers, school students, and a varying number of recreational visitors who are mainly located on or around the Altamaha River, Bullard Creek WMA, and the Moody Forest Natural Area.

IEM derived the 2012 permanent population estimates, as well as business location data, from 2010 Census, the 2012 Plant Hatch TAR Database, the SNC 2012 first-quarter population estimates, and the population estimates obtained from Synergos Technologies, Inc. Local school data was obtained through contact with the individual facilities. The recreational visitors' population figures were based on discussions with the HNP's emergency planning staff, and staff from the Toombs County Forestry Office. After discussion with the appropriate facilities and the site emergency planning personnel, it was estimated that the 2010 school and recreational user information applies to the year 2012 since no major change in the land use pattern within the EPZ. These population estimates formed the basis for determining the evacuee demand used in the analyses for any given evacuation scenario. The populations from these sources were assigned to each applicable zone.

## 3.1. Permanent Residents

IEM used GIS software to process the geographic data and associated population counts for census blocks in each of the counties surrounding HNP. IEM then aggregated these populations over each zone to generate a permanent resident population count, which is comprised of the nighttime population.

[17] Special facilities, as defined in NUREG/CR-7002, were not identified in the 10-mile EPZ.

To calculate population by each zone and radial sector, census block populations were aggregated within each of the sectors. Since boundaries of the sectors do not follow census block boundaries, many of the blocks had to be divided into sub-areas based on sector boundaries. To do this, IEM overlaid the census blocks with the zones and 10-mile radius sectors. The blocks were then split into sub-areas and allocated the block population to the sub-areas based on an area ratio method. The populations of the block sub-areas within the sector boundaries were then aggregated for each radius sector. The area ratio method assigns each sub-area a portion of the block population based on the ratio of the area of each block part to the area of the entire block. For example, if a particular sub-area contains one-fourth the area of the total block area, the sub-area receives one-fourth of the block's total population. Figure 3 illustrates this principle, in which one-fourth of the total area is located in the sub-area and it includes one-fourth of the population. The area ratio method assumes that the population within the block is evenly distributed, a reasonable assumption in most cases.

The populations of the block sub-areas within the sector boundaries were then aggregated for each sector. This method was also used in the few instances in which the zone boundaries did not follow block boundaries, making it necessary to split blocks along a particular zone boundary. Additionally, the permanent resident population is divided into auto-owning versus non-auto-owning populations.


**Figure 3: Example of the Area Ratio Method Applied to a Census Block Divided into Sub-Areas**

### 3.1.1. Auto-Owning Population

IEM collected information for auto-owning population by conducting a telephone survey of the residents within the HNP EPZ. The survey indicates an average household size of 2.4 persons for the HNP EPZ. The collected data also indicate that 99% of the households within the EPZ have at least one vehicle per household. Additionally, the respondents indicated that each household would use an average of 1.3 to 1.4 vehicles during the evacuation depending on the day of the week and time of the day.

### 3.1.2. Non-Auto-Owning Population

The telephone survey indicates that 1% of the households within the EPZ do not own a vehicle. It is assumed that privately-owned vehicles of friends and/or relatives will be available to evacuate the majority of this population component. This assumption is used since it provides the most realistic representation of evacuation traffic generated from the non-auto-owning households. For an estimate of the vehicle demand associated with the non-auto-owning population, IEM assumed one vehicle would be made available to evacuate each household. This is based on the assumptions stated above that a family would use a vehicle from neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by county emergency management officials.

### 3.1.3. Resident Population Summary

Table 4 shows the distribution of the 2012 total permanent resident population (including the shadow evacuation population in the 10 to 15 mile area) by sector and ring, while Figure 4 presents the same data for 2-5 mile, 5-10 mile, and 10-15 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 4: 2012 Permanent Resident Population Distributions by Sector and Ring**

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 288 | 288 |
| 2-3 | 499 | 787 |
| 3-4 | 445 | 1232 |
| 4-5 | 541 | 1773 |
| 5-6 | 823 | 2596 |
| 6-7 | 1,147 | 3,743 |
| 7-8 | 1,202 | 4,945 |
| 8-9 | 1,503 | 6,448 |
| 9-10 | 2,418 | 8,866 |
| 10-11 | 4,496 | 13,362 |

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 11-12 | 5,660 | 19,022 |
| 12-13 | 4,185 | 23,207 |
| 13-14 | 3,201 | 26,408 |
| 14-15 | 4,526 | 30,934 |

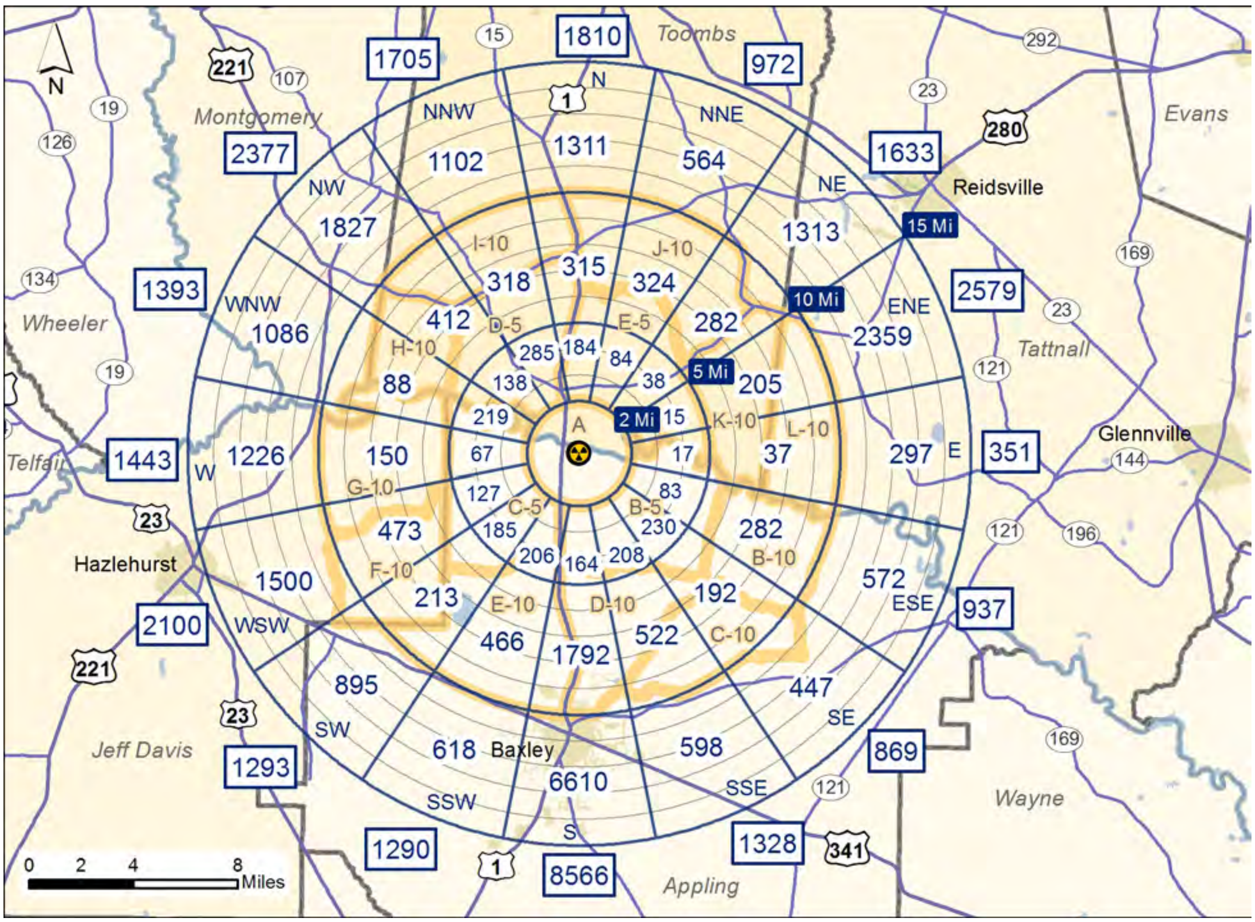


**Figure 4: 2012 HNP Sector and Ring Permanent Resident Population Map**

Table 5 shows the distribution of the permanent resident population by zone.

**Table 5: 2012 Permanent Resident Population Distributions by Zones**

| Zone | Permanent Resident Population |
|---|---|
| A | 288 |
| B-5 | 736 |
| B-10 | 341 |
| C-5 | 601 |
| C-10 | 282 |
| D-5 | 667 |
| D-10 | 1,690 |
| E-5 | 246 |
| E-10 | 1,019 |
| F-10 | 489 |
| G-10 | 274 |
| H-10 | 330 |
| I-10 | 582 |
| J-10 | 794 |
| K-10 | 94 |
| L-10 | 176 |

## 3.2. Transient Populations

The transient population for the HNP EPZ area is derived from recreation populations, and employment data. The employment data was obtained from Synergos Technologies. These populations were combined with other contributors, such as the percentage of the population that is of working age, to daytime population estimations and assigned to population centroids in a manner similar to the permanent resident populations. The daytime populations incorporate employment and workforce information, such as county working-age population and unemployment statistics.

The recreational population shown for the HNP site considers the use of Bullard Creek WMA and Moody Forest Natural Area by hunters, fishermen, and boaters on the Altamaha River. Through conversations with HNP's emergency planning staff and with staff from the Toombs County Forestry Office, IEM estimated there will be approximately 43 hunters/boaters throughout the EPZ on weekdays during the hunting season and approximately 305 hunters/boaters on peak weekends.

A vehicle occupancy rate of 1.5 was used to estimate the number of vehicles used by recreational area users, such as hunters and fishermen.

Table 6 shows the distribution of the transient population by sector and ring, while Figure 5 presents the same data for 0-2 mile, 2-5 mile, and 5-10 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 6: Transient Population Distribution by Sector and Ring**

| Population Miles | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 692 | 692 |
| 2-3 | 41 | 733 |
| 3-4 | 52 | 785 |
| 4-5 | 70 | 855 |
| 5-6 | 108 | 963 |
| 6-7 | 156 | 1,119 |
| 7-8 | 190 | 1,309 |
| 8-9 | 213 | 1,522 |
| 9-10 | 304 | 1,826 |


**Figure 5: HNP Sector and Ring Transient Populations Map**

Table 7 shows the distribution of the transient population by zone.

**Table 7: Transient Population Distribution by Zones**

| Zone | Transient Population |
|---|---|
| A | 692 |
| B-5 | 148 |
| B-10 | 40 |
| C-5 | 55 |
| C-10 | 112 |
| D-5 | 84 |
| D-10 | 116 |
| E-5 | 22 |
| E-10 | 251 |
| F-10 | 26 |

| | |
|---|---|
| G-10 | 154 |
| H-10 | 26 |
| I-10 | 49 |
| J-10 | 51 |
| K-10 | 14 |
| L-10 | 1 |

### 3.2.1. Transient Facilities

As shown in Table 8, the transient facilities include the HNP site and parks/hunter/boater recreational attraction sites. HNP is the only large employer in the EPZ, which has peak number of workers at 675 during the weekdays. The peak recreational population occurs on fall weekend periods during the hunting season (normally mid-September through early January). It is estimated that approximately one-seventh of the peak recreational population is expected for other scenarios (weekday and weeknight). Table 8 shows the transient facilities' peak and average transient populations.

**Table 8: Peak and Average Transient Population**

| Facility Type | Facility Name | County | Zone | Peak Population | Average Population | Percent of Resident |
|---|---|---|---|---|---|---|
| Employer | Hatch Nuclear Plant | Appling | A | 675 | 287 | 5% |
| Hunting | Bullard Creek WMA | Jeff Davis | G-10 | 195 | 33 | 50% |
| Hunting | Moody Forest Natural Area | Appling | B-5 | 190 | 32 | 50% |
| Boat Landing | Eason Bluff | Appling | B-10 | 25 | 4 | 50% |
| Boat Landing | Davis | Appling | B-10 | 25 | 4 | 50% |
| Boat Landing | Morris | Appling | B-5 | 25 | 4 | 50% |
| Boat Landing | Deans | Appling | A | 25 | 4 | 50% |
| Boat Landing | Red Bluff | Jeff Davis | G-10 | 25 | 4 | 50% |
| Boat Landing | Town Bluff | Jeff Davis | G-10 | 25 | 4 | 50% |
| Boat Landing | R4 – Altamaha River | Toombs | A | 25 | 4 | 50% |
| Boat Landing | Gray's Landing | Toombs | D-5 | 25 | 4 | 50% |
| Boat Landing | McNatt Falls Landing | Toombs | H-10 | 25 | 4 | 50% |

## 3.3. Transit Dependent Permanent Residents

The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). The transit dependent permanent resident population in the HNP EPZ was obtained from the county EMAs through SNC emergency planning staff. As shown in Table 9 there are 74 transit dependent permanent residents in the 10-

mile EPZ. A roster of these individuals is maintained in the Appling, Jeff Davis, Toombs, and Tattnall County EOCs. The EMA Directors maintain coordination with the County Departments of Family and Children Services on maintenance of the roster and dispatching emergency transportation to evacuate as needed.

**Table 9: Transit Dependent Permanent Residents**

| Transit Dependent Category | Appling County | Jeff Davis County | Toombs County | Tattnall County |
|---|---|---|---|---|
| Wheelchair | 2 | 5 | 6 | 1 |
| Transportation | 36 | 6 | 18 | 0 |
| Immobile | 0 | 0 | 0 | 0 |

To evacuate the transit dependent permanent residents, the counties have 139 buses that will travel their regular routes to provide transportation to those individuals lacking personal transportation. In addition, there are 21 ambulances and 7 special transport vehicles. The special equipped vehicles will be dispatched directly to the homes of non-ambulatory individuals requiring special or medical transportation means. The key information for evacuating the transit dependent population is shown in Table 10. The information shown includes the number of transit dependent permanent residents by category, number of evacuation vehicles by type and mobilization time, and evacuee loading time.

**Table 10: Transit Dependent Permanent Resident Evacuation Information**

| Transit Dependent Category | Population | Number of Vehicles | Mobilization Time | Loading Time |
|---|---|---|---|---|
| Wheelchair | 14 | 7 | 15 min | 5 min |
| Transportation | 60 | 139 | 15 min | 2 min |
| Immobile | 0 | 21 | 10 min | 10 min |

## 3.4. Special Facility and School Populations

As shown in Table 11, IEM has identified one special facility and two public schools within the EPZ. The special facility, AMIkids Baxley Wilderness Institute (BWI) [18], is a state-sponsored special school for at-risk and troubled kids. The two public schools are Altamaha Elementary School (AES) in Baxley (Appling County) and Toombs Central Elementary School (TCES) in Toombs Central (Toombs County). Figure 6 shows the location of these facilities.

Table 12 lists the key information for evacuating the population at these facilities. The information shown includes the enrollment, number of evacuation vehicles and its

[18] http://www.amikids.org/

mobilization time, evacuee loading time and distance from the facility to the EPZ boundary.

Although the schools and the special facility will require special consideration in an evacuation, it is estimated there are a sufficient number of evacuation vehicles and no return trips are needed. The evacuation vehicles at BWI are on-site, whereas the evacuation vehicles for AES and TCES will be dispatched from the school bus depot in each county. All evacuees from the schools will check in at the reception centers first, prior to being evacuated to their final destination. The BWI evacuees will check in by radio and directly evacuate to the designated receiving facility.

**Table 11: Special Facility and School Locations**

| Facility Name | Address | City | County | Zone |
|---|---|---|---|---|
| AMIkids Baxley Wilderness Institute | 1510 Deen's Landing Road | Baxley | Appling | C-5 |
| Altamaha Elementary School | 344 Altamaha School Road | Baxley | Appling | C-5 |
| Toombs Central Elementary School | 6287 US Hwy 1 S | Toombs Central | Toombs | J-10 |

**Table 12: Special Facility and School Evacuation Information**

| School Name | Population | | Number of Buses | Mobilization Time | Loading Time | Distance to EPZ Boundary |
|---|---|---|---|---|---|---|
| | Student | Staff | | | | |
| AMIkids Baxley Wilderness Institute | 30 | 36 | 2 | 10 min | 30 min | 12 mi |
| Altamaha Elementary School | 300 | 51 | 6 | 25 min | 15 min | 7 mi |
| Toombs Central Elementary School | 530 | 96 | 11 | 25 min | 15 min | 2 mi |

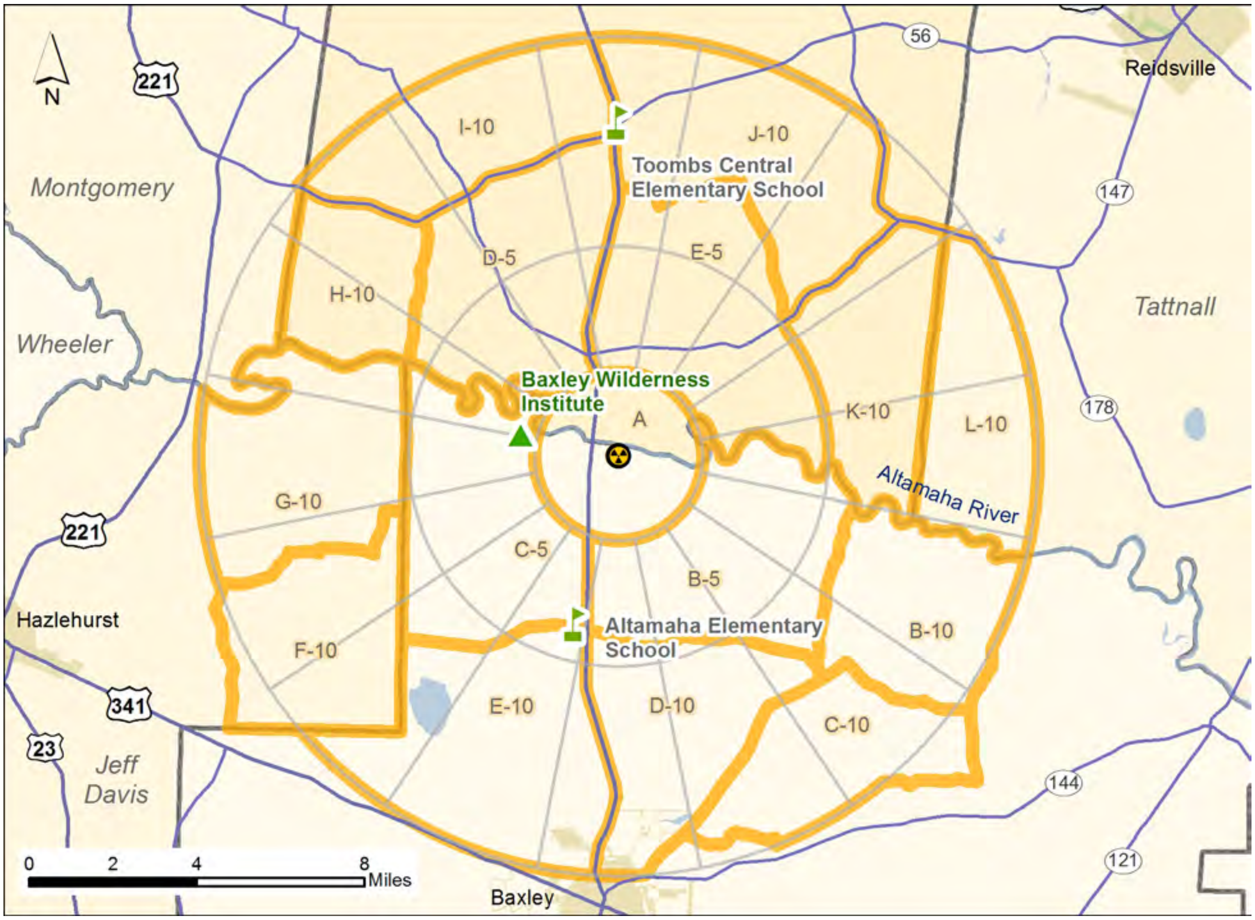


Figure 6: Map of Special Facilities and Schools within the EPZ

## 3.5. Vehicle Occupancy Rate

Different vehicle occupancy rates (VOR) were used for the various categories of population (e.g., 1.3-1.4 vehicles per household for permanent residents; 1.5 people per vehicle for recreational area users). All workers were assumed to evacuate with a VOR of 1.25, whereas the recreational population was assumed to evacuate with a VOR of 1.5. After consultation with SNC emergency planners, students were assumed to evacuate via buses at a rate of 52 students per bus, with the remaining school population departing in their own cars (occupancy rate of 1.0). Table 13 shows the VORs by different population categories used for the evacuation modeling.

**Table 13: Vehicle Occupancy Rates by Population Categories**

| Population Category | Population Subtype | Vehicle Occupancy Rate |
|---|---|---|
| Permanent Residents | Auto-Owning Permanent | 1.7-1.8 |
| | Non-Auto-Owning Permanent | 2.4 |
| Transients | Work Force Transients | 1.25 |
| | Recreational Transients | 1.5 |
| Special Facility | Students | 15 |
| | Staff | 1.0 |
| School | Students | 52 |
| | Staff | 1.0 |

## 3.6. Summary of Demand Estimation

The total evacuation population and vehicles for different types and different scenarios are summarized in Table 14 and Table 15. There are more resident evacuees during the night and weekend because people do not need to commute to work or school at those times. Transient evacuees are at peak levels during the weekday because the majority is workers. There is also a significant amount of transient population during the weekend, when the recreational population is at its peak level. It is assumed that there are few transient evacuees during the night. Because the only special facility, BWI, is a 24/7 run facility, the population for the special facility remains the same for all three scenarios. The shadow evacuees, who are assumed to be 20% of residents in 10-15 mile ring, remain the same for the weeknight and weekend scenarios. They are relatively less during the weekday because a portion of the residents commute to work or school. Since the vehicle occupancy rates for residents (including shadow evacuees) and transient population are determined by telephone survey and vary by scenario, the evacuation can be different for different scenarios, even if the population remains the same.

**Table 14: Population Summary Table**

| Scenario | Permanent residents | Transients | Special facilities | Schools | Transit Dependent | Shadow population |
|---|---|---|---|---|---|---|
| Weekday | 6,069 | 1,536 | 66 | 977 | 74 | 3,129 |
| Weeknight | 8,609 | 0 | 66 | 0 | 74 | 4,465 |
| Weekend | 8,609 | 305 | 66 | 0 | 74 | 4,465 |

**Table 15: Vehicle Summary Table**

| Scenario | Permanent residents | Transients | Special facilities | Schools | Transit Dependent | Shadow population |
|---|---|---|---|---|---|---|
| Weekday | 4,645 | 1,229 | 38 | 164 | - | 2,354 |
| Weeknight | 4,798 | 0 | 38 | 0 | - | 2,474 |
| Weekend | 5,051 | 204 | 38 | 0 | - | 2,604 |

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# 4.0 EVACUATION ROADWAY NETWORK

The evacuation routes were modeled based on the information provided in the HNP 2012 emergency information calendar. Additional information regarding the evacuation routes was obtained from the past HNP ETE report and the county REPs. Maps and descriptions in both documents were used by IEM as the basis of network verification activity. IEM personnel also met with the HNP emergency response planning staff and county emergency preparedness officials regarding additional information and clarifications.

The 2012 emergency information calendar included a detailed description of the evacuation routes for each zone within the 10-mile radius plume exposure pathway EPZ. It provided descriptive information on recommended protective actions and the names and locations of reception centers for each PAZ. The map in the calendar clearly marks the evacuation routes and the direction of evacuation towards the respective reception centers. The reception centers are located well beyond the 10-mile EPZ.

IEM personnel drove along the designated evacuation routes in the direction of an evacuation, as marked on the emergency information calendar to collect complete and accurate information about the physical state of the roads. Any differences between information indicated in the calendar, NAVTEQ data, and existing field conditions were noted and were incorporated into the analyses, as necessary. Figure 7 shows the entire evacuation network (including the routes for shadow evacuees) that is modeled.

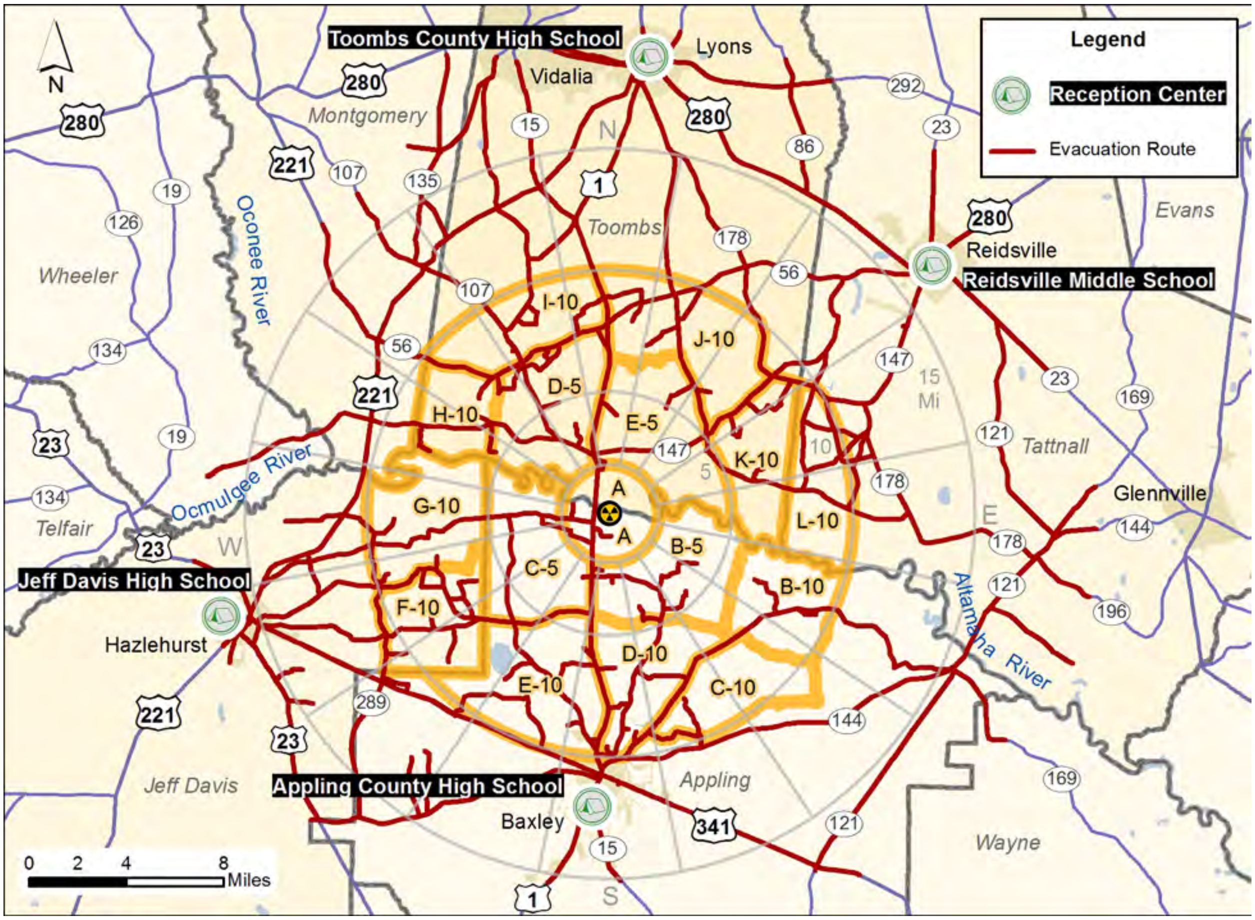


Figure 7: HNP Evacuation Network

## 4.1. Network Definition

IEM performed a complete review of the evacuation roadway network. The evacuation network was developed using published evacuation routes and GIS road network data representing roads available from NAVTEQ[19] and the Georgia Department of Transportation (GDOT).[20] The high accuracy NAVTEQ street network GIS data, obtained for the PTV Vision simulation software, was used for field validation purposes and to build the digital evacuation network database. The GDOT data was used to supplement the NAVTEQ data where required. To ensure the accuracy of this data, the entire evacuation network, including those roads outside the 10-mile EPZ leading to the reception centers, was verified by traveling each route in the network in the direction of evacuation and collecting detailed information regarding the properties of each road section using a Global Positioning System (GPS)-enabled device. The GPS allowed

[19] PTV America, Inc. "NAVTEQ Data for PTV VISION." Online: http://www.ptvamerica.com/navteq_tiles/index.html.
[20] Georgia Department of Transportation. Online http://www.dot.state.ga.us/. Georgia Deportment of Transportation road network data was downloaded from the Georgia GIS Clearinghouse Web site: https://gis1.state.ga.us/index.asp.

locating—with a high degree of precision—any sections that had changed in channelization, curvature, speed limits, or other necessary network information.

The specific network attributes that were collected during the field trip included number of lanes, speed, turns, traffic controls, pavement type and width, shoulder width, and any other information required to model the traffic capacity of each link in the network. The information collected during the field visit is listed as follows.

- *Land width* (in feet, field observation)
- *Shoulder width* (in feet, field observation)
- *Number of lanes* (field observation)
- *FFS* (in mph, field observation)
- *Speed limit* (in mph, field observation)
- *Intersection control method:* actuated signal, fixed timing signal, stop sign controlled, yield sign controlled, uncontrolled (field observation )
- Intersection layout (taking pictures)
- Toll gates and lane channelization (taking picture)
- *Access control*: whether road has full access control (field observation)
- *Median type*: divided or undivided cross section (road has divided cross section with >=4 ft median or curbed barrier median, note that two way left turn lanes can be considered as >4 ft median for evacuation scenarios) (field observation)
- *Pavement type*: whether the road is paved or not (field observation)
- *Terrain type*: level, rolling or mountainous area (field observation)
- *Separation line*: whether the two travel directions are separated by center lines (field observation)

## 4.2. Evacuation Route Descriptions

The evacuation network modeled for the ETE analyses covers Appling, Jeff Davis, Tattnall, and Toombs Counties in Georgia. The evacuation routes were originally developed by the Georgia Emergency Management Agency and county emergency officials. The evacuation route network is composed of three kinds of roads: highways, major arterial (roads connecting to highways), and minor arterial or connector roads (residential roads connecting to major arterial roads).

An example of a highway in the EPZ is U. S. Hwy 1. Examples of major arterials are State Road 56 (SR-56), Lennox Road (CR-538), and Cedar Crossing Road (SR-107). An example of a connector road is Martin Luther King, Jr. Avenue. The connector roads, although not part of the evacuation routes described in the calendar, actually load the evacuee population onto the evacuation routes. The following items are descriptions of each evacuation route as mentioned in the calendar (see also Figure 8).

## Evacuation Route 1 (Toombs County, west of U.S. Hwy 1)

- U.S. Hwy 1, north to County Road 115 (Aimwell Road Extension), west to County Road 337 (Lyons-Center Road), north to Toombs County High School:
  - County Road 364 (Cedar Crossing-Alston Road), north to County Road 78 (Cedar Crossing-Vidalia Road), north to U.S. Hwy 1
  - County Road 97 (South Thompson Road), north to U.S. Hwy 1
  - County Road 78 (Cedar Crossing-Vidalia Road), north to U.S. Hwy 1
  - Georgia Hwy 56, east to U.S. Hwy 1
  - Georgia Hwy 147, west to U.S. Hwy 1
  - County Road 336 (Old River Road), east to U.S. Hwy 1

## Evacuation Route 2 (Toombs County, east of U.S. Hwy 1)

- Georgia Hwy 178, north to U.S. Hwy 1, south to Parker Avenue, west to County Road 337 (Lyons-Center Road), south to Toombs County High School:
  - Georgia Hwy 147, east to Georgia Hwy 178
  - Georgia Hwy 56, east to Georgia Hwy 178
  - County Road 332 (Marvin Church Road), north to County Road 333 (Johnson Corner Road), north to Georgia Hwy 178

## Evacuation Route 3 (Tattnall County)

- Georgia Hwy 147, northeast to Reidsville Middle School:
  - Georgia Hwy 178, north to Georgia Hwy 147
  - County Road 184 (P.E. Davis Road), County Road 185 (Halleluiah Trail), County Road 183 (Honey Dew Road), northeast to Elza District Road to Hwy 147
  - County Road 186 (Edwin Phillips Road), County Road 189, (Peach Tree Road), east to County Road 192, (Cedar Haw Road), north to Hwy 147
  - County Road 626 (Maple Drive), County Road 187 (Catherine T. Sanders Road), south to County Road 188 (Old River Road), east to Hwy 178, north to Hwy 147

## Evacuation Route 4 (Appling County)

- U.S. Hwy 1, south to Georgia Hwy 15, south to Appling County Comprehensive High School:
  - County Road 3 (west River Road), east to U.S. Hwy 1
  - County Road 538 (Altamaha School Road), south to U.S. Hwy 1

- County Road 537 (Ten Mile Road), south to Georgia Hwy 144, south to U.S. Hwy 1
- County Road 1 (Nails Ferry Extension Road), south to County Road 1 (Nails Ferry Road), south to U.S. Hwy 1

## Evacuation Route 5 (Jeff Davis County)

- County Road 203 (Altamaha Road), west to U.S. Hwy 341, south to U.S. Hwy 23 (Contos Boulevard), south to Jefferson Street (Alma Hwy), north to Broxton Hwy, west to Jeff Davis High School:
    - County Road 245 (Owl Head Road), east to County Road 185 (Graham Road), south to County Road 203 (Altamaha Road)
    - County Road 223 (Bullard Creek Road), west to County Road 185 (Graham Road), south to County Road 203 (Altamaha Road)
    - County Road 185 (Graham Road), south to County Road 203 (Altamaha Road)
    - County Road 185 (Graham Road), north to County Road 203 (Altamaha Road)
    - County Road 301 (Will Waters Road), west to U.S. Hwy 341
    - County Road 182 (Mt. Zion Church Road), south to U.S. Hwy 341, east to U.S. Hwy 23 (Contos Boulevard)

Each evacuation route leads to one of four designated reception centers. Table 16 lists the designated reception centers, their physical addresses, and associated evacuation route numbers, as listed in the 2012 emergency information calendar. Figure 8 illustrates the designated evacuation routes with numbers that lead to the designated reception areas.

**Table 16: Reception Centers**

| Reception Center | Address | Evacuation Routes |
|---|---|---|
| Toombs County High School | 600 Bulldog Road<br>Lyons, GA 30436 | 1, 2 |
| Reidsville Middle School | 148 W. Brazell Street<br>Reidsville, GA 30453 | 3 |
| Appling County Comprehensive High School | 482 Blackshear Hwy<br>Baxley, GA 31513 | 4 |
| Jeff Davis High School | 156 Collins Street<br>Hazlehurst, GA 31539 | 5 |

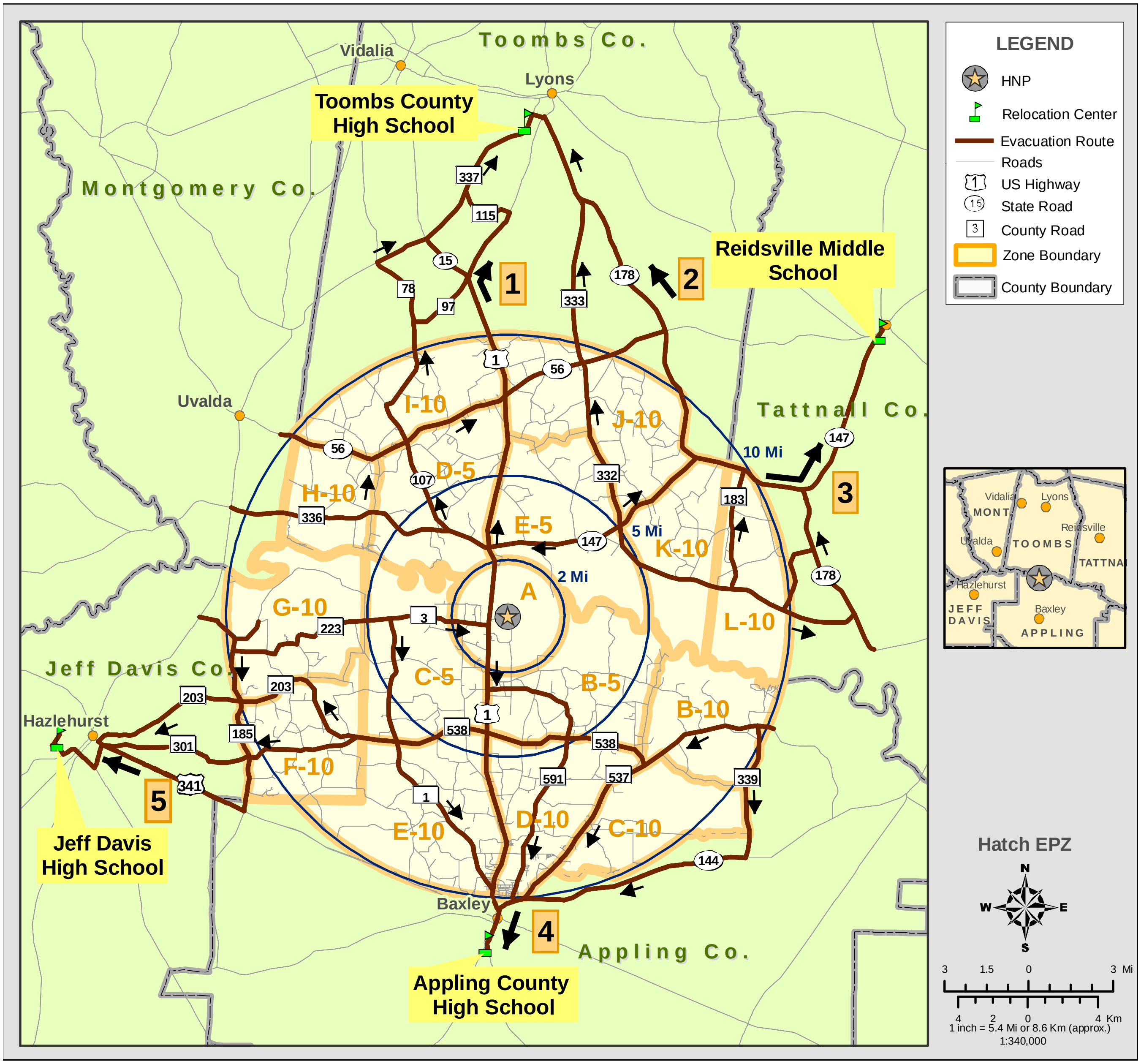


**Figure 8: Evacuation Routes with Numbers and Reception Centers**

## 4.3. Evacuation Network Characteristics

The evacuation network, as modeled using the NAVTEQ street network data, contains 321 links[21] in the direction of evacuation and includes the connector roads. The total length of the modeled network, again in the direction of evacuation and all the way to the reception centers, is about 620 miles. Detailed information regarding the roads that make up the evacuation network is provided in Appendix B.

The state highways generally have a posted speed limit of 55–65 mph. The major and minor arterial or connector roads generally have a posted speed limit of 55 mph. On some of the roads, especially the highways, the posted speed limit decreases to 35–25 mph near city limit boundaries. Unpaved roads or dirt roads have randomly posted speed limits, so a speed limit of 35 mph was assumed for modeling purposes based on comfortable and safe driving speeds achieved by IEM personnel on these roads during field verification. Most of the links in the evacuation network (including some highways) generally have one lane available in the direction of evacuation. There are no interstates within the 10-mile plume exposure pathway EPZ. Two roads in the EPZ have network links with two lanes in the direction of evacuation—U.S. Hwy 341 west toward Hazlehurst and U.S. Hwy 1 south of HNP in the direction of Baxley.

Traffic control along the evacuation routes is mostly managed using stop signs. Traffic lights were found along U.S. Hwy 1 (approaching Baxley) in the direction of Appling County Comprehensive High School and along U.S. Hwy 341 (approaching Hazlehurst) and East Jefferson Street in the direction of Jeff Davis High School.

The number of intersections for different control types during the evacuation is listed in Table 17. There are 52 intersections that will be manned controlled and are modeled as actuated signal controlled, with varied cycle length. No fixed timing traffic signal is observed in the evacuation network.

**Table 17: Intersection Control Type**

| Control Type | Number of Intersections |
|---|---|
| Stop sign Control | 98 |
| Signal Control | 0 |
| Manned Control | 52 |

The key information for the ten highest volume intersections is listed in Table 18. Most of these intersections are manned controlled. The only exception is the intersection of U.S. Hwy 1 at Sursson Street, which collect some residents in northern Baxley and is stop sign controlled to turning traffic into U.S. Hwy 1. Due to the high volume on U.S. Hwy 1, it is recommend setting up a traffic control point at this intersection. The majority of

[21] A link is defined as a road section where its characteristics (e.g., speed limit and number of lanes) are constant. An intersection starts a new link or ends a link.

the ten highest volume intersection lie along U.S. Hwy 1, which serve as a backbone highway to transport evacuees in Appling County.

**Table 18: Information for Ten Highest Volume Intersections**

| Location | Cycle Length | Green Time | Evacuation Direction Turn | Turning Lane Queue Capacity (# vehicle)* |
|---|---|---|---|---|
| GA-15 at Appling County High School Access Road | Vary | 0 - 5 min | Right turn from GA-15 to Appling County High School | 0 |
| GA-15 at Appling County High/Primary School Access Road | Vary | 0 - 5 min | Right turn from GA-15 to Appling County Primary School | 10 |
| U.S. HWY 1 at GA-15 | Vary | 0 - 5 min | Left turn from U.S. Hwy 1 | 27 |
| U.S. HWY 1 at Zoar Road/Bay Street | Vary | 0 - 5 min | Right turn from Zoar Road to U.S. Hwy 1 | 0 |
| U.S. HWY 1 at U.S. Hwy 341 | Vary | 0 - 2 min | Left and right turn from US-421 to U.S. Hwy 1 | 0 |
| U.S. Hwy 1 at GA-144 | Vary | 0 - 2 min | Left turn from GA-1144 to U.S. Hwy 1 | 1 |
| U.S. Hwy 1 at CR-1/Nails Ferry Road | Vary | 0 - 2 min | Right turn from CR-1 to U.S. Hwy 1 | 3 |
| U.S. Hwy 1 at Sursson Street | N/A | N/A | Right turn from Sursson Street to U.S. Hwy 1 | 0 |
| SR-15/SR-29 exit of U.S. Hwy 1 (South Thompson Road) | Vary | 0 - 2 min | Left turn from U.S. Hwy 1 to SR-15; Left turn from S Thompson Road to SR-15 | 2-5 |
| Bulldog Road/Lyons Center Road at Toombs County High School Access Road | Vary | 0 - 5 min | Left and right turn from Bulldog Road to Toombs County High School | 0 |

* Queue capacity for turning lane of the evacuation direction

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# 5.0 EVACUATION TIME ESTIMATE METHODOLOGY

ETEs are developed using VISUM 11, one of the core components of the PTV Vision software suite. VISUM is used to estimate evacuation times for different scenarios (e.g., day vs. night or normal vs. adverse weather) for user-defined spatial networks. Information provided by PTV Vision includes evacuation or clearance times, operational characteristics (e.g., average evacuation speed, average distance traveled), points of congestion, and other data necessary to evaluate evacuation plans.

The evacuation network was defined based on the information provided in 2012 emergency information calendar. IEM subject matter experts drove the designated routes to ensure complete and accurate information about the state of the roads and to evaluate the appropriate selection of routes given the current conditions onsite.

Evacuation demand (in term number of vehicles) loaded onto the network is based on the data and methods described above in Section 3.0. Loading times for the evacuation network are described below. Additional details about the methodology are included in the following sections.

## 5.1. Loading of the Evacuation Network

In the event of an emergency, the public notification will mark the beginning of the evacuation times. So, public behavior (how long it takes the population to learn of the emergency and begin to evacuate) will impact the ETEs. The loading time distributions, also known as "trip generation times," described in this section are measured from the public notification, rather than from the occurrence of a hypothetical event.

### 5.1.1. Trip Generation Events and Activities

NUREG/CR-7002 requires planners estimate the amount of time for the public to begin evacuating. These elapsed times are represented as statistical distributions to reflect the variety of activities the public may undertake before evacuating. In addition, separate distributions are prepared for each population group, because, for example, a person evacuating from home will behave differently than someone who is at work, fishing, or in a nursing home, This is due to differences in their available alert systems and also systematic differences in their pre-evacuation preparations.

#### (i) Evacuation Events and Activities Series for Different Population Groups

The trip generation process consists of a series of events and activities. Each event occurs at an instant in time and is the outcome of an activity. Activities are undertaken over a period of time. As shown in Figure 9, Figure 10, and Figure 11, different population groups have different events and activity series for evacuation.

In these figures, circles represent events. Each event is coded by a number, which represents the following:

1. First notification of public
2. Individual's awareness of incident
3. Leave work/facilities
4. Arrive home
5. Leave home

An arrow indicates an activity. The following describe the activities that take place between each event:

- 1 → 2: Receive notification
- 2 → 3: Prepare to leave work/facilities
- 3 → 4: Travel home
- 2 → 5: Prepare to leave home

Transient evacuees, including travelers, boaters, hunters, and employees living outside the EPZ, will follow Series A as shown in Figure 9. They will be notified of the event and will leave their activities.

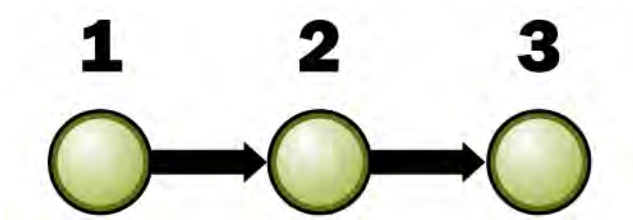


**Figure 9: Evacuation Events and Activity Series for Transients, Special Facilities (Series A)**

Households that do not have to wait for household members to return home will be notified of the emergency and leave home, following Series B, shown in Figure 10.

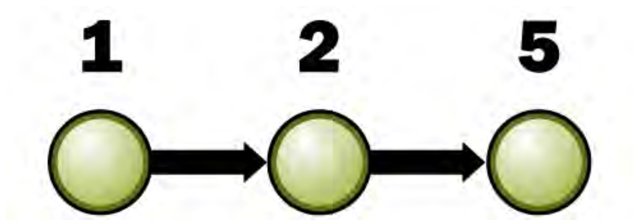


**Figure 10: Evacuation Events and Activity Series for Residences without Family Members Returning Home (Series B)**

The results of a phone survey suggest around 32% of residences have regular commuters who would wait for household members to return home before evacuating. This portion of the population will follow series C in Figure 11 to evacuate. Note the activities of the people at home (denoted with a subscript H) can be undertaken in parallel with those of the commuter (denoted with a subscript C). Specifically, an adult member of a household

can prepare to leave home while others are traveling home from work. In this instance, the household members would be able to evacuate sooner than a household that prepares to leave home after all members have returned home.

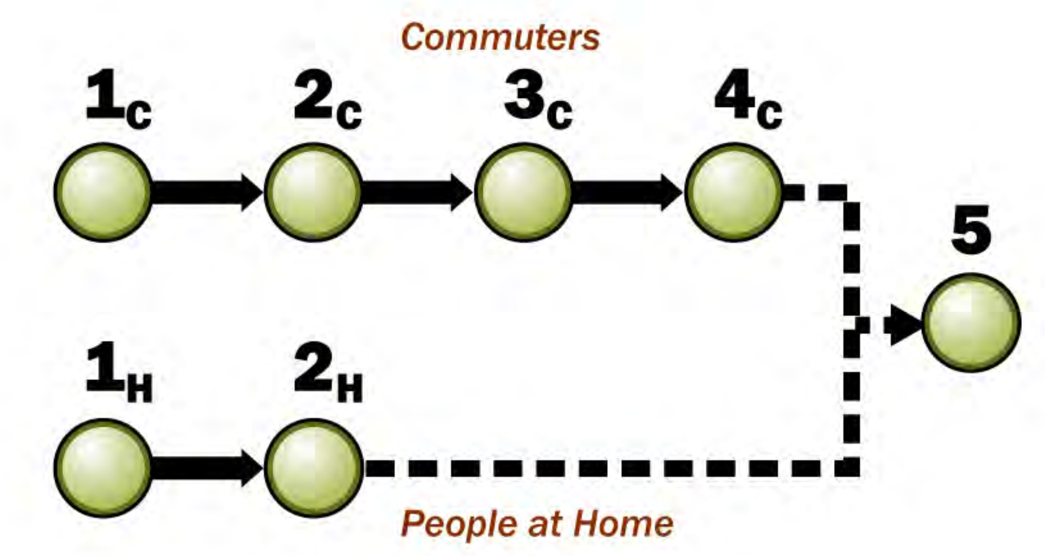


**Figure 11: Evacuation Events and Activity Series for Residences with Family Members Returning Home (Series C)**

### (ii) Calculation of Composite Distribution for Events and Activities Series in Evacuation

As indicated by NUREG/CR-7002, activities may be in sequence (i.e., an activity will be undertaken upon completion of a preceding event) or may be in parallel (i.e., two or more activities may take place over the same period of time). Given the assumption the time distribution of each activity is independent, the combined trip generation time required for individual activities undertaken in sequence would be the sum of the times required for each activity. On the other hand, the combined trip generation time required for individual activities undertaken in parallel would be the maximum of the times required for each activity. Table 19 shows the approach for estimating trip generation for different evacuation activity series.

**Table 19: Trip Generation Estimate for Different Evacuation Activity Series**

| Trip Generation Series | Composite Distribution Calculation |
|---|---|
| A | {1→2 + 2→3} |
| B | {1→2 + 2→5} |
| C | Max: {($1_C$→$2_C$ + $2_C$→$3_C$ + $3_C$→$4_C$), ($1_H$→$2_H$ + $2_H$→5)} |

### 5.1.2. Trip Generation Time Estimate

Trip generation consists of two phases of activities: notification (i.e., activity 1 → 2) and mobilization, which includes the rest of the activities. The notification process includes transmitting information and receiving and correctly interpreting the information that is transmitted. IEM adopted the time distribution for notification presented in *Evaluating Protective Actions for Chemical Agent Emergencies* (EPACAE).[22] This data was collected during evacuations executed in response to large-scale chemical spills and explicitly incorporates the time required for the communication of the warning. The data collected in this meta-study was based on transient, permanent, and special populations and is therefore appropriate to use as "general" notification curves for all three population types.

The underlying assumption in applying the EPACAE notification curves to a nuclear ETE study is the public perception of radiological emergencies is similar to that of a chemical event. These curves were developed from the empirical data collected from real-life evacuations in response to actual events, and no similar study developed specifically for radiological events is readily available. In the absence of such a study, empirical data from similar events was deemed to be more justifiable than estimating or hypothesizing about the public response to a nuclear event. IEM has successfully used this data for multiple ETE studies in the past, both for nuclear and chemical incidents or accident scenarios.

Since the EPACAE notification distribution of times depends on the warning system employed, IEM personnel incorporated the planned alert and notification systems (ANS) around the site, based on discussions with Southern Nuclear personnel. These discussions revealed the basic ANS within the HNP EPZ will include sirens, Emergency Alert Systems (EAS) (including local radio and television stations) and a rapid calling capability (RCC). The notification time distributions for these warning systems are shown in Figure 12. Any loss in capability of the ANS components would potentially increase the notification times and, as a result, ETEs.

