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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Ref 10 CFR50.4
10 CFR50 App E

Subject: Comanche Peak Nuclear Power Plant (CPNPP)
Docket Nos. 50-445, 50-446 and 72-74
Comanche Peak 2022 Evacuation Time Estimate Analysis

Dear Sir or Madam:

In accordance with 10CFR50, Appendix E, section IV.4, Vistra Operations Company LLC (Vistra OpCo) hereby submits the 2022 evacuation time estimates (ETEs) for Comanche Peak Nuclear Power Plant (CPNPP).

The enclosed ETE analysis was developed using the most recent decennial census data from the U. S. Census Bureau.

This communication contains no new licensing basis commitments regarding Comanche Peak Units 1 and 2.

Should you have any questions, please contact Jim Barnette at (254) 897-5866 or James.Barnette@luminant.com.

Sincerely,

Jack C. Hicks

Jack C. Hicks

Enclosure: Comanche Peak 2022 Evacuation Time Estimate Analysis

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Enclosure With TXX-22050

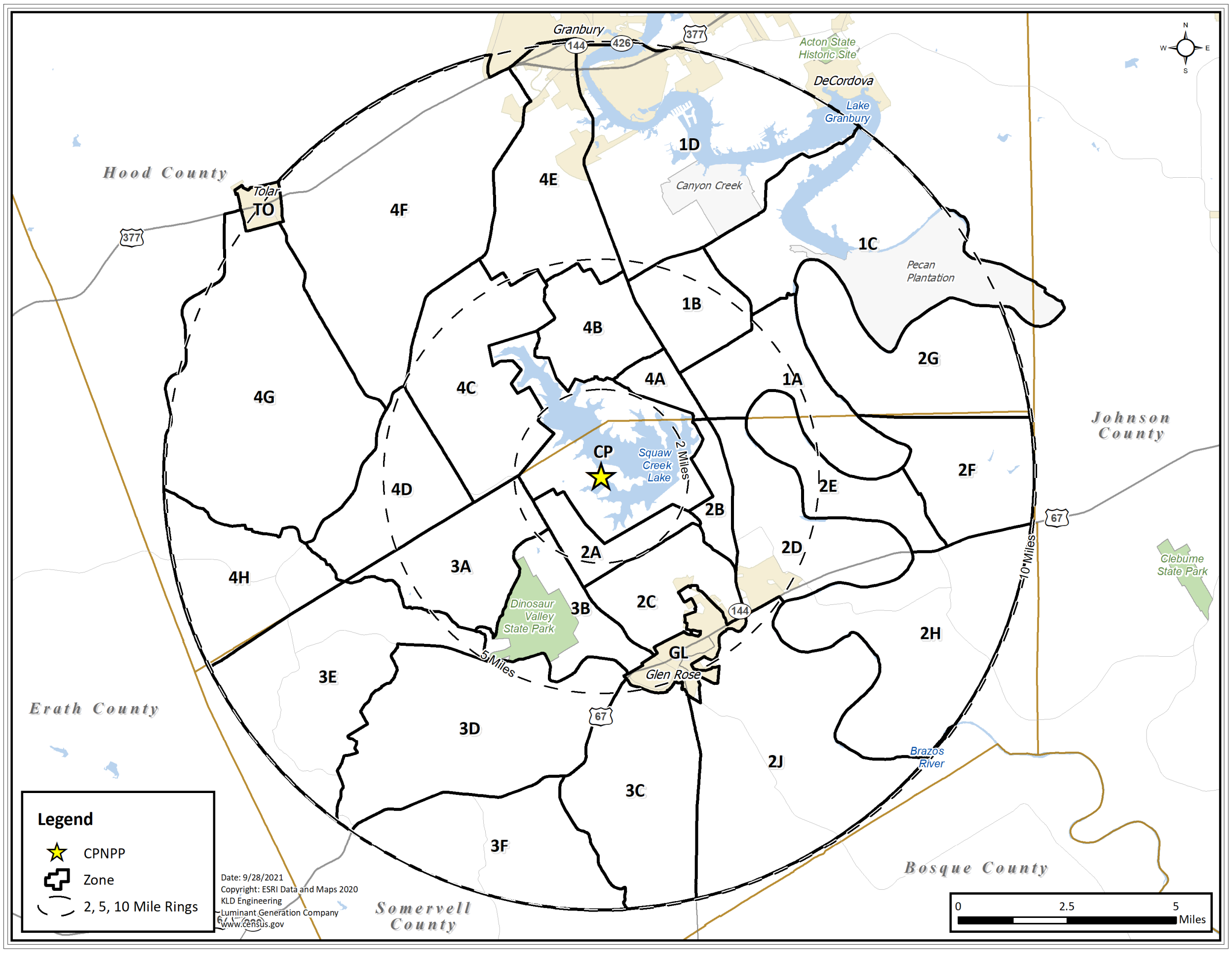
Comanche Peak 2022 Evacuation Time Estimate Analysis

(512 pages, not including this cover page)

KLD ENGINEERING, P.C.

Comanche Peak Nuclear Power Plant

Development of Evacuation Time Estimates



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May 16, 2022 **Final Report, Rev. 0** **KLD TR – 1230**

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ACRONYM LIST

Table 1. Acronym List

ACRONYM	DEFINITION
AADT	Average Annual Daily Traffic
ACP	Access Control Point
ANS	Alert and Notification System
ASLB	Atomic Safety and Licensing Board
ATE	Advisory to Evacuate
ATIS	Automated Traveler Information Systems
BFFS	Base Free Flow Speed
CPNPP	Comanche Peak Nuclear Power Plant
CR	County Road
COVID-19	Coronavirus Disease 2019
D	Destination
DDHV	Directional Design Hourly Volume
DHV	Design Hour Volume
DMS	Dynamic Message Sign
DTA	Dynamic Traffic Assignment
DTRAD	Dynamic Traffic Assignment and Distribution
DYNEV	Dynamic Network Evacuation
EAS	Emergency Alert System
EOC	Emergency Operations Center
EPZ	Emergency Planning Zone
EPFAQ	Emergency Planning Frequently Asked Question
ETE	Evacuation Time Estimate
EVAN	Evacuation Animator
EMA	Emergency Management Agency
FEMA	Federal Emergency Management Agency
FFS	Free Flow Speed
FHWA	Federal Highway Administration
FM	Farm to Market
GIS	Geographical Information System
HAR	Highway Advisory Radio
HCM	Highway Capacity Manual
HH	Household
HPMS	Highway Performance Monitoring System
ITS	Intelligent Transportation Systems
LOS	Level of Service
MOE	Measures of Effectiveness

ACRONYM	DEFINITION
mph	Miles Per Hour
MUTCD	Manual of Uniform Traffic Control Devices
MTC	Manual Traffic Control
NB	Northbound
NOAA	The National Oceanic and Atmospheric Administration
NRC	United States Nuclear Regulatory Commission
O	Origin
O-D	Origin-Destination
ORO	Offsite Response Organization
PAR	Protective Action Recommendation
pce	Passenger Car Equivalent
pcphpl	passenger car per hour per lane
PSL	Path-Size-Logit
QDF	Queue Discharge Flow
RC	Reception Center
RS	Relocation School
SH	State Highway
SR	State Route
SV	Service Volume
TA	Traffic Assignment
TCP	Traffic Control Point
TD	Trip Distribution
TI	Time Interval
TMP	Traffic Management Plan
UNITES	Unified Transportation Engineering System
USDOT	United States Department of Transportation
Vistra OpCo	Vistra Operations Company LLC
vph	Vehicles Per Hour
vpm	Vehicles Per Minute

EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Comanche Peak Nuclear Power Plant (CPNPP) located in Glen Rose, Somervell County, Texas. The ETE are part of the required planning basis and provide Vistra Operations Company LLC (Vistra OpCo), state and local governments with site-specific information needed for protective action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Governmental agencies. Most important of these are:

- Title 10, Code of Federal Regulations, Appendix E to Part 50 (10CFR50), Emergency Planning and Preparedness for Production and Utilization Facilities, NRC, 2011.
- Revision 1 of the Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, February 2021.
- FEMA, "Radiological Emergency Preparedness Program Manual" (FEMA P-1028), December 2019.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

Project Activities

This project began in, March 2021 and extended over a period of 13 months. The major activities performed are briefly described in chronological sequence:

- Conducted a virtual kickoff meeting with Vistra OpCo personnel and emergency management personnel representing state and county governments.
- Accessed the U.S. Census Bureau data files for the year 2020.
- Obtained the estimates of employees who reside outside the Emergency Planning Zone (EPZ) and commute to work within the EPZ from Vistra OpCo and counties within the EPZ.
- Studied Geographical Information Systems (GIS) maps of the area in the vicinity of the CPNPP, then conducted a detailed field survey of the highway network to observe any roadway changes relative to the previous ETE study done in 2012.
- Updated the analysis network representing the highway system topology and capacities within the EPZ, plus a Shadow Region covering the region between the EPZ boundary and approximately 15 miles radially from the plant.

- Conducted a random-sample online demographic survey of residents within the EPZ, to gather focused data needed for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by the licensee and offsite response organization (ORO) personnel prior to the survey.
- A data needs matrix (requesting data) was provided to Vistra OpCo and the OROs at the kick-off meeting. The data gathered for the 2012 ETE study were reviewed and either confirmed or updated accordingly by the OROs. If updated information was not provided and data could not be obtained from aerial imagery, internet searches or phone calls directly to the facility, the data gathered in the 2012 ETE study was assumed still accurate for this study.
- The traffic demand and trip-generation rates of evacuating vehicles were estimated from the gathered data. The trip generation rates reflect the estimated mobilization time (i.e., the time required by evacuees to prepare for the evacuation trip) computed using the results of the demographic survey of the EPZ residents.
- Following federal guidelines, the existing 30 Zones, within the EPZ, are grouped within circular areas or "keyholes" configurations (circles plus radial sectors) and the use of the Protective Action Recommendation Plan, provided by Vistra OpCo, a total of 92 Evacuation Regions (numbered R01 through R92) was defined.
- The time-varying external circumstances are represented as Evacuation Scenarios, each described in terms of the following factors: (1) Season (Summer, Winter); (2) Day of Week (Midweek, Weekend); (3) Time of Day (Midday, Evening); and (4) Weather (Good, Rain). One special event scenario involving the Fourth of July in Granbury was considered. One roadway impact scenario was considered wherein a single lane was closed on US 377 NB from TX 144 to just east of FM 167 and a single lane was closed on US 67 NB from FM 205 to CR 1119. These closures were considered for the duration of the evacuation for this scenario.
- Staged evacuation was considered for those regions wherein the 2-Mile Region and sectors downwind to 5 miles were evacuated.
- As per NUREG/CR-7002, Rev. 1, the Planning Basis for the calculation of ETE is:
    - A rapidly escalating event at the CPNPP that quickly assumes the status of general emergency wherein evacuation is ordered promptly, and no early protective actions have been implemented such that the Advisory to Evacuate (ATE) is virtually coincident with the siren alert.
    - While an unlikely scenario, this planning basis will yield ETE, measured as the elapsed time from the ATE until the stated percentage of the population exits the impacted Region, that represent "upper bound" estimates. This conservative Planning Basis is applicable for all initiating events.

- If the emergency occurs while schools, preschools/daycares or day camps are in session, the ETE study assumes that the children will be evacuated by bus directly to relocation schools or reception centers located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at these facilities prior to the arrival of the buses dispatched for that purpose. The ETE for children at these facilities are calculated separately.
- Evacuees who do not have access to a private vehicle will either ride-share with relatives, friends or neighbors, or be evacuated by buses provided as specified in the county evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: bus, wheelchair transport, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees, for access and/or special needs population, and for those evacuated from special facilities.
- Conducted a “final” meeting with Vistra OpCo personnel and the OROs to present results from the study.

Computation of ETE

A total of 1,104 ETE were computed for the evacuation of the general public. Each ETE quantifies the aggregate evacuation time estimated for the population within one of the 92 Evacuation Regions to evacuate from that Region, under the circumstances defined for one of the 12 Evacuation Scenarios (92 x 12 = 1,104). Separate ETE are calculated for transit-dependent evacuees, including schoolchildren for applicable scenarios.

Except for Region R03, which is the evacuation of the entire EPZ, only a portion of the people within the EPZ would be advised to evacuate. That is, the ATE applies only to those people occupying the specified impacted region. It is assumed that 100% of the people within the impacted region will evacuate in response to this ATE. The people occupying the remainder of the EPZ outside the impacted region may be advised to take shelter.

The computation of ETE assumes that 20% of the population within the EPZ but outside the impacted region, will elect to “voluntarily” evacuate. In addition, 20% of the population in the Shadow Region will also elect to evacuate. These voluntary evacuees could impede those who are evacuating from within the impacted region. The impedance that could be caused by voluntary evacuees is considered in the computation of ETE for the impacted region.

Staged evacuation is considered wherein those people within the 2-Mile Region evacuate immediately, while those beyond 2 miles, but within the EPZ, shelter-in-place. Once 90% of the 2-Mile Region is evacuated, those people beyond 2 miles begin to evacuate. As per federal guidance, 20% of people beyond 2 miles will evacuate (non-compliance) even though they are advised to shelter-in-place, during a staged evacuation.

The computational procedure is outlined as follows:

- A link-node representation of the highway network is coded. Each link represents a unidirectional length of highway; each node usually represents an intersection or merge point. The capacity of each link is estimated based on the field survey observations and on established traffic engineering procedures.

- The evacuation trips are generated at locations called "zonal centroids" located within the EPZ and Shadow Region. The trip generation rates vary over time reflecting the mobilization process, and from one location (centroid) to another depending on population density and on whether a centroid is within, or outside, the impacted area.
- The evacuation model computes the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of the plant), then simulate the traffic flow movements over space and time. This simulation process estimates the rate that traffic flow exits the impacted region.

The ETE statistics provide the elapsed times for 90% and 100%, respectively, to evacuate from within the impacted region. These statistics are presented in tabular and graphical formats. The 90th percentile ETE have been identified as the values that should be considered when making protective action decisions because the 100th percentile ETE are prolonged by those relatively few people who take longer to mobilize. This is referred to as the "evacuation tail" in Section 4.0 of NUREG/CR-7002, Rev 1.

Traffic Management

This study reviewed, used and analyzed the comprehensive traffic management plans provided by Hood and Somervell Counties. The existing traffic management plans are adequate and no additional traffic or access control measures have been identified as a result of this study. Refer to Section 9 and Appendix G.

Selected Results

A compilation of selected information is presented on the following pages in the form of Figures and Tables extracted from the body of the report; these are described below.

