Progress Energy

Serial: NPD-NRC-2009-101 10CFR52.79
June 10, 2009

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

LEVY NUCLEAR POWER PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 028 RELATED TO EMERGENCY PLANNING – EVACUATION TIME ESTIMATE

Reference: Letter from Brian C. Anderson (NRC) to Garry Miller (PEF), dated May 8, 2009, "Request for Additional Information Letter No. 028 Related to SRP Section 13.3 for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application"

Ladies and Gentlemen:

Progress Energy Florida, Inc. (PEF) hereby submits our response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A response to the NRC request is addressed in the enclosure. The enclosure also identifies changes that will be made in a future revision of the Levy Nuclear Power Plant Units 1 and 2 application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (919) 546-6107.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on June 10, 2009.

Sincerely,

Garry D. Miller
General Manager
Nuclear Plant Development

Enclosures/Attachments

cc : U.S. NRC Region II, Regional Administrator (without attached CD)
Mr. Brian C. Anderson, U.S. NRC Project Manager (with 2 copies of attached CD)

Progress Energy Carolinas, Inc.
P.O. Box 1551
Raleigh, NC 27602

D094
NRO

**Levy Nuclear Power Plant Units 1 and 2
Response to NRC Request for Additional Information Letter No. 028 Related to SRP Section 13.3 for the Combined License Application, dated May 8, 2009**

NRC RAI #	Progress Energy RAI #	Progress Energy Response
13.03-2	L-0223	Response enclosed – see following pages
13.03-3	L-0224	Response enclosed – see following pages
13.03-4	L-0225	Response enclosed – see following pages
13.03-5	L-0226	Response enclosed – see following pages
13.03-6	L-0227	Response enclosed – see following pages
13.03-7	L-0228	Response enclosed – see following pages
13.03-8	L-0229	Response enclosed – see following pages
13.03-9	L-0230	Response enclosed – see following pages
13.03-10	L-0231	Response enclosed – see following pages
13.03-11	L-0232	Response enclosed – see following pages
13.03-12	L-0233	Response enclosed – see following pages
13.03-13	L-0234	Response enclosed – see following pages
13.03-14	L-0235	Response enclosed – see following pages
13.03-15	L-0236	Response enclosed – see following pages
13.03-16	L-0237	Response enclosed – see following pages

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-2 (ETE-1)

Text of NRC RAI:

ETE-1: Site Location and Emergency Planning Zone
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section I.A.

A. Figure 1-1, "Levy Nuclear Plant Site Location," (Page 1-4) shows the LNP with the 2-, 5-, and 10-mile rings within the plume exposure pathway EPZ. Communities and county boundaries within the 2-, 5-, and 10-mile rings are not clearly labeled. Provide maps that include surrounding communities, county boundaries, and political boundaries.

PGN RAI ID #: L-0223

PGN Response to NRC RAI:

There are four communities within 10 miles of the proposed Levy Nuclear Plant (LNP) site – Yankeetown, Inglis, Dunnellon and Citrus Springs. Figure 1-1 has been revised (see attached) to include these communities. The LNP EPZ includes three counties – Levy, Citrus and Marion. The revised version of Figure 1-1 clearly identifies the EPZ county boundaries and labels these counties. The revised map focuses on the Levy EPZ and the three counties comprising the EPZ, while the newly added inset to the map shows the location of the Levy EPZ relative to the major population centers in the area – Tampa and Orlando. In addition, communities and counties in the surrounding area have been identified on the revised figure.

Figure 3-1 has also been revised to include the aforementioned communities and counties, appropriately labeled.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

1. Replace Figure 1-1 with the revised figure shown on page 4.
2. Replace Figure 3-1 with the revised figure shown on page 5.
3. Section 1.2 of the ETE report will be revised as follows:

1.2 The Levy Nuclear Plant Location

The Levy Nuclear Plant is located approximately 85 miles north of Tampa, Florida, 80 miles northwest of Orlando, Florida and 9 miles northeast of the existing Crystal River Nuclear Plant. The Emergency Planning Zone (EPZ) consists of parts of three counties: Levy County, Citrus County, and Marion County. Figure 1-1 displays the area surrounding LNP. This map identifies the communities in the area and the major roads. The inset to the map identifies the location of the plant relative to Tampa and Orlando.

Attachments/Enclosures:

None.

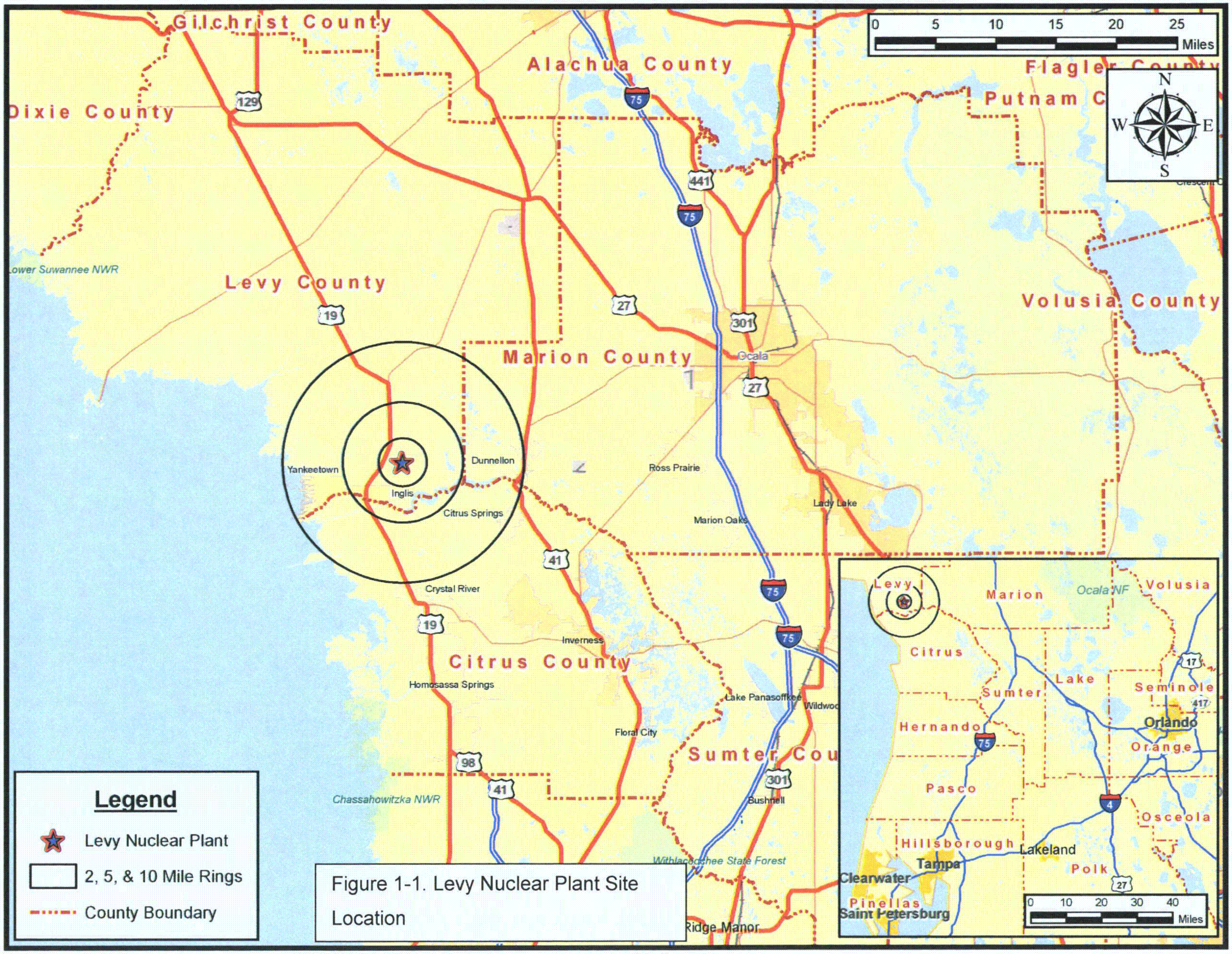


Figure 1-1. Levy Nuclear Plant Site Location

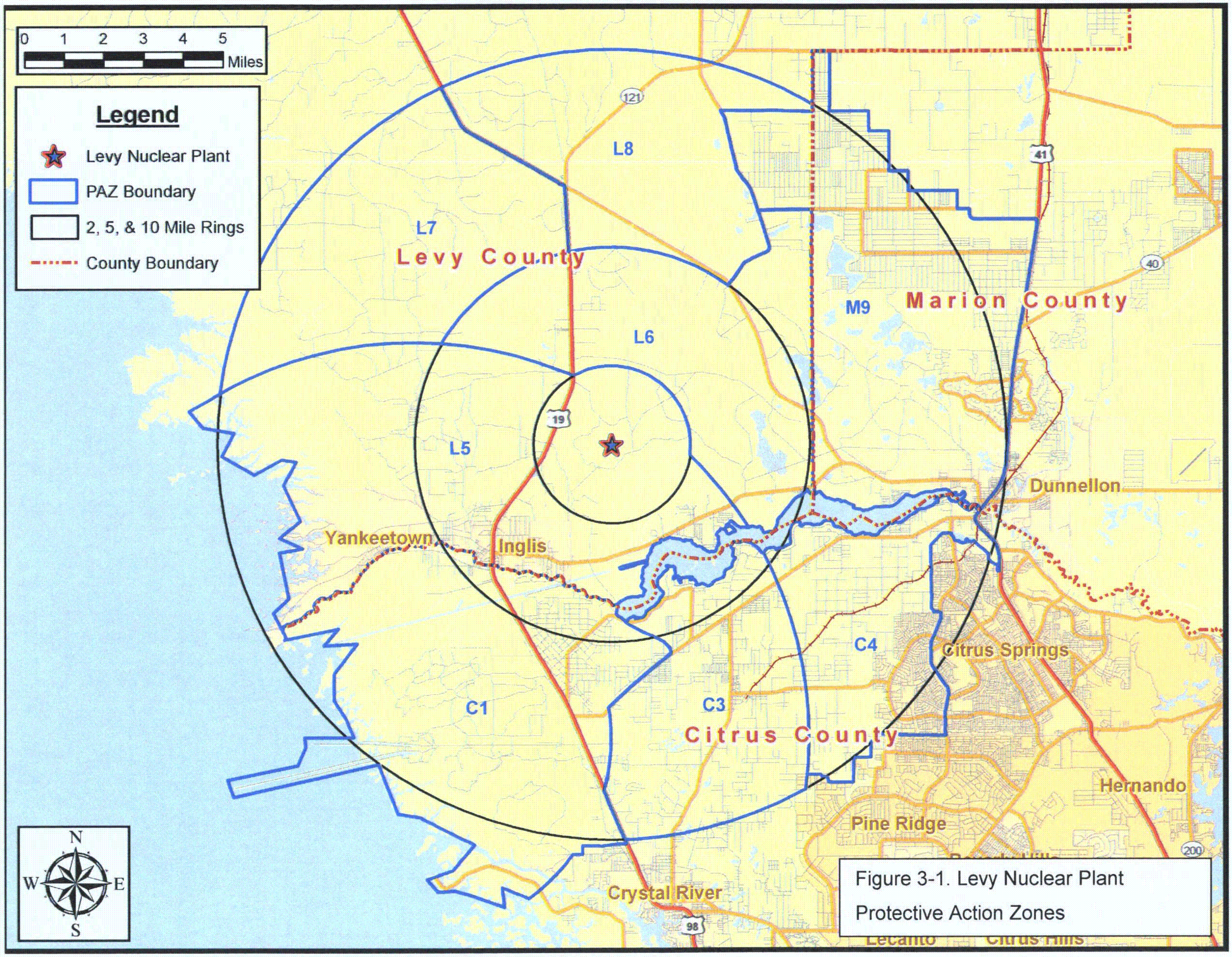


Figure 3-1. Levy Nuclear Plant Protective Action Zones

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-3 (ETE-2)

Text of NRC RAI:

ETE-2: ETE General Assumptions
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Sections I.B, Section II.C, Section III.A, IV.A.1

A. Section 2.1, "Data Estimates", (Page 2-1) assumption #5 states that the relationship between the resident population and evacuating vehicles is developed from the telephone survey. Appendix F, "Telephone Survey," Section 2, "Survey Instrument and Sampling Plan," states that a sample size of 550 completed survey forms would provide an acceptable sampling error and sampling would be performed within the plume exposure pathway EPZ using zip codes. Table F-1, "Survey Sampling Plan," (Page F-2) identifies the required sample size for each zip code within the EPZ totaling 550, while also providing the overall total of the population size as 34,880 based on census data from the year 2000. Table 3-1, "EPZ Permanent Resident Population," indicates the 2007 resident population is 22,758.

1. Provide the actual number of completed survey forms and sampling error used throughout the Telephone Survey or describe why they are not necessary.
2. Clarify whether or not completed survey forms received included populations within the associated zip codes, outside of the plume exposure pathway EPZ.
3. Clarify what population size was used as a basis for the telephone sampling plan and whether or not the population size used had an effect on the evacuation time estimates, if different from the 22,758 population size found on Page 3-4.

B. Section 2.1, "Data Estimates", (Page 2-1) assumption #7 states that the ETEs are presented for the evacuation of the 100^{th} percentile. The evacuation times provided in Section 7, "General Population Evacuation Time Estimates (ETE)," indicate ETEs of about 5 hours for the general population, whereas the telephone survey results in Figure F-11, "Time to Prepare Home for Evacuation," (page F-10) indicate that it may take as long as 6 hours for the general public to prepare to evacuate. Clarify the inconsistency in the time it takes to evacuate 100 percent of the general population.

C. Section 2.3, "Study Assumptions," (Page 2-4) assumption #7 states that the number and location of Traffic Control Points (TCPs) depends on available personnel resources and the region being evacuated.

1. Provide information regarding changes that would have to be implemented due to lack of resources or regions being evacuated.
2. Clarify whether there is an effect on the ETE if these traffic control points are not established.

D. Section 2.3, "Study Assumptions," assumption #10, (Page 2-5) indicates that there is assumed to be no effect on mobilization time due to rain. However, Section 8.4, "Evacuation Time Estimates for Transit Dependent People," (Page 8-5) indicates that time is increased for activities during mobilization, such as "Activity: Mobilize Drivers", where mobilization time is "slightly longer – 100 minutes- when raining," versus 90 minutes for normal weather. Clarify why there is an effect on mobilization time for schools and special facilities, but not for the general public.

E. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People", Table 8-5A, "School Evacuation Time Estimates – Good Weather," (Page 8-13) indicates students are loaded in 5 minutes. For Dunnellon Middle School, there are 1,100 students and 22 buses required. The logistics of such a movement indicate that a five minute loading time would be challenging. Provide additional detail regarding the assumptions used to support boarding 1,100 students in five minutes.

F. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People", (Page 8-8) indicates that for wheelchair bus runs, wheelchair vans and buses are often scarce and regular buses may be used. Wheelchairs would be stacked in the back and evacuees would sit in the front of the bus. Discuss the assumptions related to bus capacity when using this approach for wheelchair-bound passengers.

G. Section 1.3, "Preliminary Activities," subsection, "Field Surveys of the Highway Network," states that in developing the ETE analysis for the LNP site, the entire highway system within the EPZ and for some distance outside of the EPZ was driven, and characteristics of each section of highway were recorded. These characteristics included "unusual characteristics" such as narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc. Explain the significance of these identified unusual characteristics, and how they impact the proposed LNP site. In addition, address whether or not these, or any other, unusual characteristics unique to the proposed LNP site could pose a significant impediment to the development of the LNP emergency plan.

PGN RAI ID #: L-0224

PGN Response to NRC RAI:

A.1. Table 1 below summarizes the total number of telephone surveys completed for each zip code, as provided by the sub-contractor. As indicated in the table, a total of 553 surveys were completed. Table 2 is a modified version of Table F-1 from the ETE report. Table F-1 was provided to the sub-contractor as guidance in performing the telephone survey. As shown in Table 2; the total of the required sample column was shown as 550 when it should have been 553; this error was due to round-off. (Table F-1 is revised as attached in the response to RAI ETE-4 and will be replaced in a future revision of the ETE report.) Comparing Tables 1 and 2, it is evident that the number of completed telephone surveys adhered to the survey sampling plan, exactly.

Table 1. Combined Levy/Crystal River Nuclear Plant Telephone Survey

Zip Code	Total Surveys Completed	Percent of Total Surveys Completed
34428	150	27.1%
34429	129	23.3%
34431	127	23.0%
34433	68	12.3%
34449	79	14.3%
Total	**553**	**100%**

Table 2. Survey Sampling Plan				
Levy Telephone Survey				
Zip Code	**Population in ZIP (2000)**	**Households in ZIP (2000)**	**Required Sample**	**Percentage of Total Households**
34428	9,479	3,779	150	27.1%
34429	9,528	3,233	129	23.3%
34431	7,336	3,176	127	23.0%
34433	4,583	1,691	68	12.3%
34449	3,954	1,979	79	14.3%
Total:	**34,880**	**13,858**	**553**	**100%**

Sampling Error

With regard to the use of the data and the sampling error, it is most relevant to discuss the 95% confidence bounds on the key quantities of interest.

It is necessary to focus on the quantities to be used in the analyses, so that one can identify the "key quantities of interest" for generating confidence bounds. For instance, for each figure in Appendix F, one needs to know the information derived from them and used in the overall analysis.

Once that is done, one can then generate confidence bounds on the key quantities of interest. The two broad categories of interest are:

1) The quantity is itself a percentage, such as the percent "p" of people giving a certain response. Using N = 553 samples, the 95% confidence bound on "p" generally ranges from ± 0.026 to ± 0.043, with the largest confidence bound resulting if "p" is estimated at 0.500. In such a case, with N = 553 samples, one could say with 95% confidence that the true value of "p" is in the range of 0.500 ± 0.043;

2) The quantity is a number, such as the average number of cars per household (Figure F-2). For this, let us consider the data at hand, for which there were N = 552 samples. One of the quantities of interest was the overall weighted average number of cars per household, which was computed with 95% confidence as 1.82 ± 0.09.

The question sometimes arises as to whether the confidence bound can be made tighter by a larger sample size. The answer is of course "yes", but it is an issue of diminishing returns. Because of the basic formulas in statistics, in order to cut a confidence range in half, the sample size must be quadrupled.

The confidence bounds cited in Item 1 above are purely illustrative, as upper bounds based upon the sample size involved. The confidence bounds cited in Item 2 above are related to Figure F-2 of the report. Given the question raised in the RAI, a future revision of the ETE report will contain additional confidence bound estimates as follows: (a) For Figures F-1 and F-5 to F-8, similar work to that done above for Figure F-2 will be done and reported; (b) Figures F-3 and F-4 are used to build Figure F-2, which has been addressed, and they need not be addressed separately; (c) Figures F-9 to F-11 are used to build Figure 5-3 and Table 5-1; confidence bounds will be provided for the end-products – Figure 5-3 and Table 5-1; however, they will not be provided for base distributions presented in Figures F-9 to F-11; (d) In Figure F-6, confidence bounds will also be done for the percent of households with zero commuters as this number is used throughout the ETE analysis.

A.2. As shown in Table 1 above, the telephone survey adhered to the survey sampling plan. Phone calls were made to people living in the zip codes identified in Table F-1 of the ETE report. It is possible that phone calls were made within the zip codes, but outside of the proposed Levy and existing Crystal River EPZs. It is assumed that the demographics are uniform across a zip code. Therefore calls made within the zip codes identified in Table F-1 will produce valid results, even if the person may live just outside the EPZs of the two plants.

A.3. As discussed in the response to ETE-8, Part A, Progress Energy contracted KLD Associates, Inc. to develop ETE for the proposed Levy site as well as update the ETE study for the existing Crystal River plant. Due to the close proximity of the two sites (approximately 9.8 miles between the existing Crystal River Plant and the proposed Levy site), a combined telephone survey of residents living within the zip codes identified in Table F-1 of the ETE report was deemed appropriate. Therefore, the population size used as a basis for the telephone survey sampling plan is 34,880 as shown in Table F-1 of the ETE report. The computation of this population size is discussed in the response to RAI ETE-4, part B, question 1. This population size differs from the EPZ population of 22,758 shown in Table 3-2 of the ETE report; this difference is explained in the response to RAI ETE-4, part B, question 2.

B. As discussed in Section 7.3, the flow rate of evacuating vehicles declines rapidly towards the end of the evacuation such that there is a trickle of vehicles moving towards the EPZ boundary over the last hour. This is seen by the fact that the curves of Figure 7-7 are essentially horizontal past an ETE of 4 hours (zero slope indicates zero flow rate). Consequently, the time to evacuate 100% of the population is indistinct and difficult to quantify.

More to the point, the use of the ETE for 100% of the evacuating population, as a basis for developing a protective action recommendation can be viewed as a biased estimate. In effect, the vast majority of the population within the EPZ could be "penalized" by a protective action based on an ETE that reflects the lethargic response by the very few – the case of "the tail wagging the dog." Therefore, in the example presented on page 7-6, the 95th percentile value of ETE rather than the 100 percentile value is used. Local governments may also consider the use of the 90th percentile value as a basis for developing the protective action recommendation.

Given these characteristics, a statistical analysis on the mobilization distributions was performed to quantify a "confidence band" about the distribution. This band serves as the basis for establishing the point in time where the long tail should be truncated. In this instance, the mobilization time is estimated to extend over a period of 5 hours, as shown in Table 5-1. Although a small percentage of the population indicated, via the telephone survey, that their mobilization time may extend out as long as six hours (Figure F-11), the vehicles for this small percentage of population were loaded into the evacuation network at five hours to provide a conservative estimate of the vehicle flow within the roadway network.

It is essential that the ETE avoid bias by reflecting the behavior of these few stragglers. Specifically, it is important to accurately represent the ETE at the 90th and 95th percentiles of the evacuating public. To that end, truncating the cited distribution (Figure F-11 – prepare home for evacuation) at 5 hours ensures that these ETE of interest (i.e. at the 90th and 95th percentiles) are based on a conservative estimate of traffic demand. That is, advancing the departures of about 2 percent of the population to 5 hours, from up to 6 hours, assures that the evacuating traffic demand includes <u>all</u> evacuees over that time frame when congested conditions arise.

As discussed on Page 7-2 and displayed in Figure 7-6, the congestion clears from the EPZ well before the trip generation time of 5 hours; thus the ETE for the 100^{th} percentile is dictated by the trip generation time. The congestion within the EPZ has dissipated by 2 hours and 30 minutes after the advisory to evacuate. This discussion references the evacuation of the entire EPZ (Region R03) under Scenario 8 conditions. Consequently...

- Advancing the tail of the trip generation distribution as described above did not extend congestion within the EPZ beyond 2 hours and 30 minutes, well before the trip generation time of 5 hours.
- Traffic within the EPZ was free-flowing at 4 hours, which is after the ETE for 95 percent of the population (see Table 7-1C).
- The ETE for 100 percent of the population, 5:10 for Scenario 8 (see Table 7-1D) does not include a few stragglers belonging in Distribution C (see Table 5-1), who could still be within the EPZ.
- It is recommended that the 95^{th} percentile ETE (Table 7-1C) be used by those emergency response personnel charged with recommending and deciding on protective actions during an emergency; see item 6 in Section 13 of the ETE report.

In conclusion, the tails of the tables in Section 5 were truncated by advancing the responsiveness of the small number of stragglers for each activity. Text will be added to Section 5 in a future revision of the ETE report to discuss this truncation procedure. Also, the attached Appendix M will be added to the revised ETE report.

C. It is assumed that the capacity estimates presented in Appendix K are not enhanced nor compromised by the establishment of a TCP at an intersection. As detailed in Section 9, the functions to be performed in the field at TCPs are to (1) facilitate evacuating traffic movements; and (2) discourage those movements that would move travelers closer to the nuclear plant. The personnel manning these TCPs will also serve a surveillance function to inform the EOC of any problems that occur in the vicinity or are reported to them by evacuees.

The attached Figure 1 (see page 14) illustrates that the ETE for the LNP EPZ is dictated by the mobilization time. The horizontal distance between the trip generation curve and the ETE curve represents the travel time to the EPZ boundary. The short travel times (closeness of the two curves) indicate there is not pronounced traffic congestion within the EPZ delaying the departure of evacuees from the EPZ. Therefore, the establishment of TCPs strictly to manage traffic congestion is not necessary; however, the establishment of TCPs is recommended to provide guidance and reassurance to evacuees, and fixed point surveillance as noted above.

Therefore, there would be no affect on the ETE presented in this report if traffic control points were not established. Thus, no changes to the ETE are needed due to lack of resources or the regions being evacuated.

D. The "No Effect" in the table on Page 2-5 refers to the mobilization time for the general population. The name of the final column in the table will be changed to "Mobilization Time of the General Population," to reflect the text above the table. As discussed in Section 5 of the ETE report, the mobilization of the general public consists of notification time, time to prepare to leave work, time to return home (if not already home), and the time to prepare the home. The only portion of this mobilization that involves driving is the time to return home. Travel home generally occurs prior to the onset of congestion; any reduction in free speed due to weather would not materially increase this travel time.

The mobilization times discussed in Section 8 are for that portion of the population which is dependent on transit resources – schoolchildren, special facility populations and those people who do not have access to a private vehicle. The mobilization time for the transit resources is defined on page 8-1 as the elapsed time from the advisory to evacuate to when the bus arrives at the facility to be evacuated. This mobilization process consists of alerting the bus drivers, the travel time of the bus drivers from home to the depot, the briefing of the bus driver and the travel time from the depot to the facility to be evacuated. The majority of this mobilization time is spent driving; as a result, the reductions of 10% in capacity and in speed for rain are assumed to add a total of 10 minutes to the mobilization time.

E. The enclosed Figure 2 (see page 15) shows an overhead image of Dunnellon Middle School taken as a screen capture from Google Earth. Figure 2 is altered to show a realistic arrangement of 22 buses, assuming all arrive concurrently. Buses were scaled to 2 car lengths using vehicles from an adjacent parking lot in the overhead image. Assuming all buses will enter and exit from the north side of the school, the farthest walking distances to the buses were measured using Google Earth pro. Walking times to the buses were computed using a speed of 4 feet per second as suggested in the 2000 Highway Capacity Manual (pages 16-5 and 18-1).

It was determined that 50 students could walk to the farthest bus and board it within 5 minutes, at an average boarding rate of 2 sec/person (HCM Exhibit 27-9). The use of a 5 minute boarding time was approved by the counties as indicated by the signed Certification Letters submitted with the COL.

Figure 3 (attached; see page 16) is taken from MSN Live Maps and provides a bird's eye image of 29 buses parked behind the school. Note that there are several smaller buses (lower capacity) parked there, explaining why there are 29 buses parked in the figure versus the 22 buses considered as part of the ETE study.

While this scenario demonstrates the validity of a 5-minute estimate for boarding time, and is responsive to the RAI, as a practical matter, buses will arrive in bunches, load and depart. This situation is quite different from that of a scheduled school dismissal.

F. The capacity for wheelchair buses is identified as 15 patients in Section 8.3 on Page 8-4. According to the North Carolina (a similar site could not be found for the State of Florida; however, it is assumed that school buses are standard across the country) school bus safety website[1], most school buses have 22-24 seats. Standard seats are 39 inches wide, which can easily accommodate 2 adults. Therefore, 8 seats would be needed for a capacity of 15 patients. This leaves 14-16 seats for the stacking of wheelchairs, the personal items of the patients and any staff that may be assisting the patients.

G. Please see the response to RAI ETE-10, parts A through C for a detailed discussion of the road survey. A large-scale (4 ft. by 3 ft.) version of Figure 1-2 is provided in electronic format with node numbers annotated so that links can be cross referenced with Appendix K.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

[1] http://itre.ncsu.edu/GHSP/FAQs.html

1. Compute and report confidence bounds on the averages for Figures F-1, F-2, and F-5 through F-8. Also compute confidence bounds on the percent of households with zero vehicles in Figure F-6.
2. Compute and report confidence bounds on Figure 5-3 and Table 5-1, which are derived from Figures F-9 to F-11 (separate confidence bounds will not be provided for Figures F-9 to F-11).
3. The paragraph on page 5-11 will be replaced with the following text:

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

   As shown in Figure 5-2 and in the figures of Appendix F, the mobilization activity distributions have long tails. Combining multiple distributions with long tails results in a distribution with an even longer tail. Thus, the 100th percentile of the combined distribution is indistinct and difficult to quantify. Given these characteristics, a statistical analysis on the mobilization distributions was performed to quantify a "confidence band" about the distribution. This band serves as the basis for establishing the point in time where the long tail should be "truncated".

   The ETE for the vast majority of evacuees should not be distorted for those few stragglers (typically less than 2 percent of households) who take considerably longer to prepare to evacuate. As such, the combined distributions are "truncated" to avoid biasing the ETE. In "truncating" these distributions, the mobilization of the stragglers is advanced. Therefore, the stragglers are not eliminated from the ETE. Appendix F presents the raw distributions for the various mobilization activities. Appendix M describes the statistical analysis used to "truncate" the resultant distributions.
   Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. Comparison of the distributions in Appendix F with those in Figures 5-2 and 5-3 indicates that the combined distributions are somewhat shorter (5 hours) than the individual distributions (up to 6 hours). This is a result of the aforementioned "truncation" procedure.
   The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, and D, properly displaced with respect to one another, are tabulated in Table 5-1 (Distribution B, Arrive Home, omitted for clarity).

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

4. Appendix M (attached) will be added to the report. Appendix M will also be added to page ii of the Table of Contents.
5. The last column of the table on page 2-5 will be changed to "Mobilization Time for the General Population" in the revised ETE report.

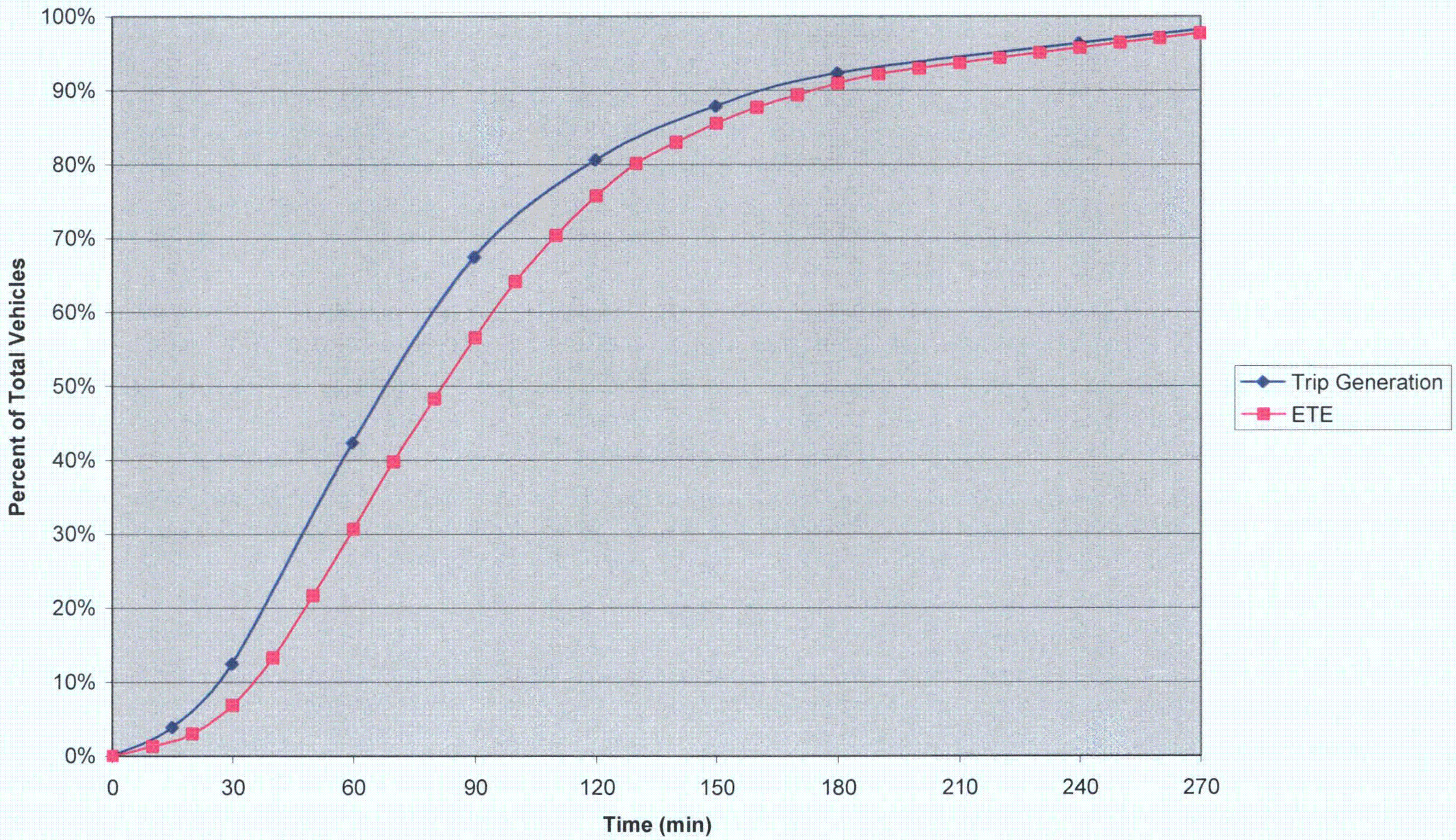
6. The following paragraph will be added to the end of the "Developing the Evacuation Time Estimates" section on page 1-6:

   Given the scale of Figure 1-2, it is not feasible to identify the links and nodes to enable the reader to relate to the information presented in Appendix K. Therefore, an annotated map is provided in electronic format which can be printed at a suitable scale, if desired.