[22] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

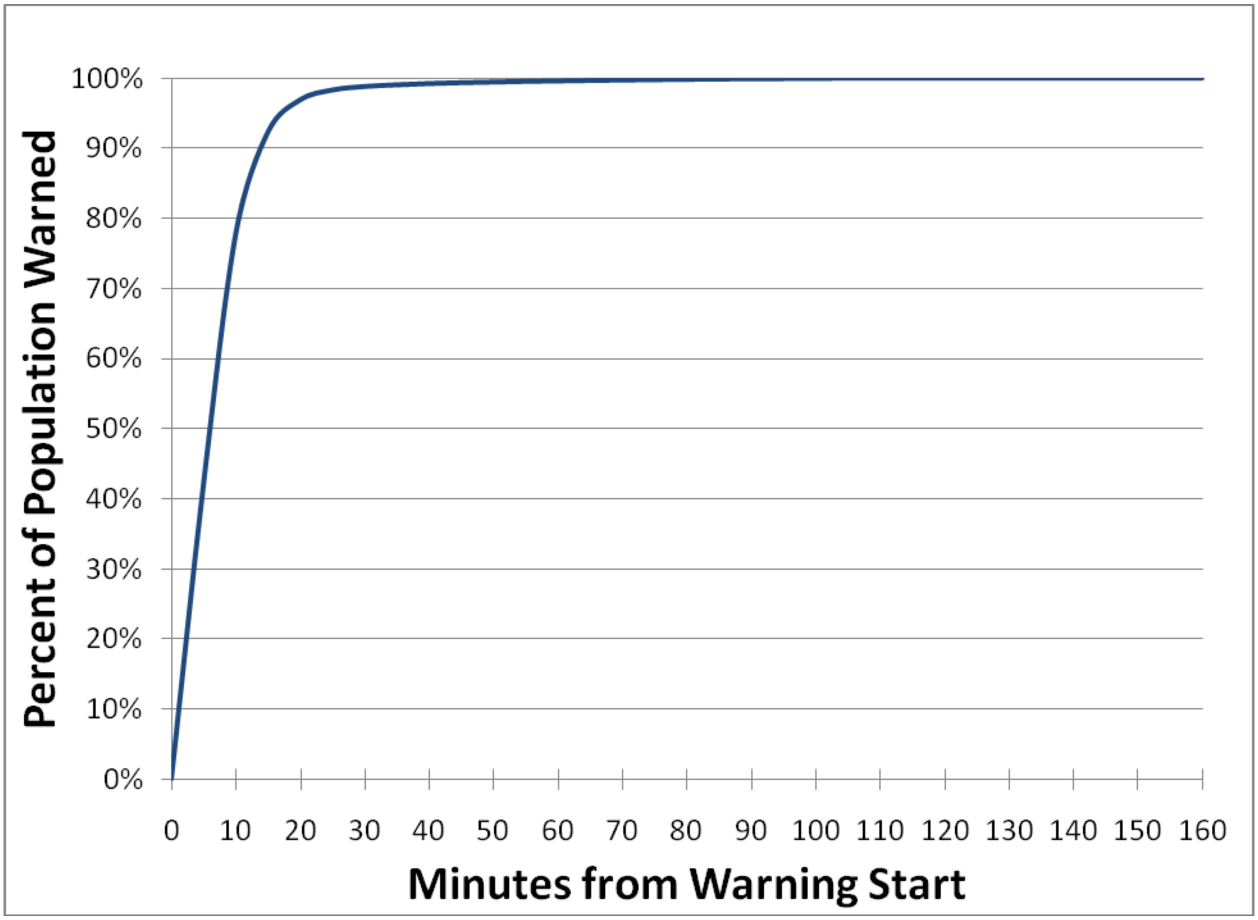


**Figure 12: Notification Times for Selected Alert and Notification Systems[23]**

Notification times for hunters, boaters, and park visitors were increased by 45 minutes to allow time for local emergency officials to patrol the forest, river, or park with loud speakers to warn visitors.

Generally, the information required to estimate the second phase of trip generation, the mobilization process, was obtained from a telephone survey of EPZ residents, supplemented by mobilization time estimated for similar sites. See Appendix C for details about the survey and its raw data.

Mobilization times will vary from one individual to the next depending on where they are, what they are doing, and related factors. Furthermore, some persons, including commuters, shoppers, and other travelers, will return home to join the other members of their households for evacuation upon receiving notification of an emergency. Therefore, the time elapsed for those people to travel home should be considered as part of the mobilization time before evacuation can begin.

[23] *Ibid.*

Figure 13 presents the distribution of trip generation times (i.e., the combination of notification and mobilization times) for different population groups. These curves were obtained by applying the methodology described in Table 19 to the activities of each population group.

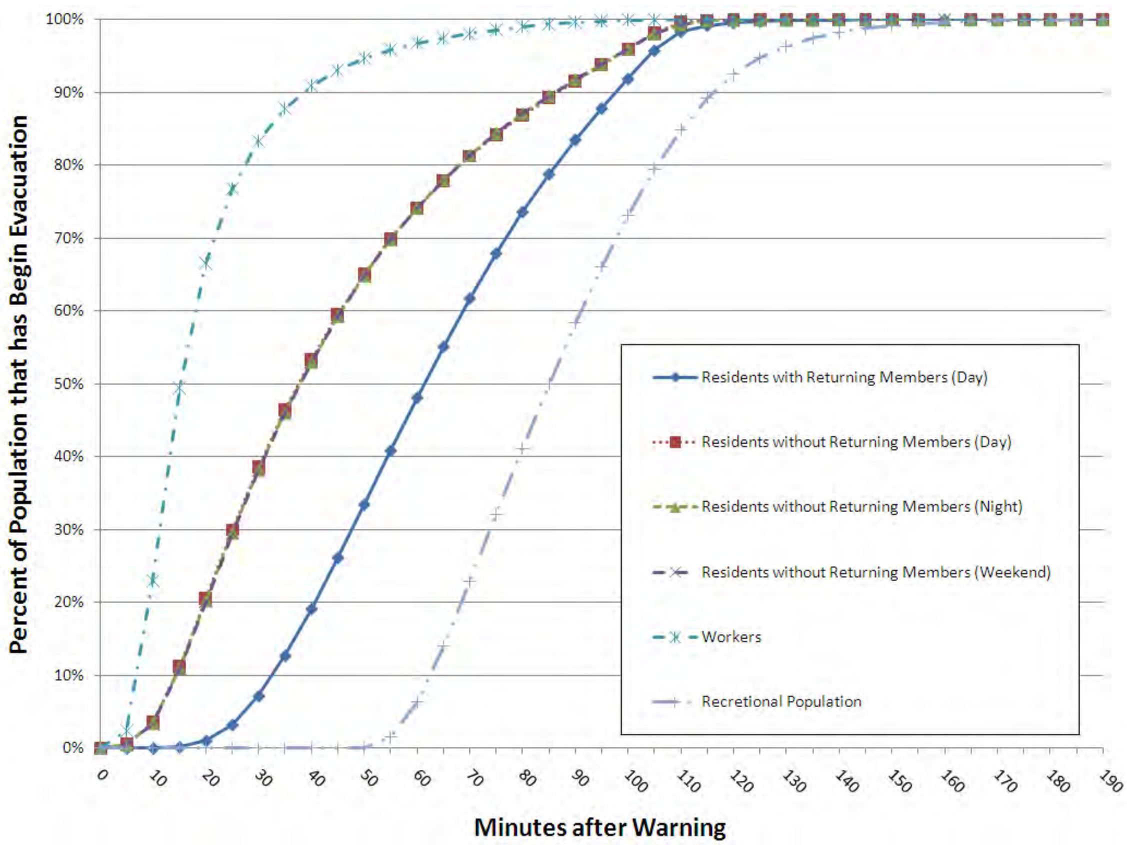


**Figure 13: Distribution of Trip Generation Times by Population Group**

## 5.1.3. Trip Generation Time for Transit Dependent Permanent Residents

As described in Section 3.3, the transit dependent permanent residents in the HNP EPZ are estimated at 74. Table 20 shows the assumptions for determining the trip generation time for evacuating the transit dependent population. The trip generation time for the transit dependent population was determined by consulting with relevant EMA personnel and the SNC planning staff.

**Table 20: Trip Generation Time for Transit Dependent Permanent Residents**

| Transit Dependent Category | County | Assumptions | Trip Generation Time |
|---|---|---|---|
| Wheelchair | Appling | Residents will evacuate by special equipped vehicles | 20 minutes |
| | Jeff Davis | Residents will evacuate by special equipped vehicles | 20 minutes |
| | Tattnall | Residents will evacuate by special equipped vehicles | 20 minutes |
| | Toombs | Residents will evacuate by special equipped vehicles | 20 minutes |
| Transportation | Appling | Residents will evacuate by school bus and standard vans | 17 minutes |
| | Jeff Davis | Residents will evacuate by school bus and standard vans | 17 minutes |
| | Tattnall | Residents will evacuate by school bus and standard vans | 17 minutes |
| | Toombs | Residents will evacuate by school bus and standard vans | 17 minutes |
| Immobile | Appling | Residents will evacuate by ambulance | 20 minutes |
| | Jeff Davis | Residents will evacuate by ambulance | 20 minutes |
| | Tattnall | Residents will evacuate by ambulance | 20 minutes |
| | Toombs | Residents will evacuate by ambulance | 20 minutes |

### 5.1.4. Trip Generation Time for Schools and Special Facilities

As described in Section 3.4, there is one special facility and two schools within the HNP EPZ. Table 21 shows the assumptions for determining trip generation times for the population segments associated with these facilities. The trip generation times for the schools and the special facilities were determined by consulting with relevant personnel at the facilities.

**Table 21: Trip Generation Time for Population in Special Facilities and Schools**

| Facility Category | Facility Name | Assumptions | Trip Generation Time |
|---|---|---|---|
| School Students | Altamaha Elementary School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Altamaha Elementary School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |

| Facility Category | Facility Name | Assumptions | Trip Generation Time |
|---|---|---|---|
| School Students | Toombs Central Elementary School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Toombs Central Elementary School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |
| Special Facility Students | AMIkids Baxley Wildness Institute | Students will evacuate in 40 minutes. | 40 minutes |
| Special Facility Staff | AMIkids Baxley Wildness Institute | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |

## 5.2. Evacuation Simulation

Evacuations were simulated using the population and vehicle demand data, evacuation network data, and loading distribution data discussed in the previous sections. VISUM 11 was used to simulate evacuations. Figure 14 describes the framework of the analysis and three of its main features: the demand model, the network model, and the impact model.

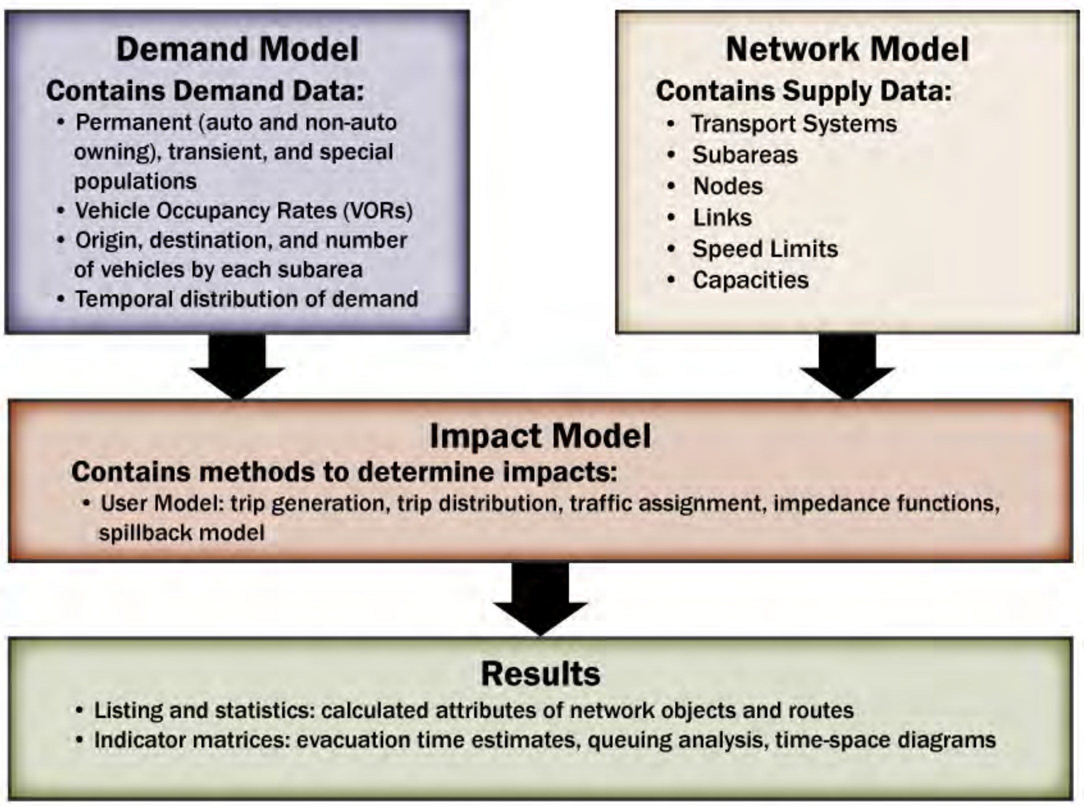


**Figure 14: ETEs Analysis Framework Using VISUM**

### 5.2.1. The Demand Model

The demand model contains the travel demand data. The total number of vehicles originating from a zone is calculated by dividing a population with its expected vehicle occupancy rate. The total number of vehicles originating from a zone is then distributed to different time intervals based on the loading distribution curve for the zone. The loading distribution curve for the zone depends on the warning system available for that zone. The travel demand is described by an origin-destination (OD) matrix. The OD matrix refers to a time interval and the total number of vehicles departing in that time interval.

### 5.2.2. The Network Model

The network model describes the relevant supply data of an evacuation network. The supply data consists of subareas, nodes, links, speed limits, and capacities. The subareas describe areas with particular boundaries based on demography, topography, land characteristics, access routes, and local jurisdictions. They represent the origin and destination of trips within the evacuation network. Nodes define positions of intersections in the evacuation network. Links connect nodes and, therefore, describe the road infrastructure. Every network object is described by its attributes (e.g., speed limits and capacities for the links). The travel time of a vehicle on a given link depends on the permitted speed and the capacity (i.e., the traffic volume a road can handle before the formation of a traffic jam) of the link. The roadway capacities used in the evacuation analysis were calculated using the field collected road attributes and capacity calculation methodology from the U.S. Federal Highway Administration.[24] The details of roadway capacity calculation method are presented as follows.

#### (i) Roadway Capacity Calculation Method

IEM estimated roadway capacity based on road type and free flow speed. Using the characteristics data field (e.g., access control, median type, number of lanes in one direction, pavement type), roadway is categorized into five types: 1) full access controlled road; 2) rural multilane highway; 3) urban multilane highway; 4) single lane road; 5) unpaved road. The classification method is shown in the flow chart below.

[24] U.S. Federal Highway Administration. "Highway Performance Monitoring System Field Manual, Appendix N - Procedures for Estimating Highway Capacity." Online: http://www.fhwa.dot.gov/ohim/hpmsmanl/appn.htm.

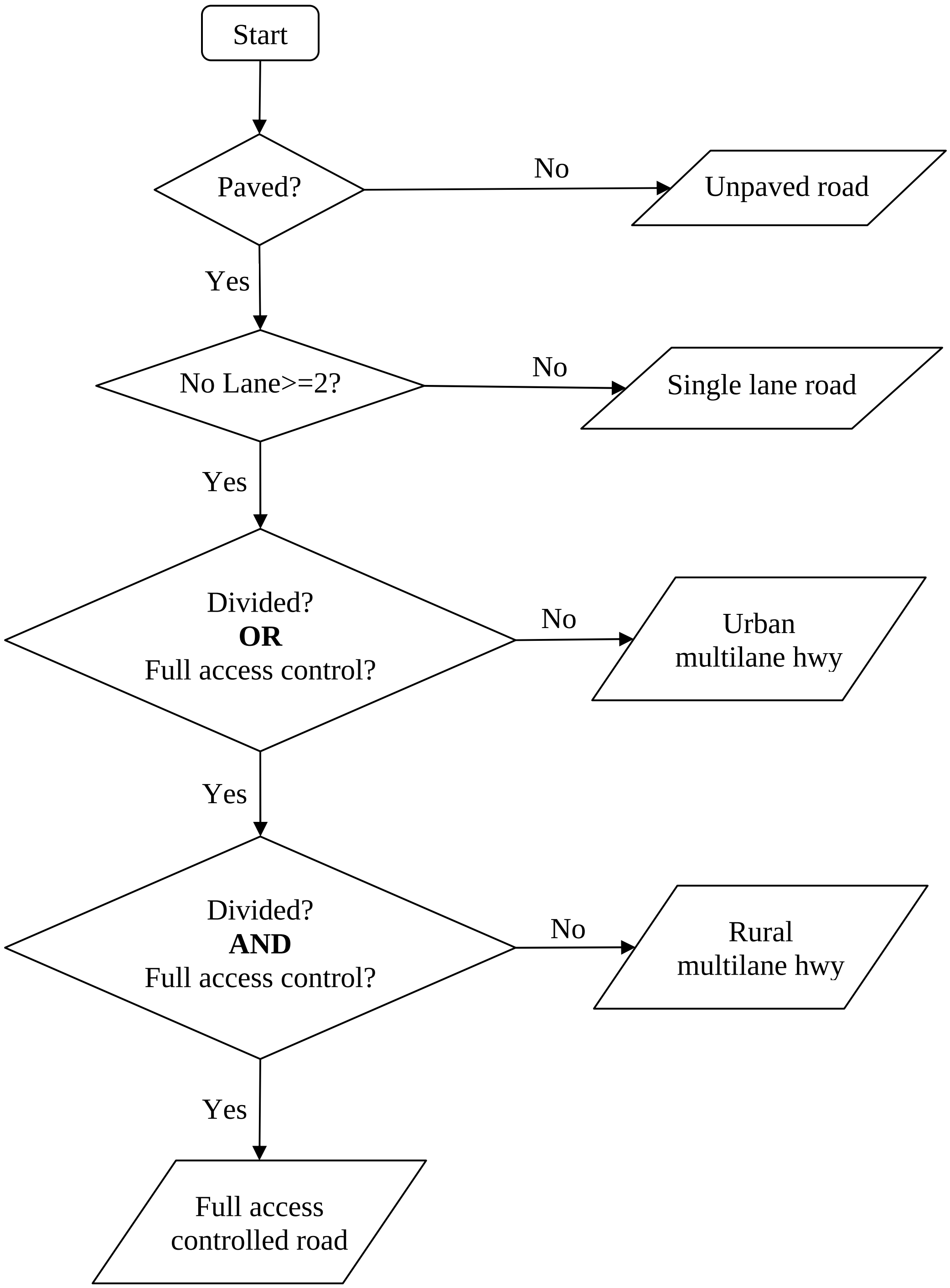


**Figure 15: Roadway Type Classification Method**

Once the roadway type is determined, the capacity (in vehicle per lane per hour) can be calculated for each road segment using the following method.

- Full access controlled road: Capacity = 1700 + *FFS* * 10 with maximum of 2400
- Rural multilane highway: Capacity = 1000 + *FFS* * 20 with maximum of 2200
- Urban multilane highway: Capacity = 1900
- Single lane road: Capacity = 1700 * $f_G$ - $V_{NP}$
- Unpaved road: Capacity = 800 * $f_G$ - $V_{NP}$

The unit for capacity of the above formula is pcplph (passenger car per lane per hour). One need is to multiply this value by number of lanes to obtain the capacity for all lanes in the unit of pcph (passenger car per hour). No heavy vehicle factor adjustment should be made to the adjustment because VISUM needs capacity as an input in passenger car units and heavy vehicles are modeled as different vehicle groups than the passenger cars. Peak hour factor (PHF) should not be considered for adjusting capacity in modeling, as modeling time step is typically less than 15 min (e.g., 5 min).

FFS *(definition: The desired speed of drivers in low volume conditions and in the absence of traffic control devices or other adverse conditions.)* is the key to estimate capacity and is a required input for modeling. It can be directly estimated in the field and is typically 5-10 mph higher than the speed limit.

$f_G$ and $V_{NP}$ are adjustment factor for grades and adjustment value for no passing zones. $f_G$ can be found from Table 22[25]. If no other information is available, one may assume the two-way flow rate is in the range 0-600 pcph.

**Table 22: Grade Adjustment Factors ($f_G$)**

| Two-Way Flow Rates (pcph) | Level | Rolling | Mountainous |
|---|---|---|---|
| 0-600 | 1.00 | 0.71 | 0.57 |
| >600-1,200 | 1.00 | 0.93 | 0.85 |
| >1,200 | 1.00 | 0.99 | 0.99 |

[25] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 6, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

$V_{NP}$ can be calculated as $V_{NP} = f_{NP} / 0.00776$, where $f_{NP}$ is the adjustment factor for no-passing zones on average travel speed and can be found in Table 23[26]. If no other information is available, one may assume the two-way flow rate is in the range 101-300 pch, no passing zone percent is 50% for separated roads and 90% for non-separated roads.

**Table 23: Adjustment ($f_{np}$) for Effect of No-Passing Zones on Average Travel Speed on Two-Way Segments**

| Two-Way Demand Flow Rate, $v_p$(pcph) | Reduction in Average Travel Speed (mph) No-Passing Zones (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 0-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 101-300 | 0.0 | 0.3 | 0.6 | 1.0 | 1.4 | 1.9 | 2.4 | 2.5 | 2.6 | 3.1 | 3.5 |
| 301-500 | 0.0 | 0.9 | 1.7 | 2.2 | 2.7 | 3.1 | 3.5 | 3.7 | 3.9 | 4.2 | 4.5 |
| 501-700 | 0.0 | 0.8 | 1.6 | 2.0 | 2.4 | 2.7 | 3.0 | 3.2 | 3.4 | 3.7 | 3.9 |
| 701-900 | 0.0 | 0.7 | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.6 | 2.7 | 2.9 | 3.0 |
| 901-1,100 | 0.0 | 0.6 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 2.2 | 2.4 | 2.6 |
| 1,101-1,300 | 0.0 | 0.4 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.1 |
| 1,301-1,500 | 0.0 | 0.3 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 |
| 1,501-1,700 | 0.0 | 0.3 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| 1,701-1,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 |
| 1,901-2,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 |
| 2,101-2,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 |
| 2,301-2,500 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 |

[26] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 8, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

| Two-Way Demand Flow Rate, $v_p$(pcph) | Reduction in Average Travel Speed (mph) No-Passing Zones (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 2,501-2,700 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 |
| 2,701-2,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 |
| 2,901-3,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 |
| 3,101-3,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| >3,300 | 0.0 | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

#### (ii) Roadway Capacity Calculation Example

Link #1 (node 0055 to node 0057, shown in Figure 18 and Table 34) as a segment of U.S. Hwy 1 is a rural single lane road located in a level area with approximate 50 percent no-passing zones and the two-way traffic is estimated in a range of 101-300. Therefore, its capacity is estimated as 1700 * 1.0 – 1.9/0.00776 = 1455 pcph.

Another example is link #157 (node 6096 to 6103, shown in Figure 19 and Table 34) as a segment of U.S. Hwy 341/GA 27 is a rural multi-lane highway with two lanes in each direction and free flow speed of 65 mph. Therefore, its capacity is estimated as 2 * *max* (2200, 1000 + 65 * 20) = 4400 pcph.

### 5.2.3. The Impact Model

The impact model takes its input data from the demand model and the network model. PTV Vision provides different impact models to analyze and evaluate the evacuation network. A user model simulates the behavior of travelers. It calculates traffic volumes and service indicators, such as travel time. The VISUM traffic assignment procedure chosen for this analysis simulates the movement of vehicles on the network as time passes in the evacuation and outputs volumes for each link at each time after analyzing the queuing behavior. This time-dynamic functionality allows for loading of the network via distributions, as when using a range of mobilization times.

The ETEs are measured by noting the time and counting the number of vehicles passes the boundary of the EPZ. VISUM displays the calculated results in graphic and tabular forms and allows graphical analysis of results. In this way, for example, routes per OD pair, traffic flow, and isochrones can be displayed and analyzed. Using the outputs from VISUM, IEM modeler was able to ensure that the traffic simulation model is in equilibrium, by checking whether the number of vehicles entering the roadway network is equal to the number of vehicles exiting the network.

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# 6.0 ANALYSIS OF EVACUATION TIMES

Evacuation times were estimated in order to give emergency planners in the area an approximate time required for evacuation of various parts of the footprint. The estimates were derived by using population (demand) data to determine the number of vehicles and then modeling the travel of the vehicles along the evacuation routes from their origin to their assigned reception center. Both 100% and 90% ETE were studied. The 100% ETE is the time between public notification and when the last evacuating vehicle exits the EPZ. On the other hand, 90% ETE is the time between public notification and when 90% of the evacuating vehicles exit the EPZ.

The ETEs are composed of two components. The first is loading (or “trip generation”) time, which is the time required for residents within the area to prepare and then begin their evacuation. Loading times depend, in part, on how long it takes evacuees to receive the warning and is, thus, dependent on the warning systems in their area. The trip generation times estimated for the HNP EPZ are described in detail in Section 5.1. The second component of an ETE is travel time, which is the time between the resident’s departure and when they cross the EPZ boundary. The travel time is determined via the evacuation model.

As a part of the analysis, zones in the study area were grouped to represent the different areas that might need to be evacuated during an incident, so that the decision makers could more effectively order evacuations based on the scenarios and potential wind direction. These areas are discussed in more detail in Section 1.2.

Each zone had been assigned a set of evacuation routes by State and local EMA planners, and these route restrictions were reflected in the modeling of the scenarios. These guidelines generally route evacuees based on the county these are located at the time of the incident. The evacuation routes are described in more detail in Section 4.2.

## 6.1. Summary of ETE Results for General Public

The evacuation time estimate results are displayed in Table 24 and Table 25. Evacuation times listed include warning diffusion, public mobilization, and travel time out of the EPZ. It is important to note that the evacuation time is the time from the moment at which public notification begins—not the start time of a hypothetical event.

## Table 24 : 2012 100% ETEs in Minutes[27]

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 170 | 170 | 170 | 175 | 175 | 175 |
| A, B-5, C-5, D-5, E-5 | 5-mile ring | 175 | 175 | 180 | 180 | 180 | 180 |
| All | 10-mile EPZ | 185 | 195 | 215 | 190 | 215 | 235 |
| Evacuate 2 to 5 miles downwind | | | | | | | |
| B-5,C-5 | N | 170 | 170 | 175 | 175 | 175 | 175 |
| B-5,C-5 | NNE | 170 | 170 | 175 | 175 | 175 | 175 |
| C-5 | NE | 170 | 170 | 170 | 170 | 175 | 175 |
| C-5 | ENE | 170 | 170 | 170 | 170 | 175 | 175 |
| C-5,D-5 | E | 175 | 175 | 175 | 175 | 180 | 180 |
| C-5,D-5 | ESE | 175 | 175 | 175 | 175 | 180 | 180 |
| C-5,D-5 | SE | 175 | 175 | 175 | 175 | 180 | 180 |
| D-5,E-5 | SSE | 175 | 175 | 175 | 175 | 175 | 180 |
| D-5,E-5 | S | 175 | 175 | 175 | 175 | 175 | 180 |
| D-5,E-5 | SSW | 175 | 175 | 175 | 175 | 175 | 180 |
| E-5 | SW | 160 | 165 | 165 | 165 | 165 | 165 |
| E-5,B-5 | WSW | 170 | 170 | 170 | 170 | 170 | 175 |
| E-5,B-5 | W | 170 | 170 | 170 | 170 | 170 | 175 |
| E-5,B-5 | WNW | 170 | 170 | 170 | 170 | 170 | 175 |
| B-5 | NW | 170 | 170 | 170 | 170 | 170 | 175 |
| B-5 | NNW | 170 | 170 | 170 | 170 | 170 | 175 |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | |
| A,B-5,C-5 | N | 175 | 175 | 175 | 175 | 175 | 180 |
| A,B-5,C-5 | NNE | 175 | 175 | 175 | 175 | 175 | 180 |
| A,C-5 | NE | 175 | 175 | 175 | 175 | 175 | 175 |
| A,C-5 | ENE | 175 | 175 | 175 | 175 | 175 | 175 |
| A,C-5,D-5 | E | 175 | 175 | 180 | 180 | 180 | 180 |
| A,C-5,D-5 | ESE | 175 | 175 | 180 | 180 | 180 | 180 |
| A,C-5,D-5 | SE | 175 | 175 | 180 | 180 | 180 | 180 |
| A,D-5,E-5 | SSE | 175 | 175 | 175 | 180 | 180 | 180 |
| A,D-5,E-5 | S | 175 | 175 | 175 | 180 | 180 | 180 |
| A,D-5,E-5 | SSW | 175 | 175 | 175 | 180 | 180 | 180 |
| A,E-5 | SW | 170 | 170 | 170 | 175 | 175 | 175 |

[27] Note: The scenarios are each considered individually; if combinations of the geographic evacuation areas are to be evacuated together, the larger of the two numbers should be used as the evacuation time. For example, if zones A, B-5, and E-5 (combination of 5-mile NE and 5-mile SE scenarios) were to be evacuated on a normal 2012 weekday, the ETE would be the greater of the two ETEs or 130 minutes.

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A,E-5,B-5 | WSW | 175 | 175 | 175 | 175 | 175 | 175 |
| A,E-5,B-5 | W | 175 | 175 | 175 | 175 | 175 | 175 |
| A,E-5,B-5 | WNW | 175 | 175 | 175 | 175 | 175 | 175 |
| A,B-5 | NW | 175 | 175 | 175 | 175 | 175 | 175 |
| A,B-5 | NNW | 175 | 175 | 175 | 175 | 175 | 175 |

### Table 25: 2012 90% ETEs in Minutes

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 95 | 105 | 110 | 100 | 105 | 110 |
| A, B-5, C-5, D-5, E-5 | 5-mile ring | 110 | 115 | 120 | 110 | 115 | 120 |
| All | 10-mile EPZ | 140 | 155 | 165 | 150 | 165 | 180 |
| Evacuate 2 to 5 miles downwind | | | | | | | |
| B-5,C-5 | N | 110 | 110 | 120 | 110 | 115 | 120 |
| B-5,C-5 | NNE | 110 | 110 | 120 | 110 | 115 | 120 |
| C-5 | NE | 105 | 110 | 110 | 110 | 110 | 110 |
| C-5 | ENE | 105 | 110 | 110 | 110 | 110 | 110 |
| C-5,D-5 | E | 110 | 110 | 115 | 110 | 115 | 115 |
| C-5,D-5 | ESE | 110 | 110 | 115 | 110 | 115 | 115 |
| C-5,D-5 | SE | 110 | 110 | 115 | 110 | 115 | 115 |
| D-5,E-5 | SSE | 105 | 110 | 110 | 110 | 110 | 115 |
| D-5,E-5 | S | 105 | 110 | 110 | 110 | 110 | 115 |
| D-5,E-5 | SSW | 105 | 110 | 110 | 110 | 110 | 115 |
| E-5 | SW | 100 | 100 | 100 | 100 | 100 | 100 |
| E-5,B-5 | WSW | 110 | 110 | 115 | 110 | 110 | 115 |
| E-5,B-5 | W | 110 | 110 | 115 | 110 | 110 | 115 |
| E-5,B-5 | WNW | 110 | 110 | 115 | 110 | 110 | 115 |
| B-5 | NW | 105 | 110 | 115 | 110 | 110 | 115 |
| B-5 | NNW | 105 | 110 | 115 | 110 | 110 | 115 |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | |
| A,B-5,C-5 | N | 110 | 115 | 120 | 110 | 115 | 120 |
| A,B-5,C-5 | NNE | 110 | 115 | 120 | 110 | 115 | 120 |
| A,C-5 | NE | 105 | 110 | 115 | 105 | 115 | 115 |
| A,C-5 | ENE | 105 | 110 | 115 | 105 | 115 | 115 |

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A,C-5,D-5 | E | 110 | 115 | 115 | 110 | 115 | 115 |
| A,C-5,D-5 | ESE | 110 | 115 | 115 | 110 | 115 | 115 |
| A,C-5,D-5 | SE | 110 | 115 | 115 | 110 | 115 | 115 |
| A,D-5,E-5 | SSE | 105 | 110 | 115 | 110 | 115 | 115 |
| A,D-5,E-5 | S | 105 | 110 | 115 | 110 | 115 | 115 |
| A,D-5,E-5 | SSW | 105 | 110 | 115 | 110 | 115 | 115 |
| A,E-5 | SW | 100 | 105 | 110 | 105 | 110 | 115 |
| A,E-5,B-5 | WSW | 105 | 110 | 120 | 110 | 115 | 120 |
| A,E-5,B-5 | W | 105 | 110 | 120 | 110 | 115 | 120 |
| A,E-5,B-5 | WNW | 105 | 110 | 120 | 110 | 115 | 120 |
| A,B-5 | NW | 105 | 110 | 120 | 110 | 110 | 120 |
| A,B-5 | NNW | 105 | 110 | 120 | 110 | 110 | 120 |

## 6.2. Discussion of Scenario Results

### 6.2.1. General Trends

- The ETEs in both normal and adverse weather are mainly driven more by the warning system and available speeds rather than the roadway capacities because the vehicular demand is low compared to the available roadway capacities in most parts of the network.
- The ETEs for scenarios in adverse weather increased in a range of 0 to 15 minutes from the corresponding scenarios in normal weather. The adverse weather conditions have little impacts on ETEs, increasing with no more than a 5 minute increase for the majority of the scenarios. The increase is due more to the reduced available speeds than to reduced roadway capacities.
- For each area, the weekend scenario produced the highest evacuation times. This is due to the increased amount of recreational transients in the area (hunters and boaters) on the weekend. This population has a higher warning and diffusion time than other populations – up to 2 hours 35 minutes, compared to 2 hours 5 minutes for permanent residents.

### 6.2.2. Evacuation Area: 0–2 Miles

The majority of the population in the Zone A evacuation area consists of employees of HNP. In addition, Zone A includes a small number of permanent residents, non-plant employees, and recreational visitors in the area for hunting and other activities along the Altamaha River. For the weekday scenarios, the plant workforce was modeled to reflect 475 employees who would evacuate during an event, excluding another 200 emergency personnel, who will not evacuate. For the weeknight and weekend scenarios, the

workforce for the plant was modeled such that all employees were emergency personnel and would remain during an event. For the weekend scenario, the recreational population was at its peak.

The longest evacuation times for the 2-mile radius occurred in the weekend scenario. The evacuation times are relatively low and were affected by the loading times and available speed limits, not by congestion in the network. Evacuees in the 2-mile radius will generally use U.S. Hwy 1 to leave the EPZ. Population north of the Altamaha River will evacuate to the Toombs County reception Center and population south of the Altamaha River will evacuate to the Appling County Reception Center.

### 6.2.3. Evacuation Area: 0–5 Miles

This area includes the entire 5-mile EPZ, consisting of zones A, B-5, C-5, D-5 and E-5. There are several evacuation routes leading out of the EPZ; however, a portion of the evacuating population will converge on U.S. Hwy 1. Population from zones D-5 and E-5 will converge on U.S. Hwy 1 and travel north to the Toombs County Reception Center. Population from zone B-5 and C-5 will converge on U.S. Hwy 1 and travel south to the Appling County Reception Center. Evacuation times for the entire 5-mile EPZ are similar to maximum evacuation times for all subzones for each scenario, and are slightly longer than evacuation times for the 2-mile radius scenarios. The evacuation times indicate that as the traffic converges for the evacuation of the entire 5-mile boundary, the road network will continue to provide sufficient capacity in both normal and adverse weather.

### 6.2.4. Evacuation Area: 0–10 Miles

The evacuation times of the entire 10-mile EPZ was noticeably longer than those of 0-5 mile area, due to the additional evacuees from 5-10 mile area. This is especially true for the weekend scenarios, when the recreational populations are at their peak level.

Zones B-5, C-5, B-10, C-10, D-10, and E-10 will evacuate to the Appling County Reception Center and will primarily use U.S. Hwy 1 and Hwy 1 to leave the EPZ. Zones F-10 and G-10 will evacuate to the Jeff Davis County Reception Center and will primarily use the Altamaha School road to leave the EPZ. Zones D-5, H-10 and I-10 will evacuate to the Toombs County Reception Center, primarily using U.S. Hwy 1, County Road 364 (Cedar Crossing), and County Road 336 (Old River Road). Zones E-5, J-10 and K-10 evacuating to Toombs County will primarily use U.S. Hwy 1, Hwy 147, County Road 332, and County Road 333. Zone L-10 will evacuate the EPZ to Tattnall County Reception Center primarily using Old River Road.

Population for this area includes permanent residents, transients working in the EPZ, the Toombs Central Elementary School, the Altamaha Elementary School, the AMIkids Baxley Wilderness Institute, and recreational visitors including boaters on the Altamaha River and hunters in the Bullard Creek Wildlife Management Area. The population for the Toombs Central School and Altamaha School was only considered for the weekday scenario. Hunting activities in the Bullard Creek Wildlife Management Area were considered at peak levels for the weekend scenario.

These evacuation times are mainly influenced by three factors: 1) the higher warning and diffusion times for hunters in the area; 2) moderate congestions on the roads and intersections at Baxley (e.g., intersection U.S. Hwy 1 and Parker Street); 3) larger evacuation population resulting in larger chance of having a few evacuees who need extensive long loading time.

## 6.3. ETE Results for Transit Dependent Permanent Residents

The ETEs for the transit dependent population are shown in Table 26. Note that the ETEs for the transit dependent population counts from the notification time of vehicles dispatched for this population group (assuming one hour earlier than the general public).

**Table 26: Transit Dependent Permanent Resident Evacuation Times**

| Transit Dependent Vehicle Category | ETE |
|---|---|
| Special Equipped Vehicle/Lift-Equipped Bus | 50 min |
| School Bus/Standard Van | 55 min |
| Ambulance | 50 min |

## 6.4. ETE Results for Special Facility and School Populations

The ETEs, average travel speed and travel time for special facility and school populations for evacuating full EPZ on weekday under normal weather condition are shown in Table 27. The bus queue occurs due to several buses loading students simultaneously. TCES is located near the northern boundary of the EPZ and it only takes an average of 6 minutes for the evacuees to travel 2 miles to the boundary. The BWI and AES evacuees take longer time to evacuate because they need to travel a longer distance to the EPZ boundary, and will encounter traffic congestion in Baxley.

**Table 27: Special Facility and School Evacuation Times**

| Facility Name | Outbound Travel Speed | Travel Time to EPZ Boundary | Bus Queue Length | ETE |
|---|---|---|---|---|
| AMIkids Baxley Wilderness Institute | 11 mph | 67 min | 0 ft. | 140 min |
| Altamaha Elementary School | 8 mph | 52 min | 400 ft. | 130 min |
| Toombs Central Elementary School | 21 mph | 6 min | 550 ft. | 60 min |

## 6.5. Example Model Output

Some example model outputs are presented as follows for the weekday, full EPZ, normal weather evacuation scenario. The total volumes and hourly percents at each exit road are listed in Table 28. Due to the high concentration of population located along U.S. Hwy 1

in Appling County, the highest evacuation exit traffic is observed at a segment of U.S. Hwy 1 crossing the southern EPZ boundary near Baxley. The network wide average travel time from the origins to the reception centers is 46 minutes. The total number of vehicles exiting the EPZ is 6,211 and is the a little more than total number of vehicles of residents, transient and special facility loaded into the network due to the additional vehicles for shadow evacuees. The mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ are plotted in Figure 16. The average speeds for the five designated evacuation routes are shown in Table 29.

**Table 28: Total Volumes and Hourly Percents at Exit Roads**

| Exit Road Name | Total Volume | Hour 1 Percent | Hour 2 Percent | Hour 3 Percent | Hour 4 Percent |
|---|---|---|---|---|---|
| Cr-185/Philadelphia Church Road | 1 | 100.0% | 0.0% | 0.0% | 0.0% |
| Cr-186 | 143 | 61.3% | 32.4% | 6.3% | 0.0% |
| Cedar Crossing-Vidalia Road | 793 | 58.3% | 34.4% | 7.3% | 0.0% |
| Cr-185/Hammond Powell Road | 171 | 58.6% | 34.6% | 6.8% | 0.0% |
| Martin Luther King Jr Avenue | 312 | 37.0% | 32.5% | 30.0% | 0.0% |
| Moody Altman Road | 202 | 75.2% | 19.7% | 5.1% | 0.0% |
| Johnson Corner Road | 460 | 62.3% | 31.6% | 6.4% | 0.0% |
| Altamaha Road | 225 | 60.6% | 32.0% | 6.9% | 0.0% |
| US 1 (Lyons) | 388 | 72.6% | 22.5% | 4.6% | 0.0% |
| US 1 (Baxley) | 2717 | 39.4% | 36.0% | 24.3% | 0.1% |
| Ten Mile Road | 201 | 74.4% | 16.0% | 12.2% | 0.0% |
| SR 178 | 168 | 58.8% | 32.1% | 7.6% | 0.0% |
| Cr-245/Bill Quarterman Road | 77 | 56.7% | 35.0% | 6.7% | 0.0% |
| Cr-301/Leon a Wildes Road | 118 | 64.1% | 30.4% | 6.5% | 0.0% |
| Ten Mile Road | 104 | 45.7% | 53.1% | 0.0% | 0.0% |
| Lamar Crosby Road | 130 | 69.3% | 24.8% | 5.0% | 0.0% |

**Table 29: Average Speed for Different Evacuation Routes**

| Evacuation Route | Average Speed (mph) |
|---|---|
| 1 | 45 |
| 2 | 43 |
| 3 | 41 |

| | |
|---|---|
| 4 | 34 |
| 5 | 44 |

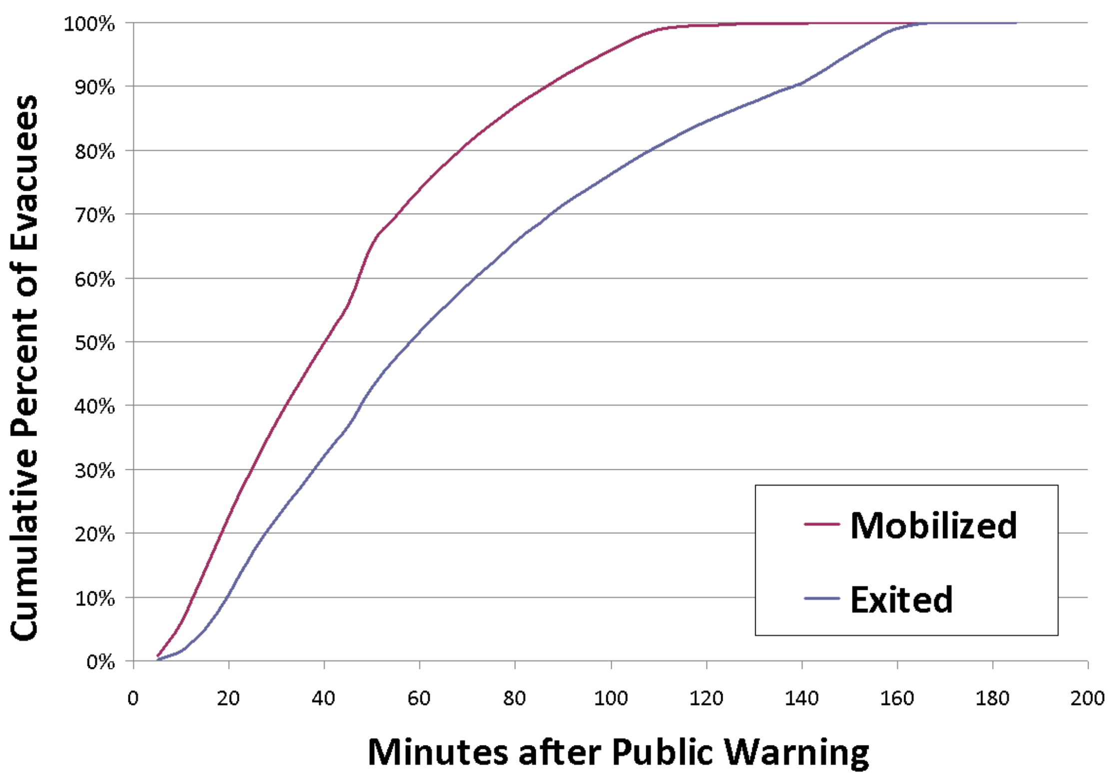


Figure 16: Mobilization and Evacuation Curve

# 7.0 SUPPLEMENTAL ANALYSIS

The analyses related to confirmation of evacuation and potential mitigating measures to effectively manage the traffic flow were performed and are provided in the following sections.

## 7.1. Confirmation of Evacuation

The confirmation of evacuation process determines if the evacuation has been completed. The time required for confirmation of evacuation is dependent upon the method employed. The most time-consuming method typically employed is to use ground vehicles. The time required involves the driving time for each route selected.

Informing people to leave some standard signs on their doors or windows, such as tying a white cloth to the front doorknob of the house or to the mailbox (as mentioned in the 2012 emergency information calendar), when they leave their houses would help the authorities in the confirmation of evacuation. Presence of TCPs and Access Control Points (ACPs) at strategic locations within the evacuation network could provide real-time feedback regarding the progress of the evacuation process. All evacuees are recommended to register in at the designated county reception centers as they arrive. This procedure helps the authorities to account for the population within the designated county. This can be accounted as one of the means of confirmation of evacuation, only under the assumption that all the evacuees would actually report to the reception centers and nowhere else. Telephoning people at their homes could also be considered as a possible means of ensuring completion of evacuation.

As noted in the county REPs[28], evacuation confirmation will be accomplished by the county Sheriff's Department and supporting law enforcement agency personnel that will traverse roadways throughout the affected area to ensure that the residential population has evacuated their homes. Personnel from the Georgia Department of Natural Resources Law Enforcement Section and the county EMAs will ensure that hunters and fishermen within the 10-mile EPZ are notified and evacuated from the waterways and recreational areas. Additional assistance is available from other State agencies as requested (i.e., Georgia Forestry Commission and Department of Transportation).

The actual time associated with the confirmation process would depend on both the number of personnel and the amount of equipment available. These resources may change significantly under various emergency conditions.

[28] State of Georgia REP Plan, Appling County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011
State of Georgia REP Plan, Jeff Davis County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Tattnall County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.
State of Georgia REP Plan, Toombs County Emergency Management Agency Radiological Plan for Nuclear Incidents/Accidednts involving Edwin I. Hatch Nuclear Power Plant. July 2011.

## 7.2. Evacuation Traffic Management Locations and Other Potential Mitigating Measures

In order to efficiently promote smooth movement of traffic flow during an evacuation, several TCPs have been identified by the plant and county emergency response planning personnel. The TCPs are listed in Table 30 and shown graphically in Figure 17. The responsibility of supervising traffic controls during an evacuation will be shared between the State and county emergency management and law enforcement agencies, as available. Each TCP will be manned and/or road blocks will be established to direct evacuees out of the EPZ and to deny access into the affected area. Also, route markers will be placed along the evacuation routes at critical intersections and road block locations to promote more efficient traffic flow out from the EPZ.

**Table 30: Traffic Control Points for the HNP EPZ**

| Location ID | Operation Control | Description |
|---|---|---|
| 1 | Appling County Sheriff | U.S. Hwy 1 at South end of Altamaha River Bridge |
| 2 | Appling County Sheriff | U.S. Hwy 1 at CR-3 (West River Road) |
| 3 | Appling County Sheriff | U.S. Hwy 1 at CR-538 (Altamaha School Road) |
| 4 | Appling County Sheriff | CR-591 (Ben Carter Road) at CR-538 (Lennox Road) |
| 5 | Appling County Sheriff | CR-537 (Ten Mile Road) at CR-538 (Lennox Road) |
| 6 | Appling County Sheriff | CR-537 (Ten Mile Road) at CR-339 (Oscar Tippins Road) |
| 7 | Appling County Sheriff | GA-144 at CR-537 (Ten Mile Road) |
| 8 | Appling County Sheriff | GA-15 at Elementary Complex |
| 9 | Appling County Sheriff | GA-15 at Appling County Comprehensive High School |
| 10 | Appling County Sheriff | U.S. Hwy 1 at GA-15 |
| 11 | Appling County Sheriff | U.S. Hwy 1 at U.S. HWY 341 |
| 12 | Appling County Sheriff | U.S. Hwy 1 at GA-144 |
| 13 | Appling County Sheriff | GA-144 at CR-537 (Ten Mile Road) |
| 14 | Appling County Sheriff | U.S. Hwy 1 at CR-1 (Nails Ferry Road) |
| 15 | Appling County Sheriff | CR-538 (Altamaha School Road) at CR-1 (Nails Ferry Road) |
| 16 | Appling County Sheriff | CR-1 (Nails Ferry Extension Road) at CR-3 (West River Road) |
| 17 | Appling County Sheriff | U.S. HWY 341 and GA-289/CR-576 (Graham-Zoar Road) |
| 18 | Jeff Davis County Sheriff | Intersection of County Roads 188, 189 and 190 |
| 19 | Jeff Davis County Sheriff | CR-187 at CR-185 (Graham Road) |
| 20 | Jeff Davis County Sheriff | CR-301 (Mt. Zion Road) at CR-185 (Graham Road) |
| 21 | Jeff Davis County Sheriff | CR-203 (Altamaha Road) at CR-185 (Graham Road) |
| 22 | Jeff Davis County Sheriff | CR-245 (Own Head Road) at CR-185 (Graham Road) |

| Location ID | Operation Control | Description |
|---|---|---|
| 23 | Jeff Davis County Sheriff | CR-185 (Graham Road) at CR-223 (Philadelphia Church) |
| 24 | Jeff Davis County Sheriff | U.S. HWY 341 at US-23 (Contos Boulevard) |
| 25 | Jeff Davis County Sheriff | U.S. HWY 341 at Gill Street |
| 26 | Jeff Davis County Sheriff | US-23 (Contos Boulevard) at Jefferson Street |
| 27 | Jeff Davis County Sheriff | Jefferson Street at Tallahassee Street |
| 28 | Jeff Davis County Sheriff | West Jefferson Street at Collins Street |
| 28 | Toombs County Sheriff | U.S. Hwy 1 at North end of Altamaha River Bridge |
| 29 | Toombs County Sheriff | U.S. Hwy 1 at GA-147 |
| 30 | Toombs County Sheriff | CR-336 (Old River Road) at CR-57 (Hitchcock Road) |
| 31 | Toombs County Sheriff | CR-336 (Old River Road) at Toombs/Montgomery County Line |
| 32 | Toombs County Sheriff | GA-56 at CR-65 (George Davis Road) |
| 33 | Toombs County Sheriff | GA-56 at CR-364 (Cedar Crossing-Alston Road) |
| 34 | Toombs County Sheriff | CR-78 (Cedar Crossing-Vidalia Road) at CR-364 (Cedar Crossing-Alston Road) |
| 35 | Toombs County Sheriff | CR-97 (South Thompson Road) at CR-78 (Cedar Crossing-Vidalia Road) |
| 36 | Toombs County Sheriff | U.S. Hwy 1 at GA-56 |
| 37 | Toombs County Sheriff | U.S. Hwy 1 at (Ten-Mile Boundary) (South of CR-103) |
| 38 | Toombs County Sheriff | U.S. Hwy 1 at GA-15 (South Thompson) |
| 39 | Toombs County Sheriff | U.S. Hwy 1 at CR-115 (Hardens Chapel Road) |
| 40 | Toombs County Sheriff | CR-115 (Hardens Chapel Road) at CR-337 (Lyons/Center Road) |
| 41 | Toombs County Sheriff | CR-337 (Lyons/Center Road) at Toombs County High School |
| 42 | Toombs County Sheriff | CR-337 (Lyons/Center Road) at Parker Avenue |
| 43 | Toombs County Sheriff | U.S. Hwy 1 at Parker Avenue |
| 44 | Toombs County Sheriff | U.S. Hwy 1 at GA-178 (in Lyons) |
| 45 | Toombs County Sheriff | GA-56 at CR-333 (Johnson Corner Road) |
| 46 | Toombs County Sheriff | GA-147 at CR-332 (Marvin Church Road) |
| 47 | Toombs County Sheriff | GA-178 at GA-147 |
| 48 | Tattnall County Sheriff | Hwy 147 & Elza District Road |
| 49 | Tattnall County Sheriff | Elza District Road & CR-188 (Old River Road) |
| 50 | Tattnall County Sheriff | CR-188 (Old River Road) & Hwy 178 |
| 51 | Tattnall County Sheriff | CR-192 (Cedar Haw Road) & Hwy 178 |
| 52 | Tattnall County Sheriff | CR-192 (Cedar Haw Road) CR-189 (Peach Tree Road) |
| 53 | Tattnall County Sheriff | Hwy 147 & Hwy 178 |

| Location ID | Operation Control | Description |
|---|---|---|
| 54 | Tattnall County Sheriff | Hwy 147 & Hwy 280 |
| 55 | Tattnall County Sheriff | GA Hwy 23 at County High School |

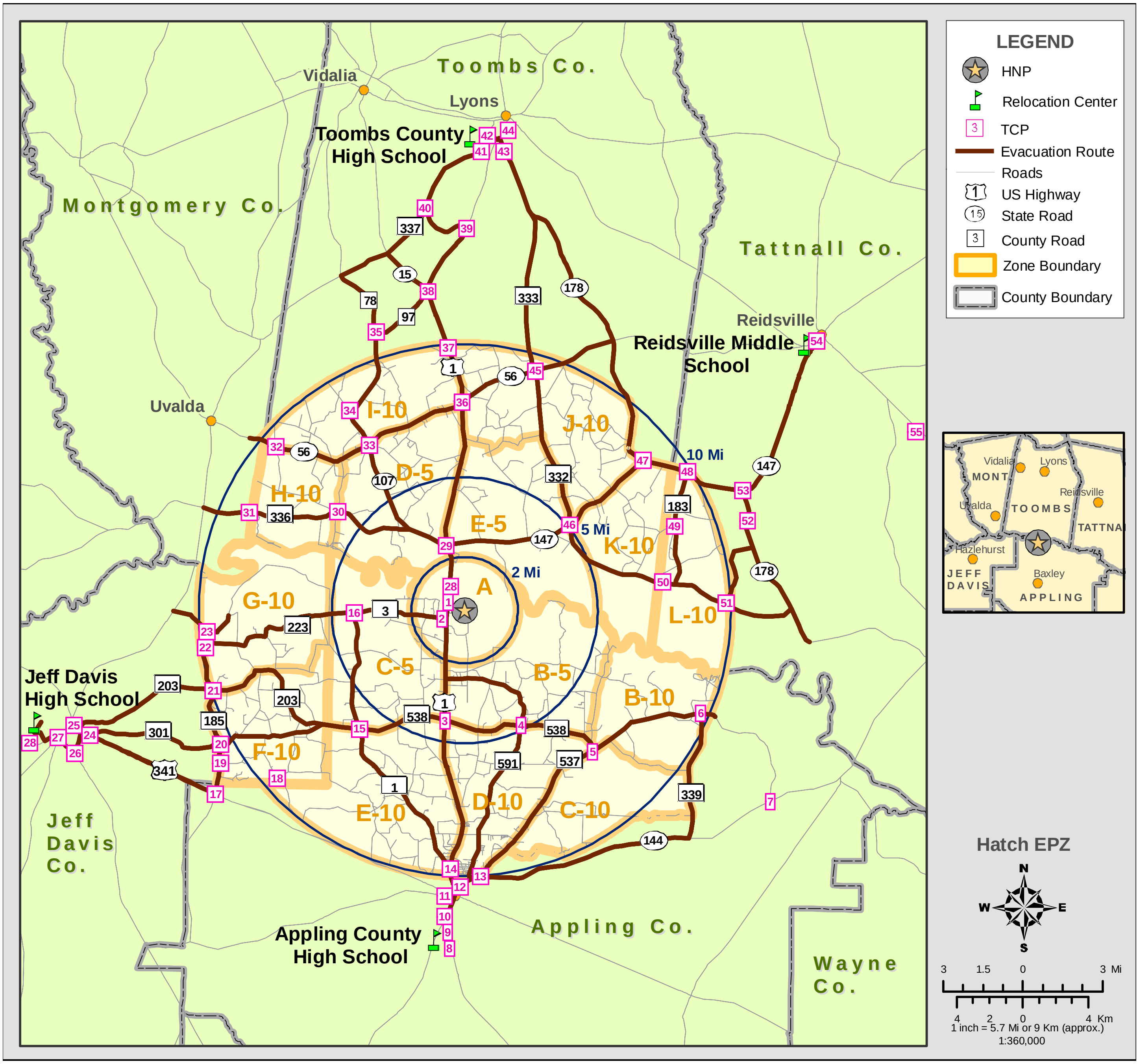


Figure 17: Traffic Control Points in and around HNP EPZ

# 8.0 SENSITIVITY STUDY ON POPULATION CHANGE

ETEs vary with factors such as population, roadway networks and vehicle occupancy rates. In response to new federal regulations, IEM conducted a population sensitivity analysis for HNP to address the uncertainty in population data by estimating the anticipated impact of a population change on ETEs. This sensitivity analysis will provide a basis for decisions on future ETE update thresholds.