- Table 3-1 presents the estimates of permanent resident population in each Zone based on the 2020 Census data.
- Table 6-1 through Table 6-4 define each of the 92 Evacuation Regions in terms of their respective groups of Zones.
- Table 6-5 defines the 12 Evacuation Scenarios.
- Tables 7-1 and 7-2 are compilations of the ETE. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the EPZ and from the Shadow Region.
- Tables 7-3 and 7-4 present the ETE for the 2-Mile Region, when evacuating additional Zones downwind to 5 miles for un-staged and staged evacuations for the 90th and 100th percentile ETEs, respectively.
- Table 8-2 presents the ETE for the children at schools and preschools/daycares in good weather.
- Table 8-6 presents the ETE for the transit-dependent population in good weather.
- Table 8-8 presents the ETE for the medical facility population in good weather.

- Figure 6-1 displays a map of the CPNPP EPZ showing the layout of the 30 Zones that comprise, in aggregate, the EPZ.
- Figure H-8 presents an example of an Evacuation Region (Region R08) to be evacuated under the circumstances defined in Table 6-1 through Table 6-6. Maps of all regions are provided in Appendix H.

Conclusions

- General population ETE were computed for 1,104 unique cases – a combination of 92 unique Evacuation Regions and 12 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document these ETE for the 90th and 100th percentiles. The 90th percentile ETE range from 2:00 (hr:min) to 4:50. The 100th percentile ETE are dictated by trip mobilization of residents (i.e., the time it takes to prepare to evacuate) for non-special scenarios and special scenario Regions that do not contain Zones 1C, 1D and 4E. These ETE range from 5:00 to 5:10 at the 100th percentile. For the Special Event and Roadway Impact scenarios, where Regions do contain Zones 1C, 1D and 4E, which is dictated by congestion, the 100th percentile ETE are at most 5:55 and 6:20, respectively.
- The comparison of Table 7-1 and Table 7-2 indicate that the 100th percentile ETE are significantly longer than those for the 90th percentile ETE. This is the result of the long trip generation "tail" and some congestion. As these stragglers mobilize, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand. See Figures 7-9 through 7-20.
- The population centers of Granbury and Tolar display the most congestion during the evacuation for Scenario 1 for the full EPZ. US 377 northbound, going towards Fort Worth/Dallas, exhibits the last of the traffic congestion within the EPZ. All congestion within the EPZ clears by 4 hours and 30 minutes after the ATE. See Section 7.3 and Figures 7-3 through 7-8.
- The comparison of Scenarios 3 (summer, weekend, midday with good weather) and 11 (summer, weekend, midday, special event) in Table 7-1 indicates that the special event – Fourth of July in Granbury – does have a material impact on the 90th percentile, with up to 40-minute increases in ETE, in regions that include Zones 1C, 1D and/or 4E. The additional 3,699 vehicles intensify traffic congestion in Granbury and prolongs ETE. The 100th percentile is increased by 45 minutes due to the additional vehicles evacuating from the special event as indicated in Table 7-2. See Section 7.5 for additional discussion.
- The comparison of Scenarios 1 and 12 in Table 7-1 indicates that the roadway closure – US 377 NB from TX 144 to just east of FM 167 and a single lane was closed on US 67 NB from FM 205 to TX 144 and Somervell CR 316 to CR 1119 – increase ETE at the 90th percentile by at most 1 hour and 30 minutes. The lane closure on US 67 does not impact ETE; however, the lane closure along US 377 compounds congestion in Granbury and in the Shadow Region to the northeast, prolonging ETE. The 100th percentile is increased by at most 1 hour and 10 minutes as indicated in Table 7-2 when comparing Scenarios 1 and 12, for Regions that include 1C, 1D and/or 4E. See Section 7.5 for additional discussion.
- Inspection of Table 7-3 and Table 7-4, indicates that a staged evacuation provides no

benefits to evacuees from within the 2-Mile Region (compare Regions R64 through R78 with Regions R02 and R04 through R17, respectively, for three sectors; compare Regions R79 through R92 with Regions R34 through R47, respectively, for five sectors). See Section 7.6 for additional discussion.

- Separate ETE were computed for special facilities (schools, preschools/daycares, day camps, medical facilities, and correctional facility), transit-dependent persons, and the access and/or functional needs persons. The average single-wave ETE for all special facilities and the transit-dependent persons are less or comparable to the 90th percentile ETE for the general population; whereas the average single-wave ETE for the access and/or functional needs persons are greater than the 90th percentile ETE for the general population. See Section 8.
- Table 8-1 indicates that there are not enough transportation resources available, except for minibuses and wheelchair buses, to evacuate the schoolchildren, ambulatory patients and bedridden patients at medical facilities, transit-dependent persons, or access and/or functional needs persons. Multiple waves are needed to evacuate these populations. The second-wave ETE for this population exceeds the general population ETE at the 90th percentile except for buses being used for schoolchildren. See Sections 8.1 and 8.2.
- A reduction in the base trip generation time by 1 hour has no impact to the 90th percentile ETE for the general population but decreases the 100th percentile ETE by 35 minutes. An increase in mobilization time by 1 hour increases the 90th percentile ETE by 10 minutes and increases the 100th percentile ETE by 1 hour. Congestion within the EPZ persists for 4 hours and 30 minutes after the ATE for an evacuation of the entire EPZ during the summer, midweek, midday with good weather conditions, after this point, the ETE is dictated by the mobilization time. As such, changes to the trip generation impacts the 100th percentile ETE. See Appendix M.1 and Table M-1.
- The general population ETE is minimally impacted when reducing the voluntary evacuation of vehicles in the Shadow Region. The 90th and 100th percentile ETE are sensitive to increases in shadow evacuation. For example, the 90th percentile and 100th percentile ETE increases by 30 minutes and 15 minutes respectively, during an evacuation of the entire Shadow Region. See Appendix M and Table M-2.
- An increase in permanent resident population (EPZ plus Shadow Region) of 18% or greater result in an increase in the longest 90th percentile ETE by 30 minutes for the full EPZ (Regions R03), which meets the federal criterion for performing a fully updated ETE study between decennial Censuses. See Appendix M.3 and Section M.3.

Table 3-1. EPZ Permanent Resident Population

Zone	2010 Population[1]	2020 Population
1A	672	656
1B	337	351
1C	6,871	8,105
1D	11,793	14,713
2A	736	548
2B	364	251
2C	466	717
2D	695	567
2E	70	127
2F	115	153
2G	16	21
2H	431	507
2J	1,202	1,557
3A	134	149
3B	83	122
3C	546	592
3D	363	366
3E	111	129
3F	309	320
4A	59	58
4B	104	108
4C	123	189
4D	181	182
4E	4,261	4,856
4F	1,543	1,509
4G	523	491
4H	73	70
CP	66	283
GL	2,291	2,369
TO	661	803
EPZ TOTAL	**35,199**	**40,869**
EPZ Population Growth (2010-2020):		**16.11%**

[1] The 2010 population shown in the table for Zones 1D, 4Eand 4F reflect the new zone boundaries and will therefore not align with the previous ETE study.

Table 6-1. Description of Evacuation Regions – Regions R01 through R17

Region	Site PAR Central Sector	Description	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R01	N/A	2-Mile Region	X					X																								
R02	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R03	N/A	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R04	A	168.75 – 191.24	X		X			X															X	X	X							
R05	B	191.25 – 213.74	X	X	X			X															X	X								
R06	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R07	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R08	E	258.75 – 281.24	X	X				X	X		X	X																				
R09	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R10	G	303.75 – 326.24	X					X	X	X	X																				X	
R11	H, J	326.25 – 11.24	X					X		X								X													X	
R12	K	11.25 – 33.74	X					X		X							X	X													X	
R13	L	33.75 – 56.24	X					X									X	X								X						
R14	M	56.25 – 78.74	X					X									X	X							X	X						
R15	N	78.75 – 101.24	X					X									X								X	X						
R16	P	101.25 – 123.74	X					X																	X	X						
R17	Q, R	123.75 – 168.74	X					X																X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 6-2. Description of 3-Sector Evacuation Regions – Regions 18 through R33

Evacuate 2-Mile Region and Downwind to EPZ Boundary (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R18	A	168.75 – 191.24	X		X	X	X	X															X	X	X		X	X				
R19	B	191.25 – 213.74	X	X	X	X	X	X						X									X	X			X					
R20	C	213.75 – 236.24	X	X	X	X	X	X	X		X	X		X									X	X								
R21	D	236.25 – 258.74	X	X	X	X		X	X		X	X	X	X									X									
R22	E	258.75 – 281.24	X	X		X		X	X		X	X	X	X	X																	
R23	F	281.25 – 303.74	X					X	X	X	X	X	X		X	X															X	
R24	G	303.75 – 326.24	X					X	X	X	X				X	X			X												X	
R25	H	326.25 – 348.74	X					X		X					X	X		X	X	X		X									X	
R26	J	348.75 – 11.24	X					X		X						X		X	X	X		X									X	
R27	K	11.25 – 33.74	X					X		X							X	X	X	X	X	X									X	
R28	L	33.75 – 56.24	X					X									X	X		X	X	X				X				X		
R29	M	56.25 – 78.74	X					X									X	X		X	X				X	X			X	X		
R30	N	78.75 – 101.24	X					X									X				X				X	X		X	X	X		
R31	P	101.25 – 123.74	X					X																	X	X		X	X	X		X
R32	Q	123.75 – 146.24	X					X																X	X		X	X	X			X
R33	R	146.25 – 168.74	X				X	X																X	X		X	X				X

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 6-3. Description of 5-Sector Evacuation Regions – Regions R34 through R63

Evacuate 2-Mile Region and Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R34	A	168.75 – 191.24	X	X	X			X															X	X	X							
R35	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R36	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R37	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R38	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R39	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R40	H	326.25 – 348.74	X					X	X	X	X							X													X	
R41	J	348.75 – 11.24	X					X		X							X	X													X	
R42	K	11.25 – 33.74	X					X		X							X	X								X					X	
R43	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R44	M, N	56.25 – 101.24	X					X									X	X							X	X						
R45	P	101.25 – 123.74	X					X									X							X	X	X						
R46	Q	123.75 – 146.24	X					X																X	X	X						
R47	R	146.25 – 168.74	X		X			X															X	X	X							

Evacuate 2-Mile Region and Downwind to EPZ Boundary (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R48	A	168.75 – 191.24	X	X	X	X	X	X						X									X	X	X		X	X				X
R49	B	191.25 – 213.74	X	X	X	X	X	X	X		X	X		X									X	X	X		X	X				
R50	C	213.75 – 236.24	X	X	X	X	X	X	X		X	X	X	X									X	X			X					
R51	D	236.25 – 258.74	X	X	X	X	X	X	X		X	X	X	X	X								X	X								
R52	E	258.75 – 281.24	X	X	X	X		X	X	X	X	X	X	X	X	X							X								X	
R53	F	281.25 – 303.74	X	X		X		X	X	X	X	X	X	X	X	X			X												X	
R54	G	303.75 – 326.24	X					X	X	X	X	X	X		X	X		X	X	X		X									X	
R55	H	326.25 – 348.74	X					X	X	X	X				X	X		X	X	X		X									X	
R56	J	348.75 – 11.24	X					X		X					X	X	X	X	X	X	X	X									X	
R57	K	11.25 – 33.74	X					X		X						X	X	X	X	X	X	X				X				X	X	
R58	L	33.75 – 56.24	X					X		X							X	X	X	X	X	X			X	X			X	X	X	
R59	M	56.25 – 78.74	X					X									X	X		X	X	X			X	X		X	X	X		
R60	N	78.75 – 101.24	X					X									X	X		X	X				X	X		X	X	X		X
R61	P	101.25 – 123.74	X					X									X				X			X	X	X	X	X	X	X		X
R62	Q	123.75 – 146.24	X				X	X																X	X	X	X	X	X	X		X
R63	R	146.25 – 168.74	X		X	X	X	X															X	X	X		X	X	X			X

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 6-4. Description of Staged Evacuation Regions – Regions R64 through R92

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (3 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R64	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R65	A	168.75 – 191.24	X		X			X															X	X	X							
R66	B	191.25 – 213.74	X	X	X			X															X	X								
R67	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R68	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R69	E	258.75 – 281.24	X	X				X	X		X	X																				
R70	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R71	G	303.75 – 326.24	X					X	X	X	X																				X	
R72	H, J	326.25 – 11.24	X					X		X								X													X	
R73	K	11.25 – 33.74	X					X		X							X	X													X	
R74	L	33.75 – 56.24	X					X									X	X								X						
R75	M	56.25 – 78.74	X					X									X	X							X	X						
R76	N	78.75 – 101.24	X					X									X								X	X						
R77	P	101.25 – 123.74	X					X																	X	X						
R78	Q, R	123.75 – 168.74	X					X																X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
N/A	N/A	5-Mile Region	Refer to Region R64																													
R79	A	168.75 – 191.24	X	X	X			X															X	X	X							
R80	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R81	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R82	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R83	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R84	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R85	H	326.25 – 348.74	X					X	X	X	X							X													X	
R86	J	348.75 – 11.24	X					X		X							X	X													X	
R87	K	11.25 – 33.74	X					X		X							X	X								X					X	
R88	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R89	M, N	56.25 – 101.24	X					X									X	X							X	X						
R90	P	101.25 – 123.74	X					X									X							X	X	X						
R91	Q	123.75 – 146.24	X					X																X	X	X						
R92	R	146.25 – 168.74	X		X			X															X	X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

Table 6-5. Evacuation Scenario Definitions

Scenario	Season[2]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Weekend	Midday	Good	Special Event: Fourth of July in Granbury
12	Summer	Midweek	Midday	Good	Roadway Impact: Single Lane Closure on US 377 NB and on US 67 NB

[2] Winter means that school is in session, at normal enrollment levels (also applies to spring and autumn). Summer means that school is in session at summer school enrollment levels (lower than normal enrollment).