Attachments/Enclosures:

1. Appendix M – "Procedure for Estimating Mobilization Time Based upon Survey Data"
2. Figure 1-2 – "Levy Nuclear Plant Link-Node Analysis Network" provided separately as a large scale electronic file in PDF format

Figure 1. Comparison of ETE and Trip Generation Time
Levy Nuclear Plant
Evacuation of Region R03, Scenario 1



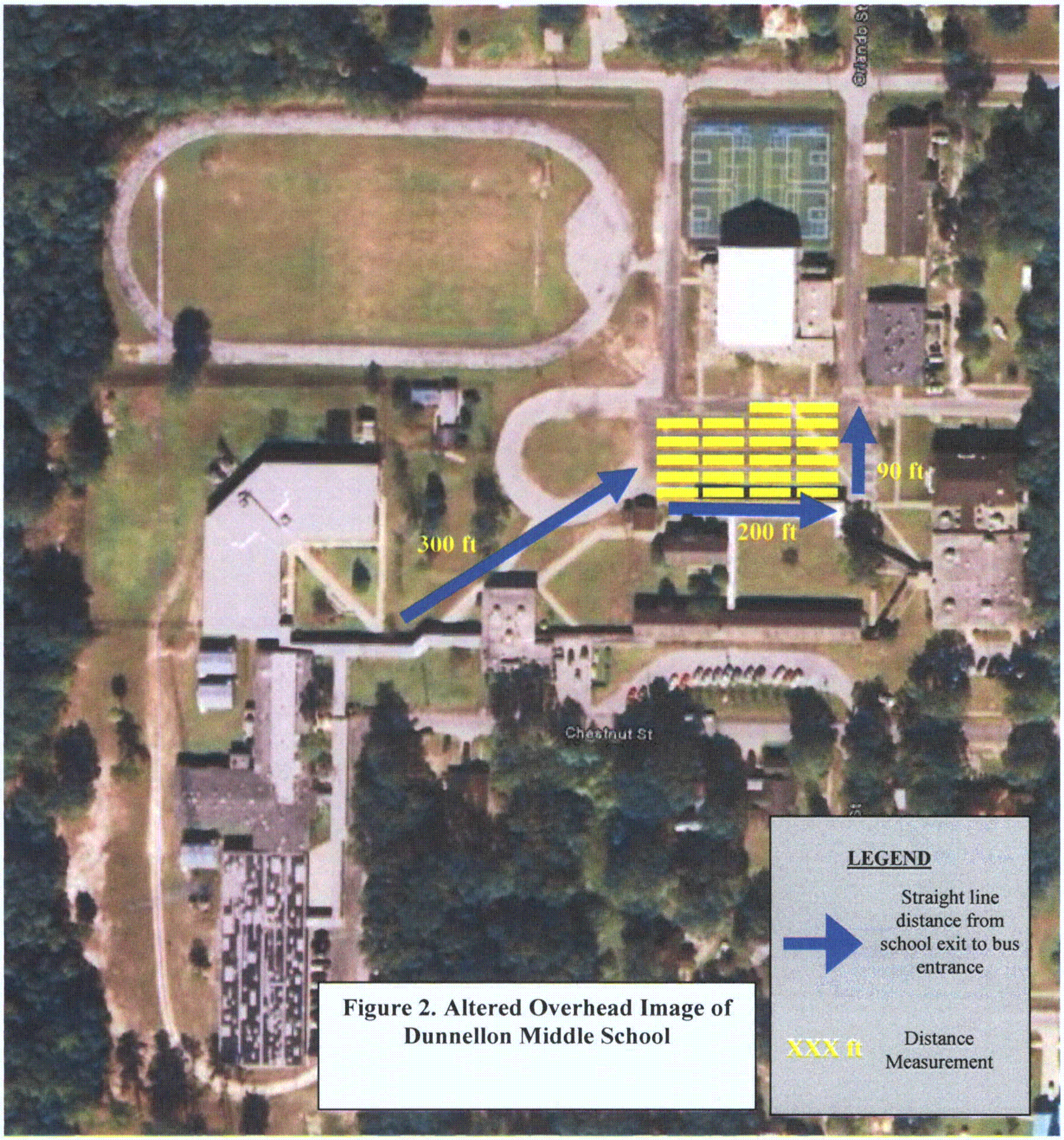


Figure 2. Altered Overhead Image of Dunnellon Middle School

Figure 3. Overhead Image of Bus Arrangement at Dunnellon Middle School

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-4 (ETE-3)

Text of NRC RAI:

ETE-3: ETE Methodology
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section I.C.

A. Section 4,"Estimation of Highway Capacity," describes the process used to determine the capacity of the roadways on the network. The algorithm for intersections is provided along with a description of variables on pages 4-1 and 4-2. Provide a general description of other important algorithms used to generate input for the PC-DYNEV traffic simulation model.

B. Section 4 (Page 4-1) states that certain intersections will be controlled by traffic control personnel during an evacuation. Their direction may supersede traffic control devices.
1. Discuss how this may affect the variables in the equation and/or intersection capacity.
2. Explain any effect it may also have on the PC-DYNEV traffic simulation model.

C. The equation for the capacity of an approach to intersections in Section 4 (Page 4-1) does not include parameter values for variables used in this equation.
1. Provide the values, or range of possible values, for the parameters in the equation, where applicable, including "Mean Duration of Green Time" and "Mean Queue Discharge".
2. Clarify whether these values are estimated or field verified.
3. Discuss how this equation is applied to staffed intersections where traffic control is in place.

D. Describe how the values for each variable in Section 4 were derived. For example, on Page 4-2, the variables F_1 and F_2 are only defined as the various known factors that influence the turn-movement-specific mean discharge headway h_m.

E. Section 1.1, "Overview of the ETE Determination Process," (Pages 1-2 and 1-3) Item 7, fifth bullet item, states that the traffic management strategy is represented in the modeling. Discuss the level of detail to which the traffic management strategy is represented in the modeling.

PGN RAI ID #: L-0225

PGN Response to NRC RAI:

A. Appendices B through D of the ETE report provide additional detail on the IDYNEV system and its use in computing ETEs. Traffic routing is computed by the TRAD model described in Appendix B. Further detail on the PC-DYNEV simulation model is found in NUREG/CR-4873, "Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code", and NUREG/CR-4874, "The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code". These two reports document studies undertaken to assess the validity of the DYNEV model for use in calculating ETEs. The discussions in the two cited references are at a level of technical detail and complexity which we believe lies outside the needs of an ETE document. Additional references to papers describing other algorithms are provided as a footnote on page 4-2.

B. Traffic control points are modeled as traffic signals with a reasonable (for evacuation purposes) allocation of effective green time to each of the competing traffic streams.

Conservatively, the ETE calculations do not rely upon any of the traffic control measures in Appendix G. The estimates of capacity, which are used by the I-DYNEV model and are documented in Appendix K, are based upon the factors described in Section 4 and upon the observations made during the road survey. It is assumed that these capacity estimates are not enhanced nor compromised by the establishment of a TCP at an intersection. As detailed in Section 9, the functions to be performed in the field at TCPs are to (1) facilitate evacuating traffic movements; and (2) discourage those movements that would move travelers closer to the Power Station. The personnel manning these TCPs will also serve a surveillance function to inform the EOC of any problems that occur in the vicinity or are reported to them by evacuees. The calculated ETE does not rely upon implementation of the Traffic Control Points, as outlined in ETE Appendix G.

The values of the variables in the intersection algorithm in Section 4 were derived by applying the I-DYNEV system as an analysis tool rather than as a single "pass-through" calculation of an ETE. This tool was used to identify points of congestion and locations where traffic control points (TCPs) could be helpful to the evacuating public.

C. Traffic control points are modeled as traffic signals with a reasonable (for evacuation purposes) allocation of effective green time to each of the competing traffic streams. The "Mean Duration of Green Time", G_m in the equation on page 4-1, is the amount of time per signal cycle, C, that the signal indication is "green" and services vehicles entering the intersection to perform movement, m, from an approach to the intersection. The signals were modeled in the analysis network with 75-second cycle lengths. The mean duration of green time ranged from 10 seconds to 61 seconds, depending on the signal and the approach being serviced. Two seconds of yellow were included for each phase of the signal.

"Mean queue discharge headway" ("h_m" in equation on page 4-1) as defined on page 7-8 of the Highway Capacity Manual 2000 (HCM2000), is "the time between the passage of the front axle of one vehicle and of the front axle of the next vehicle over a given cross-section of the roadway" (e.g. at a stop-bar). The mean queue discharge headway ranged from 1.9 seconds (multi-lane US/State highways) to 3.6 seconds (inter-city roadways). The mean "lost time" ("L" in equation on page 4-1) is defined on page 10-12 of HCM 2000 as "the time during which an intersection is not used effectively by any movement; it is the sum of clearance lost time plus start-up lost time." Clearance lost time is "the time between signal phases during which an intersection is not used by any traffic," and start-up lost time is "the additional time consumed by the first few vehicles in a queue at a signalized intersection above and beyond the saturation headway, because of the need to react to the initiation of the green phase and to accelerate." The mean lost time was 2.0 seconds for each intersection in the analysis network.

The headway, h, is definitionally related to the saturation flow rate, s, by equation (7-9) of HCM2000: $s = 3600 \div h$, where h is in seconds per vehicle and s is in vehicles per hour. The values of s were estimated (see Appendix K) from the field survey (Section 1.3 of the ETE report), and h was computed using equation (7-9). The saturation flow rate ("capacity") ranged from 1000 vehicles per hour per lane to 1895 vehicles per hour per lane.

The green times for each approach and for each intersection are input to DYNEV to represent the reasonable responses of evacuees on the competing approaches. These green times are adjusted during the iterative procedure described above until the queues on the competing approaches dissipate at comparable times; no attempt is made to "optimize" these inputs.

This adjustment of green times was undertaken by applying the I-DYNEV system as an analysis tool rather than as a single "pass-through" calculation of an ETE. This tool was used to identify points of congestion and locations where traffic control points (TCPs) could be helpful to the evacuating public. Detailed results of the simulation were analyzed to identify locations where the green time was specified to realistically service the competing traffic volumes under evacuation conditions. The model was executed iteratively to provide assurance that the allocation of "effective green time" appropriately represents the operating conditions of an evacuation.

The establishment of a TCP at an intersection could well provide greater operational performance than is represented by the calibrated DYNEV model. Thus, if all TCPs are manned in a timely manner by experienced personnel, it is possible that the ETEs predicted by the model and shown in Tables 7-1A, B, C, D of Section 7, may be somewhat longer than is achievable under these ideal circumstances. The ETEs represent reasonable, but not optimal expectations. Therefore, no allowance is made for TCP operations. The access control points (ACPs) are assumed to restrict and divert travelers who wish to travel through the EPZ, after 90 minutes following the Advisory to Evacuate.

When there are competing traffic movements at an intersection or juncture, the real estate within the intersection must be time shared by these competing movements in order to afford safe passage. This is the situation during normal conditions as well. This process is implemented in the simulation model based in part on the allocation of effective green time as described above. Thus, depending upon circumstances, one or more of the competing traffic flows may be delayed at the intersection as it would be in the real world, thereby influencing the travel time of evacuees.

D. The variables F_1 and F_2 formally represent the factors that influence the turn movement specific flow rates through an intersection. These factors are detailed in Chapters 16 and 17 of the 2000 Highway Capacity Manual (HCM); Exhibit 16-7 summarizes the factors influencing saturation flow rate. A further (overlapping) list of factors is presented and identified in Equation 16-4 on page 16-9. These two chapters contain detailed technical discussions which extend over more than 250 pages. This level of detail is not appropriate for inclusion in an ETE report.

Chapter 31 of the HCM provides further discussion of simulation models and their relationship with the HCM. Note that models such as DYNEV are described as "operational simulation models" in the sense that they do not replicate the procedures of the HCM, but describe the operational performance of traffic in a manner that is consistent with the HCM analysis. Thus, there is no facility-specific Level of Service (LOS) calculation embodied within such simulation models which describe the flow process throughout the analysis network over time and compute flow statistics known as "measures of effectiveness." It is the calibration of these operational models (and of DYNEV, in particular) that relates to the procedures of the HCM. As stated on page 31-2 of the HCM, traffic simulation models use numerical techniques on a digital computer to create a description of how traffic behaves over extended periods of time for a given transportation facility or system.

E. See discussion for part B above.

Associated LEVY COL Application Revisions:

The following changes will be incorporated in the ETE report:

1. The following text will be added to the bottom of page 1-6:

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

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

2. Replace item 7 in Section 2.3 with the following text:

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

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

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

3. Add the following text to the end of Section 9:

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

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

   Study Assumptions 6 and 7 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

4. Add the following text to the end of page G-1:

   With reference to the discussion of Section 2.3, these TCP serve many useful functions, but are not considered in specifying the inputs to the I-DYNEV system used to calculate ETE. Consequently, the results presented in Section 7 and in Appendix J do not credit the presence of these TCP.

5. Add the following text after the first paragraph on page 4-3:

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

6. Add a new sub-section "Simulation and Capacity Estimation" at the end of Section 4:

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

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

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

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

Attachments/Enclosures:

None.

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-5 (ETE-4)

Text of NRC RAI:

ETE-4: Demand Estimation, Permanent Residents
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section II.A.

A. Section 3, "Demand Estimation," (Page 3-2) provides a description of estimations used for the permanent resident population, household, and vehicles. The average number of evacuating vehicles per household adapted from the telephone survey is assumed to be 1.32 vehicles per household (Table 1-1, Page 1-9). However, Figure F-2, "Household Vehicle Availability," (Page F-4) indicates that there are 1.82 vehicles per household, and subsection "Evacuation Response," (Page F-7) indicates an average of 1.37 vehicles per household.

1. Clarify which value for the number of vehicles per household is correct and used in the calculation.
2. Clarify whether the data presented in Table 3-2, "Permanent Resident Population and Vehicles by Protective Action Zone (PAZ)," (Page 3-4) and in Figure 3-3, "Permanent Resident Vehicles by Sector," (Page 3-6) will need to be updated if the number of vehicles per household value is changed.

B. Appendix F, "Telephone Survey," Table F-1, "Survey Sampling Plan," (page F-2) lists the population total for the five zip codes areas as 34,880. These zip codes cover part of Levy, Citrus, and Marion counties. The U.S. Census data for 2007 identifies the projected population estimates in these respective counties as 39,065, 140,169, and 324,875.

1. Clarify how the population values per zip code were determined for Table F-1.
2. Provide the EPZ population for each listed zip code, or justify why it is not needed.

C. Column 2 of Table 6-3, "Percent of Population Groups Evacuating for Various Scenarios," (Page 6-5) is labeled "Residents with Commuters in Household." However, the definition of this column below the table indicates that the values are the percentages of households that await the return of a commuter. There are two different parameters: Figure F-6, "Levy EPZ Commuters," (Page F-6) identifies 0.70 commuters per household and subsection, "Evacuation Response," on Page F-7 states that 59% of households await the return of a commuter.

1. Clarify the values used in Column 2 of Table 6-3.
2. Discuss how the percentages in Table 6-3 were developed.

D. Table 6-4, "Vehicle Estimates by Scenario," (Page 6-6) presents vehicle estimates for each of the 11 scenarios. In Scenario 11, the total vehicle estimate is 41,898, which indicates a growth of greater than 60% with no additional transit buses or external traffic projected.

1. Clarify if Table 6-4 represents an evacuation of Region R03.
2. Discuss the county-specific growth rates used to obtain the permanent resident

population and shadow population expanded to the year 2017 for Scenario 11.

3. Clarify how the values for residents with commuters, residents without commuters, and shadow were developed for Scenario 11 in Table 6-4.
4. Explain why no additional transit buses or external traffic would be anticipated if a 60% growth increase is expected.

PGN RAI ID #: L-0226

PGN Response to NRC RAI:

A.1. The telephone survey instrument is provided as Attachment A to Appendix F of the ETE report. There are two questions related to vehicle ownership: Question number 3 which asks the total number of vehicles usually available to the household and question number 13 which asks how many of the vehicles available to the household would actually be used during an evacuation. The weighted average of the responses to question 13 is used to estimate the number of evacuating vehicles for permanent residents within the EPZ and the Shadow Region. Table 1 summarizes the responses to question 13 from those households which were surveyed.

Table 1. Responses to Question 13 of the Levy Telephone Survey

Number of Vehicles Used for Evacuation	Number of Households	Percentage of Households
0	25	4.6%
1	337	62.3%
2	142	26.2%
3	29	5.4%
4	4	0.7%
5	2	0.4%
6	0	0.0%
7	1	0.2%
8	0	0.0%
9	1	0.2%
Total	**541**	**100.0%**
Weighted Average:		**1.39 vehicles/household**

As stated in Table 1-1 of the ETE report, a value of 1.32 vehicles per household was used to estimate the number of vehicles evacuating. Figure F-8 indicates an average of 1.37 vehicles per household. Both of these values are incorrect. The correct value is 1.39 evacuating vehicles per household, as shown in Table 1. Figure F-8 omitted the single house which indicated 9 vehicles would be used for evacuation, which resulted in the lower weighted average of 1.37 vehicles.

As shown in Table 3-2, the estimated permanent resident population within the EPZ is 22,758 persons. Dividing by the average household size of 2.25 persons per household (Figure F-1) and multiplying by 1.32 vehicles per household (incorrect value) results in 13,350 evacuating vehicles. Using the correct value of 1.39 vehicles per household results in 14,060 vehicles – a difference of 5.3%. As indicated in the response to RAI ETE-2, part C, there is excess capacity in the EPZ and ETE closely mimic trip generation times. Therefore, an increase in permanent resident vehicles of 5.3% will likely not significantly affect ETE.

A.2. Based on the change to evacuating vehicles per household noted in the response to part A, question 1, the following changes will be made to the ETE report:

- Change all references from 1.32 evacuating vehicles per household and 1.37 evacuating vehicles per household to 1.39 evacuating vehicles per household (pages 1-9, 2-1, 3-2, F-7 and F-8)
- Replace Figure F-8 with the attached revised figure (see page 33).
- Re-compute the number of evacuating vehicles for permanent residents in the EPZ and in the Shadow Region using the correct value of 1.39 evacuating vehicles per household and update the vehicle loading onto the analysis network accordingly. Re-run all the ETE cases using the updated vehicle loading. Update Tables 7-1A through D (7-1C and 7-1D also appear in the Executive Summary), Tables J-1A through D, Figures 7-3 through 7-7 and Figures J-1 through J-11.
- Update the "2007 Vehicles" column in Table 3-2.
- Update Figure 3-3 with the new number of evacuating vehicles.
- Update the number of shadow and resident vehicles in Table 6-4.
- Update the number of shadow vehicles on page I-2.
- Update the number of shadow vehicles in Table I-2.

B.1. The population within each zip code was found using ArcMap Geographical Information Systems (GIS) software. The attached Figure 1 (see page 34) shows the location of the Crystal River and Levy Nuclear Plants. A 10-mile radius was drawn around both facilities; the union of these two 10-mile radii was defined as the survey study area. A shapefile of zip code areas was overlaid on the study area. All zip codes having a significant portion of their population within the study area were included in the survey sampling plan (zip codes 32668, 34432, 34434 and 34465 were excluded as a small portion of their population was within the study area). The small zip code 34498 (Yankeetown) was grouped with zip code 34449 (Inglis) as it is completely surrounded by the Inglis zip code area.

The zip code area shapefile has attributes such as the Year 2000 population, the Year 2004 population estimate, the post office name and the zip code number. The values presented in the second column of Table F-1 of the ETE report are actually the Year 2004 population estimates and are mistakenly labeled as Year 2000 population. Table F-1 is revised as attached (see page 33) to provide Year 2000 population and household data, and will be included in a future revision of the ETE report. The title has been changed to indicate that a combined survey was done for the Levy and Crystal River EPZs. The text on page F-2 will also be revised to indicate that a combined survey was done.

The Census "blockpop" points shapefile consists of points placed at the center of each Census block. Each point has attributes, including Year 2000 households. The selection tool was used to sum the number of households in each zip code, which was then documented in the third column of Table F-1.

B.2. Table 2 provides the Year 2000 EPZ population and households within each zip code.

Table 2. Levy Nuclear Plant EPZ Population by Zip Code			
Zip Code	**Population within EPZ (2000)**	**Households within EPZ (2000)**	**Required Sample**
34428	3,793	1,526	106
34429	2	1	0
34431	6,186	2,820	197
34433	4,134	1,686	118
34434	168	71	5
34449	3,461	1,541	107
34465	7	4	0
34498	574	287	20
Total	**18,325**	**7,936**	**553**

The combined telephone survey for the Levy and Crystal River Nuclear Plants was completed in May 2007. As noted in the response to RAI ETE-8, part A, the Levy EPZ boundaries were not finalized until June 19, 2007. Therefore, the Levy EPZ was not finalized in time to support the telephone survey. As discussed in the response to part A of this RAI, a 10-mile radius was drawn centered at the proposed Levy site in order to approximate the EPZ. A combined telephone survey was conducted for the union of the Levy and Crystal River 10-mile radii. The sampling plan for this combined survey is shown in the attached Table F-1 (see page 33). Comparison of the final column in the attached Table F-1 and the final column in Table 2 shows that the distribution of phone calls is different amongst the zip codes; however, this is to be expected as the actual survey conducted was a blend of the two EPZs, whereas Table 2 focuses only on the Levy EPZ.

Note that the combined zip codes 34449 and 34498 have 1,979 households within the combined study area, versus a total of 13,858 households for the whole study area (attached Table F-1). Thus, the sample size for these two zip codes is 1,979 ÷ 13,858 x 553 = 79. The combined zip codes 34449 and 34498 have 1,828 households when using only the Levy EPZ versus a total of 7,936 households for the whole study area (Table 2). Thus, the sample size for these two zip codes when considering only the Levy EPZ is 1,828 ÷ 7,936 x 553 = 127. Therefore, the required sample size increases even though the total households and population decrease. This anomaly is explained by the fact that the total households nearly doubles when using the combined study area versus only the Levy EPZ and the number of households in those zip codes makes up a larger percentage of the total households when just considering the Levy EPZ.

As indicated above, the telephone survey was developed to provide valid results for both the Crystal River and Levy EPZs. The survey sampling plan, as documented in the attached Table F-1, achieves this goal and is valid and will be maintained.

C.1. As discussed in the response to RAI ETE-14, part C, Figure F-6 indicates that 45% of households surveyed have at least 1 commuter. Page 7 of NUREG/CR-6953, Vol. 2 "Review of NUREG-0654, Supplement 3, 'Criteria for Protective Action Recommendations for Severe Accidents' Focus Groups and Telephone Survey" indicates that one of the major themes derived from the public focus groups was "[t]he public prefers to respond as a family unit". Page 8 reiterates this point and adds that time is needed to gather the family together. Figure 5-3 of the ETE report indicates that resident households with commuters take longer to mobilize than those households without commuters, supporting the findings of NUREG/CR-6953, Vol. 2. The fourth paragraph on page 8-1 of the ETE report discusses the family "bonding" process prior to evacuation. Based on this information, it is conservatively assumed that all households with at least one commuter will await the return of the commuter before beginning their evacuation trip. Assumption 3 in Section 2.3 of the ETE report will be revised accordingly. The data provided on page F-7 (59% of households await return of the commuter) was not used in this study.

C.2. The percentages for "residents with commuters in household" and "residents with no commuters in household" were taken from the telephone survey data shown in Figure F-6: 55% of households have no commuters and 45% have at least one commuter. These percentages were applied for midweek, midday scenarios when people are typically at work. It is assumed that 10% of households with commuters would have a commuter working during the evening and on weekends.

"Employee" percentages are set to 100% during normal work hours – midweek, midday. The percentages are reduced to 96% during the summer, midweek, midday due to summer vacation. (Assume 50% of population takes a summer vacation for two weeks; these vacations are uniformly dispersed over the approximate 12 weeks of summer resulting in 4% of population on vacation during any given week.) As shown on page 3-10 of the ETE report, almost all employees commuting into the EPZ to work are working at the Crystal River Nuclear Plant. Therefore, the night and weekend percentages in Table 6-3 should reflect night and weekend staffing at the Crystal River Nuclear Plant. Based on data provided by Progress Energy, 800 people work at the plant during peak times, 75% of which commute in from outside the EPZ. 100 people work during the evening and weekends. Therefore, the evening and weekend percentages should be about 12.5% (100÷800). As shown in Table 6-3, the evening scenarios (Scenarios 5 and 10) are in agreement with this estimate; however, the employment percentages for the weekend scenarios (Scenarios 3, 4, 8, 9 and 11) are overstated at 75%. All weekend and evening scenario employee percentages will be changed to 15% (conservatively rounded up from the estimated 12.5%). Table 6-4 will be revised accordingly. This change will be incorporated into the DYNEV input stream along with the changes identified in the response to Part A, question 2 and Part D, question 3 of this RAI question. All simulations will be re-run and ETE will be recomputed. Tables 7-1A through D (7-1C and 7-1D also appear in the Executive Summary), Tables J-1A through D, Figures 7-3 through 7-7 and Figures J-1 through J-11 will be updated accordingly.

The percentages for "transients" are assumed. As discussed on page 3-7 of the ETE report, the peak tourist season in the EPZ is winter: Data gathered through phone calls to recreational areas in the EPZ confirmed this. Scenarios 8, 9 and 11 are winter weekend scenarios and show peak transient activity with a percentage of 100%. The remainder of the percentages are less than the peak, with summer percentages less than winter percentages.

The basis for the "shadow" percentages is discussed in the shadow footnote to Table 6-3. The basis for the values shown is a 30% relocation of shadow residents (see assumption 5 of Section 2.2 of the ETE report) along with a proportional percentage of shadow employees. See the response to RAI ETE-12, part F for additional information.

As stated on page 2-2 of the ETE report, one special event was considered – construction of Unit 2 at the Levy site. It is assumed that 100% of the construction workers at Unit 2 would evacuate in the event of an incident at Unit 1; thus the "special event" percentage is 100% for Scenario 11.

School bus percentages were determined as follows:
- 100% of buses are needed during the winter, midweek when schools are in session
- 10% of buses are needed during the summer, midweek when summer school is in session (see the response to RAI ETE-7, part D for more information).
- 0% of buses are needed for all weekend and evening scenarios.

It is assumed that the transit-dependent population is always present in the EPZ and is always in need of buses; therefore, "transit buses" are always 100% evacuated.

The "external traffic" percentages are also assumed: 100% of external traffic flows midday during weekday and weekend scenarios. External traffic is 40% less during evening scenarios.

D.1. The numbers presented in Table 6-4 are for a 100% evacuation of the full EPZ (Region R03). The numbers are less for all other Regions as fewer PAZ will be evacuating for those Regions. A footnote will be added to Table 6-4 in the revised ETE report, indicating that the values presented are for an evacuation of the full EPZ (Region R03).

D.2. Representatives from the Planning Departments for Citrus, Levy and Marion Counties were contacted on June 22, 2007 to obtain population growth rate data. The following estimated yearly population growth rates were provided:

- Citrus = 3.10% per year
- Levy = 2.62% per year
- Marion = 3.55% per year

D.3. The compound growth formula was used to estimate the Year 2007 base population and the Year 2017 Construction population, based on the 2000 Census population.

$$Pop_{2007} = Pop_{2000}(1 + yearly\ growth\ rate)^{7}$$
$$Pop_{2017} = Pop_{2000}(1 + yearly\ growth\ rate)^{17}$$

The DYNEV input streams were checked for the construction scenario. The input streams indicate that 2007 was used as a base year and projected 17 years forward resulting in a construction year of 2024. Therefore, the values for residents with commuters, residents without commuters and shadow presented for Scenario 11 in Table 6-4 are overstated. This error will be corrected in a future revision of the ETE report. Also, as noted in the response to RAI ETE-5, part E, the peak construction date has shifted outward to year 2019. The simulations will be re-run for all construction cases to correct the projection error and to update the peak construction year to 2019: Table 6-4, Tables 7-1A through D, Tables J-1A through D, Figure J-11, and Tables 7-1C and 7-1D in the Executive Summary will be revised to reflect the new simulation results.

The External Traffic values shown in Table 6-4 are hourly volumes, whereas all other values are total vehicles. External Traffic values will be expressed as total vehicles over the 90 minutes following the advisory to evacuate. The discussion of external traffic on page 3-13 will be changed in the revised ETE report to reflect this. The external traffic was input correctly to DYNEV; however, the numbers were not properly depicted in Table 6-4.

D.4. As noted above in the response to part D, question 3, there was an error in the construction projections and the 60% growth is overstated. Nonetheless, all vehicles should be extrapolated to the peak construction year – 2019. The following describes the year 2019 vehicle estimate methodology that will be used in a future revision of the ETE report. The discussion of construction on page 3-2 of the ETE report and the construction footnote to Table 6-4 of the ETE report will be revised accordingly.

The EPZ permanent resident population and shadow population will be extrapolated using the methodology discussed in question 3 above and the growth rates provided in response to question 2 above. Using this methodology, the year 2019 EPZ permanent resident population and shadow population are estimated to be 33,062 and 73,277, respectively.

The estimates of employees will be extrapolated to year 2019 using the compound growth formula and county-specific labor growth rates obtained from the US Department of Labor website, as shown in Table 3 below.

Table 3. County-Specific Labor Growth Rates

Average Annual Employment	COUNTY		
	Citrus	Levy	Marion
Year 2001	28,185	7,748	82,168
Year 2007	34,025	9,122	103,410
Annual Growth Rate	2.7%	2.4%	3.3%

As shown in Table 8-1 of the ETE report, 2.6% of the EPZ population is transit-dependent, after ridesharing. Applying this same percentage to the year 2019 permanent resident population estimate results in 860 transit dependent persons (2.6% x 33,062). Based on the transit bus occupancy of 30 persons, 29 bus runs will be needed to service this component of the 2019 permanent resident population. As stated in the footnote to Table 6-3, 1 bus is considered as 2 passenger car equivalents (PCEs); thus, 58 vehicles will be included for the construction scenario to represent transit buses. Transit buses will be extrapolated to 2019 using this methodology in a future revision of the ETE report.

As noted in Table 6-2 of the ETE report, the construction scenario is a weekend scenario. Therefore, school will not be in session for this scenario (no school buses indicated for Scenario 11 in Table 6-4) and projection of school buses to year 2019 need not be considered.

Special event traffic (Unit 2 construction worker vehicles), by definition, is already in the year 2019 timeframe.

It is assumed that the total transient vehicles and the total external traffic for the year 2019 scenario will have the same proportion of the year 2019 permanent resident vehicle totals, as the 2007 transient vehicles to the 2007 permanent resident vehicles. As shown in Table 6-4 of the ETE report, there are 889 transient vehicles and 13,350 permanent resident vehicles for scenario 8 in 2007. Thus, the number of transient vehicles evacuating is 6.7% of the number of permanent resident vehicles evacuating. This percentage will be applied to the year 2019 permanent resident vehicle estimate in order to estimate the transient vehicles in year 2019. This same methodology will be used to extrapolate external traffic.

These changes will be incorporated into the DYNEV input stream and all Scenario 11 cases will be re-run. The results of these new runs will be used to update Tables 7-1A through D (Tables 7-1C and D also appear in the Executive Summary), Tables J-1A through D and Figure J-11 in a future revision of the ETE report.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- Change "1.32 evacuating vehicles per household" to "1.39 evacuating vehicles per household" on pages 1-9, 2-1 and 3-2.
- Change "1.37 evacuating vehicles per household" to "1.39 evacuating vehicles per household" on pages F-7 and F-8.
- Replace Figure F-8 with the attached revised figure (see page 33).
- Re-compute the number of evacuating vehicles for permanent residents in the EPZ and in the Shadow Region using the correct value of 1.39 evacuating vehicles per household and update the vehicle loading onto the analysis network accordingly. Also update the input streams for the Construction scenario (scenario 11) so that construction growth extrapolates the 2007 base year permanent resident and shadow population 12 years forward, rather than the 17 years used in the past. Also, update the employee, transient, transit buses and external traffic for Scenario 11 as discussed in the response to part D, question 4 above. Finally, update the employee scenario percentages to 15% for all weekend and evening scenarios. Re-run all the ETE cases using the updated vehicle loading, construction, and employee scenario percentage inputs. Update Tables 7-1A through D (7-1C and 7-1D also appear in the Executive Summary), Tables J-1A through D, Figures 7-3 through 7-7 and Figures J-1 through J-11.
- Update the "2007 Vehicles" column in Table 3-2.
- Update Figure 3-3 with the new number of evacuating vehicles.
- Change the employee percentages to 15% for all weekend and evening scenarios in Table 6-3.
- Update the number of shadow and resident vehicles in Table 6-4 based on the change to 1.39 evacuating vehicles per household and the change in the construction projection for Scenario 11. Also update the external traffic to show total volumes as opposed to hourly volumes. Update the employee vehicles as the scenario percentages for weekend and evening scenarios have been changed in Table 6-3.
- Revise the final paragraph of Section 3 as follows:
  Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major routes through the EPZ (e.g. US Hwy 19, US Hwy 41). It is assumed that this traffic will

continue to enter the EPZ during the first 90 minutes following the Advisory to Evacuate. We estimate ~~approximately~~ 3,600 (2,400 vehicles per hour) vehicles enter the EPZ as external-external trips during this period.

- Update the number of shadow vehicles on page I-2.
- Update the number of shadow vehicles in Table I-2.
- Replace Table F-1 with the attached revised table (see page 33).
- Revise the second paragraph on page F-2 as follows:

  Following the completion of the instrument, a sampling plan was developed. Due to the close proximity of the Crystal River and Levy Nuclear Plants, a combined survey of the two EPZs was done in order to obtain demographic data useful for both plants. A sample size of approximately 553 completed survey forms yields results with an acceptable sampling error. The sample must be drawn from the EPZ population. Consequently, a list of ~~EPZ~~ zip codes within the combined Levy/Crystal River EPZ was developed. ~~This list is shown in Table F-1.~~ The population and number of households within each zip code area was estimated using geographical information systems (GIS) software. ~~Along with each zip code, an estimate of the population in each area was determined, based on average household size provided by Census data.~~ The list of zip codes considered, the Year 2000 population of each zip code, the number of households within each zip code and ~~T~~the proportional number of the desired completed survey interviews for each zip code ~~area was identified, as~~ are shown in Table F-1.

- Revise the discussion of "Household Size" on page F-3 as follows:

  Figure F-1 presents the distribution of household size within the EPZ. The average household contains 2.25 people. The estimated household size (2.~~52~~38 persons) used to determine the survey sample (Table F-1) was drawn from Census data. ~~The difference in the factors can be described in the rapid population growth and a likely shift in demographics within the EPZ since the 2000 Census.~~ The close agreement between the average household size obtained from the survey and from the Census is an indication of the reliability of the survey.

- Revise assumption 3 of Section 2.3 as follows:

  It is further assumed that:

  ~~Schools may be evacuated prior to notification of the general public, if possible.~~

  ~~1.~~ ~~59 percent of~~ all households in the EPZ with at least one commuter (45% of households according to Figure F-6) will await the return of ~~a~~ the commuter before beginning their evacuation trip.~~, based on the telephone survey results.~~

- Add the following footnote to Table 6-4:

  The values presented are for an evacuation of the full EPZ (Region R03).

- Revise the construction discussion on page 3-2 to indicate that all vehicles are extrapolated to Year 2019 for the construction scenario. Beginning with the revised construction discussion on page 3-2 as provided in the COLA revision section in the response to RAI ETE-5, the following changes will be made:

A "special event" scenario (Scenario 11) which represents a typical winter, weekend, midday with construction workers on-site at the time of the emergency, is considered. Based on discussions with Progress Energy, there will be two units constructed at the proposed Levy site. The construction plans are offset slightly in that Unit 1 will be operational in ~~June 2016~~ February 2018, while construction will persist on Unit 2 which will be operational in ~~June 2017~~ February 2019. There will be 565 workers on site at Unit 1 when operational and 150 construction workers will remain at Unit 2, for a total of 715 additional people in the EPZ for this special event. An average vehicle occupancy of 1.03 workers per vehicle (adapted from telephone survey results) is used to convert workers to vehicles – 695 total vehicles. The existing roadway system is used for the construction scenario; no roadway improvements are considered.

~~Permanent resident population and shadow population~~ All vehicles and population are extrapolated to ~~2016~~ 2019 for this scenario, as follows:

The EPZ permanent resident population and shadow population will be extrapolated using a compound growth rate and yearly population growth rates, by county.

$$Pop_{2007} = Pop_{2000}(1 + yearly\ growth\ rate)^{7}$$

$$Pop_{2019} = Pop_{2000}(1 + yearly\ growth\ rate)^{19}$$

Growth Rates
Citrus = 3.10% per year
Levy = 2.62% per year
Marion = 3.55% per year

Using this methodology, the year 2019 EPZ permanent resident population and shadow population are estimated to be 33,062 and 73,277, respectively.