IEM increased the residential population (for both EPZ and shadow evacuees) to determine the population value that will cause ETE values to increase by 25 percent or 30 minutes, whichever is less for the scenario with the longest ETE. This scenario is evacuating the entire EPZ during the weekday under adverse weather conditions. The base ETE for this scenario is 200 minutes, and hence the threshold for triggering an ETE update is 30 minutes increase in ETE. IEM found that an increase of 30 minutes occurs with a permanent resident population increase of 161% or 6,409 people within the EPZ (along with the increase of shadow evacuees with the same percentage).

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# 9.0 CONCLUSION AND RECOMMENDATIONS

The ETEs developed for 17 evacuation areas within the 10-mile HNP EPZ measured the time from the public notification to when the last evacuating vehicle exited the EPZ boundary.

The 100% ETEs for the evacuation areas ranged from 170 minutes to 215 minutes for the normal scenarios, and from 175 minutes to 235 minutes for those occurring in adverse weather. The 90% ETEs for the evacuation areas ranged from 95 minutes to 165 minutes for the normal scenarios, and from 100 minutes to 180 minutes for those occurring in adverse weather. Variations in ETEs between scenarios generally correlated to differences in the number of evacuating vehicles, the capacity of the evacuation routes, the roadway conditions, or the distance from the origin zones to the EPZ boundary. The weekend scenario produced the highest evacuation times due to the longer mobilization time for the higher number of recreational transients in the area (hunters and boaters) on the weekend.

The analysis shows that the capacity of the roadway network within the EPZ is adequate to accommodate the population for all scenarios. However, there are a few areas that could become congested during an evacuation. Several intersections where two heavily-traveled evacuation routes converge were identified from the models as possible congestion points. These potential traffic congestion points are listed in Table 31. The congestion points 2, 4, and 5 in the table are all outside of the EPZ, but the traffic congestion at these intersections might create a spillback toward and within the 10-mile EPZ. This spillback might put people at risk, so it is advised that these intersections are controlled in a way to facilitate a smoother evacuation to reception centers. Providing an efficient and effective flow of traffic through these intersections will ensure that the evacuees in route to reception centers are outside of the EPZ before encountering the potential congestion points.

**Table 31: Potential Congestion Points for the HNP EPZ**

| S. No. | Operation Control | Description |
|---|---|---|
| 1 | Appling County | U.S. Hwy 1 at County Road 1 |
| 2 | Appling County | U.S. Hwy 1 at Ga. Hwy 144 |
| 3 | Toombs County | U.S. Hwy 1 at Ga. Hwy 178 |
| 4 | Toombs County | U.S. Hwy 1 at Ga. Hwy 56 |
| 5 | Jeff Davis County | U.S. Hwy 341 at Altamaha Road |

In conclusion, based on the data gathered and the results of the evacuation study conducted, IEM believes that the existing evacuation strategy is functional for the year 2012 conditions, given the lack of severe congestion or very high ETEs.

## 9.1. Summary of Recommendations

The following recommendations will help emergency managers to improve the evacuation times from an event at HNP:

- ETEs can also be reduced by implementing additional measures that will shorten the elapsed time between the incident's occurrence and the time the public uses to take the required protective action—especially for the recreational area users, such as hunters and fishermen.
- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use TCPs to facilitate flow in populated areas where vehicles might otherwise have to slow due to congestion and traffic signals.
- Alter Evacuation Route 1, use SR-15 to get to CR-337 (Lyons-Center Road) instead of using CR-115 (Aimwell Road Ext). SR-15 is a straight wide road and has a major intersection with U.S. Hwy 1. CR-115 (Aimwell Road Ext) is paved but is a minor road and has a couple major curves.
- Developing comprehensive regional evacuation plans and/or working with local and state road/transportation departments to suggest improvements to the road infrastructure can contribute to a more successful evacuation.

# APPENDIX A: GEOGRAPHICAL BOUNDARIES OF EVACUATION ZONES

**Table 32: Geographical Boundaries of HNP EPZ Evacuation Zones**

| Evacuation Zones | Zone Boundaries | Landmark Descriptions |
|---|---|---|
| A | North – Altamaha River<br>South, East, and West – 2-mile boundary | HNP, Deen's Landing, Altamaha River Bridge Landing, Boy Scout Camp |
| B-5 | North – 2–mile boundary and Altamaha River<br>West – U.S. Hwy 1<br>South – Lennox Road<br>East – Davis Landing Road | Includes Davis Landing and Morris Landing, Moody Forest Natural Area |
| B-10 | North – Altamaha River<br>West – Davis Landing Road<br>South – Ten Mile Road and Fire Tower Road<br>East – Oscar Tippins Road and then 10-mile boundary | Includes Eason Bluff Landing |
| C-5 | North – Altamaha River and 2-mile boundary<br>West – Appling/Jeff Davis County Line<br>South – Altamaha School Road<br>East – U.S. Hwy 1 | Includes Altamaha Elementary School and the AMIkids Baxley Wilderness Institute |
| C-10 | North – Ten Mile Road and Fire Tower Road<br>West/Northwest – Ten Mile Road<br>South/Southeast – Manning Williams Road, then 10-mile boundary, and then to Old Field Cemetery Road<br>East – Oscar Tippins Road | Lookout Tower |
| D-5 | North – Georgia Hwy 56<br>West – Grays Landing Road and Hitchcock Road<br>South – Altamaha River<br>East – U.S. Hwy 1 | Includes Grays Landing, Cedar Crossing |
| D-10 | North – Altamaha School Road<br>West – U.S. Hwy 1<br>South – Georgia Power transmission line then the 10-mile boundary<br>East/Northeast – Ten Mile Road | Ten Mile Church |

| Evacuation Zones | Zone Boundaries | Landmark Descriptions |
|---|---|---|
| E-5 | North – C. V. Alexander Road and Roderick Clifton Road and Maxwell O'Neal Road and Knight Road<br>West – U.S. Hwy 1<br>South – 2-mile boundary and Altamaha River<br>East – David Bell Road, Providence Church/Old River Road, and 5-mile boundary | Marvin Church |
| E-10 | North – Altamaha School Road<br>West – Appling/Jeff Davis County line and Oil Well Road<br>South – Georgia Power transmission line<br>East – U.S. Hwy 1 | Sellers Cemetery, Midway Church |
| F-10 | North – Altamaha Road and Bullard Creek Road<br>West – Graham Road<br>South and East – Jeff Davis and Appling County Lines | |
| G-10 | North – Altamaha River<br>West – Graham Road and then 10-mile boundary<br>South – Altamaha Road and Bullard Creek Road<br>East – Jeff Davis and Appling County Lines | Includes Red Bluff and Town Bluff landings, Bullard Creek WMA, Philadelphia Church |
| H-10 | North – Georgia Hwy 56<br>West – Toombs/Montgomery County Line<br>South – Altamaha River<br>East – Grays Landing Road and Hitchcock Road | Includes Grays Landing and McNatt Falls Landing |
| I-10 | North – 10-mile boundary<br>West – Georgia Hwy 56 and Toombs/Montgomery County Line<br>South – Georgia Hwy 56<br>East – U.S. Hwy 1 | |
| J-10 | North – 10-mile boundary<br>West – U.S. Hwy 1 and David Bell Road<br>South – C. V. Alexander Road and Roderick Clifton Road and Maxwell O'Neal Road and Knight Road<br>East/Southeast – Georgia Hwy 178 and Georgia Hwy 147 | Includes Toombs Central School |
| K-10 | North – Georgia Hwy 147<br>Northwest – Georgia Hwy 147<br>West – 5-mile boundary and Providence Church/Old River Road<br>South – Altamaha River<br>East – Toombs/Tattnall County Line | |

| Evacuation Zones | Zone Boundaries | Landmark Descriptions |
|---|---|---|
| L-10 | North – Georgia Hwy 147<br>West – Tattnall/Toombs County Line<br>South – Altamaha River<br>East – 10 mile boundary | |

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# APPENDIX B: EVACUATION NETWORK LINKS (DETAILED INFORMATION)

The detailed map for the evacuation network with legible values for nodes and links are provided in Figure 18 through Figure 21. In addition, detailed information for each roadway link is listed in Table 34.

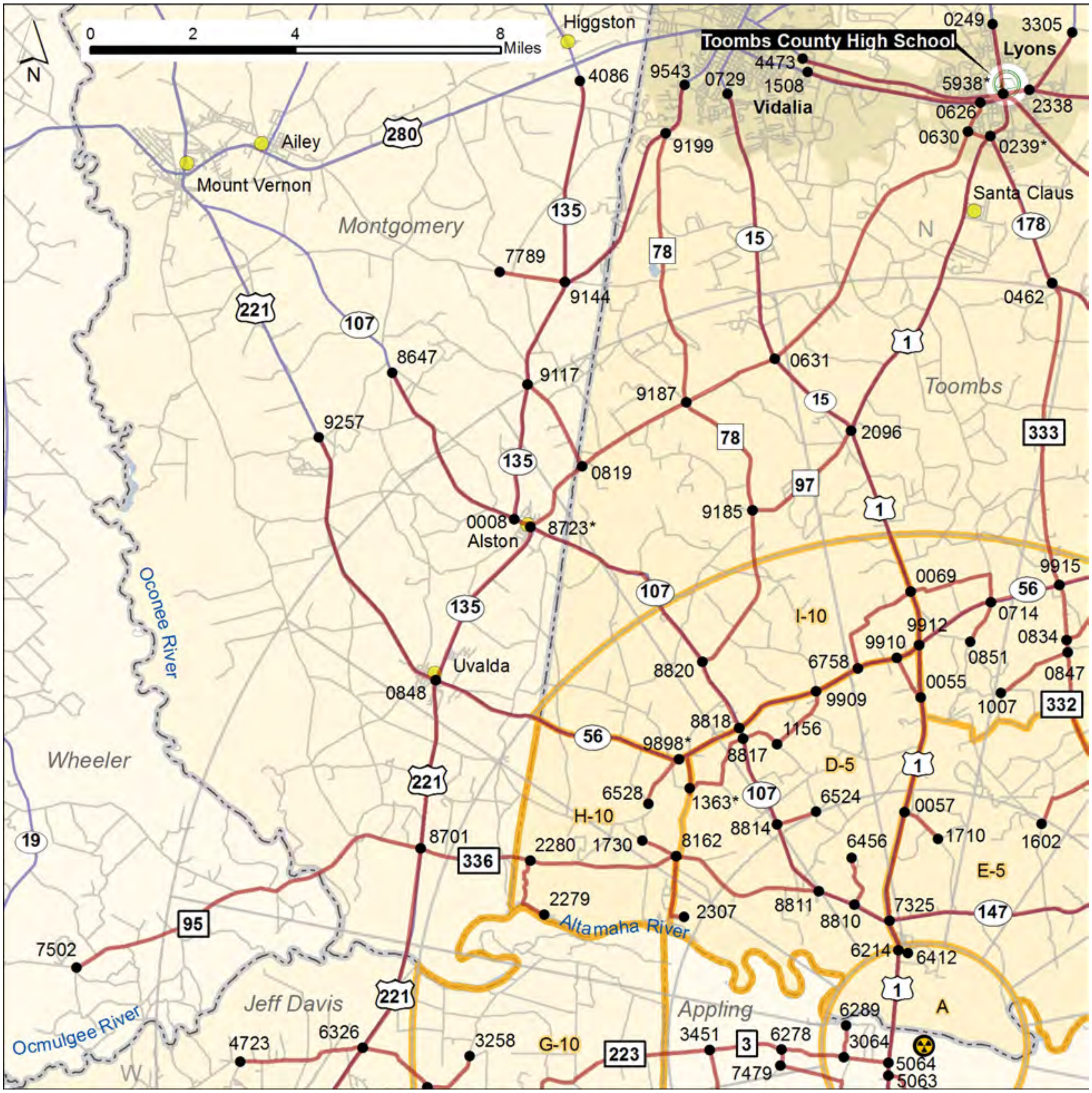


Figure 18: Detailed Roadway Nodes and Links – Northeast Quadrant

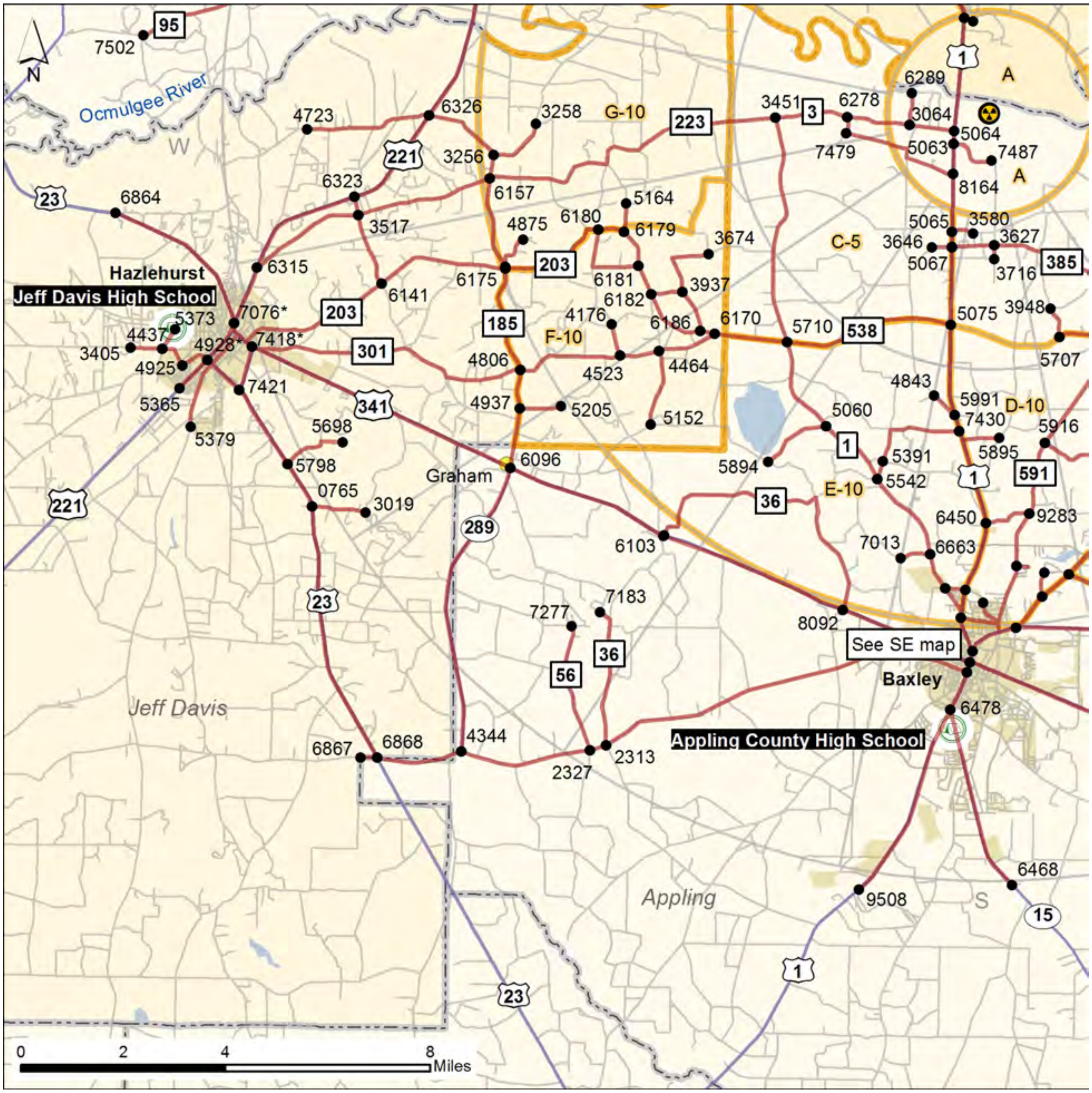


Figure 19: Detailed Roadway Nodes and Links – Southeast Quadrant

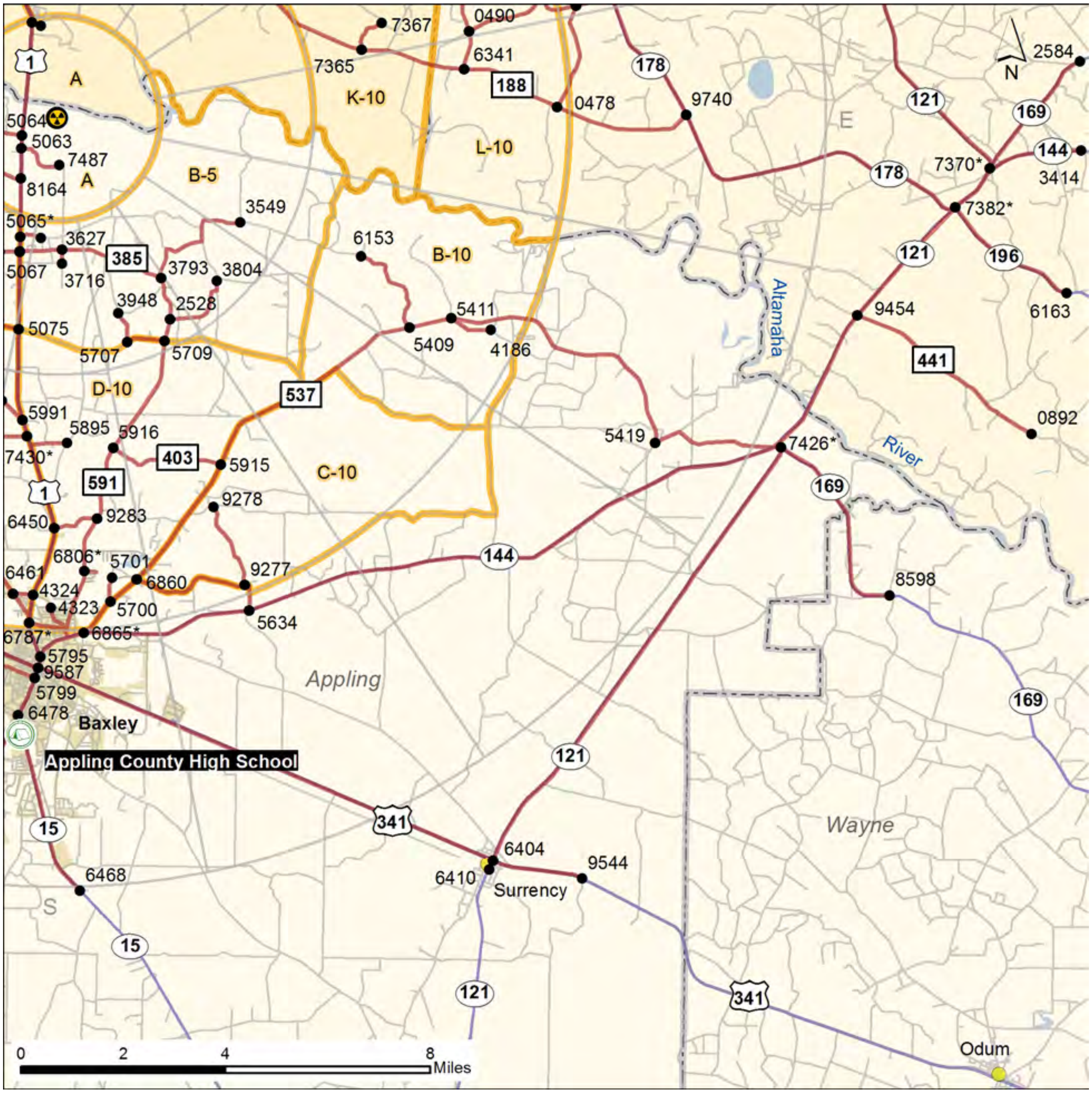


Figure 20: Detailed Roadway Nodes and Links – Southwest Quadrant

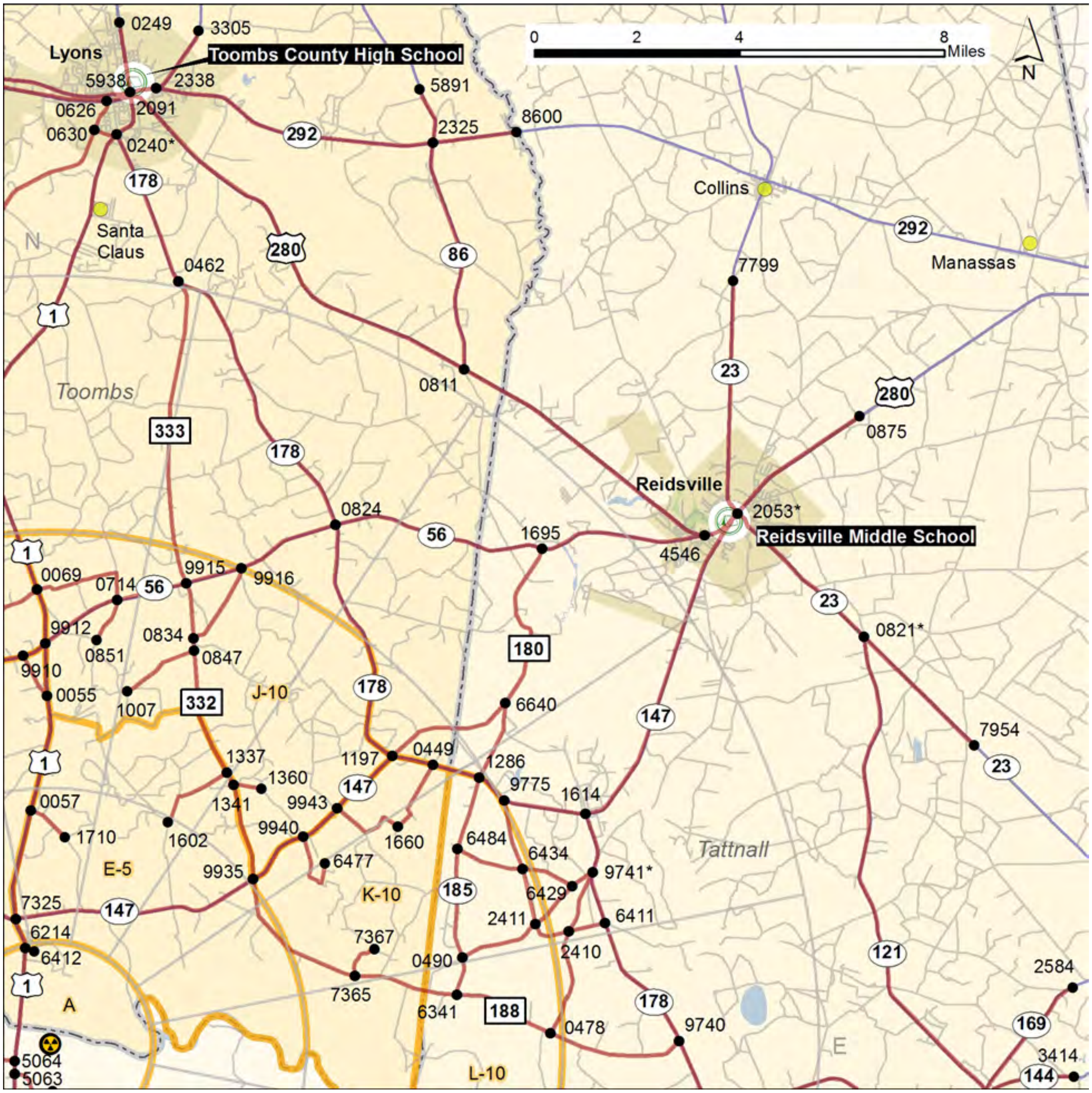


Figure 21: Detailed Roadway Nodes and Links – Northwest Quadrant

**Table 33: Glossary of Attributes for Roadway Characteristics**

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

**Table 34: Roadway Network Characteristics**

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0055 | 0057 | 2.293 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 2 | 0057 | 1710 | 0.855 | 10 | 1 | Unpaved Road | 800 | 35 |
| 3 | 0069 | 0714 | 2.145 | 10 | 1 | Unpaved Road | 800 | 35 |
| 4 | 0069 | 2096 | 3.353 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 5 | 0069 | 6758 | 2.244 | 10 | 1 | Unpaved Road | 800 | 35 |
| 6 | 0081 | 0082 | 0.037 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 7 | 0239 | 0240 | 0.075 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 8 | 0239 | 0630 | 0.408 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 9 | 0239 | 2096 | 6.416 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 10 | 0240 | 0462 | 3.126 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 11 | 0449 | 1197 | 0.810 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 12 | 0449 | 1286 | 0.942 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 13 | 0449 | 1660 | 1.474 | 10 | 1 | Unpaved Road | 800 | 35 |
| 14 | 0626 | 0630 | 0.639 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 15 | 0626 | 1508 | 3.429 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 16 | 0630 | 0631 | 6.103 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 17 | 0631 | 0729 | 5.323 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 18 | 0631 | 2096 | 2.068 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 19 | 0714 | 0851 | 0.903 | 10 | 1 | Unpaved Road | 800 | 35 |
| 20 | 0811 | 2091 | 8.759 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 21 | 0811 | 2325 | 4.581 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 22 | 0811 | 4546 | 5.735 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 23 | 0819 | 8724 | 1.630 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 24 | 0819 | 9117 | 1.948 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 25 | 0819 | 9187 | 2.398 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 26 | 0821 | 0081 | 0.055 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 27 | 0821 | 0082 | 0.040 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 28 | 0824 | 0462 | 5.887 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 29 | 0824 | 1197 | 4.988 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 30 | 0824 | 1695 | 4.188 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 31 | 0824 | 9916 | 2.052 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 32 | 0834 | 0847 | 0.235 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 33 | 0847 | 1007 | 1.559 | 10 | 1 | Unpaved Road | 800 | 35 |
| 34 | 0847 | 1337 | 2.522 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 35 | 0848 | 8701 | 3.328 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 36 | 0848 | 8723 | 3.607 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 37 | 0848 | 9257 | 5.604 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 38 | 0848 | 9898 | 5.069 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 39 | 1197 | 6640 | 2.587 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 40 | 1286 | 6484 | 1.461 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 41 | 1286 | 6640 | 1.581 | 10 | 1 | Unpaved Road | 800 | 35 |
| 42 | 1286 | 9775 | 0.668 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 43 | 1337 | 1341 | 0.277 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 44 | 1337 | 1602 | 1.625 | 10 | 1 | Unpaved Road | 800 | 35 |
| 45 | 1341 | 1360 | 0.552 | 10 | 1 | Unpaved Road | 800 | 35 |
| 46 | 1614 | 8761 | 6.623 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 47 | 1614 | 9741 | 1.196 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 48 | 1614 | 9775 | 1.612 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 49 | 1695 | 4546 | 3.279 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 50 | 1695 | 6640 | 3.427 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 51 | 2053 | 0821 | 3.467 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 52 | 2053 | 0875 | 3.285 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 53 | 2053 | 7799 | 4.677 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 54 | 2053 | 8761 | 0.151 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 55 | 2091 | 0240 | 0.912 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 56 | 2091 | 0626 | 0.474 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 57 | 2091 | 5938 | 0.093 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 58 | 2279 | 2280 | 1.466 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 59 | 2313 | 2327 | 0.327 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 60 | 2313 | 7183 | 2.746 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 61 | 2325 | 2338 | 5.700 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 62 | 2325 | 5891 | 1.412 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 63 | 2325 | 8600 | 1.697 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 64 | 2327 | 7277 | 2.577 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 65 | 2338 | 3305 | 1.527 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 66 | 2410 | 0478 | 2.151 | 10 | 1 | Unpaved Road | 800 | 35 |
| 67 | 2410 | 2411 | 0.791 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 68 | 2410 | 6411 | 0.718 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 69 | 2410 | 6769 | 1.249 | 10 | 1 | Unpaved Road | 800 | 35 |
| 70 | 2411 | 0490 | 1.619 | 10 | 1 | Unpaved Road | 800 | 35 |
| 71 | 2411 | 6429 | 1.041 | 10 | 1 | Unpaved Road | 800 | 35 |
| 72 | 2411 | 6434 | 1.115 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 73 | 3019 | 0765 | 1.057 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 74 | 3064 | 6278 | 1.235 | 12 | 1 | Unpaved Road | 800 | 40 |
| 75 | 3064 | 6289 | 0.634 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 76 | 3256 | 3258 | 1.164 | 10 | 1 | Unpaved Road | 800 | 35 |
| 77 | 3256 | 6157 | 0.459 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 78 | 3451 | 6157 | 6.232 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 79 | 3451 | 6278 | 1.437 | 12 | 1 | Unpaved Road | 800 | 40 |
| 80 | 3517 | 6157 | 2.693 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 81 | 3549 | 3793 | 2.483 | 10 | 1 | Unpaved Road | 800 | 35 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 82 | 3627 | 3645 | 0.826 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 83 | 3627 | 3716 | 0.272 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 84 | 3627 | 3793 | 2.053 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 85 | 3674 | 3937 | 1.444 | 10 | 1 | Unpaved Road | 800 | 35 |
| 86 | 3793 | 2528 | 0.857 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 87 | 3804 | 2528 | 1.459 | 10 | 1 | Unpaved Road | 800 | 35 |
| 88 | 4176 | 4523 | 0.636 | 10 | 1 | Unpaved Road | 800 | 35 |
| 89 | 4324 | 4328 | 0.463 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 90 | 4324 | 6450 | 1.390 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 91 | 4324 | 6461 | 0.391 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 92 | 4328 | 6461 | 0.586 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 93 | 4344 | 2327 | 2.597 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 94 | 4344 | 6096 | 5.950 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 95 | 4344 | 6868 | 1.700 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 96 | 4437 | 3405 | 0.621 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 97 | 4437 | 5373 | 0.461 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 98 | 4464 | 4523 | 0.781 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 99 | 4464 | 5152 | 1.506 | 12 | 1 | Unpaved Road | 800 | 40 |
| 100 | 4523 | 4806 | 2.090 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 101 | 4806 | 4937 | 0.766 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 102 | 4806 | 6240 | 5.387 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 103 | 4843 | 5991 | 0.559 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 104 | 4875 | 4893 | 0.750 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 105 | 4925 | 4437 | 0.583 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 106 | 4925 | 4928 | 0.580 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 107 | 4928 | 5365 | 0.781 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 108 | 4928 | 5392 | 0.121 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 109 | 4928 | 7076 | 0.897 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 110 | 4937 | 5205 | 0.813 | 10 | 1 | Unpaved Road | 800 | 35 |
| 111 | 5060 | 5542 | 1.477 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 112 | 5060 | 5894 | 1.419 | 10 | 1 | Unpaved Road | 800 | 35 |
| 113 | 5063 | 5064 | 0.252 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 114 | 5063 | 7487 | 0.963 | 12 | 1 | Single-Lane Road | 1455 | 45 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 115 | 5064 | 3064 | 0.878 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 116 | 5064 | 6214 | 2.222 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 117 | 5065 | 3580 | 0.436 | 10 | 1 | Unpaved Road | 800 | 35 |
| 118 | 5065 | 3645 | 0.286 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 119 | 5067 | 3645 | 0.010 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 120 | 5067 | 3646 | 0.394 | 12 | 1 | Unpaved Road | 800 | 45 |
| 121 | 5067 | 5075 | 1.519 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 122 | 5075 | 5710 | 4.846 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 123 | 5075 | 5991 | 1.789 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 124 | 5379 | 5392 | 1.332 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 125 | 5391 | 5542 | 0.363 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 126 | 5392 | 7075 | 0.777 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 127 | 5409 | 5411 | 0.829 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 128 | 5409 | 5915 | 4.742 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 129 | 5409 | 6153 | 2.051 | 10 | 1 | Unpaved Road | 800 | 35 |
| 130 | 5411 | 4186 | 0.865 | 10 | 1 | Unpaved Road | 800 | 35 |
| 131 | 5411 | 5419 | 5.496 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 132 | 5419 | 5429 | 2.463 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 133 | 5429 | 5634 | 10.949 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 134 | 5542 | 6663 | 1.874 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 135 | 5634 | 9277 | 0.592 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 136 | 5700 | 5701 | 0.492 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 137 | 5707 | 3948 | 0.628 | 10 | 1 | Unpaved Road | 800 | 35 |
| 138 | 5707 | 5709 | 0.760 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 139 | 5709 | 2528 | 0.438 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 140 | 5709 | 5916 | 2.390 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 141 | 5710 | 3451 | 6.087 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 142 | 5710 | 5060 | 3.100 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 143 | 5795 | 6787 | 0.704 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 144 | 5795 | 6866 | 0.674 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 145 | 5798 | 0765 | 0.969 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 146 | 5798 | 5698 | 1.285 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 147 | 5799 | 2313 | 7.481 | 12 | 1 | Single-Lane Road | 1455 | 45 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 148 | 5799 | 6478 | 0.804 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 149 | 5915 | 5916 | 2.246 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 150 | 5916 | 9283 | 1.450 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 151 | 5938 | 0249 | 1.489 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 152 | 5938 | 2338 | 0.513 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 153 | 5938 | 4473 | 4.041 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 154 | 6033 | 6141 | 3.026 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 155 | 6033 | 7075 | 0.241 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 156 | 6096 | 4937 | 1.180 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 157 | 6096 | 6103 | 3.296 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 158 | 6096 | 6240 | 5.431 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 159 | 6103 | 7984 | 0.014 | 12 | 2 | Multi-Lane Hwy | 4400 | 60 |
| 160 | 6103 | 8092 | 3.795 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 161 | 6141 | 3517 | 1.442 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 162 | 6141 | 6175 | 2.616 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 163 | 6157 | 4893 | 1.840 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 164 | 6170 | 4464 | 1.177 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 165 | 6170 | 5710 | 1.422 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 166 | 6170 | 6186 | 0.290 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 167 | 6175 | 4806 | 2.130 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 168 | 6175 | 4893 | 0.027 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 169 | 6175 | 6180 | 2.141 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 170 | 6179 | 5164 | 0.562 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 171 | 6179 | 6180 | 0.519 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 172 | 6179 | 6181 | 0.775 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 173 | 6180 | 6181 | 1.653 | 10 | 1 | Unpaved Road | 800 | 35 |
| 174 | 6181 | 6182 | 0.605 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 175 | 6182 | 3937 | 0.649 | 10 | 1 | Unpaved Road | 800 | 35 |
| 176 | 6182 | 6186 | 1.349 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 177 | 6186 | 3937 | 0.859 | 10 | 1 | Unpaved Road | 800 | 35 |
| 178 | 6278 | 7479 | 0.321 | 10 | 1 | Unpaved Road | 800 | 35 |
| 179 | 6315 | 3517 | 2.316 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 180 | 6315 | 6323 | 2.517 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 181 | 6315 | 7076 | 1.187 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 182 | 6323 | 3517 | 0.359 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 183 | 6323 | 6326 | 2.223 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 184 | 6326 | 3256 | 1.558 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 185 | 6326 | 4723 | 2.470 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 186 | 6326 | 8701 | 4.138 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 187 | 6341 | 0478 | 2.016 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 188 | 6341 | 0490 | 0.762 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 189 | 6341 | 7365 | 2.050 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 190 | 6404 | 6410 | 0.196 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 191 | 6404 | 9544 | 1.797 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 192 | 6411 | 9740 | 2.791 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 193 | 6411 | 9741 | 1.036 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 194 | 6412 | 6214 | 0.188 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 195 | 6429 | 6434 | 1.046 | 10 | 1 | Unpaved Road | 800 | 35 |
| 196 | 6429 | 6769 | 0.451 | 10 | 1 | Unpaved Road | 800 | 35 |
| 197 | 6434 | 6484 | 1.354 | 10 | 1 | Unpaved Road | 800 | 35 |
| 198 | 6434 | 9775 | 1.406 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 199 | 6450 | 9283 | 0.924 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 200 | 6468 | 6478 | 3.708 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 201 | 6478 | 9508 | 4.001 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 202 | 6484 | 0490 | 2.162 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 203 | 6663 | 6461 | 0.743 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 204 | 6663 | 7013 | 0.602 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 205 | 6787 | 4328 | 0.088 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 206 | 6787 | 7254 | 0.721 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 207 | 6799 | 6806 | 0.253 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 208 | 6806 | 7252 | 1.194 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 209 | 6806 | 9283 | 1.097 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 210 | 6860 | 5700 | 0.676 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 211 | 6860 | 5915 | 2.793 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 212 | 6860 | 9277 | 2.336 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 213 | 6864 | 7076 | 3.356 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 214 | 6865 | 5634 | 3.314 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 215 | 6865 | 5700 | 0.805 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 216 | 6865 | 6866 | 0.338 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 217 | 6866 | 7252 | 0.175 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 218 | 6867 | 6868 | 0.321 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 219 | 6868 | 0765 | 5.195 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 220 | 7075 | 7076 | 0.230 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 221 | 7252 | 7254 | 0.008 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 222 | 7254 | 4323 | 0.527 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 223 | 7325 | 0057 | 2.168 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 224 | 7325 | 6214 | 0.614 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 225 | 7325 | 8810 | 0.759 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 226 | 7325 | 9935 | 4.839 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 227 | 7365 | 7367 | 0.769 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 228 | 7369 | 3414 | 2.128 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 229 | 7369 | 7383 | 0.891 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 230 | 7370 | 0081 | 9.908 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 231 | 7370 | 2584 | 3.051 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 232 | 7370 | 7369 | 0.149 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 233 | 7382 | 7383 | 0.081 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 234 | 7382 | 9454 | 2.772 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 235 | 7382 | 9740 | 6.376 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 236 | 7383 | 6163 | 3.017 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 237 | 7418 | 6033 | 0.151 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 238 | 7418 | 6240 | 0.137 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 239 | 7418 | 7421 | 0.887 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 240 | 7421 | 5392 | 0.735 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 241 | 7421 | 5798 | 1.744 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 242 | 7424 | 5429 | 0.200 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 243 | 7424 | 7426 | 0.127 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 244 | 7424 | 9454 | 2.898 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 245 | 7426 | 5429 | 0.149 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 246 | 7426 | 6404 | 9.899 | 12 | 1 | Single-Lane Road | 1455 | 45 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 247 | 7426 | 8598 | 4.081 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 248 | 7429 | 5895 | 0.727 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 249 | 7429 | 6450 | 1.688 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 250 | 7429 | 7430 | 0.183 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 251 | 7430 | 5391 | 2.004 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 252 | 7430 | 5991 | 0.330 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 253 | 7502 | 8701 | 7.504 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 254 | 7954 | 0082 | 2.981 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 255 | 7984 | 8092 | 6.084 | 11 | 1 | Unpaved Road | 800 | 40 |
| 256 | 8162 | 1730 | 0.736 | 10 | 1 | Unpaved Road | 800 | 35 |
| 257 | 8162 | 2280 | 2.918 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 258 | 8162 | 2307 | 1.451 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 259 | 8162 | 8811 | 3.104 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 260 | 8164 | 5063 | 0.591 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 261 | 8164 | 5065 | 1.143 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 262 | 8164 | 7479 | 2.404 | 12 | 1 | Unpaved Road | 800 | 40 |
| 263 | 8647 | 0008 | 3.950 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 264 | 8701 | 2280 | 2.181 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 265 | 8723 | 8724 | 0.062 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 266 | 8724 | 0008 | 0.337 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 267 | 8761 | 4546 | 0.644 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 268 | 8810 | 6456 | 1.038 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 269 | 8810 | 8811 | 0.749 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 270 | 8811 | 8814 | 1.583 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 271 | 8814 | 6524 | 0.802 | 10 | 1 | Unpaved Road | 800 | 35 |
| 272 | 8814 | 8817 | 1.825 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 273 | 8817 | 1156 | 0.773 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 274 | 8817 | 1363 | 1.805 | 10 | 1 | Unpaved Road | 800 | 35 |
| 275 | 8817 | 8818 | 0.222 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 276 | 8818 | 8820 | 1.505 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 277 | 8818 | 9899 | 1.164 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 278 | 8818 | 9909 | 1.719 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 279 | 8820 | 8723 | 4.487 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 280 | 8820 | 9185 | 3.407 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 281 | 9117 | 0008 | 2.692 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 282 | 9117 | 9144 | 2.194 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 283 | 9144 | 4086 | 4.280 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 284 | 9144 | 7789 | 1.287 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 285 | 9185 | 2096 | 2.607 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 286 | 9185 | 9187 | 2.716 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 287 | 9187 | 0631 | 1.928 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 288 | 9187 | 9199 | 5.419 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 289 | 9199 | 9144 | 3.722 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 290 | 9199 | 9543 | 1.092 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 291 | 9277 | 9278 | 1.729 | 10 | 1 | Unpaved Road | 800 | 35 |
| 292 | 9454 | 0892 | 6.449 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 293 | 9587 | 5795 | 0.224 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 294 | 9587 | 5799 | 0.208 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 295 | 9587 | 6404 | 9.638 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 296 | 9587 | 8092 | 2.690 | 12 | 2 | Multi-Lane Hwy | 4400 | 65 |
| 297 | 9740 | 0478 | 2.703 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 298 | 9741 | 6769 | 0.028 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 299 | 9898 | 6528 | 1.102 | 10 | 1 | Unpaved Road | 800 | 35 |
| 300 | 9898 | 9899 | 0.168 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 301 | 9899 | 1343 | 0.650 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 302 | 9909 | 1156 | 1.369 | 10 | 1 | Unpaved Road | 800 | 35 |
| 303 | 9909 | 6758 | 0.927 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 304 | 9910 | 0055 | 0.917 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 305 | 9910 | 6758 | 0.801 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 306 | 9910 | 9912 | 0.502 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 307 | 9912 | 0055 | 1.022 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 308 | 9912 | 0069 | 1.078 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 309 | 9912 | 0714 | 1.659 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 310 | 9915 | 0462 | 6.026 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 311 | 9915 | 0714 | 1.383 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 312 | 9915 | 0834 | 1.098 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length (mi) | Lane Width (ft) | Number of Lanes | Roadway Type | Saturation Flow Rate (pcph) | FFS (mph) |
|---|---|---|---|---|---|---|---|---|
| 313 | 9915 | 9916 | 1.120 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 314 | 9916 | 0834 | 1.731 | 10 | 1 | Unpaved Road | 800 | 35 |
| 315 | 9935 | 1341 | 1.898 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 316 | 9935 | 7365 | 3.005 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 317 | 9935 | 9940 | 1.344 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 318 | 9940 | 6477 | 1.480 | 10 | 1 | Single-Lane Road | 1292 | 35 |
| 319 | 9940 | 9943 | 0.879 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 320 | 9943 | 1197 | 1.488 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 321 | 9943 | 1660 | 1.565 | 12 | 1 | Single-Lane Road | 1455 | 45 |

# APPENDIX C: TELEPHONE SURVEY

## Introduction

The development of evacuation time estimates (ETE) for the area surrounding the HNP requires the identification of travel patterns, available vehicles, and household size of the people who live or work in the area. Specific data is needed in developing ETEs in order to effectively quantify mobilization time and vehicle usage for residents responding to an evacuation advisory. A telephone survey was conducted to interview a sample of residents who live within the 10-mile EPZ of the proposed nuclear power plant site to acquire information required for the ETE study.

IEM secured the services of Survey Technology & Research Center (STR) in Allentown, Pennsylvania to conduct the telephone survey and provide data to IEM for analysis.

## Survey Instrument and Sampling Plan

A survey instrument/questionnaire was developed by IEM, and was reviewed and approved by Southern Nuclear project personnel. The approved survey questionnaire was used to interview a sample of residents who live or work within 10 miles of the site to acquire information required for the ETE study. To achieve a representative sample of households living in the EPZ, respondents were randomly selected to participate in the survey. STR fielded the telephone survey and provided data to IEM for analysis. Calls were conducted in the early evening hours from Wednesday, June 6, 2012 to Monday, June 11, 2012. Only residents 18 years of age and older were allowed to participate in the survey. Telephone calls were made during weekday evenings and on weekends in an attempt to reach households with both workers and non-workers. To ensure the highest quality of work was performed, a quality assurance plan was implemented in this survey process that included call-taker training, telephone monitoring by IEM, and extensive data quality control checks.

The sampling frame consisted of a list of households within the study area. The survey required over 550 completed surveys in order to achieve the desired margin of error of 4 percentage points or less. However, there were not enough telephone listings available in the databases used by STR to attain this sample size. Several efforts were made to get a more comprehensive listing. With the available telephone numbers, the survey effort produced a total of 225 completed surveys, resulting in a margin of error of 6.5% with 95% confidence level.

## Survey Results

1. How many people live in your home?

**Table 35: Household Size**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 18% |
| 2 | 44% |
| 3 | 21% |
| 4 | 12% |
| 5 or more | 5% |

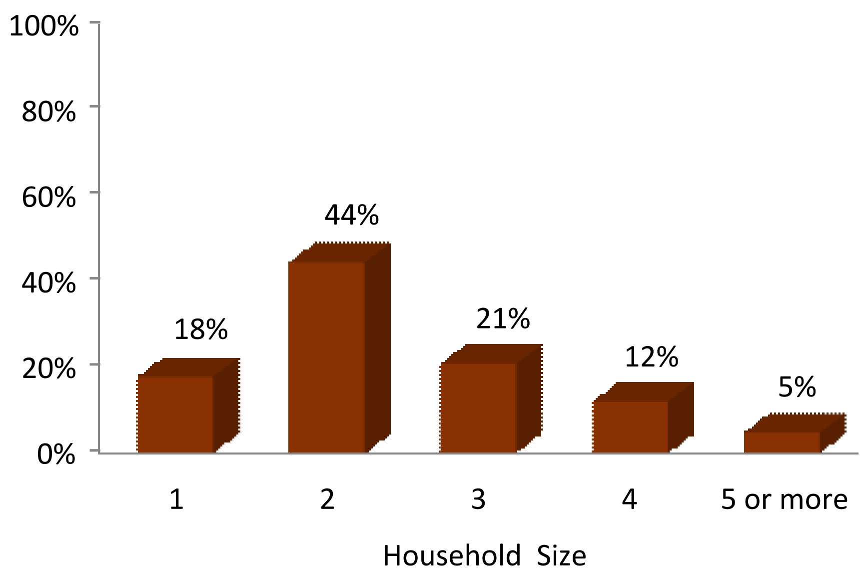


**Figure 22: Household Size**

2. If instructed to evacuate, how many cars would your family use to evacuate…
   a. During the day?

**Table 36: Percentage of Cars Used to Evacuate During the Day**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 63% |
| 2 | 28% |
| 3 or more | 7% |
| None | 1% |

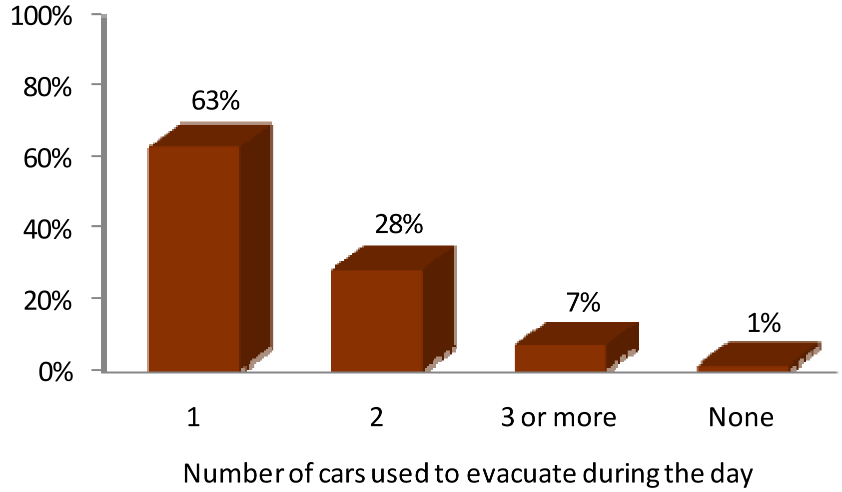


**Figure 23: Number of cars used to evacuate during the day**

b. At night?

**Table 37: Percentage of Cars Used to Evacuate at Night**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 69% |
| 2 | 25% |
| 3 or more | 5% |
| None | 1% |

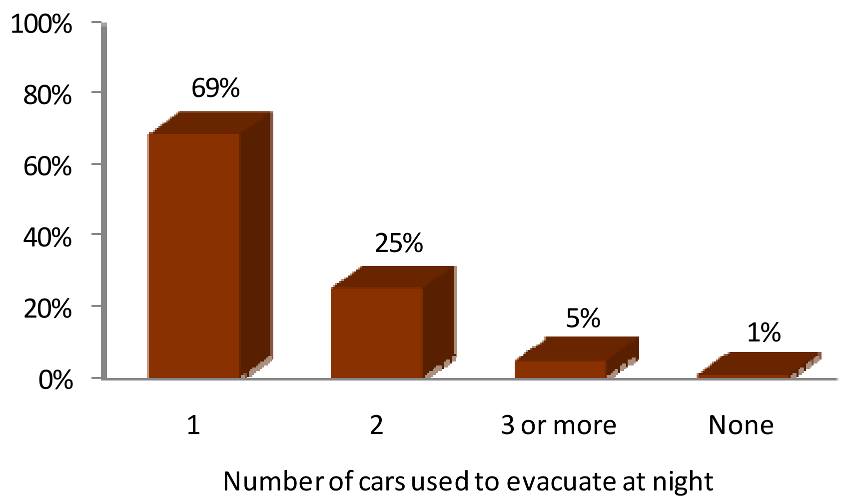


**Figure 24: Number of cars used to evacuate at night**

c. On most weekends?