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R02	2:25	2:25	2:15	2:20	2:10	2:30	2:30	2:25	2:30	2:15	2:15	2:25
R03	3:25	3:45	3:35	3:45	3:15	3:20	3:40	3:30	3:45	3:15	4:10	4:35
2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	2:40	2:40	2:25	2:25	2:25	2:40	2:45	2:25	2:25	2:25	2:25	2:40
R05	2:40	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:40
R06	2:25	2:25	2:10	2:10	2:15	2:25	2:30	2:10	2:10	2:15	2:10	2:25
R07	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R08	2:15	2:20	2:10	2:10	2:10	2:20	2:20	2:10	2:10	2:10	2:10	2:15
R09	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R10	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R11	2:20	2:20	2:10	2:10	2:15	2:25	2:25	2:10	2:15	2:05	2:10	2:20
R12	2:15	2:20	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R13	2:35	2:35	2:15	2:15	2:15	2:35	2:35	2:15	2:15	2:15	2:15	2:35
R14	2:35	2:35	2:15	2:15	2:15	2:35	2:40	2:15	2:15	2:15	2:15	2:35
R15	2:50	2:50	2:30	2:30	2:30	2:50	2:50	2:30	2:30	2:30	2:30	2:50
R16	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R17	2:40	2:40	2:25	2:25	2:25	2:40	2:40	2:25	2:25	2:25	2:25	2:40
2-Mile Region and Keyhole to EPZ Boundary (3 Sector Groups)												
R18	3:30	3:50	3:40	4:00	3:20	3:20	3:40	3:35	3:50	3:20	4:20	4:40
R19	3:25	3:40	3:35	3:50	3:15	3:20	3:35	3:25	3:45	3:15	3:55	4:45
R20	3:15	3:20	3:10	3:20	2:55	3:05	3:10	3:05	3:20	2:55	3:20	4:10
R21	3:05	3:10	2:45	2:50	2:50	3:05	3:10	2:45	2:50	2:45	2:45	3:05
R22	2:55	3:00	2:40	2:45	2:45	3:00	3:05	2:40	2:45	2:45	2:40	2:55

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R23	2:25	2:25	2:20	2:20	2:10	2:30	2:30	2:30	2:35	2:20	2:20	2:25
R24	2:25	2:25	2:20	2:20	2:10	2:30	2:30	2:25	2:35	2:15	2:20	2:25
R25	2:25	2:25	2:10	2:15	2:10	2:25	2:30	2:25	2:30	2:10	2:10	2:25
R26	2:25	2:25	2:10	2:10	2:10	2:25	2:30	2:20	2:25	2:10	2:10	2:25
R27	2:25	2:25	2:10	2:15	2:10	2:25	2:25	2:20	2:25	2:10	2:10	2:20
R28	2:20	2:20	2:10	2:10	2:15	2:20	2:25	2:10	2:10	2:15	2:10	2:20
R29	2:25	2:25	2:15	2:15	2:20	2:25	2:25	2:15	2:15	2:15	2:15	2:25
R30	2:20	2:20	2:10	2:15	2:15	2:20	2:20	2:10	2:15	2:15	2:10	2:20
R31	2:30	2:30	2:20	2:20	2:20	2:30	2:30	2:20	2:20	2:20	2:20	2:30
R32	2:35	2:35	2:20	2:25	2:25	2:35	2:35	2:20	2:25	2:25	2:40	2:40
R33	3:05	3:25	3:10	3:30	2:55	3:00	3:15	3:10	3:25	2:55	3:45	4:25
2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R35	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R36	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R37	2:25	2:25	2:15	2:20	2:10	2:25	2:25	2:25	2:35	2:15	2:15	2:25
R38	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R39	2:20	2:20	2:15	2:20	2:05	2:20	2:20	2:25	2:30	2:15	2:15	2:20
R40	2:20	2:20	2:15	2:20	2:05	2:20	2:20	2:25	2:30	2:15	2:15	2:20
R41	2:15	2:15	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R42	2:15	2:20	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R43	2:15	2:15	2:05	2:10	2:00	2:15	2:20	2:20	2:20	2:05	2:05	2:15
R44	2:30	2:30	2:00	2:00	2:05	2:35	2:35	2:05	2:05	2:05	2:00	2:30
R45	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R46	2:45	2:45	2:25	2:30	2:30	2:45	2:45	2:30	2:30	2:30	2:30	2:45
R47	2:40	2:40	2:25	2:25	2:25	2:40	2:45	2:25	2:25	2:25	2:25	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
2-Mile Region and Keyhole to EPZ Boundary (5 Sector Groups)												
R48	3:35	3:55	3:40	4:05	3:25	3:35	3:50	3:40	3:55	3:25	4:20	4:45
R49	3:30	3:45	3:40	4:00	3:20	3:25	3:45	3:35	3:50	3:20	4:10	4:50
R50	3:20	3:35	3:30	3:45	3:15	3:20	3:30	3:25	3:45	3:15	3:50	4:50
R51	3:15	3:25	3:15	3:30	2:55	3:05	3:10	3:05	3:25	3:00	3:25	4:00
R52	2:50	2:55	2:30	2:35	2:35	2:55	2:55	2:40	2:45	2:30	2:30	2:50
R53	2:50	2:55	2:30	2:35	2:35	2:55	2:55	2:40	2:45	2:30	2:35	2:50
R54	2:30	2:30	2:20	2:25	2:15	2:30	2:30	2:30	2:35	2:20	2:20	2:30
R55	2:30	2:30	2:20	2:20	2:15	2:30	2:30	2:30	2:35	2:20	2:20	2:30
R56	2:25	2:25	2:20	2:20	2:10	2:25	2:30	2:30	2:35	2:20	2:20	2:25
R57	2:25	2:25	2:10	2:15	2:10	2:30	2:30	2:20	2:25	2:10	2:10	2:25
R58	2:25	2:30	2:10	2:15	2:10	2:30	2:30	2:20	2:25	2:10	2:10	2:25
R59	2:20	2:20	2:10	2:15	2:15	2:20	2:20	2:10	2:15	2:15	2:10	2:20
R60	2:20	2:25	2:15	2:15	2:15	2:25	2:25	2:15	2:15	2:15	2:15	2:25
R61	2:35	2:35	2:25	2:25	2:25	2:35	2:35	2:20	2:25	2:25	2:40	2:40
R62	3:10	3:25	3:10	3:30	2:55	3:05	3:20	3:10	3:25	2:55	3:45	4:25
R63	3:35	3:50	3:40	4:00	3:15	3:25	3:45	3:35	3:55	3:20	4:15	4:50
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (3 Sector Groups)												
R64	2:45	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:50	2:45	2:45	2:45
R65	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
R66	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50
R67	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R68	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R69	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:35	2:40	2:35	2:40
R70	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45
R71	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R72	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R73	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:40	2:35	2:35	2:40
R74	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R75	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R76	2:55	2:55	2:45	2:45	2:45	2:55	2:55	2:45	2:45	2:45	2:45	2:55
R77	2:50	2:50	2:40	2:45	2:40	2:50	2:50	2:40	2:45	2:40	2:40	2:50
R78	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (5 Sector Groups)												
R79	2:50	2:50	2:45	2:50	2:45	2:50	2:50	2:45	2:50	2:45	2:45	2:50
R80	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45
R81	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R82	2:45	2:45	2:45	2:45	2:45	2:45	2:50	2:45	2:50	2:45	2:45	2:45
R83	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45
R84	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:45	2:50	2:40	2:40	2:45
R85	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:45	2:50	2:40	2:40	2:45
R86	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:40	2:35	2:35	2:40
R87	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R88	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R89	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R90	2:50	2:55	2:50	2:50	2:50	2:55	2:55	2:50	2:50	2:50	2:50	2:50
R91	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
R92	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R02	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R03	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:55	6:20
2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R06	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R07	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R08	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R09	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R10	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R11	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R12	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R13	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R14	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R15	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R16	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R17	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
2-Mile Region and Keyhole to EPZ Boundary (3 Sector Groups)												
R18	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:45	6:00
R19	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	6:05
R20	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R21	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R22	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	**Midday**		**Midday**		**Evening**	**Midday**		**Midday**		**Evening**	**Midday**	**Midday**
	Good Weather	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Good Weather**	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Special Event**	**Roadway Impact**
R23	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R24	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R25	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R26	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R27	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R28	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R29	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R30	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R31	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R32	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R33	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:45
2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R35	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R36	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R37	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R38	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R39	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R40	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R41	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R42	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R43	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R44	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R45	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R46	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R47	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
2-Mile Region and Keyhole to EPZ Boundary (5 Sector Groups)												
R48	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:55	6:10
R49	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:35	6:20
R50	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:15	6:20
R51	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R52	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R53	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R54	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R55	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R56	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R57	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R58	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R59	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R60	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R61	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R62	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R63	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:50	6:00
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (3 Sector Groups)												
R64	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R65	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R66	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R67	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R68	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R69	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R70	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R71	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R72	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R73	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R74	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R75	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R76	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R77	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R78	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (5 Sector Groups)												
R79	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R80	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R81	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R82	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R83	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R84	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R85	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R86	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R87	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R88	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R89	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R90	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R91	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R92	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

Table 7-3. Time to Clear 90 Percent of the 2-Mile Region within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R02	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R05	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R06	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R07	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R08	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R09	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R10	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R11	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R12	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R13	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R14	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R15	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R16	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R17	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R35	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R36	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R37	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R38	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R39	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R40	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R41	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R42	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R43	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R44	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R45	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R46	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R47	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Staged Evacuation - 5-Mile Region												
R64	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R65	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R66	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R67	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R68	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R69	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R70	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R71	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R72	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R73	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R74	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R75	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R76	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R77	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R78	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	**Midday**		**Midday**		**Evening**	**Midday**		**Midday**		**Evening**	**Midday**	**Midday**
	Good Weather	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Good Weather**	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Special Event**	**Roadway Impact**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R79	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R80	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R81	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R82	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R83	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R84	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R85	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R86	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R87	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R88	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R89	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R90	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R91	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R92	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

Table 7-4. Time to Clear 100 Percent of the 2-Mile Region within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R02	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R05	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R06	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R07	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R08	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R09	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R10	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R11	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R12	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R13	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R14	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R15	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R16	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R17	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R35	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R36	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R37	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R38	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	**Midday**		**Midday**		**Evening**	**Midday**		**Midday**		**Evening**	**Midday**	**Midday**
	Good Weather	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Good Weather**	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Special Event**	**Roadway Impact**
R39	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R40	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R41	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R42	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R43	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R44	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R45	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R46	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R47	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Staged Evacuation - 5-Mile Region												
R64	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R65	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R66	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R67	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R68	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R69	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R70	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R71	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R72	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R73	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R74	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R75	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R76	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R77	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R78	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R79	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R80	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R81	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R82	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R83	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R84	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R85	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R86	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R87	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R88	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R89	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R90	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R91	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R92	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

Table 8-2. School Evacuation Time Estimates – Good Weather

School/Day Care	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
HOOD COUNTY									
Mambrino Elementary School	10	10	5.1	43.3	7	**0:30**	29.2	35	**1:05**
Premier High School	90	15	0.7	4.3	10	**1:55**	27.6	33	**2:30**
Lakeside Baptist Academy	90	15	4.2	5.2	49	**2:35**	27.6	33	**3:10**
Brawner Intermediate School	10	10	2.9	34.6	5	**0:25**	27.6	33	**1:00**
Emma Roberson Elementary School	90	15	8.8	5.3	99	**3:25**	27.6	33	**4:00**
Granbury High School	10	10	7.7	50.0	9	**0:30**	21.2	25	**0:55**
Tolar High School	90	15	0.2	39.7	0	**1:45**	20.8	25	**2:10**
Tolar Elementary School	90	15	0.9	8.1	7	**1:55**	20.8	25	**2:20**
Tolar Jr. High School	90	15	0.9	8.1	7	**1:55**	20.8	25	**2:20**
Rainbow's Promise	90	15	10.3	7.4	83	**3:10**	27.6	33	**3:45**
Lakeside WEEschool	90	15	4.7	5.2	55	**2:40**	27.6	33	**3:15**
Lil Pirates Daycare	90	15	0.2	3.5	3	**1:50**	27.6	33	**2:25**
Cross Town Preschool	90	15	2.7	4.5	36	**2:25**	27.6	33	**3:00**
Miss Dee Little Angels	90	15	2.9	4.5	39	**2:25**	27.6	33	**3:00**
Tolar Small Steps Childcare & Early Learning Center, LLC	90	15	0.6	26.1	1	**1:50**	20.8	25	**2:15**
Little Rattlers Preschool & Childcare	90	15	0.4	26.1	1	**1:50**	20.8	25	**2:15**
SOMERVELL COUNTY									
North Central Texas Academy	90	15	9.9	50.0	12	**2:00**	13.8	17	**2:20**
Brazos River Charter School	90	15	3.2	50.0	4	**1:50**	13.8	17	**2:10**
Glen Rose Junior High School	10	10	10.1	48.9	12	**0:35**	23.3	28	**1:05**
Glen Rose High School	10	10	8.7	49.2	11	**0:35**	23.3	28	**1:05**
Glen Rose Elementary School	10	10	9.1	48.2	11	**0:35**	23.3	28	**1:05**

School/Day Care	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
Glen Rose Intermediate School	10	10	9.1	48.2	11	**0:35**	23.3	28	**1:05**
Grace Preschool	90	15	10.4	49.5	13	**2:00**	13.0	16	**2:20**
Glen Rose Early Head Start	90	15	9.6	49.5	12	**2:00**	13.0	16	**2:20**
Little Tigers Learning Center	90	15	10.4	49.5	13	**2:00**	13.0	16	**2:20**
Endless Discoveries Child Development Center	90	15	8.0	49.3	10	**1:55**	13.0	16	**2:15**
First United Methodist Preschool	90	15	9.1	49.5	11	**2:00**	13.0	16	**2:20**
Rockin' D Day Care	90	15	8.3	49.5	10	**1:55**	13.0	16	**2:15**
					Maximum for EPZ:	**3:25**		**Maximum:**	**4:00**
					Average for EPZ:	**1:45**		**Average:**	**2:15**

Table 8-6. Transit-Dependent Evacuation Time Estimates – Good Weather

Route Number	Bus Number	Single-Wave						Second-Wave						
		Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	1	135	7.9	50.0	9	30	**2:55**	23.3	28	5	10	47	30	**4:55**
2	1	135	8.9	50.0	11	30	**3:00**	13.0	16	5	10	37	30	**4:40**
3	1	135	2.3	50.0	3	30	**2:50**	13.0	16	5	10	22	30	**4:15**
4	1	135	13.2	50.0	16	30	**3:05**	23.3	28	5	10	60	30	**5:20**
5	1	135	14.1	10.9	78	30	**4:05**	20.8	25	5	10	59	30	**6:15**
6	1	135	6.7	4.7	86	30	**4:15**	20.8	25	5	10	41	30	**6:10**
7	2	135	4.3	6.0	43	30	**3:30**	23.7	28	5	10	40	30	**5:25**
8	1	135	10.7	50.0	13	30	**3:00**	13.0	16	5	10	42	30	**4:45**
9	1	135	7.1	7.9	54	30	**3:40**	23.7	28	5	10	45	30	**5:40**

Route Number	Bus Number	Single-Wave Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Second-Wave Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
10	1	135	3.7	3.5	64	30	**3:50**	20.8	25	5	10	35	30	**5:35**
11	1	135	5.9	41.5	9	30	**2:55**	23.3	28	5	10	43	30	**4:55**
12	1	135	1.0	33.2	2	30	**2:50**	18.4	22	5	10	25	30	**4:25**
						Maximum ETE:	**4:15**						**Maximum ETE:**	**6:15**
						Average ETE:	**3:20**						**Average ETE:**	**5:15**