The estimates of employees will be extrapolated to year 2019 using the compound growth formula and county-specific labor growth rates obtained from the US Department of Labor website, as shown below.

County-Specific Labor Growth Rates			
Average Annual Employment	COUNTY		
	Citrus	Levy	Marion
Year 2001	28,185	7,748	82,168
Year 2007	34,025	9,122	103,410
Annual Growth Rate	2.7%	2.4%	3.3%

As shown in Table 8-1, 2.6% of the EPZ population is transit-dependent, after ridesharing. Applying this same percentage to the year 2019 permanent resident population estimate results in 860 transit dependent persons (2.6% x 33,062). Based on the transit bus occupancy of 30 persons (see Section 8), 29 bus runs will be needed to service this component of the 2019 permanent resident population. As stated in the footnote to Table 6-3, 1 bus is considered as 2 passenger car equivalents (PCEs); thus, 58 vehicles will be included for the construction scenario to represent transit buses.

As noted in Table 6-2 of the ETE report, the construction scenario is a weekend scenario. Therefore, school will not be in session for this scenario (no school buses indicated for Scenario 11 in Table 6-4) and projection of school buses to year 2019 need not be considered.

Special event traffic (Unit 2 construction worker vehicles), by definition, is already in the year 2019 timeframe.

It is assumed that the total transient vehicles and the total external traffic for the year 2019 scenario will have the same proportion of the year 2019 permanent resident vehicle totals, as the 2007 transient vehicles to the 2007 permanent resident vehicles. As shown in Table 6-4 of the ETE report, there are 889 transient vehicles and 13,350 permanent resident vehicles for scenario 8 in 2007. Thus, the number of transient vehicles evacuating is 6.7% of the number of permanent resident vehicles evacuating. This percentage will be applied to the year 2019 permanent resident vehicle estimate in order to estimate the transient vehicles in year 2019. This same methodology will be used to extrapolate external traffic.

- Remove the "**" footnote to Table 6-4 from the "residents with commuters", "residents without commuters" and "shadow" columns. Add the "**" footnote to the "Scenario" column. Revise the "**" footnote as follows:

  ~~Permanent Resident population and Shadow population have been expanded (using County specific growth rates)~~ All vehicles have been extrapolated to the Year 2019 when Unit 1 will be operational while Unit 2 construction is being completed (see the discussion of construction on page 3-2 for additional information).

Attachments/Enclosures:

None.

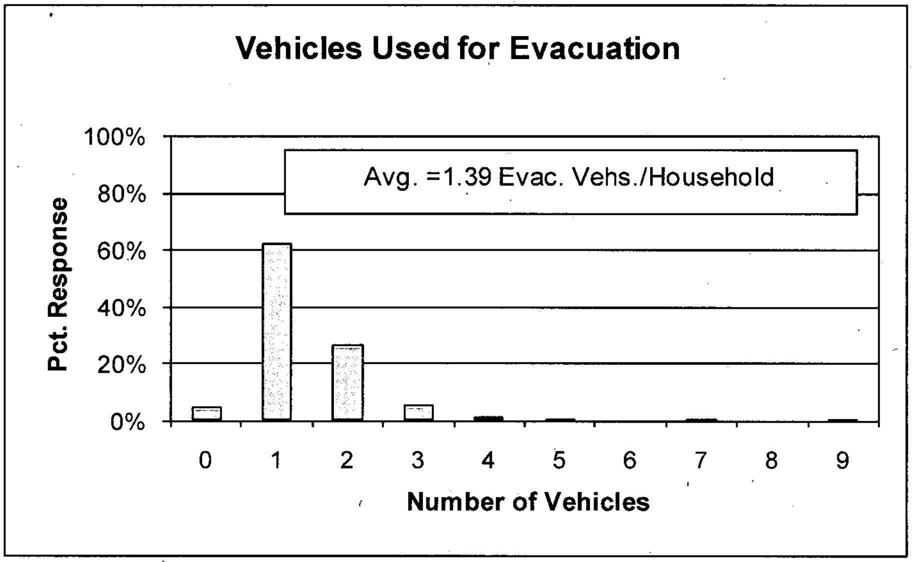


Figure F-8. Number of Vehicles Used for Evacuation

Table F-1. Combined Levy and Crystal River Nuclear Plants Telephone Survey Sampling Plan			
Zip Code	**Population in ZIP (2000)**	**Households in ZIP (2000)**	**Required Sample**
34428	8,920	3,779	151
34429	8,605	3,233	129
34431	6,664	3,176	127
34433	4,246	1,691	67
34449	3,908	1,979	79
34498	574		
Total:	**32,917**	**13,858**	**553**
Average Household Size			**2.38**
Total Sample Required			**553**

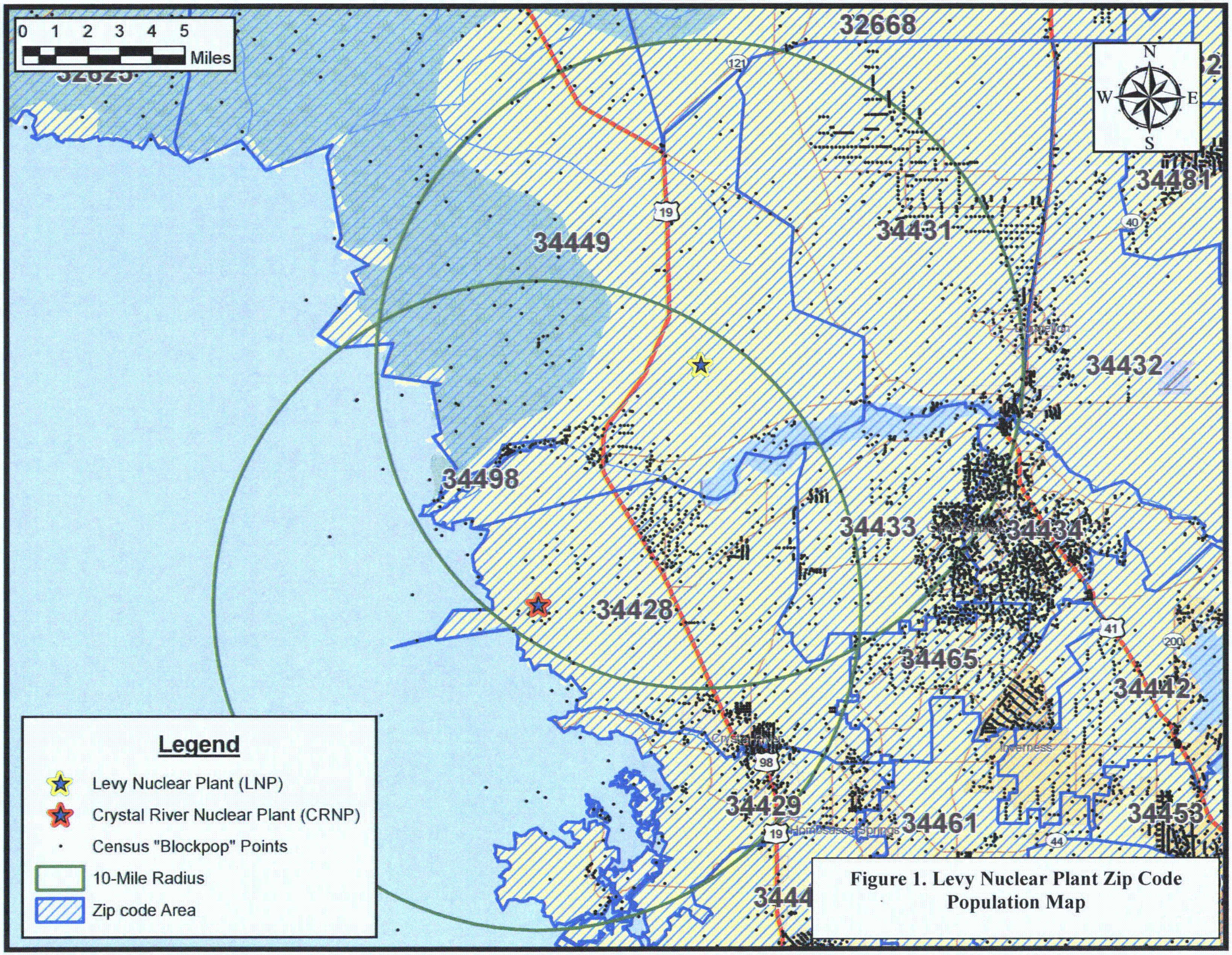


Figure 1. Levy Nuclear Plant Zip Code Population Map

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-6 (ETE-5)

Text of NRC RAI:

ETE-5: Demand Estimation, Transient Populations
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Sections II.B, II.E, IV.B.5

A. Information regarding the transient population is found in Section 3, "Demand Estimation," (Page 3-7). A total of 1,416 people and 889 vehicles are estimated to be present in the plume exposure pathway EPZ at peak season mainly in and around Lake Rousseau and the Gulf of Mexico. Appendix E, "Special Facility Data," identifies 11 recreational areas and 6 lodging areas with expected occupancy. When added together, the total number of persons is 1,417 and the total number of vehicles is 889. Verify that the correct value has been used for the transient population.

B. Information regarding the logistics involved in evacuating the lake area or the gulf coast areas has not been provided. Provide clarification on logistics for evacuating the lake and gulf coast areas.

C. Mobilization of the permanent resident, transient, and employee population is discussed in Section 5, "Estimation of Trip Generation Time." Figure 5-1(b), (Page 5-3) shows that transients will be: 1. Notified, 2. Become aware of the incident, and then 3. Begin evacuation trip. The figure suggests that transients would not be returning to their "residence" prior to an evacuation. Explain why the possibility for transients to return to a location to gather belongings was not considered in the evacuation time estimate.

D. Section 8, "Transit-Dependent and Special Facility Evacuation Times," (page 8-1) states transit service may be needed for residents, employees, and transients. Discuss whether employees and transients have been factored into this need for transit service.

E. The Levy Nuclear Plant (LNP) is not listed as a major employer on Page 3-10. It is listed as a major employer on Page E-4 in Appendix E. Clarify the inconsistency. Discuss the effects on the Evacuation Time Estimate (ETE) if LNP employees are included in the calculation.

F. It is not likely that 100% of the employees of Crystal River Nuclear Power Plant (CRNPP) would evacuate during an emergency. Clarify the actual percentage of CRNPP employees that might be expected to evacuate.

G. Appendix E, "Special Facilities Data," (Page E-4) states that the Seven Rivers Regional Medical Center employs 190 people.

1. Clarify why this facility is not considered a major employer.
2. Discuss the affect on the ETE from additional vehicle demand due to these employees.

PGN RAI ID #: L-0227

PGN Response to NRC RAI:

A. The data shown in Appendix E is correct – there are 1,189 people (730 vehicles) at the recreational areas in the EPZ and 228 people (159 vehicles) at the lodging facilities in the EPZ for a total of 1,417 transients in 889 vehicles.

As indicated in the table on page E-6, the Inglis Dam Recreation Area is located 4.6 miles south of the Levy Nuclear Plant and there are 90 transients visiting this facility. The entry for 4-5 miles in the southern direction in Figure 3-4 indicates 89 people, explaining why there is a difference of 1 transient between Section 3 of the ETE report and Appendix E. This entry in Figure 3-4 will be updated in a future revision of the ETE report. Also, the text on page 3-7 will be updated to read "1,417 people".

The difference of 1 transient person between Section 3 and Appendix E of the ETE report does not affect any other sections of the ETE report. The number of transient vehicles is correct in Section 3 and that is the number that is used throughout the analysis.

B. Page 2-6 of Annex A to the State of Florida Radiological Emergency Management Plan states that Fish and Wildlife Conservation Commission will conduct warning and evacuation of both deep and shallow waterways in and around nuclear power plants during radiological emergency operations. It is also stated that the Florida Department of Environmental Protection, Division of Law Enforcement will conduct warning and evacuation in state parks and recreation areas around nuclear power plants during radiological emergency operations.

Page VI-26 of the Levy Nuclear Plant Site Plan (Appendix VI of Annex A to the State of Florida Radiological Emergency Management Plan) states that boaters in the waters within the 10-mile Emergency Planning Zone will be notified of the emergency by loud speakers from boats and aircraft operated by the Levy, Citrus and Marion County Sheriff's Offices, State Emergency Support Function 16 assets, U.S. Coast Guard, volunteer Fire Departments and the Citrus County Aquatic Services.

Once those transients on the waterways in the EPZ return to the mainland, they will evacuate using private vehicles on the evacuation routes identified in Section 10 of the ETE report. As indicated in the response to RAI ETE-7, part A, those transients on the waterways in the EPZ have been accounted for in the ETE analysis.

C. If the emergency occurs during the daytime, it is reasonable to expect that at least some of those who stay overnight at lodging facilities will leave their personal belongings in their respective rooms. Others, who want to have access to their belongings during the day (or are on their last day), will have their belongings with them. Those of the former group have two choices:

- Evacuate immediately, leaving their belongings in the room for subsequent retrieval; or
- Return to the lodging facility to gather up their belongings and then evacuate.

The mobilization distribution for transients extends over a period of 2 hours, as shown in Distribution A in Table 5-1. Those who elect to return to the motel to pick up their belongings will be able to do so and then begin their evacuation trip within this time frame. The majority of the lodging facilities (see Figure E-4 in the revised report) are located within ½ mile of the EPZ boundary; thus, travel time to the EPZ boundary will be negligible relative to the mobilization time.

Figure 5-1 is revised as attached (see page 41) to include the possibility that transients may return to lodging facilities or campsites prior to beginning their evacuation trip. The text of Section 5 will be revised to agree with the changes to Figure 5-1.

D. Since there is no mass transit servicing the area (other than taxis), it is reasonable to expect that virtually all transients and employees will have private vehicles available for evacuation. The ETE study therefore assumes that employees and transients will not require transit resources for evacuation. The text on page 8-1 will be corrected in the revised report.

E. The base year for this ETE study is 2007. As discussed in the "Construction" section on page 3-2 of the ETE report, the first unit at the Levy Nuclear Plant (LNP) will not come online until 2016. Therefore, the LNP does not exist in the 2007 base year and is not considered as a major employer at this point in time. The Levy Nuclear Plant will be removed from the table on page E-4 in Appendix E. When the first unit at the Levy site is complete and ready for fuel loading, the ETE will be updated to include the Levy Nuclear Plant as a major employer.
The employment data for the Crystal River Nuclear Power Plant is also misstated in the Table on page E-4 and does not agree with the data presented on page 3-10. The table on page E-4 will be revised accordingly, as attached (see page 42). Also, the tables in Appendix E will be labeled Tables E-1 through E-7.

Based on recent information provided by Progress Energy, Unit 1 coming online is currently delayed by 20 months. Therefore, the construction scenario will be 2019 rather than 2017, as stated on page 3-2. The discussion of construction on page 3-2 and the footnote to table 6-4 will be revised accordingly. Also, the input streams to DYNEV will be updated to project to a construction year of 2019. All ETE will be re-computed based on this change; Tables 7-1A through D (Tables 7-1C and D also appear in the Executive Summary, Tables J-1A through D and Figure J-11 will be revised accordingly.

F. Based on information provided by Progress Energy, in the event of an emergency evacuation, a skeleton crew of 40 employees would remain at the Crystal River Nuclear Power Plant. Based on the max shift employment of 800 employees, this skeleton crew equates to 5% of the workforce. Thus, 95% (100% - 5%) of the workforce would evacuate. This ETE study conservatively assumes that 100% of the CRNPP workforce evacuates. Based on an estimated 75% non-EPZ resident employees at CRNPP and the average vehicle occupancy of 1.03 employees per vehicle, 29 too many vehicles are evacuated (40 x 75% ÷ 1.03 = 29). These 29 vehicles represent 0.1% (29 ÷ 25,735) of the evacuating vehicle stream for an evacuation of the entire EPZ under Scenario 1 conditions. It is unlikely that this small change in evacuating vehicles would impact ETE. The conservative assumption that 100% of the workforce would evacuate will be added to page 3-10 of the ETE report.

G.1. The omission of Seven Rivers Regional Medical Center as a major employer was an oversight and will be corrected in a future revision of the ETE report. Data provided for Seven Rivers Regional Medical Center indicates that there are 190 people working during the day shift and 100 people working during the evening shift, qualifying it as a major employer (more than 50 employees).

G.2. An estimated percentage of people commuting from outside the EPZ to work at Seven Rivers Regional Medical Center was not provided. Based on the data provided by Progress Energy for the Crystal River Nuclear Plant, it will be assumed that 75% of the workforce commutes into the EPZ to work at this facility. Based on this assumption and the average vehicle occupancy of 1.03 employees per vehicle, 138 vehicles (190 x 75% ÷ 1.03) will have to be added into the simulation. As indicated in Table 6-4, the average number of vehicles evacuating is about 25,000 vehicles. Thus, the vehicles added at this facility constitute about

0.6% of the evacuating vehicle stream. As indicated in the table on page E-4 and in Figure E-2, Seven Rivers Regional Medical Center is located 8.4 miles south of the Levy Nuclear Plant along US Highway 19/98. Figures 7-3 through 7-6 indicate that US Highway 19/98 is operating at LOS A in this area throughout the evacuation. The addition of 138 vehicles in this area will not significantly increase congestion and will not impact the ETE.

The following changes will be made to the ETE report based on the addition of Seven Rivers Regional Medical Center as a major employer:

- Add discussion of the facility as item 4 on page 3-10.
- Add "143" for the south, 8-9 mile entry in Figure 3-6.
- Add "138" for the south, 8-9 mile entry in Figure 3-7.
- Update the "employees" column in Table 6-4.
- Add facility to major employers table on page E-4.
- Identify facility as both a medical facility and a major employer in Figure E-2.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- Change "89" to "90" for the south, 4-5 mile entry in Figure 3-4.
- Revise the first sentence of the second paragraph on page 3-7 as follows:

  A total of ~~1,416~~ 1,417 people could be recreating in the EPZ during the peak season based on data obtained from the survey of the major recreational areas for LNP.

- The first paragraph of Section 8 will be revised as follows:

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

- Figure 5-1 will be replaced with the attached revised figure (see page 41).
- The first paragraph on page 5-4 will be revised as follows:

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

An employee who lives outside the EPZ will follow sequence (c) of Figure 5-1. A household within the EPZ that has one or more commuters at work, and will await their return before beginning the evacuation trip will follow the first sequence of Figure 5-1(a). A household within the EPZ that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. For this study, we adopt the conservative posture that all activities will occur in sequence.

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

- The following text will be added as he 5th bullet under item 1 on page 3-10:

  Based on information provided by Progress Energy, in the event of an emergency evacuation, a skeleton crew of 40 employees would remain at the Crystal River Nuclear Power Plant (CRNPP). It is conservatively assumed in this study, however, that 100% of CRNPP employees would evacuate.
- The tables in Appendix E will be labeled Tables E-1 through E-7.
- The Levy Nuclear Plant will be removed from the Major Employers table on page E-4.
- The total employees and maximum shift for the Crystal River Nuclear Plant in the Major Employers table on page E-4 will be revised to 1000 and 800, respectively, to be in agreement with the numbers presented on page 3-10.
- Add Seven Rivers Regional Medical Center to major employers table on page E-4.
- Identify Seven Rivers Regional Medical Center as both a medical facility and a major employer in Figure E-2.
- Add the following discussion as item 4 on page 3-10
  4. Seven Rivers Regional Medical Center
     - Total and maximum shift employment of 190 people.
     - Assumed 75% of employees are non-EPZ residents.
- Change "0" to "143" for the south, 8-9 mile entry in Figure 3-6. The software used to generate the figure automatically updates the table in the lower left corner of the figure based on changes made in the main part of the figure.
- Change "0" to "138" for the south, 8-9 mile entry in Figure 3-7. The software used to generate the figure automatically updates the table in the lower left corner of the figure based on changes made in the main part of the figure.
- Update the "employees" column in Table 6-4 to reflect the addition of Seven Rivers Regional Medical Center. The "Total Scenario Vehicles" column will be updated accordingly.

- Replace the "Major Employers" table on page E-4 with the attached Table E-5 (see page 42).
- Revise the discussion of construction on page 3-2 as follows:

  A "special event" scenario (Scenario 11) which represents a typical winter, weekend, midday with construction workers on-site at the time of the emergency, is considered. Based on discussions with Progress Energy, there will be two units constructed at the proposed Levy site. The construction plans are offset slightly in that Unit 1 will be operational in ~~June 2016~~ February 2018, while construction will persist on Unit 2 which will be operational in ~~June 2017~~ February 2019. There will be 565 workers on site at Unit 1 when operational and 150 construction workers will remain at Unit 2, for a total of 715 additional people in the EPZ for this special event. An average vehicle occupancy of 1.03 workers per vehicle (adapted from telephone survey results) is used to convert workers to vehicles – 695 total vehicles. The existing roadway system is used for the construction scenario; no roadway improvements are considered. Permanent resident population and shadow population are extrapolated to ~~2016~~ 2019 for this scenario.

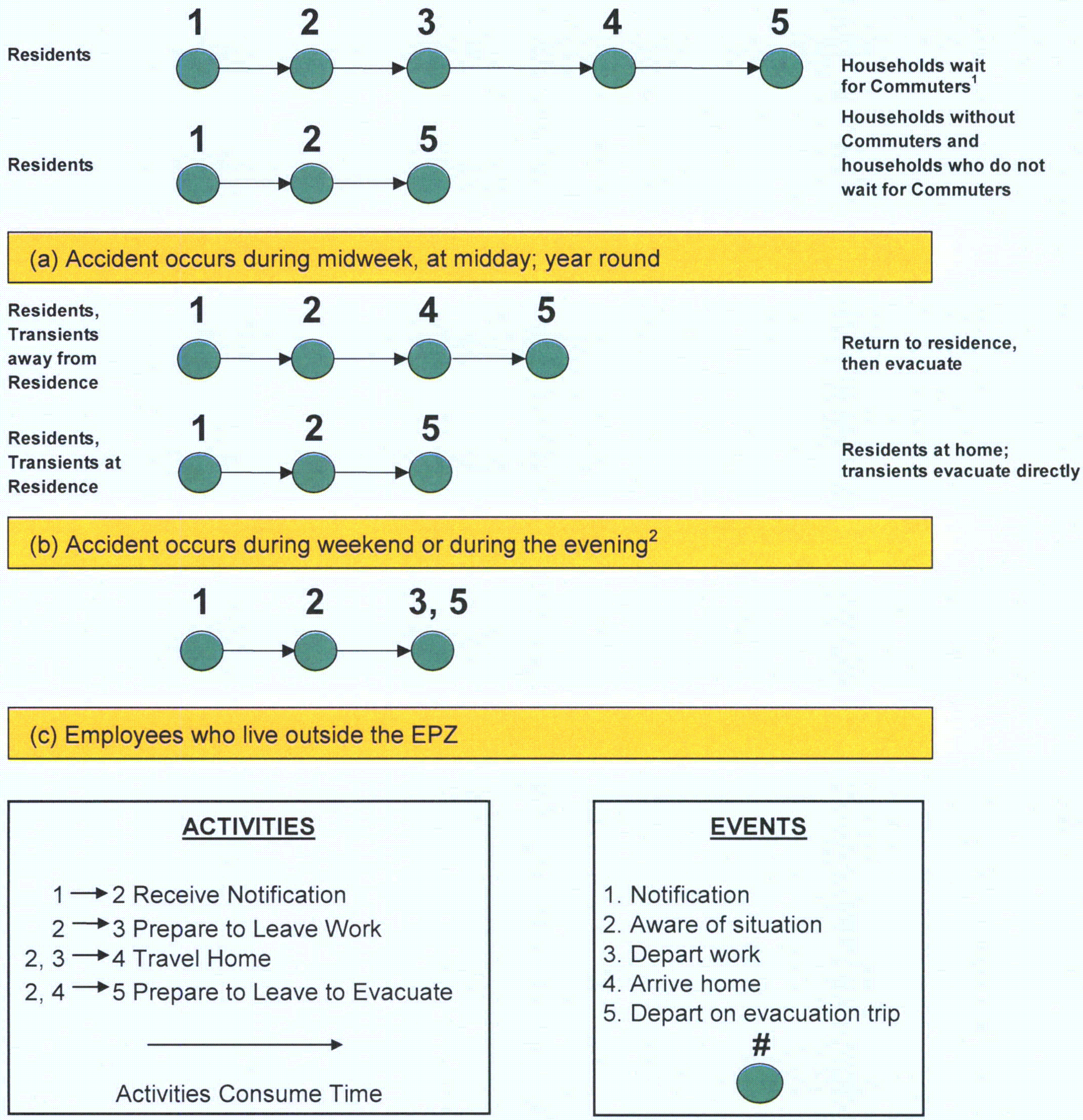
- Revise the footnote to Table 6-4 as follows:

  **Permanent Resident population and Shadow population have been expanded (using County specific growth rates) to the Year ~~2017~~ 2019 when Unit 1 will be operational while Unit 2 construction is completed.

- Revise the input stream to DYNEV to include Seven Rivers Regional Medical Center and to change the construction projection year to 2019 based on the 20 month schedule shift. Re-compute all ETE and update Tables 7-1A through D (Tables 7-1C and D also appear in Executive Summary), Tables J-1A through D and Figures J-1 through J-11.

Attachments/Enclosures:

None.



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

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

Table E-5. Levy EPZ Major Employers (As of July 2007)										
PAZ	Distance (miles)	Dir-ection	Facility Name	Street Address	Municipality	Phone	Total Employees	Maximum Shift	% Non-EPZ	Max Shift Non-EPZ Employees
Citrus County										
C1	8.9	SSW	Crystal River Nuclear Plant	15760 W Powerline St	Crystal River	(352) 563-2358	1,000	800	75%	600
C1	8.4	S	Seven Rivers Regional Medical Center	6201 N Suncoast Blvd	Crystal River	(352) 795-8311	190	190	75%	143
						Citrus County Total:	*1,190*	*990*	*75%*	*743*
Marion County										
M9	10	E	Sweetbay Supermarket	11352 N. Williams St. #305	Dunnellon	(352) 489-6607	60	25	50%	13
M9	10	E	Super Wal-mart	11012 N. Williams St	Dunnellon	(352) 489-4210	100	50	50%	25
						Marion County Total:	*160*	*75*	*50%*	*38*
						Total	**1,350**	**1,065**	**73%**	**781**

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-7 (ETE-6)

Text of NRC RAI:

ETE-6: Demand Estimation, Special facility population
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Sections II.C, II.E, III.A, IV.B.4, IV.B.5

A. Subsection "Emergency Medical Services (EMS) Vehicles," in Section 8, "Transit Dependent and Special Facility Evacuation Time Estimates [ETEs]," (Page 8-8) states that a conservative loading time of 30 minutes is used. Table 8-4, "Special Facility Transit Demand," (Page 8-12) indicates there are 20 bedridden persons who reside in special facilities. This equates to 1.5 minutes per person to load. However, a 5-minute loading time per wheelchair-bound person is assumed in the estimate for non-ambulatory residents evacuating special facilities. Explain why it is reasonable to assume that non-ambulatory individuals may be loaded in 1.5 minutes.

B. In Appendix E, "Special Facility Data," the Levy plume exposure pathway EPZ Lodging table is presented twice, once on Page E-2 and then again on Page E-8. Discuss why the Levy EPZ Lodging table is presented twice.

C. Section 8,"Transit-Dependent and Special Facility Evacuation Time Estimates," discusses evacuation plans for schools, residents without vehicles, and special care facilities. There is one youth correctional facility (Page E-4) and five day care facilities (Page E-2) that are located inside the EPZ. These facilities are not listed in any of the tables in Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," or discussed in the text. Clarify whether or not pre-school children and the youth in the correctional facilities have been included in the ETE.

D. Section 8,"Transit-Dependent and Special Facility Evacuation Time Estimates," includes a definition for the transit-dependent population, however does not include any individuals with special needs. Estimates have been made for those needing aid that are located at one of the three specified special care/medical centers, however there could be other people, elderly or medically incapable, that are not residents of the facility that may need special aid to evacuate. Clarify whether this transit-dependent special needs population exists and whether it was considered in the ETE.

E. Section 8.4,"Evacuation Time Estimates for Transit-Dependent People," (Page 8-4) states that the available resources are said to be sufficient in each county to evacuate the population in one wave, if all drivers are available. This section also states that based on discussions with the county, evacuation of schools can be done in a single wave, but the number of buses available for school evacuation is never stated in the ETE.

1. Clarify whether there are enough drivers and resources available to support a single run.
2. Clarify the impact on transit services if Crystal River Nuclear Plant had an evacuation at the same time as Levy Nuclear Plant.

F. An estimate has been provided for a second wave in case there is a lack of resources or inefficiency that would require buses to return to the plume exposure pathway EPZ to aid in evacuation. Section 8.4,"Evacuation Time Estimates for Transit-Dependent People," Activity G-C (Page 8-7), states for the second wave bus evacuation, the bus travel time back to the EPZ (to the start of the route) is estimated to be 20 minutes for good weather and 25 minutes for rain. Clarify whether this estimate considers the necessary time to transverse traffic control points.

G. Mobilization times in Section 5, "Estimation of Trip Generation Times," do not include information on transit dependent people getting to bus routes or waiting for buses. It is also does not explain how local authorities will inform the transit dependent people of the time which buses should be expected to arrive. Explain how transit dependent individuals are expected to get from their residences to the bus routes, and whether this time was factored into the ETE.

H. Figure 8-2, "Proposed Transit Dependent Bus Routes," (Page 8-15) does not include the number or location of the bus stops along the various routes.

1. Provide additional information on bus stops, specifically whether or not the buses will make random stops or if the stops are predetermined.
2. If stops are predetermined, provide maps that show the bus stop locations, and describe the effect on ETE calculations.

I. In Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," there is no discussion on the number of times the buses will be stopping or the duration stopped on their proposed routes and what affect this will have on the evacuation times. If the buses are constantly stopping to pickup people, the average speeds for the buses during the evacuation scenarios will also need to be reexamined. Clarify whether stopping and dwell time were considered in the estimation of the average route time proposed for transit services.

J. According to Page 8-1, it takes 90 minutes to mobilize bus drivers and get the buses to their proper locations. This estimate is said to be based on "experience" at other rural plants. Provide information on the "experience" used to establish the mobilization time of 90 minutes for buses.

K. In Section 8.4,"Evacuation Time Estimates for Transit-Dependent People," (Page 8-5) it is assumed that it will take 5 minutes to load buses for schools and public transportation in Activity C-D which references HCM 2000. Discuss the assumptions related to the estimated time to load buses for evacuation.

L. The relocation centers that will be used for the evacuation of transit-dependent people are listed in Table 8-3,"School Relocation Schools," (Page 8-11). Discuss why these locations are not indentified on the map in Figure 8-2,"Proposed Transit Dependent Bus Routes," (Page 8-15).

PGN RAI ID #: L-0228

PGN Response to NRC RAI:

A. The 30 minute loading time is per ambulance. As stated on page 3-13 and in Section 8.3 of the ETE report, the capacity per ambulance is 2 patients. Therefore, the loading for these non-ambulatory patients is 30 ÷ 2 = 15 minutes per patient – 3 times as much as for wheelchair bound patients. The text on page 8-8 will be revised to indicate loading time is 30 minutes per ambulance.

B. The table titled "Levy EPZ: Lodging (As of July 2007)" on page E-2 will be replaced with the table titled "Table E-1. Levy EPZ Schools (As of July 2007)". The new table is attached to this response (see page 60). The repeated table was the result of a PDF conversion error. All tables in Appendix E will be numbered in a future revision of the ETE report.

C. It was assumed that children at daycare centers are picked up by their parents and that this activity is accounted for in the mobilization times for residents presented in Section 5. As discussed on Page F-1 of the ETE report, the telephone survey asks questions about activities performed by the residents on a daily basis. Those parents with children in daycare typically drop the child off in the morning and pick the child up later in the day. Question 9 (Page F-14) of the telephone survey asks how long it would take the worker to travel home from work. Figure F-10 shows that the travel home from work activity takes up to 2½ hours to complete. It is reasonable to assume that, if applicable, this activity includes the picking up of children at daycare centers.

The Crystal River public information calendar advises parents to not pick up children at schools or daycares as they will be transported by bus to relocation schools where they can be subsequently picked up. It is likely that the Levy Nuclear Plant will adapt this same policy once the plant is operational. Thus, the assumption that parents will pick up children at daycare centers is likely not valid. The daycare centers identified on page E-2 of the ETE report will be added to Tables 8-2, 8-3, 8-5A and 8-5B. The titles of these tables will also be revised to include daycare centers. Section 8.2 will be revised to include discussion of daycare centers.

According to page VI-46 of the Levy Nuclear Plant Site Plan (Appendix VI of Annex A to the State of Florida Radiological Emergency Management Plan), inmates at the Forestry Youth Camp Incarceration Center will be transported to a facility outside the EPZ in Tallahassee, FL by combined efforts of the Sheriff's Office and the affected police departments. Data provided by the facility indicates that they have sufficient transportation resources to evacuate all inmates in a single wave. As shown in Figure E-2, the Forestry Youth Camp is located on State Hwy 336 in Levy County. Given that the inmates will be evacuated to Tallahassee, buses will travel northbound on State Hwy 336 to US Hwy 19/98 and then north on 19/98 out of the EPZ. The route from the facility to the EPZ boundary is 8.7 miles long. It is conservatively assumed that 2 hours will be needed to mobilize all inmates and the transportation and security resources needed to move the inmates. Thirty minutes will be needed to load the inmates and secure the buses. As shown in Figure 7-6, congestion with the EPZ has dissipated by 2 hours and 30 minutes after the advisory to evacuate. Therefore, it can be safely assumed that buses evacuating the inmates will average 40 mph. Travel time would be 13 minutes (8.7 miles ÷ 40 miles/hr x 60 minutes/hr). Thus, the ETE for the Forestry Youth Camp Incarceration Center is:

ETE: 120 + 30 + 13 = 163 minutes = 2:45 (hr:min), rounded to the nearest 5 minutes.

This discussion of the evacuation of the Forestry Youth Camp Incarceration Center will be added to the end of page 8-8 in the revised ETE report.

D. Recent communication with the county emergency management agencies has yielded the following data concerning registered homebound special needs population within the Levy EPZ:

Table 1. Registered Special Needs Population within the Levy EPZ				
Within EPZ	Citrus	Levy	Marion	Total
Registered Special Needs Population	49	30	17	96
Bed-ridden	0	10	0	10
Wheelchair bound	21	10	4	35
Ambulatory	12	10	6	28
Total Population Requiring Transportation	33	30	10	73

As stated in Section 8.3 of the ETE report, buses can transport 30 ambulatory persons per trip, wheelchair buses can transport 15 persons per trip, wheelchair vans can transport 4 persons per trip and ambulances can transport 2 bed-ridden persons per trip. Based on these capacities, the following transportation resources are needed to evacuate the homebound special needs population residing within the Levy EPZ:

Table 2. Transportation Needs for Evacuation of Special Needs Population within the Levy EPZ				
Within EPZ	Citrus	Levy	Marion	Total
Ambulances	0	5	0	5
Wheelchair Vans	6	3	1	10
Buses	1	1	1	3

The counties have identified the following transportation resource availability:

Table 3. Transportation Resource Availability				
County-wide	Citrus	Levy	Marion	Total
Ambulances	11	7	59	77
Wheelchair Vans	8	17	41	66
Wheelchair Buses	68	0	35	103
Buses	158	9	339	506

Comparison of Tables 2 and 3 indicates that the counties have sufficient resources to evacuate the homebound special needs population.