**Table 38: Percentage of Cars Used to Evacuate on Weekends**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 65% |
| 2 | 29% |
| 3 or more | 6% |
| None | 0% |

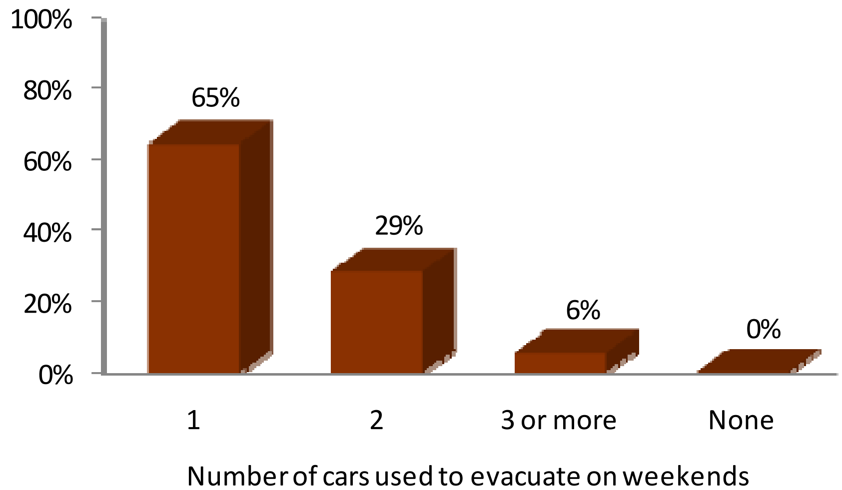


**Figure 25: Number of cars used to evacuate on weekends**

3. Does anyone in your family rely on public transportation in the event of an evacuation?

**Table 39: Percentage who rely on public transportation to evacuate**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 2% |
| 2 | <1% |
| 3 | 0% |
| 4 | 0% |
| 5 or more | <1% |
| None | 97% |

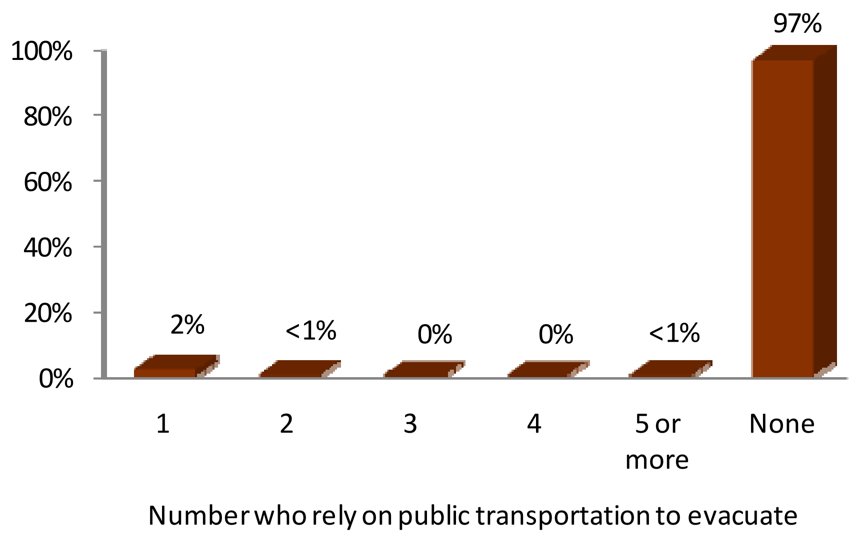


**Figure 26: Number who rely on public transportation to evacuate**

4. How many people in your family commute to a job, or to college, at least 4 times a week?

**Table 40: Percentage of Respondents who indicated there are commuters in the family**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 24% |
| 2 | 18% |
| 3 | 8% |
| 4 | 1% |
| 5 or more | 1% |
| None | 48% |

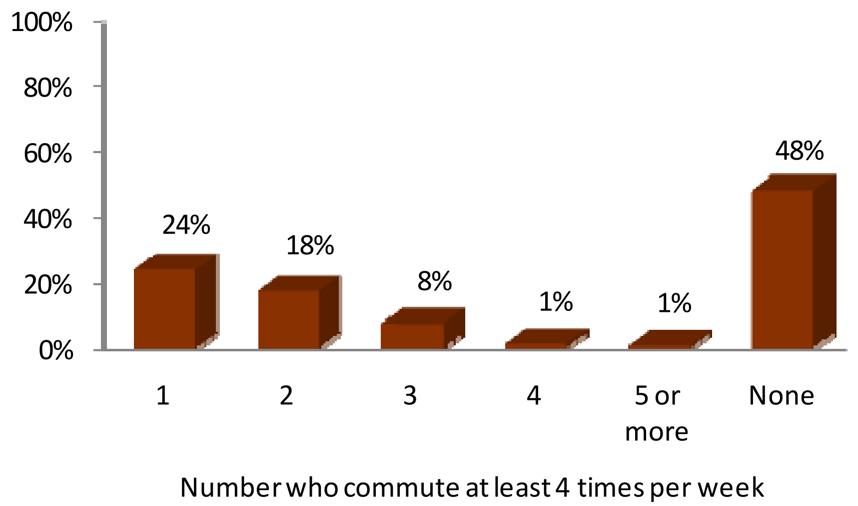


**Figure 27: Number who commutes at least 4 times per week**

5. How long would it take each family member who works to return home, including the preparation time to leave work and the travel time back home?

**Table 41: Time to Return Home from Work**

| Response | Percentage of Commuters (n=116) |
|---|---|
| 1-5 minutes | 5% |
| 6-10 minutes | 9% |
| 11-15 minutes | 10% |
| More than 15 minutes | 75% |

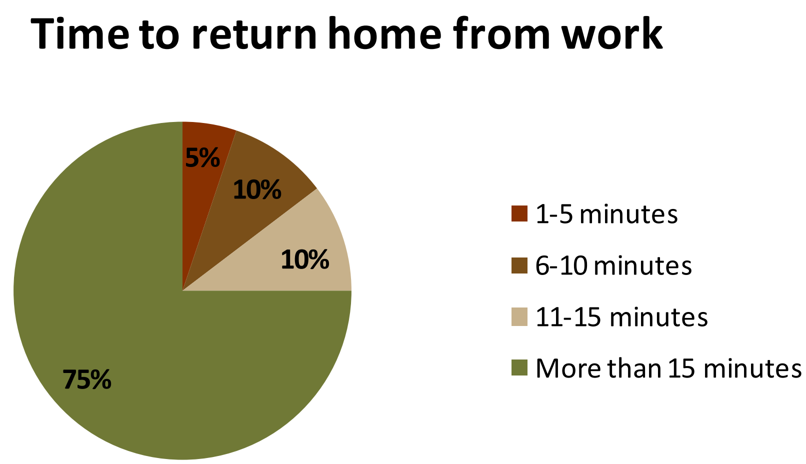


**Figure 28: Time to return home from work**

6. Would the people at home evacuate on their own, or wait for family members to come home before evacuating?

**Table 42: Percentage who would Evacuate or Wait**

| Response | Percentage of Respondents (n=225) |
|---|---|
| Evacuate on own | 68% |
| Await the return of family members | 32% |

7. If you had to evacuate, how long would it take for the family to pack clothing, secure the house, load the car, and complete preparations…
   a. During the day?

**Table 43: Time to Complete Evacuation Preparations during the Day**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1-5 minutes | 7% |
| 6-10 minutes | 11% |
| 11-15 minutes | 8% |
| More than 15 minutes | 74% |

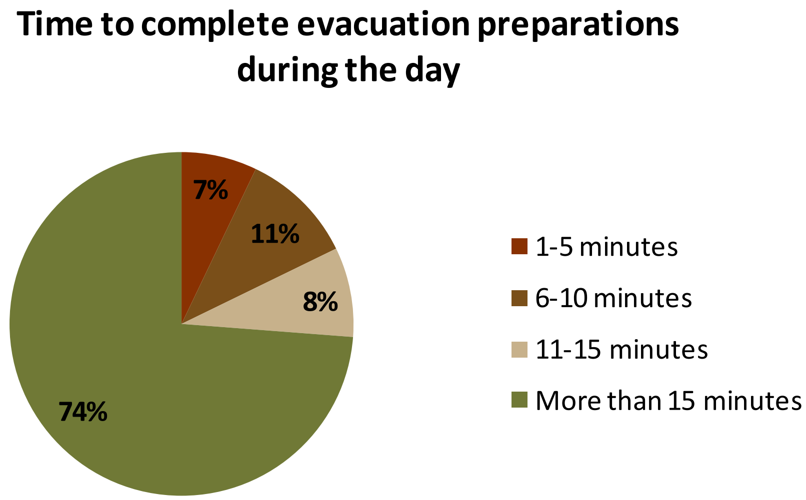


**Figure 29: Time to complete evacuation preparations during the day**

b. At night?

**Table 44: Time to Complete Evacuation Preparations at Night**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1-5 minutes | 7% |
| 6-10 minutes | 10% |
| 11-15 minutes | 8% |
| More than 15 minutes | 75% |

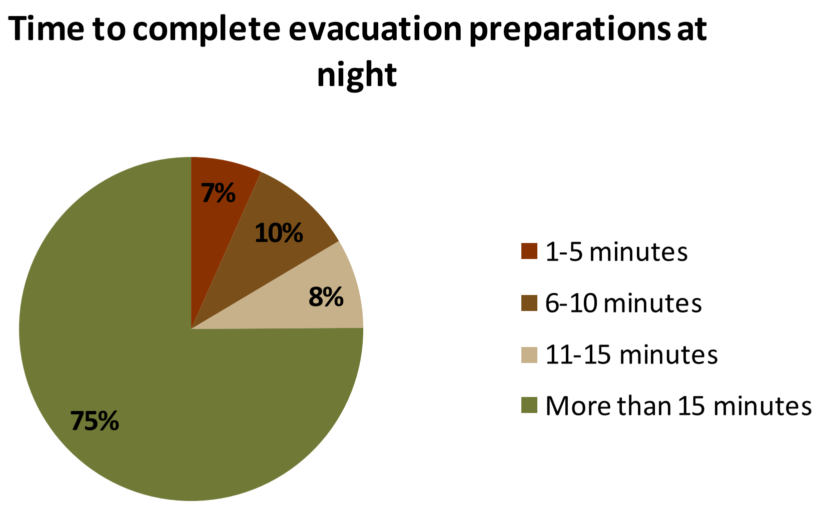


**Figure 30: Time to complete evacuation preparations at night**

c. On most weekends?

**Table 45: Time to Complete Evacuation Preparations on Weekends**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1-5 minutes | 6% |
| 6-10 minutes | 11% |
| 11-15 minutes | 8% |
| More than 15 minutes | 75% |

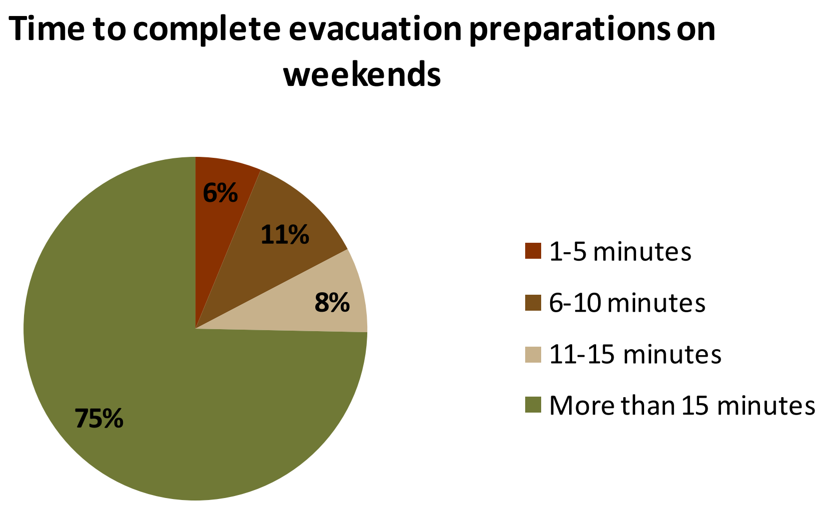


**Figure 31: Time to complete evacuation preparations on weekends**

8. Do any family members require assistance because they don't drive or cannot drive? If so, how many?

**Table 46: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=225) |
|---|---|
| 1 | 12% |
| 2 | 2% |
| 3 | 0% |
| 4 | 0% |
| 5 or more | 0% |
| None | 85% |

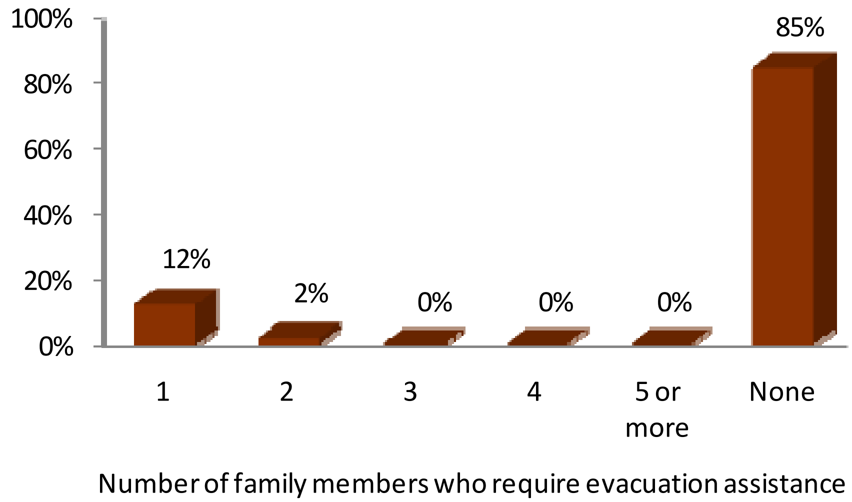


**Figure 32: Number of family members who require evacuation assistance**

9. What type of assistance is needed?

**Table 47: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=33) |
|---|---|
| Just a ride, no special accommodations | 78% |
| A wheelchair van | 18% |
| An ambulance with medical equipment and personnel to provide special medical attention. | 0% |
| An ambulance that can carry a stretcher, but no special medical attention is required. | 0% |
| Other | 3% |

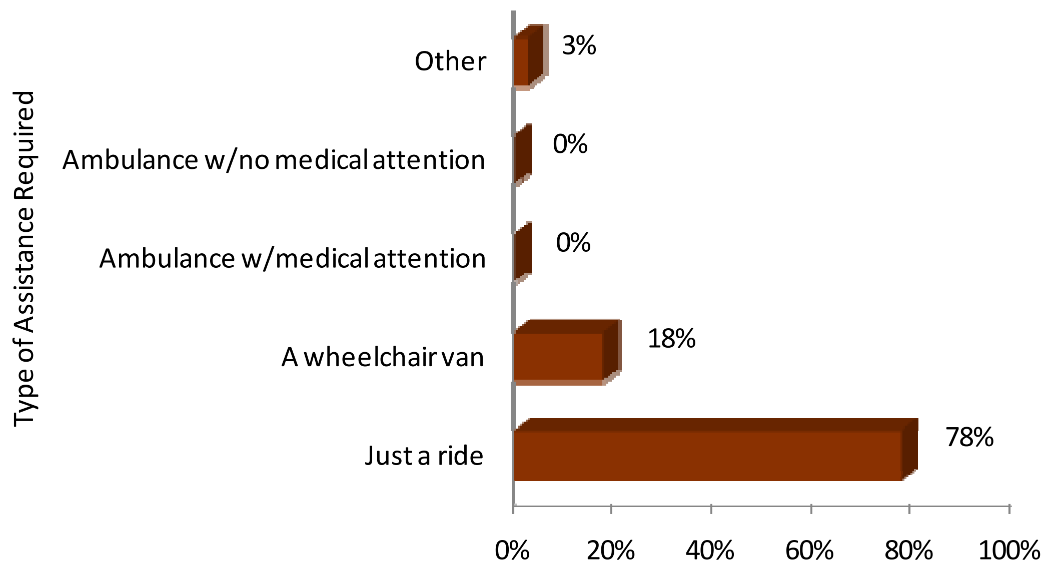


**Figure 33: Type of Evacuation Assistance Required**

Other types of assistance requested include:

- I have epilepsy, my mother has Alzheimer's and we have to get my brother from about 5 miles away

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# APPENDIX D: PTV VISION QUALITY ASSURANCE AND INDUSTRY ACCEPTANCE INFORMATION

traffic mobility logistics.

PTV America, Inc.
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4384
Fax: 302-691-4740
www.ptvamerica.com

March 28, 2006

Akhil Chauhan
Transportation Analyst/Modeler
IEM, Inc.
8555 United Plaza Blvd.
Baton Rouge, LA 70809

**RE: PTV Vision® Quality Assurance and Industry Acceptance**

Dear Mr. Chauhan:

Per your request, I am providing the following information concerning quality assurance and industry acceptance of the PTV Vision traffic simulation and transportation planning software.

PTV AG has performed extensive research and development of the PTV Vision software since 1992. The basis of the VISSIM simulation model is the car-following and lane-changing models developed at the University of Karlsruhe, Germany since 1974. The first commercial release of VISSIM was in 1993. The VISSIM simulation model components have been validated by PTV for accuracy and performance based on field data in Germany and the United States.

A comprehensive quality assurance procedure is conducted before each service pack and major software release by PTV, ensuring consistency of the results within acceptable stochastic variation. A summary of changes/improvements/fixes for each service pack are provided in the release_notes_..._e.txt file included with any service pack.

There are over 430 users of the VISSIM simulation software in North America and over 800 users worldwide. There are over 200 users of the VISUM planning software in North America and over 600 user worldwide. In total, there are over 850 VISSIM licenses and over 350 VISUM licenses within North America. PTV Vision is accepted and used by over 90 academic agencies in the United States and Canada, 18 State Department of Transportation agencies in United States, 3 Provincial Transport Ministries in Canada, and the Federal Highway Administration.

traffic mobility logistics.

*PTV America, Inc.*
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4384
Fax: 302-691-4740
www.ptvamerica.com

The following public agencies are currently using VISSIM:

- Arkansas State Highway Dept,
- CALTRANS,
- Colorado DOT,
- Florida DOT,
- Idaho DOT,
- Kansas DOT,
- Louisiana DOT,
- Michigan DOT,
- Missouri DOT,
- Nevada DOT,
- New Mexico DOT,
- NYSDOT.
- Ohio DOT,
- Oregon DOT,
- South Carolina DOT,
- UDOT,
- Washington DOT

The following public agencies are currently using VISUM:

- AGFTC, Fort Edward NY
- BMPO, Bend OR
- BMTS, Binghamton NY
- CAMPO, Corvallis OR
- CDTC, Albany NY
- El Paso MPO, El Paso TX
- Farmington MPO, Farmington NM
- KMPO, Coeur D'Alene ID
- Las Cruces MPO, Las Cruces NM
- LCOG, Eugene OR
- METRO, Portland OR
- MWVCOG, Salem OR
- NOCTC, Goshen NY
- PPACG, Colorado Springs CO
- RATS, Rockford IL
- Santa Fe MPO, Santa Fe NM
- Skagit COG, Mount Vernon WA
- Southwest WA RTC, Vancouver WA
- SRTC, Spokane WA
- WVTC, Wenatchee, WA
- YVCOG, Yakima WA

If you have any questions about the PTV Vision software, feel free to contact me at 302-654-4384.

Sincerely yours,

Kiel Ova, P.E., PTOE
Project Manager

traffic mobility logistics

PTV America, Inc
1300 N Market Street, Suite 803
Wilmington, DE 19801-1809

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# APPENDIX E: ETE REVIEW CRITERIA CHECKLIST[29]

**Table 48: NUREG/CR-7002 ETE Review Criteria Checklist**

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| 1.0 | Introduction | | |
| a. | The emergency planning zone (EPZ) and surrounding area should be described. | Yes | Section 1.1 Site Location<br>Section 1.2 Emergency Planning Zone |
| b. | A map should be included that identifies primary features of the site, including major roadways, significant topographical features, boundaries of counties, and population centers within the EPZ. | Yes | Figure 2: HNP EPZ Boundary and Protective Action Zones |
| c. | A comparison of the current and previous ETE should be provided and includes similar information as identified in Table 1-1, "ETE Comparison," of NUREG/CR-7002. | Yes | Section 1.3 ETE Comparison Chart |
| 1.1 | Approach | | |
| a. | A discussion of the approach and level of detail obtained during the field survey of the roadway network should be provided. | Yes | Section 2.2 Methodology<br>Section 2.4 Scenarios Modeled<br>Section 3.0 Population and Vehicle Demand Estimation (and sub-sections)<br>Section 4.0 Evacuation Roadway Network<br>Section 4.3 Evacuation Network Characteristics<br>Section 5.2 Evacuation Simulation |
| b. | Sources of demographic data for schools, special facilities, large employers, and special events should be identified. | Yes | Section 2.3 Sources of Data |
| c. | Discussion should be presented on use of traffic control plans in the analysis. | Yes | Section 4.3 Evacuation Network Characteristics<br>Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures [30] |

[29] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| d. | Traffic simulation models used for the analyses should be identified by name and version. | Yes | Section 2.2 Methodology<br>Section 5.0 Evacuation Time Estimate Methodology |
| e. | Methods used to address data uncertainties should be described. | Yes | Section 8.0 Sensitivity Study on Population Change |
| **1.2** | **Assumptions** | | |
| a. | The planning basis for the ETE includes the assumption that the evacuation is ordered promptly and no early protective actions have been implemented. | Yes | Section 2.1 General Assumptions. |
| b. | Assumptions consistent with Table 1-2, “General Assumptions,” of NUREG/CR-7002 should be provided and include the basis to support their use. | Yes | Section 2.1 General Assumptions |
| **1.3** | **Scenario Development** | | |
| a. | The ten scenarios in Table 1-3, Evacuation Scenarios, should be developed for the ETE analysis, or a reason should be provided for use of other scenarios. | Yes | Section 2.4 Scenarios Modeled<br>Table 2: ETE Scenarios Modeled |
| **1.3.1** | **Staged Evacuation** | | |
| a. | A discussion should be provided on the approach used in development of a staged evacuation. | Yes | Section 2.5 Evacuation Area Modeled |
| **1.4** | **Evacuation Planning Areas** | | |
| a. | A map of the EPZ with emergency response planning areas (ERPAs) should be included. | Yes | Section 1.2 Emergency Planning Zone<br>Figure 2: HNP EPZ Boundary and Protective Action Zones |
| b. | A table should be provided identifying the ERPAs considered for each ETE calculation by downwind direction in each sector. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |

[30] Because the HNP EPZ does not have any population centers, traffic control plans have not been produced. However, Section 4.3 discusses traffic control points.

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | A table similar to Table 1-4, "Evacuation Areas for a Staged Evacuation Keyhole," of NUREG/CR-7002 should be provided and includes the complete evacuation of the 2, 5, and 10 mile areas and for the 2 mile area/5 mile keyhole evacuations. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |
| 2.0 | Demand Estimation | | |
| a. | Demand estimation should be developed for the four population groups, including permanent residents of the EPZ, transients, special facilities, and schools. | Yes | Section 3.0 Population and Vehicle Demand Estimation (and subsections) |
| 2.1 | Permanent Residents and Transient Population | | |
| a. | The US Census should be the source of the population values, or another credible source should be provided. | Yes | Section 2.3 Sources of Data<br>Section 3.1 Permanent Residents |
| b. | Population values should be adjusted as necessary for growth to reflect population estimates to the year of the ETE. | Yes | Section 3.0 Population and Vehicle Demand Estimation |
| c. | A sector diagram should be included, similar to Figure 2-1, "Population by Sector," of NUREG/CR-7002, showing the population distribution for permanent residents. | Yes | Figure 4: 2012 HNP Sector and Ring Permanent Resident Population Map |
| 2.1.1 | Permanent Residents with Vehicles | | |
| a. | The persons per vehicle value should be between 1 and 2 or justification should be provided for other values. | Yes | Section 3.1 Permanent Residents<br>Section 3.5 Vehicle Occupancy Rate |
| b. | Major employers should be listed. | Yes | Section 3.0 Population and Vehicle Demand Estimation<br>Section 3.2 Transient Populations |
| 2.1.2 | Transient Population | | |
| a. | A list of facilities which attract transient populations should be included, and peak and average attendance for these facilities should be listed. The source of information used to develop attendance values should be provided. | Yes | Section 3.2 Transient Populations |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | The average population during the season should be used, itemized and totaled for each scenario. | Yes | Section 3.2 Transient Populations.<br>Peak recreational population numbers were used for the fall weekend scenarios. Off-peak are estimated for other scenarios. |
| c. | The percent of permanent residents assumed to be at facilities should be estimated. | Yes | Section 3.2 Transient Populations |
| d. | The number of people per vehicle should be provided. Numbers may vary by scenario, and if so, discussion on why values vary should be provided. | Yes | Section 3.5 Vehicle Occupancy Rate |
| e. | A sector diagram should be included, similar to Figure 2-1 of NUREG/CR-7002, showing the population distribution for the transient population. | Yes | Figure 5: HNP Sector and Ring Transient Populations Map |
| 2.2 | Transit Dependent Permanent Residents | | |
| a. | The methodology used to determine the number of transit dependent residents should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| b. | Transportation resources needed to evacuate this group should be quantified. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| c. | The county/local evacuation plans for transit dependent residents should be used in the analysis. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | The methodology used to determine the number of people with disabilities and those with access and functional needs who may need assistance and do not reside in special facilities should be provided. Data from local/county registration programs should be used in the estimate, but should not be the only set of data. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| e. | Capacities should be provided for all types of transportation resources. Bus seating capacity of 50% should be used or justification should be provided for higher values. | Yes | Section 3.3 Transit Dependent Permanent Residents |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| f. | An estimate of this population should be provided and information should be provided that the existing registration programs were used in developing the estimate. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| g. | A summary table of the total number of buses, ambulances, or other transport needed to support evacuation should be provided and the quantification of resources should be detailed enough to assure double counting has not occurred. | Yes | Table 10: Transit Dependent Permanent Resident Evacuation Information |
| 2.3 | Special Facility Residents | | |
| a. | A list of special facilities, including the type of facility, location, and average population should be provided. Special facility staff should be included in the total special facility population. | Yes | Section 3.4 Special Facility and School Populations |
| b. | A discussion should be provided on how special facility data was obtained. | Yes | Section 2.3 Sources of Data |
| c. | The number of wheelchair and bed-bound individuals should be provided. | Yes | There are no special facilities in the EPZ with wheelchair and bed-bound individuals. |
| d. | An estimate of the number and capacity of vehicles needed to support the evacuation of the facility should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 3.5 Vehicle Occupancy Rate |
| e. | The logistics for mobilizing specially trained staff (e.g., medical support or security support for prisons, jails, and other correctional facilities) should be discussed when appropriate. | Yes | Section 3.4 Special Facility and School Populations |
| 2.4 | Schools | | |
| a. | A list of schools including name, location, student population, and transportation resources required to support the evacuation, should be provided. The source of this information should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 3.5 Vehicle Occupancy Rate |
| b. | Transportation resources for elementary and middle schools are based on 100% of the school capacity. | Yes | Section 3.4 Special Facility and School Populations |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | The estimate of high school students who will use their personal vehicle to evacuate should be provided and a basis for the values used should be provided. | N/A | There are no high schools in the 10-mile EPZ. |
| d. | The need for return trips should be identified if necessary. | Yes | Section 3.4 Special Facility and School Populations |
| **2.5** | **Other Demand Estimate Considerations** | | |
| **2.5.1** | **Special Events** | | |
| a. | A complete list of special events should be provided and includes information on the population, estimated duration, and season of the event. | N/A | No special events were studied. |
| b. | The special event that encompasses the peak transient population should be analyzed in the ETE. | N/A | No special events were studied. |
| c. | The percent of permanent residents attending the event should be estimated. | N/A | No special events were studied. |
| **2.5.2** | **Shadow Evacuation** | | |
| a. | A shadow evacuation of 20 percent should be included for areas outside the evacuation area extending to 15 miles from the NPP. | Yes | Section 2.1 General Assumptions |
| b. | Population estimates for the shadow evacuation in the 10 to 15 mile area beyond the EPZ are provided by sector. | Yes | Section 3.1.3. Resident Population Summary |
| c. | The loading of the shadow evacuation onto the roadway network should be consistent with the trip generation time generated for the permanent resident population. | Yes | Section 2.1 General Assumptions |
| **2.5.3** | **Background and Pass Through Traffic** | | |
| a. | The volume of background traffic and pass-through traffic should be based on the average daytime traffic. Values may be reduced for nighttime scenarios. | Yes | Section 2.1 General Assumptions.<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | Pass-through traffic should be assumed to have stopped entering the EPZ about two hours after the initial notification. | Yes | Section 2.1 General Assumptions.<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |
| 2.6 | Summary of Demand Estimation | | |
| a. | A summary table should be provided that identifies the total populations and total vehicles used in the analysis for permanent residents, transients, transit dependent residents, special facilities, schools, shadow population, and pass-through demand used in each scenario. | Yes | Section 3.6 Summary of Demand Estimation |
| 3.0 | Roadway Capacity | | |
| a. | The method(s) used to assess roadway capacity should be discussed. | Yes | Section 5.2.2 The Network Model |
| 3.1 | Roadway Characteristics | | |
| a. | A field survey of key routes within the EPZ has been conducted. | Yes | Section 4.1 Network Definition |
| b. | Information should be provided describing the extent of the survey, and types of information gathered and used in the analysis. | Yes | Section 4.1 Network Definition |
| c. | A table similar to that in Appendix A, “Roadway Characteristics,” of NUREG/CR-7002 should be provided. | Yes | Table 34: Roadway Network Characteristics |
| d. | Calculations for a representative roadway segment should be provided. | Yes | Section 5.2.2 The Network Model |
| e. | A legible map of the roadway system that identifies node numbers and segments used to develop the ETE should be provided and should be similar to Figure 3-1, “Roadway Network Identifying Nodes and Segments,” of NUREG/CR-7002. | Yes | Appendix B: Evacuation Network Lines (Detailed Information)<br>Figure 18 through Figure 21 |
| 3.2 | Capacity Analysis | | |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | The approach used to calculate the roadway capacity for the transportation network should be described in detail and identifies factors that are expressly used in the modeling. | Yes | Section 5.2.2 The Network Model |
| b. | The capacity analysis identifies where field information should be used in the ETE calculation. | Yes | Section 5.2.2 The Network Model |
| 3.3 | Intersection Control | | |
| a. | A list of intersections should be provided that includes the total numbers of intersections modeled that are unsignalized, signalized, or manned by response personnel. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 17: Intersection Control Type |
| b. | Characteristics for the 10 highest volume intersections within the EPZ are provided including the location, signal cycle length, and turn lane queue capacity. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 18: Information for Ten Highest Volume Intersections |
| c. | Discussion should be provided on how time signal cycle is used in the calculations. | N/A | There are no fixed timing traffic signals in the network. |
| 3.4 | Adverse Weather | | |
| a. | The adverse weather condition should be identified and the effect of adverse weather on mobilization should be considered. | Yes | Section 2.1 General Assumptions<br>Section 2.4 Scenarios Modeled<br>Because there are few extreme weather conditions such as heavy snow at the HNP, no significant impacts of adverse weather on mobilization are expected. |
| b. | The speed and capacity reduction factors identified in Table 3-1, “Weather Capacity Factors,” of NUREG/CR-7002 should be used or a basis should be provided for other values. | Yes | Section 2.1 General Assumptions |
| c. | The study identifies assumptions for snow removal on streets and driveways, when applicable. | N/A | Because there are few extreme weather conditions such as heavy snow at the HNP, no significant impacts of adverse weather on mobilization are expected. |
| 4.0 | Development of Evacuation Times | | |
| 4.1 | Trip Generation Time | | |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | The process used to develop trip generation times should be identified. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | When telephone surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance should be provided. | Yes | Appendix C: Telephone Survey |
| c. | Data obtained from telephone surveys should be summarized. | Yes | Appendix C: Telephone Survey |
| d. | The trip generation time for each population group should be developed from site specific information. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.1** | **Permanent Residents and Transient Population** | | |
| a. | Permanent residents are assumed to evacuate from their homes but are not assumed to be at home at all times. Trip generation time includes the assumption that a percentage of residents will need to return home prior to evacuating. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | Discussion should be provided on the time and method used to notify transients. The trip generation time discusses any difficulties notifying persons in hard to reach areas such as on lakes or in campgrounds. | Yes | Section 5.1.2 Trip Generation Time Estimate |
| c. | The trip generation time accounts for transients potentially returning to hotels prior to evacuating. | N/A | No Hotels are found within the EPZ. |
| d. | Effect of public transportation resources used during special events where a large number of transients are expected should be considered. | N/A | No Special events are expected. |
| e. | The trip generation time for the transient population should be integrated and loaded onto the transportation network with the general public. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.2** | **Transit Dependent Residents** | | |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | If available, existing plans and bus routes are used in the ETE analysis. If new plans are developed with the ETE, they should have been agreed upon by the responsible authorities. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| b. | Discussion should be included on the means of evacuating ambulatory and non-ambulatory residents. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| c. | The number, location and availability of buses, and other resources needed to support the demand estimation are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | Logistical details, such as the time to obtain buses, brief drivers and initiate the bus route are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| e. | Discussion should identify the time estimated for transit dependent residents to prepare and then travel to a bus pickup point, and describes the expected means of travel to the pickup point. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| f. | The number of bus stops and time needed to load passengers should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| g. | A map of bus routes should be included. | N/A | There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| h. | The trip generation time for non-ambulatory persons includes the time to mobilize ambulances or special vehicles, time to drive to the home of residents, loading time, and time to drive out of the EPZ should be provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br><br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br><br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br><br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| i. | Information should be provided to support analysis of return trips, if necessary. | N/A | No return trips are expected. |
| 4.1.3 | Special Facilities | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | Yes | Section 3.4 Special Facility and School Populations |
| b. | Discussion should be provided on the inbound and outbound speeds. | Yes | Section 6.4 ETE Results for Special Facility and School Populations<br><br>No return trips are expected |
| c. | The number of wheelchair and bed-bound individuals should be provided, and the logistics of evacuating these residents should be discussed. | N/A | N/A |
| d. | Time for loading of residents should be provided. | Yes | Section 3.4 Special Facility and School Populations |
| e. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 3.4 Special Facility and School Populations<br><br>No return trips are expected |
| f. | If return trips are needed, the destination of vehicles should be provided. | N/A | No return trips are expected |
| g. | Discussion should be provided on whether special facility residents are expected to pass through the reception center prior to being evacuated to their final destination. | Yes | Section 3.4 Special Facility and School Populations |
| h. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No return trips are expected |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **4.1.4** | **Schools** | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation Time for Schools<br>Section 6.4 ETE Results for Special Facility and School Population |
| b. | Discussion should be provided on the inbound and outbound speeds. | Yes | Section 6.4 ETE Results for Special Facility and School Population |
| c. | Time for loading of students should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation Time for Schools |
| d. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 3.4 Special Facility and School Populations<br>No return trips are expected |
| e. | If return trips are needed, the destination of school buses should be provided. | N/A | No return trips are expected |
| f. | If used, reception centers should be identified. Discussion should be provided on whether students are expected to pass through the reception center prior to being evacuated to their final destination. | Yes | Section 3.4 Special Facility and School Populations |
| g. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No return trips are expected. |
| **4.2** | **ETE Modeling** | | |
| a. | General information about the model should be provided and demonstrates its use in ETE studies. | Yes | Section 5.2 Evacuation Simulation |
| b. | If a traffic simulation model is not used to conduct the ETE calculation, sufficient detail should be provided to validate the analytical approach used. All criteria elements should have been met, as appropriate. | N/A | A traffic simulation model is used for ETE study. |
| **4.2.1** | **Traffic Simulation Model Input** | | |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| a. | Traffic simulation model assumptions and a representative set of model inputs should be provided. | Yes | Section 3.5 Vehicle Occupancy<br>Section 3.6 Summary of Demand Estimation<br>Section 5.1 Loading of the Evacuation Network<br>Section 5.2 Evacuation Simulation |
| b. | A glossary of terms should be provided for the key performance measures and parameters used in the analysis. | Yes | Appendix B: Evacuation Network Lines (Detailed Information) |
| 4.2.2 | Traffic Simulation Model Output | | |
| a. | A discussion regarding whether the traffic simulation model used must be in equilibration prior to calculating the ETE should be provided. | Yes | Section 5.2.3 The Impact Model |
| b. | The minimum following model outputs should be provided to support review:<br>1. Total volume and percent by hour at each EPZ exit mode.<br>2. Network wide average travel time.<br>3. Longest Queue length for the 10 intersections with the highest traffic volume.<br>4. Total vehicles exiting the network.<br>5. A plot that provides both the mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ.<br>6. Average speed for each major evacuation route that exits the EPZ. | Yes | Section 6.5 Example Model Output |
| c. | Color coded roadway maps should be provided for various times (i.e., at 2, 4, 6 hrs., etc.) during a full EPZ evacuation scenario, identifying areas where long queues exist including level of service (LOS) "E" and LOS "F" conditions, if they occur. | N/A | No extensive LOS E or LOS F was observed. |
| 4.3 | Evacuation Time Estimates for the General Public | | |
| a. | The ETE should include the time to evacuate 90% and 100% of the total permanent resident and transient population. | Yes | Section 6.0 Analysis of Evacuation Times |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | The ETE for 100% of the general public should include all members of the general public. Any reductions or truncated data should be explained. | Yes | Section 6.1 Summary of ETE Results for General Public |
| c. | Tables should be provided for the 90 and 100 percent ETEs similar to Table 4-3, "ETEs for Staged Evacuation Keyhole," of NUREG/CR-7002. | Yes | Section 6.1 Summary of ETE Results for General Public<br>Table 24: 100% ETEs in Minutes<br>Table 25: 90% ETEs in Minutes |
| d. | ETEs should be provided for the 100 percent evacuation of special facilities, transit dependent, and school populations. | Yes | Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>Section 6.4 ETE Results for School Populations |
| **5.0** | **Other Considerations** | | |
| **5.1** | **Development of Traffic Control Plans** | | |
| a. | Information that responsible authorities have approved the traffic control plan used in the analysis should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| b. | A discussion of adjustments or additions to the traffic control plan that affect the ETE should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| **5.2** | **Enhancements in Evacuation Time** | | |
| a. | The results of assessments for improvement of evacuation time should be provided. | Yes | Section 9.0 Conclusion and Recommendations |
| b. | A statement or discussion regarding presentation of enhancements to local authorities should be provided. | Yes | Section 9.0 Conclusion and Recommendations |
| **5.3** | **State and Local Review** | | |
| a. | A list of agencies contacted and the extent of interaction with these agencies should be discussed. | Yes | Section 2.3 Sources of Data |
| b. | Information should be provided on any unresolved issues that may affect the ETE. | Yes | The ETE has been reviewed and no unresolved issues were found. |
| **5.4** | **Reviews and Updates** | | |
| a. | A discussion of when an updated ETE analysis is required to be performed and submitted to the NRC. | Yes | Section 8.0 Sensitivity Study on Population Change |

| | Review of ETE for Edwin I. Hatch Nuclear Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| 5.5 | **Reception Centers and Congregate Care Center** | | |
| a. | A map of congregate care centers and reception centers should be provided. | Yes | Figure 7: HNP Evacuation Network |
| b. | If return trips are required, assumptions used to estimate return times for buses should be provided. | N/A | No return trips are expected |
| c. | It should be clearly stated if it is assumed that passengers are left at the reception center and are taken by separate buses to the congregate care center. | N/A | The congregate care centers are located adjacent to the reception centers. No separate buses are required. |

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**Joseph M. Farley Nuclear Plant – Units 1 and 2**
**Edwin I. Hatch Nuclear Plant – Units 1 and 2**
**Vogtle Electric Generating Plant – Units 1 and 2**
**Evacuation Time Estimates Update**

**Enclosure 3**

**Evacuation Time Estimates for the Vogtle Electric Generating Plant**

November 2012, Revised October 2013

# Evacuation Time Estimates for the Vogtle Electric Generating Plant

IEM/TEC12-1003

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# EXECUTIVE SUMMARY

In order to ensure the safety of the public living in the vicinity of nuclear power plants in the nation, the U.S. Nuclear Regulatory Commission (NRC) requires the plants to update their evacuation times estimates (ETEs) within the 10-mile radius plume exposure pathway emergency planning zone (EPZ) as local conditions change (e.g., significant changes in population, change in the type of effectiveness of public notification system, etc.).

Southern Nuclear Operating Company (SNC) contracted IEM to estimate evacuation times for the 2012 populations within the 10-mile plume exposure pathway EPZ surrounding the Vogtle Electric Generating Plant (VEGP). This document describes the methods used to obtain population data and to estimate evacuation times. It also reports the estimated population figures, evacuation road network information, and ETEs.

In compliance with the guidelines outlined in the NRC's *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002), this report breaks down the population by geographic areas and protective action zones (PAZ).[1] As described in NUREG/CR-7002, three population segments have been identified in this report: permanent residents and transient population; transit dependent permanent residents; and school populations. No special facilities were found within the EPZ. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The total year 2012 permanent resident populations within the 10-mile EPZ for VEGP are estimated to be 3,080. The transient population consists of workers employed within the area, recreational sportsmen, and visitors. The total peak transient population within the 10-mile EPZ is estimated to be 2,915. Only one school, Lord's House of Praise Christian School, was identified in the VEGP EPZ. IEM contacted the school to collect current enrollment, staff figures, and the evacuation plan. The total peak population for the school in the EPZ is estimated to be 70. Transit dependent permanent residents in the EPZ are estimated to be 29. This study also considered the voluntary evacuees, who are also known as shadow evacuees that reside within 10 to 15 miles from VEGP.

IEM used PTV Vision VISUM—a computer traffic simulation model—to perform the ETE analyses. For the analyses, the 10-mile plume exposure pathway EPZ was divided into 19 unique geographic areas based on two-mile, five-mile, and ten-mile radius rings, the 16 22.5-degree PAZs, as well as keyhole and staged evacuation logic. In order to represent the most realistic emergency scenarios, evacuations for the 19 geographic evacuation areas were modeled individually for the midweek daytime, midweek – weekend evening, and weekend daytime scenarios. Each of these scenarios was then considered under both normal and adverse weather conditions using the 2012 population estimations. A total of 114 evacuation scenarios were considered as part of this study to represent different wind, temporal, seasonal and weather conditions.

[1] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

Both 100% and 90% ETEs for each scenario were collected. The 100% ETEs for the evacuation areas ranged from 2 hour 10 minutes to 3 hours 25 minutes for the normal scenarios, and from 2 hour 15 minutes to 3 hours 25 minutes for those occurring in adverse weather. The 90% ETEs for the evacuation areas ranged from 1 hour 20 minutes to 2 hours 20 minutes for the normal scenarios, and from 1 hour 20 minutes to 2 hours 25 minutes for those occurring in adverse weather. The factors that contributed to the variations in ETEs between scenarios include differences in the number of evacuating vehicles, the capacity of the evacuation routes used, and the distance from the origin zones to the EPZ boundary.

Based on the data gathered and the results of the evacuation simulations, the existing evacuation strategy is functional for the 2012 conditions, given the lack of severe congestion or very high ETEs. However, the following recommendations will help emergency managers to improve the evacuation times from an event at VEGP:

- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use traffic control points (TCP) to facilitate flow in the areas (e.g., intersection of Thompson Bridge Rd and GA-24) where vehicles might otherwise have to slow due to congestion and traffic signals.
- Developing comprehensive regional evacuation plans and/or working with local and state road/transportation departments to suggest improvements to the road infrastructure can contribute to a more successful evacuation.

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# 1.0 INTRODUCTION

The Vogtle Electric Generating Plant (VEGP) is a two-unit pressurized water reactor operated by Southern Nuclear Operating Company (SNC). In order to ensure the safety of the public living in the vicinity of the power plant, the U.S. Nuclear Regulatory Commission (NRC) requires nuclear power plants in the nation to conduct evacuation studies for the population within the 10-mile radius plume exposure pathway emergency planning zone (EPZ) at regular intervals. This population evacuation study fulfills regulatory requirements outlined in the NRC *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002).[2]

SNC contracted IEM to perform a population evacuation study for the 10-mile radius plume exposure pathway EPZ surrounding VEGP. This document presents the results of that study. It describes the assumptions and methodologies used by IEM to obtain population and evacuation network data and to perform evacuation time estimates (ETE) analyses. ETEs in this evacuation study incorporate the actual population numbers[3] for the year 2012. This document reports the updated population figures, evacuation road network information, and ETEs.

The study is consistent with the requirements specified in NUREG/CR-7002 guidelines. The study is intended to provide information for State and local officials, and VEGP emergency management personnel to effectively plan for an accidental event at the plant.

## 1.1. Site Location

VEGP is located on the southwestern bank of the Savannah River in Burke County, Georgia. The plant is approximately 15 miles east-northeast of the City of Waynesboro. The small town of Girard is approximately seven miles south of the plant. The closest population center is the town of Sardis, which is approximately 12 miles south of the plant. Figure 1 shows location of the VEGP site.

[2] NRC. *Criteria for Development of Evacuation Time Estimate Studies* (NUREG/CR-7002) guidelines. November 2011.
[3] SNC 2012 first-quarter population estimates


Figure 1: Vogtle Electric Generating Plant Site Location

## 1.2. Emergency Planning Zone

The plume exposure pathway EPZ includes the majority of the 10-mile geographic area surrounding VEGP. The VEGP EPZ covers areas in both Georgia and South Carolina. The land within the plume exposure pathway is divided almost equally by the Savannah River. The EPZ covers portions of the counties of Burke and Richmond, Georgia, and Barnwell, Allendale, and Aiken, South Carolina. Burke County has the largest resident population within the EPZ. This population is small and dispersed.

The major portion of the EPZ in South Carolina is within the United States Department of Energy's (DOE) Savannah River Site (SRS). DOE's Savannah River Operations Office (DOE-SR), pursuant to a memorandum of agreement[4] between Georgia Power Company (GPC), as assigned to SNC, will be responsible for all emergency response actions on the SRS whenever an emergency occurs at VEGP. For this reason, a portion of the VEGP EPZ located in Barnwell County in South Carolina contained by the DOE-SR facility is not included in the study.

The areas in South Carolina that are not Federally-owned or controlled are along the Savannah River lowlands in Aiken, Allendale, and Barnwell counties. The segment in Aiken County, approximately 8–10 miles north-northwest of VEGP, is part of the Cowden Plantation, which has no resident population. The segments in Barnwell and Allendale counties, approximately 9–10 miles east-southeast of VEGP, are largely comprised of portions of the Creek Plantation, a horse farm. Within the South Carolina portion of the EPZ, the only housing is located within the Creek Plantation in Barnwell County, where there are only a limited number of permanent residences.

The State of Georgia Radiological Emergency Plan (REP)[5] and VEGP Emergency Plan are the bases for the geographical and political boundaries for the EPZ. For evacuation and emergency response planning purposes, the 10-mile radius plume exposure pathway EPZ has been divided into 13 Emergency Response Planning Areas (ERPAs) known as protective action zones (PAZ).[6] The PAZ descriptions were obtained and verified from the VEGP Emergency Plan, VEGP's 2012 emergency information calendar[7], county REP[8], and discussions with both SNC and VEGP representatives. The PAZs were selected based on existing political boundaries and prominent physical features—either natural (e.g., rivers and lakes) or man-made (e.g., roads and bridges)—to enhance direction and coordination of the public in the affected area. Figure 2 shows a map of the PAZs for VEGP. Appendix A of this document contains boundary descriptions of the PAZs within the 10-mile plume exposure pathway EPZ of the plant.

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[4] A copy of the memorandum of agreement is located in the SNC planning office.
[5] State of Georgia Radiological Emergency Plan (REP) – Annex D – Plant Vogtle. Georgia Emergency Management Agency. January 2009.
[6] Protective Action Zone is also referred to as "Zone" in this document.
[7] 2012 Vogtle Electric Generating Plant Emergency Information Calendar.
[8] Annex D – Plant Vogtle – Burke County Emergency Management Radiological Plan. May 2009. (Obtained from State of Georgia REP).

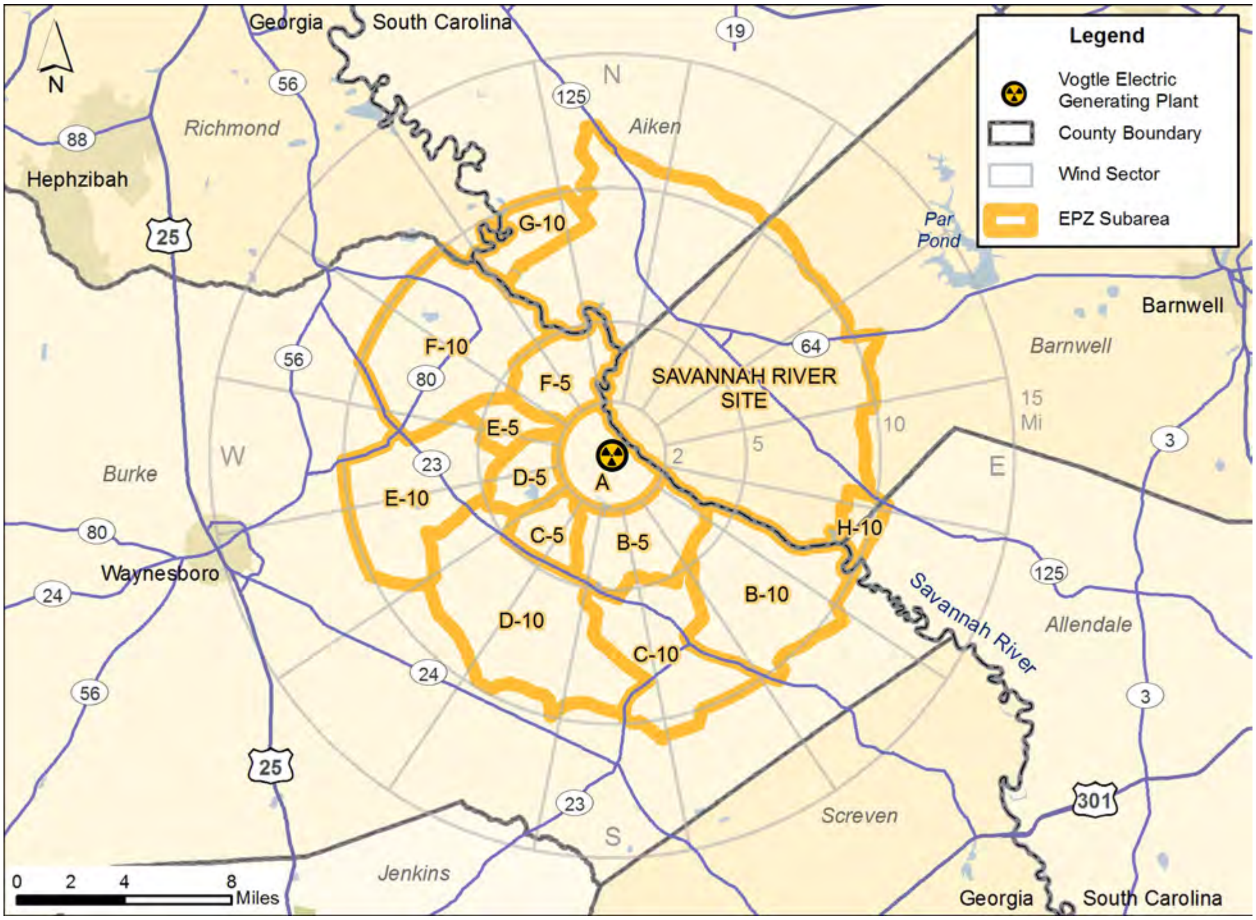


Figure 2: VEGP EPZ Boundary and Protective Action Zones

## 1.3. Comparison with Previous ETE Study

Table 1 identifies information that is useful in comparing the 2006 and 2012 ETE studies. Note that the 2006 ETE study was modeled using both 2006 and 2010 estimated population data. For comparison purpose, Table 1 lists the information for the 2010 estimated population from the 2006 study, as well as the 2012 population from this study.

**Table 1: ETE Comparison Chart**

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Permanent Residents** | | |
| - Total Population | 3,224 | 3,080 |
| - Vehicle Occupancy Rate | 2.75 | 1.7-1.8 |

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Transit Dependent Population** | | |
| - Total Population | 0 | 29 |
| - Number of Buses/Standard Vans | 0 | 86 |
| - Number of Ambulances | 0 | 12 |
| - Number of Special Equipped Vehicles | 0 | 5 |
| **Transient Population** | | |
| - Total Population | 753 | 871 |
| **Special Facilities** [9] | | |
| - Total Population | 0 | 0 |
| - Number of Buses | N/A | N/A |
| - Other Transportation Resources | N/A | N/A |
| **Schools** | | |
| - Total Student Population | 50 | 50 |
| - Number of Buses | 2 | 2 |
| **Shadow Evacuation Percent Estimated** | 0 | 20% |
| **Special Event(s)** | | |
| - Population | N/A | N/A |
| - Location | N/A | N/A |
| - Duration | N/A | N/A |
| **Adverse Weather (rain, snow, ice, fog)** | Heavy Rain | Heavy Rain |
| **Evacuation Model - name and version** | VISUM 10 | VISUM11 |
| **Scenarios** | Combination of time (Weekday, Weeknight, Weekend) and weather (adverse and normal) | Combination of time (Weekday, Weeknight, Weekend) and weather (adverse and normal) |

[9] No special facilities, as defined in NUREG/CR-7002, were identified in the 10-mile EPZ.

| ETE Element | Previous ETE (for 2010) | Updated ETE (for 2012) |
|---|---|---|
| **Assumptions** | • One evacuation vehicle per household for residents<br>• Mobilization time for resident and transient population are based on literature[10]<br>• No shadow evacuation considered | • Vehicle occupancy rates for residents are based on telephone survey<br>• Mobilization time for resident and transient population are based on telephone survey<br>• 20% of residents in 10-15 mile ring are shadow evacuees |

[10] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

# 2.0 ASSUMPTIONS AND METHODOLOGY

## 2.1. General Assumptions

IEM made the following general assumptions to model the population evacuation study:

- The ETEs include the times associated with warning diffusion, public mobilization, and travel time out of the EPZ. The ETE is measured from the time that instructions were first made available to the public within the EPZ (e.g., initial emergency alert system [EAS] broadcast). Mobilization of the public begins after initial notification.
- Following initial notification, all persons within the EPZ will evacuate. 100% ETE will be considered as the time when all evacuating vehicles are outside the EPZ. 90% ETE will be considered as the time when 90% of the evacuating vehicles are outside the EPZ.
- Existing lane utilization patterns will prevail during the course of the evacuation. There will be traffic control points (TCP) in the network to allow efficient flow of traffic toward the reception centers.
- Reception centers are modeled as defined in the 2012 emergency information calendar.
- Non-auto-owning households will evacuate with neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by State and county emergency management officials. This is also consistent with the 2012 emergency information calendar and county REP.
- The major adverse weather condition in the area is considered as heavy rain. To model the population evacuation during adverse weather conditions, the free flow speeds are reduced by 15%, and the road capacities are reduced by 10%.
- The evacuation is ordered promptly and no early protective actions have been implemented.
- There is only one school in the EPZ. Initial notification will be received the same time as the general public within the EPZ.
- A shadow evacuation of 20% of the permanent resident population was assumed to occur in areas outside of the evacuation area being assessed extending to 15 miles from the VEGP. The vehicle occupancy rates and trip generation times of shadow evacuees are consistent with those of the residents within the EPZ.
- Information such as the number of vehicles by the residents during the evacuation and mobilization times are estimated based on a telephone survey on the residents within the EPZ.
- Located in a rural area, there is little pass-through traffic and the majority of the trips are home-work trips made by the local residents within the EPZ. Due to this nature, IEM assumed that minimum background traffic would exist after the evacuees start to

load into the roadway network. No significant impact of pass-through traffic on the ETEs is expected.