Table 8-8. Medical Facility Evacuation Time Estimates - Good Weather

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
HOOD COUNTY								
Southern Concepts - South Town	Ambulatory	90	1	6	6	1.0	14	**1:50**
Southern Concepts - Meadowlark	Ambulatory	90	1	4	4	1.0	17	**1:55**
Harbor Lakes Nursing & Rehab	Ambulatory	90	1	20	20	1.3	2	**1:55**
	Wheelchair bound	90	5	30	75	1.3	2	**2:50**
	Bedridden	90	15	25	30	1.3	2	**2:05**
Lakestone Terrace Senior Living	Ambulatory	90	1	78	30	1.4	2	**2:05**
	Wheelchair bound	90	5	11	55	1.4	2	**2:30**
	Bedridden	90	15	1	15	1.4	2	**1:50**
Courtyards at Lake Granbury	Ambulatory	90	1	44	30	0.5	5	**2:05**
	Wheelchair bound	90	5	30	75	0.5	4	**2:50**
Southern Concepts - Torrey House	Ambulatory	90	1	6	6	1.3	2	**1:40**
Waterview The Point Independent Living	Ambulatory	90	1	186	30	11.9	17	**2:20**
	Wheelchair bound	90	5	24	75	11.9	18	**3:05**

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Waterview The Cove Assisted Living & Memory Care	Ambulatory	90	1	24	24	11.9	18	**2:15**
	Wheelchair bound	90	5	12	60	11.9	17	**2:50**
	Bedridden	90	15	2	30	11.9	18	**2:20**
Bridgewater Memory Care	Ambulatory	90	1	22	22	1.4	25	**2:20**
	Wheelchair bound	90	5	23	75	1.4	15	**3:00**
Granbury Care Center	Ambulatory	90	1	59	2	2.9	42	**2:15**
	Wheelchair bound	90	5	84	10	2.9	39	**2:20**
	Bedridden	90	15	2	30	2.9	30	**2:30**
Magnolia Court	Ambulatory	90	1	17	2	4.3	42	**2:15**
	Wheelchair bound	90	5	1	5	4.3	42	**2:20**
	Bedridden	90	15	13	30	4.3	31	**2:35**
Granbury Villa Nursing Center	Ambulatory	90	1	21	2	2.5	11	**1:45**
	Wheelchair bound	90	5	38	10	2.5	9	**1:50**
	Bedridden	90	15	3	30	2.5	11	**2:15**
SOMERVELL COUNTY								
Cherokee Rose Manor	Ambulatory	90	1	37	2	16.5	20	**1:55**
	Wheelchair bound	90	5	19	10	16.5	20	**2:00**
	Bedridden	90	15	4	30	16.5	20	**2:20**
Glen Rose Nursing and Rehab Center	Ambulatory	90	1	50	2	6.4	8	**1:40**
	Wheelchair bound	90	5	25	10	6.4	8	**1:50**
	Bedridden	90	15	5	30	6.4	8	**2:10**
Glen Rose Medical Center-Hospital	Ambulatory	90	1	52	2	8.2	12	**1:45**
	Wheelchair bound	90	5	27	10	8.2	10	**1:50**
	Bedridden	90	15	5	30	8.2	10	**2:10**
							Maximum ETE:	**3:05**
							Average ETE:	**2:15**

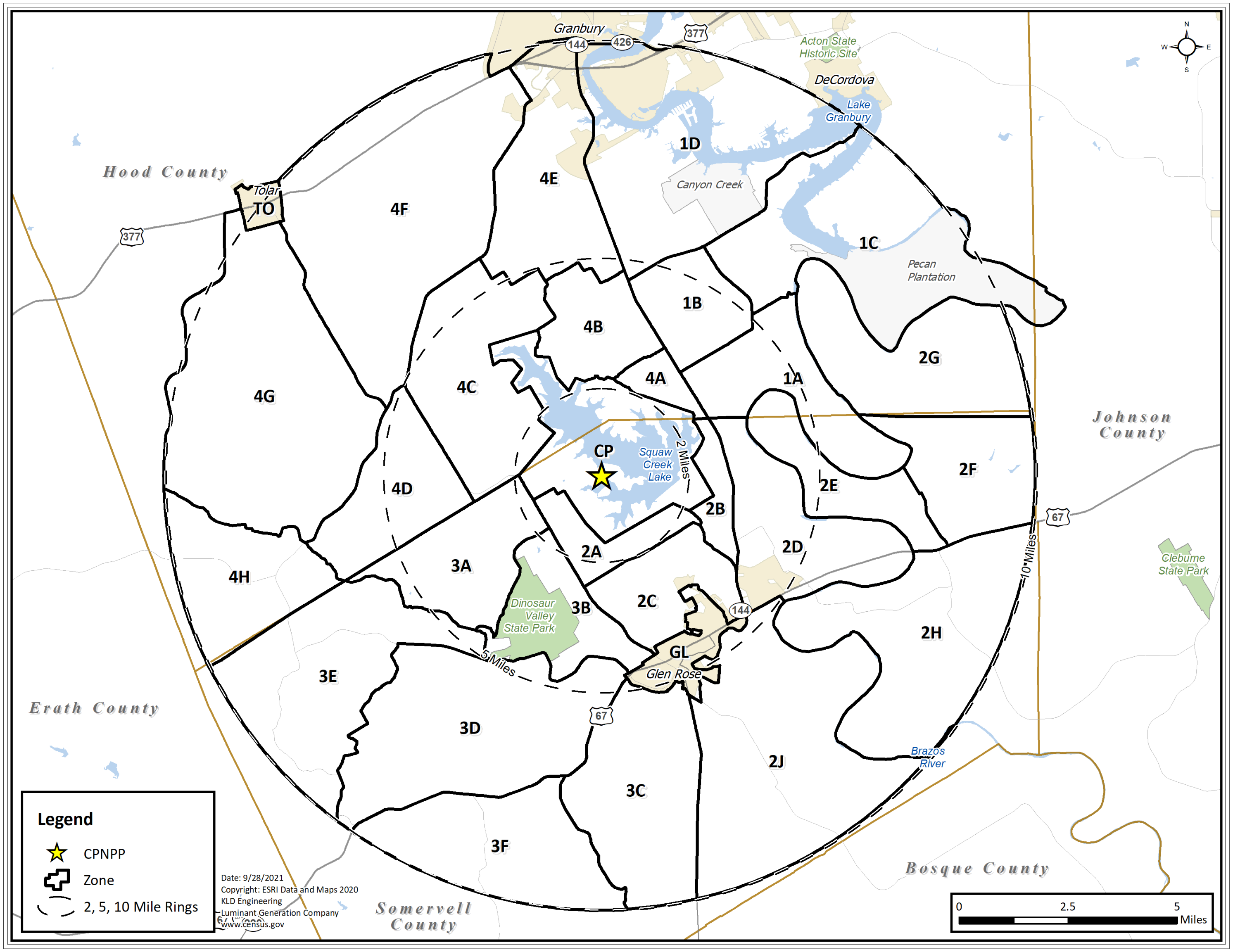


Figure 6-1. CPNPP EPZ Zones

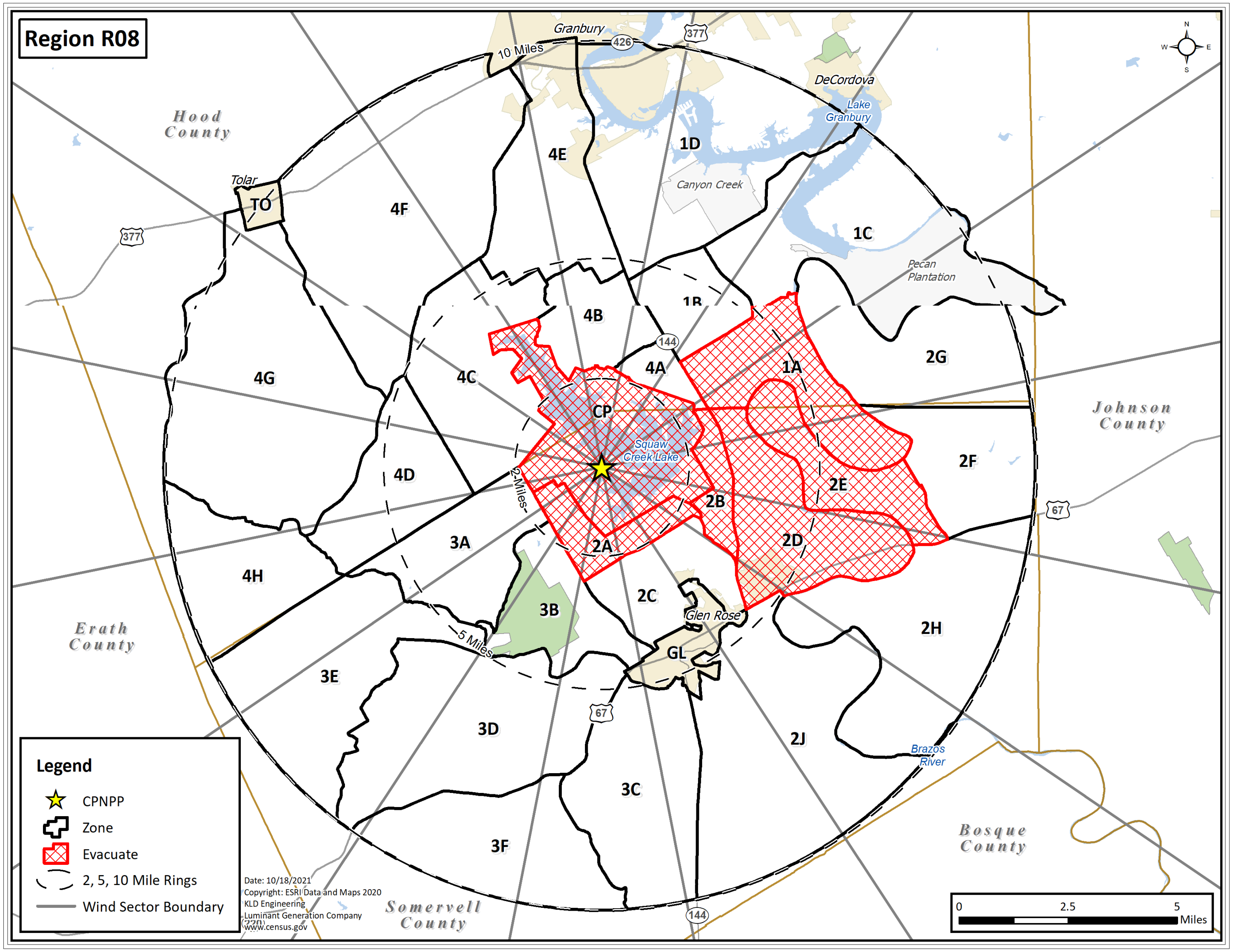


Figure H-8. Region R08

1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Comanche Peak Nuclear Power Plant (CPNPP), located in Somervell County, Texas. This ETE provide Vistra Operations Company LLC (Vistra OpCo), state and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Government agencies. Most important of these are:

- Title 10, Code of Federal Regulations, Appendix E to Part 50 (10CFR50), Emergency Planning and Preparedness for Production and Utilization Facilities, NRC, 2011.
- Revision 1 of the Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, February 2021.
- FEMA, "Radiological Emergency Preparedness Program Manual" (FEMA P-1028), December 2019.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

The work effort reported herein was supported and guided by local stakeholders who contributed suggestions, critiques, and the local knowledge base required. Table 1-1 presents a summary of stakeholders and interactions.

1.1 Overview of the ETE Process

The following outline presents a brief description of the work effort in chronological sequence:

1. Information Gathering:
    a. Defined the scope of work in discussions with representatives from Vistra OpCo.
    b. Attended a project kickoff meeting with emergency planners from Hood and Somervell Counties and the Texas Department of State Health Services to discuss methodology, project assumptions and to identify resources available.
    c. Conducted a detailed field survey of the highway system and of the area traffic conditions within the Emergency Planning Zone (EPZ) and Shadow Region.
    d. Obtained demographic data from the 2020 Census (See Section 3.1)
    e. Conducted a random sample demographic survey of EPZ residents.
    f. Conducted a data collection effort to identify and describe schools, special facilities, transient attractions, major employers, transportation providers, and other important information.
2. Estimated distributions of trip generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare

(mobilize) for the evacuation trip. These estimates are primarily based upon the random sample demographic survey.

3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, in trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Reviewed the existing traffic management plan to be implemented by local and state police in the event of an incident at the plant. Traffic control is applied at specified Traffic Control Points (TCP) and Access Control Points (ACP) located within the study area.

5. Used existing Zones to define Evacuation Regions as well as the Vistra OpCo Protective Action Recommendation (PAR) plan. The EPZ is partitioned into 30 Zones along jurisdictional and geographic boundaries. "Regions" are groups of contiguous Zones for which ETE are calculated. The configurations of these regions reflect wind direction and the radial extent of the impacted area. Each region, other than those that approximate circular areas, approximates a "keyhole section" within the EPZ and three or five adjoining sectors, each with a central angle of 22.5 degrees, as recommended by NUREG/CR-7002, Rev 1 and defined in CPNPP Protective Action Recommendations Procedure No. EPP-304.

6. Estimated demand for transit services for persons at special facilities and for transit-dependent persons at home.

7. Prepared the input streams for DYNEV II.
    a. Estimated the evacuation traffic demand, based on the available information derived from Census data, and from data provided by local and state agencies, Vistra OpCo and from the demographic survey.
    b. Applied the procedures specified in the 2016 Highway Capacity Manual (HCM[1] 2016) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.
    c. Updated the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.
    d. Calculated the evacuating traffic demand for each Region and for each Scenario.
    e. Specified selected candidate destinations for each "origin" (location of each "source" where evacuation trips are generated over the mobilization time) to support evacuation travel consistent with outbound movement relative to the location of the plant.

8. Executed the DYNEV II system to determine optimal evacuation routing and compute ETE for all residents, transients and employees ("general population") with access to private vehicles. Generated a complete set of ETE for all specified Regions and Scenarios.

9. Documented ETE in formats in accordance with NUREG/CR-7002, Rev 1.

[1] Highway Capacity Manual (HCM 2016), Transportation Research Board, National Research Council, 2016.

10. Calculated the ETE for all transit activities including those for special facilities (schools, preschools/daycares, day camps, medical facilities and correctional facility), for the transit-dependent population and for access and/or functional needs population.

1.2 The Comanche Peak Nuclear Power Plant Location

The CPNPP is located in Glen Rose, Somervell County, Texas, along the shores of the Squaw Creek Reservoir. The site is approximately 40 miles southwest of Fort Worth, Texas. The EPZ consists of parts of Somervell and Hood Counties in Texas. Figure 1-1 shows the location of the plant relative to Fort Worth. This map also identifies the communities in the area and the major roads.

1.3 Preliminary Activities

These activities are described below.