Note that approximately 76% (73 of 96) special needs persons require transportation assistance – see Table 1. Other special needs persons living at home have their transport needs provided by other members of the household and would not require assistance from the county.

ETE for Homebound Special Needs Population

Buses

Assuming no more than one special needs person per household implies that 28 households (HH) need to be serviced. While only 3 buses are needed from a capacity perspective (Table 2), if 6 buses are deployed to service these special needs HH, then each would require about 5 stops. The following outlines the ETE calculations:

1. Assume 6 buses are deployed, each with about 5 stops, to service a total of 28 HH.
2. The ETE is calculated as follows:
    a. Buses arrive at the first pickup location: 90 minutes
    b. Load HH members at first pickup: 5 minutes
    c. Travel to subsequent pickup locations: 4 @ 6 minutes = 24 minutes
    d. Load HH members at subsequent pickup locations: 4 @ 5 minutes = 20 minutes
    e. Travel to EPZ boundary (assume 8 miles): 24 minutes.

   ETE: 90 + 5 + 24 + 20 + 24 = 2:45

   Rain ETE: 100 + 5 + 28 + 20 + 28 = 3:00

   The estimated travel time between pickups is based on a distance of 2 miles @ 20 mph = 6 minutes. If planned properly, the pickup locations for each bus run should be clustered within the same general area. The estimated travel time to the EPZ boundary is based on a distance of 8 miles @ 20 mph = 24 minutes. It is assumed that mobilization time to first pickup is 10 minutes longer in rain = 100 minutes. It is further assumed that travel speeds are 10% lower in rain – travel time to the EPZ boundary at free speed from last pickup requires 28 minutes (8 miles @ 18 mph) in rain and that travel time between pickups is 7 minutes (2 miles @ 18 mph). All ETE are rounded to nearest 5 minutes.

Assuming all HH members (avg. HH size equals 2.25 persons) travel with the disabled person yields 5 x 2.25 = 12 persons per bus. From the perspective of bus capacity, fewer buses could be deployed. For example, 3 buses, each servicing 10 HH could accommodate 2.25 x 8 = 18 people, but the additional 5 stops would add 5 x (6 + 5) = 55 minutes to the ETE. The ETE would equal 3:40 with good weather and 3:55 for rain using 3 buses.

Ambulances

As shown in Table 8-4, it is estimated that 10 ambulance runs will be needed to evacuate the institutionalized bed-ridden population within the EPZ, all of which reside in Citrus County. Table 3 indicates that there are 11 ambulances available in Citrus County. Table 2 indicates that 5 ambulances are needed to evacuate the homebound bed-ridden population within the EPZ, all of which reside in Levy County. Table 3 indicates that there are 7 ambulances available in Levy County. There are no ambulances needed to service the Marion County portion of the EPZ; however, as noted in Table 3, there are 59 ambulances available in the county.

Based on the information provided in Table 8-4 of the ETE report and Tables 2 and 3 of this response, there are sufficient ambulance resources in the EPZ to evacuate the institutionalized and homebound bed-ridden populations in a single wave.

As stated on page 8-8, mobilization time and loading time are assumed to be 30 minutes each per ambulance. Each ambulance servicing the homebound bed-ridden population will make 2 stops with an estimated distance of 5 miles between stops and an estimated distance of 5 miles to the EPZ boundary after the final stop. It is conservatively assumed that ambulances will travel at 30 mph within the EPZ. Mobilization time is 5 minutes longer and travel speed is 10% less in rain – 27 mph. All ETE are rounded to nearest 5 minutes.

The ETE are computed as follows:

a. Ambulance arrives at first household: 30 minutes
b. Loading time at first household: 30 minutes
c. Ambulance travels to second household: 5 miles @ 30 mph = 10 minutes
d. Loading time at second household: 30 minutes
e. Travel time to EPZ boundary: 5 miles @ 30 mph = 10 minutes

ETE: 30 + 30 + 10 + 30 + 10 = 1:50

Rain ETE: 35 + 30 + 11 + 30 + 11 = 2:00

Wheel-Chair Vans

Table 1 indicates that there are 35 homebound wheelchair bound persons in the EPZ, while Table 2 indicates that 10 wheelchair vans are needed to evacuate this population. Assuming one special needs person per household, each wheelchair van will service about 4 households. It is conservatively assumed that the households are spaced 5 miles apart and that van speeds approximate those of school buses = 20 mph between households. It is further assumed that vans travel 5 miles to the EPZ boundary after the last pickup. Mobilization time is 10 minutes longer and travel speed is 10% less in rain.

a. Assumed mobilization time for wheelchair van resources to arrive at first household: 90 minutes
b. Loading time at first household: 15 minutes
c. Travel to next household: 3 @ 15 minutes (5 miles @ 20 mph) = 45 minutes
d. Loading time: 3 @ 15 minutes = 45 minutes
e. Travel time to EPZ boundary: 5 miles @ 20 mph = 15 minutes

ETE: 90 + 15 + 45 + 45 + 15 = 3:30

Rain ETE: 100 + 15 + 51 + 45 + 17 = 3:50

The above discussion of homebound special needs population within the EPZ will be added as Section 8.5 to a future revision of the ETE report.

E.1. As stated in the first sentence of Section 8.4 of the ETE report, it is assumed that there are sufficient drivers for all buses available to the EPZ counties. This assumption will be added to Section 2.3 of a future revision of the ETE report. As discussed in Section 8.3 of the ETE report, ambulances are assumed to 2 patients per trip, wheelchair vans are assumed to accommodate 4 wheelchairs per trip, wheelchair buses are assumed to accommodate 15 wheelchairs per trip, and bus runs are assumed to accommodate 30 ambulatory patients per trip. (Note that the capacities provided in the discussion of "medical facilities" on page 3-13 of the ETE report are not correct and do not reflect the capacities used in this study. This section will be revised in a future ETE report to match the capacities provided in Section 8.3). Using this data, the transportation needs for homebound special needs population (see Table 2 above), and the data presented in Tables 8-2, 8-4 and 8-6 of the ETE report, Table 4 was compiled to illustrate the available and required resources for each county within the Levy EPZ. Table 4 will be added to Section 8 as Table 8-11 in a future revision of the ETE report.

Table 4. Available and Required Transit Resources by County				
Requirements	**Buses**	**Ambulances**	**Wheelchair Vans**	**Wheelchair Buses**
Citrus County				
Available Resources	**158**	**11**	**8**	**68**
School	13	0	0	0
Medical Facilities	4	10	2	2
Transit Routes	10	0	0	0
Homebound Special Needs	1	0	6	0
Total Resources Needed	28	10	8	2
Levy County				
Available Resources	**9**	**7**	**17**	**0**
Schools	5	0	0	0
Medical Facilities	0	0	0	0
Transit Routes	4	0	0	0
Homebound Special Needs	1	5	3	0
Total Resources Needed	**10**	**5**	**3**	**0**
Marion County				
Available Resources	**339**	**59**	**41**	**35**
Schools	38	0	0	0
Medical Facilities	0	0	0	0
Transit Routes	6	0	0	0
Homebound Special Needs	1	0	1	0
Total Resources Needed	45	0	1	0

There are sufficient resources of each type available to each county for a single wave evacuation with the exception of buses in Levy County. Note, however, that there are substantial excesses of resources in both Citrus and Marion Counties. Note that there are only 10 homebound special needs persons within Levy County that require a bus to be evacuated. The insufficient bus resources in Levy County can be addressed either through a mutual aid agreement with Marion and Citrus Counties for transportation assistance in the event of an emergency at the plant, or by using the surplus wheelchair vans within Levy County to evacuate the homebound special needs population.

E.2. As noted in the response to ETE-10, part E, question 2, there is considerable overlap of the EPZs for the Crystal River Nuclear Plant (CRNP) and the Levy Nuclear Plant (LNP). The only Protective Action Zone (PAZ) within the CRNP EPZ that is not within the LNP EPZ is PAZ C2 in Citrus County. Therefore, only the resources for Citrus County would be affected by a simultaneous evacuation of both EPZs. The following data are provided for PAZ C2 in Revision 1 of the CRNP ETE prepared by KLD Associates in January 2008:

- Table 8-2 – 60 school buses needed for the schools in PAZ C2.
- Table 8-4 – 3 buses, 24 ambulances, 12 wheelchair buses and 2 wheelchair vans needed for the medical facilities in PAZ C2.

- Table 8-6 and Figure 8-2 – transit- dependent bus routes 6, 7 and 8 service PAZ C2. There are a total of 8 buses on these routes.
- Assume homebound special needs is the same for PAZ C2 as it is for the Citrus County portion of the Levy EPZ; therefore 1 bus and 6 wheelchair vans (see Table 2 above) are needed.

Table 5 summarizes the Citrus County data from Table 4 and the data presented above for the evacuation of the CRNP EPZ. Comparing the available resources with the resources needed indicates that there is a shortage of ambulances and wheelchair vans. The shortage of wheelchair vans can be addressed using the surplus of wheelchair buses in the county. The shortage of ambulances can be resolved by establishing a mutual aid agreement with Marion County, who has excess ambulance resources, as noted in Table 4 above.

Table 5. Available and Required Transit Resources for Citrus County (Levy and Crystal River Nuclear Plants combined)

Requirements	Buses	Ambulances	Wheelchair Vans	Wheelchair Buses
Citrus County				
Available Resources	**158**	**11**	**8**	**68**
School	73	0	0	0
Medical Facilities	7	34	4	14
Transit Routes	16	0	0	0
Homebound Special Needs	2	0	12	0
Total Resources Needed	98	34	16	14

As noted in the response to ETE-10, part E, question 2, a discussion of a simultaneous evacuation of the Crystal River and Levy EPZs will be added to Appendix I in a future revision of the ETE report. This response and Table 5 will also be added to the discussion in Appendix I. Also, a recommendation will be added to Section 13 of the ETE report indicating that a mutual aid agreement is needed between Marion and Citrus Counties for ambulance resource support in the rare event that a simultaneous evacuation of the Crystal River and Levy EPZs is advised.

F. As discussed in Section 9 of the ETE report, the primary objectives of traffic control points are to facilitate and guide the flow of evacuating traffic. It is especially critical that traffic control points facilitate the movements of transit resources (buses and ambulances) which are needed to evacuate the transit-dependent and special facility populations within the EPZ. Therefore, it is reasonable to conclude that the inbound bus speed of 45 mph will be unaffected as buses traverse traffic control points.

The following statement will be added to the end of Section 9 of the ETE report: "All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCP."

G. Given that the evacuees in question have no access to private transportation, then those who are ambulatory and within an accessible distance would be expected to walk to the routes. Those who are unable to walk to the route should register with the county as special needs persons. See the response to part D above for discussion of these people. The bus routes were designed to service the populated areas of the EPZ; therefore, it is assumed that evacuees will have to walk at most ½ mile to access the route. The 2000 Highway Capacity Manual recommends a pedestrian walking speed of 4.0 feet per second for travel time computations. Based on this speed, it would take an evacuee 11 minutes (0.5 miles x 5280 feet/mile ÷ 4.0 feet/sec ÷ 60 sec/min) to walk to the route.

As shown in Table 8-7A, it is estimated that the first bus will arrive at the start of the routes about 120 minutes after the advisory to evacuate and will take between 15 and 20 minutes to traverse the route. The mobilization time estimates (Table 5-1, Distribution D) indicate that 87% of evacuees will have completed their preparatory activities in that time frame. Therefore, the vast majority of the transit dependent population will be able to complete their preparation activities and walk to the routes by the time the first bus on the route arrives. Since there will be multiple bus runs on each route, those who take longer to get to the route will still have the opportunity to board a later bus run.

H.1,2 It is assumed that transit-dependent persons will walk to the nearest route and "flag" down a bus traversing the route. Thus, there are no pre-established pickup points for transit-dependent persons. This assumption will be added to the discussion of "Activity: Board Passengers (C→D)" on page 8-5 of the ETE report in a future revision.

I. The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

where B = Dwell time to service passengers. The total distance, "s" in feet, travelled during the deceleration and acceleration activities is: $s = v^2/a$. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s, would be: s/v, or $(v^2/a)/v = v/a$. Then the total delay (i.e. pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

- B = 45 seconds: a very generous value for about 2 passengers per stop
- v = 35 mph = 52 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 58 seconds per stop. Allowing 15 minutes pick-up time per bus run implies 15 stops per run. Thus the delay associated with stopping and the dwell time for buses has been considered as the "pickup time".

This discussion of pickup time for transit-dependent persons will be added to the discussion of "Activity: Board Passengers (C→D)" on page 8-5 of the ETE report in a future revision.

The DYNEV model has recently been improved to include a bus route feature. The links representing bus routes for each school and each transit-dependent route are input to the model using KLD's UNITES software (see "analytical tools" section on page 1-6 of the ETE report). DYNEV then outputs the average speed for each bus route for every 10-minute interval following the advisory to evacuate. This will provide more accurate route-specific speeds than using the average network-wide speed output by DYNEV. Tables 8-5A, 8-5B, 8-7A and 8-7B will be revised to include the route specific average speed output by DYNEV and route travel time will be recomputed based on the new average speed. Also, a description of the bus route feature will replace the first paragraph under "School Evacuation" on page 8-5 of the ETE report.

J. The 90-minute estimate of mobilization time for transit vehicles is based on discussions with local emergency management personnel at this and several other sites. This estimate has been used as a baseline assumption for several COLA ETE studies in the past 3 years and has been deemed reasonable by emergency management personnel at those sites as well. This mobilization time was approved by the counties as indicated by the signed Certification Letters submitted with the COL.

K. Please refer to the response to RAI ETE-2, part E.

L. The schools within the EPZ will be evacuated to the relocation schools identified in Table 8-3. The transit-dependent population within the EPZ will be evacuated to the reception centers identified in Table 10-1 and mapped in Figure 10-1. Figure E-1 is modified as attached (see page 61) to include the locations of the relocation schools; this figure will replace the existing Figure E-1 in a future revision of the ETE report. Also, a footnote will be added to Table 8-3 to indicate that Figure E-1 identifies the location of each EPZ school and relocation school.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

1. Revise the second sentence of the second paragraph of the Emergency Medical Services (EMS) Vehicles discussion on page 8-8 as follows:

   Loading times are conservatively estimated as 30 minutes per ambulance.

2. Replace "Levy EPZ: Lodging (As of July 2007)" table on page E-2 with Table E-1 "Levy EPZ Schools (As of July 2007)".

3. Number all tables in Appendix E from Table E-1 through Table E-7.

4. Revise Section 8.2 of the ETE report as follows:

   8.2 <u>School and Daycare Population – Transit Demand</u>

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

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

We recommend that the Counties introduce procedures whereby the schools and daycares are contacted prior to the dispatch of buses from the depot (approximately one hour after the Advisory to Evacuate), to ascertain the current estimate of ~~students~~ children to be evacuated. In this way, the number of buses dispatched to the schools and daycares will reflect the actual number needed. Some parents will likely pick up their children ~~at school~~, although they are asked to pick children up at the ~~reception centers~~ relocation schools. Those buses originally allocated to evacuate school and daycare children that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing. Table 8-3 presents a list of the ~~reception centers~~ relocation schools for each school and daycare in the EPZ. Those ~~students~~ children not picked up by their parents prior to the arrival of the buses, will be transported to these ~~centers~~ relocation schools where they will be subsequently retrieved by their respective families.

5. Add all daycare centers identified on page E-2 to Tables 8-2, 8-3, 8-5A and 8-5B.
6. Revise the titles of Table 8-2, 8-3, 8-5A and 8-5B to include daycares.
7. The following discussion will be added to the end of page 8-8:

<u>Forestry Youth Camp Incarceration Center</u>

According to page VI-46 of the Levy Nuclear Plant Site Plan (Appendix VI of Annex A to the State of Florida Radiological Emergency Management Plan), inmates at the Forestry Youth Camp Incarceration Center will be transported to a facility outside the EPZ in Tallahassee, FL by combined efforts of the Sheriff's Office and the affected police departments. Data provided by the facility indicates that they have sufficient transportation resources to evacuate all inmates in a single wave. As shown in Figure E-2, the Forestry Youth Camp is located on State Hwy 336 in Levy County. Given that the inmates will be evacuated to Tallahassee, buses will travel northbound on State Hwy 336 to US Hwy 19/98 and then north on 19/98 out of the EPZ. The route from the facility to the EPZ boundary is 8.7 miles long. It is conservatively assumed that 2 hours will be needed to mobilize all inmates and the transportation and security resources needed to move the inmates. Thirty minutes will be needed to load the inmates ad secure the buses. As shown in Figure 7-6, congestion with the EPZ has dissipated by 2 hours and 30 minutes after the advisory to evacuate. Therefore, it can be safely assumed that buses evacuating the inmates will average 40 mph. Travel time would be 13 minutes (8.7 miles ÷ 40 miles/hr x 60 minutes/hr). Thus, the ETE for the Forestry Youth Camp Incarceration Center is:

ETE: 120 + 30 + 13 = 163 minutes = 2:45 (hr:min), rounded to the nearest 5 minutes.

8. Add new Section 8.5 "Evacuation of Homebound Special Needs Population" to Section 8 as follows:

8.5 <u>Evacuation of Homebound Special Needs Population</u>
The registered homebound special needs population within the Levy EPZ is summarized by county in Table 8-8. These data were provided by the county offices of emergency management.

As stated in Section 8.3 of the ETE report, buses can transport 30 ambulatory persons per trip, wheelchair buses can transport 15 persons per trip, wheelchair vans can transport 4 persons per trip and ambulances can transport 2 bed-ridden persons per trip. Based on these capacities, the transportation resources needed to evacuate the homebound special needs population residing within the Levy EPZ were estimated and are presented in Table 8-9. The transportation resources available by county are summarized in Table 8-10.

Comparison of Tables 8-9 and 8-10 indicates that the counties have sufficient resources to evacuate the homebound special needs population. Note that approximately 76% (73 of 96) special needs persons require transportation assistance – see Table 8-8. Other special needs persons living at home have their transport needs provided by other members of the household and would not require assistance from the county.

<u>ETE for Homebound Special Needs Population</u>

<u>Buses</u>

Assuming no more than one special needs person per household implies that 28 households (HH) need to be serviced. While only 3 buses are needed from a capacity perspective (Table 8-9), if 6 buses are deployed to service these special needs HH, then each would require about 5 stops. The following outlines the ETE calculations:

1. Assume 6 buses are deployed, each with about 5 stops, to service a total of 28 HH.
2. The ETE is calculated as follows:
    a. Buses arrive at the first pickup location: 90 minutes
    b. Load HH members at first pickup: 5 minutes
    c. Travel to subsequent pickup locations: 4 @ 6 minutes = 24 minutes
    d. Load HH members at subsequent pickup locations: 4 @ 5 minutes = 20 minutes
    e. Travel to EPZ boundary (assume 8 miles): 24 minutes.

ETE: 90 + 5 + 24 + 20 + 24 = <u>2:45</u>

Rain ETE: 100 + 5 + 28 + 20 + 28 = <u>3:00</u>

The estimated travel time between pickups is based on a distance of 2 miles @ 20 mph = 6 minutes. If planned properly, the pickup locations for each bus run should be clustered within the same general area. The estimated travel time to the EPZ boundary is based on a distance of 8 miles @ 20 mph = 24 minutes. It is assumed that mobilization time to first pickup is 10 minutes longer in rain = 100 minutes. It is further assumed that travel speeds are 10% lower in rain – travel time to the EPZ boundary at free speed from last pickup requires 28 minutes (8 miles @ 18 mph) in rain and that travel time between pickups is 7 minutes (2 miles @ 18 mph). All ETE are rounded to nearest 5 minutes.

Assuming all HH members (avg. HH size equals 2.25 persons) travel with the disabled person yields 5 x 2.25 = 12 persons per bus. From the perspective of bus capacity, fewer buses could be deployed. For example, 3 buses, each servicing 10

HH could accommodate 2.25 x 8 = 18 people, but the additional 5 stops would add 5 x (6 + 5) = 55 minutes to the ETE. The ETE would equal 3:40 with good weather and 3:55 for rain using 3 buses.

Ambulances

As shown in Table 8-4, it is estimated that 10 ambulance runs will be needed to evacuate the institutionalized bed-ridden population within the EPZ, all of which reside in Citrus County. Table 8-10 indicates that there are 11 ambulances available in Citrus County. Table 8-9 indicates that 5 ambulances are needed to evacuate the homebound bed-ridden population within the EPZ, all of which reside in Levy County. Table 8-10 indicates that there are 7 ambulances available in Levy County. There are no ambulances needed to service the Marion County portion of the EPZ; however, as noted in Table 8-10, there are 59 ambulances available in the county.

Based on the information provided in Tables 8-4, 8-9 and 8-10, there are sufficient ambulance resources in the EPZ to evacuate the institutionalized and homebound bed-ridden populations in a single wave.

As stated on page 8-8, mobilization time and loading time are assumed to be 30 minutes each per ambulance. Each ambulance servicing the homebound bed-ridden population will make 2 stops with an estimated distance of 5 miles between stops and an estimated distance of 5 miles to the EPZ boundary after the final stop. It is conservatively assumed that ambulances will travel at 30 mph within the EPZ. Mobilization time is 5 minutes longer and travel speed is 10% less in rain – 27 mph. All ETE are rounded to nearest 5 minutes.

The ETE are computed as follows:

a. Ambulance arrives at first household: 30 minutes
b. Loading time at first household: 30 minutes
c. Ambulance travels to second household: 5 miles @ 30 mph = 10 minutes
d. Loading time at second household: 30 minutes
e. Travel time to EPZ boundary: 5 miles @ 30 mph = 10 minutes

ETE: 30 + 30 + 10 + 30 + 10 = <u>1:50</u>

Rain ETE: 35 + 30 + 11 + 30 + 11 = <u>2:00</u>

Wheel-Chair Vans

Table 8-8 indicates that there are 35 homebound wheelchair bound persons in the EPZ, while Table 8-9 indicates that 10 wheelchair vans are needed to evacuate this population. Assuming one special needs person per household, each wheelchair van will service about 4 households. It is conservatively assumed that the households are spaced 5 miles apart and that van speeds approximate those of school buses = 20 mph between households. It is further assumed that vans travel 5 miles to the EPZ boundary after the last pickup. Mobilization time is 10 minutes longer and travel speed is 10% less in rain.

a. Assumed mobilization time for wheelchair van resources to arrive at first household: 90 minutes
b. Loading time at first household: 15 minutes

c. Travel to next household: 3 @ 15 minutes (5 miles @ 20 mph) = 45 minutes
d. Loading time: 3 @ 15 minutes = 45 minutes
e. Travel time to EPZ boundary: 5 miles @ 20 mph = 15 minutes

ETE: 90 + 15 + 45 + 45 + 15 = <u>3:30</u>

Rain ETE: 100 + 15 + 51 + 45 + 17 = <u>3:50</u>

9. Add Section 8.5 "Evacuation of Homebound Special Needs Population" to page i of the Table of Contents.

10. Insert Tables 1, 2 and 3 from the response to part D above as Tables 8-8, 8-9 and 8-10, respectively, into Section 8.

11. Add Tables 8-8 through 8-11 to page vi of the Table of Contents.

12. Revise the discussion of medical facilities on page 3-13 as follows:

    There are three medical facilities in the LNP EPZ; a data request form was completed for each facility. Chapter 8 details the evacuation time estimate for the patients residing in these facilities. The number and type of evacuating vehicles that need to be provided depends on the state of health of the patients. Buses can transport up to ~~40~~ 30 people; wheelchair vans, up to ~~12~~ 4 people; wheelchair buses up to 15 people; and ambulances, up to 2 people (patients).

13. Insert Table 4 from the response to part E above into Section 8 as Table 8-11.

14. As noted in item 22 of the COLA Revision section of the response to RAI ETE-10, a discussion of a simultaneous evacuation of the Crystal River and Levy EPZs will be added to the end of Appendix I. The following discussion will be added at the end of that new discussion:

    There is considerable overlap of the EPZs for the Crystal River Nuclear Plant (CRNP) and the Levy Nuclear Plant (LNP). The only Protective Action Zone (PAZ) within the CRNP EPZ that is not within the LNP EPZ is PAZ C2 in Citrus County. Therefore, only the resources for Citrus County would be affected by a simultaneous evacuation of both EPZs. The following data are provided for PAZ C2 in Revision 1 of the CRNP ETE prepared by KLD Associates in January 2008:

    - Table 8-2 – 60 school buses needed for the schools in PAZ C2.
    - Table 8-4 – 3 buses, 24 ambulances, 12 wheelchair buses and 2 wheelchair vans needed for the medical facilities in PAZ C2.
    - Table 8-6 and Figure 8-2 – transit- dependent bus routes 6, 7 and 8 service PAZ C2. There are a total of 8 buses on these routes.
    - Assume homebound special needs is the same for PAZ C2 as it is for the Citrus County portion of the Levy EPZ; therefore 1 bus and 6 wheelchair vans (see Table 8-9) are needed.

    Table I-4 summarizes the Citrus County data from Table 8-11 and the data presented above for the evacuation of the CRNP EPZ. Comparing the available resources with the resources needed indicates that there is a shortage of ambulances and wheelchair vans. The shortage of wheelchair vans can be addressed using the surplus of wheelchair buses in the county. The shortage of ambulances can be resolved by establishing a mutual aid agreement with Marion County, who has excess ambulance resources, as noted in Table 8-11.

Table I-4. Available and Required Transit Resources for Citrus County (Levy and Crystal River Nuclear Plants combined)

Requirements	Buses	Ambulances	Wheelchair Vans	Wheelchair Buses
Citrus County				
Available Resources	**158**	**11**	**8**	**68**
School	73	0	0	0
Medical Facilities	7	34	4	14
Transit Routes	16	0	0	0
Homebound Special Needs	2	0	12	0
Total Resources Needed	98	34	16	14

15. Add Item 7 to Section 13 as follows:

   7. In the rare event that a simultaneous evacuation of both the Crystal River Nuclear Plant and Levy Nuclear Plant EPZs is advised, there would be a shortage of ambulances in Citrus County. As discussed in Appendix I, it is recommended that a mutual aid agreement be established between Citrus and Marion Counties for ambulance resource support in the event of a simultaneous evacuation.

16. Add the following assumption to Section 2.3:

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

17. The following text will be added to the end of Section 9:

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

18. Revise the discussion of "Activity: Board Passengers (C→D)" on page 8-5 as follows:

   Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school) is about 5 minutes. A loading time of 10 minutes will be used for rain scenarios. For multiple stops along a pick-up route (such as the routes for the transit-dependent population) we must allow for the additional delay associated with stopping and starting at each pick-up point. ~~This additional delay to service passengers expands this estimate of boarding time to 15 minutes in good weather, and 20 minutes in rain.~~ There are no pre-determined pickup points established for the transit dependent population within the EPZ. It is assumed that transit-dependent persons will walk to the nearest route and flag down a passing bus as it traverses the route. These "flag" stops result in an estimate of boarding time of 15 minutes in good weather computed as follows:

The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

where B = Dwell time to service passengers. The total distance, "s" in feet, travelled during the deceleration and acceleration activities is: s = v2/a. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s, would be: s/v, or (v2/a)/v = v/a. Then the total delay (i.e. pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

B = 45 seconds: a very generous value for about 2 passengers per stop

v = 35 mph = 52 ft/sec

a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 58 seconds per stop. Allowing 15 minutes pick-up time per bus run implies 15 stops per run. Thus the delay associated with stopping and the dwell time for buses has been considered as the "pickup time". It is assumed that pickup time is 5 minutes longer (20 minutes total) in rain.

19. Replace the first paragraph under "School Evacuation" on page 8-5 with the following:

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

The UNITES software discussed in Section 1.3 was used to define bus routes along the most likely path from a school being evacuated to the EPZ boundary, traveling toward the appropriate relocation school. This is done in UNITES by interactively selecting the series of nodes from the school to the EPZ boundary. The bus route is given an identification number and is written to the I-DYNEV input stream. UNITES computes the route length and DYNEV outputs the average speed for each 10 minute interval for each bus route input. The travel times to the EPZ boundary are computed from the route length and the speeds output by the model (at the mobilization plus loading time). The bus routes input are documented in Table 8-12.

20. Insert new Table 8-12 at the end of Section 8 which provides the bus routes input to UNITES/DYNEV for each of the schools and transit-dependent bus routes.

21. Add Table 8-12 to page vi of the Table of Contents.

22. Add a column "Average Speed" to tables 8-5A, 8-5B, 8-7A and 8-7B which provides the average speed for each route input. Re-compute the route travel time and update the ETE accordingly, based on the new average speed.

23. Replace Figure E-1 with the attached revised figure (see page 61).

24. Revise the title of Figure E-1 on page E-3 and in the Table of Contents as follows:
    Figure E-1. Levy Nuclear Plant: Schools, ~~and~~ Daycare Facilities and Relocation Schools ~~within the EPZ~~

25. Add the following footnote to Table 8-3:

    Figure E-1 in Appendix E identifies the location of all EPZ schools and the relocation schools they are evacuated to.

26. Add Item 8 to Section 13 as follows:

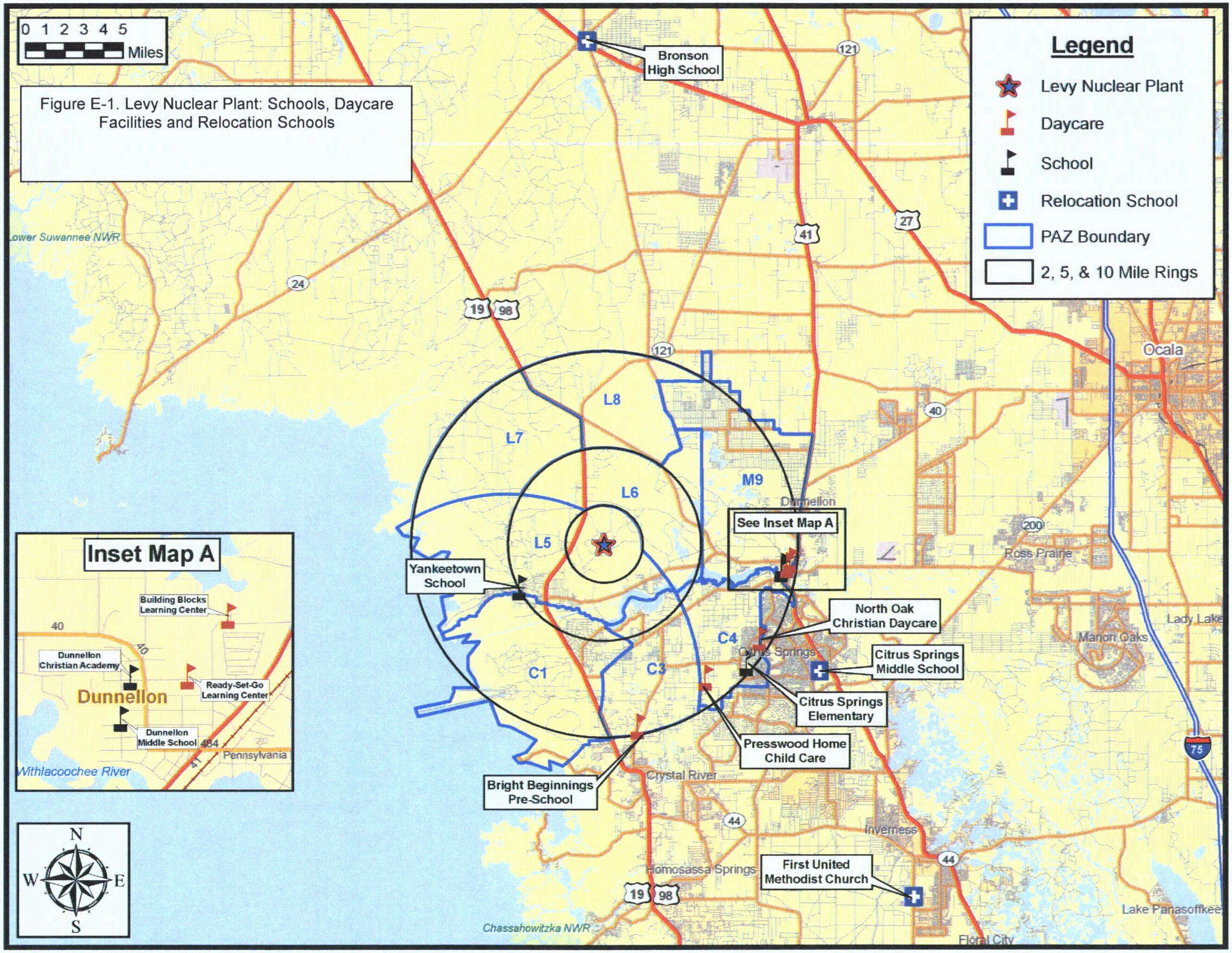
    8. As shown in Section 8, there would be a shortage of buses in Levy County in the event of an evacuation of the Levy EPZ. There is, however, a surplus of wheelchair buses in Levy County. It is recommended that plans are made to use these surplus wheelchair buses within the county or that a mutual aid agreement be established by Levy County with Citrus and/or Marion Counties for bus resource support in the event of an evacuation.

Attachments/Enclosures:

None.

Table E-1. Levy EPZ Schools (As of July 2007)

Zone	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
				Levy County				
L5	5	WSW	Yankeetown School	4500 Hwy 40 West	Yankeetown	(352) 447-2372	329	51
				Citrus County				
C4	9.9	SW	Citrus Springs Elementary	3570 W Century Blvd	Citrus Springs	(352) 344-4079	875	55
				Marion County				
M9	9.4	E	Dunnellon Middle School	21005 Chestnut St	Dunnellon	(352) 465-6720	1,100	110
M9	9.4	E	Dunnellon Christian Academy	20831 Powell Rd	Dunnellon	(352) 489-7716	263	33
M9	11.9	ENE	Romeo Elementary School	19550 SW 36th St	Dunnellon	(352) 465-6700	810	105
						Total	**3,377**	**354**


0 1 2 3 4 5
Miles
Figure E-1. Levy Nuclear Plant: Schools, Daycare Facilities and Relocation Schools
Legend
Levy Nuclear Plant
Daycare
School
Relocation School
PAZ Boundary
2, 5, & 10 Mile Rings
Bronson High School
Lower Suwannee NWR
Ocala
L5
L6
L7
L8
M9
C1
C3
C4
Dunnellon
See Inset Map A
Yankeetown School
North Oak Christian Daycare
Citrus Springs Middle School
Citrus Springs Elementary
Presswood Home Child Care
Bright Beginnings Pre-School
Ross Prairie
Lady Lake
Marion Oaks
Crystal River
Inverness
Homosassa Springs
First United Methodist Church
Chassahowitzka NWR
Lake Panasoffkee
Floral City
Inset Map A
Building Blocks Learning Center
Dunnellon Christian Academy
Ready-Set-Go Learning Center
Dunnellon
Dunnellon Middle School
Withlacoochee River
Pennsylvania
N
W
E
S

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-8 (ETE-7)

Text of NRC RAI:

ETE-7: Demand Estimation, Emergency planning zone (EPZ)

Acceptance Criteria: Requirements A and H; Acceptance Criterion 11

Regulatory Basis: Appendix 4 to NUREG-0654 Section II.D, Section III.B, IV.B.1

A. Section 3, "Demand Estimation," (Page 3-2) states that the plume exposure pathway EPZ is subdivided into 8 Protective Action Zones (PAZs). Figure 3.1, "Levy Nuclear Plant Protective Action Zones," (Page 3-3) shows the location of the 8 PAZs within the plume exposure pathway EPZ and the surrounding counties. In Figure 7-2, "Levy Nuclear Plant Shadow Evacuation Region," (Page 7-13), Lake Rousseau is shown as part of the shadow evacuation region. Clarify why the lake is in the shadow evacuation region and not one of the PAZs.