- Buses used to evacuate schools and special facilities are loaded to capacity.
- Shadow evacuation of 20% of the residents in 10-15 mile ring would occur when an evacuation order is issued.

## 2.2. Methodology

IEM used PTV Vision VISUM (version 11), a computer simulation model, to perform the ETEs for the VEGP site.[11] PTV Vision is the leading software suite for transportation planning and operations analyses used in more than 70 countries. Detailed information on the evacuation time analysis methodology using PTV Vision is provided in Section 5.2. PTV Vision quality assurance and industry acceptance information is provided in Appendix D.

## 2.3. Sources of Data

The most up-to-date data sources were reviewed and analyzed to prepare appropriate input data for running the traffic simulation and providing the best ETEs. The data sources are explained below:

- Geographical and political boundaries for the EPZ were obtained from the State of Georgia REP plan.
- The 13 PAZ descriptions were obtained and verified from VEGP's 2012 emergency information calendar[12], the GA REP[13], the county REP[14], and discussions with SNC and VEGP representatives.
- The 2012 population estimates, as well as business location data, were obtained from the 2010 U.S. Census Bureau, the 2012 Plant VEGP TAR Database, and the population estimates from Synergos Technologies, Inc.[15]
- The peak and average estimated employment level at VEGP obtained from SNC representatives reflects office and operations personnel.
- Roadway geometric data was obtained from PTV. PTV data is based on high-quality, regularly updated, NAVTEQ street network data. NAVTEQ networks are detailed and include neighborhood streets in every community in North America. This data was validated by IEM during a "ground truthing" field trip in April 2012.
- Roadway and intersection approach capacities were calculated using the concepts and procedures defined in the Highway Capacity Manual[16] published by the Transportation Research Board.

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[11] PTV Vision can be found online at http://www.ptvamerica.com.
[12] 2012 Vogtle Electric Generating Plant Emergency Information Calendar.
[13] State of Georgia Radiological Emergency Plan – Annex D – Plant Vogtle. Georgia Emergency Management Agency. January 2009.
[14] Annex D – Plant Vogtle – Burke County Emergency Management Radiological Plan. May 2009. (Obtained from State of Georgia REP).
[15] Synergos Technologies, Inc. Online: http://www.synergos-tech.com.
[16] Transportation Research Board, National Research Council. *Highway Capacity Manual*. Washington, D.C. 2000.

- Warning diffusion and mobilization times were based on the data presented in *Evaluating Protective Actions for Chemical Agent Emergencies*[17] published by the Oak Ridge National Laboratory. The data in this report was collected during evacuations executed in response to large-scale chemical spills, and explicitly incorporates the time required for communication of the warning (warning diffusion) and the time required for an individual to respond to the warning (mobilization). The data collected in this meta-study were based on permanent residents and transient populations. Section 5.1 of this report provides more information on warning diffusion and mobilization time assumptions.
- Vehicle occupancy rates for the different population categories were derived based on telephone surveys and discussions with the counties' and plant's emergency planning staffs. Section 5.1.1 provides more information on population and vehicle demand assumptions.
- Agencies participating in the study are provided below. These agencies participated in an initial briefing for the study and provided input regarding specifics for the data and assumptions for the ETE within their jurisdiction.
  - South Carolina Emergency Management Division
  - Aiken County Emergency Management Division
  - Barnwell County Emergency Management Agency
  - Allendale County Emergency Management Agency
  - Georgia Emergency Management Agency
  - Burke County Emergency Management Agency

## 2.4. Scenarios Modeled

In accordance with NUREG/CR-7002 guidelines, ETEs for each of the evacuation areas (refer to Table 3) have been prepared for different temporal and weather conditions. Based on the discussion with the SNC emergency planning staff, estimates have been prepared for both normal and adverse weather conditions for midweek daytime, midweek – weekend night, and weekend daytime.

Normal weather refers to conditions where roads are clear and dry and visibility is not impaired. Adverse weather refers to rainy or snowy conditions where road capacities are reduced by 10% and speed limits are reduced by 15%.

Evacuation conditions are modeled for the populations of the year 2012, in addition to the construction workforce for the new units being built at the VEGP site. Table 2 presents the snapshot of the ETE scenarios that were modeled for the study.

[17] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615). Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

**Table 2: ETE Scenarios Modeled***

| Scenario | Day | Time | Weather |
|---|---|---|---|
| 1 | Midweek | Daytime | Normal |
| 2 | Midweek | Daytime | Adverse |
| 3 | Midweek and Weekend | Night | Normal |
| 4 | Midweek and Weekend | Night | Adverse |
| 5 | Weekend | Daytime | Normal |
| 6 | Weekend | Daytime | Adverse |

** Per discussions with SNC emergency planning staff, special events and seasonal variation scenarios were not modeled. However, peak recreational population numbers were used for the weekend scenarios (5 and 6). This condition would most likely occur during any weekend day during the hunting season (i.e., September 15 through January 6), when there would be a large number of hunters and fishermen at various points along the Savannah River.*

The various population components for different scenarios are summarized below:

- **Midweek Daytime – Normal Weather:** This situation represents a typical normal weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.
  - The plant site employment is at an estimated peak daytime level.
  - Workplaces are fully staffed at daytime levels.
  - Schools are in session.
  - Recreational activities, such as hunting and fishing, are at daytime levels.
- **Midweek Daytime – Adverse Weather:** This situation represents an adverse weather weekday period when the workforce is at a full daytime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.
  - The plant site employment is at an estimated peak daytime level.
  - Workplaces are fully staffed at daytime levels.
  - Schools are in session.
- **Midweek and Weekend Evening – Normal Weather:** This situation reflects a typical normal weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:
  - Permanent residents within the EPZ will evacuate from their places of residence.

- The plant site is staffed at an estimated peak nighttime level.
- Workplaces are at nighttime levels.
- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Midweek and Weekend Evening – Adverse Weather:** This situation reflects an adverse weather evening period when the workforce is at a nighttime level. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is staffed at an estimated peak nighttime level.
- Workplaces are at nighttime levels.
- Schools are closed.
- There are no recreational (hunting and fishing) activities.

▪ **Weekend Daytime – Normal Weather:** The normal weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

▪ **Weekend Daytime – Adverse Weather:** The adverse weather weekend situation represents a daytime period when recreational activities are at peak levels. This condition would most likely occur during any weekend day during the hunting season. Assumptions on the population levels for this condition include the following:

- Permanent residents within the EPZ will evacuate from their places of residence.
- The plant site is at an estimated peak weekend level.
- Workplaces are at weekend levels.
- Schools are closed.
- Recreational (hunting and fishing) activities are at a peak estimated level.

## 2.5. Evacuation Areas Modeled

NUREG/CR-7002 recommends that the EPZ be subdivided into evacuation areas for performing the evacuation time estimate analyses.[18] As indicated in Table 3, each evacuation area includes one or more affected PAZ's to support the various evacuation logic including keyhole and staged evacuations. Based on the geography and political boundaries in the EPZ, 19 unique areas were defined by IEM for the VEGP EPZ, in agreement with the SNC personnel. As shown in the lower part of Table 3, separate evacuation areas are modeled for the 0-2 mile zone and the 2-5 mile zone to support protective action decision making for a staged evacuation.

[18] NUREG/CR-7002. Table 1-4, p.8.

## Table 3: Evacuation Areas for a Staged Evacuation Keyhole

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | F-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0–2 miles | X | | | | | | | | | | | | |
| A, B-5, C-5, D-5, E-5, F-5 | 0–5 miles | X | X | X | X | X | X | | | | | | | |
| All Evacuation Zones | 0-10 miles, Full EPZ | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Evacuate 2 to 5 miles downwind** | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (EPRAs) | | | | | | | | | | | | |
| | | **A** | **B-5** | **C-5** | **D-5** | **E-5** | **F-5** | **B-10** | **C-10** | **D-10** | **E-10** | **F-10** | **G-10** | **H-10** |
| B-5, C-5 | N | | X | X | | | | | | | | | | |
| B-5, C-5 | NNE | | X | X | | | | | | | | | | |
| B-5, C-5, D-5 | NE | | X | X | X | | | | | | | | | |
| C-5, D-5, E-5 | ENE | | | X | X | X | | | | | | | | |
| D-5, E-5 | E | | | | X | X | | | | | | | | |
| D-5, E-5, F-5 | ESE | | | | X | X | X | | | | | | | |
| E-5, F-5 | SE | | | | | X | X | | | | | | | |
| F-5 | SSE | | | | | | X | | | | | | | |
| F-5 | S | | | | | | X | | | | | | | |
| F-5 | SSW | | | | | | X | | | | | | | |
| N/A | SW | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| N/A | WSW | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B-5 | W | | X | | | | | | | | | | | |
| B-5 | WNW | | X | | | | | | | | | | | |

| Affected PAZs (ERPAs) | Evacuation Area | A | B-5 | C-5 | D-5 | E-5 | F-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-5 | NW | | X | | | | | | | | | | | |
| B-5 | NNW | | X | | | | | | | | | | | |
| Evacuate 2-mile zone and 5-miles downwind | | | | | | | | | | | | | | |
| | Wind Direction (from) | Affected PAZs (EPRAs) | | | | | | | | | | | | |
| | | A | B-5 | C-5 | D-5 | E-5 | F-5 | B-10 | C-10 | D-10 | E-10 | F-10 | G-10 | H-10 |
| A, B-5, C-5 | N | X | X | X | | | | | | | | | | |
| A, B-5, C-5 | NNE | X | X | X | | | | | | | | | | |
| A, B-5, C-5, D-5 | NE | X | X | X | X | | | | | | | | | |
| A, C-5, D-5, E-5 | ENE | X | | X | X | X | | | | | | | | |
| A, D-5, E-5 | E | X | | | X | X | | | | | | | | |
| A, D-5, E-5, F-5 | ESE | X | | | X | X | X | | | | | | | |
| A, E-5, F-5 | SE | X | | | | X | X | | | | | | | |
| A, F-5 | SSE | X | | | | | X | | | | | | | |
| A, F-5 | S | X | | | | | X | | | | | | | |
| A, F-5 | SSW | X | | | | | X | | | | | | | |
| A | SW | X | | | | | | | | | | | | |
| A | WSW | X | | | | | | | | | | | | |
| A, B-5 | W | X | X | | | | | | | | | | | |
| A, B-5 | WNW | X | X | | | | | | | | | | | |
| A, B-5 | NW | X | X | | | | | | | | | | | |
| A, B-5 | NNW | X | X | | | | | | | | | | | |

# 3.0 POPULATION AND VEHICLE DEMAND ESTIMATION

IEM identified three population segments[19] within the EPZ surrounding VEGP, as specified in the NUREG/CR-7002 guidelines. These populations include the permanent residents and transient population, transit dependent permanent residents, and school population. The permanent resident population is made up of individuals residing in the 10-mile EPZ. The transient population is comprised of individuals working and/or visiting within the EPZ but not living there. The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). The school population consists of students and staff and may require additional consideration in the event of an evacuation.

VEGP is located in a densely-wooded rural area of Georgia. There are no concentrated population centers, and there is minimal transient population with in the 10-mile EPZ. The transient facilities include the VEGP plant and the recreational attraction sites that consist of parks and the hunter/boater population. There are no special facility populations within the 10-mile EPZ. The only school is a private school (The Lord's House of Praise Christian School).The majority of the population consists of permanent residents, workers, school students, and a varying number of recreational visitors who are mainly located on or around the Savannah River.

IEM derived the 2012 permanent population estimates, as well as business location data, from 2010 Census, the 2012 Plant Vogtle TAR Database, the SNC 2012 first-quarter population estimates, and the population estimates obtained from Synergos Technologies, Inc. Local school data was obtained through contact with the individual facility. The recreational visitors' population figures were based on discussions with the SNC emergency planning staff. After discussion with the appropriate facilities and the site emergency planning personnel, it was estimated that the 2010 school and recreational user information applies to the year 2012 since no major change in the land use pattern within the EPZ. These population estimates formed the basis for determining the evacuee demand used in the analyses for any given evacuation scenario. The populations from these sources were assigned to each applicable zone.

## 3.1. Permanent Residents

IEM used GIS software to process the geographic data and associated population counts for census blocks in each of the counties surrounding VEGP. IEM then aggregated these populations over each zone to generate a permanent resident population count, which is comprised of the nighttime population.

To calculate population by each zone and radial sector, census block populations were aggregated within each of the sectors. Since boundaries of the sectors do not follow census block boundaries, many of the blocks had to be divided into sub-areas based on

[19] Special facilities, as defined in NUREG/CR-7002, were not identified in the 10-mile EPZ.

sector boundaries. To do this, IEM overlaid the census blocks with the zones and 10-mile radius sectors. The blocks were then split into sub-areas and allocated the block population to the sub-areas based on an area ratio method. The populations of the block sub-areas within the sector boundaries were then aggregated for each radius sector.
The area ratio method assigns each sub-area a portion of the block population based on the ratio of the area of each block part to the area of the entire block. For example, if a particular sub-area contains one-fourth the area of the total block area, the sub-area receives one-fourth of the block's total population. Figure 3 illustrates this principle, in which one-fourth of the total area is located in the sub-area and it includes one-fourth of the population. The area ratio method assumes that the population within the block is evenly distributed, a reasonable assumption in most cases.

The populations of the block sub-areas within the sector boundaries were then aggregated for each sector. This method was also used in the few instances in which the zone boundaries did not follow block boundaries, making it necessary to split blocks along a particular zone boundary. Additionally, the permanent resident population is divided into auto-owning versus non-auto-owning populations.

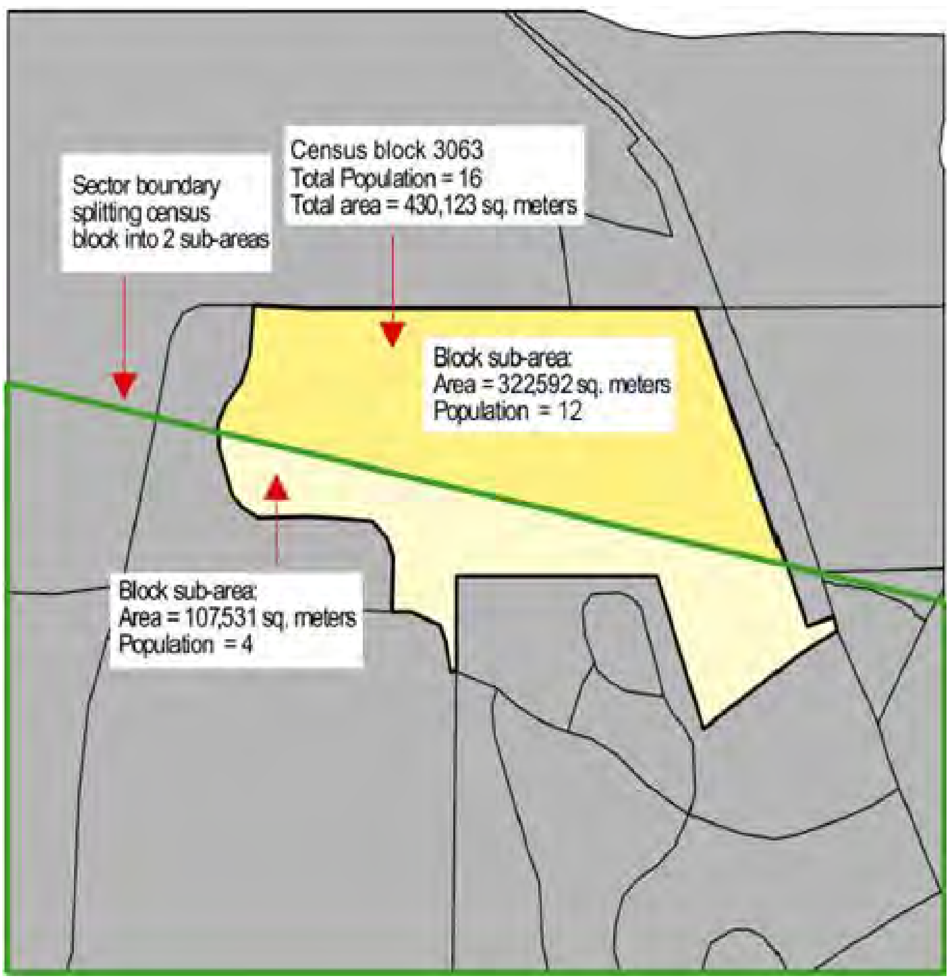


**Figure 3: Example of the Area Ratio Method Applied to a Census Block Divided into Sub-Areas**

### 3.1.1. Auto-Owning Population

IEM collected information for auto-owning population by conducting a telephone survey of the residents within the VEGP EPZ. The survey indicates an average household size of 2.6 persons for the VEGP EPZ. The collected data also indicate that 96% of the households within the EPZ have more than one vehicle per household. Additionally, the respondents indicated that each household would use an average of 1.7 to 1.8 vehicles during the evacuation depending on the day of the week and time of the day.

### 3.1.2. Non-Auto-Owning Population

The telephone survey indicates that 4% of the households within the EPZ do not own a vehicle. It is assumed that privately-owned vehicles of friends and/or relatives will be available to evacuate the majority of this population component. This assumption is used since it provides the most realistic representation of evacuation traffic generated from the non-auto-owning households. For an estimate of the vehicle demand associated with the non-auto-owning population, IEM assumed one vehicle would be made available to evacuate each household. This is based on the assumptions stated above that a family would use a vehicle from neighbors, friends, and relatives, or they will be evacuated through coordinated efforts by county emergency management officials.

### 3.1.3. Resident Population Summary

Table 4 shows the distribution of the 2012 total permanent resident population (including the shadow evacuation population in the 10 to 15 mile area) by sector and ring, while Figure 4 presents the same data for 2-5 mile, 5-10 mile, and 10-15 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 4: 2012 Permanent Resident Population Distributions by Sector and Ring**

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 42 | 42 |
| 2-3 | 91 | 133 |
| 3-4 | 155 | 288 |
| 4-5 | 360 | 648 |
| 5-6 | 367 | 1,015 |
| 6-7 | 468 | 1,483 |
| 7-8 | 722 | 2,205 |
| 8-9 | 489 | 2,694 |
| 9-10 | 554 | 3,248 |
| 10-11 | 1,009 | 4,257 |
| 11-12 | 1,878 | 6,135 |

| Population Mile | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 12-13 | 2,878 | 9,013 |
| 13-14 | 3,103 | 12,116 |
| 14-15 | 4,326 | 16,442 |

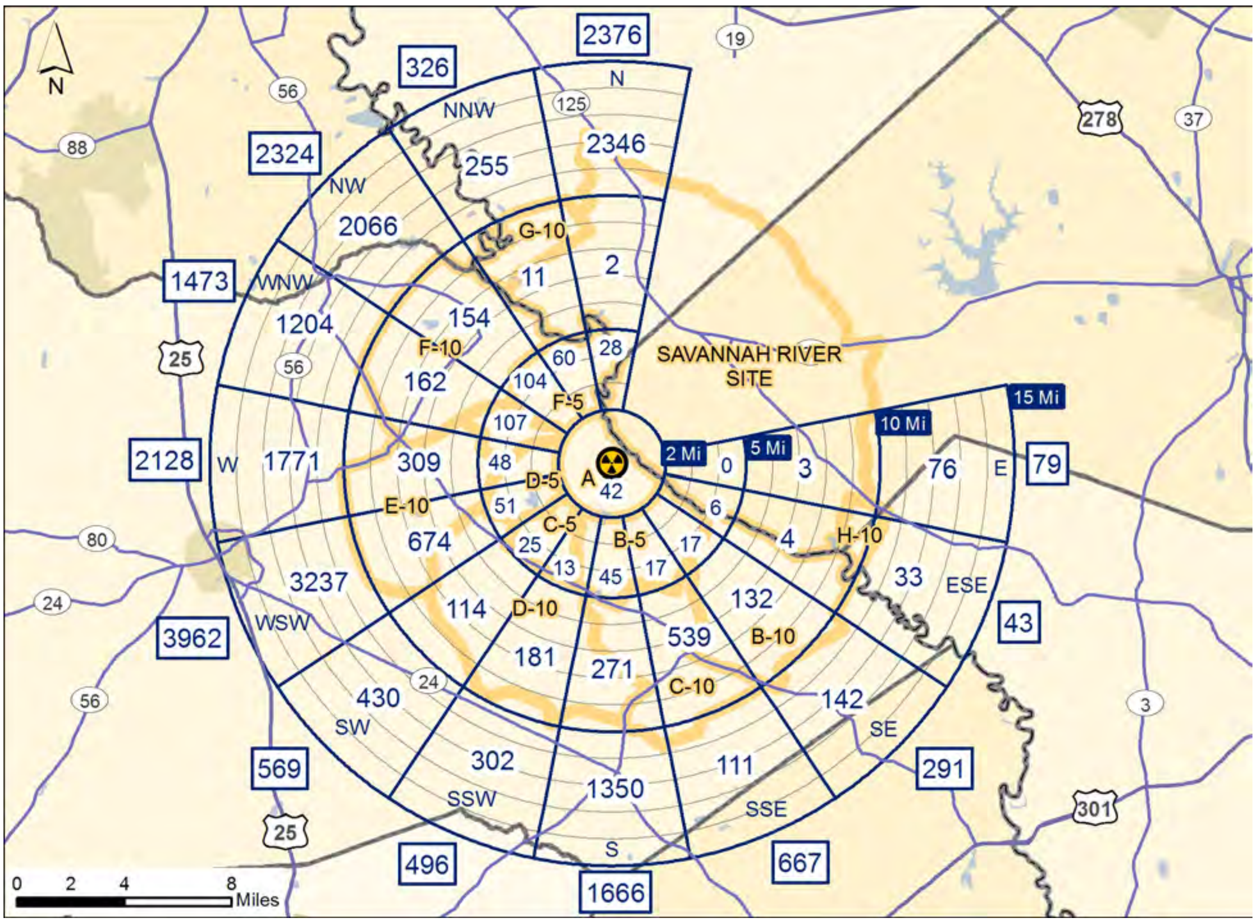

**Figure 4: 2012 VEGP Sector and Ring Permanent Resident Population Map**

Table 5 shows the distribution of the permanent resident population by zone.

**Table 5: 2012 Permanent Resident Population Distributions by Zones**

| Zone | Permanent Resident Population |
|---|---|
| A | 71 |
| B-5 | 51 |
| B-10 | 249 |
| C-5 | 31 |
| C-10 | 739 |
| D-5 | 93 |
| D-10 | 588 |
| E-5 | 89 |
| E-10 | 510 |
| F-5 | 141 |
| F-10 | 492 |
| G-10 | 6 |
| H-10 | 20 |

## *3.2. Transient Populations*

The transient population for the VEGP EPZ area is derived from a combination of daytime populations, recreation populations, and employment data. The employment data was obtained from Synergos Technologies. These populations were combined with other contributors, such as the percentage of the population that is of working age, to daytime population estimations and assigned to population centroids in a manner similar to the permanent resident populations. The daytime populations incorporate employment and workforce information, such as county working-age population and unemployment statistics.

The recreational population shown for the VEGP site considers users of private land and wildlife management areas by hunters and fishermen along the Savannah River. Through conversations with SNC's emergency planning staff, IEM estimated recreational population approximates within the EPZ. There are three public boat landings in the VEGP EPZ. Two are in Burke County, Georgia—the Vogtle Boat Landing in zone B-5 and Brigham's Landing in zone B-10. The third boat landing is in Aiken County, South Carolina—Grays Landing located in zone G-10. It is estimated that there will be 200 hunters/boaters in zones G-10 and H-10 during the hunting season.

A vehicle occupancy rate of 1.0 was used to estimate the number of vehicles used by recreational area users, such as hunters and fishermen.

Table 6 shows the distribution of the transient population by sector and ring, while Figure 5 presents the same data for 0-2 mile, 2-5 mile, and 5-10 mile 22.5 degree sectors graphically. Note that the population numbers in the box outside the 15 mile radius do not include the population within the 2 mile radius.

**Table 6: 2012 Transient Population Distributions by Sector and Ring**

| Population Miles | Subtotal by Ring | Cumulative Population |
|---|---|---|
| 0-2 | 2,173 | 2,173 |
| 2-3 | 23 | 2,196 |
| 3-4 | 56 | 2,252 |
| 4-5 | 236 | 2,488 |
| 5-6 | 114 | 2,602 |
| 6-7 | 81 | 2,683 |
| 7-8 | 96 | 2,779 |
| 8-9 | 49 | 2,828 |
| 9-10 | 79 | 2,907 |

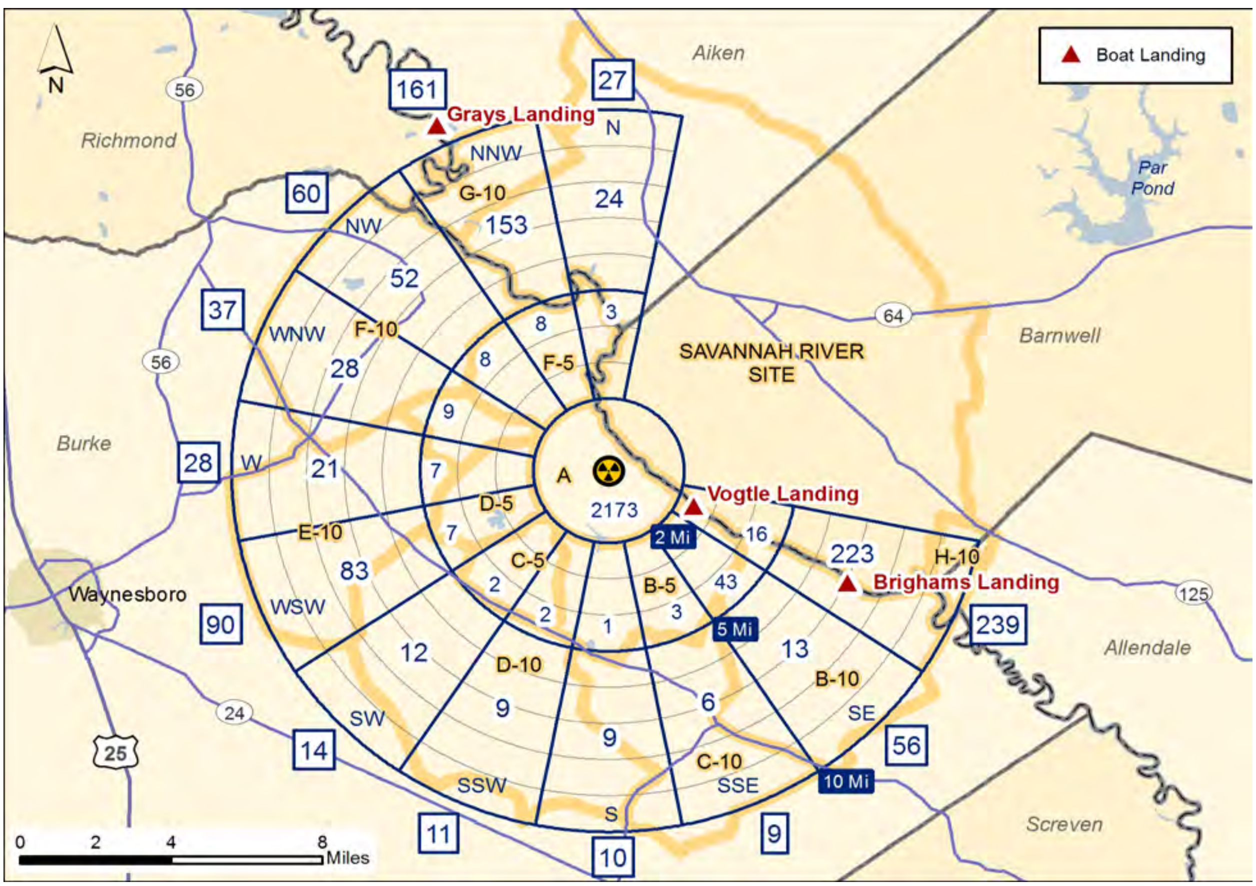


**Figure 5: 2012 VEGP Sector and Ring Transient Populations Map**

Table 7 shows the distribution of the transient population by zone.

**Table 7: 2012 Transient Population Distributions by Zones**

| Zone | Transient Population |
|---|---|
| A | 2,173 |
| B-5 | 56 |
| B-10 | 44 |
| C-5 | 3 |
| C-10 | 12 |
| D-5 | 9 |
| D-10 | 32 |
| E-5 | 10 |
| E-10 | 96 |
| F-5 | 21 |
| F-10 | 59 |
| G-10 | 200 |
| H-10 | 200 |

### 3.2.1. Transient Facilities

The transient facilities consist of the VEGP site and a few hunter/boater recreational attraction sites. VEGP is the largest employer in the EPZ, which has peak number of workers at 2,882 during the weekdays. The construction workforce at VGEP is divided into two categories: permanent and temporary. The permanent construction workers would stay for a period of two years or longer and would bring families. The temporary construction workers would stay for less than two years and would not bring family. The permanent construction workers are assumed to be housed outside the VEGP EPZ, and the temporary construction workers are assumed to be housed inside the VEGP EPZ at a temporary housing location. SNC emergency planners estimate that a total of 203 temporary workers would be living at the temporary housing location in 2012.

The peak recreational population occurs on fall weekend periods during the hunting season (normally mid-September through early January). It is estimated that approximately one seventh of peak recreational population is expected for other scenarios (weekday and weeknight). Table 8 shows the peak and average transient populations.

**Table 8: 2012 Peak and Average Transient Population**

| Facility Type | Facility Name | County | Zone | Peak Population | Average Population | Percent of Resident |
|---|---|---|---|---|---|---|
| Employer | Vogtle Electric Generating Plant | Burke | A | 2,882 | 898 | 25% |
| Boat Landing | Vogtle Boat Landing | Burke | B-5 | 50 | 8 | 50% |
| Boat Landing | Brigham's Landing | Burke | B-10 | 50 | 8 | 50% |
| Boat Landing | Gray's Landing | Aiken | G-10 | 50 | 8 | 50% |

## 3.3. Transit Dependent Permanent Residents

The transit dependent population includes permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate (e.g., lift equipped vehicles or ambulances). The transit dependent permanent resident population in the VEGP EPZ was obtained from the county EMA through SNC emergency planning staff. As shown in Table 9 there are 29 transit dependent permanent residents in the 10-mile EPZ. A roster of these individuals is maintained in the Burke County EOC. The EMA Director maintains coordination with the County Health Department and County Department of Family and Children Services on maintenance of the roster and dispatching the Burke County Transit Authority to evacuate as needed.

**Table 9: Transit Dependent Permanent Residents**

| Transit Dependent Category | Burke County | Aiken County | Allendale County | Barnwell County |
|---|---|---|---|---|
| Wheelchair | 18 | 0 | 0 | 0 |
| Transportation | 10 | 0 | 0 | 0 |
| Immobile | 1 | 0 | 0 | 0 |

To evacuate the transit dependent permanent residents, the Burke County Board of Education has 83 county school buses that will travel their regular routes to provide transportation to those individuals lacking personal transportation.[20] The Burke County Transit Authority has three 14-passenger standard vans with low band radio communications, four 10-passenger coaches with wheelchair lifts and low band radio communications, and one 16-passenger coach with a wheelchair lift and low band radio communications. In addition, the Burke County EMA has a total of 12 ambulances. The special equipped vehicles and ambulances will be dispatched directly to the homes of non-ambulatory individuals requiring special transportation. The key information for evacuating the transit dependent population is shown in Table 10. The information shown includes the number of transit dependent permanent residents by category, number of evacuation vehicles by type and its mobilization time, and evacuee loading time.

[20] Annex D – Plant Vogtle – Burke County Emergency Management Radiological Plan. Attachment H – Evacuation and Sheltering.. May 2009.

**Table 10: Transit Dependent Permanent Resident Evacuation Information**

| Transit Dependent Category | Population | Number of Vehicles | Mobilization Time | Loading Time |
|---|---|---|---|---|
| Wheelchair | 18 | 5 | 15 min | 5 min |
| Transportation | 10 | 86[21] | 15 min | 2 min |
| Immobile | 1 | 12 | 10 min | 10 min |

## 3.4. Special Facility and School Populations

No special facilities, as defined in NUREG/CR-7002, were found within the EPZ; however, IEM identified one private school—Lord's House of Praise Christian School—within the EPZ (Table 11). The key information for evacuating the population at this facility is shown in Table 12. The information shown includes the enrollment, number of evacuation vehicles and its mobilization time, evacuee loading time and distance from the facility to the EPZ boundary.

Although the school will require special consideration in an evacuation, it is estimated there are a sufficient number of evacuation vehicles available and no return trips are needed. The Burke County Board of Education maintains all buses and equipment at the bus maintenance shop. The Burke County EMA Director will dispatch County busses to the school if needed. All evacuees from the school will check in at the reception center at the Burke County Comprehensive High School located at 1057 Perimeter Road in Waynesboro[22], prior to being evacuated to their final destination. Figure 6 shows the location of these facilities.

**Table 11: School Locations**

| Facility Name | Address | City | County | Zone |
|---|---|---|---|---|
| Lord's House of Praise Christian School | 162 Daybreak Road | Waynesboro | Burke | E-10 |

**Table 12: School Evacuation Information**

| School Name | Population | | Number of Buses | Mobilization Time | Loading Time | Distance to EPZ Boundary |
|---|---|---|---|---|---|---|
| | Student | Staff | | | | |
| Lord's House of Praise Christian School | 50 | 20 | 2 | 15 min | 25 min | 1.4 mi |

[21] The number of vehicles available for transportation dependent residents include 83 county school buses and 3 standard passenger vans.
[22] Annex D – Plant Vogtle – Burke County Emergency Management Radiological Plan. May 2009. Attachment H – Evaucaiton and Sheltering. May 2009.


Figure 6: Map of Schools within the EPZ

## 3.5. Vehicle Occupancy Rate

Different vehicle occupancy rates (VOR) were used for the various categories of population (e.g., 1.7-1.8 vehicles per household for permanent residents). All workers were assumed to evacuate with a VOR of 1.25, whereas the recreational population was assumed to evacuate with a VOR of 1.5. After consultation with SNC emergency planners, students were assumed to evacuate via two buses at a rate of 25 students per bus, with the remaining school population departing in their own cars (occupancy rate of 1.0). Table 13 shows the VORs by different population categories used for the evacuation modeling.

**Table 13: Vehicle Occupancy Rates by Population Categories**

| Population Category | Population Subtype | Vehicle Occupancy Rate |
|---|---|---|
| Permanent Residents | Auto-Owning Permanent | 1.7-1.8 |
| | Non-Auto-Owning Permanent | 2.6 |
| Transients | Work Force Transients | 1.25 |
| | Recreational Transients | 1.5 |
| School | Students | 25 |
| | Staff | 1 |

## 3.6. Summary of Demand Estimation

The total evacuation population and vehicles for different types and different scenarios are summarized in Table 14 and Table 15. There are more resident evacuees during the night and weekend because people do not need to commute to work or school at those times. Transient evacuees are at its peak level during the weekday because the majority is workers. There is also a significant amount of transient population during the weekend when the recreational population is at its peak level. It is assumed that there are few transient evacuees during the night. The shadow evacuees, who are assumed to be 20% of residents in the 10-15 mile ring, remain the same for the weeknight and weekend scenarios. They are relatively less during the weekday because a portion of the residents commute to work or school. As the vehicle occupancy rates for residents (including shadow evacuees) and transient population are determined by telephone survey and vary by scenario, the evacuation can be different for different scenarios, even if the population remains the same.

**Table 14: Population Summary Table**

| Scenario | Permanent residents | Transients | Schools | Transit Dependent | Shadow Population |
|---|---|---|---|---|---|
| Weekday | 1,746 | 2,433 | 70 | 29 | 1,492 |
| Weeknight | 3,119 | 78 | - | 29 | 2,665 |
| Weekend | 3,119 | 340 | - | 29 | 2,665 |

**Table 15: Vehicle Summary Table**

| Scenario | Permanent residents | Transients | Schools | Transit Dependent | Shadow Population |
|---|---|---|---|---|---|
| Weekday | 1,136 | 1,947 | 22 | --- | 1,465 |
| Weeknight | 1,699 | 63 | - | --- | 2,229 |
| Weekend | 1,796 | 239 | - | --- | 2,313 |

# 4.0 EVACUATION ROADWAY NETWORK

The evacuation routes were modeled based on the information provided in the VEGP 2012 Emergency Information Calendar. Additional information regarding the evacuation routes was obtained from the past VEGP ETE report and the county REP. Maps and descriptions in both documents were used by IEM as the basis of network verification activity. IEM personnel also met with the VEGP emergency response planning staff and county emergency preparedness officials regarding additional information and clarifications.

The 2012 emergency information calendar included a detailed description of the evacuation routes for each zone within the 10-mile radius plume exposure pathway EPZ. It provided descriptive information on recommended protective actions and the names and locations of reception centers for each PAZ. The map in the calendar clearly marks the evacuation routes and the direction of evacuation towards the respective reception centers. The reception centers are located well beyond the 10-mile EPZ.

IEM personnel drove along the designated evacuation routes in the direction of an evacuation, as marked in the 2012 emergency information calendar to collect complete and accurate information about the physical state of the roads. Any differences between information indicated in the calendar, NAVTEQ data, and existing field conditions were noted and were incorporated into the analyses, as necessary. Figure 7 shows the entire evacuation network (including the routes for shadow evacuees) that is modeled.

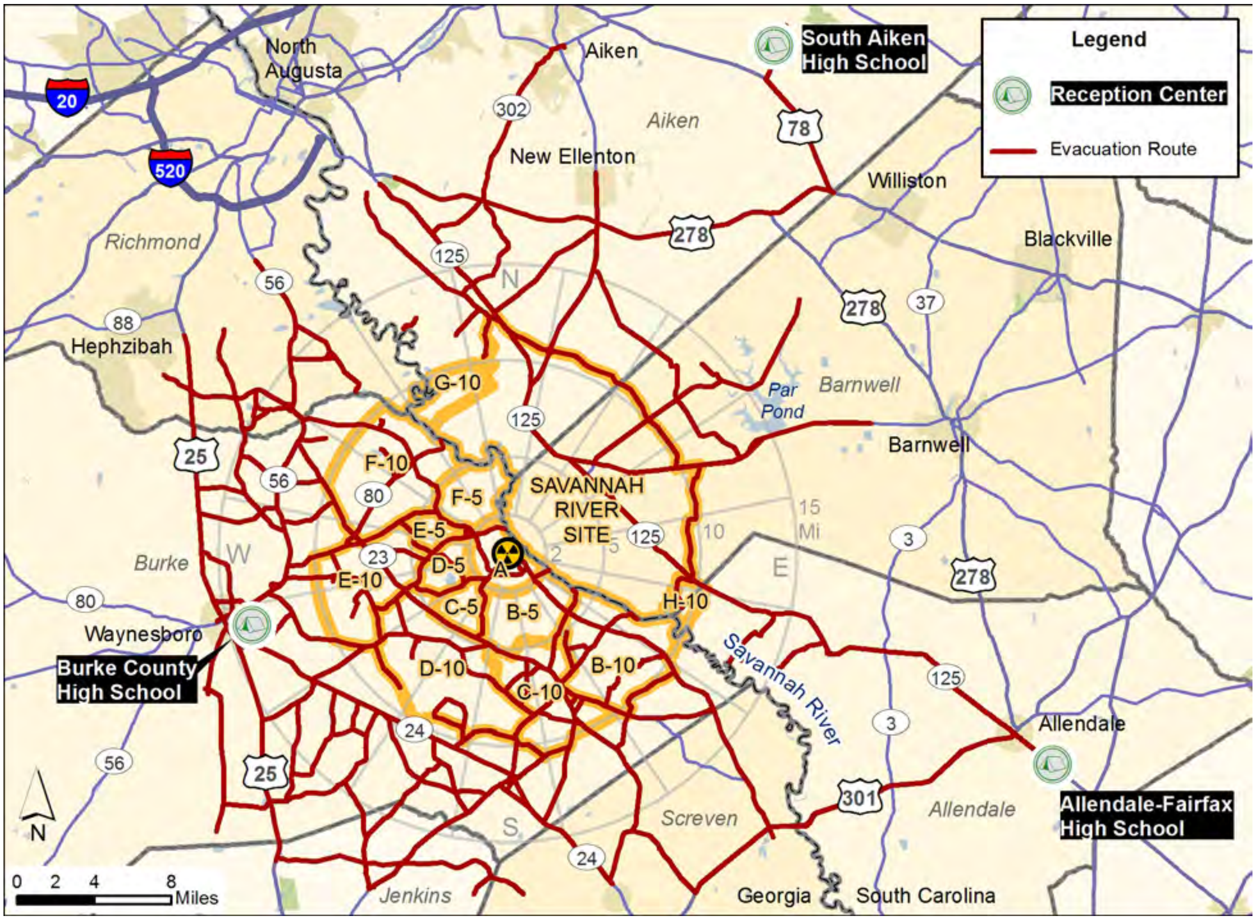


Figure 7: VEGP Evacuation Network

## 4.1. Network Definition

IEM performed a complete review of the evacuation roadway network. The evacuation network was developed using published evacuation routes and GIS road network data representing roads available from NAVTEQ[23] and the Georgia Department of Transportation (GDOT).[24] The high accuracy NAVTEQ street network GIS data, obtained for the PTV Vision simulation software, was used for field validation purposes and to build the digital evacuation network database. The GDOT data was used to supplement the NAVTEQ data where required. To ensure the accuracy of this data, the entire evacuation network, including those roads outside the 10-mile EPZ leading to the reception centers, was verified by traveling each route in the network in the direction of evacuation and collecting detailed information regarding the properties of each road section using a Global Positioning System (GPS)-enabled device. The GPS allowed locating—with a high degree of precision—any sections that had changed in channelization, curvature, speed limits, or other necessary network information.

[23] PTV America, Inc. "NAVTEQ Data for PTV VISION." Online: http://www.ptvamerica.com/navteq_tiles/index.html.
[24] Georgia Department of Transportation. Online http://www.dot.state.ga.us/. GDOT road network data was downloaded from the Georgia GIS Clearinghouse website at https://gis1.state.ga.us/index.asp.

The specific network attributes that were collected during the field trip included number of lanes, speed, turns, traffic controls, pavement type and width, shoulder width, and any other information required to model the traffic capacity of each link in the network. The information collected during the field visit is listed as follows.

- *Land width* (in feet, field observation)
- *Shoulder width* (in feet, field observation)
- *Number of lanes* (field observation)
- *FFS* (in mph, field observation)
- *Speed limit* (in mph, field observation)
- *Intersection control method:* actuated signal, fixed timing signal, stop sign controlled, yield sign controlled, uncontrolled (field observation )
- Intersection layout (taking pictures)
- Toll gates and lane channelization (taking picture)
- *Access control*: whether road has full access control (field observation)
- *Median type*: divided or undivided cross section (road has divided cross section with >=4 ft median or curbed barrier median, note that two way left turn lanes can be considered as >4 ft median for evacuation scenarios) (field observation)
- *Pavement type*: whether the road is paved or not (field observation)
- *Terrain type*: level, rolling or mountainous area (field observation)
- *Separation line*: whether the two travel directions are separated by center lines (field observation)

## 4.2. Evacuation Route Descriptions

The evacuation network modeled for the ETE analyses covers Burke County in Georgia, and Aiken, Barnwell, and Allendale Counties in South Carolina. The evacuation routes were originally developed to permit a general radial travel pattern away from the plant toward the designated reception center. The evacuation route network is composed of three kinds of roads: highways, major arterial (roads connecting to highways), and minor arterial or connector roads (residential roads connecting to major arterial roads).

Examples of state highways are GA Hwy 23 and GA Hwy 80. Examples of major arterials are Ben Hatcher Road and Thompson Bridge Road. Examples of connector roads are Claxton-Lively Road and Thomas Road. The connector roads, although not part of the evacuation routes as described in the 2012 emergency information calendar, actually load the evacuee population (in cars) onto the evacuation routes composed of highways, major, and minor arterial roads. The following items are descriptions of each evacuation route as mentioned in the calendar (see also Figure 8).

## Evacuation Route 1

- Ben Hatcher Road to Shell Bluff Spur to Georgia Hwy 80 to Georgia Hwy 56 to Perimeter Road to Burke County High School.

## Evacuation Route 2

- Hancock Landing Road to Botsford Church Road to Seven Oaks Road to Cates Mead Road to Hwy 56 to Perimeter Road to Burke County High School.

## Evacuation Route 3

- Ebenezer Church Road to Hwy 23 to Thompson Bridge Road to Georgia Hwy 24 to Perimeter Road to Burke County High School.

## Evacuation Route 4

- Brigham's Landing Road to Georgia Hwy 23 to Tom Bargeron Road to Georgia Hwy 24 to Perimeter Road to Burke County High School.
- Royal Road to Stoney Bluff Road to Georgia Hwy 23 to Tom Bargeron Road to Georgia Hwy 24 to Perimeter Road to Burke County High School.

## Evacuation Route 5 (Zone G-10, Cowden Plantation)

- West on County Road 5 to County Road 63 north to County Road 57 west to U.S. Hwy 278 north to South Carolina Hwy 302 north to South Aiken High School.

## Evacuation Route 6 (Zone H-10, Creek Plantation)

- South on South Carolina Hwy 125 to U.S. Hwy 278 to Allendale-Fairfax High School.

Each evacuation route leads to one of three designated reception centers. Table 16 lists the designated reception centers, their physical addresses, and associated evacuation route numbers, as listed in the 2012 emergency information calendar. Figure 8 illustrates the designated evacuation routes with numbers that lead to the designated reception areas.

**Table 16: Reception Centers**

| Reception Center | Address | Evacuation Routes |
|---|---|---|
| Burke County High School | 1057 Perimeter Road<br>Waynesboro, GA 30830 | 1, 2, 3, 4 |
| South Aiken High School | 232 E Pine Log Road<br>Aiken, SC 29803 | 5 |
| Allendale-Fairfax High School | 3581 Allendale-Fairfax Highway<br>Fairfax, SC 29827 | 6 |

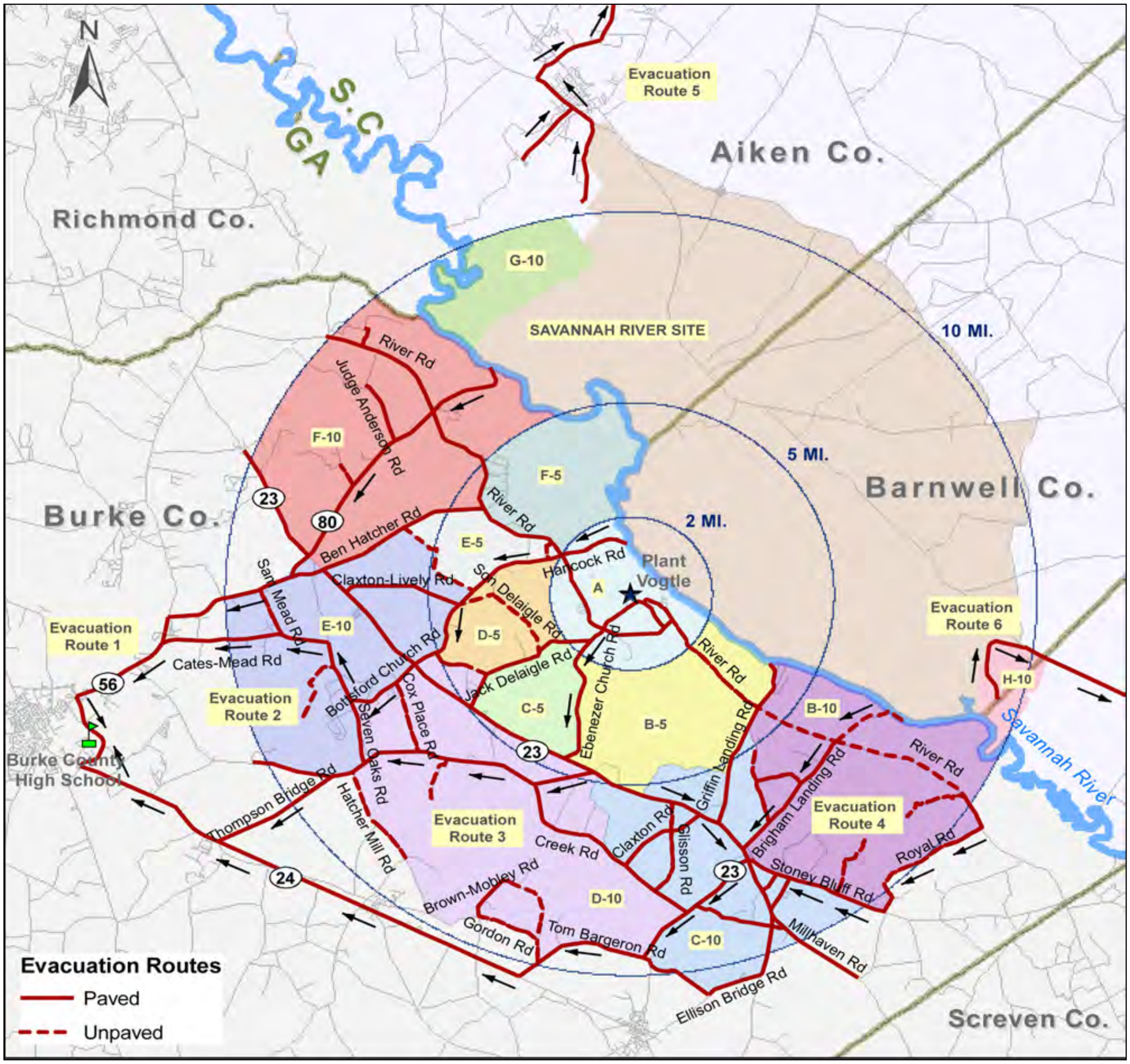


**Figure 8: Designated Evacuation Routes and Reception Centers**

## 4.3. Evacuation Network Characteristics

The evacuation network, as modeled using the NAVTEQ street network data, contains 377 links[25] in the direction of evacuation and includes the connector roads. The total length of the modeled network, again in the direction of evacuation and all the way to the

[25] A link is defined as a road section where its characteristics (e.g., speed limit and number of lanes) are constant. An intersection starts a new link or ends a link.

reception centers, is about 671.4 miles. Detailed information regarding the roads that make up the evacuation network is provided in Appendix B.

The state highways generally have a posted speed limit of 55 mph. The major and minor arterial or connector roads generally have a posted speed limit of 45 mph. On some of the roads, especially the highways, the posted speed limit decreases to 35 mph near city limit boundaries. Unpaved roads or dirt roads have randomly posted speed limits, so a speed limit of 20-25 mph was assumed for modeling purposes based on comfortable and safe driving speeds achieved by IEM personnel on these roads during field verification. Most of the links in the evacuation network (including highways) generally have one lane available in the direction of evacuation. There are no interstates within the 10-mile plume exposure pathway EPZ. Perimeter Road is the only road that has at least two lanes available in the direction of evacuation. Other roads that have network links with two lanes are River Road, SC 302 (Pine Log Road inside Aiken City limits), and SC 125 (Augusta Highway in Allendale City limits).

Traffic control along the evacuation routes is mostly managed using stop signs. Traffic lights were found at Perimeter Road, Pine Log Road, and Augusta Highway. However, they are either replaced by manned control during the evacuation or located way beyond the EPZ with little impacts on the ETE. Therefore, no fixed timing traffic signal is modeled in the evacuation network.