Field Surveys of the Highway Network

In 2020, KLD personnel drove the entire highway system within the EPZ and the Shadow Region which consists of the area between the EPZ boundary and approximately 15 miles radially from the plant. The characteristics of each section of highway were recorded. These characteristics are shown in Table 1-2.

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 15-7 in the HCM 2016 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 15-46 in the HCM 2016 shows little sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographical information systems (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 DYNEV II System.

Roadway types were assigned based on the following criteria:

- Freeway: limited access highway, 2 or more lanes in each direction, high free flow speeds
- Freeway Ramp: ramp on to or off of a limited access highway
- Major Arterial: 3 or more lanes in each direction
- Minor Arterial: 2 lanes in each direction
- Collector: single lane in each direction
- Local Roadway: single lane in each direction, local road with low free flow speeds

As documented on page 15-6 of the HCM 2016, the capacity of a two-lane highway is 1,700 passenger cars per hour in one direction. For freeway sections, a value of 2,250 vehicles per hour per lane is assigned, as per Exhibit 12-37 of the HCM 2016. The road survey has identified several segments which are characterized by adverse geometrics on two-lane highways which are reflected in reduced values for both capacity and speed. These estimates are consistent with the service volumes for LOS E presented in HCM 2016 Exhibit 15-46. Link capacity is an input to DYNEV II which computes the ETE. Further discussion of roadway capacity is provided in Section 4 of this report.

Traffic signals are either pre-timed (signal timings are fixed over time and do not change with the traffic volume on competing approaches), or are actuated (signal timings vary over time based on the changing traffic volumes on competing approaches). Actuated signals require detectors to provide the traffic data used by the signal controller to adjust the signal timings. These detectors are typically magnetic loops in the roadway, or video cameras mounted on the signal masts and pointed toward the intersection approaches. If detectors were observed on the approaches to a signalized intersection during the road survey, detailed signal timings were not collected as the timings vary with traffic volume. TCPs and ACPs at locations which have control devices are represented as actuated signals in the DYNEV II system.

If no detectors were observed, the signal control at the intersection was considered pre-timed, and detailed signal timings were gathered for several signal cycles. These signal timings were input to the DYNEV II system used to compute ETE, as per NUREG/CR-7002, Rev. 1 guidance.

Figure 1-2 presents the link-node analysis network that was constructed to model the evacuation roadway network in the EPZ and Shadow Region. The directional arrows on the links and the node numbers have been removed from Figure 1-2 to clarify the figure. The detailed figures provided in Appendix K depict the analysis network with directional arrows shown and node numbers provided. The observations made during the field survey were used to calibrate the analysis network.

<u>Demographic Survey</u>

An online demographic survey was performed in March 2022, to gather information needed for the ETE study. Appendix F presents the survey instrument, the procedures used, and tabulations of data compiled from the survey returns.

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

<u>Computing the Evacuation Time Estimates</u>

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data. The vehicle demand was loaded onto appropriate "source" links of the analysis network using GIS mapping software. The DYNEV II system was then used to compute ETE for all Regions and Scenarios.

Analytical Tools

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

DYNEV II consists of four sub-models:

- A macroscopic traffic simulation model (for details, see Appendix C).
- A Trip Distribution (TD), model that assigns a set of candidate destination (D) nodes for each "origin" (O) located within the analysis network, where evacuation trips are "generated" over time. This establishes a set of O-D tables.
- A Dynamic Traffic Assignment (DTA), model which assigns trips to paths of travel (routes) which satisfy the O-D tables, over time. The TD and DTA models are integrated to form the DTRAD (Dynamic Traffic Assignment and Distribution) model, as described in Appendix B.
- A Myopic Traffic Diversion model which diverts traffic to avoid intense, local congestion, if possible.

Another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System) was used to expedite data entry and to automate the production of output tables.

The dynamics of traffic flow over the network are graphically animated using the software product, EVAN (EVacuation ANimator), developed by KLD. EVAN is GIS based, and displays statistics such as LOS, vehicles discharged, average speed, and percent of vehicles evacuated, output by the DYNEV II System. The use of a GIS framework enables the user to zoom in on areas of congestion and query road name, town name and other geographical information.

The procedure for applying DYNEV II within the framework of developing ETE is outlined in Appendix D. Appendix A is a glossary of terms.

For the reader interested in an evaluation of the original model, I-DYNEV, 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

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths of travel that will expedite their travel from their respective points of origin to points outside the EPZ.
- Restrict movement toward the plant to the extent practicable and disperse traffic demand so as to avoid focusing demand on a limited number of highways.
- Move traffic in directions that are generally outbound, relative to the location of the plant.

DYNEV II provides a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to represent the behavioral responses of evacuees. The effects of these countermeasures may then be tested with the model.

1.4 Comparison with Prior ETE Study

Table 1-3 presents a comparison of the present ETE study with the 2012 ETE study (KLD TR-589, Rev. 1, dated December 2012). The 90th percentile ETE for the entire EPZ (Region R03) increased by at most 1 hour and 10 minutes for all non-scenarios except for special scenarios (Special Event & Roadway Impact), which increased at most by 1 hour and 55 minutes. The 100th percentile ETE for the full EPZ increased by 1 hour for all scenarios except for Scenario 11 (Special Event) and Scenario 12 (Roadway Impact). The 100th percentile ETE for Scenario 11 and Scenario 12 has increased by 1 hour and 30 minutes and 1 hour 55 minutes, respectively.

The factors contributing to the differences between the ETE values obtained in this study and those of the previous study are:

- The permanent resident population in the EPZ has increased by approximately 16%, resulting in additional vehicles, which can increase the ETE.
- The Shadow Region permanent resident population has increased by approximately 21%, resulting in additional vehicles evacuating in the Shadow Region, which decreases the available roadway capacity for EPZ evacuees and can increase the ETE.
- Trip-generation time increased by at most 1 hour for the permanent residents based on data collected from the demographic survey. As a result, vehicles are generated over a longer period of time which can decrease local congestion decreasing the 90th percentile ETE. This trip generation increase is directly correlated with the increase of the 100th percentile ETE for non-special scenarios. During non-special scenarios, for this site, since all congestion clears prior to the end of the trip generation time, the 100th percentile ETE is dictated by the time needed to mobilize (plus a 10-minute travel time to the EPZ boundary).

The various factors, discussed above, that can increase ETE outweigh those that can decrease the ETE, thereby explaining why the 90th percentile and the 100th percentile ETEs for the full EPZ increased for all scenarios in this study, relative to the 2012 ETE Study.

Table 1-1. Stakeholder Interaction

Stakeholder	Nature of Stakeholder Interaction
Vistra Operations Company LLC (Vistra OpCo)	Attended kick-off meetings to define methodology and data requirements. Set up contacts with local government agencies. Provided recent CPNPP employee data. Reviewed and approved all project assumptions. Engaged in the ETE development and was informed of the study results.
Hood and Somervell County Emergency Management Offices	Attended kick-off meeting to discuss the project methodology, key project assumptions and to define data needs. Provided emergency plans, and existing traffic management plans. Provided/confirmed special facility and special event data. Reviewed and approved all project assumptions. Engaged in the ETE development and were informed of the study results.
Texas Department of State Health Services	Attended kick-off meetings to define methodology and data requirements. Provided recent emergency plans. Reviewed and approved all project assumptions and was informed of the study results.
Texas Department of Transportation (TXDOT)	Obtain traffic data from TXDOT GIS website for the external traffic.

Table 1-2. Highway Characteristics

- Number of lanes
- Lane width
- Shoulder type & width
- Interchange geometries
- Lane channelization & queuing capacity (including turn bays/lanes)
- Geometrics: curves, grades (>4%)
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Intersection configuration (including roundabouts where applicable)
- Traffic signal type
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, toll booths, etc.

Table 1-3. ETE Study Comparisons

Topic	Previous ETE Study	Current ETE Study
Resident Population Basis	ArcView GIS Software using 2010 US Census blocks and area ratio method. Population = 35,199	ArcGIS Software using 2020 US Census blocks; area ratio method used. Population = 40,869
Resident Population Vehicle Occupancy	2.21 persons/household, 1.29 evacuating vehicles/household yielding: 1.71 persons/ vehicle.	2.57 persons/household, 1.44 evacuating vehicles/household yielding: 1.78 persons/ vehicle.
Employee Population	Employee and transient estimates based on information provided by the counties. 1.02 employees/vehicle based on phone survey results. Employees = 1,382	Employee estimates based on information provided about major employers in EPZ. 1.08 employees per vehicle based on demographic survey results. Employees = 534
Transit-Dependent Population	Estimates based upon 2010 U.S. Census data and the results of the telephone survey. A total of 627 people who do not have access to a vehicle, requiring 21 buses to evacuate. An additional 80 access and/or functional needs population needed special transportation to evacuate (44 require a bus, 36 require a wheelchair accessible vehicle).	Estimates based upon 2020 U.S. Census data and the results of the demographic survey. A total of 120 people who do not have access to a vehicle, requiring 13 buses to evacuate. An additional 66 access and/or functional needs population needed special transportation to evacuate (32 require a bus, 23 require a wheelchair accessible vehicle and 11 require ambulances).
Transient Population	Transient estimates based upon information provided about transient attractions in EPZ. Transients = 17,787	Transient estimates based upon information provided about transient attractions in EPZ. Transients = 20,568

Topic	Previous ETE Study	Current ETE Study
Special Facilities Population	Special facility population based on information provided by each county within the EPZ. **Medical Facilities:** Current census = 875 Buses Required = 15 Minibuses = 61 Wheelchair Bus/Vans Required = 5 Ambulances Required = 5 **Correctional Facilities:** Total Population: 32 Buses Required: 2	Special facility population based on information provided by each county within the EPZ, the previous ETE study and supplemented by internet searches. **Medical Facilities:** Current census = 1,026 Buses Required = 15 Minibuses = 30 Wheelchair Bus/Van Required = 17 Ambulances Required = 39 **Correctional Facilities:** Total Population: 32 Buses Required: 2
School, Preschool/Daycare, and Day Camp Population	School, Preschool/Daycare, and Day Camp population based on information provided by each county within the EPZ. **Schools:** School enrollment = 4,171 Buses required = 79 **Preschool/Daycares:** Daycare enrollment = 217 Buses required = 5 **Day Camps:** Day Camp enrollment = 2,121 Day Camp Buses = 42	School, Preschool/Daycare, and Day Camp population based on information provided by each county within the EPZ. **Schools:** School enrollment = 6,436 Buses required = 125 **Preschool/Daycares:** Daycare enrollment = 635 Buses required = 15 **Day Camps:** Day Camp enrollment = 2,221 Day Camp Buses = 44
Voluntary evacuation from within EPZ in areas outside region to be evacuated	20% of the population within the EPZ, but not within the Evacuation Region	20% of the population within the EPZ, but not within the Evacuation Region (see Figure 2-1)
Shadow Population/Evacuation	20% of people outside of the EPZ within the Shadow Region Population = 22,924	20% of people outside of the EPZ within the Shadow Region (see Figure 7-2) Population = 27,644
Network Size	1,308 links; 876 nodes	1,680 links; 1,170 nodes

Topic	Previous ETE Study	Current ETE Study
Roadway Geometric Data	Field surveys conducted in April 2012. Roads and intersections were video archived. Road capacities based on HCM 2010.	Field surveys conducted in March 2022. Roads and intersections were video archived. Aerial imagery used for additional roadways which were not included in the field surveys. Road capacities based on the HCM 2016.
School Evacuation	Reception Center first for monitoring, then to a Host School.	Direct evacuation to relocation schools
Ridesharing	50% of transit-dependent persons will evacuate with a neighbor or friend.	77% of transit-dependent persons will evacuate with a neighbor or friend based on the results of the demographic survey
Trip Generation for Evacuation	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 240 minutes. Residents without commuters returning leave between 15 and 180 minutes. Employees and transients leave between 15 and 105 minutes. All times measured from the Advisory to Evacuate.	Based on demographic survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 300 minutes. Residents without commuters returning leave between 15 and 225 minutes. Employees and transients leave between 15 and 105 minutes. All times measured from the Advisory to Evacuate.
Weather	Normal or Rain. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain.	Normal or Rain. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain.
Modeling	DYNEV II System – Version 4.0.0.0	DYNEV II System – Version 4.0.21.0
Special Events	4th of July in Granbury Special Event Population = 11,303 additional transients	4th of July in Granbury Special Event Population = 11,097 additional transients
Evacuation Cases	92 Regions (central sector wind direction and each adjacent sector technique used) and 12 Scenarios producing 1,104 unique cases.	92 Regions (central sector wind direction and each adjacent sector technique used) and 12 Scenarios producing 1,104 unique cases.

Topic	Previous ETE Study	Current ETE Study
Evacuation Time Estimates Reporting	ETE reported for 90th and 100th percentile population. Results presented by Region and Scenario.	ETE reported for 90th and 100th percentile population. Results presented by Region and Scenario.
Evacuation Time Estimates for the entire EPZ, 90th percentile	Winter Midweek Midday, Good Weather: 2:25 Rain: 2:40 Summer Weekend, Midday, Good Weather: 2:25 Rain: 2:35	Winter Midweek Midday, Good Weather: 3:20 Rain:3:40 Summer Weekend, Midday, Good Weather: 3:35 Rain: 3:45
Evacuation Time Estimates for the entire EPZ, 100th percentile	Winter Midweek Midday, Good Weather: 4:10 Rain: 4:10 Summer Weekend, Midday, Good Weather: 4:10 Rain: 4:10	Winter Midweek Midday, Good Weather: 5:10 Rain: 5:10 Summer Weekend, Midday, Good Weather: 5:10 Rain: 5:10