B. Table 6-2,"Evacuation Scenario Definitions," (Page 6-4) provides a description of the timeframes evaluated for each evacuation scenario. Scenario 11 is described as occurring in the winter, on a weekend, midday, with good weather and new plant construction. Clarify why a scenario, such as Scenario 7, was not chosen to be midweek with rain and new plant construction to provide a worst-case estimate.

C. Table 6-3,"Percent of Population Groups for Various Scenarios," (Page 6-5) provides an estimate of the percentage of different population groups that are expected to evacuate for each scenario, including the shadow population identified in Section 2.2,"Study Methodological Assumptions" (Page 2-2). Explain where voluntary evacuees are included in Table 6-3.

D. Section 7.4,"Guidance on Using ETE Tables," (Page 7-4) states that schools are not in session. In contrast, Table 6-3, "Percent of Population Groups Evacuating for Various Scenarios," (Page 6-5) and Table 6-4, "Vehicle Estimates by Scenario," shows that 10% of school buses are used for evacuation in scenarios 1 and 2. Clarify the apparent inconsistency and discuss whether or not school bus use accounts for summer school.

PGN RAI ID #: L-0229

PGN Response to NRC RAI:

A. As stated in Section 7.1 of the ETE report, the Shadow Evacuation Region "extends radially from the boundary of the EPZ to a distance of 15 miles from LNP." Based on this description, Lake Rousseau is not included in the Shadow Region. Figure 7-2 has been revised to indicate that Lake Rousseau is within PAZs C3, C4, L5, L6, and M9; the PAZ boundaries now follow the county boundaries. The revised figure is attached (see page 67). The descriptions of PAZs C3, C4, L5, L6 and M9 will be revised accordingly in Appendix L of the ETE report.

The transients visiting Lake Rousseau have been accounted for as part of the EPZ population. As indicated in Figure E-3, there are 3 recreational areas along the shore of Lake Rousseau;

transients have been loaded at these locations. Therefore, no changes to the analysis are needed.

All maps in the ETE report will be revised to show the new PAZ boundaries which include Lake Rousseau:

- Figure 1-2
- Figure 3-1 (also appears in Executive Summary, on pg. ES-5)
- Figure 6-1
- Figure 7-2
- Figure 8-2
- Figures 10-1, 10-2 and 10-3
- Figures E-1, E-2, E-3 and E-4
- Figures G-1, G-2, G-3 and G-4
- Appendix H (Regions 1 through 13) – pages H-2 through H-14

In addition, Figure E-1, E-2, E-3 and E-4 will be annotated with the names of the facilities in the map.

Figure A6-2, sheets 1 through 3 of the LNP E-Plan are the same as Figures 10-1 through 10-3 of the ETE report. These figures will also be updated accordingly, including the changes noted in the response to RAI ETE-9.

B. The specific details of construction scheduling were not yet determined when the ETE study was conducted. Table 6-4 of the ETE report identifies the total vehicles evacuating for each scenario. As shown in Table 6-4, Scenarios 8 (winter, weekend, midday with good weather) and 9 (winter, weekend, midday with rain) have the highest total vehicles evacuating (26,307) for the non-construction scenarios. Scenario 7 as suggested in the text of this RAI has slightly fewer vehicles (26,233) than Scenarios 8 and 9. It was uncertain how inclement weather would impact the construction workforce; therefore, Scenario 8 (winter, weekend, midday with good weather) conditions were chosen for the construction scenario, assuming that the full construction workforce would be present under good weather conditions and that this would be a "worst-case" scenario.

C. The numbers presented in Tables 6-3 and 6-4 are for a 100% evacuation of the full EPZ (Region R03). There are no voluntary evacuation percentages applied in obtaining the numbers in Tables 6-3 and 6-4 because all PAZ evacuate 100% for an evacuation of the entire EPZ. The vehicles for the evacuation of the full EPZ are presented because they represent the upper bound of vehicles evacuating for a given scenario. A footnote will be added to Table 6-4 to indicate that the numbers presented are for an evacuation of the entire EPZ.

Table H-1 (attached; see page 68) will be added to the revised ETE report; this table identifies the voluntary evacuation percentages for each PAZ for each Regional configuration. The values shown in Table H-1 were determined using the methodology discussed in assumption 5 of Section 2.2, Figure 2-1 and Figure 7-1 of the ETE report. The text of page H-1 of the ETE report will be revised to discuss Table H-1.

The maximum vehicle loading is calculated for each link on the network. This loading is characterized by the vehicle types identified in the column headings of Table 6-3. This maximum vehicle loading for each link is reduced by a number of factors which provides the time period specific loading for that link. The factors are: (1) trip generation rates shown in Table 5-1; (2) scenario specific percentages provided in Table 6-3; and (3) Region specific voluntary evacuation percentages provided in Table H-1.

Review of the input streams to DYNEV indicates that the voluntary evacuation percentages were not properly specified for any region, except Region R03. PAZ C1 and C3 were originally included in the 5-mile evacuation. Based on comments received during the review process, PAZ C1 and C3 were removed from the 5-mile evacuation. This revision was carried out in Tables 6-1, 7-2 and J-2, as well as in the figures of Appendix H; however, the input stream was not modified accordingly. These percentages will be corrected to the values shown in Table H-1 and the ETE will be recomputed. The ETE values presented in the Executive Summary (pages ES-9 and ES-10), in Tables 7-1A through D and in Tables J-1A through D will be updated based on these changes.

DYNEV has recently been modified to allow for the input of specific bus routes within the analysis area. DYNEV outputs the average speed on these bus routes at each 10 minute interval during evacuation. This new feature of DYNEV will be used to compute the average speed during evacuation on each of the school and transit-dependent bus routes servicing the EPZ. The average speeds discussed in Section 8.4 of the ETE report will be updated accordingly. Tables 8-5A and B and Tables 8-7A and B, which rely on the average speed output by the model, will be updated accordingly. Pages ES-11 and ES-12 in the Executive Summary will also be revised.

D. For Scenarios 1 and 2, the buses are evacuating summer school students. It is assumed that summer school enrollment is approximately 10% of enrollment for the regular school year. This assumption will be added to Section 2 of the ETE report and added to the "School and Transit Buses" footnote to Table 6-3. The references to "school not in session" for the summer season in Section 7.4 and Section J.1 will be removed to avoid confusion.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- The descriptions of PAZs C3, C4, L5, L6 and M9 in Appendix L will be revised as follows:

Zone C3: Bound on the north by ~~Lake Rousseau~~ the Citrus/Levy county boundary. Bound on the east by the CRNP's 10-mile boundary. Bound on the south by the Levy Nuclear Plant's (LNP) 10-mile boundary. Bound on the west by USHY 19, the CRNP's 5-mile boundary, Dunnellon Rd, a line between the intersection of Dunnellon Rd and Pomegranate Rd and the northern end of Cherry Hill Rd, a line between the northern end of Cherry Hill Rd and the northern end of Ira Martin Rd, and a line from the northern end of Ira Martin Rd to ~~a point on the southwestern shore of Lake Rousseau, at approximately 82.61º West and 29.01ºNorth.~~ the Citrus/Levy county boundary.

Zone C4: Bound on the north by ~~Lake Rousseau~~ the Citrus/Levy and Citrus/Marion county boundaries. Bound on the east by USHY 41, the Citrus Springs town boundary, and Elkcam Rd. Bound on the south by the Pine Ridge town boundary. Bound on the west by the CRNP's 10-mile boundary.

Zone L5: Bound on the north by the CRNP's 10-mile boundary. Bound on the east by ~~Lake Rousseau~~ the Citrus/Levy county boundary. Bound on the south by the Withlacoochee River/Levy County boundary, and the Yankeetown town boundary. Bound on the west by a line between the southwestern-most point of the Yankeetown boundary and the CRNP's 10 mile boundary.

Zone L6: Bound on the north by the LNP's 5-mile boundary, STHY 337, and 120th St. Bound on the east by Halfmoon Rd and the Levy/Marion ~~C~~county boundary. Bound on the south by the Citrus/Levy county boundary through Lake Rousseau. Bound on the west by the CRNP's 10-mile boundary and the LNP's 5 mile boundary.

Zone M9: Bound on the north by a line between STHY 337 and the west end of 95th St, 95th St, Ridgewood Rd, County Rd 545, Buena Vista Rd, Falcon Ave, Terrapin Dr, Amberjack Ave, Timberlake Rd, Indian Hill Dr, Viburnum Rd, Pine Bluffs Rd, a line from the western end of Pine Bluffs Rd to Sea Cliff Ave, 210th Ave, and 36th St. Bound on the east by USHY 41. Bound on the south by the Citrus/Marion county boundary through Lake Rousseau. Bound on the west by the Marion County boundary, Halfmoon Dr, 120th St, and STHY 337.

- Note in Appendix L that Zone C2 is not in use for the Levy Nuclear Plant EPZ.
- All maps in the ETE report will be updated to reflect the inclusion of Lake Rousseau within the EPZ:
    - Figure 1-2
    - Figure 3-1 (also on pg. ES-5 of Executive Summary)
    - Figure 6-1
    - Figure 7-2
    - Figure 8-2
    - Figures 10-1, 10-2 and 10-3
    - Figures E-1, E-2, E-3 and E-4
    - Figures G-1, G-2, G-3 and G-4
    - Appendix H – pages H-2 through H-14
- Figure A6-2, sheets 1 through 3 of the LNP E-Plan will be updated based on the changes to Figures 10-1, 10-2 and 10-3.

- Figures E-1, E-2, E-3 and E-4 will be annotated with the names of the facilities mapped in the figures.
- Add the following footnote to Table 6-4:

  The values presented are for an evacuation of the full EPZ (Region R03).
- Table H-1 will be added to Appendix H of the revised ETE report.
- Appendix H will be renamed "Evacuation Regions"
- The text on page H-1 will be revised as follows:

  This appendix presents the assumed voluntary evacuation percentages for each Evacuation Region (Table H-1) and maps of all Evacuation Regions. The values shown in Table H-1 were determined using the methodology discussed in assumption 5 of Section 2.2 and shown graphically in Figures 2-1 and 7-1.
- Change title of Appendix H to "Evacuation Regions" on page ii of the Table of Contents.
- Correct voluntary evacuation percentages input to the model and recompute ETE for all Regions, except R03. Update Tables 7-1A through D, Tables J-1A through D and pages ES-9 and ES-10 accordingly.
- Use the new DYNEV bus route feature to compute the average speed for each of the schools and transit-dependent routes identified. Update Section 8.4, Tables 8-5A, 8-5B, 8-7A and 8-7B accordingly. Replace tables on pages ES-11 and ES-12 with the revised versions of Tables 8-5A and 8-7A.
- Add assumption 12 to Section 2.3 of the ETE report:

  12. It is assumed that summer-school enrollment is 10% of the enrollment for the regular school year.
- Revise the "School and Transit Buses" footnote to Table 6-3 to read:

  Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles), respectively. It is assumed that summer school is in session for Scenarios 1 and 2 and that 10% of the buses needed for the regular school session will be needed to evacuate summer school students.
- Delete "(schools not in session)" from the Summer sub-bullet to Item #1 on pages 7-4 and J-1.
- Revise the first sub-bullet of the second bullet on page 7-5 and the first sub-bullet of the sixth bullet on page J-2 to read:

  - Summer implies that public schools are ~~*not*~~ in summer session (assumed 10% enrollment of regular school year).

Attachments/Enclosures:

None.

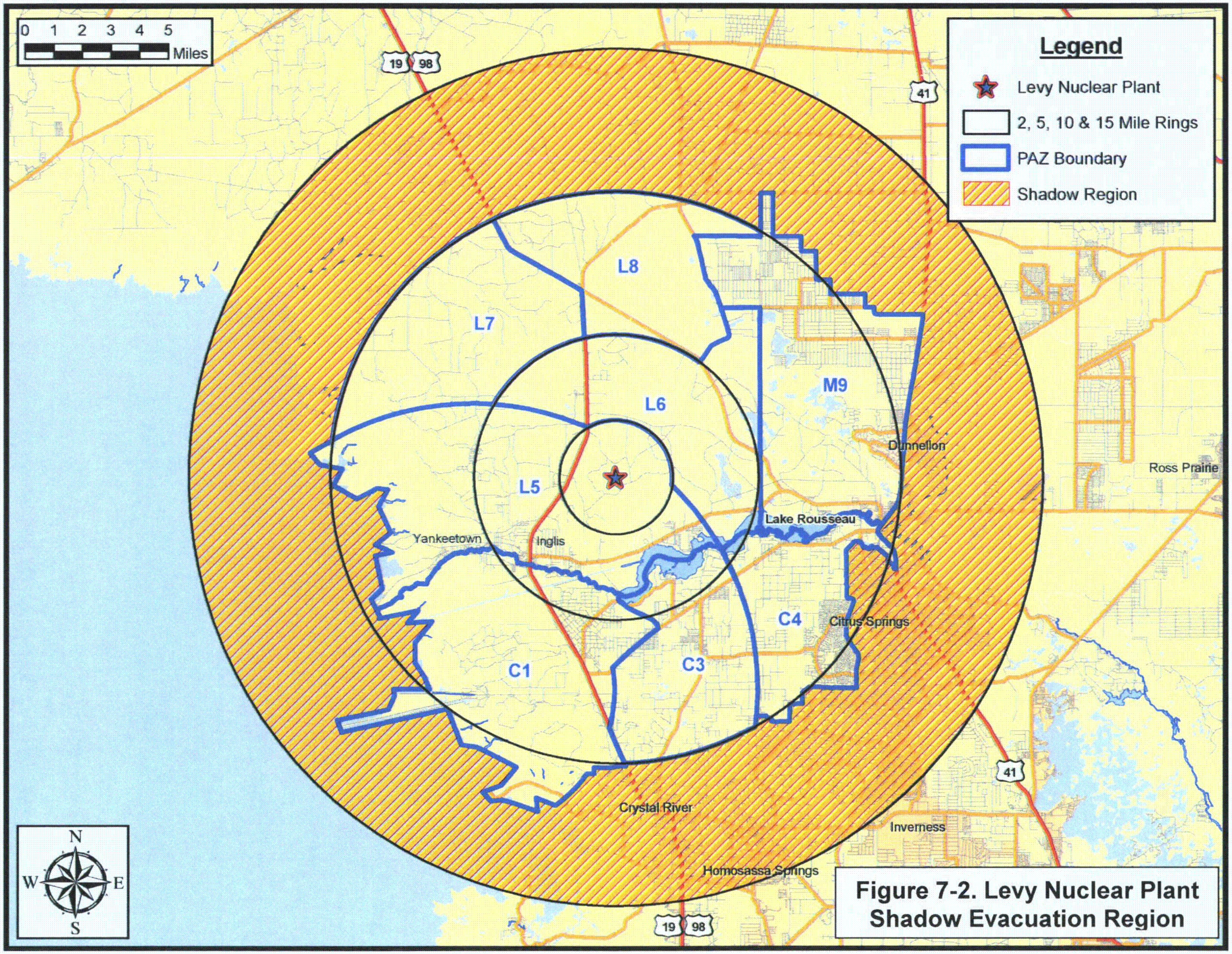


Figure 7-2. Levy Nuclear Plant Shadow Evacuation Region

Table H-1. Percent of PAZ Population Evacuating for Each Region

	Region												
	2-Mile Ring, 5-Mile Ring, Entire EPZ			5-Mile Radius and Downwind to EPZ Boundary									
PAZ	1	2	3	4	5	6	7	8	9	10	11	12	13
C1	35%	35%	100%	50%	50%	50%	50%	100%	100%	100%	100%	50%	50%
C3	35%	35%	100%	50%	50%	50%	100%	100%	100%	50%	50%	50%	50%
C4	35%	35%	100%	50%	50%	100%	100%	100%	50%	50%	50%	50%	50%
L5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
L6	35%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
L7	35%	35%	100%	100%	50%	50%	50%	50%	50%	50%	100%	100%	100%
L8	35%	35%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	100%
M9	35%	35%	100%	100%	100%	100%	100%	50%	50%	50%	50%	50%	50%

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-9 (ETE-8)

Text of NRC RAI:

ETE-8: Demand Estimation, Emergency Planning Zone and Sub-Areas
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section II.E.

A. The physical boundaries of the PAZs are described in Appendix L,"Protective Action Zone Boundaries." All zones are bound by major roads, county lines, city/town boundaries, lakes, rivers, or Crystal River Nuclear Plant PAZ boundaries. The Dunnellon and Citrus Springs communities appear to be bisected by PAZs C4 and M9 according to Figure 3-1, "Levy Nuclear Plant Protective Action Zones," (Page 3-3). Clarify whether a densely populated area has been bisected by this boundary. If so, provide a resolution for the boundary for these zones.

B. The shadow population consists of people that reside outside of the plume exposure pathway EPZ between 10 and 15 miles from the site. They are assumed to evacuate voluntarily and simultaneously with affected regions at a rate of 30% of the population. A map of the shadow region can be found in Figure 7-2, "Levy Nuclear Plant Shadow Evacuation Region" (Page 7-13).

1. Provide the population size for the shadow population.
2. Explain why the shadow population also appears to include the waterway in the plume exposure pathway EPZ in Figure 7-2.

PGN RAI ID #: L-0230

PGN Response to NRC RAI:

A. The proposed Levy Nuclear Plant site is approximately 9.8 miles northeast of the existing Crystal River Nuclear Plant. There is considerable overlap (see attached Figure 1 on page 71) of the 10-Mile radii surrounding each plant, due to the close proximity of the two plants. Progress Energy contracted KLD Associates, Inc. to develop ETE for the proposed Levy site as well as update the ETE studies for the existing Crystal River plant. Part of this work effort was to identify a set of Protective Action Zones (PAZ) that was suitable for both sites. The design of these combined PAZ was first discussed at a project kickoff meeting on February 14, 2007 with representatives from Progress Energy, KLD Associates, the State of Florida and the EPZ counties. A large scale paper map was marked up with draft PAZ boundaries. Another meeting was held on June 19, 2007 at which the EPZ/PAZ boundaries were finalized.

Table 1 (page 17) in Section I of NUREG-0654 recommends a plume exposure pathway emergency planning zone (EPZ) of *about* 10 miles in radius. As shown in Figure 2 (attached; see page 72), the communities of Dunnellon and Citrus Springs extend well beyond the 10 mile radius. The boundaries of PAZs M9 and C4 do bisect the densely populated communities of Dunnellon and Citrus Springs; however, these boundaries were developed in conjunction with the offsite agencies along well-defined features (major roadways for the most part) that would be easily identifiable to area residents and that would conform to an EPZ radius of *about* 10 miles. As stated in Section II.D of Appendix 4 to NUREG-0654 (page 4-4), "[t]o the extent practical, the sector [PAZ in this case] boundaries shall not divide densely populated areas." It was not deemed practical by the offsite agencies to include all of Dunnellon and Citrus Springs as they extend well beyond the 10 mile radius.

As noted in the response to RAI ETE-7, part A, the PAZ boundaries are to be revised to include Lake Rousseau. There is no permanent resident population on the lake (the shores of the lake where population is located were already included in the original PAZ boundaries); thus, there will be no further division of densely populated areas caused by these changes. Other than these changes, the PAZ boundaries as defined adhere to NRC guidelines and will be maintained.

B.1. As stated on page I-2 of the ETE report, the estimated Year 2007 permanent resident population within the Shadow Region is 50,324 people, evacuating in 29,520 vehicles. The shadow population was estimated using the same methodology used for the permanent residents within the EPZ, which is described on page 3-2 of the ETE report. Text will be added to Section 7.1 of the revised ETE report to indicate the population within the Shadow Region and the methodology used to compute that estimate.

The population loading is done within the Shadow Region using GIS software and Census block data. The Census block data is overlaid with the roadway system within the study area. Population is then distributed to the nearest accessible roadway section. The population on each link is then converted to households using the average household size of 2.25 persons (Figure F-1). Finally, the number of households is multiplied by the number of evacuating vehicles per household to determine how many vehicles are loaded on each roadway section. The value of 1.37 vehicles per household (Figure F-8) was used to calculate the base ETE presented in Table 7-1. (Note, as discussed in the response to RAI ETE-4, part A, the value of 1.37 vehicles per household is not correct and should be 1.39 vehicles per household. The computation of the number of vehicles in the Shadow Region will be updated and page I-2 will be revised accordingly.) Of course, only 30% of the resulting vehicles in the Shadow Region were actually generated as voluntary evacuees for the Base condition (see Assumption 5 on page 2-2 of the ETE report).

B.2. Please refer to the response to RAI ETE-7, Part A.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

The following text will be added to the end of the second paragraph of Section 7.1:

> The estimated 2007 permanent-resident population within the Shadow Region is 50,324 people; this estimate was obtained using the same methodology described in Section 3 for permanent resident population residing within the EPZ.

The number of vehicles in the Shadow Region will be re-computed using the correct value of 1.39 evacuating vehicles per household and the number of vehicles reported on page I-2 will be updated accordingly.

Attachments/Enclosures:

None.

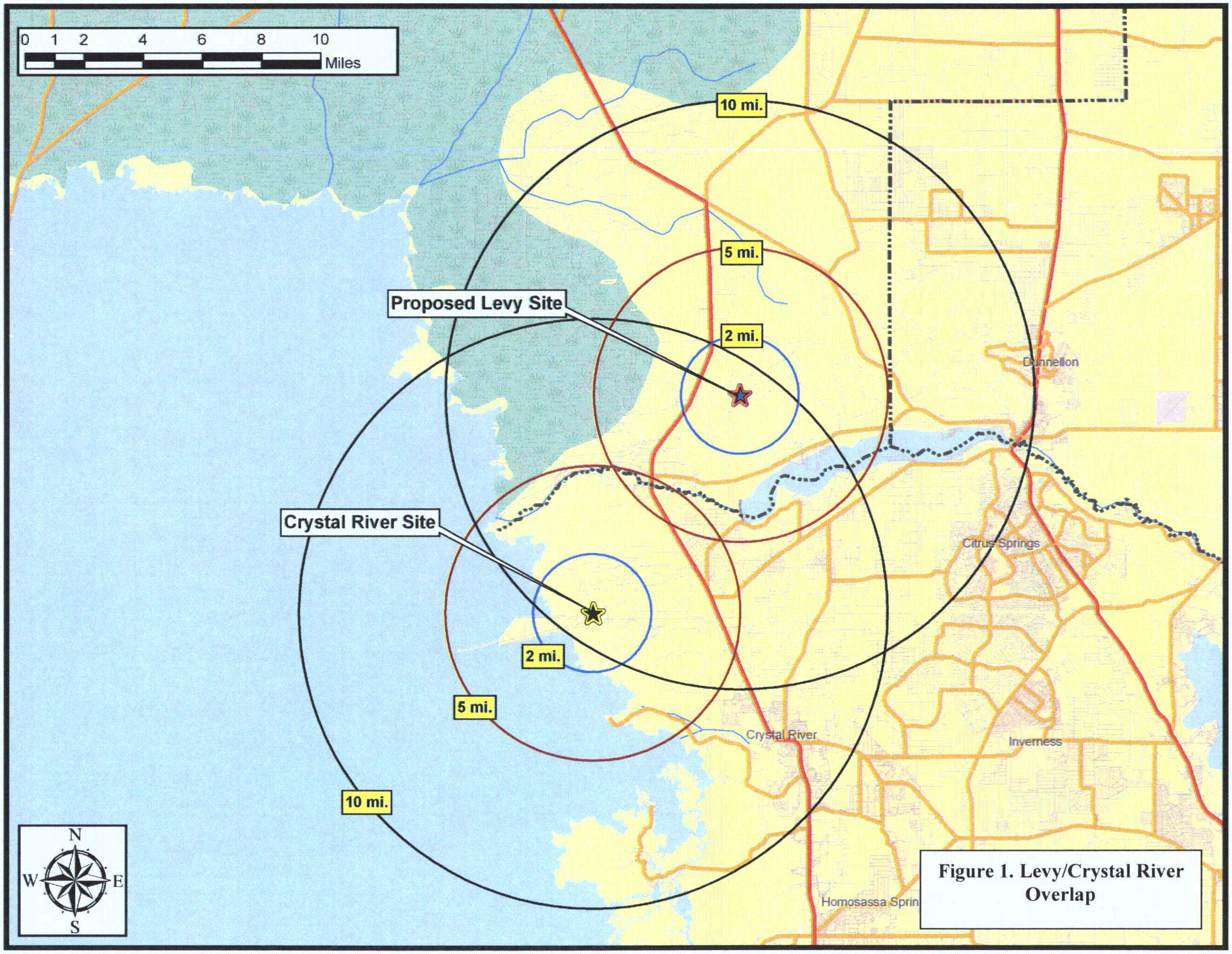


Figure 1. Levy/Crystal River Overlap

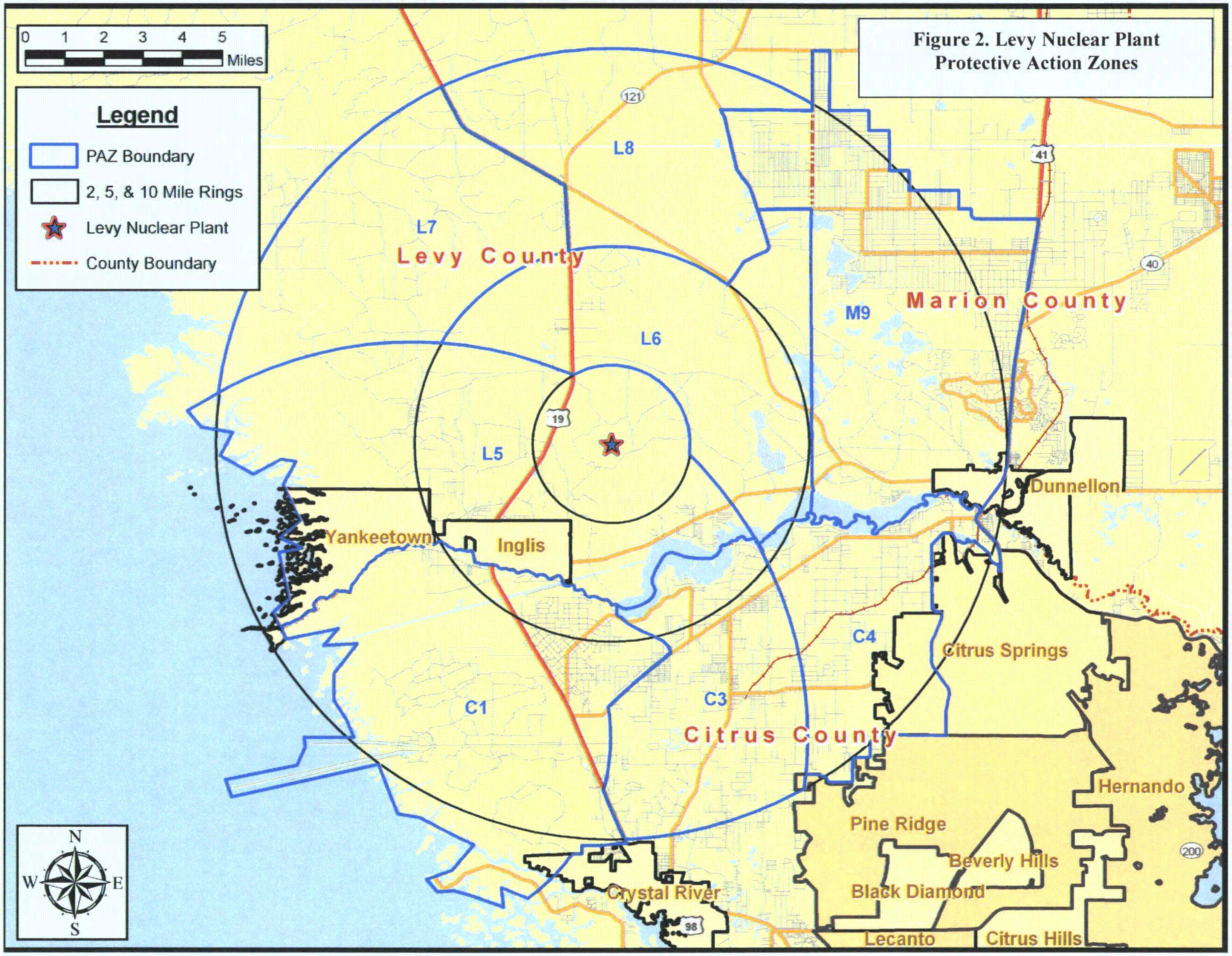


Figure 2. Levy Nuclear Plant Protective Action Zones

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-10 (ETE-9)

Text of NRC RAI:

ETE-9: Traffic Capacity, Evacuation Roadway Network
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Sections III.A, Section III.B

A. Provide route and highway numbers for evacuation routes identified by the evacuation roadway network, as described in Section 10, "Evacuation Routes."

PGN RAI ID #: L-0231

PGN Response to NRC RAI:

A. Figures 10-2 and 10-3 have been updated to include highway numbers and road names for the major evacuation routes. Figures 10-1, 10-2 and 10-3 were also modified to include the names of the reception centers. All three revised figures are attached to this response (see pages 76 through 78).

Section 10 of the ETE report was reviewed for consistency. Table 10-1 identifies Bronson High School as both a primary shelter and a day care shelter. The table will be revised as attached (see page 75) to only show one entry for Bronson High School and indicate that it is a primary shelter and a daycare shelter. Also, the text of Section 10 will be revised to indicate that it is assumed the shelters/reception centers to be used for the Levy EPZ are the same as those identified for the existing Crystal River Nuclear Plant.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- Revise the final paragraph on page 10-1 as follows:

  It is assumed that the reception centers/shelters for the Levy EPZ will be the same as those used for the existing Crystal River Nuclear Plant. Table 10-1 lists the details – ~~N~~name, ~~F~~facility type and ~~L~~location for all the designated reception centers/shelters. ~~The facilities of the type – reception center and primary shelter – are shown as primary shelters, while all other facility types are shown as secondary shelters in Figure 10-1.~~ Figure 10-1 maps each of the reception centers/shelters identified in Table 10-1. The major evacuation routes for the three counties within the EPZ are presented in Figures 10-2 and 10-3.

- Replace Table 10-1 with the attached revised table (see page 75).
- Replace Figure 10-1 with the attached revised figure (see page 76).
- Replace Figure 10-2 with the attached revised figure (see page 77).

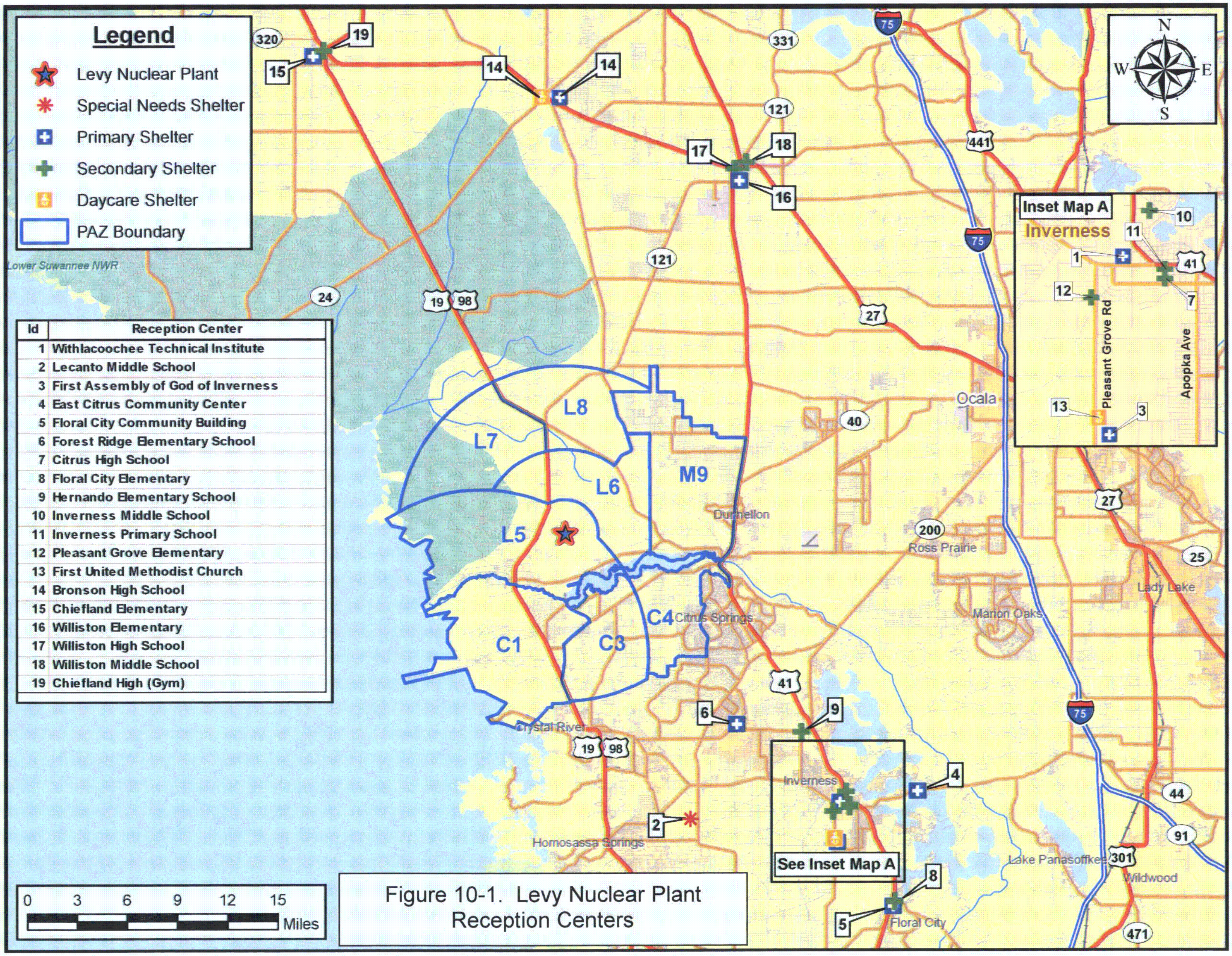
- Replace Figure 10-3 with the attached revised figure (see page 78).

Attachments/Enclosures:

None.