The number of intersections for different control types during the evacuation is listed in Table 17. There are 32 intersections that will be manned controlled and are modeled as actuated signal controlled, with varied cycle length.

**Table 17: Intersection Control Type**

| Control Type | Number of Intersections |
|---|---|
| Stop sign Control | 64 |
| Signal Control | 0 |
| Manned Control | 32 |

The key information for the ten highest volume intersections is listed in Table 18. The majority of these intersections are manned controlled. However, there are three stop sign control intersections. It is recommended to set up manned control for these busy intersections to facilitate the traffic flow and avoid potential extensive delay.

**Table 18: Information for Ten Highest Volume Intersections**

| Location | Control Type | Cycle Length | Green Time | Evacuation Direction Turn | Turning Lane Queue Capacity (# vehicle)* |
|---|---|---|---|---|---|
| Thompson Bridge Road at GA-24 | Stop sign | N/A | N/A | Right turn from Thompson Bridge Road to GA-24 | 1 |
| US-25/Perimeter Road at Burke County High School | Manned | Vary | 0 - 2 min | Left and right turn from US-25 to Burke County High School | 13 |
| GA-24 and US-25/Perimeter Road | Manned | Vary | 0 - 2 min | Right turn from GA-24 to US-25 | 13 |
| GA-56 at US-25/Perimeter Road | Manned | Vary | 0 - 5 min | Left turn from GA-56 to US-25 | 8 |
| Bates Road at GA-56 | Stop sign | N/A | N/A | Left turn from Bates Road to GA-56 | 0 |
| Cates Mead Road at GA-56 | Manned | Vary | 0 - 2 min | Left turn from Cates Mead Road to GA-56 | 0 |
| Shell Bluff Spur at GA-80 | Manned | Vary | 0 - 2 min | Left turn from Shell Bluff Spur at GA-80 | 0 |
| GA-80 at GA-56 | Manned | Vary | 0 - 5 min | Left turn from GA-80 to GA-56 | 0 |
| Hatchers Mill Road at Thompson Bridge Road | Manned | Vary | 0 - 5 min | Left turn from Hatchers Mill Road to Thompson Bridge Road | 0 |
| Bates Road at Thompson Bridge Road | Stop-sign Controlled | N/A | N/A | Right turn from Bates Road to Thompson Bridge Road | 0 |

* Queue capacity for turning lane of the evacuation direction

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# 5.0 EVACUATION TIME ESTIMATE METHODOLOGY

ETEs were developed using VISUM 11, one of the core components of the PTV Vision software suite. VISUM is used to estimate evacuation times for different scenarios (e.g., day vs. night or normal vs. adverse weather) for user-defined spatial networks. Information provided by PTV Vision includes evacuation or clearance times, operational characteristics (e.g., average evacuation speed, average distance traveled), points of congestion, and other data necessary to evaluate evacuation plans.

The evacuation network was defined based on the information provided in the 2012 emergency information calendar. IEM subject matter experts drove the designated routes to ensure complete and accurate information about the state of the roads and to evaluate the appropriate selection of routes given the current conditions onsite.

Evacuation demand (in term number of vehicles) loaded onto the network is based on the data and methods described above in the Section 3.0. Loading times for the evacuation network are described below. Additional details about the methodology are included in the following sections.

## 5.1. Loading of the Evacuation Network

In the event of an emergency, the public notification will mark the beginning of the evacuation times. So, public behavior (how long it takes the population to learn of the emergency and begin to evacuate) will impact the ETEs. The loading time distributions, also known as "trip generation times," described in this section are measured from the public notification, rather than from the occurrence of a hypothetical event.

### 5.1.1. Trip Generation Events and Activities

NUREG/CR-7002 requires planners estimate the amount of time for the public to begin evacuating. These elapsed times are represented as statistical distributions to reflect the variety of activities the public may undertake before evacuating. In addition, separate distributions are prepared for each population group, because, for example, a person evacuating from home will behave differently than someone who is at work, fishing, or in a nursing home, This is due to differences in their available alert systems and also systematic differences in their pre-evacuation preparations.

#### (i) Evacuation Events and Activities Series for Different Population Groups

The trip generation process consists of a series of events and activities. Each event occurs at an instant in time and is the outcome of an activity. Activities are undertaken over a period of time. As shown in Figure 9, Figure 10, and Figure 11, different population groups have different events and activity series for evacuation.

In these figures, circles represent events. Each event is coded by a number, which represents the following:

1. First notification of public
2. Individual's awareness of incident
3. Leave work/facilities
4. Arrive home
5. Leave home

An arrow indicates an activity. The following describe the activities that take place between each event:

- 1 → 2: Receive notification
- 2 → 3: Prepare to leave work/facilities
- 3 → 4: Travel home
- 2 → 5: Prepare to leave home

Transient evacuees, including travelers, boaters, hunters, and employees living outside the EPZ, will follow Series A as shown in Figure 9. They will be notified of the event and will leave their activities.

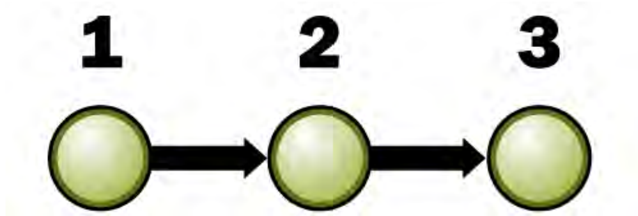


**Figure 9: Evacuation Events and Activity Series for Transients, Special Facilities (Series A)**

Households that do not have to wait for household members to return home will be notified of the emergency and leave home, following Series B, shown in Figure 10.

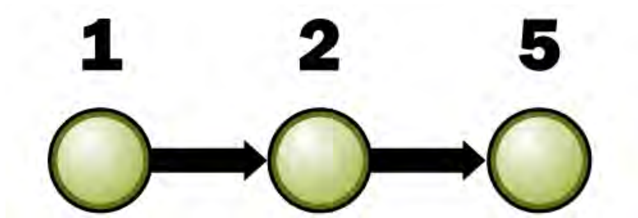


**Figure 10: Evacuation Events and Activity Series for Residences without Family Members Returning Home (Series B)**

The results of a phone survey suggest around 48% of residences have regular commuters who would wait for household members to return home before evacuating. This portion of the population will follow series C in Figure 11 to evacuate. Note the activities of the people at home (denoted with a subscript H) can be undertaken in parallel with those of the commuter (denoted with a subscript C). Specifically, an adult member of a household can prepare to leave home while others are traveling home from work. In this instance,

the household members would be able to evacuate sooner than a household that prepares to leave home after all members have returned home.

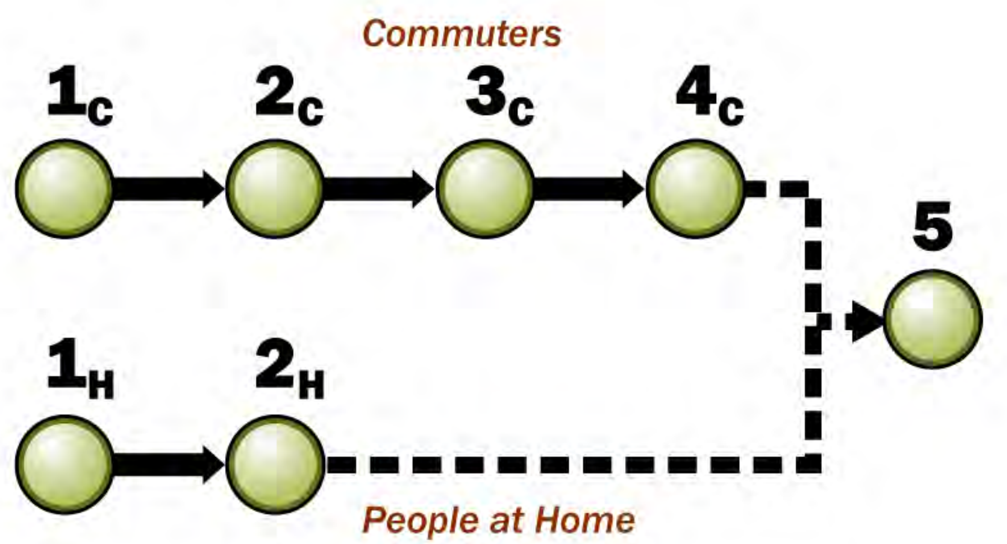


**Figure 11: Evacuation Events and Activity Series for Residences with Family Members Returning Home (Series C)**

### (ii) Calculation of Composite Distribution for Events and Activities Series in Evacuation

As indicated by NUREG/CR-7002, activities may be in sequence (i.e., an activity will be undertaken upon completion of a preceding event) or may be in parallel (i.e., two or more activities may take place over the same period of time). Given the assumption the time distribution of each activity is independent, the combined trip generation time required for individual activities undertaken in sequence would be the sum of the times required for each activity. On the other hand, the combined trip generation time required for individual activities undertaken in parallel would be the maximum of the times required for each activity. Table 19 shows the approach for estimating trip generation for different evacuation activity series.

**Table 19: Trip Generation Estimate for Different Evacuation Activity Series**

| Trip Generation Series | Composite Distribution Calculation |
|---|---|
| A | {1→2 + 2→3} |
| B | {1→2 + 2→5} |
| C | Max: {($1_C$→$2_C$ + $2_C$→$3_C$ + $3_C$→$4_C$), ($1_H$→$2_H$ + $2_H$→5)} |

### 5.1.2. Trip Generation Time Estimate

Trip generation consists of two phases of activities: notification (i.e., activity 1 → 2) and mobilization, which includes the rest of the activities. The notification process includes transmitting information and receiving and correctly interpreting the information that is transmitted. IEM adopted the time distribution for notification presented in *Evaluating Protective Actions for Chemical Agent Emergencies* (EPACAE).[26] This data was collected during evacuations executed in response to large-scale chemical spills and explicitly incorporates the time required for the communication of the warning. The data collected in this meta-study was based on transient, permanent, and special populations and is therefore appropriate to use as "general" notification curves for all three population types.

The underlying assumption in applying the EPACAE notification curves to a nuclear ETE study is the public perception of radiological emergencies is similar to that of a chemical event. These curves were developed from the empirical data collected from real-life evacuations in response to actual events, and no similar study developed specifically for radiological events is readily available. In the absence of such a study, empirical data from similar events was deemed to be more justifiable than estimating or hypothesizing about the public response to a nuclear event. IEM has successfully used this data for multiple ETE studies in the past, both for nuclear and chemical incidents or accident scenarios.

Since the EPACAE notification distribution of times depends on the warning system employed, IEM personnel incorporated the planned alert and notification systems (ANS) around the site, based on discussions with Southern Nuclear personnel. These discussions revealed the basic ANS within the VEGP EPZ will include sirens, Emergency Alert Systems (EAS) and tone alert radios (TAR). The notification time distributions for these warning systems are shown in Figure 12. Any loss in capability of the ANS components would potentially increase the notification times and, as a result, ETEs.

[26] Rogers, G. O., et al., *Evaluating Protective Actions for Chemical Agent Emergencies* (ORNL-6615), Oak Ridge, TN: Oak Ridge National Laboratory, 1990.

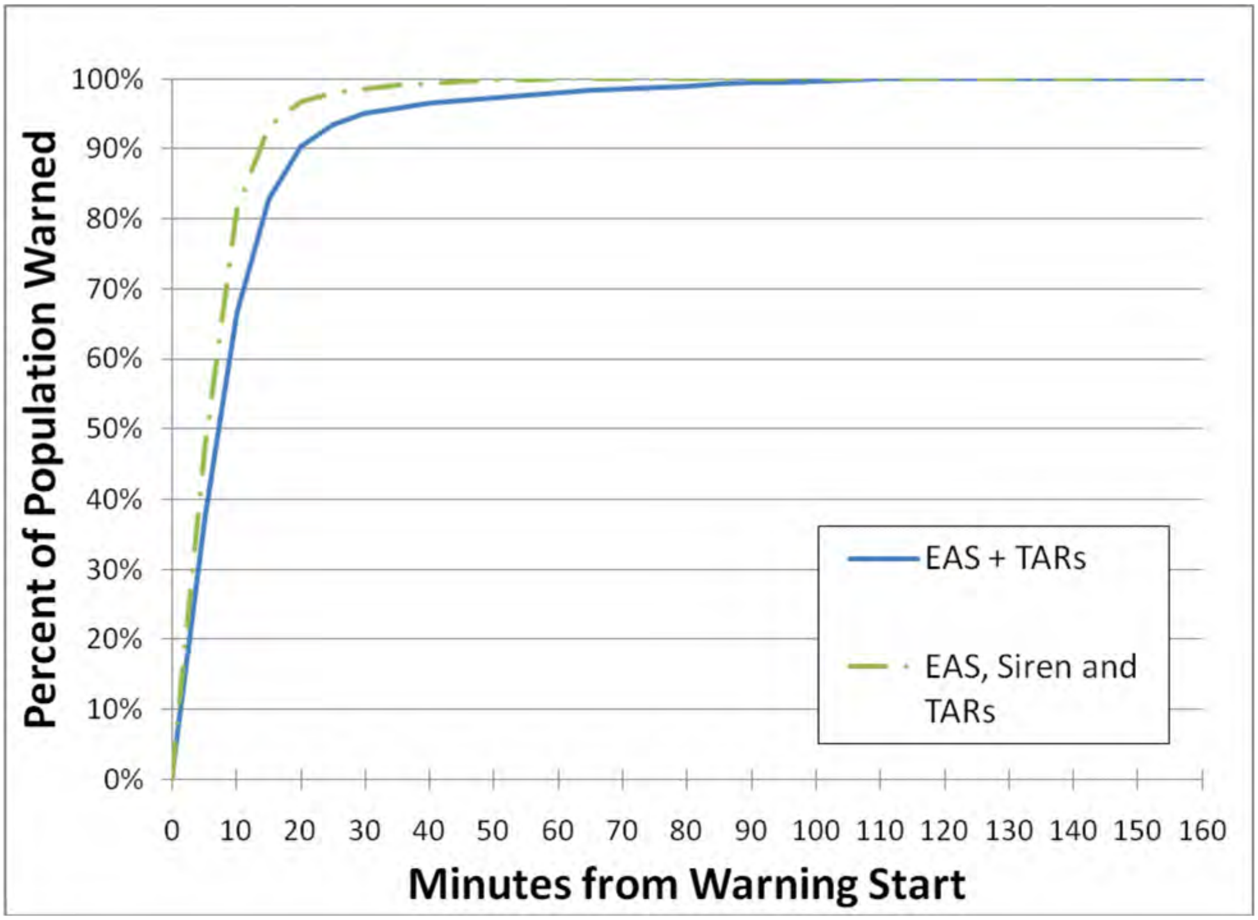


**Figure 12: Notification Times for Selected Alert and Notification Systems[27]**

Notification times for hunters, boaters, and park visitors were increased by 45 minutes to allow time for local emergency officials to patrol the forest, river, or park with loud speakers to warn visitors.

Generally, the information required to estimate the second phase of trip generation, the mobilization process, was obtained from a telephone survey of EPZ residents, supplemented by mobilization time estimated for similar sites. See Appendix C for details about the survey and its raw data.

Mobilization times will vary from one individual to the next depending on where they are, what they are doing, and related factors. Furthermore, some persons, including commuters, shoppers, and other travelers, will return home to join the other members of their households for evacuation upon receiving notification of an emergency. Therefore, the time elapsed for those people to travel home should be considered as part of the mobilization time before evacuation can begin.

[27] *Ibid.*

Figure 13 presents the distribution of trip generation times (i.e., the combination of notification and mobilization times) for different population groups. These curves were obtained by applying the methodology described in Table 19 to the activities of each population group.

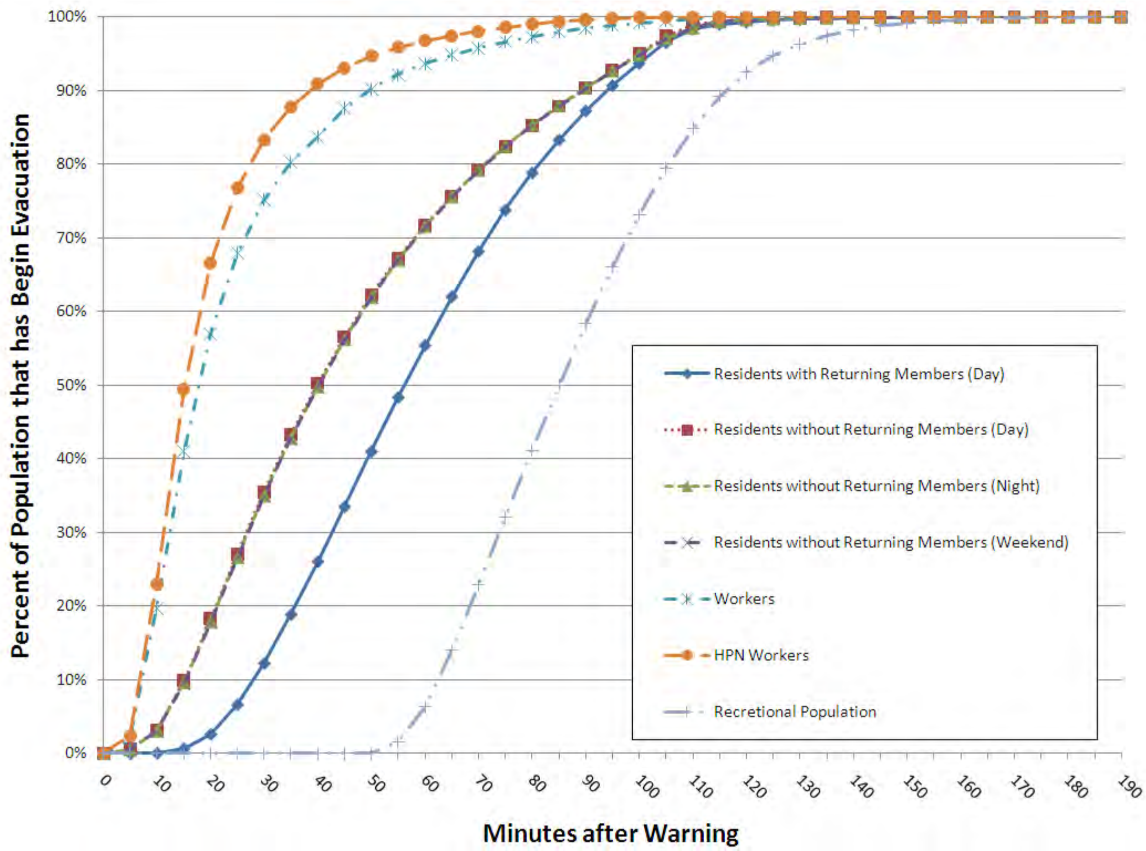


**Figure 13: Distribution of Trip Generation Times by Population Group**

## 5.1.3. Trip Generation Time for Transit Dependent Permanent Residents

As described in Section 3.3, the transit dependent permanent residents in the VEGP EPZ are estimated at 29. Table 20 shows the assumptions for determining the trip generation time for evacuating the transit dependent population. The trip generation time for the transit dependent population was determined by consulting with relevant EMA personnel and the SNC planning staff.

**Table 20: Trip Generation Time for Transit Dependent Permanent Residents**

| Transit Dependent Category | County | Assumptions | Trip Generation Time |
|---|---|---|---|
| Wheelchair | Burke | Residents will evacuate by special equipped vehicles | 20 minutes |
| Transportation | Burke | Residents will evacuate by school bus and standard vans | 17 minutes |
| Immobile | Burke | Residents will evacuate by ambulance | 20 minutes |

### 5.1.4. Trip Generation Time for Schools

As described in Section 3.4, there is one school within the VEGP EPZ. Table 21 shows the assumptions for determining the trip generation time for the school population. The trip generation time for the school was determined by consulting with relevant personnel at the school.

**Table 21: Trip Generation Time for Population in Schools**

| Facility Category | Facility Name | Assumptions | Trip Generation Time |
|---|---|---|---|
| School Students | Lord's House of Praise Christian School | Students will evacuate in 40 minutes. | 40 minutes |
| School Staff | Lord's House of Praise Christian School | Staff will not leave until students have evacuated. | Trip generation time for students (40 minutes) plus 5 minutes |

## 5.2. Evacuation Simulation

Evacuations were simulated using the population and vehicle demand data, evacuation network data, and loading distribution data discussed in the previous sections. VISUM 11 was used to simulate evacuations. Figure 14 describes the framework of the analysis and three of its main features: the demand model, the network model, and the impact model.

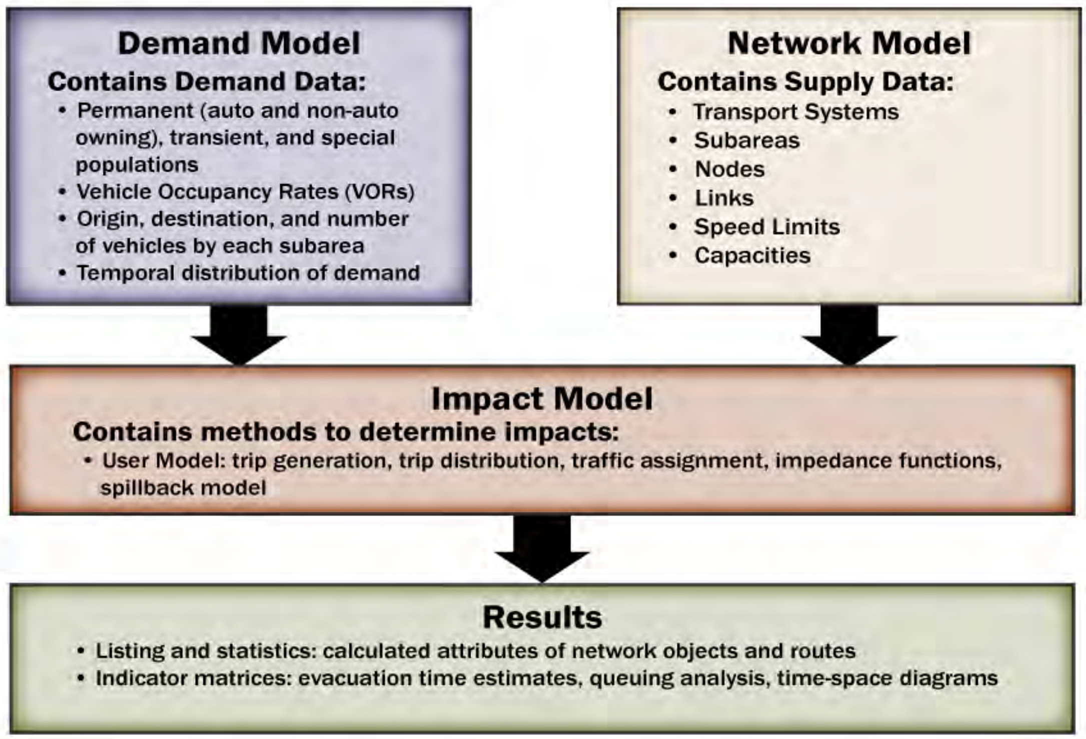


Figure 14: ETEs Analysis Framework Using VISUM

### 5.2.1. The Demand Model

The demand model contains the travel demand data. The total number of vehicles originating from a zone is calculated by dividing a population with its expected vehicle occupancy rate. The total number of vehicles originating from a zone is then distributed to different time intervals based on the loading distribution curve for the zone. The loading distribution curve for the zone depends on the warning system available for that zone. The travel demand is described by an origin-destination (OD) matrix. The OD matrix refers to a time interval and the total number of vehicles departing in that time interval.

### 5.2.2. The Network Model

The network model describes the relevant supply data of an evacuation network. The supply data consists of subareas, nodes, links, speed limits, and capacities. The subareas describe areas with particular boundaries based on demography, topography, land

characteristics, access routes, and local jurisdictions. They represent the origin and destination of trips within the evacuation network. Nodes define positions of intersections in the evacuation network. Links connect nodes and, therefore, describe the road infrastructure. Every network object is described by its attributes (e.g., speed limits and capacities for the links). The travel time of a vehicle on a given link depends on the permitted speed and the capacity (i.e., the traffic volume a road can handle before the formation of a traffic jam) of the link. The roadway capacities used in the evacuation analysis were calculated using the field collected road attributes and capacity calculation methodology from the U.S. Federal Highway Administration.[28] Details of the roadway capacity calculation method are presented as follows.

### (i) Roadway Capacity Calculation Method

IEM estimate roadway capacity based on road type and free flow speed. Using the characteristics data field (e.g., access control, median type, number of lanes in one direction, pavement type), roadway is categorized into five types: 1) full access controlled road; 2) rural multilane highway; 3) urban multilane highway; 4) single lane road; 5) unpaved road. The classification method is shown in the flow chart in Figure 15.

[28] U.S. Federal Highway Administration. “Highway Performance Monitoring System Field Manual, Appendix N - Procedures for Estimating Highway Capacity.” Online: http://www.fhwa.dot.gov/ohim/hpmsmanl/appn.htm.

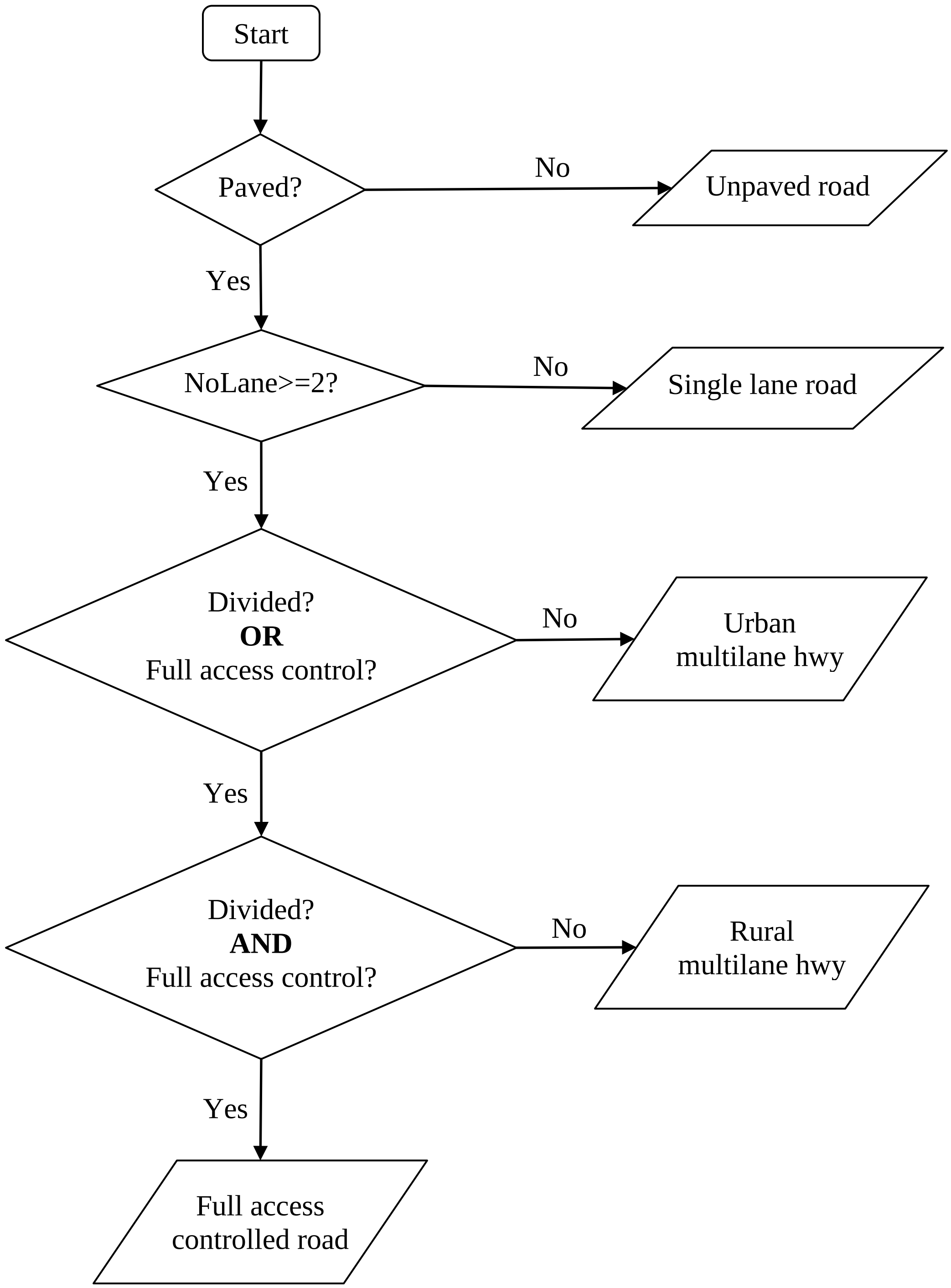


**Figure 15: Roadway Type Classification Method**

Once the roadway type is determined, the capacity (in vehicle per lane per hour) can be calculated for each road segment using the following method.

- Full access controlled road: Capacity = 1700 + *FFS* * 10    with maximum of 2400
- Rural multilane highway: Capacity = 1000 + *FFS* * 20    with maximum of 2200
- Urban multilane highway: Capacity = 1900
- Single lane road: Capacity = 1700 * $f_G$ - $V_{NP}$
- Unpaved road: Capacity = 800 * $f_G$ - $V_{NP}$

The unit for capacity of the above formula is pcplph (passenger car per lane per hour). One need is to multiply this value by the number of lanes to obtain capacity for all lanes in the unit of pcph (passenger cars per hour). No heavy vehicle factor adjustment should be made to the adjustment because VISUM needs capacity as an input in passenger car units and heavy vehicles are modeled as different vehicle groups than the passenger cars. Peak hour factor (PHF) should not be considered for adjusting capacity in modeling, as modeling time step is typically far less than 15 min (e.g., 5 min).

FFS *(definition: The desired speed of drivers in low volume conditions and in the absence of traffic control devices or other adverse conditions.)* is the key to estimate capacity and is a required input for modeling. It can be directly estimated in the field and is typically 5-10 mph higher than the speed limit.

$f_G$ and $V_{NP}$ are adjustment factors for grades and adjustment value for no passing zones. $f_G$ can be found from Table 22[29]. If no other information is available, one may assume the two-way flow rate is in the range 0-600 pcph.

**Table 22: Grade Adjustment Factors ($f_G$)**

| Two-Way Flow Rates (pcph) | Level | Rolling | Mountainous |
|---|---|---|---|
| 0-600 | 1.00 | 0.71 | 0.57 |
| >600-1,200 | 1.00 | 0.93 | 0.85 |
| >1,200 | 1.00 | 0.99 | 0.99 |

[29] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 6, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

$V_{NP}$ can be calculated as $V_{NP} = f_{NP} / 0.00776$, where $f_{NP}$ is the adjustment factor for no-passing zones on average travel speed and can be found in Table 23[30]. If no other information is available, one may assume the two-way flow rate is in the range 101-300 pcph, with a no passing zone percentage of 50% for separated roads and 90% for non-separated roads.

**Table 23: Adjustment ($f_{np}$) for Effect of No-Passing Zones on Average Travel Speed on Two-Way Segments**

| Two-Way Demand Flow Rate, $v_p$(pcph) | Reduction in Average Travel Speed (mph) No-Passing Zones (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 0-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 101-300 | 0.0 | 0.3 | 0.6 | 1.0 | 1.4 | 1.9 | 2.4 | 2.5 | 2.6 | 3.1 | 3.5 |
| 301-500 | 0.0 | 0.9 | 1.7 | 2.2 | 2.7 | 3.1 | 3.5 | 3.7 | 3.9 | 4.2 | 4.5 |
| 501-700 | 0.0 | 0.8 | 1.6 | 2.0 | 2.4 | 2.7 | 3.0 | 3.2 | 3.4 | 3.7 | 3.9 |
| 701-900 | 0.0 | 0.7 | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.6 | 2.7 | 2.9 | 3.0 |
| 901-1,100 | 0.0 | 0.6 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 2.2 | 2.4 | 2.6 |
| 1,101-1,300 | 0.0 | 0.4 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.1 |
| 1,301-1,500 | 0.0 | 0.3 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 |
| 1,501-1,700 | 0.0 | 0.3 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| 1,701-1,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 |
| 1,901-2,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 |
| 2,101-2,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 |
| 2,301-2,500 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 |

[30] FHWA, Highway Performance Monitoring System (HPMS) Field Manual, Appendix N: Procedures for Estimating Highway Capacity, Rural Tow-lane Capacity, Table 8, http://www.fhwa.dot.gov/ohim/hpmsmanl/appn3.cfm

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,501-2,700 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 |
| 2,701-2,900 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 |
| 2,901-3,100 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 |
| 3,101-3,300 | 0.0 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| >3,300 | 0.0 | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

#### (ii) Roadway Capacity Calculation Example

Link #5 (node 0259 to node 8908, shown in Figure 20 and Table 34) as a segment of Hephzibah McBean Road is a rural single lane road located in a level area with approximate 50% no-passing zones and the two-way traffic is estimated in a range of 101-300. Therefore, its capacity is estimated as 1700 * 1.0 – 1.9/0.00776 = 1455 pcph.

Another example is link #126 (node 5435 to 4517, shown in Figure 20 and Table 34) as a segment of U.S. Hwy 278 is a rural multi-lane highway with two lanes in each direction and free flow speed of 55 mph. Therefore, its capacity is estimated as 2 * *max* (2200, 1000 + 55 * 20) = 4200 pcph.

### 5.2.3. The Impact Model

The impact model takes its input data from the demand model and the network model. PTV Vision provides different impact models to analyze and evaluate the evacuation network. A user model simulates the behavior of travelers. It calculates traffic volumes and service indicators, such as travel time. The VISUM traffic assignment procedure chosen for this analysis simulates the movement of vehicles on the network as time passes in the evacuation and outputs volumes for each link at each time after analyzing the queuing behavior. This time-dynamic functionality allows for loading of the network via distributions, as when using a range of mobilization times.

The ETEs are measured by noting the time and counting the number of vehicles passes the boundary of the EPZ. VISUM displays the calculated results in graphic and tabular forms and allows graphical analysis of results. In this way, for example, routes per OD pair, traffic flow, and isochrones can be displayed and analyzed. Using the outputs from VISUM, IEM modeler was able to ensure that the traffic simulation model is in equilibrium, by checking whether the number of vehicles entering the roadway network is equal to the number of vehicles exiting the network.

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# 6.0 ANALYSIS OF EVACUATION TIMES

Evacuation times were estimated in order to give emergency planners in the area an approximate time required for evacuation of various parts of the footprint. The estimates were derived by using population (demand) data to determine the number of vehicles and then modeling the travel of the vehicles along the evacuation routes from their origin to their assigned reception center. Both 100% and 90% ETE were studied. The 100% ETE is the time between public notification and when the last evacuating vehicle exits the EPZ. On the other hand, 90% ETE is the time between public notification and when 90% of the evacuating vehicles exit the EPZ.

The ETEs are composed of two components. The first is loading (or "trip generation") time, which is the time required for residents within the area to prepare and then begin their evacuation. Loading times depend, in part, on how long it takes evacuees to receive the warning and is, thus, dependent on the warning systems in their area. The trip generation times estimated for the VEGP EPZ are described in detail in Section 5.1. The second component of an ETE is travel time, which is the time between the resident's departure and when they cross the EPZ boundary. The travel time is determined via the evacuation model.

As a part of the analysis, zones in the study area were grouped to represent the different areas that might need to be evacuated during an incident, so that the decision makers could more effectively order evacuations based on the scenarios and potential wind direction. These areas are discussed in more detail in Section 1.2.

Each zone had been assigned a set of evacuation routes by State and local EMA planners, and these route restrictions were reflected in the modeling of the scenarios. These guidelines generally route evacuees based on the county these are located at the time of the incident. The evacuation routes are described in more detail in Section 4.2.

## 6.1. Summary of ETE Results for General Public

The evacuation time estimate results are displayed in Table 24 and Table 25. Evacuation times listed include warning diffusion, public mobilization, and travel time out of the EPZ. It is important to note that the evacuation time is the time from the moment at which public notification begins—not the start time of a hypothetical event.

**Table 24 : 2012 100% ETEs in Minutes**

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 150 | 145 | 145 | 150 | 150 | 145 |
| A, B-5, C-5, D-5, E-5, F-5 | 5-mile ring | 180 | 185 | 190 | 180 | 185 | 190 |
| All Evacuation Zones | 10-mile EPZ | 200 | 205 | 205 | 200 | 205 | 205 |
| Evacuate 2 to 5 miles downwind | | | | | | | |
| B-5,C-5 | N | 135 | 140 | 165 | 140 | 145 | 175 |
| B-5,C-5 | NNE | 135 | 140 | 165 | 140 | 145 | 175 |
| B-5,C-5,D-5 | NE | 140 | 150 | 165 | 145 | 155 | 175 |
| C-5,D-5,E-5 | ENE | 140 | 150 | 145 | 145 | 150 | 145 |
| D-5,E-5 | E | 140 | 145 | 140 | 140 | 145 | 140 |
| D-5,E-5,F-5 | ESE | 160 | 175 | 175 | 160 | 175 | 175 |
| E-5,F-5 | SE | 150 | 165 | 165 | 150 | 170 | 170 |
| F-5 | SSE | 140 | 145 | 140 | 140 | 150 | 140 |
| F-5 | S | 140 | 145 | 140 | 140 | 150 | 140 |
| F-5 | SSW | 140 | 145 | 140 | 140 | 150 | 140 |
| - | SW | N/A | N/A | N/A | N/A | N/A | N/A |
| - | WSW | N/A | N/A | N/A | N/A | N/A | N/A |
| B-5 | W | 130 | 135 | 165 | 135 | 140 | 170 |
| B-5 | WNW | 130 | 135 | 165 | 135 | 140 | 170 |
| B-5 | NW | 130 | 135 | 165 | 135 | 140 | 170 |
| B-5 | NNW | 130 | 135 | 165 | 135 | 140 | 170 |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | |
| A,B-5,C-5 | N | 155 | 155 | 170 | 160 | 160 | 175 |
| A,B-5,C-5 | NNE | 155 | 155 | 170 | 160 | 160 | 175 |
| A,B-5,C-5,D-5 | NE | 160 | 165 | 170 | 165 | 165 | 175 |
| A,C-5,D-5,E-5 | ENE | 160 | 165 | 165 | 165 | 170 | 170 |
| A,D-5,E-5 | E | 160 | 165 | 160 | 160 | 165 | 165 |
| A,D-5,E-5,F-5 | ESE | 170 | 180 | 180 | 175 | 180 | 180 |
| A,E-5,F-5 | SE | 165 | 175 | 175 | 170 | 175 | 175 |
| A,F-5 | SSE | 160 | 165 | 165 | 160 | 165 | 165 |
| A,F-5 | S | 160 | 165 | 165 | 160 | 165 | 165 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A,F-5 | SSW | 160 | 165 | 165 | 160 | 165 | 165 |
| A | SW | 150 | 145 | 145 | 150 | 150 | 145 |
| A | WSW | 150 | 145 | 145 | 150 | 150 | 145 |
| A,B-5 | W | 155 | 155 | 170 | 155 | 155 | 175 |
| A,B-5 | WNW | 155 | 155 | 170 | 155 | 155 | 175 |
| A,B-5 | NW | 155 | 155 | 170 | 155 | 155 | 175 |
| A,B-5 | NNW | 155 | 155 | 170 | 155 | 155 | 175 |

**Table 25: 2012 90% ETEs in Minutes**

| Affected ERPAs | Area | Normal Weather | | | Adverse Weather | | |
|---|---|---|---|---|---|---|---|
| | | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime | Midweek Daytime | Midweek Weekend Evening | Weekend Daytime |
| A | 2-mile ring | 80 | 80 | 80 | 80 | 85 | 80 |
| A, B-5, C-5, D-5, E-5, F-5 | 5-mile ring | 90 | 100 | 100 | 90 | 105 | 105 |
| All Evacuation Zones | 10-mile EPZ | 100 | 110 | 115 | 100 | 115 | 115 |
| Evacuate 2 to 5 miles downwind | | | | | | | |
| B-5,C-5 | N | 105 | 115 | 135 | 115 | 120 | 140 |
| B-5,C-5 | NNE | 105 | 115 | 135 | 115 | 120 | 140 |
| B-5,C-5,D-5 | NE | 110 | 120 | 105 | 110 | 120 | 110 |
| C-5,D-5,E-5 | ENE | 105 | 115 | 105 | 110 | 115 | 105 |
| D-5,E-5 | E | 115 | 125 | 110 | 115 | 130 | 115 |
| D-5,E-5,F-5 | ESE | 110 | 115 | 110 | 110 | 115 | 110 |
| E-5,F-5 | SE | 110 | 120 | 110 | 110 | 120 | 115 |
| F-5 | SSE | 110 | 120 | 110 | 115 | 120 | 110 |
| F-5 | S | 110 | 120 | 110 | 115 | 120 | 110 |
| F-5 | SSW | 110 | 120 | 110 | 115 | 120 | 110 |
| - | SW | N/A | N/A | N/A | N/A | N/A | N/A |
| - | WSW | N/A | N/A | N/A | N/A | N/A | N/A |
| B-5 | W | 125 | 130 | 140 | 125 | 140 | 145 |
| B-5 | WNW | 125 | 130 | 140 | 125 | 140 | 145 |
| B-5 | NW | 125 | 130 | 140 | 125 | 140 | 145 |
| B-5 | NNW | 125 | 130 | 140 | 125 | 140 | 145 |
| Evacuate 2-mile zone and 5 miles downwind | | | | | | | |
| A,B-5,C-5 | N | 80 | 90 | 95 | 85 | 90 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A,B-5,C-5 | NNE | 80 | 90 | 95 | 85 | 90 | 100 |
| A,B-5,C-5,D-5 | NE | 85 | 90 | 85 | 85 | 95 | 90 |
| A,C-5,D-5,E-5 | ENE | 85 | 95 | 85 | 85 | 95 | 90 |
| A,D-5,E-5 | E | 85 | 90 | 85 | 85 | 95 | 90 |
| A,D-5,E-5,F-5 | ESE | 85 | 100 | 90 | 85 | 100 | 90 |
| A, E-5,F-5 | SE | 85 | 95 | 90 | 85 | 95 | 90 |
| A,F-5 | SSE | 80 | 95 | 85 | 85 | 95 | 90 |
| A,F-5 | S | 80 | 95 | 85 | 85 | 95 | 90 |
| A,F-5 | SSW | 80 | 95 | 85 | 85 | 95 | 90 |
| A | SW | 80 | 80 | 80 | 80 | 85 | 80 |
| A | WSW | 80 | 80 | 80 | 80 | 85 | 80 |
| A,B-5 | W | 80 | 90 | 95 | 85 | 90 | 100 |
| A,B-5 | WNW | 80 | 90 | 95 | 85 | 90 | 100 |
| A,B-5 | NW | 80 | 90 | 95 | 85 | 90 | 100 |
| A,B-5 | NNW | 80 | 90 | 95 | 85 | 90 | 100 |

## 6.2. Discussion of Scenario Results

### 6.2.1. General Trends

- The ETEs in both normal and adverse weather are mainly driven more by the warning system and available speeds rather than the roadway capacities because vehicular demand is low compared to available roadway capacities in most parts of the network.
- The ETEs for scenarios in adverse weather increased in a range of 0 to 10 minutes from the corresponding scenarios in normal weather. The adverse weather conditions have little impacts on ETEs, increasing with no more than 5 minutes increase for the majority of the scenarios. The increase is due more to reduced available speeds than to reduced roadway capacities.
- For most area, the weekend scenario produced the highest evacuation times. This is due to the increased amount of recreational transients in the area (hunters and boaters) on the weekend. This population has a higher warning and diffusion time than other populations – up to 2 hours 35 minutes, compared to 2 hours 5 minutes for permanent residents. The only exception is for zone A, where the majority of the workers at VEGP consist of the evacuation population and few recreational populations.

### 6.2.2. Evacuation Area: 0–2 Miles

The majority of the population in the Zone A evacuation area consists of employees of VEGP and SNC contractors (e.g., Shaw). In addition, Zone A includes a small number of

permanent residents and non-plant employees. For the weekday scenario, the plant workforce was modeled to reflect 2,682 workers who would evacuate during an event, excluding another 200 emergency personnel, who will not evacuate. For the weeknight and weekend scenarios, the workforce for the plant was modeled such that 78-90 contractor employees will evacuate all VEGP employees were emergency personnel and would remain during an event. Evacuees in the 2-mile radius will mainly use Thompson Bridge Road to leave the EPZ and evacuate to the Burke County reception Center.

The longest evacuation times for the 2-mile radius occurred in the weekday scenario, because there is little recreational population. The evacuation times are relatively low and were affected by the loading times and available speed limits, not by significant congestion in the network. However, due to the large number of workforce at the VEGP, potential congestion could occur along the VEGP evacuation route. For example, Ebenezer Church Road and Thompson Bridge Road each exhibited volumes exceeding their capacities.

### 6.2.3. Evacuation Area: 0–5 Miles

This area includes the entire 5-mile EPZ, consisting of zones A, B-5, C-5, D-5, E-5 and F-5. There are several evacuation routes leading out of the EPZ; however, a portion of the evacuating population will converge on SR-23 and SR-80 and evacuate to Burke County reception Center. Evacuation times for the entire 5-mile EPZ are similar to maximum evacuation times for all subzones for each scenario, and are noticeably longer than evacuation times for the 2-mile radius scenarios. Though the traffic converges for the evacuation of the entire 5-mile boundary, the road network capacity is generally sufficient in both normal and adverse weather. However, moderate congestion along Ebenezer Church Road and Thompson Bridge Road was observed, similar to the 0-2 miles scenarios.

### 6.2.4. Evacuation Area: 0–10 Miles

The evacuation times of the entire 10-mile EPZ was noticeably longer than those of 0-5 mile area, due to the additional evacuees from 5-10 mile area. Zones A, B-5, C-5, D-5, E-5, F-5, B-10, C-10, D-10, E-10 and F-10 will evacuate to the Burke County Reception Center and will primarily use SR-80 and SR-24 to leave the EPZ. Zones G-10 will evacuate to the Aiken County Reception Center and will use local road to leave the EPZ. Zones H-10 will evacuate to the Allendale County Reception Center and will primarily use SR-125 to leave the EPZ.

Population for this area includes permanent residents, transients working in the EPZ, the Lord’s House of Praise Christian School, and recreational visitors including boaters on the Savannah River and hunters in the wooded areas. The population for the Lord’s House of Praise Christian School was only considered for the weekday scenario. The recreational activities were considered at peak levels for the weekend scenario.

These evacuation times are mainly influenced by three factors: 1) the higher warning and diffusion times for hunters in the area; 2) moderate congestions on the roads and intersections along Ebenezer Church Road and Thompson Bridge Road; 3) larger

evacuation population resulting in larger chance of having a few evacuees who need extensive long loading time.

## 6.3. ETE Results for Transit Dependent Permanent Residents

The ETEs for the transit dependent population are shown in Table 26. Note that the ETEs for the transit dependent population counts from the notification time of vehicles dispatched for this population group (assuming one hour earlier than the general public).

**Table 26: Transit Dependent Permanent Resident Evacuation Times**

| Transit Dependent Vehicle Category | ETE |
|---|---|
| Special Equipped Vehicle | 50 min |
| School Bus/Standard Van | 55 min |
| Ambulance | 50 min |

## 6.4. ETE Results for School Population

The ETEs, average travel speed and travel time for school population when evacuating full EPZ on weekday under normal weather condition are shown in Table 27. The bus queue occurs due to two buses loading students simultaneously at the school. Lord's House of Praise Christian School is located just inside the EPZ boundary of the EPZ and it only takes an average of 6 min for the evacuees to travel 1.4 miles to the boundary.

**Table 27: School Evacuation Times**

| School Name | Outbound Travel Speed | Travel Time to EPZ Boundary | Bus Queue Length | ETE |
|---|---|---|---|---|
| Lord's House of Praise Christian School | 14 mph | 6 min | 100 ft | 55 min |

## 6.5. Example Model Output

Some example model outputs are presented as follows for the weekday, full EPZ, normal weather evacuation scenario. The total volumes and hourly percents at each exit road are listed in Table 28. Due to the high concentration of evacuation population from VGEP, the highest evacuation exit traffic is observed at a segment of Thompson Bridge Road crossing the southern EPZ boundary. The network wide average travel time from the origins to the reception centers is 33 minutes. The total number of vehicle exit the EPZ is 3,127 and is the same as the total number of vehicles (excluding shadow evacuees) loaded into the network. The mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ are plotted in Figure 16. The average speeds for the five designated evacuation routes are shown in Table 29.

**Table 28: Total Volumes and Hourly Percents at Exit Roads**

| Exit Road Name | Total Volume | Hour 1 Percent | Hour 2 Percent | Hour 3 Percent | Hour 4 Percent |
|---|---|---|---|---|---|
| Thompson Bridge Road | 1079 | 57.3% | 39.3% | 2.8% | 0.1% |
| River Road | 17 | 88.2% | 5.9% | 0.0% | 0.0% |
| GA Hwy 23 | 3 | 100.0% | 0.0% | 0.0% | 0.0% |
| Tom Bargeron Road | 401 | 63.1% | 31.9% | 5.7% | 0.0% |
| Bates Road | 2 | 100.0% | 0.0% | 0.0% | 0.0% |
| Cates-Mead Road/Cates Head Road | 687 | 71.7% | 26.1% | 1.5% | 0.0% |
| GA Hwy 80 | 934 | 64.1% | 30.3% | 5.6% | 0.1% |
| SC Hwy 125 | 2 | 100.0% | 0.0% | 0.0% | 0.0% |
| Jackson Street | 2 | 100.0% | 0.0% | 0.0% | 0.0% |

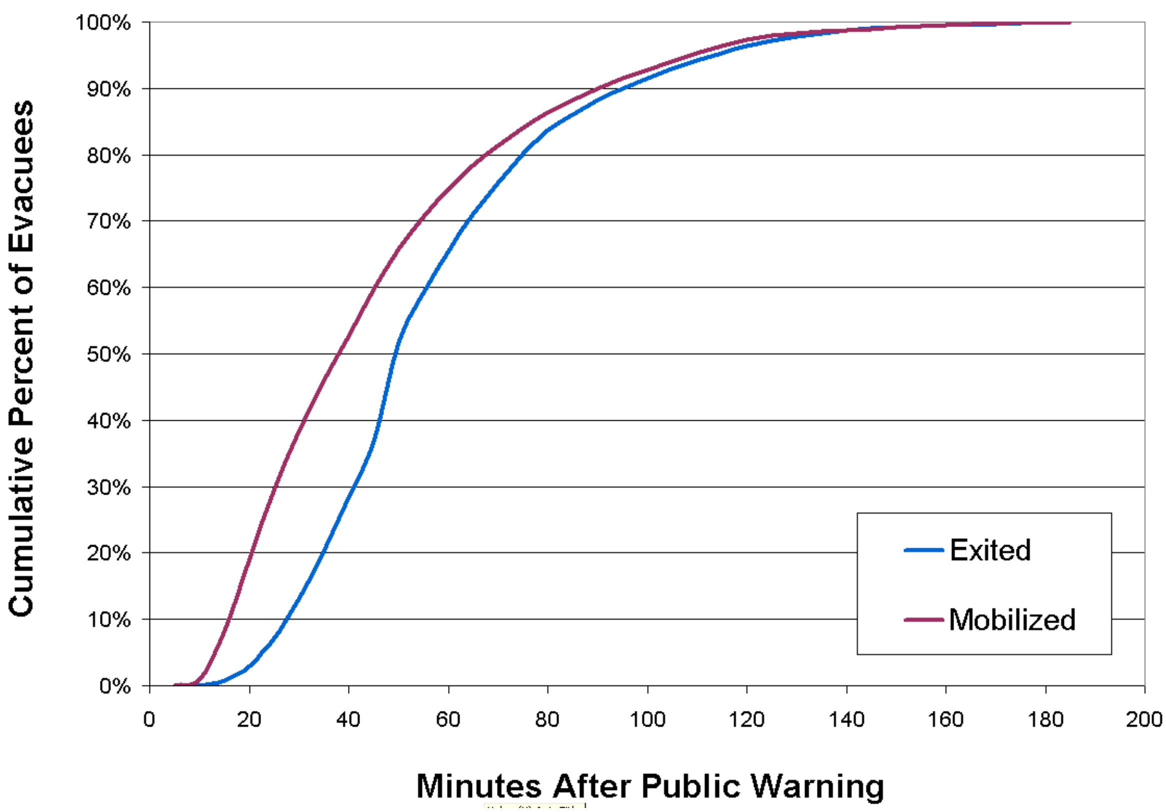


**Figure 16: Mobilization and Evacuation Curve**

### Table 29: Average Speed for Different Evacuation Routes

| Evacuation Route | Average Speed (mph) |
|---|---|
| 1 | 45 |
| 2 | 41 |
| 3 | 35 |
| 4 | 35 |
| 5 | 37 |
| 6 | 48 |

# 7.0 SUPPLEMENTAL ANALYSIS

The analyses related to confirmation of evacuation and potential mitigating measures to effectively manage the traffic flow were performed and are provided in the following sections.