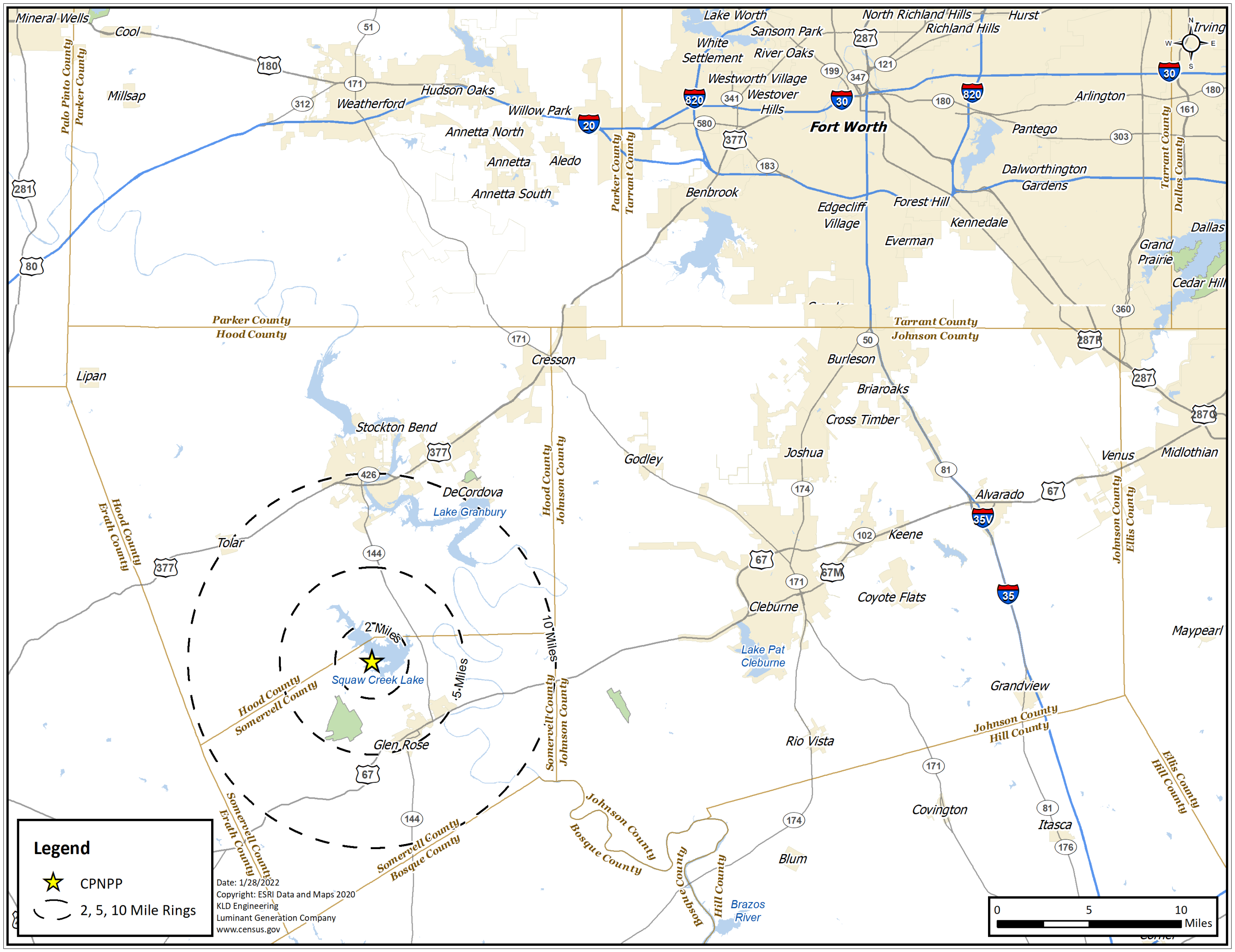


Figure 1-1. CPNPP Location

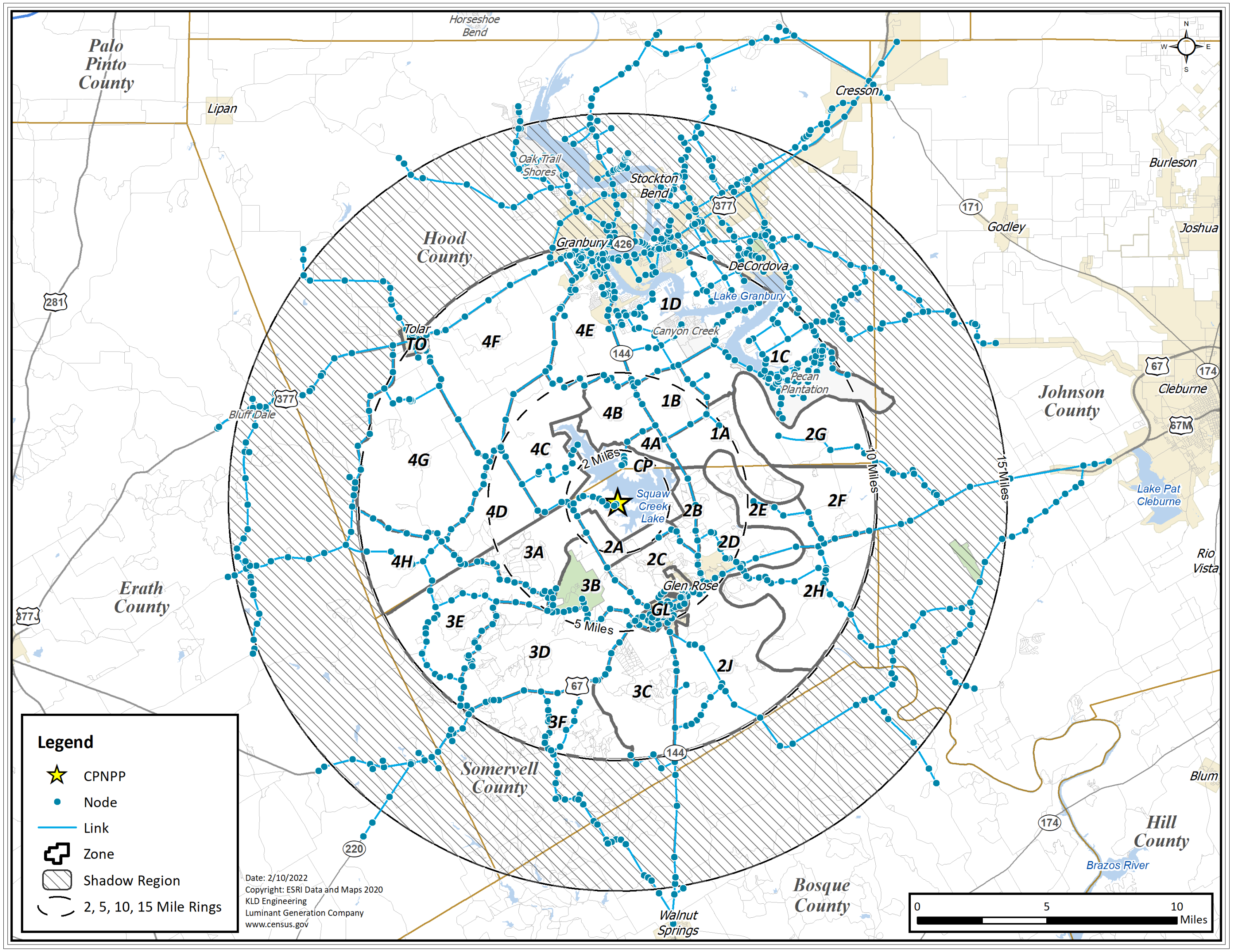


Figure 1-2. CPNPP Link-Node Analysis Network

2 STUDY ESTIMATES AND ASSUMPTIONS

This section presents the estimates and assumptions utilized in the development of the evacuation time estimates (ETE).

2.1 Data Estimate Assumptions

1. The permanent resident population are based on the 2020 U.S. Census population from the Census Bureau website[1]. A methodology, referred to as the "area ratio method", is employed to estimate the population within portions of census blocks that are divided by Zone boundaries. It is assumed that the population is evenly distributed across a census block in order to employ the area ratio method. (See Section 3.1.)
2. Estimates of employees who reside outside the Emergency Planning Zone (EPZ) and commute to work within the EPZ are based upon data provided by Vistra OpCo, each county and the data from the previous ETE study (confirmed by Hood and Somervell Counties). (See Section 3.4.)
3. Population estimates at transient and special facilities are based on the data received from the counties within the EPZ and the previous ETE study (confirmed by the counties), supplemented by phone calls and internet searches where data was missing.
4. The relationship between permanent resident population and evacuating vehicles are based on the results of the demographic survey (see Appendix F). Values of 2.57 persons per household (Figure F-1) and 1.44 evacuating vehicles per household (Section F.3.1) are used for the permanent resident population.
5. Employee vehicle occupancies are based on the results of the demographic survey. For this study, 1.08 employees per vehicle is used. In addition, it is assumed there are two people per carpool, on average (See Figure F-7).
6. The relationship between persons and vehicles for transients (see Section 3.3) and the special event (see Section 3.9) are as follows:
    a. Transients on average have an occupancy of 2.17 persons per vehicle (occupancy varies depending on the type of facility. See Section 3.3 and Appendix E.)
    b. Special Event (see Section 3.9): Transients attending the 4th of July in Granbury has an occupancy of 3 people per vehicle.
    c. Where data was not provided, the average household size is assumed to be the vehicle occupancy rate for transient facilities and the special event.
7. The maximum bus speed assumed within the EPZ is 50 mph (based on Texas Transportation Code[2]) for school buses and average posted speed limits on roadways within the EPZ.

[1] www.census.gov
[2] https://texas.public.law/statutes/tex._transp._code_section_545.352

8. Roadway capacity estimates are based on field surveys performed in 2021 (verified by aerial imagery) and the application of the Highway Capacity Manual 2016.

2.2 Methodological Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following[3] (as per NRC guidance):
    a. Advisory to Evacuate (ATE) is announced coincident with the Alert and Notification system.
    b. Mobilization of the general population will commence within 15 minutes after the notification.
    c. The ETE are measured relative to the ATE.
2. The center-point of the plant is located at 32°17'53.2"N, 97°47'08.4"W.
3. The DYNEV II[4] (Dynamic Network Evacuation) macroscopic simulation model is used to compute ETE in this study.
4. Evacuees will drive safely, travel radially away from the plant to the extent practicable given the highway network, and obey all control devices and traffic guides. All major evacuation routes are used in the analysis.
5. The existing EPZ and Zone boundaries are used. See Figure 3-1.
6. The Shadow Region extends to 15 miles radially from the plant or approximately 5 miles radially from the EPZ boundary, as per NRC guidance. See Figure 7-2.
7. One hundred percent (100%) of the people within the impacted keyhole will evacuate. Twenty percent (20%) of the population within the Shadow Region and within Zones of the EPZ not advised to evacuate will voluntarily evacuate, as shown in Figure 2-1 as per NRC guidance. Sensitivity studies explore the effect on ETE of increasing the percentage of voluntary evacuees in the Shadow Region (see Appendix M).
8. Shadow population characteristics (household size, evacuating vehicles per household, and mobilization time) is assumed to be the same as that of the permanent resident population within the EPZ.
9. The ETE are presented at the 90th and 100th percentiles, as well as in graphical and tabular format, as per NRC guidance. The percentile ETE is defined as the elapsed time from the ATE issued to a specific Region of the EPZ, to the time that Region is clear of the indicated

[3] We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:
1. Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Section 2.13 of NUREG/CR-6863.
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is likely that a longer time will elapse between the various stages of an emergency. See Section 5.1 for more detail.

[4] The models of the I-DYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment.

percentile of evacuees.

10. The ETE also includes consideration of "through" (External-External) trips during the time that such traffic is permitted to enter the evacuated Region. See Section 3.10.
11. This study does not assume that roadways are empty at the start of the first time period. Rather, there is a 50-minute initialization period (often referred to as "fill time" in traffic simulation) wherein the traffic volumes from the first time period are loaded onto roadways in the study area. The amount of initialization/fill traffic that is on the roadways in the study area at the start of the first time period depends on the scenario and the region being evacuated. See Section 3.11.
12. To account for boundary conditions beyond the study area, this study assumed a 25 percent (%) reduction in capacity on two-lane roads and multi-lane highways for roadways that have traffic signals downstream. The 25% reduction in capacity is based on the prevalence of actuated traffic signals in the study area and the fact that the evacuating traffic volume will be more significant than the competing traffic volume at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time. There is no reduction in capacity for freeways due to boundary conditions.

2.3 Assumptions on Mobilization Times

1. Trip generation time (also known as mobilization time, or the time required by evacuees to prepare for the evacuation) are based upon the results of the demographic survey (see Section 5 and Appendix F). It is assumed that stated events take place in sequence such that all preceding events must be completed before the current event can occur.
2. One hundred percent (100%) of the EPZ population can be notified within 45 minutes, in accordance with the 2019 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness Program Manual.
3. Commuter percentages (and percentage of residents awaiting the return of a commuter) are based on the results of the demographic survey. According to the survey results, approximately 56% of the households in the EPZ have at least 1 commuter (see Section F.3.1); 57.7% of those households with commuters will await the return of a commuter before beginning their evacuation trip (see Section F.3.2.). Therefore, 32.3% (56% x 57.7% = 32.3%) of EPZ households will await the return of a commuter, prior to beginning their evacuation trip.

2.4 Transit Dependent Assumptions

1. The percentage of transit-dependent people who will rideshare with a neighbor or friend will be based on the results of the demographic survey. According to the survey results, approximately 77% of the transit-dependent population will rideshare.

2. Transit vehicles are used to transport those without access to private vehicles:
   a. Schools, Pre-schools/Day Cares and Day Camps
      i. If schools, Pre-schools/Day Cares are in session, transport (buses) will evacuate students directly to the designated relocation schools.
      ii. If day camps are in session, transport (buses) will evacuate children to the nearest reception center.
      iii. For the schools, pre-schools/day cares, and day camp children are evacuated via buses, it is assumed no children will be picked up by their parents prior to the arrival of the buses.
      iv. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
   b. Medical Facilities
      i. Buses, minibuses, vans, passenger cars, wheelchair buses, wheelchair vans and ambulances will evacuate patients at medical facilities and at any senior facilities within the EPZ, as needed.
      ii. The percent breakdown of ambulatory, wheelchair bound, and bedridden patients for most medical facilities were determined using medical facilities with similar capacities to determine the number of ambulatory, wheelchair bound and bedridden patients at the medical facilities.
   c. Transit-dependent permanent residents:
      i. The transit-dependent permanent resident population are evacuated to reception centers.
      ii. The access and/or functional needs population may require county assistance (ambulance, bus or wheelchair transport) to evacuate. This is considered separately from the general population ETE, as per NRC guidance (see Section 8).
      iii. Households with 3 or more vehicles were assumed to have no need for transit vehicles.
   d. Somervell County Jail (Correctional Facility):
      i. Inmates at Somervell County Jail are transported to a comparable facility (i.e., Johnson County Correctional Facility).
   e. Analysis of the number of required round-trips (“waves”) of evacuating transit vehicles is presented.
   f. Transport of transit-dependent evacuees from reception centers to congregate care centers is not considered in this study.