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

Reception Center	Facility Type	Street Address	City	State	ZIP	County
Withlacoochee Technical Institute	Reception Center	1201 W Main Street	Inverness	Florida	34450	Citrus
Lecanto Middle School	Special Needs Shelter	3800 W Educational Path	Lecanto	Florida	34461	Citrus
First Assembly of God of Inverness	Primary Shelter	4201 S Pleasant Grove Rd	Inverness	Florida	34452	Citrus
East Citrus Community Center	Primary Shelter	9907 E. Gulf-to-Lake Hwy.	Inverness	Florida	34450	Citrus
Floral City Community Building	Primary Shelter	8370 E Orange Ave	Floral City	Florida	34436	Citrus
Forest Ridge Elementary School	Primary Shelter	2927 N Forest Ridge Blvd	Hernando	Florida	34442	Citrus
Citrus High School	Secondary Shelter	600 W Highland Blvd	Inverness	Florida	34452	Citrus
Floral City Elementary	Secondary Shelter	8457 E. Marvin St.	Floral City	Florida	34436	Citrus
Hernando Elementary School	Secondary Shelter	2353 N Croft Ave	Hernando	Florida	34442	Citrus
Inverness Middle School	Secondary Shelter	1000 Middle School Dr	Inverness	Florida	34450	Citrus
Inverness Primary School	Secondary Shelter	206 S Line Avenue	Inverness	Florida	34452	Citrus
Pleasant Grove Elementary	Secondary Shelter	630 Pleasant Grove Rd.	Inverness	Florida	34452	Citrus
First United Methodist Church	Daycare Shelter	3896 S. Pleasant Grove Rd	Inverness	Florida	34452	Citrus
Bronson High School	Primary and Daycare Shelter	350 School St~~reet~~	Bronson	Florida	32621	Levy
Chiefland Elementary	Primary Shelter	1205 NW 4th Ave.	Chiefland	Florida	32626	Levy
~~Bronson High School~~	~~Daycare Shelter~~	~~350 School St.~~	~~Bronson~~	~~Florida~~	~~32621~~	~~Levy~~
Chiefland High (Gym)	Secondary Shelter	816 N. Main St.	Chiefland	Florida	32626	Levy
Williston Middle School	Secondary Shelter	1345 NE 3rd Ave.	Williston	Florida	32696	Levy
Williston High School	Secondary Shelter	427 W. Noble Ave.	Williston	Florida	32696	Levy
Williston Elementary	Primary Shelter	801 S. Main St.	Williston	Florida	32696	Levy



Id	Reception Center
1	Withlacoochee Technical Institute
2	Lecanto Middle School
3	First Assembly of God of Inverness
4	East Citrus Community Center
5	Floral City Community Building
6	Forest Ridge Elementary School
7	Citrus High School
8	Floral City Elementary
9	Hernando Elementary School
10	Inverness Middle School
11	Inverness Primary School
12	Pleasant Grove Elementary
13	First United Methodist Church
14	Bronson High School
15	Chiefland Elementary
16	Williston Elementary
17	Williston High School
18	Williston Middle School
19	Chiefland High (Gym)

Figure 10-1. Levy Nuclear Plant Reception Centers

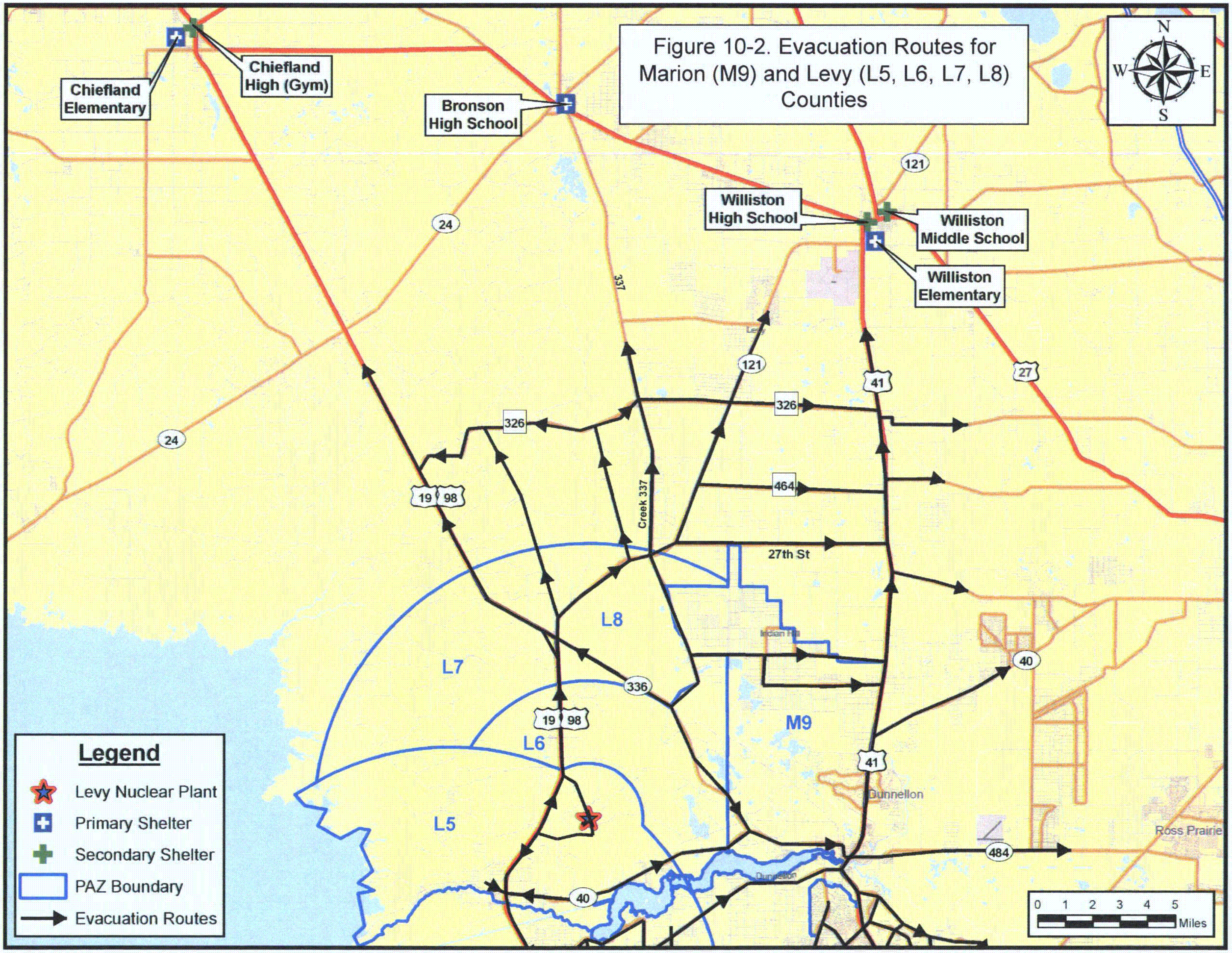


Figure 10-2. Evacuation Routes for Marion (M9) and Levy (L5, L6, L7, L8) Counties
N
W
E
S
Chiefland Elementary
Chiefland High (Gym)
Bronson High School
Williston High School
Williston Middle School
Williston Elementary
24
337
121
41
27
326
464
19
98
Creek 337
27th St
L8
L7
L6
L5
M9
336
40
Dunnellon
Ross Prairie
484
Legend
Levy Nuclear Plant
Primary Shelter
Secondary Shelter
PAZ Boundary
Evacuation Routes
0 1 2 3 4 5
Miles

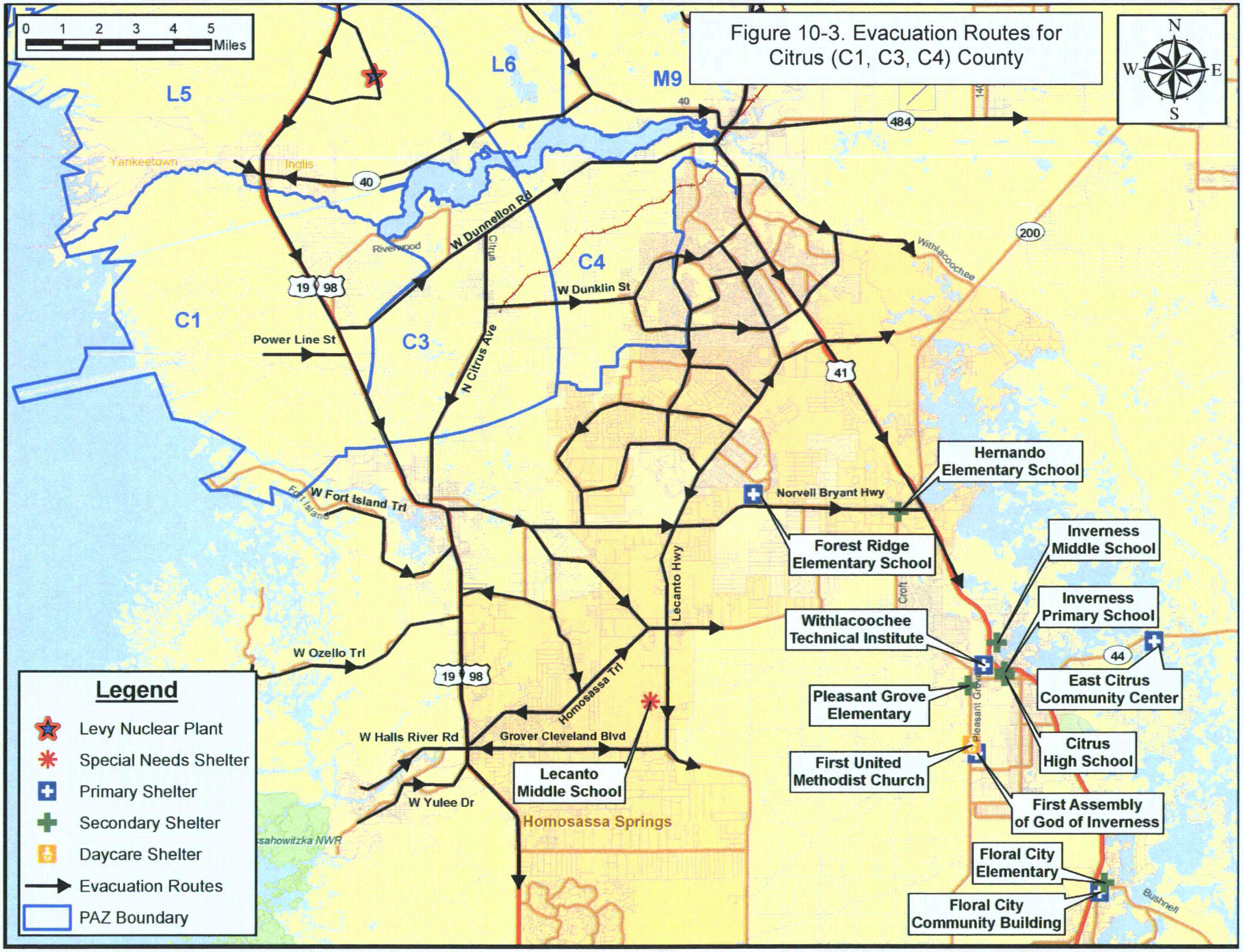


Figure 10-3. Evacuation Routes for Citrus (C1, C3, C4) County
0 1 2 3 4 5 Miles
N
S
E
W
L5
L6
M9
C1
C3
C4
Yankeetown
Inglis
Riverwood
40
484
200
19
98
41
44
W Dunnellon Rd
Citrus
W Dunklin St
Power Line St
N Citrus Ave
Withlacoochee
W Fort Island Trl
Norvell Bryant Hwy
Lecanto Hwy
Croft
W Ozello Trl
Homosassa Trl
W Halls River Rd
Grover Cleveland Blvd
W Yulee Dr
Homosassa Springs
Pleasant Grove
Bushnell
Hernando Elementary School
Forest Ridge Elementary School
Inverness Middle School
Inverness Primary School
Withlacoochee Technical Institute
East Citrus Community Center
Pleasant Grove Elementary
Lecanto Middle School
Citrus High School
First United Methodist Church
First Assembly of God of Inverness
Floral City Elementary
Floral City Community Building
Legend
Levy Nuclear Plant
Special Needs Shelter
Primary Shelter
Secondary Shelter
Daycare Shelter
Evacuation Routes
PAZ Boundary

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-11 (ETE-10)

Text of NRC RAI:

ETE-10: Traffic Capacity, Roadway Segment Characteristics
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section III.B

A. Appendix K, "Evacuation Roadway Network Characteristics," only lists the number of full lanes as 1, 2, or 3.

1. Provide information related to lane width, or justify why it is not needed.
2. Discuss whether actual lane width, as measured in the field survey, is used.

B. Evacuation routes are analyzed using the IDYNEV models. Classification of the roadways within the EPZ is described in Section 4,"Estimation of Highway Capacity." Section 1.3, Preliminary Activities," (Page 1-5) states that during field surveys of the highway network (both within and outside the EPZ), characteristics of each section of the highway was recorded. These included unusual characteristics, such as narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.

1. Clarify the location and nature of the highway sections with unusual characteristics, and describe how this information was reflected in the ETE calculations.
2. For Appendix K, "Evacuation Roadway Network Characteristics," provide the value that was used for the "Full Lane" lane width.
3. Identify where the narrowest roadway sections exist within the roadway network and discuss how this was factored into the calculations.

C. Section 4 (Page 4-5) states that the 2 lane roadway capacity is 1,700 passenger cars per hour (pc/hr) as identified in Chapter 20 of the HCM. However, the HCM identifies these capacities for 'ideal conditions' such as 12 foot widths and 6 foot shoulders.

1. Clarify whether the field survey confirmed that lane and shoulder widths meet the conditions for 'ideal'.
2. Discuss the operational considerations applied to the roadway capacity estimate including time spent following other vehicles.
3. If necessary, explain the affect on the ETE if the capacity is determined to be lower than the value used.

D. Section 4 (Page 4-4) states that a reduction factor (R=0.85) was used.

1. Clarify whether this reduction factor was applied to all roadways, including freeways.
2. Provide additional information, such as a reference, for the basis of this empirical data.

E. Section 8.4, "Evacuation Time Estimates for Transit Dependent People," provides an average speed output of 53.9 mph on Page 8-6, 53.8 mph on Page 8-7, and 51.3 mph on Page 8-8 for average roadway speeds at various times in the evacuation.

1. Explain how the average speed can exceed 50 mph when more than 70% of the roadway segments in Appendix K have free flow speeds between 30 and 50 mph.

2. Discuss the impact on the average evacuation travel speeds if an evacuation occurred at the same time at Crystal River Nuclear Plant.

PGN RAI ID #: L-0232

PGN Response to NRC RAI:

A. In Appendix K, the term "full lanes" is used to identify the number of lanes that extend over the entire length of the roadway segment or link; it does not pertain to lane width. Many network links are widened with additional lanes near the downstream intersection (e.g., left-turn bays, right-turn bays, additional through lanes). These additional lanes are all properly represented in the input stream for the I-DYNEV system. Lane widths vary from one link to the next and even within one link as do shoulder width, grade, and horizontal curvature. In accord with NUREG-0654, Appendix 4, Section IIIB, the estimation of capacity (expressed as saturation flow rate in the fifth column of the table in Appendix K) is based on the narrowest section of the roadway segment. The free-flow speed shown in Appendix K is based upon observation of traffic movements during the field survey conducted the week of February 12, 2007; these estimates do not necessarily comport with the speed advisory signing. Lane widths were observed but not measured during the field survey.

To represent the changing geometric features along a highway, the modeling process subdivides a highway into sequential links, each with its own reasonably consistent set of attributes, including lane width. The objective is to assign estimated values of saturation flow rates and free speed for each link that are reflective of its features.

Additional text will be added to Section 1.3 and to Appendix K to further describe the road survey and to clarify what is meant by "Full Lanes".

B.1. The number of bridges, sharp curves, narrow shoulders and other capacity-reducing features on the evacuation network were observed and considered in estimating capacity. Bridges are treated, for ETE purposes, as links in the highway network. For example, Links (18,63); (63,18); (17,63) and (63,17) are used to model the narrowing of US Route 19 from 2 lanes in each direction to 1 lane in each direction on the bridge crossing the Cross Florida Barge Canal [Note, links are denoted as (upstream node, downstream node) – see the large scale version of Figure 1-2 provided in response to RAI ETE-2, Part G for the location of links]. The capacity drops to 1714 vehicles per hour per lane (vphpl) across the bridge and the number of lanes decreases to 1 as shown for link (17,63) in Appendix K. (The capacity is 1895 vphpl when the road is 2 lanes in each direction, as shown for link (16,17) in Appendix K.) The properties of all links representing bridges are recorded in Appendix K (with all other links), but are not otherwise delineated. For further clarification see response to part A.

B.2. See the response to part A.

B.3. See the response to part A.

C.1. The capacity and free flow speed data input to DYNEV and documented in Appendix K are based upon observations made during the road survey, which is described in the response to Part A. Where the base conditions are not realized, downward adjustments to the capacity estimate of 1,700 pc/hr were made. For example, links (326,325); (325,324) and (324,323) are used to model W Ozello Trail. This road is narrow and windy with no shoulders and limited site distance. These non-ideal roadway conditions resulted in a reduced capacity of 1,000 pc/hr and a lower free speed of 40 mph. These and other adjustments for non-ideal conditions, which can be viewed in Appendix K, are based on the guidance provided in Exhibit 12-15 of the HCM. Note that the base conditions for this exhibit include a 60/40 directional split. This assumption would not be realized during an evacuation where the flow is primarily outbound. There would be limited inbound traffic, particularly after 90 minutes following the advisory to evacuate when evacuating traffic volumes are high and inbound traffic has been diverted at access control points. As is shown in Exhibit 12-7(b), a reduced opposing flow rate is associated with a lower percentage of "Time-spent-following," a measure of "[t]he comfort and convenience of travel." [p.12-12, HCM] As shown in HCM Exhibit 20-4, Level of Service (LOS) is related to percent time-spent-following. Percent time-spent-following was observed during the road survey; however, as noted above, evacuation traffic is highly directional and would be quite different than during regular traffic conditions.

The effect of narrow lanes and shoulders on free-flow speed (FFS) is shown in HCM Exhibit 20-5. For example, a 10-foot lane width and 2-foot shoulder width would reduce FFS by only 3.7 mph relative to a 12-foot lane and 6-foot shoulder. Based on the range of free-flow speeds presented in Appendix K (30 to 60 mph), this 3.7 mph FFS reduction equates to a range of 6-12%.

C.2. Operational considerations were based on observations made during the road survey. See the response to Part A and Part C.1 for additional information.

C.3. The link capacities presented in Appendix K are accurate; therefore the ETE are unaffected.

D.1,2. The advisability of such a capacity factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[2] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2250 pcphpl estimated for the ETE and input for freeway links, where applicable (Note that the Levy EPZ does not have any freeways; therefore, the value of 2250 pcphpl does not appear in Appendix K). The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90. The data collected in the cited reference indicates that the variation of QDF at a location is generally in the range of +/- 5% about the average QDF. That is, the lower tail of this distribution would be equivalent to a capacity reduction factor of 0.90 - 0.05 = 0.85 which is the figure applied by DYNEV.

The ETE report takes a conservative view in estimating the capacity at bottlenecks when congestion develops (this capacity is the QDF rate discussed above). One could argue that a more representative value for this capacity reduction factor could be 0.90 as discussed above. Given the emergency conditions, we believed that a conservative stance was justified. Therefore, the software applies a factor of 0.85 *only when flow breaks down*, as determined by the simulation model.

---

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

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

E.1. While 70% of the roadway links have free flow speeds below 50 mph, 80% of the evacuating vehicles are travelling along the major evacuation routes, which have free flow speeds that are 50 mph or greater. There are many local roads with free speeds less than 40 mph which feed the major evacuation routes; however, the majority of the time evacuating is spent on the higher speed major evacuation routes.

Table 1 below lists the links exiting the EPZ, and the volume of traffic and free flow speeds on each of those links for an evacuation of the entire EPZ (Region R03) under Scenario 6 (winter, midweek, midday, good weather) conditions.

Table 1. Exit Link Statistics for Region R03, Scenario 6

UpNode	DnNode	Volume (veh)	Free Flow Speed (mph)	Cumulative Percent (veh)
143	145	3411	40	18.6%
156	157	166	40	19.5%
160	159	31	40	19.7%
266	269	0	40	19.7%
268	272	0	40	19.7%
58	13	2148	50	31.4%
103	41	965	50	36.7%
156	175	169	50	37.6%
161	162	1122	50	43.7%
161	198	180	50	44.7%
28	29	1998	60	55.6%
111	110	760	60	59.8%
125	124	58	60	60.1%
130	129	2915	60	76.0%
135	246	1768	60	85.7%
151	152	664	60	89.3%
151	177	1964	60	100.0%
Weighted Average Speed:			53.6	

As shown in the last column, the percentage of evacuating vehicles traversing links with free flow speeds of 40 mph is 19.7%. The remaining 80.3% is distributed among links with free flow speeds of 50 mph or greater. The resulting weighted average of these speeds, using the associated volumes, is 53.6 mph, which is in good agreement with the speeds presented on pages 8-6 through 8-8 of the ETE report.

Also note that the average speed of 53.9 mph reported on page 8-6 is at 2 hours after the advisory to evacuate (ATE), when transit-dependent buses have mobilized. There is no congestion within the EPZ at that time, as shown in Figure 7-5 of the ETE report. Thus, vehicles are moving at free speed.

The DYNEV model has recently been improved to include a bus route feature. The links representing bus routes for each school and each transit-dependent route are input to the model using KLD's UNITES software (see "Analytical Tools" section on page 1-6 of the ETE report). DYNEV then outputs the average speed for each bus route for every 10-minute interval following the advisory to evacuate. This will provide more accurate route-specific speeds than using the average network-wide speed output by DYNEV. Tables 8-5A, 8-5B, 8-7A and 8-7B will be revised to include the route specific average speed output by DYNEV and route travel time will be recomputed based on the new average speed. Also, a description of the bus route feature will replace the first paragraph under "School Evacuation" on page 8-5 of the ETE report.

E.2. A sensitivity study was conducted to measure the effects of a simultaneous evacuation of the EPZs for both the Levy Nuclear Plant and the Crystal River Nuclear Plant during Scenario 6 conditions. The combined EPZ differs from the LNP EPZ with the addition of PAZ C2 within the Crystal River EPZ, as shown in Figure 1 (attached; see page 90). All people living between the two plants (mostly Yankeetown and Inglis residents) were routed east along State Route 40 into Dunnellon and then out of the EPZ, rather than using US Route 19/98 – a high speed, high capacity roadway. This change in routing and the addition of the population in PAZ C2 increases congestion (especially in Dunnellon) and increases the ETE at the 50th, 90th and 95th percentiles by 10, 30 and 15 minutes, respectively. The results of this study are provided in Table 2.

Table 2. Combined Crystal River/Levy ETE – Scenario 6 Conditions

Percentile	50%	90%	95%	100%
Levy (Region R03)	1:20	2:50	3:40	5:10
Crystal River (Region R02)	1:25	3:00	3:40	5:00
Combined	1:30	3:20	3:55	5:10

The increased congestion in the combined EPZ results in lower average speeds. Those people in Yankeetown and Inglis who were evacuating on US Route 19/98 are now traveling east on State Route 40 and experience significant delay and reductions in speed in Dunnellon. The average speed of 53.9 mph reported on page 8-6 decreased to 19.2 mph; 53.8 mph reported on page 8-7 decreased to 18.1 mph; and 51.3 mph reported on page 8-8 decreased to 37.7 mph. Therefore, a simultaneous evacuation of both EPZs (although a highly unlikely event) would increase ETE and decrease average travel speeds.

The eastbound routing of evacuees from Yankeetown and Inglis along State Highway 40 increases the ETE for these residents. For an evacuation of the Levy plant alone, they would evacuate southbound on US Highway 19/98, a higher capacity, higher speed road than State Highway 40. Also, the ETE for Dunnellon residents is increased by a simultaneous evacuation in that the available roadway capacity in the area would also be used by Yankeetown and Inglis evacuees. The ETE for Citrus Springs may be increased slightly by a simultaneous evacuation in that those evacuating through Dunnellon may proceed southbound along US Highway 41 and travel through Citrus Springs. The ETE for the City of Crystal River is not impacted by the simultaneous evacuation. The city is on the southern portion of the Crystal River Nuclear Plant EPZ and is outside of the Levy Nuclear Plant EPZ. The routing for Crystal River is the same for a simultaneous evacuation of both plants as it would be for an evacuation of only the Crystal River Nuclear Plant. Also, no traffic is re-routed from other populated areas through Crystal River in the event of a simultaneous evacuation.

A discussion of the simultaneous evacuation of the Crystal River and Levy EPZs will be added as a sensitivity study in Appendix I of a future revision of the ETE report.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

1. Revise the first paragraph under "Field Surveys of the Highway Network" on page 1-5 as follows:

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

2. Replace the final paragraph under "Field Surveys of the Highway Network" on page 1-5 with the following:

   ~~The data were then transcribed; this information was referenced while preparing the input stream for the IDYNEV System. Key highway locations were video archived.~~ Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 20-5 in the Highway Capacity Manual (HCM) indicates that a reduction in lane width from 12 feet (the "base" value) to 10 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two lane highways. Exhibit 12-15 in the HCM shows no sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS. The highway terrain (Level, Rolling, and Mountainous) is a far more important factor than lane and shoulder width when estimating capacity. The data from the audio and video recordings were used to create detailed GIS shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the I-DYNEV System.

   As documented on page 20-3 of the HCM2000, the capacity of a two-lane highway is 1700 passenger cars per hour for each direction of travel. For freeway sections, a value of 2250 vehicles per hour per lane is assigned. The road survey has identified several segments which are characterized by adverse geometrics which are reflected in reduced values for both capacity and speed. These estimates reflect the service volumes for LOS E presented in HCM Exhibit 12-15. These links may be identified by reviewing Appendix K. Link capacity is an input to I-DYNEV which calculates the ETE. The locations of these sections may be identified by reference to the large-scale map of Figure 1-2 which is discussed under the "Development of Evacuation

Time Estimates" heading on the next page. Further discussion of roadway capacity is provided in Section 4 of this report.

3. The following paragraph will be added to the end of the "Developing the Evacuation Time Estimates" section on page 1-5:

   Given the scale of Figure 1-2, it is not feasible to identify the links and nodes to enable the reader to relate to the information presented in Appendix K. Therefore, an annotated map is provided in electronic format which can be printed at a suitable scale, if desired.

4. Move table on page K-1 to page K-2. Label the table "Table K-1. Evacuation Roadway Network Characteristics."

5. Add new page K-1 to Appendix K, with the following text:

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

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

6. Add the following text after the second paragraph on page 4-1:

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

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

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

   - Lane width
   - Shoulder width
   - Pavement Condition

- Percent Truck Traffic
- Weather conditions (rain, snow, fog, wind speed, ice)

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

7. Revise the first sentence of the third paragraph on page 4-1 as follows:

~~Because of the effect of weather on the capacity of a roadway,~~ As discussed in Section 2.3, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as heavy rain reduce the values of free speed and of highway capacity by approximately 10 percent. Over the last decade new studies have been made on the effects of rain on traffic capacity. These studies indicate a range of effects between 5 and 20 percent depending on wind speed and precipitation rates.

8. Add the following paragraph after the fourth paragraph on page 4-1:

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

9. Add the following paragraph after the first paragraph on page 4-3:

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

10. Replace the third paragraph on page 4-4 with the following text:

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

We have employed a value of R=0.85. The advisability of such a capacity factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[3] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE and indicated in Appendix K for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90. The data collected in the cited reference indicates that the variation of QDF at a location is generally in the range of +/- 5% about the average QDF. That is, the lower tail of this distribution would be equivalent to a capacity reduction factor of 0.90 - 0.05 = 0.85 which is the figure adopted.

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

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

11. Revise the fourth paragraph on page 4-4 as follows:

    The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. Exhibit 12-15 in the Highway Capacity Manual was referenced to estimate saturation flow rates. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction.

12. Change the reference under "Two-Lane Roads" on page 4-5 as follows:

    Ref: HCM Chapters 12 and 20

13. Change the reference under "Multi-Lane Highway" on page 4-5 as follows:

    Ref: HCM Chapters 12 and 21

---

3 Lei Zhang and David Levinson, "Some Properties of Flows at Freeway Bottlenecks," Transportation Research Record 1883, 2004.

14. Add the following sentence to the end of the discussion on page 4-5:

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

15. Change the reference under "Intersections" on page 4-6 as follows:

    Ref: HCM Chapters 10, 16 and 17

16. Add the following sentence to the end of the discussion under "Intersections" on page 4-6:

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

17. Add the following discussion at the end of Section 4:

    Simulation and Capacity Estimation

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

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

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

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

18. Replace the first paragraph under "School Evacuation" on page 8-5 with the following:

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

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

19. Insert new Table 8-8 at the end of Section 8 which provides the bus routes input to UNITES/DYNEV for each of the schools and transit-dependent bus routes.
20. Add Table 8-8 to the list of tables on page vi of the Table of Contents.
21. Add a column "Average Speed" to tables 8-5A, 8-5B, 8-7A and 8-7B which provides the average speed for each route input. Re-compute the route travel time and update the ETE accordingly, based on the new average speed.
22. Add a discussion of the simultaneous evacuation of the Crystal River and Levy EPZs as an additional sensitivity study at the end of Appendix I. Table 2 above will be added as Table I-3 in the report.

Attachments/Enclosures:

None.

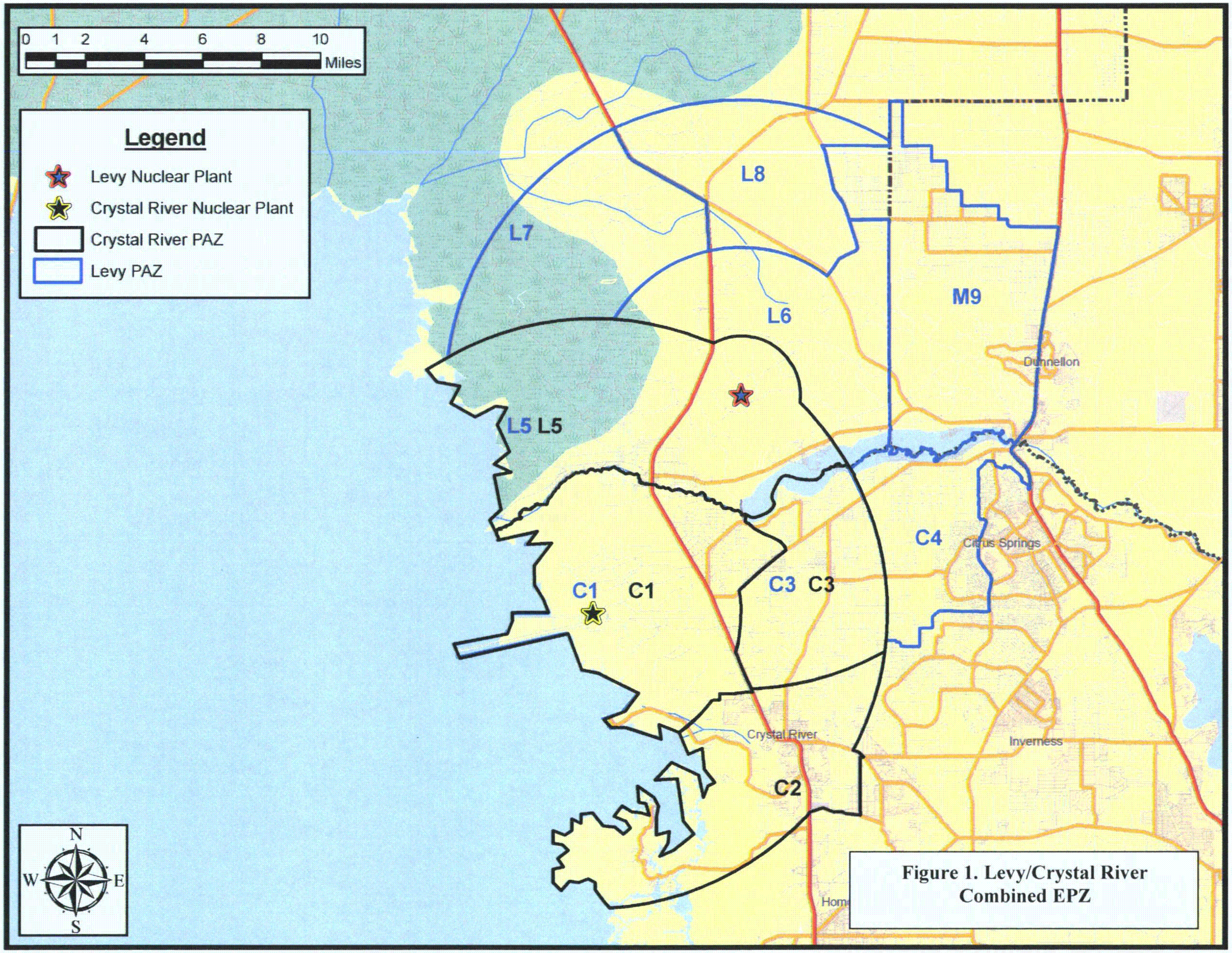


Figure 1. Levy/Crystal River Combined EPZ

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-12 (ETE-11)

Text of NRC RAI:

ETE-11: Analysis of Evacuation Times, Report Format
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section IV.A.1

A. In Table 7-1A, "Time to Clear Indicated Area of 50 Percent of the Affected Population," (Page 7-7) rain only appears to cause a five-minute delay in most regions. Tables 7-1B through 7-1D, (Pages 7-8 through 7-10) do not appear to show any difference in evacuation time between rain conditions, except for Region R03 for the time to clear 90 percent of the affected population, winter weekend, midday (Table 7-1B). Explain why only region R03 is affected by rain when evacuating 90%, 95%, or 100% of the population.

PGN RAI ID #: L-0233

PGN Response to NRC RAI:

A. As stated on page 2-5 of the ETE report, the presence of rain reduces capacity and free speed on all network links by 10%. When evacuating the entire EPZ (Region 03), this reduction in speed and capacity led to a modest increase (10 minutes or less) in ETE at both the 90th percentile and 95th percentile level of evacuation (compare Scenarios 8 and 9 in Table 7-1B and Scenarios 1 and 2 in Table 7-1C).

Note that in Figure 7-5, all congestion within the EPZ has dissipated by 2 hours after the Advisory to Evacuate (ATE). Rain does not materially affect the ETE for the 100th percentile population because the volume of traffic after 2 hours following the ATE declines to the extent where capacity is no longer a factor in influencing travel time. The effect of the reduction in free travel speed, alone, due to rain is generally not sufficient, by itself, to increase the ETE, due to the relatively short trip lengths. For example, US Highway 19 northbound [see link (25,26) in Appendix K] has a capacity of 1895 veh/hr/lane and a free flow speed of 60 mph during good weather. During rain, the capacity and free flow speed are reduced to 1706 veh/hr/lane and 54 mph, respectively. As previously discussed, traffic volume 2 hours following the ATE have diminished to the point that there is excess roadway capacity in the EPZ and all roads are operating at LOS A; therefore, the reduction in capacity due to rain will not impact ETE. Thus, only the reduction in free flow speed can influence ETE. Assume a 10-mile evacuation trip along US Highway 19; in good weather, this trip would require 10 minutes (10 mile ÷ 60 mi/hr x 60 min/hr) of travel time; in rain, this trip would require 11.1 minutes (10 mile ÷ 54 mi/hr x 60 min/hr) – a difference of 1.1 minutes. As stated in the second paragraph of Section 7 of the ETE report, ETE data are generated by DYNEV at 10-minute intervals, then interpolated to the nearest 5 minutes. Based on this information, a change of travel time of 1.1 minutes generally would not affect ETE.