## 7.1. Confirmation of Evacuation

The confirmation of evacuation process determines if the evacuation has been completed. The time required for confirmation of evacuation is dependent upon the method employed. The most time-consuming method typically employed is to use ground vehicles. The time required involves the driving time for each route selected. Given the lack of congestion evident around VEGP in 2006, the evacuation confirmation process in this case would not need to wait for the bulk of the evacuation to complete. This indicates that the confirmation could be completed concurrently with the evacuation. Substantial congestion was, however, observed in 2012 scenarios, so confirmation in this case is recommended to be conducted after the evacuation had completed.

Informing people to leave some standard signs on their doors or windows, such as tying a white cloth to the front doorknob of the house or to the mailbox (as mentioned in the emergency information calendar), when they leave their houses would help the authorities in the confirmation of evacuation. Presence of TCPs and Access Control Points (ACPs) at strategic locations within the evacuation network could provide real-time feedback regarding the progress of the evacuation process. All evacuees are recommended to register in at the designated county reception centers as they arrive. This procedure helps the authorities to account for the population within the designated county. This can be accounted as one of the means of confirmation of evacuation, only under the assumption that all the evacuees would actually report to the reception centers and nowhere else. Telephoning people at their homes could also be considered as a possible means of ensuring completion of evacuation.

As noted in the county REP[31], evacuation confirmation will be accomplished by the county Sheriff's Department and supporting law enforcement agency personnel that will traverse roadways throughout the affected area to ensure that the residential population has evacuated their homes. Personnel from the Georgia Department of Natural Resources Law Enforcement Section and the county Emergency Management Agency will move along the Savannah River and tributaries in boats to ensure that hunters and fishermen within the 10-mile EPZ are evacuated from the area. Additional assistance is available from other State agencies (i.e., Georgia Forestry Commission and Department of Transportation).

[31] Annex D – Plant Vogtle – Burke County Emergency Management Radiological Plan. May 2009. (Obtained from State of Georgia REP).

The actual time associated with the confirmation process would depend on both the number of personnel and the amount of equipment available. These resources may change significantly under various emergency conditions.

## 7.2. Evacuation Traffic Management Locations and Other Potential Mitigating Measures

In order to efficiently promote smooth movement of traffic flow during an evacuation, several TCPs have been identified by the plant and county emergency response planning personnel. The TCPs are listed in Table 30 and Table 31, and shown graphically in Figure 17. The responsibility of supervising traffic controls during an evacuation will be shared between the State's and counties' emergency management and law enforcement agency personnel, as available. Each TCP will be manned and/or road blocks will be established to direct evacuees out of the EPZ and to deny access into the affected area. Also, route markers will be placed along the evacuation routes at critical intersections and road block locations to promote more efficient traffic flow out from the EPZ.

**Table 30: Georgia Traffic Control Points for the VEGP EPZ**

| Location ID | Description |
|---|---|
| 1 | Georgia Hwy 56 SP (River Road) at McBean Club Road |
| 2 | Georgia Hwy 23 at Spring Branch Church Road |
| 3 | Georgia Hwy 80 at Georgia Hwy 23 |
| 4 | Georgia Hwy 23 at Hancock Landing Road |
| 5 | Botsford Church Road at Seven Oaks Road |
| 6 | Sam Mead Road at Seven Oaks Road |
| 7 | Georgia Hwy 80 at Shell Bluff Spur |
| 8 | Georgia Hwy 56 at Georgia Hwy 80 |
| 9 | Georgia Hwy 56 at Cates Mead Road |
| 10 | Georgia Hwy 56 at Perimeter Road |
| 11 | Entrance to Reception Center, Perimeter Road |
| 12 | Georgia Hwy 24 at Perimeter Road |
| 13 | Thompson Bridge Road at Hatchers Mill Road |
| 14 | Georgia Hwy 24 at Tom Bargeron Road |
| 15 | Georgia Hwy 23 at Johnson Road |
| 16 | Ellison Bridge Road at Johnson Road |
| 17 | Ellison Bridge Road at Murray Hill Road |
| 18 | Millhaven Road, 1 mile south of Givens Church Road |
| 19 | Millhaven Road, Stony Bluff Road, Georgia Hwy 23 Intersection in Girard |
| 20 | Stony Bluff Road at Intersection at Oak Grove Church |

| | |
|---|---|
| 21 | Royal Road at River Road |
| 22 | VEGP Main Access Road at River Road |
| 23 | River Road at Hancock Landing Road |
| 24 | Jack Delaigle Road at Ebenezer Church Road |

**Table 31: South Carolina Traffic Control Points for the VEGP EPZ**

| County | Location ID | Description |
|---|---|---|
| Aiken | 1 | Route 437 (Browns Road) at Route 5 (direct traffic north on Route 5: restrict vehicles from traveling south on Route 437) |
| | 2 | Route 5 at Route 299 (direct traffic north on Route 5) |
| | 3 | Route 5 at Route 63 (direct traffic west on Route 63) |
| | 4 | Route 63 at Route 125 (allow traffic to flow on Route 63) |
| | 5 | Route 63 at Route 57 (direct traffic north on Route 57) |
| Barnwell | 6 | Route 125 at Route 493 (direct traffic south on Route 125) |
| Allendale | 7 | Route 125 at Route 12 (direct traffic south on Route 125) |
| | 8 | Route 125 at Route 17 (direct traffic south on Route 125) |

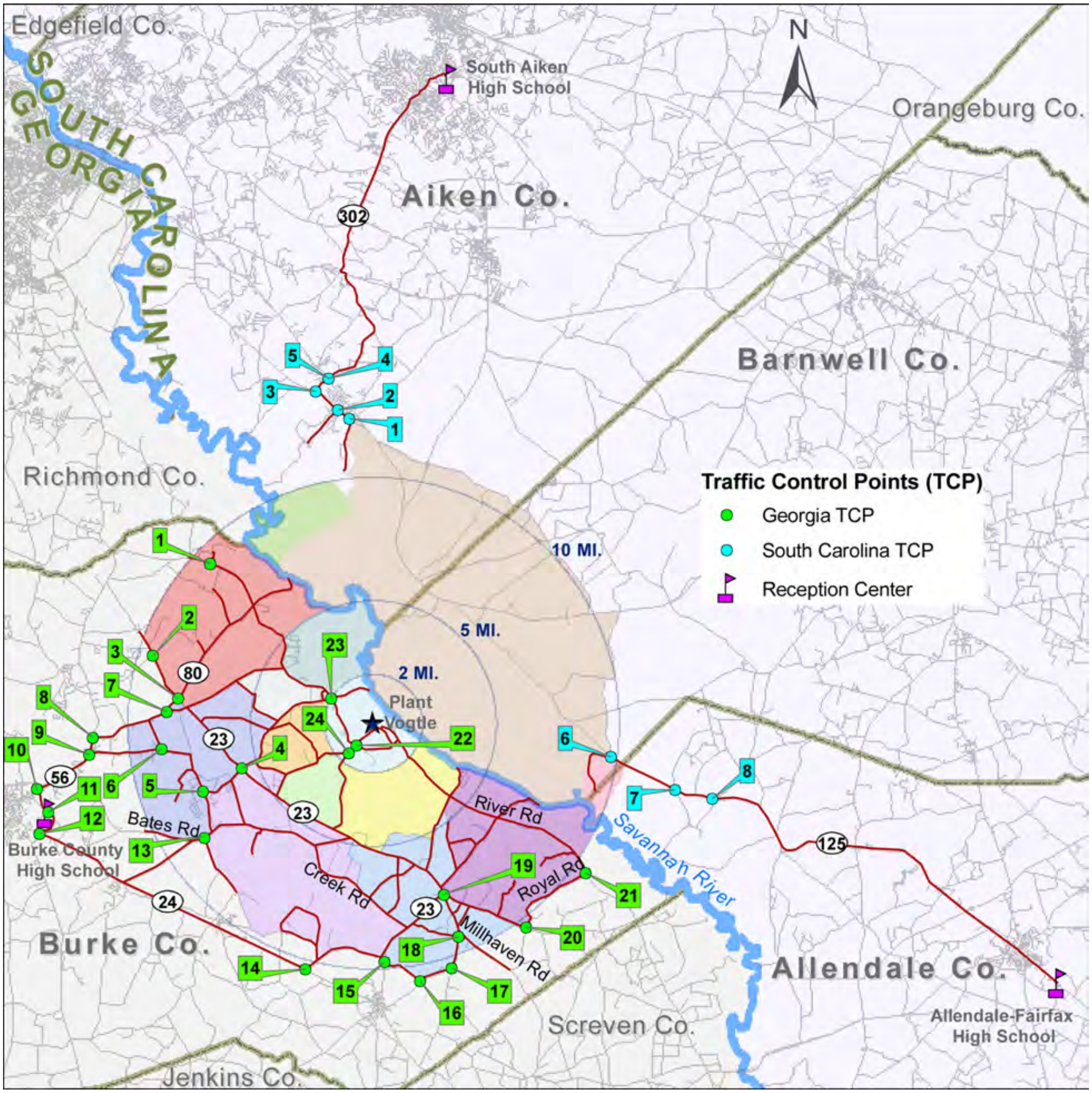


Figure 17: Traffic Control Points in and around VEGP EPZ

# 8.0 SENSITIVITY STUDY ON POPULATION CHANGE

ETEs vary with factors such as population, roadway networks and vehicle occupancy rates. In response to new federal regulations, IEM conducted a population sensitivity analysis for VEGP to address the uncertainty in population data by estimating the anticipated impact of a population change on ETEs. This sensitivity analysis will provide a basis for decisions on future ETE update thresholds.

IEM increased the residential population (for both EPZ and shadow evacuees) to determine the population value that will cause ETE values to increase by 25 percent or 30 minutes, whichever is less for the scenario with the longest ETE. This scenario is evacuating the entire EPZ during the weekend under adverse weather conditions. The base ETE for this scenario is 205 minutes, and hence the threshold for triggering an ETE update is 30 minutes increase in ETE. IEM found that an increase of 30 minutes occurs with a permanent resident population increase of 278% or 8,671 people within the EPZ (along with the increase of shadow evacuees with the same percentage).

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# 9.0 CONCLUSION AND RECOMMENDATIONS

The ETEs developed for 19 evacuation areas within the 10-mile VEGP EPZ measured the time from the public notification to when the last evacuating vehicle exited the EPZ boundary.

The 100% ETEs for the evacuation areas ranged from 130 minutes to 205 minutes for the normal scenarios, and from 135 minutes to 205 minutes for those occurring in adverse weather, also. The 90% ETEs for the evacuation areas ranged from 80 minutes to 140 minutes for the normal scenarios, and from 80 minutes to 145 minutes for those occurring in adverse weather. Variations in ETEs between scenarios generally correlated to differences in the number of evacuating vehicles, the capacity of the evacuation routes, the roadway conditions, or the distance from the origin zones to the EPZ boundary. Except for 0-2 mi area (where the workforce at VEGP consists the majority population and there are few recreational population), the weekend scenario produced the highest evacuation times due to the longer mobilization time for the higher number of recreational transients in the area (hunters and boaters) on the weekend.

The analysis shows that the capacity of the roadway network within the EPZ is adequate to accommodate the population for most scenarios. However, there are a few areas that could become congested during an evacuation. Examples of such route include the Ebenezer Church Road and Thompson Bridge Road, which are used by a large number of evacuees from VGEP.

In conclusion, based on the data gathered and the results of the evacuation study conducted, IEM believes that the existing evacuation strategy is functional for the year 2012 conditions, given the lack of severe congestion or very high ETEs.

## 9.1. Summary of Recommendations

The following recommendations will help emergency managers to improve the evacuation times from an event at VEGP:

- Continue working through existing public outreach efforts to educate residents of how best to evacuate the EPZ and to clearly identify the location of the reception centers.
- Use traffic control points (TCP) to facilitate flow in the areas (e.g., intersection of Thompson Bridge Rd and GA-24) where vehicles might otherwise have to slow due to congestion and traffic signals.
- Developing comprehensive regional evacuation plans and/or working with local and state Departments of Transportation to suggest improvements to the road infrastructure can contribute to a more successful evacuation.

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# APPENDIX A: GEOGRAPHICAL BOUNDARIES OF EVACUATION ZONES

**Table 32: Geographical Boundaries of VEGP EPZ Evacuation Zones**

| Evacuation Zones | Geographical Boundaries |
|---|---|
| A | Northeast—Savannah River |
| | Southeast, South/Southwest and West Northwest—2-mile area |
| B-5 | North—2-mile area |
| | West—Ebenezer Church Road |
| | Southwest—GA Hwy 23 |
| | South—Chance Road |
| | Southeast—Griffin's Landing Road |
| | Northeast—Savannah River |
| B-10 | Northwest—Griffin's Landing Road |
| | West—Dixon Road and City of Girard eastern boundary |
| | Southwest—Stony Bluff Road |
| | Southeast—Royal Road and then 10-mile area |
| | Northeast—Savannah River |
| C-5 | Northwest—Jack Delaigle Road |
| | Southwest—GA Hwy 23 |
| | East—Ebenezer Church Road |
| C-10 | North—Chance Road and GA Hwy 23 |
| | West—Brier Creek Road, Buck Road, and GA Hwy 23 |
| | South—Johnson Road, Ellison Bridge Road, Murray Hill Road, and the 10-mile area |
| | Southeast—Stony Bluff Road |
| | East—City of Girard eastern boundary and Dixon Road |
| D-5 | North—Hancock Landing Road |
| | West—Hancock Landing Road and Thomas Road |
| | Southwest—Hatchers Mill Road and Thompson Bridge Road |
| | South—Gordon Road and Tom Bargeron Road |
| | East—GA Hwy 23, Brier Creek Road, and Buck Road |
| E-5 | North—Ben Hatcher Road |

| | |
|---|---|
| | East—River Road |
| | South—Hancock Landing Road |
| | West—Nathaniel Howard Road |
| E-10 | Northeast—Nathaniel Howard Road |
| | North—GA Hwy 80, GA Hwy 23, and Ben Hatcher Road |
| | West—10-mile area and Bates Road |
| | South—Thompson Bridge, Seven Oaks Road, and Botsford Church Road |
| | East—Hancock Landing Road |
| F-5 | North—Savannah River |
| | East—Savannah River |
| | West—5-mile radius and River Road |
| | South—2-mile area |
| F-10 | Northeast—Savannah River |
| | West—10-mile radius and GA Hwy 23 |
| | South—Ben Hatcher Road |
| | East—River Road and the 5-mile area |
| G-10 | North—Gray's Landing on the Savannah River to the CSX track and Cowden Plantation Road |
| | East—SRS boundary and the CSX line |
| | South—Savanna River and the SRS boundary |
| | West—Savannah River |
| | Northeast—CSX track |
| H-10 | North—the SRS boundary and S125 extending into Allendale County's northern boundary |
| | East—Creek Plantation Road |
| | South—Savannah River |
| | West—SRS boundary |

# APPENDIX B: EVACUATION NETWORK LINKS (DETAILED INFORMATION)

The detailed map for the evacuation network with legible values for nodes and links are provided in Figure 18 through Figure 21. In addition, detailed information for each roadway link is listed in Table 34.

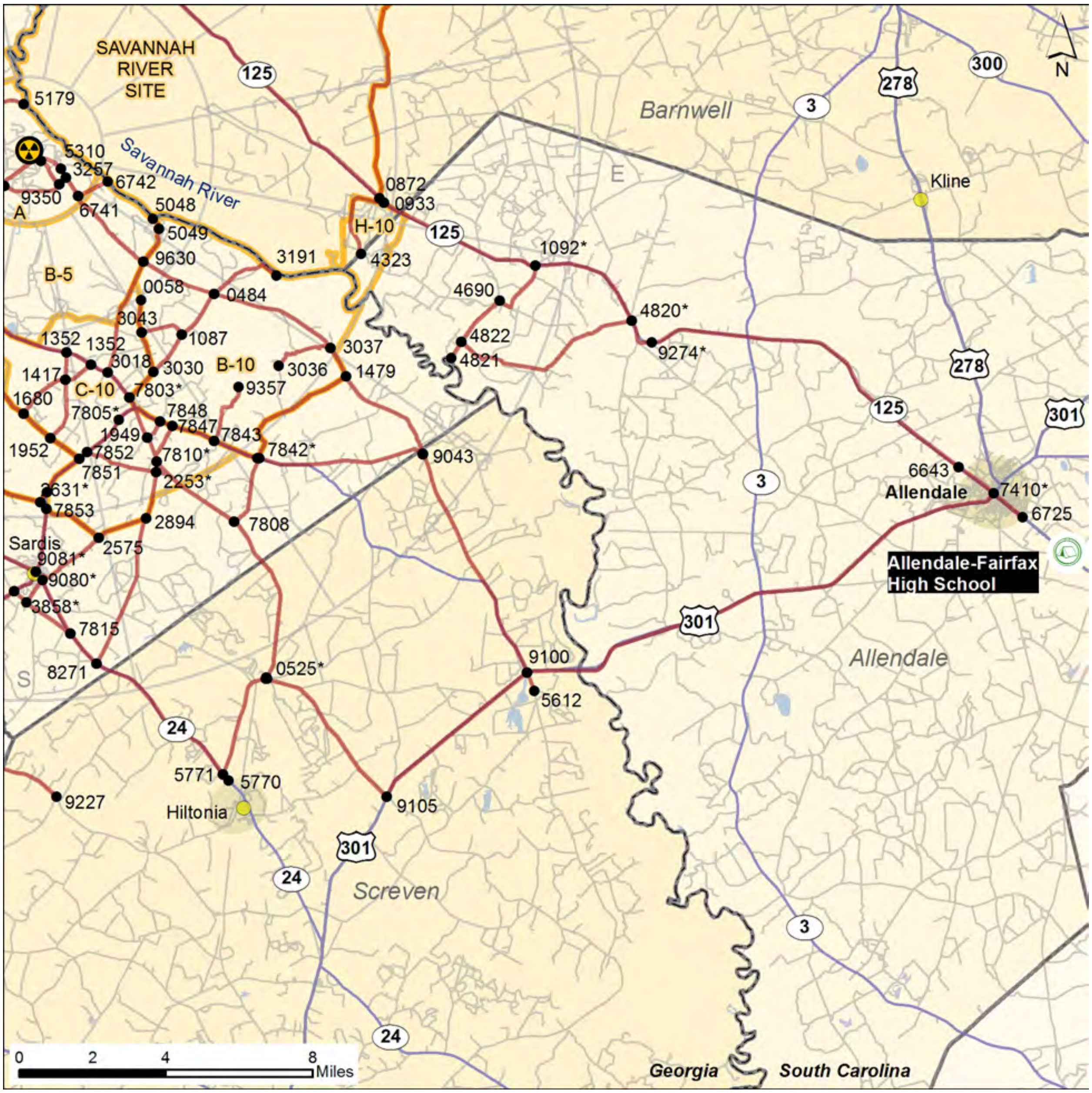


Figure 18: Detailed Roadway Nodes and Links – Southeast Quadrant

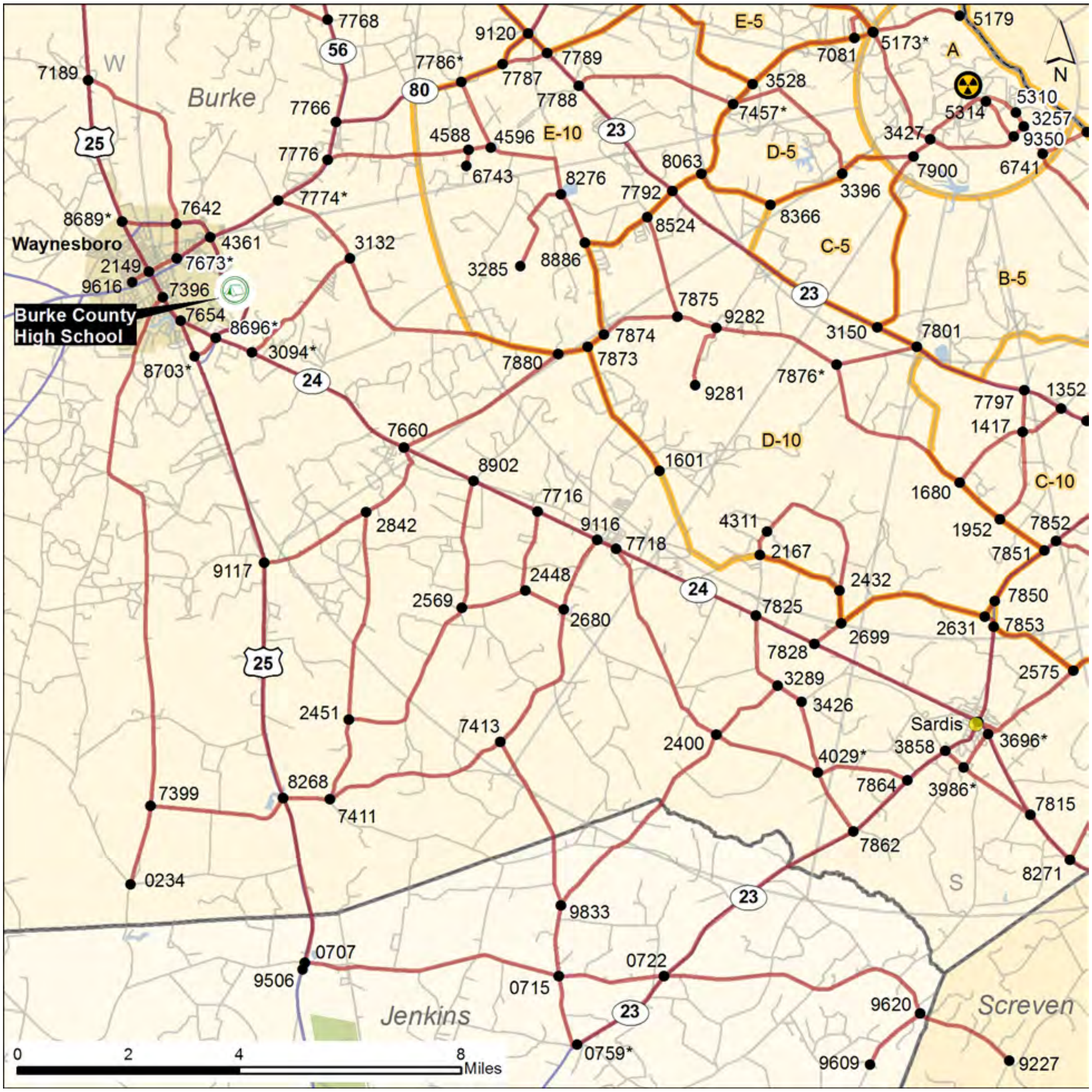


Figure 19: Detailed Roadway Nodes and Links – Southwest Quadrant

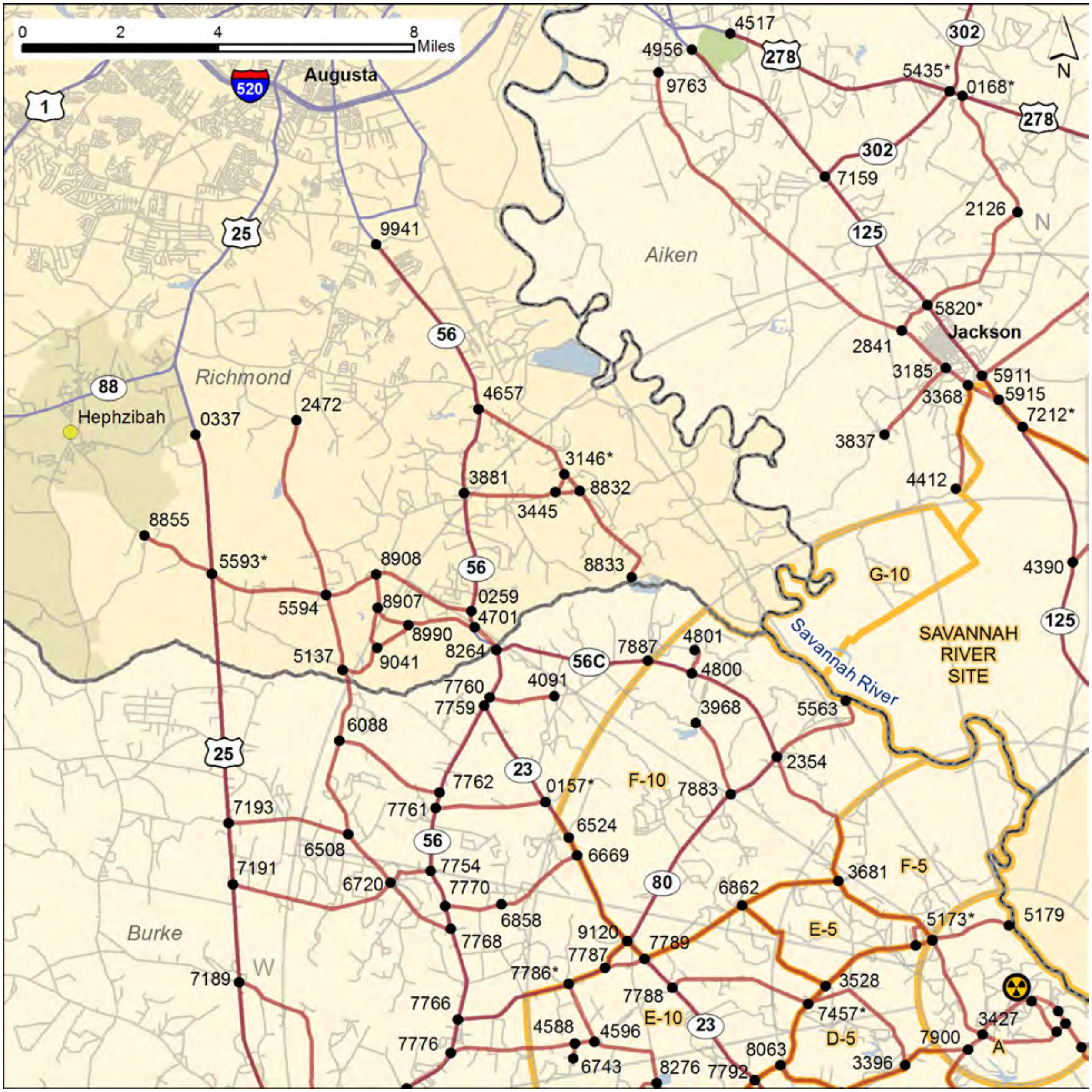

Figure 20: Detailed Roadway Nodes and Links – Northwest Quadrant

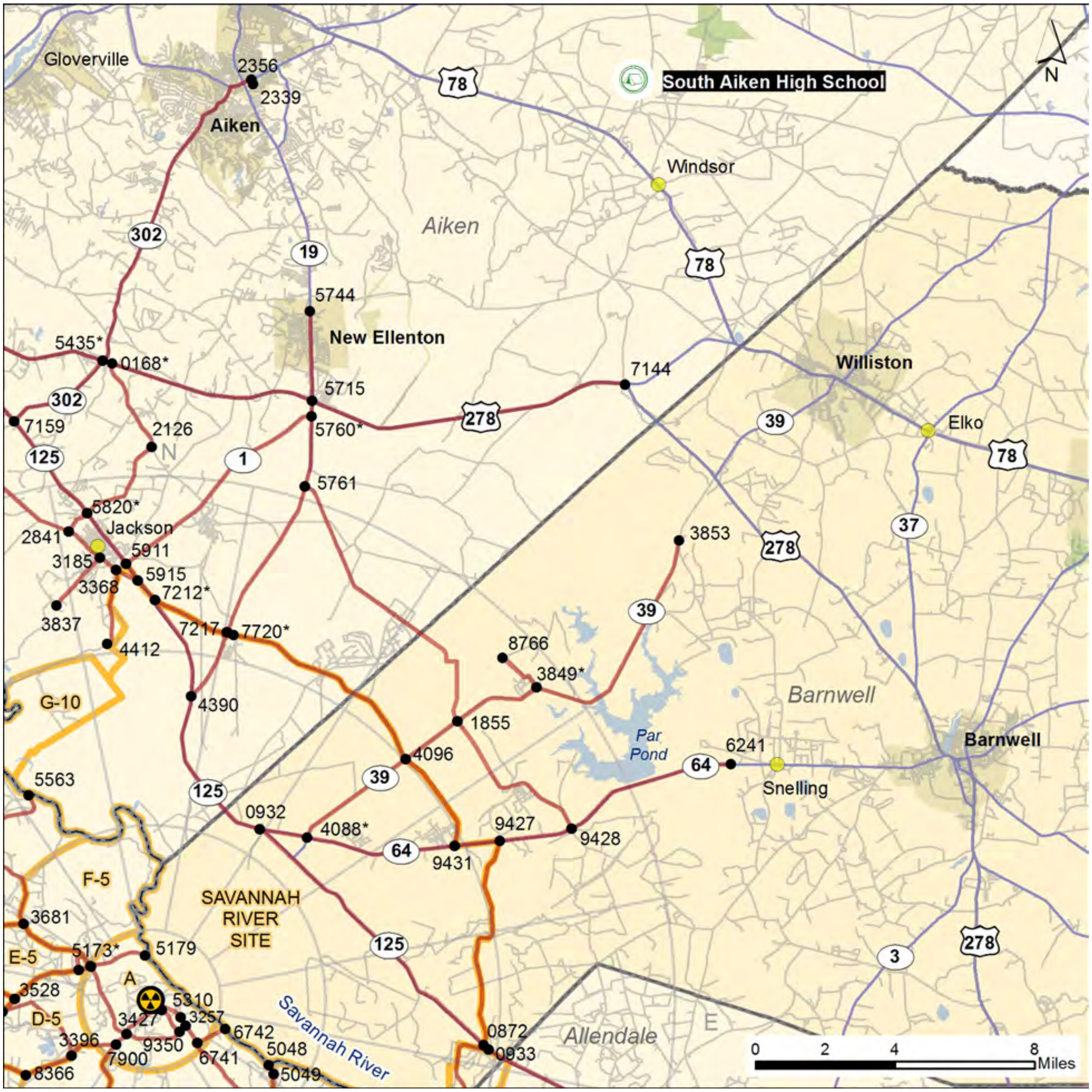


Figure 21: Detailed Roadway Nodes and Links – Northeast Quadrant

## Table 33: Glossary of Terms for Roadway Links Inputs

| Attribute | Definition |
|---|---|
| Link # | The unique identifier for each roadway segment between two nodes. |
| U-Node | Upstream node number for associated link. |
| D-Node | Downstream node number for associated link. |
| Length | Length of the roadway segment. |
| Lane Width | Width of lane for the link. |
| Number of Lanes | Number of lanes in the direction of travel. |
| Roadway Type | As defined in the ETE study such as Interstate, major arterial, minor arterial, etc. |
| Saturation Flow Rate | The equivalent hourly rate at which vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced in vehicles per hour of green per lane. |
| FFS | Free flow speed over the link. |

## Table 34: Roadway Network Characteristics

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 1 | 0058 | 3043 | 0.908 | 10 | 1 | Unpaved | 800 | 30 |
| 2 | 0157 | 0161 | 0.124 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 3 | 0168 | 2126 | 2.755 | 11 | 1 | Single-Lane Road | 1292 | 50 |
| 4 | 0234 | 7399 | 1.470 | 11 | 1 | Unpaved | 800 | 35 |
| 5 | 0259 | 8908 | 2.143 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 6 | 0381 | 4096 | 6.418 | 11 | 1 | Unpaved | 800 | 35 |
| 7 | 0484 | 1087 | 1.431 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 8 | 0484 | 3037 | 3.576 | 10 | 1 | Unpaved | 800 | 30 |
| 9 | 0484 | 3191 | 2.070 | 10 | 1 | Unpaved | 800 | 30 |
| 10 | 0525 | 2011 | 0.035 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 11 | 0525 | 2012 | 0.033 | 11 | 1 | Unpaved | 800 | 35 |
| 12 | 0707 | 0715 | 4.694 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 13 | 0707 | 9506 | 0.125 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 14 | 0715 | 0722 | 1.926 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 15 | 0715 | 0759 | 1.389 | 11 | 1 | Unpaved | 800 | 35 |
| 16 | 0715 | 9833 | 1.297 | 11 | 1 | Unpaved | 800 | 35 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 17 | 0722 | 0759 | 2.029 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 18 | 0722 | 9620 | 5.191 | 11 | 1 | Unpaved | 800 | 35 |
| 19 | 0932 | 0872 | 9.028 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 20 | 0932 | 4088 | 1.376 | 11 | 1 | Unpaved | 800 | 35 |
| 21 | 0932 | 4390 | 4.897 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 22 | 0933 | 0872 | 0.189 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 23 | 0933 | 1092 | 4.536 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 24 | 0933 | 4323 | 2.429 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 25 | 1087 | 3030 | 1.292 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 26 | 1087 | 3043 | 1.226 | 10 | 1 | Unpaved | 800 | 30 |
| 27 | 1092 | 4690 | 1.714 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 28 | 1092 | 4820 | 3.379 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 29 | 1352 | 1417 | 0.846 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 30 | 1352 | 3018 | 0.514 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 31 | 1417 | 1680 | 1.515 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 32 | 1417 | 1952 | 1.773 | 10 | 1 | Unpaved | 800 | 30 |
| 33 | 1479 | 2095 | 3.134 | 11 | 1 | Unpaved | 800 | 35 |
| 34 | 1479 | 3037 | 0.892 | 10 | 1 | Unpaved | 800 | 30 |
| 35 | 1680 | 1952 | 0.993 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 36 | 1949 | 8775 | 0.857 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 37 | 2011 | 2012 | 0.043 | 11 | 1 | Unpaved | 800 | 35 |
| 38 | 2149 | 7396 | 0.526 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 39 | 2149 | 7673 | 0.555 | 11 | 1 | Unpaved | 800 | 35 |
| 40 | 2149 | 8690 | 0.966 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 41 | 2149 | 9616 | 0.359 | 11 | 1 | Unpaved | 800 | 35 |
| 42 | 2167 | 2432 | 1.614 | 10 | 1 | Unpaved | 800 | 30 |
| 43 | 2167 | 4311 | 0.475 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 44 | 2253 | 2894 | 1.310 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 45 | 2339 | 2356 | 0.133 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 46 | 2354 | 3681 | 3.222 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 47 | 2354 | 4800 | 2.579 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 48 | 2354 | 5563 | 2.210 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 49 | 2354 | 7883 | 1.234 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 50 | 2356 | 4457 | 9.495 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 51 | 2400 | 9833 | 4.270 | 11 | 1 | Unpaved | 800 | 35 |
| 52 | 2432 | 2699 | 0.598 | 10 | 1 | Unpaved | 800 | 30 |
| 53 | 2432 | 4311 | 2.858 | 10 | 1 | Unpaved | 800 | 30 |
| 54 | 2448 | 2569 | 1.200 | 12 | 1 | Ramp | 570 | 25 |
| 55 | 2448 | 2680 | 0.774 | 12 | 1 | Ramp | 570 | 25 |
| 56 | 2451 | 2842 | 3.835 | 12 | 1 | Ramp | 570 | 25 |
| 57 | 2569 | 2451 | 3.371 | 12 | 1 | Ramp | 570 | 25 |
| 58 | 2569 | 8902 | 2.363 | 12 | 1 | Ramp | 570 | 25 |
| 59 | 2575 | 4174 | 1.758 | 11 | 1 | Unpaved | 800 | 35 |
| 60 | 2631 | 2699 | 2.821 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 61 | 2841 | 3185 | 1.181 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 62 | 2894 | 2575 | 1.417 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 63 | 3018 | 8778 | 0.548 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 64 | 3028 | 4820 | 0.266 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 65 | 3030 | 3043 | 1.133 | 10 | 1 | Unpaved | 800 | 30 |
| 66 | 3036 | 3037 | 1.740 | 10 | 1 | Unpaved | 800 | 30 |
| 67 | 3094 | 3132 | 2.517 | 11 | 1 | Unpaved | 800 | 35 |
| 68 | 3094 | 8696 | 0.689 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 69 | 3146 | 3445 | 0.427 | 11 | 1 | Unpaved | 800 | 35 |
| 70 | 3146 | 4657 | 2.281 | 11 | 1 | Unpaved | 800 | 35 |
| 71 | 3146 | 8832 | 0.472 | 11 | 1 | Unpaved | 800 | 35 |
| 72 | 3185 | 3368 | 0.582 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 73 | 3185 | 3837 | 1.865 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 74 | 3257 | 5310 | 0.289 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 75 | 3257 | 6741 | 0.607 | 10 | 1 | Unpaved | 800 | 35 |
| 76 | 3257 | 9350 | 0.260 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 77 | 3289 | 2400 | 1.473 | 12 | 1 | Ramp | 570 | 25 |
| 78 | 3289 | 3426 | 0.514 | 12 | 1 | Ramp | 570 | 25 |
| 79 | 3368 | 4412 | 2.229 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 80 | 3426 | 4029 | 1.331 | 11 | 1 | Unpaved | 800 | 35 |
| 81 | 3427 | 5173 | 2.293 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 82 | 3427 | 5314 | 1.303 | 11 | 1 | Single-Lane Road | 1292 | 35 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 83 | 3427 | 9350 | 1.622 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 84 | 3445 | 8832 | 0.533 | 11 | 1 | Unpaved | 800 | 35 |
| 85 | 3681 | 8002 | 2.034 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 86 | 3696 | 3986 | 0.746 | 11 | 1 | Unpaved | 800 | 35 |
| 87 | 3696 | 4174 | 0.174 | 11 | 1 | Unpaved | 800 | 35 |
| 88 | 3849 | 3850 | 0.070 | 11 | 1 | Unpaved | 800 | 35 |
| 89 | 3849 | 3851 | 0.076 | 11 | 1 | Unpaved | 800 | 35 |
| 90 | 3849 | 3853 | 6.979 | 11 | 1 | Unpaved | 800 | 35 |
| 91 | 3850 | 3851 | 0.058 | 11 | 1 | Unpaved | 800 | 35 |
| 92 | 3850 | 8766 | 1.375 | 11 | 1 | Unpaved | 800 | 35 |
| 93 | 3851 | 1855 | 2.533 | 11 | 1 | Unpaved | 800 | 35 |
| 94 | 3858 | 3986 | 0.446 | 11 | 1 | Unpaved | 800 | 35 |
| 95 | 3881 | 0259 | 2.449 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 96 | 3881 | 3445 | 1.882 | 11 | 1 | Unpaved | 800 | 35 |
| 97 | 3881 | 4657 | 1.802 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 98 | 4029 | 2400 | 1.962 | 11 | 1 | Unpaved | 800 | 35 |
| 99 | 4029 | 4050 | 0.055 | 11 | 1 | Unpaved | 800 | 35 |
| 100 | 4088 | 4096 | 3.652 | 11 | 1 | Unpaved | 800 | 35 |
| 101 | 4088 | 9431 | 4.302 | 11 | 1 | Unpaved | 800 | 35 |
| 102 | 4096 | 1855 | 1.839 | 11 | 1 | Unpaved | 800 | 35 |
| 103 | 4096 | 9431 | 3.063 | 11 | 1 | Unpaved | 800 | 35 |
| 104 | 4361 | 7642 | 0.772 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 105 | 4361 | 7774 | 1.403 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 106 | 4361 | 8572 | 0.577 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 107 | 4361 | 9594 | 1.083 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 108 | 4588 | 4596 | 0.402 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 109 | 4588 | 6743 | 0.303 | 10 | 1 | Unpaved | 800 | 30 |
| 110 | 4657 | 9941 | 4.049 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 111 | 4690 | 4822 | 1.550 | 11 | 1 | Unpaved | 800 | 35 |
| 112 | 4701 | 0259 | 0.350 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 113 | 4701 | 8990 | 1.418 | 11 | 1 | Unpaved | 800 | 35 |
| 114 | 4800 | 4801 | 0.580 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 115 | 4820 | 4822 | 5.390 | 11 | 1 | Unpaved | 800 | 35 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 116 | 4821 | 4822 | 0.524 | 11 | 1 | Unpaved | 800 | 35 |
| 117 | 5048 | 5049 | 0.325 | 10 | 1 | Unpaved | 800 | 30 |
| 118 | 5137 | 6088 | 1.535 | 11 | 1 | Unpaved | 800 | 35 |
| 119 | 5137 | 9041 | 1.015 | 11 | 1 | Unpaved | 800 | 35 |
| 120 | 5173 | 5174 | 0.011 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 121 | 5173 | 5179 | 1.667 | 10 | 1 | Unpaved | 800 | 30 |
| 122 | 5174 | 8002 | 0.383 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 123 | 5310 | 5314 | 0.681 | 10 | 1 | Unpaved | 800 | 30 |
| 124 | 5435 | 0168 | 0.280 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 125 | 5435 | 4457 | 0.103 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 126 | 5435 | 4517 | 4.804 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 127 | 5593 | 0337 | 2.879 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 128 | 5593 | 5594 | 2.437 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 129 | 5593 | 8855 | 1.618 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 130 | 5594 | 2472 | 3.813 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 131 | 5594 | 5137 | 1.598 | 11 | 1 | Unpaved | 800 | 35 |
| 132 | 5594 | 8908 | 1.142 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 133 | 5715 | 0168 | 5.929 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 134 | 5715 | 5744 | 2.587 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 135 | 5715 | 5760 | 0.433 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 136 | 5760 | 5761 | 2.044 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 137 | 5760 | 5911 | 6.896 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 138 | 5761 | 1855 | 8.786 | 11 | 1 | Unpaved | 800 | 35 |
| 139 | 5770 | 5771 | 0.223 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 140 | 5771 | 2011 | 3.042 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 141 | 5820 | 2126 | 2.898 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 142 | 5820 | 2841 | 0.770 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 143 | 5820 | 5911 | 1.832 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 144 | 5911 | 5915 | 0.592 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 145 | 5915 | 3368 | 0.730 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 146 | 6088 | 6508 | 2.066 | 11 | 1 | Unpaved | 800 | 35 |
| 147 | 6508 | 6720 | 1.330 | 11 | 1 | Unpaved | 800 | 35 |
| 148 | 6524 | 0161 | 0.749 | 12 | 1 | Single-Lane Road | 1455 | 55 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 149 | 6524 | 6669 | 0.408 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 150 | 6643 | 9274 | 9.847 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 151 | 6669 | 6882 | 1.892 | 11 | 1 | Unpaved | 800 | 35 |
| 152 | 6741 | 6742 | 0.888 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 153 | 6858 | 6882 | 0.005 | 11 | 1 | Unpaved | 800 | 35 |
| 154 | 6862 | 3528 | 2.704 | 10 | 1 | Unpaved | 800 | 30 |
| 155 | 6862 | 3681 | 2.072 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 156 | 7081 | 3528 | 2.110 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 157 | 7081 | 5174 | 0.360 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 158 | 7081 | 8002 | 0.517 | 10 | 1 | Unpaved | 800 | 30 |
| 159 | 7144 | 5715 | 9.316 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 160 | 7159 | 4956 | 3.825 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 161 | 7159 | 5435 | 3.206 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 162 | 7159 | 5820 | 3.379 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 163 | 7189 | 7191 | 2.019 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 164 | 7189 | 7642 | 3.499 | 11 | 1 | Unpaved | 800 | 35 |
| 165 | 7189 | 8689 | 2.660 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 166 | 7191 | 6720 | 3.446 | 11 | 1 | Unpaved | 800 | 35 |
| 167 | 7191 | 7193 | 1.250 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 168 | 7193 | 5593 | 5.134 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 169 | 7193 | 6508 | 2.497 | 11 | 1 | Unpaved | 800 | 35 |
| 170 | 7212 | 5786 | 0.062 | 12 | 1 | Ramp | 570 | 25 |
| 171 | 7212 | 5915 | 0.754 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 172 | 7212 | 7214 | 0.045 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 173 | 7214 | 4390 | 3.025 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 174 | 7217 | 7218 | 0.019 | 12 | 1 | Ramp | 570 | 25 |
| 175 | 7217 | 7219 | 0.138 | 12 | 1 | Ramp | 570 | 25 |
| 176 | 7218 | 5761 | 4.637 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 177 | 7219 | 7222 | 0.052 | 12 | 1 | Ramp | 570 | 25 |
| 178 | 7219 | 7223 | 0.211 | 12 | 1 | Ramp | 570 | 25 |
| 179 | 7222 | 7224 | 0.208 | 12 | 1 | Ramp | 570 | 25 |
| 180 | 7222 | 7227 | 0.126 | 12 | 1 | Ramp | 570 | 25 |
| 181 | 7227 | 7228 | 0.030 | 12 | 1 | Ramp | 570 | 25 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 182 | 7228 | 4390 | 1.931 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 183 | 7376 | 3028 | 0.290 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 184 | 7376 | 9274 | 0.426 | 11 | 1 | Unpaved | 800 | 35 |
| 185 | 7396 | 7399 | 9.767 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 186 | 7396 | 7654 | 0.540 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 187 | 7410 | 6643 | 1.196 | 11 | 2 | Single-Lane Road | 1292 | 45 |
| 188 | 7410 | 6725 | 1.018 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 189 | 7411 | 2451 | 1.538 | 12 | 1 | Ramp | 570 | 25 |
| 190 | 7411 | 7413 | 3.405 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 191 | 7413 | 2680 | 2.911 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 192 | 7413 | 9833 | 3.243 | 11 | 1 | Unpaved | 800 | 35 |
| 193 | 7457 | 7458 | 0.021 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 194 | 7457 | 8063 | 1.488 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 195 | 7458 | 3396 | 2.863 | 10 | 1 | Unpaved | 800 | 30 |
| 196 | 7458 | 3528 | 0.486 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 197 | 7642 | 7673 | 0.634 | 11 | 1 | Unpaved | 800 | 35 |
| 198 | 7642 | 8688 | 0.921 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 199 | 7654 | 8697 | 0.704 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 200 | 7654 | 8703 | 0.699 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 201 | 7660 | 2842 | 1.594 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 202 | 7660 | 3094 | 3.297 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 203 | 7660 | 7880 | 3.270 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 204 | 7660 | 8902 | 1.392 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 205 | 7673 | 8572 | 0.138 | 11 | 1 | Unpaved | 800 | 35 |
| 206 | 7716 | 2448 | 1.495 | 12 | 1 | Ramp | 570 | 25 |
| 207 | 7716 | 8902 | 1.278 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 208 | 7718 | 2400 | 3.973 | 11 | 1 | Unpaved | 800 | 35 |
| 209 | 7718 | 7825 | 2.794 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 210 | 7720 | 0381 | 0.046 | 12 | 1 | Ramp | 570 | 25 |
| 211 | 7720 | 7218 | 0.220 | 12 | 1 | Ramp | 570 | 25 |
| 212 | 7720 | 7223 | 0.130 | 12 | 1 | Ramp | 570 | 25 |
| 213 | 7721 | 0381 | 0.022 | 12 | 1 | Ramp | 570 | 25 |
| 214 | 7721 | 7228 | 0.268 | 12 | 1 | Ramp | 570 | 25 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 215 | 7721 | 7723 | 0.154 | 12 | 1 | Ramp | 570 | 25 |
| 216 | 7723 | 7222 | 0.217 | 12 | 1 | Ramp | 570 | 25 |
| 217 | 7723 | 7224 | 0.041 | 12 | 1 | Ramp | 570 | 25 |
| 218 | 7724 | 7219 | 0.176 | 12 | 1 | Ramp | 570 | 25 |
| 219 | 7724 | 7223 | 0.045 | 12 | 1 | Ramp | 570 | 25 |
| 220 | 7724 | 7726 | 0.142 | 12 | 1 | Ramp | 570 | 25 |
| 221 | 7726 | 5786 | 2.048 | 12 | 1 | Ramp | 570 | 25 |
| 222 | 7726 | 7217 | 0.249 | 12 | 1 | Ramp | 570 | 25 |
| 223 | 7727 | 5786 | 2.067 | 12 | 1 | Ramp | 570 | 25 |
| 224 | 7727 | 7224 | 0.129 | 12 | 1 | Ramp | 570 | 25 |
| 225 | 7727 | 7227 | 0.189 | 12 | 1 | Ramp | 570 | 25 |
| 226 | 7754 | 6720 | 0.944 | 11 | 1 | Unpaved | 800 | 35 |
| 227 | 7754 | 7761 | 1.299 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 228 | 7754 | 7770 | 0.785 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 229 | 7759 | 0157 | 2.341 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 230 | 7759 | 7760 | 0.207 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 231 | 7759 | 7762 | 2.004 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 232 | 7760 | 4091 | 1.352 | 11 | 1 | Unpaved | 800 | 35 |
| 233 | 7761 | 0157 | 2.260 | 11 | 1 | Unpaved | 800 | 35 |
| 234 | 7761 | 7762 | 0.331 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 235 | 7762 | 6088 | 2.390 | 11 | 1 | Unpaved | 800 | 35 |
| 236 | 7766 | 7768 | 1.922 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 237 | 7766 | 7776 | 0.701 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 238 | 7766 | 7786 | 2.460 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 239 | 7768 | 6720 | 1.606 | 11 | 1 | Unpaved | 800 | 35 |
| 240 | 7768 | 7770 | 0.483 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 241 | 7770 | 6882 | 1.173 | 11 | 1 | Unpaved | 800 | 35 |
| 242 | 7774 | 3132 | 1.746 | 11 | 1 | Unpaved | 800 | 35 |
| 243 | 7774 | 7776 | 1.184 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 244 | 7776 | 4588 | 2.567 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 245 | 7786 | 4596 | 1.310 | 10 | 1 | Unpaved | 800 | 35 |
| 246 | 7786 | 7787 | 0.812 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 247 | 7787 | 7789 | 0.843 | 11 | 1 | Single-Lane Road | 1292 | 45 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 248 | 7788 | 7457 | 2.948 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 249 | 7788 | 7789 | 0.829 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 250 | 7788 | 7792 | 2.551 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 251 | 7789 | 6862 | 2.285 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 252 | 7792 | 3150 | 4.475 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 253 | 7792 | 8063 | 0.610 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 254 | 7792 | 8524 | 0.651 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 255 | 7797 | 1352 | 0.753 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 256 | 7797 | 1417 | 0.752 | 10 | 1 | Unpaved | 800 | 30 |
| 257 | 7797 | 7801 | 2.114 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 258 | 7801 | 3150 | 0.803 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 259 | 7801 | 7876 | 1.480 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 260 | 7803 | 3030 | 0.961 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 261 | 7803 | 7805 | 0.322 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 262 | 7803 | 8778 | 0.364 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 263 | 7805 | 8775 | 0.011 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 264 | 7805 | 8860 | 0.537 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 265 | 7808 | 0525 | 4.721 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 266 | 7808 | 7809 | 2.248 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 267 | 7808 | 7842 | 1.952 | 11 | 1 | Unpaved | 800 | 35 |
| 268 | 7809 | 2253 | 0.311 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 269 | 7809 | 7810 | 0.441 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 270 | 7810 | 2253 | 0.285 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 271 | 7810 | 7811 | 0.160 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 272 | 7811 | 1949 | 0.550 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 273 | 7811 | 7847 | 0.961 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 274 | 7815 | 3696 | 1.648 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 275 | 7815 | 3986 | 1.477 | 11 | 1 | Unpaved | 800 | 35 |
| 276 | 7825 | 3289 | 1.464 | 12 | 1 | Ramp | 570 | 25 |
| 277 | 7825 | 7828 | 1.172 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 278 | 7828 | 2699 | 0.603 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 279 | 7842 | 7846 | 0.050 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 280 | 7842 | 9043 | 4.584 | 12 | 1 | Single-Lane Road | 1455 | 40 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 281 | 7843 | 7846 | 1.265 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 282 | 7843 | 7847 | 1.219 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 283 | 7843 | 9357 | 1.824 | 10 | 1 | Unpaved | 800 | 30 |
| 284 | 7846 | 1479 | 3.721 | 10 | 1 | Unpaved | 800 | 30 |
| 285 | 7847 | 7848 | 0.358 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 286 | 7848 | 1949 | 0.575 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 287 | 7848 | 8775 | 0.800 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 288 | 7850 | 2631 | 0.334 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 289 | 7850 | 7851 | 1.299 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 290 | 7851 | 1952 | 0.981 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 291 | 7851 | 7852 | 0.275 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 292 | 7852 | 2253 | 1.992 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 293 | 7852 | 8860 | 1.260 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 294 | 7853 | 2575 | 1.706 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 295 | 7853 | 2631 | 0.286 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 296 | 7862 | 0722 | 4.367 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 297 | 7862 | 4050 | 1.205 | 11 | 1 | Unpaved | 800 | 35 |
| 298 | 7862 | 7864 | 1.355 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 299 | 7864 | 3858 | 0.865 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 300 | 7864 | 4050 | 1.674 | 12 | 1 | Ramp | 570 | 25 |
| 301 | 7873 | 1601 | 2.644 | 10 | 1 | Unpaved | 800 | 30 |
| 302 | 7873 | 7874 | 0.368 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 303 | 7873 | 7880 | 0.549 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 304 | 7874 | 7875 | 1.425 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 305 | 7874 | 8886 | 1.711 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 306 | 7875 | 8524 | 1.893 | 10 | 1 | Unpaved | 800 | 30 |
| 307 | 7875 | 9282 | 0.743 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 308 | 7876 | 1680 | 3.416 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 309 | 7876 | 9282 | 2.325 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 310 | 7880 | 3132 | 4.543 | 11 | 1 | Unpaved | 800 | 35 |
| 311 | 7883 | 3968 | 1.668 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 312 | 7887 | 4800 | 0.940 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 313 | 7900 | 3150 | 3.533 | 11 | 1 | Single-Lane Road | 1292 | 45 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 314 | 7900 | 3396 | 1.421 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 315 | 7900 | 3427 | 0.442 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 316 | 8063 | 8366 | 1.447 | 10 | 1 | Unpaved | 800 | 30 |
| 317 | 8264 | 4701 | 0.667 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 318 | 8264 | 7760 | 1.026 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 319 | 8264 | 7887 | 3.161 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 320 | 8268 | 0707 | 3.068 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 321 | 8268 | 7399 | 2.601 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 322 | 8268 | 7411 | 0.837 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 323 | 8268 | 9117 | 4.319 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 324 | 8271 | 2894 | 4.244 | 11 | 1 | Unpaved | 800 | 35 |
| 325 | 8271 | 5771 | 4.704 | 12 | 2 | Single-Lane Road | 1455 | 45 |
| 326 | 8271 | 7815 | 1.093 | 12 | 2 | Single-Lane Road | 1455 | 45 |
| 327 | 8276 | 3285 | 1.768 | 10 | 1 | Unpaved | 800 | 30 |
| 328 | 8276 | 4596 | 1.841 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 329 | 8276 | 8886 | 0.983 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 330 | 8366 | 3396 | 1.457 | 11 | 1 | Single-Lane Road | 1292 | 40 |
| 331 | 8524 | 8886 | 1.321 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 332 | 8688 | 8689 | 0.062 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 333 | 8688 | 8690 | 0.070 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 334 | 8689 | 8690 | 0.068 | 12 | 1 | Single-Lane Road | 1455 | 50 |
| 335 | 8696 | 8697 | 0.014 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 336 | 8697 | 8703 | 0.511 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 337 | 8697 | 9594 | 1.275 | 12 | 2 | Multi-Lane Hwy | 4200 | 55 |
| 338 | 8832 | 8833 | 2.291 | 11 | 1 | Unpaved | 800 | 35 |
| 339 | 8907 | 8908 | 0.692 | 11 | 1 | Unpaved | 800 | 35 |
| 340 | 8907 | 8990 | 0.769 | 11 | 1 | Unpaved | 800 | 35 |
| 341 | 8907 | 9041 | 0.879 | 11 | 1 | Unpaved | 800 | 35 |
| 342 | 8990 | 9041 | 0.800 | 11 | 1 | Unpaved | 800 | 35 |
| 343 | 9043 | 2095 | 0.011 | 12 | 1 | Ramp | 570 | 25 |
| 344 | 9043 | 9100 | 6.682 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 345 | 9080 | 3696 | 0.222 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 346 | 9080 | 4174 | 0.306 | 11 | 1 | Unpaved | 800 | 35 |

| Link # | U-Node | D-Node | Length | Lane Width | Number of Lanes | Roadway Type | Saturation Flow Rate | FFS |
|---|---|---|---|---|---|---|---|---|
| 347 | 9080 | 9081 | 0.080 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 348 | 9081 | 3858 | 0.842 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 349 | 9081 | 7828 | 3.263 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 350 | 9081 | 7853 | 1.754 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 351 | 9100 | 5612 | 0.529 | 12 | 1 | Ramp | 570 | 25 |
| 352 | 9100 | 7410 | 14.177 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 353 | 9100 | 9105 | 5.155 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 354 | 9105 | 2012 | 4.760 | 11 | 1 | Unpaved | 800 | 35 |
| 355 | 9116 | 2680 | 1.413 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 356 | 9116 | 7716 | 1.192 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 357 | 9116 | 7718 | 0.376 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 358 | 9117 | 2842 | 2.089 | 12 | 1 | Single-Lane Road | 1455 | 40 |
| 359 | 9117 | 8703 | 3.946 | 12 | 2 | Multi-Lane Hwy | 4000 | 50 |
| 360 | 9120 | 6669 | 2.069 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 361 | 9120 | 7787 | 0.734 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 362 | 9120 | 7789 | 0.496 | 12 | 1 | Single-Lane Road | 1455 | 45 |
| 363 | 9120 | 7883 | 3.700 | 12 | 1 | Single-Lane Road | 1455 | 55 |
| 364 | 9227 | 9620 | 1.858 | 11 | 1 | Unpaved | 800 | 35 |
| 365 | 9281 | 9282 | 1.205 | 10 | 1 | Unpaved | 800 | 30 |
| 366 | 9350 | 5314 | 0.831 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 367 | 9427 | 0872 | 6.407 | 11 | 1 | Unpaved | 800 | 35 |
| 368 | 9427 | 9428 | 2.090 | 11 | 1 | Unpaved | 800 | 35 |
| 369 | 9427 | 9431 | 1.296 | 11 | 1 | Unpaved | 800 | 35 |
| 370 | 9428 | 1855 | 4.932 | 11 | 1 | Unpaved | 800 | 35 |
| 371 | 9428 | 6241 | 5.095 | 11 | 1 | Unpaved | 800 | 35 |
| 372 | 9609 | 9620 | 1.317 | 11 | 1 | Unpaved | 800 | 35 |
| 373 | 9630 | 0484 | 2.130 | 10 | 1 | Unpaved | 800 | 30 |
| 374 | 9630 | 3018 | 3.238 | 11 | 1 | Single-Lane Road | 1292 | 45 |
| 375 | 9630 | 5049 | 1.039 | 11 | 1 | Single-Lane Road | 1292 | 35 |
| 376 | 9630 | 6741 | 2.564 | 10 | 1 | Unpaved | 800 | 35 |
| 377 | 9763 | 2841 | 7.624 | 12 | 1 | Single-Lane Road | 1455 | 40 |

# APPENDIX C: TELEPHONE SURVEY

## Introduction

The development of evacuation time estimates (ETE) for the area surrounding the VEGP requires the identification of travel patterns, available vehicles, and household size of the people who live or work in the area. Specific data is needed in developing ETEs in order to effectively quantify mobilization time and vehicle usage for residents responding to an evacuation advisory. A telephone survey was conducted to interview a sample of residents who live within the 10-mile EPZ of the proposed nuclear power plant site to acquire information required for the ETE study.