3. Transit vehicle capacities:
    a. School buses = 65 students per bus for primary schools/pre-schools/day cares/Stevens Ranch Day Camp and 50 students per bus for middle/high schools/day camps.
    b. Transit-dependent persons, inmates, and ambulatory medical facility patients = 30 persons per bus
    c. Ambulances = 2 bedridden persons (includes advanced and basic life support)
    d. Minibuses = 25 Ambulatory and 4 wheelchair bound persons
    e. Wheelchair vans = 4 wheelchair bound persons
    f. Wheelchair buses = 15 wheelchair bound persons
4. Transit vehicles mobilization times, which are considered in ETE calculations:
    a. Tolar Independent School District (ISD), North Central Texas Academy, Brazos River Charter School, pre-schools/day cares, and day camps arrive at facilities to be evacuated within 90 minutes of the ATE. Glen Rose ISD and Granbury ISD buses are mobilized within 10 minutes of the ATE.
    b. Transit-dependent buses are mobilized when approximately 87% of residents with no commuters have completed their mobilization at 135 minutes.
    c. Vehicles will arrive at hospitals, medical facilities, and senior living facilities to be evacuated within 90 minutes of the ATE.
    d. Buses arrive at Somervell County Jail within 90 minutes of the ATE.
5. Transit Vehicle loading times:
    a. School/Day Care/Day Camp buses are loaded in 15 minutes (10 minutes for Glen Rose ISD and Granbury ISD).
    b. Transit-dependent and Somervell County Jail buses require 1 minute of loading time per passenger.
    c. Buses for hospitals and medical/senior facilities require 1 minute of loading time per ambulatory passenger.
    d. Wheelchair transport vehicles require 5 minutes of loading time per passenger.
    e. Ambulances are loaded in 15 minutes per bedridden passenger.
    f. Concurrent loading on multiple buses/transit vehicles is assumed.
6. It is assumed that drivers for all transit vehicles identified in Table 8-1 are available.

2.5 Traffic and Access Control Assumptions

1. Traffic Control Points (TCPs) and Access Control Points (ACPs) as defined in the approved county and state emergency plans are considered in the ETE analysis, as per NRC guidance. See Appendix G.
2. The TCPs and ACPs are assumed to be staffed approximately 120 minutes after the ATE, as per NRC guidance. Earlier activation of ACPs could delay returning commuters. It is assumed that no through traffic will enter the EPZ after this 120-minute time period.

3. It is assumed that all transit vehicles and other responders entering the EPZ to support the evacuation are unhindered by personnel manning TCPs.

2.6 Scenarios and Regions

1. A total of 12 "Scenarios" representing different temporal variations (season, time of day, day of week) and weather conditions are considered. Scenarios to be considered are defined in Table 2-1:
    a. Fourth of July at Granbury, located in Zones 1D, 4E, and portions within the Shadow Region, is considered as the special event (single or multi-day event that attracts a significant population into the EPZ; recommended by NRC guidance) for Scenario 11.
    b. As per NRC guidance, one of the top 5 highest volume roadways must be closed or one lane outbound on a freeway must be closed for a roadway impact scenario. This study considers the closure of a single lane on US 377 Northbound (NB) from TX 144 to slightly east of Farm to Market (FM) 167 and a single lane on US 67 NB from FM 205 to TX 144 and CR 316 to CR 1119 for the roadway impact scenario – Scenario 12.
2. One type of adverse weather scenario is considered. Rain may occur for either winter or summer scenarios. It is assumed that the rain begins earlier or at about the same time the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed. It is assumed that roads are passable.
3. Adverse weather scenarios affect roadway capacity and the free flow highway speeds. Transportation research indicates capacity and speed reductions of about 10% for rain. For this study, the capacity and free flow speed are reduced by 10% for rain, in accordance with Table 3-1 of NUREG/CR-7002, Rev. 1. The factors are shown in Table 2-2.
4. It is assumed that employment is reduced slightly (4% reduction) in the summer for vacations.
5. It is also assumed that mobilization and loading times for transit vehicles are slightly longer in adverse weather. It is assumed that mobilization times are 10 minutes longer in rain. It is assumed that loading times are 5 minutes (for schools, preschools/day cares, day camps) and 10 minutes (for transit-dependent buses) longer in rain. Refer to Table 2-2.
6. Regions are defined by the underlying "keyhole" or circular configurations as specified in Section 1.4 of NUREG/CR-7002, Rev. 1 and the PAR provided by Vistra OpCo. These Regions, as defined, display irregular boundaries reflecting the geography of the Zones included within these underlying configurations. All 16 cardinal and intercardinal wind direction keyhole configurations are considered. Three adjoining sectors (as per guidance) and five adjoining sectors (as per PAR) are considered. Three adjoining sector Regions to be considered are defined in Table 6-1 and Table 6-2. Five adjoining sector Regions to be

considered are defined in Table 6-3 and Table 6-4. It is assumed that everyone within the group of Zones forming a Region that is issued an ATE will, in fact, respond and evacuate in general accord with the planned routes

7. Staged evacuation is considered as defined in NUREG/CR-7002, Rev. 1 and PAR – those people between 2 and 5 miles will shelter-in-place until 90% of the 2-Mile Region has evacuated, then they will evacuate. See Regions R64 through R92 in Table 6-4.

Table 2-1. Evacuation Scenario Definitions

Scenario	Season[5]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Weekend	Midday	Good	Special Event: Fourth of July in Granbury
12	Summer	Midweek	Midday	Good	Roadway Impact: Single lane closure on US 377 NB and on US 7 NB

Table 2-2. Model Adjustment for Adverse Weather

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time for General Population	Mobilization Time for all Transit Vehicles	Loading Time for School/Pre-school/Daycare/Day Camp Buses	Loading Time for Other Transit Vehicles
Rain	90%	90%	No Effect	10-minute increase	5-minute increase	10-minute increase
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.						

[5] Winter means that school is in session, at normal enrollment levels (also applies to spring and autumn). Summer means that school is in session at summer school enrollment levels (lower than normal enrollment).

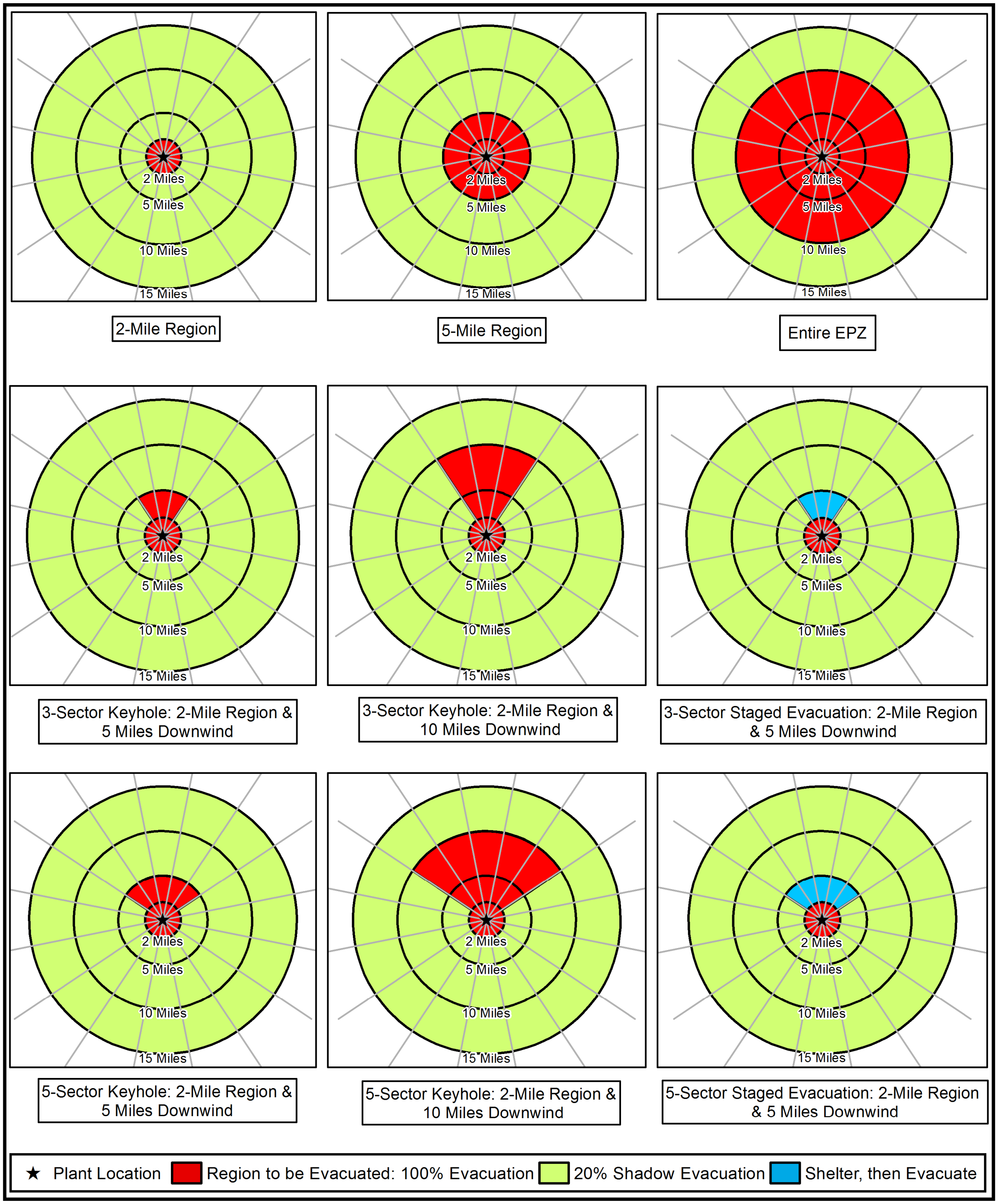


Figure 2-1. Voluntary Evacuation Methodology

3 DEMAND ESTIMATION

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

1. An estimate of population within the EPZ, stratified into groups (e.g., resident, employee, transient, special facilities, etc.).
2. An estimate, for each population group, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.
3. An estimate of potential double-counting of vehicles.

Appendix E presents much of the source material for the population estimates. Our primary source of population data, the 2020 Census, is not adequate for directly estimating some transient groups.

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

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

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

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. Estimating counts of vehicles by simply adding up the capacities of different types of parking facilities will tend to overestimate the number of transients and can lead to ETE that are too conservative.

Analysis of the population characteristics of the CPNPP EPZ indicates the need to identify three distinct groups:

- Permanent residents - people who are year round residents of the EPZ.
- Transients - people who reside outside of the EPZ who enter the area for a specific purpose (shopping, recreation) and then leave the area.
- Employees - people who reside outside of the EPZ and commute to work within the EPZ on a daily basis.

Estimates of the population and number of evacuating vehicles for each of the population groups are presented for each Zone and by polar coordinate representation (population rose). The CPNPP EPZ is subdivided into 30 Zones. The Zones comprising the EPZ is shown in Figure 3-1.

3.1 Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. with an availability date of September 16, 2021. The average household size (2.57 persons/household – was estimated based on the 2021 demographic survey - see Appendix F, Sub-section F.3.1). The number of evacuating vehicles per household (1.44 vehicles/household – See Appendix F, Sub-section F.3.2) was adapted from the demographic survey.

The permanent resident population is estimated by cutting the census block polygons by the Zone and EPZ boundaries using GIS software. A ratio of the original area of each census block and the updated area (after cutting) is multiplied by the total block population to estimate the population within the EPZ. The methodology (referred to as the "area ratio method") assumes that the population is evenly distributed across a census block. Table 3-1 provides permanent resident population within the EPZ, by Zone, for 2010 and for 2020 (based on the methodology above). As indicated, the permanent resident population within the EPZ has increased by 16.11% since the 2010 Census.

To estimate the number of vehicles, the 2020 Census permanent resident population is divided by the average household size (2.57 persons/household) and multiplied by the average number of evacuating vehicles per household (1.44 vehicles/household). Permanent resident population and vehicle estimates are presented in Table 3-2. Figure 3-2 and Figure 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from CPNPP. This population "rose" was constructed using GIS software. Note, the 2020 Census includes residents living in group quarters, such as skilled nursing facilities, group homes, prisons, etc. These people are transit dependent (will not evacuate in personal vehicles) and are included in the special facility evacuation demand estimates. To avoid double counting vehicles, the vehicle estimates for these people have been removed. The resident vehicles in Table 3-2 and Figure 3-3 have been adjusted accordingly.

3.2 Shadow Population

A portion of the population living outside the evacuation area extending to 15 miles radially from the CPNPP may elect to evacuate without having been instructed to do so. This area is called the Shadow Region. Based upon NUREG/CR-7002, Rev. 1 guidance, it is assumed that 20 percent of the permanent resident population, based on U.S. Census Bureau data, in the Shadow Region will elect to evacuate.

Shadow population characteristics (household size, evacuating vehicles per household, mobilization time) are assumed to be the same as those for the EPZ permanent resident population. Table 3-3, Figure 3-4, and Figure 3-5 present estimates of the shadow population and vehicles, by sector. Similar to the EPZ resident vehicle estimates, resident vehicles at group quarters have been removed from the shadow population vehicle demand in Table 3-3 and Figure 3-5.

3.3 Transient Population

Transient population groups are defined as those people (who are not permanent residents, nor commuting employees) who enter the EPZ for a specific purpose (e.g., shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. Data for transient facilities was reviewed and updated by the counties within the EPZ, supplemented by the previous ETE study and internet searches where data was missing. The average transient vehicle occupancy rates vary by facility from 1 person per vehicle to 5 persons per vehicle. Note, recreational vehicles (RVs) at campgrounds are treated as 2 vehicles due to their larger size and more sluggish operating characteristics. The transient facilities within the CPNPP EPZ are as follows:

- Campgrounds
- Parks
- Golf Courses
- Marinas
- Other Recreational Facilities
- Lodging Facilities
- Major Retail Facilities

There are a number of campgrounds and RV parks within the study area. Data from the previous study was reviewed and updated by the counties within the EPZ. Several new campgrounds and RV parks were identified within the study area. The estimates of transients and transient vehicles for each new facility were provided by the counties. A total of 2,090 transients and 1,252 vehicles are assigned to campgrounds and RV parks within the study area – an average of 1.67 transients per vehicle.

Some of the camping facilities have 1 to 2 week long summer day camps. Individuals attending these camps are either dropped off by parents or bussed to the facility. The ETE for day camps is computed separately in Section 8 and discussed in Section 3.7, since the children at these day camps are considered transit dependents.

There are a couple of parks within the EPZ. Data from the previous study was reviewed by the counties within the EPZ and confirmed the data was still accurate. Four new parks were identified within the EPZ and the estimates of transients and transient vehicles for each new park were provided by the counties. A total of 1,984 transients and 867 vehicles are assigned to parks within the EPZ – an average of 2.29 transients per vehicle.

There are four golf courses within the EPZ. Data of the pre-existing golf course in Somervell County was reviewed by the county and confirmed the data was still accurate. Hood County identified three new golf courses within the EPZ and provided the estimates of transients and transient vehicles for each new golf course. A total of 900 transients and 900 vehicles are assigned to the golf courses within the EPZ – an average of 1.00 transient per vehicle.

There are four marinas within the EPZ. Data of the pre-existing marina in Hood County was reviewed by the county and confirmed the data was still accurate. An additional three new

marinas were identified in Hood County portion of the EPZ. The estimates of transients and transient vehicles for each new marina were provided by Hood County. A total of 298 transients and 274 vehicles are assigned to the marinas within the EPZ – an average of 1.09 transients per vehicle.