Note that changes in ETE can be observed for rain when the travel time is near the interpolation point. For example, if the last vehicle to evacuate begins its trip at 2 hours after the ATE and its travel time is 12.4 minutes, its ETE would be rounded to the nearest 5 minutes, resulting in an ETE of 2 hours and 10 minutes. Now, if the change in travel time is again 1.1 minutes, the travel time would be 13.5 minutes and the ETE would round to 2 hours and 15 minutes. Inspection of Tables 7-1B through D indicates that the ETE for most regions are not affected by rain; the change in ETE for those regions that are affected by rain is minor (10 minutes or less). Generally speaking, a change in ETE of 10 minutes would not likely change the protective action decision making process.

In conclusion, over the last three hours of evacuation, the traffic environment is operating well within Level of Service (LOS) A and the lower speed due to adverse weather generally does not increase trip time by as much as 5 minutes, which results in the same ETE for good weather and rain for almost all regions.

Associated Levy COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:
None.

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-13 (ETE-12)

Text of NRC RAI:

ETE-12: Analysis of Evacuation Times, Report Format,
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Sections IV.A.2, Section IV.B.1

A. A railroad is shown on Figure 3-1 "Levy Nuclear Pant Protective Action Zones," Page 3-3. Discuss any assumptions related to how rail traffic may affect the evacuation time estimate.

B. With respect to the shadow evacuation values used in Table 6-4, "Vehicle Estimates by Scenario", (Page 6-6) provide the assumptions with regard to trip generation times and loading of the transportation network.

C. Regarding Table 7-1D, "Time to Clear the Indicated Area of 100 Percent of the Affected Population," (Page 7-10) clarify how the evacuation time of 5 hours 10 minutes for R03 for Scenario 11 which has 41,898 vehicles, can be the same for all other scenarios, some of which have as few as 23,834 vehicles.

D. Table 7-1D, "Time to Clear the Indicated Area of 100 Percent of the Affected Population" lists the ETE for the 5- and 10-mile rings at 5:10 (5 hours and 10 minutes). According to data provided in the report, only 19% of the plume exposure pathway EPZ population lives within the 5-mile ring. Additionally, one would have to travel a farther distance to exit the 10 mile region compared to the 5-mile ring. Discuss why the time to clear 100% of the indicated area for the 5 mile ring, is the same as the time listed for the entire plume exposure pathway EPZ.

E. Information on trip generation times for different subpopulations can be found in Section 5, "Estimation of Trip Generation Time." In Section 5, the time tables included in Distribution No. 2 and Distribution No. 3 (on Pages 5-6 and 5-7, respectively) include a NOTE, which says 'The survey data was normalized to distribute the "Don't know" response.' Discuss this note, including the process used to normalize the data.

F. Section 6, "Demand Estimation for Evacuation Scenarios," provides a description of evacuation regions and a map of the PAZs. Page I-2 identifies 8,856 vehicles as the 30% base case for the shadow evacuation, but Table 6-4, "Vehicle Estimate by Scenario," (Page 6-6) identifies from 8,898 to 14,743 vehicles for the 30% shadow evacuation.

1. Explain which value is being used for shadow resident vehicles.
2. Discuss the timing of the traffic loading onto the network for the shadow population identified in Table 6-4, "Vehicle Estimates by Scenario."
3. Clarify the impact on traffic timing and traffic loading if Crystal River Nuclear Plant had an evacuation at the same time as LNP.

PGN RAI ID #: L-0234

PGN Response to NRC RAI:

A. Based on discussions with the current Progress Energy Fleet Emergency Preparedness Manager and former supervisor of emergency preparedness for the Crystal River Nuclear Plant, there is no commuter rail or Amtrak service in the area. There is a rail line running to the Crystal River (CR) Energy Complex which is primarily used for coal (with the rare exception of hauling incoming plant equipment/material). Other than the rail line servicing the CR Energy Complex, there is no other rail traffic that would impact evacuation in the area. The CR Energy Complex has the capability to communicate with the trains making deliveries to the complex and could stop the trains from entering the EPZ in the event of an incident at either the Crystal River or Levy Nuclear Plants.

B. The shadow vehicles shown in Table 6-4 are loaded on the link-node analysis network (Figure 1-2) using the same trip generation times as EPZ residents with Commuters – Distribution C in Table 5-1.

C. As noted in the response to RAI ETE-2, part B, the ETE for the 100th percentile of evacuating population mimics the trip generation time. As shown in Figure 7-6, all congestion within the EPZ has dissipated by 2 hours and 30 minutes after the Advisory to Evacuate (ATE). The trip generation time, however, spans 5 hours after the ATE (see Table 5-1). Note that no trips are generated in Time Period 10 in Table 5-1. This Time Period is needed to allow time for traffic to leave the analysis network if there is congestion; therefore the total trip generation time is the sum of the elapsed time for time periods 1 through 9. The 100th percentile ETE for all regions is equal to the 5 hour trip generation time plus the travel time which ranges between 1 and 10 minutes depending on where evacuees originate relative to the EPZ boundary. As noted in the second paragraph of Section 7, ETE are interpolated to the nearest 5 minutes. Thus, a range of travel times from 1 to 10 minutes produces a range of ETE from 5 hours to 5 hours and 10 minutes for all regions for the 100th percentile, which agrees with the values presented in Table 7-1D.

Although the 100th percentile ETE mimic trip generation time, lesser percentiles can be affected by congestion, which is the case for the construction scenario (Scenario 11). Scenarios 8 and 11 are similar in that both are winter, weekend, midday scenarios with good weather; the difference between the two is that Scenario 11 involves construction activities and has a base year of 2017 (As noted in the response to RAI ETE-5, part E, the peak construction year has shifted outward to 2019). Comparison of the ETE for Scenarios 8 and 11 in Tables 7-1A through C indicates that ETE are longer for Scenario 11, which is to be expected as there are many more vehicles evacuating and congestion is more pronounced.

D. As indicated in the "Region R02" map in Appendix H of the ETE report, the 5-mile region includes the evacuation of PAZ L5 and L6. Table 3-2 indicates that there are 2,495 resident vehicles evacuating from these PAZ. Table 6-3 indicates that 45% of households have a commuter for an evacuation under Scenario 1 conditions. Table 5-1 indicates that 7% of the vehicles for households with commuters are mobilized during Time Period 9 which ends at 5 hours after the advisory to evacuate (ATE). Therefore, 79 vehicles (2,495 x 45% x 7%) from households with commuters are mobilized during the final time period. A vehicle mobilized from the 5-mile region at 5 hours after the ATE will have to travel at least 5 miles to reach the EPZ boundary. Assuming an average speed of 50 mph (traffic is free-flowing at this time as the network is clear of congestion after 2 hours after the ATE – see Figure 7-5), this 5 mile trip would require 6 minutes of travel time. Therefore, the ETE for the 5-mile region should be approximately 5 hours and 5 minutes (rounded to the nearest 5 minutes).

As indicated in the response to RAI ETE-7, part C, PAZ C1 and C3 were mistakenly included in the 5-mile Region. As shown in Figure 3-1, PAZ C1 and C3 extend all the way to the EPZ boundary. Therefore, the distance traveled to exit the 10-mile region (Region R03 – the entire plume exposure pathway EPZ) is similar to that to exit the 5-mile region. PAZ C1 and C3 will be removed from the 5-mile region and all ETE simulations will be re-run. Tables 7-1A through D and Tables J-1A through D will be updated in a future revision of the ETE report based on the results of the new simulation.

E. Attachment A to Appendix F is a documentation of the survey instrument used to gather the data that serves as a basis for estimating mobilization times. A review of the survey instrument reveals that several questions have a "don't know" or "refused" entry for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a "don't know" response for a few questions. To address the issue of occasional "don't know" responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the "don't know" responses are ignored and the distributions are based upon the positive data that is acquired.

For example, of the 553 households surveyed (see the response to RAI ETE-2, part A), 12 households indicated "don't know" to question 13 of the survey (see Attachment A to Appendix F of the ETE report). The 12 "don't know" responses were eliminated from the data and the average statistic was computed based on a sample size of 541 households (553-12).

F.1. See the response to RAI ETE-8, part B, question 1 for the shadow population in the base year of 2007, which applies to Scenarios 1 through 10 in Table 6-4. As indicated in the second footnote to Table 6-4, the shadow population for Scenario 11 is extrapolated to Year 2017. Refer to the response to RAI ETE-4, part D, question 4 for the shadow population in Year 2017 (As noted in the response to RAI ETE-5, part E, the peak construction year has shifted outward to 2019. Thus, shadow population will be extrapolated to Year 2019 in a future revision of the ETE, as discussed in the response to RAI ETE-4, part D).

As indicated in the "Shadow" footnote to Table 6-3, the basis for the values shown is a 30% relocation of shadow residents along with a proportional percentage of shadow employees. The percentage of shadow employees is computed using the scenario-specific ratio of EPZ employees to residents. For example, for Scenario 1 in Table 6-4, there are 13,350 resident vehicles and 594 employee vehicles. The ratio of employee vehicles to resident vehicles is equal to 4.45%. The shadow percentage for Scenario 1 in Table 6-3 is computed as follows:

$$30\% \times (1+4.45\%) = 31.34\%$$

Thus, as the number of employee vehicles changes, the shadow percentage changes. This explains why there are various shadow percentages in Table 6-3 and various values of evacuating shadow vehicles in Table 6-4.

As stated on page I-2, there are 29,520 resident vehicles in the Shadow Region. 30% of this value is 8,856 vehicles. Applying the 31% value from Table 6-3 to this value results in 9,250 vehicles which matches the entry for Scenario 1 in Table 6-4. As specified in the title of the third column of Table I-2, the numbers presented are shadow residents only.

F.2. See the response to RAI ETE-12, part B.

F.3. As discussed in the response to RAI ETE-10, part E, question 2, the simultaneous evacuation of the Crystal River Nuclear Plant (CRNP) EPZ and the Levy Nuclear Plant (LNP) EPZ presents an interesting situation for those people who reside in between the two plants (mostly Yankeetown and Inglis residents). For an evacuation of the LNP EPZ, those residents would evacuate southbound on US Highway 19/98 and would be loaded as such in the ETE simulation. For an evacuation of the CRNP EPZ, those residents would evacuate northbound on US Highway 19/98 and would be loaded as such in the ETE simulation. If both EPZs were to evacuate simultaneously, these residents would have to evacuate eastbound on State Highway 40 towards Dunnellon so as to not move closer to either plant while evacuating. These residents were loaded onto the analysis network as such for the sensitivity study conducted in response to RAI ETE-10, part E, question 2.

It is assumed that "traffic timing" refers to "traffic signal timing". The routing of Yankeetown and Inglis residents towards Dunnellon overwhelms the signal at the intersection of State Highway 40 and US Highway 41. As shown in Figures 7-3 and 7-4, the approaches to this signal are already congested for an evacuation of only the LNP EPZ. Re-routing Yankeetown and Inglis towards Dunnellon intensifies this congestion and increases ETE. The signals in the Dunnellon area would likely have to be manned as traffic control points (TCP) in the event of a simultaneous evacuation of both EPZs in order to efficiently move evacuee traffic. Figure G-2 of the ETE report identifies a number of suggested TCP in the Dunnellon area.

Associated Levy COL Application Revisions:

The following change will be incorporated in a future revision of the Levy COLA:

- Add the following sentence to the end of the first paragraph in Section 7.1:

  The shadow vehicles are loaded on the link-node analysis network (Figure 1-2) using the same trip generation times as EPZ residents with Commuters (See Distribution C in Table 5-1).

Attachments/Enclosures:

None.

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-14 (ETE-13)

ETE-13: Analysis of Evacuation Times, Methodology, Total Evacuation Times
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section IV.B.1

A. Page ES-3 states that evacuation trips were generated at locations called zonal centroids. Provide a map which identifies where these zonal centroids were located in the model.

B. Section 4, "Estimation of Highway Capacity," (page 4-1) describes the modeling of intersections and states that control at critical intersections will often be provided by traffic control personnel.

1. Clarify how traffic control, which may supersede traffic control devices, affects the modeling parameters used in the calculations.
2. Clarify any assumptions on traffic speed, service flow, capacity, and queue discharge through a staffed intersection.
3. Clarify the impact on traffic timing and traffic loading if Crystal River Nuclear Plant had an evacuation at the same time as LNP.

C. In the last row of the table on page 5-3, the event sequence for the "Prepare to leave for evacuation trip" is identified as 2, 4→5. This implies that after Awareness (Step 2), residents Arrive Home (Step 4). Clarify whether an activity Depart place of work (Step 3) should also be included in this sequence.

D. Section 5, "Estimation of Trip Generation Times," provides the process used to develop an estimation of trip generation time of mobilization for different subgroups of the population by summing time distribution for events. As mentioned in Section 3, under "Transient Population" (Page 3-7), the transient population includes boaters and divers that may be on Lake Rousseau and on the Gulf of Mexico. Provide trip generation time elements for the transient population.

E. Section 5, Page 5-4 states that 85% of the population within the plume exposure pathway EPZ will become aware of the accident within 30 minutes. Provide the basis for this statement.

F. Figure F-11, "Time to Prepare Home for Evacuation," (Page F-10) indicates that as much as 360 minutes, or 6 hours, are required for the maximum time needed for the last individuals to prepare to evacuate. They must then travel out of the plume exposure pathway EPZ. Table 7-1D, "Time to Clear the Indicated Area of 100 Percent of the Affected Population," (Page 7-10) indicates the longest evacuation time is 5 hours and 10 minutes. Clarify how the data in Figure F-11 was used in the development of the Evacuation Time Estimate.

PGN RAI ID #: L-0235

PGN Response to NRC RAI:

A. Figure 1 (provided as a separate PDF file) identifies the zonal centroids where population were loaded onto the analysis network. Due to the amount of detail in the map, a large scale (4 foot by 3 foot) version of the file was exported using ArcMap Geographical Information Systems (GIS) software. The polygons shown in the figure group Census blockpop centroids and load them onto the nearest accessible roadway. (The Census blockpop centroid places a point at the center of each Census block and assumes the block population is concentrated at that point.) The attributes of each polygon were exported and can be accessed using Adobe Reader. In Adobe Reader, click on the "View" menu, then navigate to "Toolbars" and select "Object Data". Then using the object data tool click on the border of a polygon 3 times (the first click identifies the layer, the second click identifies the sub layer "Sources" and the third click identifies the specific polygon that is click on). On the third click, the attributes for that polygon will be displayed on the left side of the screen. The attributes include an identification (ID) number, the upstream node number ("FrmNode") and downstream node number ("ToNode") of the link loaded in the analysis network and the Year 2000 population ("Pop2000") loaded on the link. These population loading data were exported to an Excel spreadsheet where growth rates were applied to extrapolate population to Year 2007. This population was then divided by the average household size provided in Figure F-1 of the ETE report and then multiplied by the average number of evacuating vehicles per household provided in Figure F-8 of the ETE report in order to estimate the number of vehicles loaded onto each link.

B.1,2. Traffic control points are modeled as traffic signals with a reasonable (for evacuation purposes) allocation of effective green time to each of the competing traffic streams. See the response to RAI ETE-3, Parts B and C for further information.

B.3. Please see the response to RAI ETE-12, part F, question number 3.

C. An Event is a 'state' that exists at a point in time (e.g., depart work, arrive home). An Activity is a 'process' that takes place over some elapsed time (e.g., prepare to leave work, travel home).

As such, an Activity changes the 'state' of an individual (e.g. the activity, 'travel home' changes the state from being at work to being at home). Therefore, an Activity can be described as an 'Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next and are described as statistical distributions in Section 5 of the ETE report.

The activity in question "prepare to leave to evacuate" changes the state from being at home to getting in the vehicle and beginning the evacuation trip. All activities (other than notification) are dependent on the evacuee being aware of the situation, which is why event number 2 has been included in the last three activities in the table on page 5-3. No action can be taken if the evacuee is unaware of the incident. The "prepare to leave to evacuate" activity is dependent on the person being at home which would mean they were already home or that the travel home activity has already been completed. Therefore, the activity "Depart place of work (Step 3)" will not be added to the "Prepare to leave for evacuation trip" sequence.

As stated in the second paragraph on page 5-4, event number 5 depends, in a complicated way, on the time distributions of all activities preceding that event. The table on page 5-3 is intended to provide the definition of each individual activity; for simplicity, all preceding dependent events (excluding event 2) have not been included in this table. A revised version of Figure 5-1 is provided as an attachment to the response to RAI ETE-5. A description of events and activities will be added to Section 5 in the revised ETE report.

D. Refer to the response to RAI ETE-5, part B for the notification of those who may be boating or diving in the EPZ. As shown in Table 5-1 of the ETE report, transient mobilization time (Distribution A) extends over a period of 2 hours, with 78% of transients mobilizing in the first hour and the remaining 22% in the last hour. It is reasonable to expect that 2 hours will be sufficient time for those who are boating or diving in the area to return to the shore and begin their evacuation trip.

E. The Notification distribution is assumed based on the presence of the siren alert system. This assumption will be added to Section 2 of the ETE report and the discussion of notification on page 5-4 will be modified to indicate that the distribution is assumed.

Page VI-27 of the Levy Nuclear Plant Site Plan (Appendix VI of Annex A to the State of Florida Radiological Emergency Management Plan) states that notification of the public will be completed within 45 minutes of an incident. The assumed distribution in the ETE report indicates that 98% of the EPZ population will be notified within 45 minutes, with the remaining 2% notified within 5 additional minutes. Thus, the assumed distribution is in good agreement with the county assumptions.

F. As shown in Figure F-11, 97.1% of those surveyed would be able to prepare the home and depart for an evacuation trip within 4 hours. The remaining 2.9% would require an additional 2 hours to complete this activity. This distribution was "truncated" to avoid the bias of those relatively few stragglers who take significantly longer to mobilize. In "truncating" these distributions, the mobilization of the stragglers is advanced. Therefore, the stragglers are not eliminated from the ETE. See the response to RAI ETE-2, part B for additional detail on the truncation procedure.

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- Assumption 12 will be added to Section 2.3 of the ETE report:

  Based on the presence of the siren system within the EPZ, it is assumed that 85 percent of the EPZ population will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes.

- The discussion of Time Distribution No. 1 on page 5-4 will be revised as follows:

  Based on the presence of the siren system within the EPZ, ~~I~~it is ~~reasonable to expect~~ assumed that 85 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes.

- The following text will be added at the top of page 5-4:

  - An Event is a 'state' that exists at a point in time (e.g., depart work, arrive home)

  - An Activity is a 'process' that takes place over some elapsed time (e.g., prepare to leave work, travel home)

    As such, an Activity changes the 'state' of an individual (e.g. the activity, 'travel home' changes the state from 'depart work' to 'arrive home'). Therefore, an Activity can be described as an 'Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next and are described as statistical distributions on the following pages.

Attachments/Enclosures:

Figure 1: "Population Loading within the Levy Nuclear Plant EPZ" provided separately as a large-scale PDF file [see attached CD].

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-15 (ETE-14)

Text of NRC RAI:

ETE-14: Analysis of Evacuation Times, Methodology, Traffic Congestion
Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section IV.B.3

A. The longest evacuation time for 100% of the Evacuation Time Estimate (ETE) is 5 hours and 10 minutes in Table 7-1D, "Time to Clear the Indicated Area of 100% of the Affected Population". .

1. Section 5, Distribution #2," Prepare to Leave Work," (Page 5-6) indicates that 100% prepare to leave in 100 minutes. Discuss how the 100 minute value was derived when Appendix F, "Telephone Survey", states on Page F-8 that this activity is completed in approximately 120 minutes and shows a curve extending to 150 minutes.
2. Section 5, Distribution #3, "Travel Home," (Page 5-7) shows that 100 percent of the population has traveled home in 120 minutes. Clarify how the 120 minutes was derived when Figure F-10, "Work to Home Travel," (Page F-9) indicates that less than 100% have traveled home in 120 minutes, and the curve for this figure projects to 150 minutes.
3. Figure F-11, "Time to Prepare Home for Evacuation," (Page F-10) indicates that it takes as long as 360 minutes to prepare to evacuate. Distribution # 4, "Prepare to leave Home," (Page 5-8) indicates that 100% of the people are prepared to leave home in 210 minutes.
   a. Discuss the differences in the data between Appendix F and Section 5.
   b. Clarify the statement under Distribution #4 (Page 5-8), "These data are provided directly from the survey."
4. If necessary, reconcile Figure 5-2, "Evacuation Mobilization Activities," and Figure 5-3, "Comparison of Trip Generation Distributions," with the comments on use of telephone survey data.

B. Clarify why Figure 7-7, "Evacuation Time Estimates Winter, Weekend, Midday, Good Weather (Scenario 8)," was not projected to include 100% of the population.

C. Table 8-1, "Transit Dependent Population Estimates," states that the survey percent of households with commuters is 45%. However, if you take 0.7 commuters per household (Figure F-6, Page F-6) multiplied by 10,150 households, that would result in 7105 commuters in the ETE, which is 31% of the population (22,758 from Page 8-10). Clarify how a value of 45% was derived in Table 8-1.

D. Provide queuing locations and estimated delay times on the maps in Figures 7-3, "Congestion Patterns at 1 Hour after the Order to Evacuate (Scenario 8)," through Figure 7-6,"Congestion Patterns at 2 Hours 30 Minutes after the Order to Evacuate (Scenario 8)."

E. In Section 8-1, "Transit Dependent People-Demand Estimates" (Page 8-2) clarify how a 50% increase in demand for buses could still be accommodated if buses are assumed to be at 68% capacity.

PGN RAI ID #: L-0236

PGN Response to NRC RAI:

A.1. As shown in Figure F-9, 98.4% of those households surveyed would be able to prepare to leave work/school within 90 minutes. 1.3% of the households surveyed would require an additional 30 minutes, while the remaining 0.3% would require an additional 60 minutes to complete this activity. This distribution was "truncated" to 100 minutes to avoid the bias of those relatively few stragglers who take significantly longer to mobilize. In "truncating" these distributions, the mobilization of the stragglers is advanced. Therefore, the stragglers are not eliminated from the ETE. See the response to RAI ETE-2, part B for additional detail on the truncation procedure.

A.2. As shown in Figure F-10, 97.8% of those surveyed would be able to travel home from work within 120 minutes. The remaining 2.2% would require an additional 30 minutes to complete this activity. This distribution was truncated to 120 minutes to avoid the bias of those relatively few stragglers who take significantly longer to mobilize. In "truncating" these distributions, the mobilization of the stragglers is advanced. Therefore, the stragglers are not eliminated from the ETE. See the response to RAI ETE-2, part B for additional detail on the truncation procedure.

A.3a. As discussed in the response to RAI ETE-2, part B, Appendix F presents the raw telephone survey data. Section 5 of the ETE report presents the trip generation for the EPZ population which includes some truncation of the distributions presented in Appendix F. A new appendix (Appendix M) will be added to the report which describes this truncation procedure. This new appendix is attached to the response to RAI ETE-2.

A.3b. This statement is used under Distribution #3 on page 5-7 and under Distribution #4 on page 5-8. As noted in the response to part 3a above, the distributions provided in Section 5 of the ETE report are truncated from the raw distributions presented in Appendix F. The statement "[t]hese data are provided directly by the telephone survey", on pages 5-7 and 5-8 will be revised accordingly.

A.4. No changes are needed to Figures 5-2 and 5-3. Appendix M will be added and will be referenced in Section 5 of the ETE report to explain the differences between the raw distributions presented in Appendix F and the final distributions presented in Section 5.

B. The Evacuation Time Estimate is defined as the elapsed time after the advisory to evacuate (ATE) when the last person exits the EPZ. Based on this definition, Figure 7-7, which plots evacuating vehicles versus elapsed time after the ATE, ends at the 100th percentile when the last vehicle has exited the EPZ. Therefore, the endpoint of each curve is the 100th percentile. As shown in Figure 7-7, the entire EPZ is clear at 5:10 (hr:min) ATE, which agrees with the value presented in Table 7-1D for an evacuation of Region R03 during Scenario 8 conditions. Figures J-1 through J-11 in Appendix J are presented in the same fashion; the endpoint of each curve is the 100th percentile ETE.

C. Figure F-6 indicates that 55% of the households surveyed have 0 commuters. Therefore, 45% (100% - 55%) of households have at least 1 commuter. These values are also indicated in Table 6-3 for scenarios 1, 2, 6 and 7, which are weekday scenarios when the full workforce will be working. Table 1 below summarizes the responses provided in the telephone survey for the number of commuters in the household question (see Question 6 on page F-13 of the ETE report).

Table 1. Telephone Survey – Responses to Question 6		
Number of Commuters in Household	Number of Households	Percent of Households
0	303	55.2%
1	143	26.0%
2	76	13.8%
3	16	2.9%
4+	11	2.0%
TOTAL	549	100.0%

The weighted average of the numbers presented in Table 1 is 0.70 commuters per household; however, note that Table 1 indicates that the majority of households (55%) do not have any commuters. The analysis presented by the NRC in the wording of this question focuses on the percentage of population, whereas Table 6-3 is discussing the percentage of households, which comes directly from the telephone survey responses shown in Table 1.

As indicated in the title of Table 6-4, the values shown in the table are the vehicles evacuating for each scenario. Focusing on Scenario 1, there are 7,330 vehicles for households with no commuters. As shown on page 3-2 of the ETE report, the average household size of 2.25 persons and the average number of evacuating vehicles per household of 1.32 (see response to RAI ETE-4) were used to estimate the number of evacuating vehicles. Applying these factors to the estimate in Table 6-4 results in:

$$7330 vehicles \times \frac{1\ household}{1.32\ vehicles} \times \frac{2.25\ people}{1\ household} = \frac{12494 people}{22758\ EPZ\ Population} = 55\%$$

The ETE computations used the percentage of households with a commuter (45%) and households without a commuter (55%) only; the value of 0.70 commuters per households was not used.

D. Figures 7-3 through 7-6 have been revised as attached (see pages 107 through 110) and will be included in a future revision of the ETE report. The major roads in the study area have been identified on the map. The major congestion points in the study area have been labeled with an identification number (CP # = Congestion Point #). Table 7-3 (attached; see page 106) provides a description of each congestion point and the link from Figure 1-2 corresponding to that area of congestion. Estimates of the average delay in minutes per vehicle are provided in Table 7-3 for each of the congestion points. The delay presented is over the previous 10 minutes of simulation. For example, Figure 7-3 shows the congestion patterns at 1 hour after the Advisory to Evacuate for an evacuation of the entire EPZ (Region R03) during Scenario 8 conditions. The average delay for each link provided in the table (column 5) applies to the 10-minute time interval from 50 to 60 minutes after the Advisory to Evacuate. Therefore, the vehicles occupying the link from node 281 to node 280 experience an average delay of 2.0 minutes during this 10-minute interval.

E. As discussed in the second to last paragraph on page 8-2 of the ETE report, it is assumed that transit buses have an average occupancy of 30 persons and a capacity of 40 persons. It is further assumed that 2/3 of the 30 passengers are adults and that 1/3 are children. Children take up less space in a seat than an adult. It is shown on page 8-2 that the 30 passengers occupy 27 seats. A 50 percent increase in demand is equivalent to applying a factor of 1.5 to the estimated demand. As shown in the calculation below, the product of 1.5 and the average load factor is 1.00 – that is, a fully occupied bus. This calculation will be added before the final paragraph on page 8-2 in the revised ETE report.

$$\left(20+\left(\frac{2}{3}\times 10\right)\right)\div 40\times 1.5=1.00$$

Associated Levy COL Application Revisions:

The following changes will be incorporated in a future revision of the Levy COLA:

- Replace the paragraph on page 5-11 with the following:

  ~~Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, and D, properly displaced with respect to one another, are tabulated in Table 5-1 (Distribution B, Arrive Home, omitted for clarity).~~
  As shown in Figure 5-2 and in Appendix F, the mobilization activity distributions have long tails. Combining multiple distributions with long tails results in a distribution with an even longer tail. Thus, the 100th percentile of the combined distribution is indistinct and difficult to quantify. Given these characteristics, a statistical analysis on the mobilization distributions was performed to quantify a "confidence band" about the distribution. This band serves as the basis for establishing the point in time where the long tail should be "truncated".

  The ETE for the vast majority of evacuees should not be distorted for those few stragglers (typically less than 2 percent of households) who take considerably longer to prepare to evacuate. As such, the combined distributions are "truncated" to avoid biasing the ETE. In "truncating" these distributions, the mobilization of the stragglers is advanced. Therefore, the stragglers are not eliminated from the ETE. Appendix F presents the raw distributions for the various mobilization activities. Appendix M describes the statistical analysis used to "truncate" the resultant distributions.

  Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. Comparison of the distributions in Appendix F with those in Figures 5-2 and 5-3 indicates that the combined distributions are somewhat shorter (5 hours) than the individual distributions (up to 6 hours). This is a result of the aforementioned "truncation" procedure.

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

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

- Replace the text on page 5-7 with the following:

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

The distribution of time to travel home from work/school is provided in the table below. This distribution is plotted in Figure 5-2.

- Replace the text on page 5-8 with the following:

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

  The distribution of time to prepare the home before departing on the evacuation trip is provided in the table below. This distribution is plotted in Figure 5-2.

- Replace Figures 7-3 through 7-6 with the attached revised figures (see pages 107 through 110).
- Table 7-3 will be added on page 7-12 of the ETE report (see page 106).
- Add Table 7-3 to page v of the Table of Contents.
- Insert the following calculation before the final paragraph on page 8-2:

$$\left(20+\left(\frac{2}{3}\times 10\right)\right)\div 40\times 1.5=1.00$$

Attachments/Enclosures:

None.