IEM secured the services of Survey Technology & Research Center (STR) in Allentown, Pennsylvania to conduct the telephone survey and provide data to IEM for analysis.

## Survey Instrument and Sampling Plan

A survey instrument/questionnaire was developed by IEM, and was reviewed and approved by Southern Nuclear project personnel. The approved survey questionnaire was used to interview a sample of residents who live or work within 10 miles of the site to acquire information required for the ETE study. To achieve a representative sample of households living in the emergency planning zone (EPZ), respondents were randomly selected to participate in the survey. STR fielded the telephone survey and provided data to IEM for analysis. Calls were conducted in the early evening hours from Wednesday, June 6, 2012 to Monday, June 11, 2012. Only residents 18 years of age and older were allowed to participate in the survey. Telephone calls were made during weekday evenings and on weekends in an attempt to reach households with both workers and non-workers. To ensure the highest quality of work was performed, a quality assurance plan was implemented in this survey process that included call-taker training, telephone monitoring by IEM, and extensive data quality control checks.

The sampling frame consisted of a list of households within the study area. The survey required over 500 completed surveys in order to achieve the desired margin of error of 4 percentage points or less. However, there were not enough telephone listings available in the databases used by STR to attain this sample size. Several efforts were made to get a more comprehensive listing. With the available telephone numbers, the survey effort produced a total of 200 completed surveys, resulting in a margin of error at 6.8% with 95% confidence level.

## Survey Results

- How many people live in your home?

**Table 35: Household Size**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 20% |
| 2 | 42% |
| 3 | 17% |
| 4 | 13% |
| 5 or more | 10% |

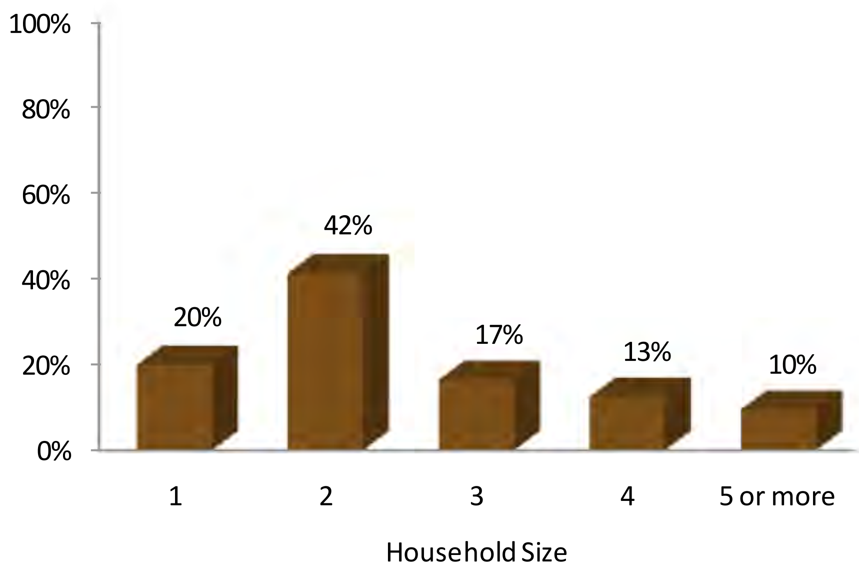


**Figure 22: Household Size**

- If instructed to evacuate, how many cars would your family use to evacuate…
  - During the day?

**Table 36: Percentage of Cars Used to Evacuate During the Day**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 63% |
| 2 | 27% |
| 3 or more | 9% |
| None | 2% |

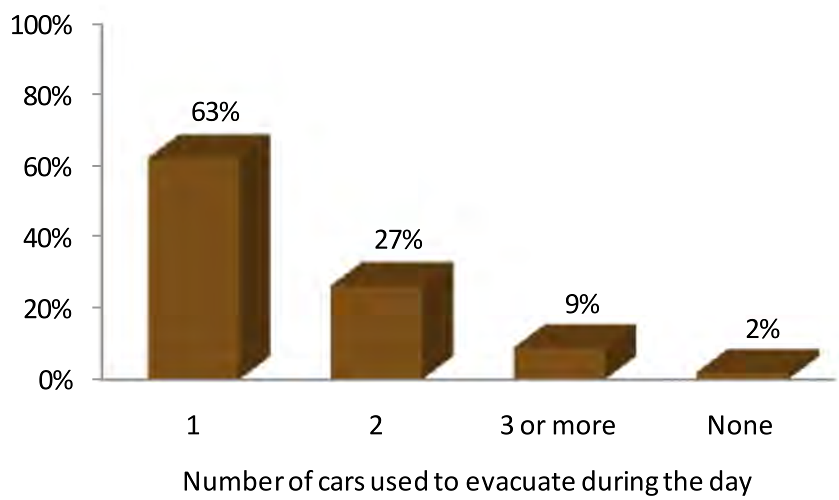


**Figure 23: Number of cars used to evacuate during the day**

- At night?

**Table 37: Percentage of Cars Used to Evacuate at Night**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 63% |
| 2 | 25% |
| 3 or more | 9% |
| None | 4% |

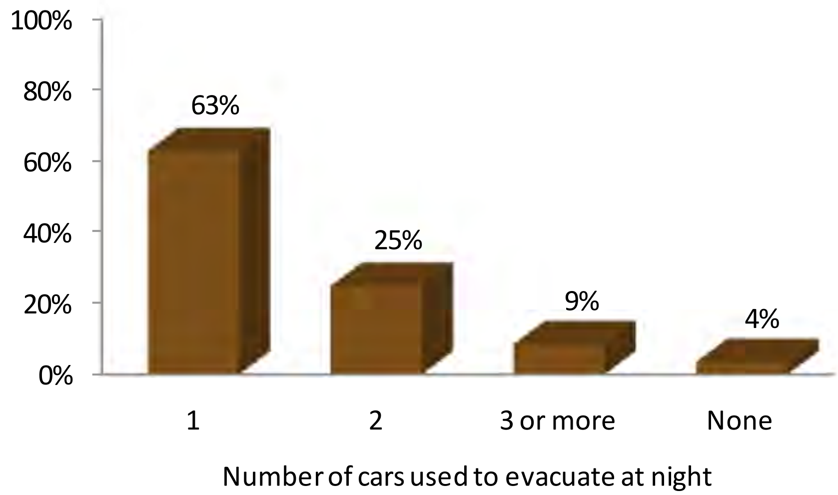


**Figure 24: Number of cars used to evacuate at night**

- On most weekends?

**Table 38: Percentage of Cars Used to Evacuate on Weekends**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 58% |
| 2 | 30% |
| 3 or more | 10% |
| None | 3% |

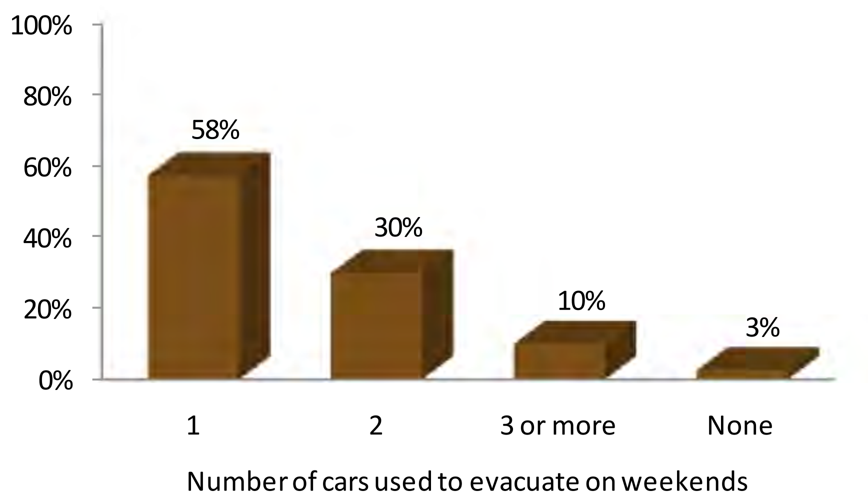


**Figure 25: Number of cars used to evacuate on weekends**

- Does anyone in your family rely on public transportation in the event of an evacuation?

**Table 39: Percentage who rely on public transportation to evacuate**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 3% |
| 2 | 1% |
| 3 | 2% |
| 4 | 0% |
| 5 or more | 1% |
| None | 94% |

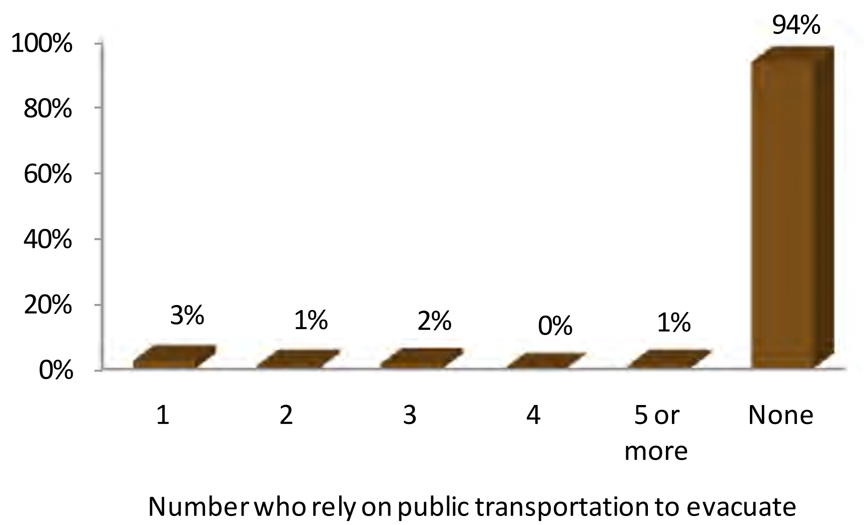


**Figure 26: Number who rely on public transportation to evacuate**

- How many people in your family commute to a job, or to college, at least 4 times a week?

**Table 40: Percentage of Respondents who indicated there are commuters in the family**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 27% |
| 2 | 17% |
| 3 | 12% |
| 4 | 2% |
| 5 or more | 1% |
| None | 43% |

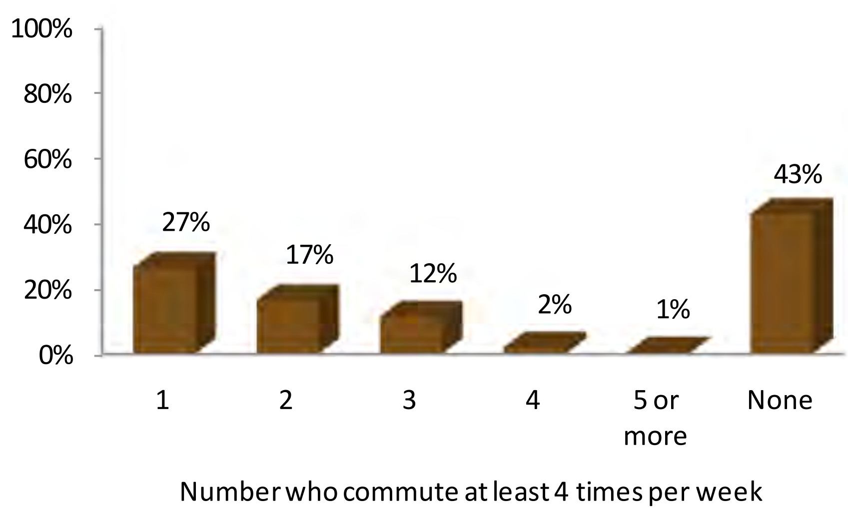


**Figure 27: Number who commutes at least 4 times per week**

- How long would it take each family member who works to return home, including the preparation time to leave work and the travel time back home?

**Table 41: Time to Return Home from Work**

| Response | Percentage of Commuters (n=114) |
|---|---|
| 1-5 minutes | 5% |
| 6-10 minutes | 9% |
| 11-15 minutes | 4% |
| More than 15 minutes | 82% |

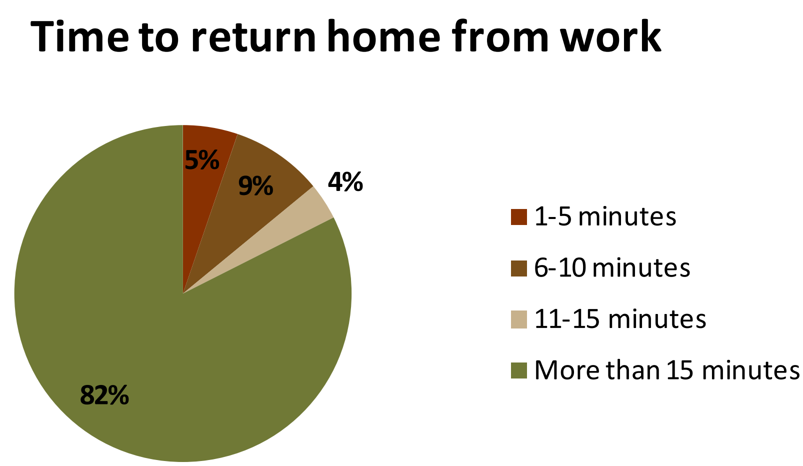


**Figure 28: Time it takes to return home from work**

- Would the people at home evacuate on their own or wait for family members to come home before evacuating?

**Table 42: Percentage who would Evacuate or Wait**

| Response | Percentage of Respondents (n=200) |
|---|---|
| Evacuate on own | 76% |
| Await the return of family members | 25% |

- If you had to evacuate, how long would it take for the family to pack clothing, secure the house, load the car, and complete preparations…
  - During the day?

**Table 43: Time to Complete Evacuation Preparations during the Day**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1-5 minutes | 17% |
| 6-10 minutes | 13% |
| 11-15 minutes | 7% |
| More than 15 minutes | 65% |

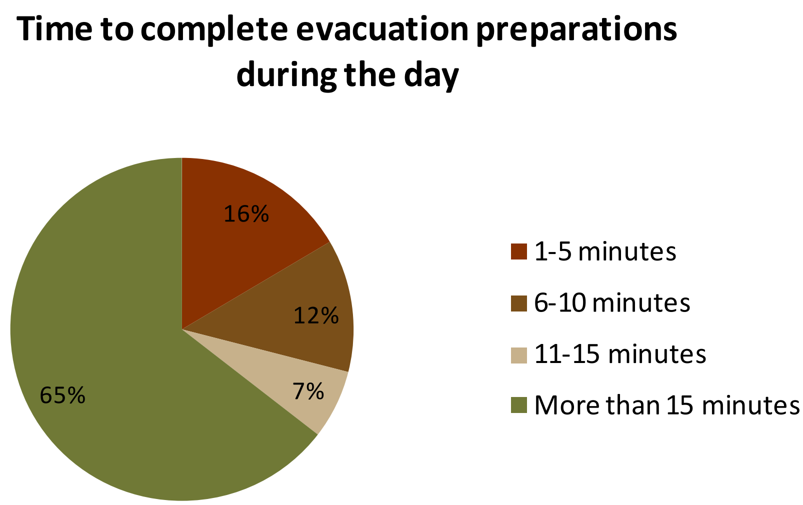


**Figure 29: Time it takes to complete evacuation preparations during the day**

- At night?

**Table 44: Time to Complete Evacuation Preparations at Night**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1-5 minutes | 12% |
| 6-10 minutes | 12% |
| 11-15 minutes | 8% |
| More than 15 minutes | 69% |

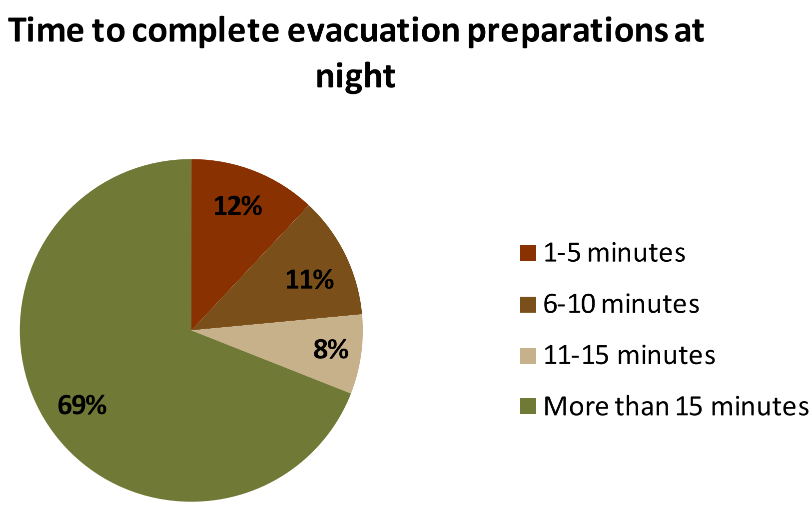


**Figure 30: Time it takes to complete evacuation preparations at night**

- On most weekends?

**Table 45: Time to Complete Evacuation Preparations on Weekends**

| Response | Percentage of Respondents (n=200) |
| --- | --- |
| 1-5 minutes | 12% |
| 6-10 minutes | 13% |
| 11-15 minutes | 10% |
| More than 15 minutes | 66% |

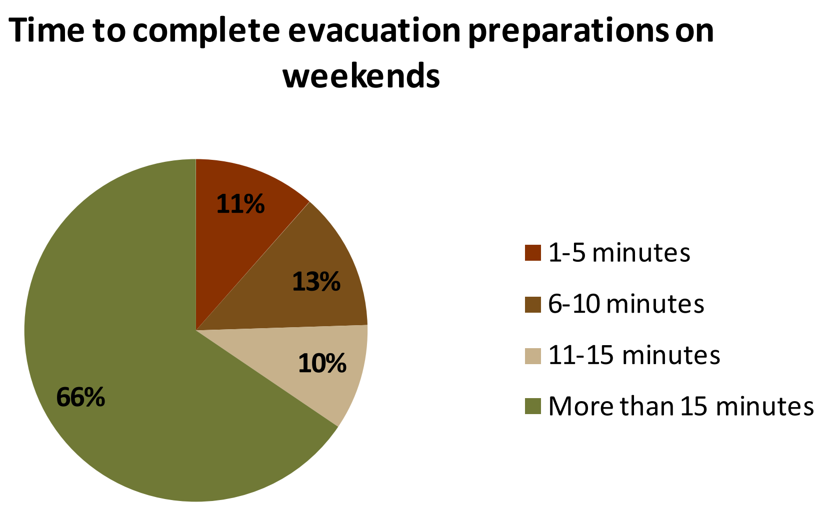


**Figure 31: Time it takes to complete evacuation preparations on the weekends**

- Do any family members require assistance because they don't drive or cannot drive? If so, how many?

**Table 46: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=200) |
|---|---|
| 1 | 15% |
| 2 | 5% |
| 3 | 3% |
| 4 | 0% |
| 5 or more | 1% |
| None | 78% |

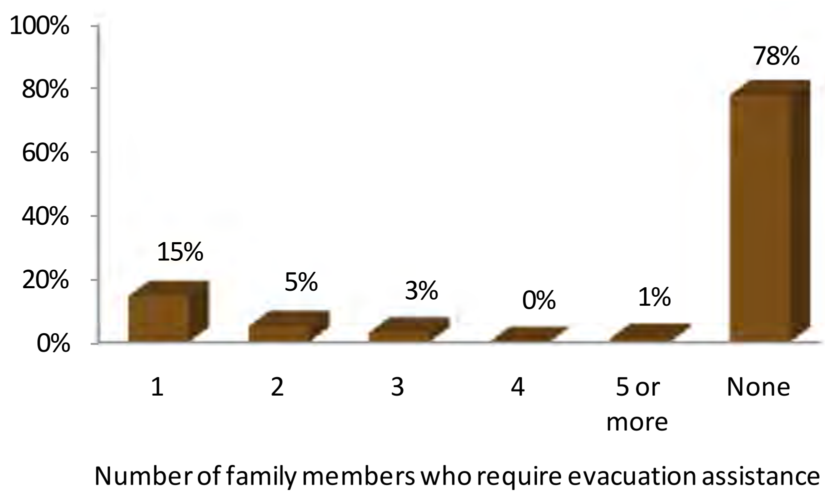


**Figure 32: Number of family members who require evacuation assistance**

- What type of assistance is needed?

**Table 47: Percentage of Respondents who indicated a family member needs assistance**

| Response | Percentage of Respondents (n=45) |
|---|---|
| Just a ride, no special accommodations | 96% |
| A wheelchair van | 4% |
| An ambulance with medical equipment and personnel to provide special medical attention. | 0% |
| An ambulance that can carry a stretcher, but no special medical attention is required. | 0% |
| Other | 0% |

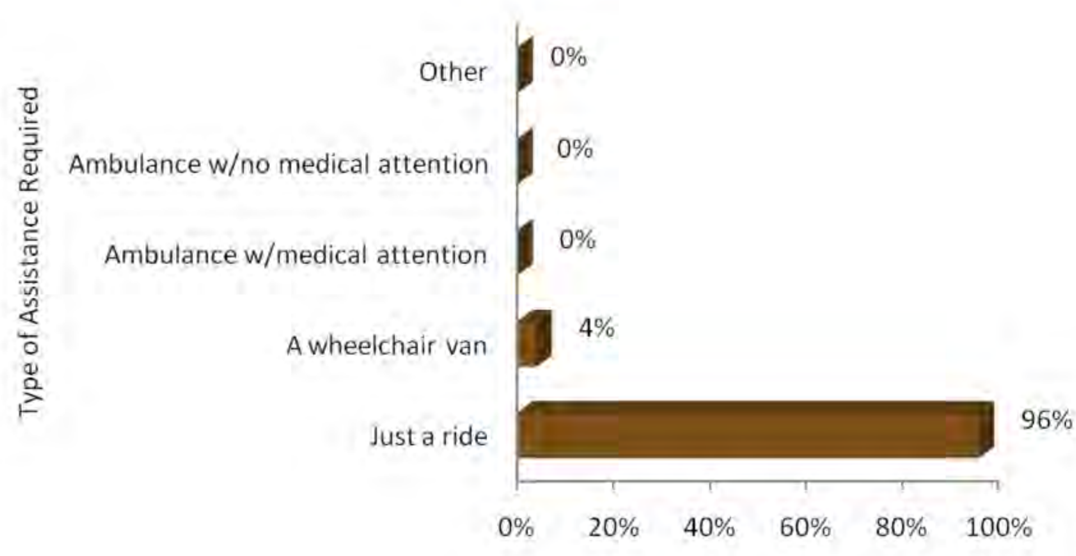


**Figure 33: Type of Evacuation Assistance Required**

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# APPENDIX D: PTV VISION QUALITY ASSURANCE AND INDUSTRY ACCEPTANCE INFORMATION

March 28, 2006

traffic mobility logistics.

[redacted]

PTV America, Inc.
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4334
Fax: 302-691-4740
www.ptvamerica.com

Akhil Chauhan
Transportation Ar ıalyst/Modeler
IEM, Inc.
8555 United Plaz a Blvd.
Baton Rouge, LA 70809

**RE: PTV Vision® Quality Assurance and Industry Acceptance**

Dear Mr. Chauha n:

Per your request, I am providing the following information concerning quality assurance and industry acceptance of the PTV Vision traffic

[redacted]

simulation and transportation plannir ıg software.

PTV AG has performed extensive re search and development of the PTV Vision software since 1992. The bas sis of the VISSIM simulation model is the car-following and lane-changing models developed at the University of Karlsruhe, Germany since 1974. The first commercial release of VISSIM was in 1993. The VISSIM s imulation model components have been validated by PTV for accuracy and performance based on field data in Germany and the United States.

A comprehensive quality assurance procedure is conducted before each service pack and major software rele ase by PTV, ensuring consistency of

[redacted]

traffic mobility logistics.

The following public agencies are currently using VISSIM:

- Arkansas State Highway Dept,

[redacted]

*PTV America, Inc.*
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302 654 4384
Fax: 302 691 4740
www.ptvamerica.com

- Colorado DOT,
- Florida DOT,
- Idaho DOT,
- Kansas DOT,
- Louisiana DOT,
- Michigan DOT,
- Missouri DOT,
- Nevada DOT,
- New Mexico DOT,
- NYSDOT,
- Ohio DOT,

[redacted]

- Oregon DOT,
- South Carolina DOT,
- UDOT,
- Washington DOT

ıg VISUM:

The following public agencies are currently usir

- AGFTC, Fort Edward NY
- BMPO, Bend OR
- BMTS, Binghamton NY
- CAMPO, Corvallis OR

[redacted]

D, El Paso TX
MPO, Farmington NM
ur D'Alene ID
MPO, Las Cruces NM
ene OR

- El Paso MP(
- Farmington I
- KMPO, Coe
- Las Cruces I
- LCOG, Euge

traffic mobility logistics.

If you have any questions about the PTV Vision software, feel free to contact me at 302-654-4384.

Sincerely yours,

Kiel Ova, P.E., PTOE
Project Manager

*PTV America, Inc.*
1300 N Market Street, Suite 603
Wilmington, DE 19801-1809

Phone: 302-654-4384
Fax: 302-691-4740
www.ptvamerica.com

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# APPENDIX E: ETE REVIEW CRITERIA CHECKLIST[32]

**Table 48: NUREG/CR-7002 ETE Review Criteria Checklist**

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **1.0** | **Introduction** | | |
| a. | The emergency planning zone (EPZ) and surrounding area should be described. | Yes | Section 1.1 Site Location<br>Section 1.2 Emergency Planning Zone |
| b. | A map should be included that identifies primary features of the site, including major roadways, significant topographical features, boundaries of counties, and population centers within the EPZ. | Yes | Figure 2: VEGP EPZ Boundary and Protective Action Zones |
| c. | A comparison of the current and previous ETE should be provided and includes similar information as identified in Table 1-1, "ETE Comparison," of NUREG/CR-7002. | Yes | Section 1.3 ETE Comparison Chart |
| **1.1** | **Approach** | | |
| a. | A discussion of the approach and level of detail obtained during the field survey of the roadway network should be provided. | Yes | Section 2.2 Methodology<br>Section 2.4 Scenarios Modeled<br>Section 3.0 Population and Vehicle Demand Estimation (and sub-sections)<br>Section 4.0 Evacuation Roadway Network<br>Section 4.3 Evacuation Network Characteristics<br>Section 5.2 Evacuation Simulation |
| b. | Sources of demographic data for schools, special facilities, large employers, and special events should be identified. | Yes | Section 2.3 Sources of Data |
| c. | Discussion should be presented on use of traffic control plans in the analysis. | Yes | Section 4.3 Evacuation Network Characteristics<br>Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures [33] |

[32] NRC. *Criteria for Development of Evacuation Time Estimate Studies*. NUREG/CR-7002. November 2011. Online: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7002/ (last accessed October 12, 2012).

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| d. | Traffic simulation models used for the analyses should be identified by name and version. | Yes | Section 2.2 Methodology<br>Section 5.0 Evacuation Time Estimate Methodology |
| e. | Methods used to address data uncertainties should be described. | Yes | Section 8.0 Sensitivity Study on Population Change<br>This study will be conducted once the 2012 VEGP ETE has been reviewed and approved by the NRC. |
| **1.2** | **Assumptions** | | |
| a. | The planning basis for the ETE includes the assumption that the evacuation is ordered promptly and no early protective actions have been implemented. | Yes | Section 2.1 General Assumptions. |
| b. | Assumptions consistent with Table 1-2, “General Assumptions,” of NUREG/CR-7002 should be provided and include the basis to support their use. | Yes | Section 2.1 General Assumptions |
| **1.3** | **Scenario Development** | | |
| a. | The ten scenarios in Table 1-3, Evacuation Scenarios, should be developed for the ETE analysis, or a reason should be provided for use of other scenarios. | Yes | Section 2.4 Scenarios Modeled<br>Table 2: ETE Scenarios Modeled |
| **1.3.1** | **Staged Evacuation** | | |
| a. | A discussion should be provided on the approach used in development of a staged evacuation. | Yes | Section 2.5 Evacuation Areas Modeled |
| **1.4** | **Evacuation Planning Areas** | | |
| a. | A map of the EPZ with emergency response planning areas (ERPAs) should be included. | Yes | Section 1.2 Emergency Planning Zone<br>Figure 2: VEGP EPZ Boundary and Protective Action Zones |
| b. | A table should be provided identifying the ERPAs considered for each ETE calculation by downwind direction in each sector. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |

[33] Because the VEGP EPZ does not have any population centers, traffic control plans have not been produced. However, Section 4.3 discusses traffic control points.

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | A table similar to Table 1-4, “Evacuation Areas for a Staged Evacuation Keyhole,” of NUREG/CR-7002 should be provided and includes the complete evacuation of the 2, 5, and 10 mile areas and for the 2 mile area/5 mile keyhole evacuations. | Yes | Section 1.2 Emergency Planning Zone<br>Table 3: Evacuation Areas for a Staged Evacuation Keyhole |
| **2.0** | **Demand Estimation** | | |
| a. | Demand estimation should be developed for the four population groups, including permanent residents of the EPZ, transients, special facilities, and schools. | Yes | Section 3.0 Population and Vehicle Demand Estimation (and sub-sections) |
| **2.1** | **Permanent Residents and Transient Population** | | |
| a. | The US Census should be the source of the population values, or another credible source should be provided. | Yes | Section 2.3 Sources of Data<br>Section 3.1 Permanent Residents |
| b. | Population values should be adjusted as necessary for growth to reflect population estimates to the year of the ETE. | Yes | Section 3.0 Population and Vehicle Demand Estimation |
| c. | A sector diagram should be included, similar to Figure 2-1, “Population by Sector,” of NUREG/CR-7002, showing the population distribution for permanent residents. | Yes | Figure 4: 2012 VEGP Sector and Ring Permanent Resident Population Map |
| **2.1.1** | **Permanent Residents with Vehicles** | | |
| a. | The persons per vehicle value should be between 1 and 2 or justification should be provided for other values. | Yes | Section 3.1 Permanent Residents<br>Section 3.5 Vehicle Occupancy Rate |
| b. | Major employers should be listed. | Yes | Section 3.0 Population and Vehicle Demand Estimation<br>Section 3.2 Transient Populations |
| **2.1.2** | **Transient Population** | | |
| a. | A list of facilities which attract transient populations should be included, and peak and average attendance for these facilities should be listed. The source of information used to develop attendance values should be provided. | Yes | Section 3.2 Transient Populations |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | The average population during the season should be used, itemized and totaled for each scenario. | Yes | Section 3.2 Transient Populations<br>Peak recreational population numbers were used for the fall weekend scenarios. Off-peak are estimated for other scenarios. |
| c. | The percent of permanent residents assumed to be at facilities should be estimated. | Yes | Section 3.2 Transient Populations |
| d. | The number of people per vehicle should be provided. Numbers may vary by scenario, and if so, discussion on why values vary should be provided. | Yes | Section 3.5 Vehicle Occupancy Rate |
| e. | A sector diagram should be included, similar to Figure 2-1 of NUREG/CR-7002, showing the population distribution for the transient population. | Yes | Figure 5: VEGP Sector and Ring Transient Populations Map |
| **2.2** | **Transit Dependent Permanent Residents** | | |
| a. | The methodology used to determine the number of transit dependent residents should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| b. | Transportation resources needed to evacuate this group should be quantified. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| c. | The county/local evacuation plans for transit dependent residents should be used in the analysis. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | The methodology used to determine the number of people with disabilities and those with access and functional needs who may need assistance and do not reside in special facilities should be provided. Data from local/county registration programs should be used in the estimate, but should not be the only set of data. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| e. | Capacities should be provided for all types of transportation resources. Bus seating capacity of 50% should be used or justification should be provided for higher values. | Yes | Section 3.3 Transit Dependent Permanent Residents |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| f. | An estimate of this population should be provided and information should be provided that the existing registration programs were used in developing the estimate. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| g. | A summary table of the total number of buses, ambulances, or other transport needed to support evacuation should be provided and the quantification of resources should be detailed enough to assure double counting has not occurred. | Yes | Table 10: Transit Dependent Permanent Resident Evacuation Information |
| **2.3** | **Special Facility Residents** | | |
| a. | A list of special facilities, including the type of facility, location, and average population should be provided. Special facility staff should be included in the total special facility population. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| b. | A discussion should be provided on how special facility data was obtained. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| c. | The number of wheelchair and bed-bound individuals should be provided. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| d. | An estimate of the number and capacity of vehicles needed to support the evacuation of the facility should be provided. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| e. | The logistics for mobilizing specially trained staff (e.g., medical support or security support for prisons, jails, and other correctional facilities) should be discussed when appropriate. | N/A | No special facilities, as defined in the NUREG/CR-7002, were identified in the EPZ. |
| **2.4** | **Schools** | | |
| a. | A list of schools including name, location, student population, and transportation resources required to support the evacuation, should be provided. The source of this information should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 3.5 Vehicle Occupancy Rate |
| b. | Transportation resources for elementary and middle schools are based on 100% of the school capacity. | Yes | Section 3.4 Special Facility and School Populations |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | The estimate of high school students who will use their personal vehicle to evacuate should be provided and a basis for the values used should be provided. | N/A | There are no high schools in the 10-mile EPZ. |
| d. | The need for return trips should be identified if necessary. | Yes | Section 3.4 Special Facility and School Populations |
| **2.5** | **Other Demand Estimate Considerations** | | |
| **2.5.1** | **Special Events** | | |
| a. | A complete list of special events should be provided and includes information on the population, estimated duration, and season of the event. | N/A | No special events were studied. |
| b. | The special event that encompasses the peak transient population should be analyzed in the ETE. | N/A | No special events were studied. |
| c. | The percent of permanent residents attending the event should be estimated. | N/A | No special events were studied. |
| **2.5.2** | **Shadow Evacuation** | | |
| a. | A shadow evacuation of 20 percent should be included for areas outside the evacuation area extending to 15 miles from the NPP. | Yes | Section 2.1 General Assumptions |
| b. | Population estimates for the shadow evacuation in the 10 to 15 mile area beyond the EPZ are provided by sector. | Yes | Section 3.1.3. Resident Population Summary |
| c. | The loading of the shadow evacuation onto the roadway network should be consistent with the trip generation time generated for the permanent resident population. | Yes | Section 2.1 General Assumptions |
| **2.5.3** | **Background and Pass Through Traffic** | | |
| a. | The volume of background traffic and pass-through traffic should be based on the average daytime traffic. Values may be reduced for nighttime scenarios. | Yes | Section 2.1 General Assumptions<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | Pass-through traffic should be assumed to have stopped entering the EPZ about two hours after the initial notification. | Yes | Section 2.1 General Assumptions<br>It is assumed that little pass-through and background traffic would exist after the evacuees start to load into the roadway network. |
| **2.6** | **Summary of Demand Estimation** | | |
| a. | A summary table should be provided that identifies the total populations and total vehicles used in the analysis for permanent residents, transients, transit dependent residents, special facilities, schools, shadow population, and pass-through demand used in each scenario. | Yes | Section 3.6 Summary of Demand Estimation |
| **3.0** | **Roadway Capacity** | | |
| a. | The method(s) used to assess roadway capacity should be discussed. | Yes | Section 5.2.2 The Network Model |
| **3.1** | **Roadway Characteristics** | | |
| a. | A field survey of key routes within the EPZ has been conducted. | Yes | Section 4.1 Network Definition |
| b. | Information should be provided describing the extent of the survey, and types of information gathered and used in the analysis. | Yes | Section 4.1 Network Definition |
| c. | A table similar to that in Appendix A, "Roadway Characteristics," of NUREG/CR-7002 should be provided. | Yes | Table 34: Roadway Network Characteristics |
| d. | Calculations for a representative roadway segment should be provided. | Yes | Section 5.2.2 The Network Model |
| e. | A legible map of the roadway system that identifies node numbers and segments used to develop the ETE should be provided and should be similar to Figure 3-1, "Roadway Network Identifying Nodes and Segments," of NUREG/CR-7002. | Yes | Appendix B: Evacuation Network Lines (Detailed Information)<br>Figure 18 through Figure 21 |
| **3.2** | **Capacity Analysis** | | |
| a. | The approach used to calculate the roadway capacity for the transportation network should be described in detail and identifies factors that are expressly used in the modeling. | Yes | Section 5.2.2 The Network Model |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | The capacity analysis identifies where field information should be used in the ETE calculation. | Yes | Section 5.2.2 The Network Model |
| **3.3** | **Intersection Control** | | |
| a. | A list of intersections should be provided that includes the total numbers of intersections modeled that are unsignalized, signalized, or manned by response personnel. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 17: Intersection Control Type |
| b. | Characteristics for the 10 highest volume intersections within the EPZ are provided including the location, signal cycle length, and turn lane queue capacity. | Yes | Section 4.3 Evacuation Network Characteristics<br>Table 18: Information for Ten Highest Volume Intersections |
| c. | Discussion should be provided on how time signal cycle is used in the calculations. | Yes | Section 4.3 Evacuation Network Characteristics |
| **3.4** | **Adverse Weather** | | |
| a. | The adverse weather condition should be identified and the effect of adverse weather on mobilization should be considered. | Yes | Section 2.1 General Assumptions<br>Section 2.4 Scenarios Modeled<br>Because there are few extreme weather conditions such as heavy snow at the VEGP, no significant impacts of adverse weather on mobilization are expected. |
| b. | The speed and capacity reduction factors identified in Table 3-1, "Weather Capacity Factors," of NUREG/CR-7002 should be used or a basis should be provided for other values. | Yes | Section 2.1 General Assumptions |
| c. | The study identifies assumptions for snow removal on streets and driveways, when applicable. | N/A | Because there are few extreme weather conditions such as heavy snow at the VEGP, no significant impacts of adverse weather on mobilization are expected. |
| **4.0** | **Development of Evacuation Times** | | |
| **4.1** | **Trip Generation Time** | | |
| a. | The process used to develop trip generation times should be identified. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | When telephone surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance should be provided. | Yes | Appendix C: Telephone Survey |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | Data obtained from telephone surveys should be summarized. | Yes | Appendix C: Telephone Survey |
| d. | The trip generation time for each population group should be developed from site specific information. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.1** | **Permanent Residents and Transient Population** | | |
| a. | Permanent residents are assumed to evacuate from their homes but are not assumed to be at home at all times. Trip generation time includes the assumption that a percentage of residents will need to return home prior to evacuating. | Yes | Section 5.1 Loading of the Evacuation Network |
| b. | Discussion should be provided on the time and method used to notify transients. The trip generation time discusses any difficulties notifying persons in hard to reach areas such as on lakes or in campgrounds. | Yes | Section 5.1.2 Trip Generation Time Estimate |
| c. | The trip generation time accounts for transients potentially returning to hotels prior to evacuating. | N/A | No Hotels are found within the EPZ. |
| d. | Effect of public transportation resources used during special events where a large number of transients are expected should be considered. | N/A | No Special events are expected. |
| e. | The trip generation time for the transient population should be integrated and loaded onto the transportation network with the general public. | Yes | Section 5.1 Loading of the Evacuation Network |
| **4.1.2** | **Transit Dependent Residents** | | |
| a. | If available, existing plans and bus routes are used in the ETE analysis. If new plans are developed with the ETE, they should have been agreed upon by the responsible authorities. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| b. | Discussion should be included on the means of evacuating ambulatory and non-ambulatory residents. | Yes | Section 3.3 Transit Dependent Permanent Residents |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| c. | The number, location and availability of buses, and other resources needed to support the demand estimation are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents |
| d. | Logistical details, such as the time to obtain buses, brief drivers and initiate the bus route are provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br><br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| e. | Discussion should identify the time estimated for transit dependent residents to prepare and then travel to a bus pickup point, and describes the expected means of travel to the pickup point. | Yes | Section 3.3 Transit Dependent Permanent Residents<br><br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br><br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br><br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| f. | The number of bus stops and time needed to load passengers should be discussed. | Yes | Section 3.3 Transit Dependent Permanent Residents<br><br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| g. | A map of bus routes should be included. | N/A | There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| h. | The trip generation time for non-ambulatory persons includes the time to mobilize ambulances or special vehicles, time to drive to the home of residents, loading time, and time to drive out of the EPZ should be provided. | Yes | Section 3.3 Transit Dependent Permanent Residents<br>Section 5.1.3 Trip Generation Time for Transit Dependent Permanent Residents<br>Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>There are no specialized bus routes or pick-up points. Per EMA SOPs, residents will be picked up at their homes by school buses running regular routes. No designated mass pick-up points will be used. |
| i. | Information should be provided to support analysis of return trips, if necessary. | N/A | No return trips are expected. |
| **4.1.3** | **Special Facilities** | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| b. | Discussion should be provided on the inbound and outbound speeds. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| c. | The number of wheelchair and bed-bound individuals should be provided, and the logistics of evacuating these residents should be discussed. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| d. | Time for loading of residents should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| e. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| f. | If return trips are needed, the destination of vehicles should be provided. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| g. | Discussion should be provided on whether special facility residents are expected to pass through the reception center prior to being evacuated to their final destination. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| h. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No special facilities, as defined by NUREG/CR-7002, were identified in the 10-mile EPZ. |
| **4.1.4** | **Schools** | | |
| a. | Information on evacuation logistics and mobilization times should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation Time for Schools<br>Section 6.4 ETE Results for Special Facility and School Population |
| b. | Discussion should be provided on the inbound and outbound speeds. | Yes | Section 6.4 ETE Results for Special Facility and School Population |
| c. | Time for loading of students should be provided. | Yes | Section 3.4 Special Facility and School Populations<br>Section 5.1.4 Trip Generation Time for Schools |
| d. | Information should be provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 3.4 Special Facility and School Populations |
| e. | If return trips are needed, the destination of school buses should be provided. | N/A | No return trips are expected |
| f. | If used, reception centers should be identified. Discussion should be provided on whether students are expected to pass through the reception center prior to being evacuated to their final destination. | Yes | Section 3.4 Special Facility and School Populations |
| g. | Supporting information should be provided to quantify the time elements for the return trips. | N/A | No return trips are expected |
| **4.2** | **ETE Modeling** | | |
| a. | General information about the model should be provided and demonstrates its use in ETE studies. | Yes | Section 5.2 Evacuation Simulation |
| b. | If a traffic simulation model is not used to conduct the ETE calculation, sufficient detail should be provided to validate the analytical approach used. All criteria elements should have been met, as appropriate. | N/A | A traffic simulation model was used for the ETE study. |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **4.2.1** | **Traffic Simulation Model Input** | | |
| a. | Traffic simulation model assumptions and a representative set of model inputs should be provided. | Yes | Section 3.5 Vehicle Occupancy<br>Section 3.6 Summary of Demand Estimation<br>Section 5.1 Loading of the Evacuation Network<br>Section 5.2 Evacuation Simulation |
| b. | A glossary of terms should be provided for the key performance measures and parameters used in the analysis. | Yes | Appendix B: Evacuation Network Lines (Detailed Information) |
| **4.2.2** | **Traffic Simulation Model Output** | | |
| a. | A discussion regarding whether the traffic simulation model used must be in equilibration prior to calculating the ETE should be provided. | Yes | Section 5.2.3 The Impact Model |
| b. | The minimum following model outputs should be provided to support review:<br>1. Total volume and percent by hour at each EPZ exit mode.<br>2. Network wide average travel time.<br>3. Longest Queue length for the 10 intersections with the highest traffic volume.<br>4. Total vehicles exiting the network.<br>5. A plot that provides both the mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ.<br>6. Average speed for each major evacuation route that exits the EPZ. | Yes | Section 6.5 Example Model Output |
| c. | Color coded roadway maps should be provided for various times (i.e., at 2, 4, 6 hrs., etc.) during a full EPZ evacuation scenario, identifying areas where long queues exist including level of service (LOS) "E" and LOS "F" conditions, if they occur. | N/A | No extensive LOS E or LOS F was observed. |
| **4.3** | **Evacuation Time Estimates for the General Public** | | |
| a. | The ETE should include the time to evacuate 90% and 100% of the total permanent resident and transient population. | Yes | Section 6.0 Analysis of Evacuation Times |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| b. | The ETE for 100% of the general public should include all members of the general public. Any reductions or truncated data should be explained. | Yes | Section 6.1 Summary of ETE Results for General Public |
| c. | Tables should be provided for the 90 and 100 percent ETEs similar to Table 4-3, "ETEs for Staged Evacuation Keyhole," of NUREG/CR-7002. | Yes | Section 6.1 Summary of ETE Results for General Public<br>Table 24: 100% ETEs in Minutes<br>Table 25: 90% ETEs in Minutes |
| d. | ETEs should be provided for the 100 percent evacuation of special facilities, transit dependent, and school populations. | Yes | Section 6.3 ETE Results for Transit Dependent Permanent Residents<br>Section 6.4 ETE Results for School Populations |
| **5.0** | **Other Considerations** | | |
| **5.1** | **Development of Traffic Control Plans** | | |
| a. | Information that responsible authorities have approved the traffic control plan used in the analysis should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| b. | A discussion of adjustments or additions to the traffic control plan that affect the ETE should be provided. | Yes | Section 7.2 Evacuation Traffic Management Locations and Other Potential Mitigating Measures |
| **5.2** | **Enhancements in Evacuation Time** | | |
| a. | The results of assessments for improvement of evacuation time should be provided. | Yes | Section 9.0 Conclusion and Recommendations |
| b. | A statement or discussion regarding presentation of enhancements to local authorities should be provided. | Yes | Section 9.0 Conclusion and Recommendations |
| **5.3** | **State and Local Review** | | |
| a. | A list of agencies contacted and the extent of interaction with these agencies should be discussed. | Yes | Section 2.3 Sources of Data |
| b. | Information should be provided on any unresolved issues that may affect the ETE. | Yes | The ETE has been reviewed and no unresolved issues were found. |
| **5.4** | **Reviews and Updates** | | |
| a. | A discussion of when an updated ETE analysis is required to be performed and submitted to the NRC. | Yes | Section 8.0 Sensitivity Study on Population Change<br>This study will be conducted once the 2012 VEGP ETE has been reviewed and approved by the NRC. |

| | Review of ETE for Vogtle Electric Generating Plant Report | Criterion Addressed in ETE Analysis (Yes/No) | Comments |
|---|---|---|---|
| **5.5** | **Reception Centers and Congregate Care Center** | | |
| a. | A map of congregate care centers and reception centers should be provided. | Yes | Figure 7: VEGP Evacuation Network |
| b. | If return trips are required, assumptions used to estimate return times for buses should be provided. | N/A | No return trips are expected |
| c. | It should be clearly stated if it is assumed that passengers are left at the reception center and are taken by separate buses to the congregate care center. | N/A | The congregate care centers are located adjacent to the reception centers. No separate buses are required. |

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