Table 7-3. Average Delay for Selected Roadways in the Levy Nuclear Plant EPZ

CP #	Link From Node	Link To Node	Roadway	Average Delay per Vehicle (min/veh) at Indicated Time After the Advisory to Evacuate (hr:min) 1:00	1:30	2:00	2:30
1	148	144	West Dunnelon Rd Eastbound	0.0	0.0	0.0	0.0
2	286	143	State Route 40 Eastbound	3.6	2.3	0.0	0.0
3	143	145	State Route 484 Eastbound	2.3	2.2	0.1	0.0
4	281	280	US Highway 41 Northbound	2.0	6.2	1.9	0.0
5	14	58	US Highway 19 / US Highway 98 Southbound	0.0	0.0	0.0	0.0
6	27	28	US Highway 19 / US Highway 98 Northbound	0.0	0.0	0.0	0.0
7	70	19	State Route 40 Eastbound (Yankeetown evacuees)	3.4	0.0	0.0	0.0
8	331	19	State Route 40 Westbound (Inglis evacuees)	3.4	0.0	0.0	0.0

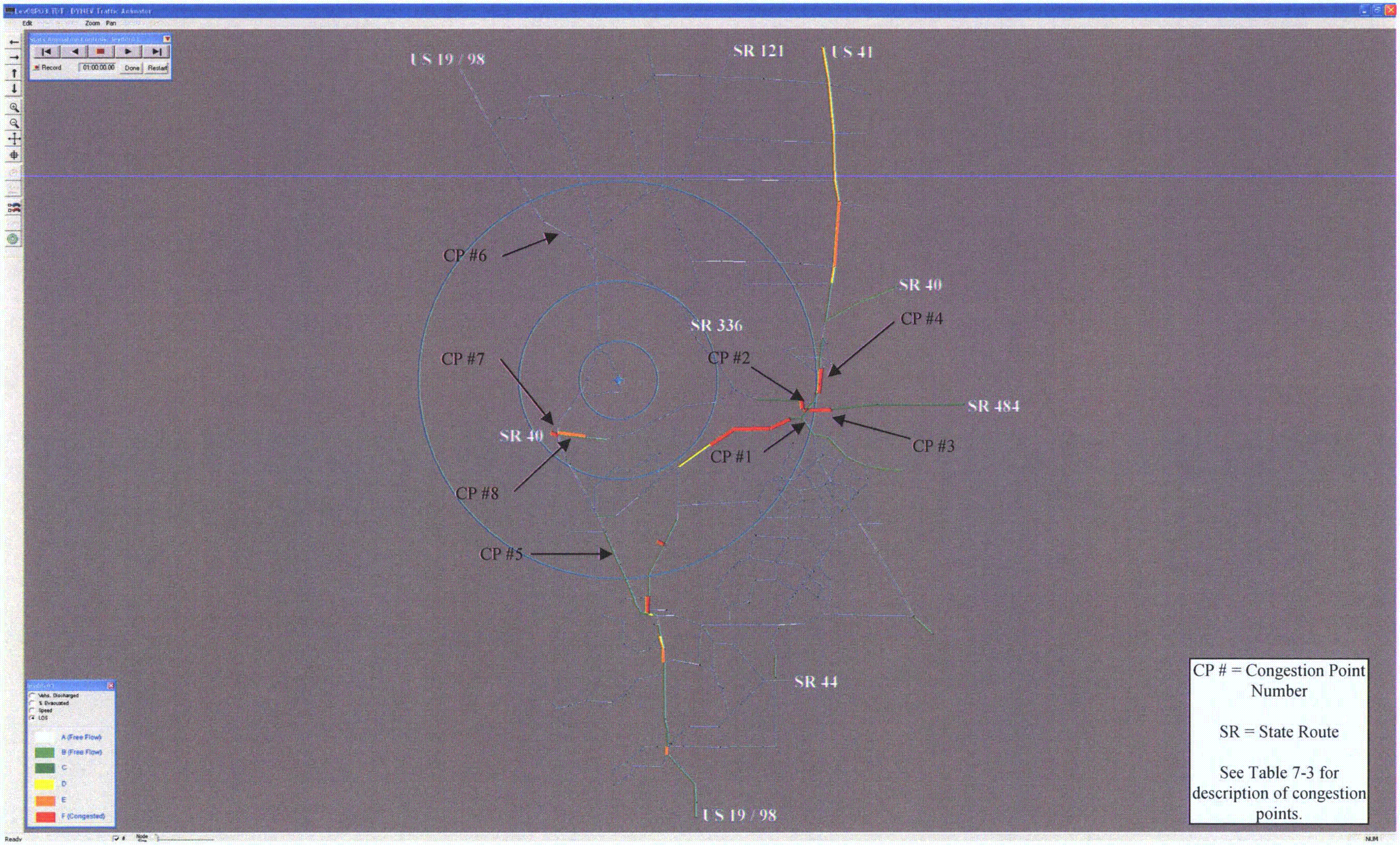


Figure 7-3. Congestion Patterns at 1 Hour After the Advisory to Evacuate (Scenario 8)

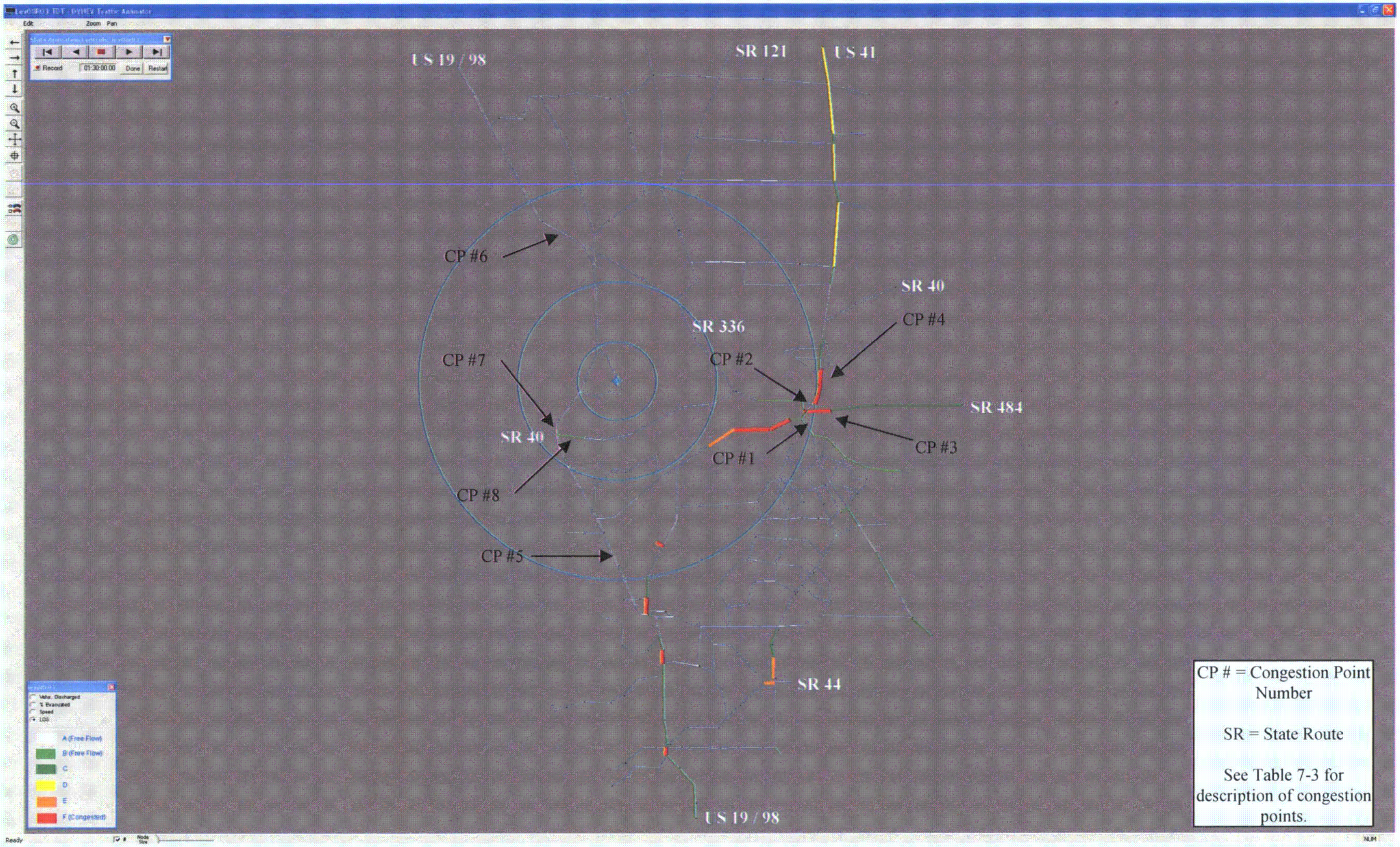


Figure 7-4. Congestion Patterns at 1 Hour, 30 Minutes After the Advisory to Evacuate (Scenario 8)

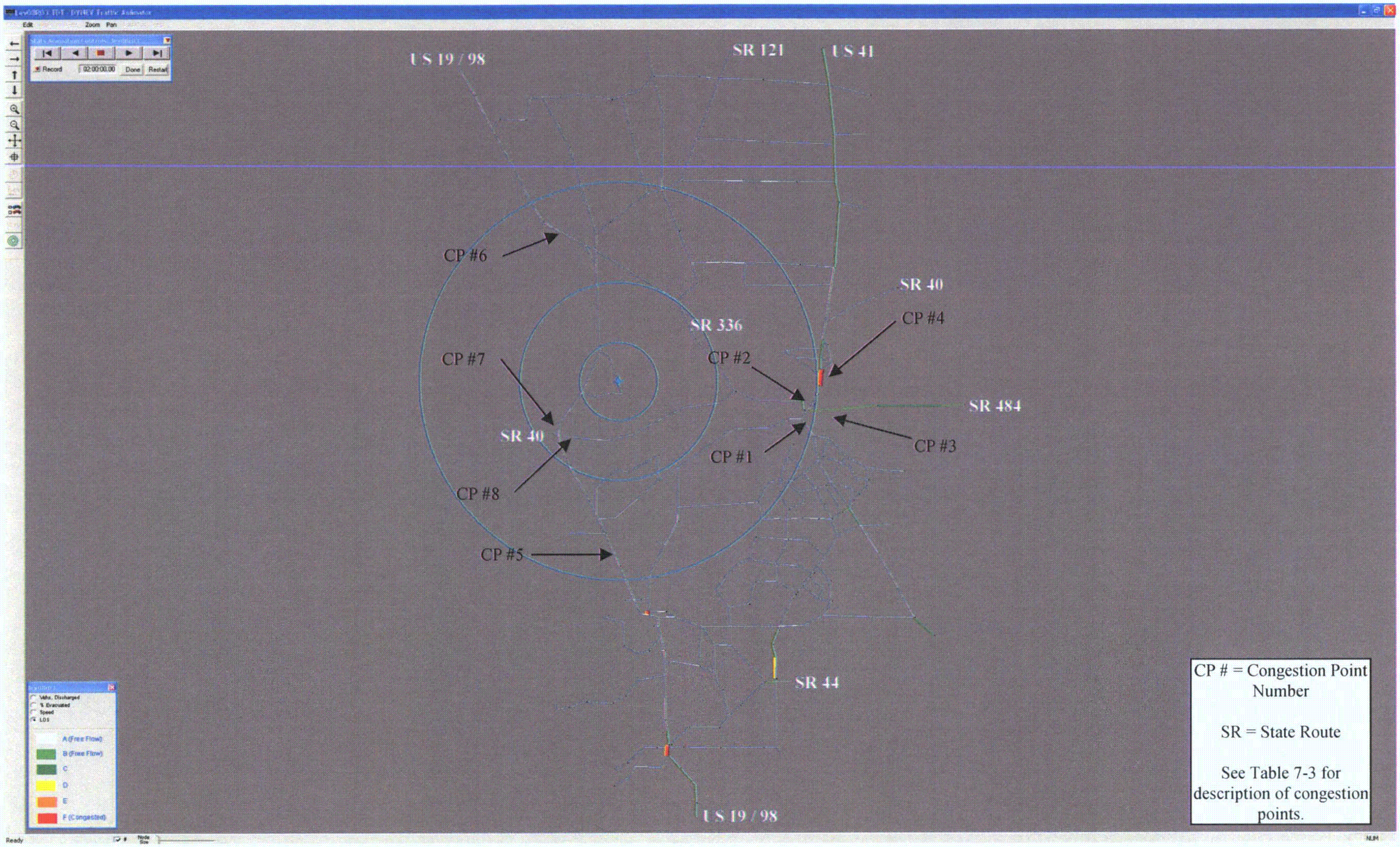


Figure 7-5. Congestion Patterns at 2 Hours After the Advisory to Evacuate (Scenario 8)

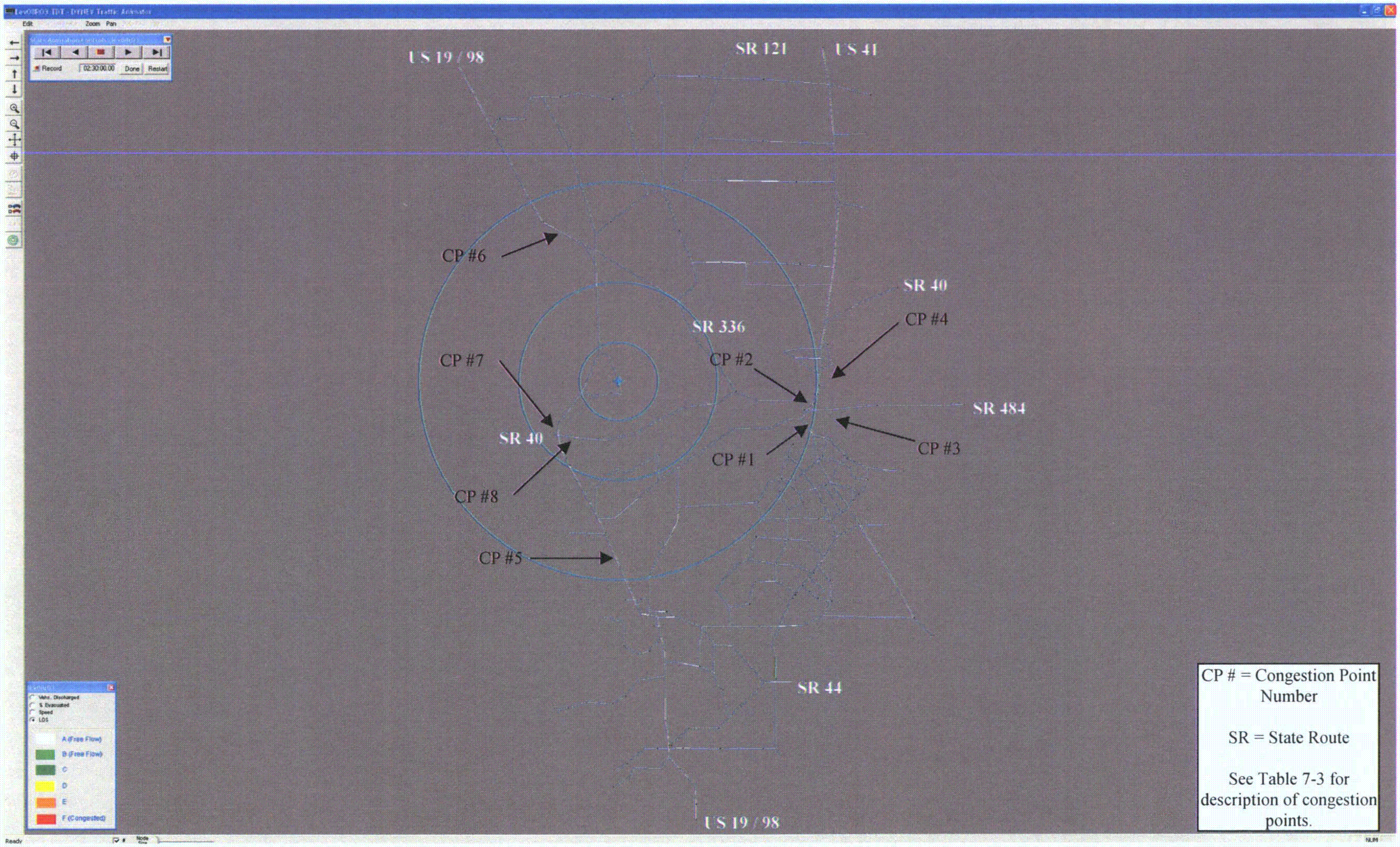


Figure 7-6. Congestion Patterns at 2 Hours, 30 Minutes After the Advisory to Evacuate (Scenario 8)

NRC Letter Number: LEVY-RAI-LTR-028

NRC Letter Date: May 8, 2009

NRC Review of Final Safety Analysis Report

NRC RAI #: 13.03-16 (ETE-15)

Text of NRC RAI:

ETE-15: Other Requirements, Draft Review

Acceptance Criteria: Requirements A and H; Acceptance Criterion 11
Regulatory Basis: Appendix 4 to NUREG-0654 Section V.C

A. In the "Executive Summary," (page ES-1) it states that the survey instrument was reviewed and modified by State and county personnel prior to the survey. The "Executive Summary," (page ES-4) states that the traffic management plan was also reviewed with State and local law enforcement personnel. The "Introduction" (Page 1-1) states that directors and staff members of the Levy County, Marion County, and Citrus County emergency management agencies, local and state law enforcement, and planning agencies provided valued guidance and information contained in this report. Provide information on State and local emergency planning agency consultations and comments.

PGN RAI ID #: L-0237

PGN Response to NRC RAI:

A. A draft telephone survey instrument was provided to the EPZ counties (Citrus, Levy and Marion) and the State of Florida at the kickoff meeting held on February 14, 2007. Comments were provided at the meeting and in e-mails in the weeks after the meeting. These comments were addressed and a revised telephone survey instrument was sent to the EPZ counties and the State of Florida. Final approval was given from all offsite agencies before beginning the telephone survey.

A meeting to discuss the preliminary results of the ETE study was held on August 8, 2007. Representatives from Progress Energy, from the EPZ county emergency management agencies and from local law enforcement agencies were in attendance. A draft ETE report was provided to the county emergency management agencies prior to the meeting. Comments were provided at the meeting and were incorporated into the final ETE report.

The traffic control documentation (Section 9 and Appendix G) in the ETE report was provided to the law enforcement representatives at the meeting for their review. Law enforcement representatives were present from the following agencies:

- Crystal River Police Department
- Levy County Sheriff's Office
- Citrus County Sheriff's Office
- Inglis Police Department
- Marion County Sheriff's Office

Comments and suggested revisions from each of these agencies were provided on August 27, 2007. These comments and revisions were incorporated into the final versions of Section 9 and Appendix G.

The signed certification letters from each EPZ county and from the State of Florida included in the COL verify that the offsite agencies approved the ETE document, including the traffic management plan as provided in Section 9 and Appendix G and the telephone survey instrument as provided in Appendix F of the ETE document.

Associated Levy COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

None.

<u>List of Attachments:</u>

1. NRC RAI # 13.03-3 [ETE-2] (PGN RAI ID # L-0224):

   Appendix M – "Procedure for Estimating Mobilization Time Based upon Survey Data" [13 pages]

2. NRC RAI # 13.03-3 [ETE-2] (PGN RAI ID # L-0224):

   Figure 1-2 – "Levy Nuclear Plant Link-Node Analysis Network" provided separately as a large scale electronic file in PDF format [on attached CD]

3. NRC RAI # 13.03-14 [ETE-13] (PGN RAI ID # L-0235):

   Figure 1: "Population Loading within the Levy Nuclear Plant EPZ" provided separately as a large-scale PDF file [on attached CD]

4. Pre-flight Report for attachments 2 & 3 above [1 page]

APPENDIX M

Procedure for Estimating Mobilization Time Based upon Survey Data

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

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

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

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

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

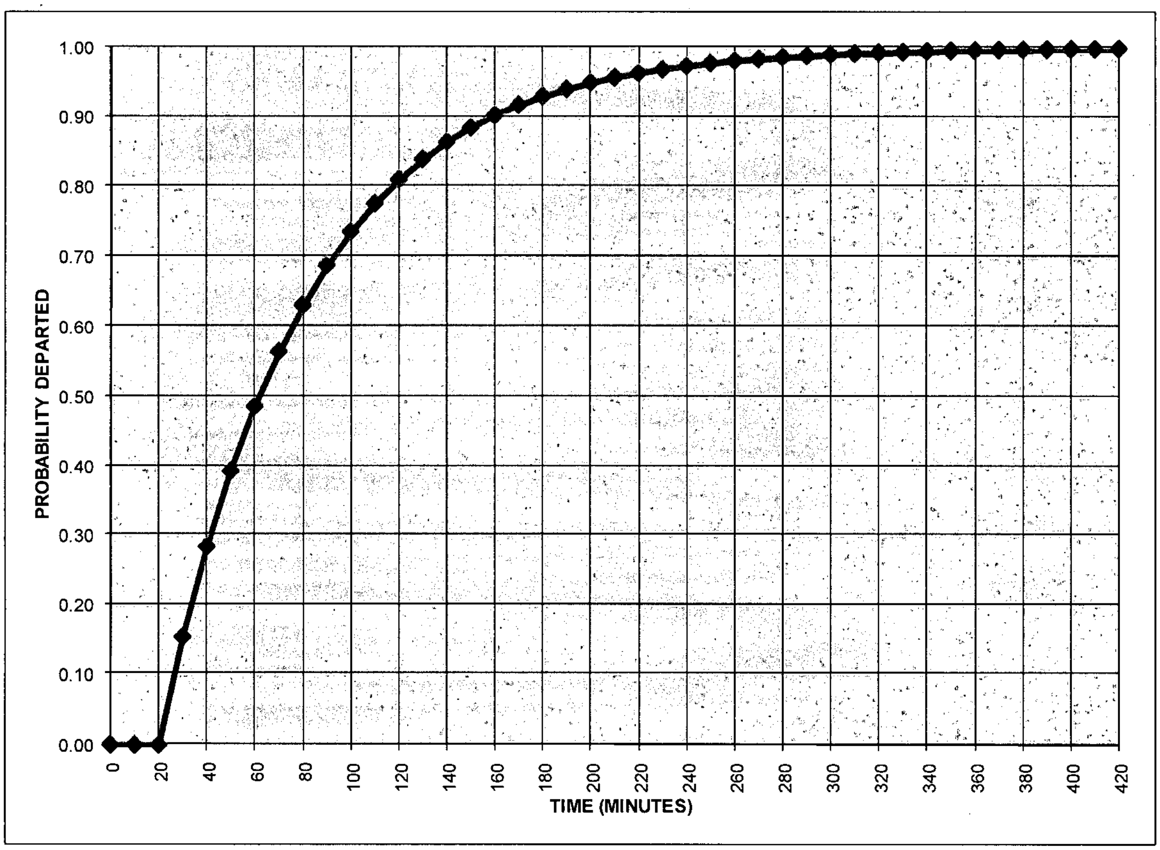


Figure 1: Common Representation of Underlying Behavior

The form of the relation shown in Figure 1 is

$$P_R(\text{departure time} \le t) = F(t) = \{1 - e^{-(t-T_0)/\tau}\} \quad \text{for } t \ge T_0$$

$$= 0 \quad \text{for } t < T_0 \qquad (1)$$

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

The relation can also be read as "the percentage of vehicles departed by time 't'".

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

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

This can be read as "the relative probability of departing at time 't'". The probability of departing in the interval {t, t + Δt} is approximately $p(t) \simeq f(t)\, \Delta t$.

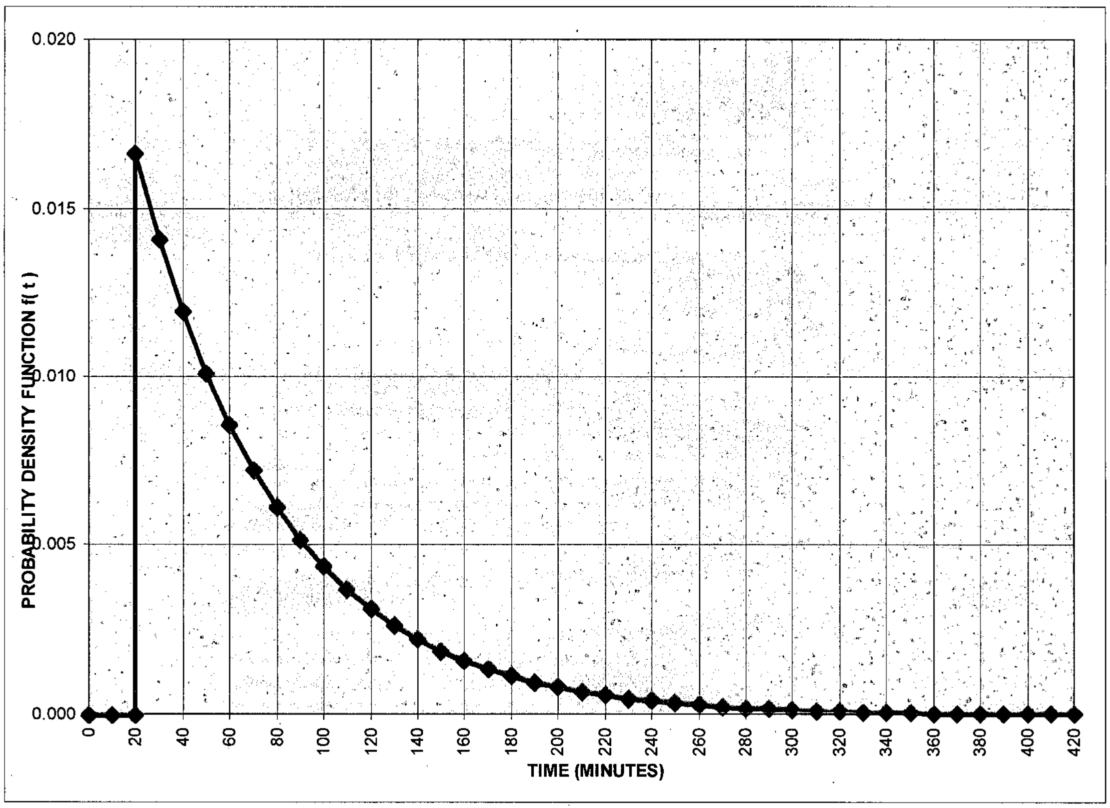


Figure 2: The probability density function f(t) Related to Figure 1

Estimating T_0

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

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

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

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

Time Constant and Settling Time

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

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

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

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

Therefore, as a key element of this procedure is to identify "τ", you will seek to establish the point at which the 1.8% threshold is passed in plots such as Figure 2, or the 98.2% threshold is passed in plots such as Figure 1 (shifted, in both cases).

The identification may be done by reference to the cumulative data plot (usually aggregated by category, from the survey) or by reference to a smooth exponential curve through that data.

Given that you are working with the curve up to the 4τ time, it can be truncated (brought to 100%) at any point thereafter.

For clarity:

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

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

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

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

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

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

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

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

{ (estimated mean mobilization time) - T_0 },

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

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

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

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

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

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

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

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

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

Note that the 95% confidence bound range on this estimate of the mean is from 52.7 to 65.7 minutes. A hypothesis that the mean is any value in this range would not be rejected[2].

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

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

A Goodness-of-Fit Test for the Hypothesized Curve

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

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

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

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

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

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

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

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

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

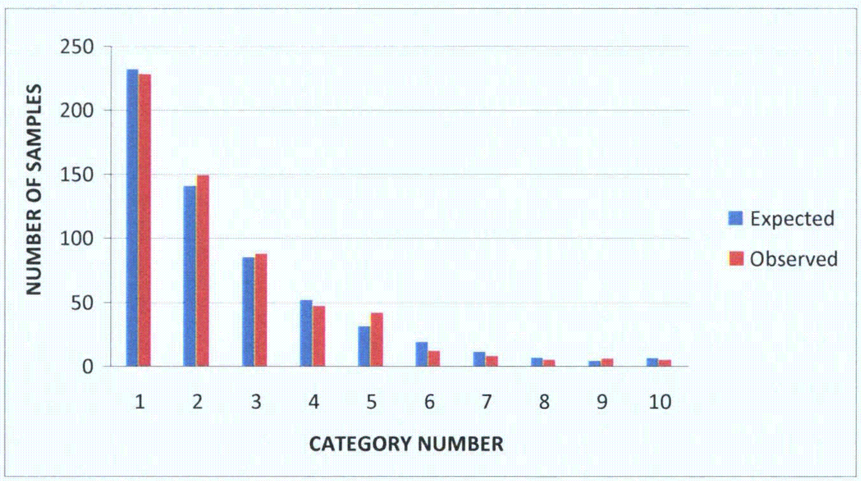
CHI-SQUARE TEST ON EXPONENTIAL DISTRIBUTION OF MOBILIZATION TIMES

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

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

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

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



HYPOTHESIS: UNDERLYING DISTRIBUTION IS EXPONENTIAL, WITH PARAMETERS SHOWN

CONCLUSION

DO NOT REJECT HYPOTHESIS

implication: use the exponential relation

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

Another Graphical Display, Involving the Natural Logarithm

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

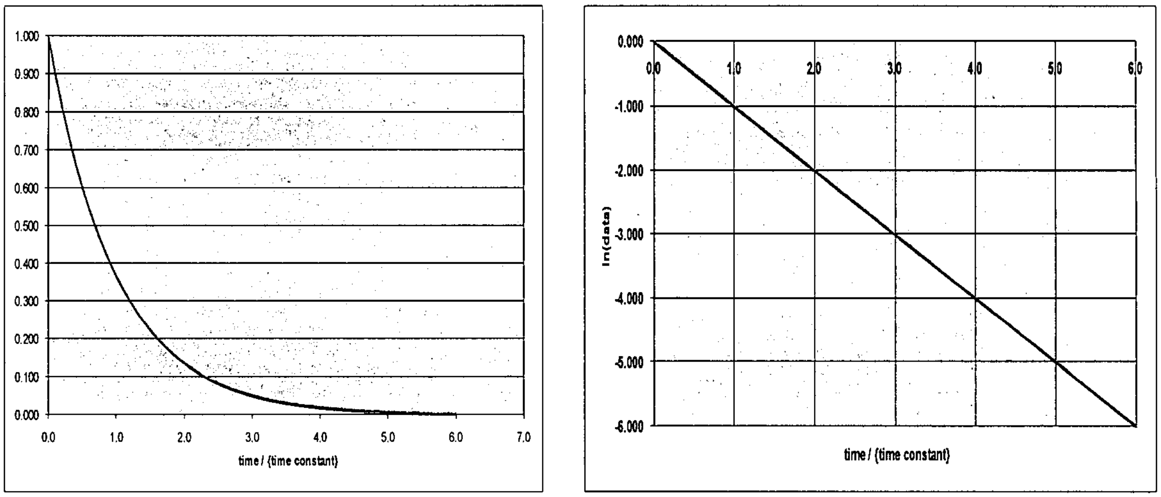
$$\ell n\{ f(t) \} = -\{ t / \tau \} + \ell n \{ 1 / \tau \}$$

or (3)

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

where "b" is actually " – A" or " -1 / τ "

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



a) f(t) versus t/τ b) ℓn{ f(t) }versus t/τ

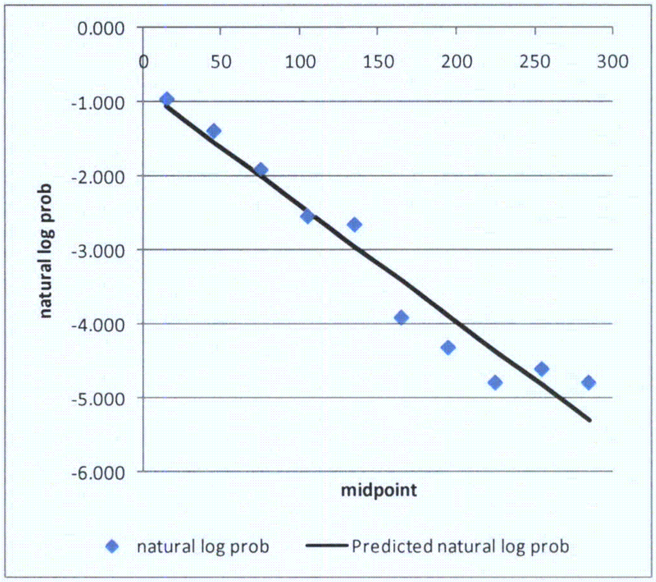
Figure 3: Plot of Exponential Function

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

Estimated time constant = 60.2 $\pm$ 11.7 minutes

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

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



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

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

This is rather consistent with the Method 2 estimate of 59.2 $\pm$ 6.5 minutes.

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

Table 3: Percentile Results, for Different Methods

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

Note: Add T_0 = 20 minutes for actual mobilization times

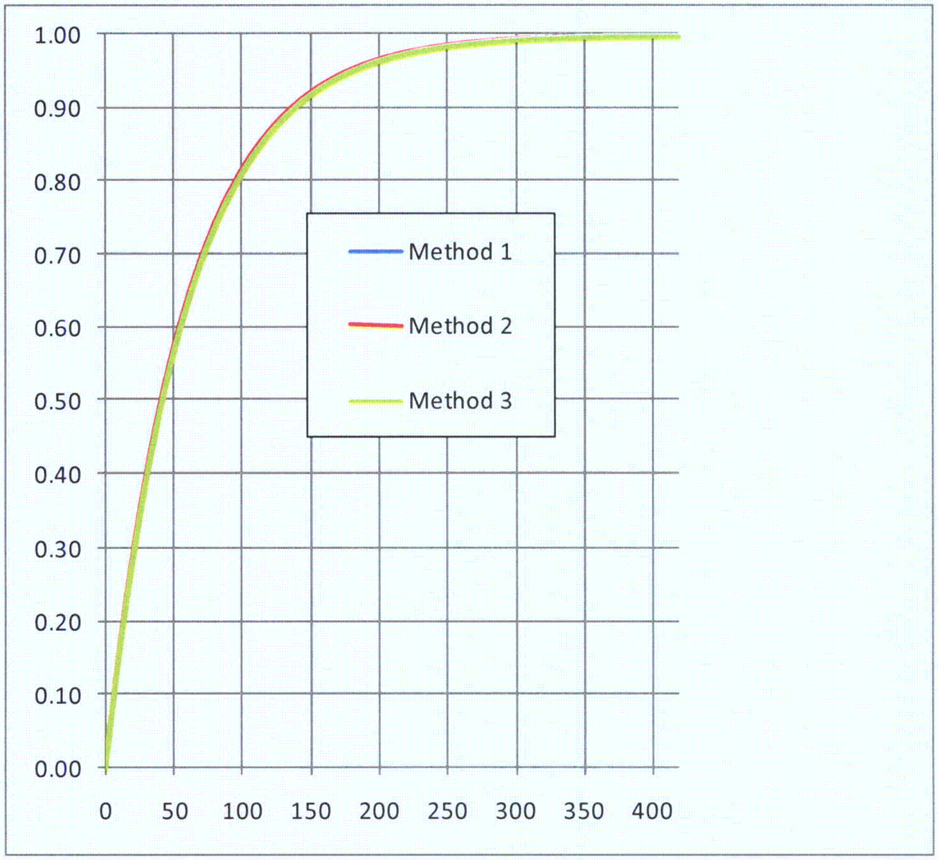


Figure 5: Comparison of Three Methods of Estimating τ

Insights and Guidance for the Analyst

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

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

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

4) All of the analysis and methods have focused on the most common model of a homogeneous population mobilizing. If there were more complex models (see the next section), the problem can be subdivided into "regimes" and the above techniques applied within each regime. Because this is not as common, the analyst should review such cases with the senior analyst and QC officer when they occur.

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

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

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

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

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

Other Model Forms

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

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

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

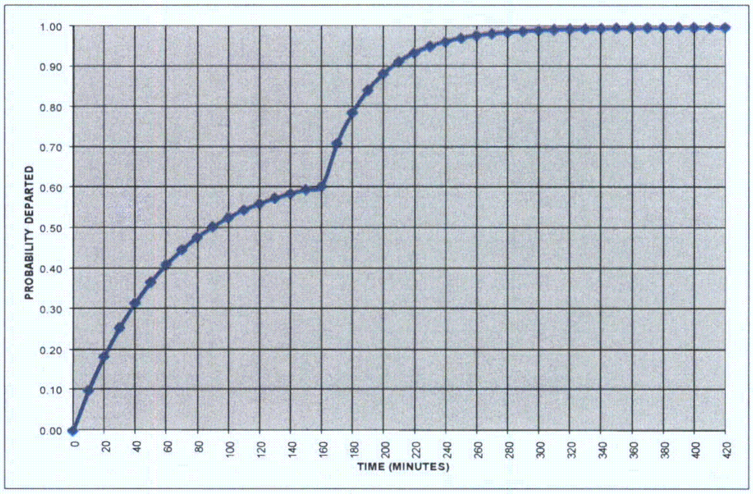


Figure 6: 2-Regime Model

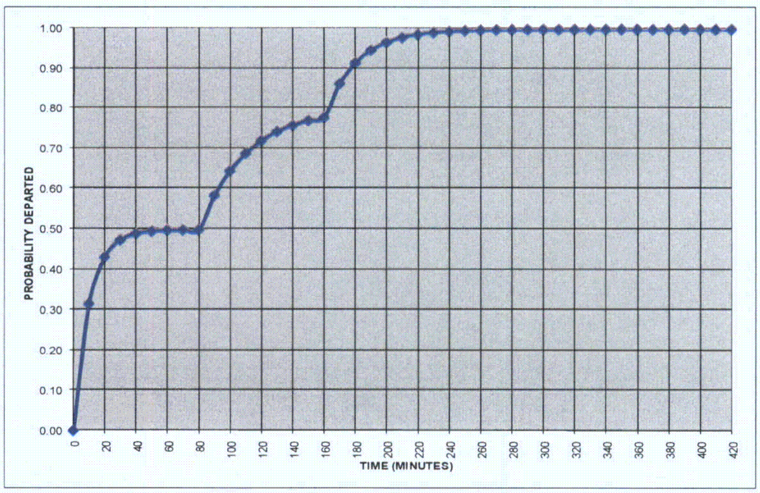


Figure 7: 3-Regime Model

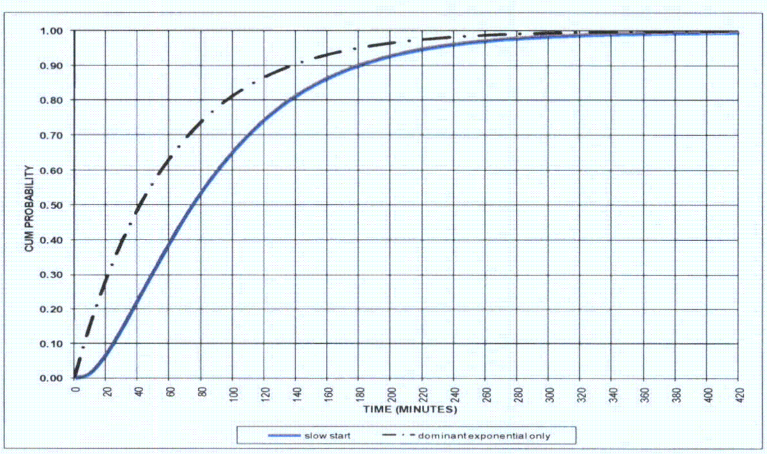


Figure 8: Delayed Initiation Model, Compared

Attachment to NPD-NRC-2009-101

PREFLIGHT REPORT: LNP RAI 28 SUBMITTAL

This table serves as a pre-flight report for the LNP RAI 28 submital in support of the LNP COLA. The following files were checked for items related to pre-flight/electronic submittal acceptance. The results of the review are shown below. For files that do not pass pre-flight, the reason for the error is provided; however, all files within this submittal are deemed compliant with the NRC electronic submittal checklist as noted below.

			Acceptance Review				Preflight Review		
Item #	File Name	File Size (MB)	Word Searchable? (Y/N)	Fast Web View? (Y/N)	Fonts Embedded? (Y/N)	No Security (Y/N)	Preflight (Pass/Fail)	Failure Reason	Comments
1	ETE-13_Figure 1 Attachment	6.83 MB	Y	Y	N	Y	Fail	Unembedded Fonts	Unembedded Fonts due to figure
2	ETE-2_Figure 1-2 Attachment	6.78 MB	Y	Y	N	Y	Fail	Unembedded Fonts	Unembedded Fonts due to figure
3									
4									
5									