There are four other recreational facilities as well within the EPZ. There is one museum in the Somervell County portion of the EPZ. Data from the previous study was reviewed by the county and confirmed the data was still accurate. A drive-in movie theater was identified in the Hood County portion of the EPZ. The parking capacity was obtained from the facility website. It is assumed that transients would drive to the theater as a family/household. As such, the average household size of 2.57 persons per household (see Section 3.1) was used to estimate the number of transients. In addition, there are two event centers that attract the largest number of transients into the EPZ – Somervell County Expo Center and Texas Amphitheatre:

- The Somervell County Expo Center is located in Zone Glen Rose and is a multi-purpose event center which hosts a variety of events, such as horse shows, exhibits, concerts, dances, and stage shows. It has a large indoor arena, a show barn, equestrian fields, two outdoor arenas, and a pavilion (multi-purpose area in which portable stalls, cattle pens or an arena can be constructed). It has an exposition hall which may be used for banquets, wedding receptions, and meetings. The Expo Center is used year-round on weekends and weekdays.
- The Texas Amphitheatre is located in Zone 2C is used for special events and is only considered during the winter weekend scenarios, which include spring and fall months, since the facility is only open on weekends in April and between September and November.
- The data from the previous study confirmed by the county, included the capacity, percent of transients traveling from outside of the EPZ, and the average vehicle occupancy rate for each event center. This data was used to estimate the number of transients and evacuating vehicles at these two facilities.

In total, an estimate of 9,321 transients and 3,130 transient vehicles are assigned to the museum, drive-in theater and the two event centers – an average of 2.98 transients per vehicle.

There are numerous lodging facilities in Hood County and Somervell County. Data from the previous study was reviewed and updated by the counties. A couple of new lodging facilities were identified within the EPZ. The estimates of transients and transient vehicles for new lodging facilities were provided by the counties and supplemented by internet searches. A total of 4,100 transients and 1,933 vehicles are assigned to lodging facilities – an average of 2.12 transients per vehicle.

Finally, there are a few major retail facilities within the Hood County portion of the EPZ. Data from previous study was reviewed by Hood County and confirmed the data was still applicable for this study. Hood County has identified an additional major retail facility within the EPZ and provided the estimates of transients and transient vehicles for this new facility. A total of 1,916 transients and 1,143 transient vehicles are assigned to major retail facilities – an average of 1.68 transients per vehicle.

Appendix E summarizes the transient data that was estimated for the study area. Table E-6 presents the number of transients visiting recreational areas within the study area; Table E-7 presents the number of transients at lodging facilities within the EPZ; Table E-8 presents the number of transients at major retail facilities within the EPZ. In total, there are 20,609 transients in the EPZ at peak times, evacuating in 9,499 vehicles (an average vehicle occupancy of 2.17 transients per vehicle). Table 3-4 presents transient population and transient vehicle estimates by Zone. Figure 3-6 and Figure 3-7 present these data by sector and distance from the plant.

3.4 Employees

Employees who work within the EPZ fall into two categories:

- Those who live and work in the EPZ
- Those who live outside of the EPZ and commute to jobs within the EPZ.

Those of the first category are already counted as part of the permanent resident population. To avoid double counting, we focus only on those employees commuting from outside the EPZ who will evacuate along with the permanent resident population.

The estimate of employees commuting into the EPZ is based on the data provided by Vistra OpCo and the data from the previous study. Data from the previous study included the maximum shift employment and percent of employees commuting into the EPZ for each facility. This was reviewed by the counties within the EPZ, indicating the data was still applicable. Note, the employment data of CPNPP was updated by Vistra OpCo.

As per the NUREG/CR-7002, Rev. 1 guidance, employers with 200 or more employees working in a single shift are considered as major employers. As such, the employers with less than 200 employees (during the maximum shift) are not considered in this study. There is only one major employer in Hood County and Somervell County, respectively. The information of these two facilities is shown in Table E-5 of Appendix E.

To estimate the evacuating employee vehicles, a vehicle occupancy rate of 1.08 employees per vehicle obtained from the demographic survey (see Appendix F, sub-section F.3.1) was used for the major employers. Table 3-5 presents the employee and vehicle estimates commuting into the EPZ by Zone. Figure 3-8 and Figure 3-9 present these data by sector.

3.5 Special Facilities

In the CPNPP EPZ, there are two additional types of special facilities that will require transit vehicles:

- Medical Facilities
- Correctional Facility – Somervell County Jail

A total of 1,058 patients and inmates require transit vehicles. A total 103 transport vehicles are needed. Section 3.5.1 (Medical Facilities) and Section 3.5.2 (Correctional Facilities) below discuss the data in detail at each facility.

3.5.1 Medical Facilities

The data from the pre-existing medical facilities was reviewed by the county and confirmed the data was still accurate. Additional new medical facilities were identified and data was provided by the county and internet searches where data was missing. Table E-4 in Appendix E summarizes the data gathered. Table 3-6 presents the census of medical facilities in the EPZ. A total of 1,026 persons have been identified as living in, or being treated in, these facilities. Since the average number of patients as these facilities fluctuates often, the capacity, current census and breakdown of ambulatory, wheelchair bound and bedridden patients for each facility were provided by the county emergency management agencies.

The transportation requirements for the medical facility population are also presented in Table 3-6. The number and type of evacuating vehicles that need to be provided depend on the patients' state of health. It is estimated that buses can transport up to 30 people; wheelchair accessible minibuses can transport up to 25 ambulatory patients and 4 wheelchair-bound persons wheelchair vans up to 4 people; wheelchair buses up to 15 wheelchair-bound people; and ambulances up to 2 people. Based on discussions with Hood County Emergency Management Agency, it was assumed no vehicles are needed for patients located in Lake Granbury Medical Center, as they shelter-in-place.

3.5.2 Correctional Facilities

As detailed in Table E-9, there is one correctional facility within the EPZ – Somervell County Jail. The total inmate population was provided by the county. As summarized in Table 3-7, the current capacity of the facility is 54. Similar to medical facilities, where population within the jail may fluctuate. The current census is 32 inmates, which requires two (2) buses to evacuate, based on a capacity of 30 inmates per bus.

3.6 Transit Dependent Population

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

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

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

Table 3-8 presents estimates of the transit-dependent people. Note the following:

- Estimates of persons requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the schoolchildren. The actual need for transit vehicles by residents is thereby less than the given estimates. However, estimates of transit vehicles are not reduced when schools are in session.
- It is reasonable and appropriate to consider that many transit-dependent persons

will evacuate by ridesharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario who did not use their own cars, shared a ride with neighbors or friends. Other documents report that approximately 70 percent of transit dependent persons were evacuated via ride sharing. **Based on the results of the demographic survey, approximately 77% of the transit-dependent population will rideshare.**

The estimated number of bus trips needed to service transit-dependent persons is based on an estimated average bus occupancy of 30 persons at the conclusion of the bus run. Transit vehicle seating capacities typically equal or exceed 60 children (roughly equivalent to 40 adults). If transit vehicle evacuees are two thirds adults and one third children, then the number of "adult seats" taken by 30 persons is 20 + (2/3 x 10) = 27. On this basis, the average load factor anticipated is (27/40) x 100 = 68 percent. Thus, if the actual demand for service exceeds the estimates of Table 3-8 by 50 percent, the demand for service can still be accommodated by the available bus seating capacity.

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

Table 3-8 indicates that transportation must be provided for 120 people. Therefore, a total of 4 bus runs are required from a capacity standpoint. In order to service all of the transit dependent population and have at least one bus drive through each of the Zones to pick up transit dependent people, **13 bus runs** are used in the ETE calculations, see Section 10 for further discussion.

To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses, B, required for the CPNPP EPZ:

$$P = No.of\ HH\ \times \sum_{i=0}^{n} \{(\%\ HH\ with\ i\ vehicles) \times [(Average\ HH\ Size) - i]\} \times A^i C^i$$

Where,

A = Percent of households with commuters

C = Percent of households who will not await the return of a commuter

$$P = 15{,}902 \times [0.00 + 0.126 \times (1.66 - 1) \times 0.562 \times 0.4225 + 0.537 \times (2.45 - 2) \times (0.562 \times 0.4225)^2] = 531$$

$$B = [(1 - 0.77) \times 531] \div 30 = (0.23 \times 531) \div 30 = 4$$

These calculations, based on the 2020 demographic survey results, are explained as follows:

- There were no households (HH) with no vehicles, so the term 0.00 represent those who do not have access to a vehicle.
- The members of HH with 1 vehicle away (12.6%), who are at home, equal (1.66-1). The number of HH where the commuter will not return home is equal to (15,902 x 0.126 x 0.93 x 0.55 x 0.43), as 56.2% of EPZ households have a commuter, 42.25% of which would not return home in the event of an emergency. The number of persons

who will evacuate by public transit or ride-share is equal to the product of these two terms.

- The members of HH with 2 vehicles that are away (53.7%), who are at home, equal (2.45 – 2). The number of HH where neither commuter will return home is equal to 15,902 x 0.537 x 0.45 x $(0.562 \times 0.4225)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms (the last term is squared to represent the probability that neither commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

The estimate of transit-dependent population in Table 3-8 far exceeds the number of registered transit-dependent persons in the EPZ as provided by the counties (discussed below in Section3.8). This is consistent with the findings of NUREG/CR-6953, Volume 2, in that a large majority of the transit-dependent population within the EPZs of U.S. nuclear plants does not register with their local emergency response agency.

3.7 School, Preschools/Daycares Center and Day Camp Population Demand

Table 3-9 presents the school population and transportation requirements for the direct evacuation of all schools, preschools/daycares and, day camps within the EPZ for the 2020 to 2021 school year. The previous ETE data for schools in Hood County were confirmed still accurate for this study. Data for schools within Somervell County was obtained from the county emergency plan. Data for preschools/daycares were provided by Hood County and the Somervell County emergency plans. The previous ETE data for day camps in Somervell County were confirmed still accurate for this study. Data for Camp Fire Camp El Tesoro was provided by Hood County. This was supplemented with The National Center for Education Statistics[1] and Texas Health and Human Services[2] where data was missing.

The column in Table 3-9 entitled "Buses Required" specifies the number of buses required for each school under the following set of assumptions and estimates:

- No students will be picked up by their parents prior to the arrival of the buses.
- While many high school students commute to school using private automobiles (as discussed in Section 2.4 of NUREG/CR-7002, Rev.1), the estimate of buses required for school evacuation does not consider the use of these private vehicles.
- Bus capacity, expressed in students per bus, is set to 65 for primary schools and preschools/daycares and 50 for middle and high schools.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism, typically 3 percent daily.

[1] https://nces.ed.gov/
[2] https://www.dfps.state.tx.us/Child_Care

The counties in the EPZ could introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. Those buses originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents (although they are not advised to do so), can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing.

3.8 Access and/or Functional Needs Population

Based on data provided by the counties, there are an estimated 17 access and/or functional needs people (10 ambulatory, 4 wheelchair-bound and 3 bedridden) within the Hood County portion of the EPZ; 49 access and/or functional needs people (22 ambulatory, 19 wheelchair-bound and 8 bedridden) within the Somervell County portion of the EPZ; This results in 32 ambulatory persons, 23 wheelchair-bound persons and 12 bedridden persons for a total access and/or functional needs population of 66 people. Table 3-10 shows the total number of people registered as access and/or functional needs by type of need. The table also estimates the number of transportation resources needed to evacuate these people in a timely manner.

3.9 Special Event

Based on discussions with Vistra OpCo and the OROs, a 4th of July celebration in Granbury was chosen as the special event (Scenario 11) in accordance with NUREG/CR-7002, Rev. 1, because it is a single event that attracts the largest number of transients entering the EPZ.

A 4th of July celebration in Granbury is a multi-day event held in conjunction with the 4th of July weekend. This summer, weekend, midday event is held at various locations in Granbury, including Historical Square and the surrounding area. Data from the previous ETE study was reviewed and confirmed by the county. It was used to estimate the number of transient and transient vehicles present during the event. The peak number of transients for the multi-day event is 50,000 people with an average daily population that ranges between 20,000 and 30,000 people. This study assumes a peak daily population of 25,000. It was assumed that (based on the previous ETE Study) 50% of event attendees are traveling from outside of the EPZ. Transients stay in local hotels in Granbury while others have weekend homes or rental properties on Lake Granbury. Transients already included at lodging facilities within Hood County (excluding the Granbury Convention Center) are subtracted out as to avoid double counting. These factors result in a total additional transient population of 11,097 people. data based on the previous ETE, a vehicle occupancy of 3 people per vehicle was assumed, resulting in an additional 3,699 vehicles.

Vehicles were assumed to be parked along various streets and parking lots within Granbury. Therefore, the vehicle trips were distributed over several links within the Town of Granbury. The special event vehicle trips were generated utilizing the same mobilization distributions for transients. Public transportation is not provided for this event and was not considered in the analysis.

3.10 External Traffic

Vehicles will be traveling through the EPZ (external-external trips) at the time of an emergency accident. After the Advisory to Evacuate (ATE) is announced, these through-travelers will also evacuate. These through vehicles are assumed to travel on the major routes traversing the EPZ – US-377 and US-67. It is assumed that this traffic will continue to enter the EPZ during the first 120 minutes following the ATE.

Average Annual Daily Traffic (AADT) data from 2019 was obtained from the North Central Texas Council of Governments - Traffic Count Information Systems[3] to estimate the number of vehicles per hour on the aforementioned routes. The AADT was multiplied by the K-Factor, which is the proportion of the AADT on a roadway segment or link during the design hour, resulting in the design hour volume (DHV). The design hour is usually the 30th highest hourly traffic volume of the year, measured in vehicles per hour (vph). The DHV is then multiplied by the D-Factor, which is the proportion of the DHV occurring in the peak direction of travel (also known as the directional split). The resulting values are the directional design hourly volumes (DDHV) and are presented in Table 3-11 for each of the routes considered. The DDHV is then multiplied by 2 hours (access control points – ACP – are assumed to be activated within 120 minutes of the ATE) to estimate the total number of external vehicles loaded on the analysis network. As indicated, there are 4,256 vehicles entering the EPZ as external-external trips prior to the activation of the ACP and the diversion of this traffic. This number is reduced by 60% for evening scenarios (Scenarios 5 and 10) as discussed in Section 6.

3.11 Background Traffic

Section 5 discusses the time needed for the people in the EPZ to mobilize and begin their evacuation trips. As shown in Table 5-8, there are 14 time periods during which traffic is loaded on to roadways in the study area to model the mobilization time of people in the EPZ. Note, there is no traffic generated during the 15th time period, as this time period is intended to allow traffic that has already begun evacuating to clear the study area boundaries.

This study does not assume that roadways are empty at the start of Time Period 1. Rather, there is a 50-minute initialization time period (often referred to as “fill time” in traffic simulation) wherein the traffic volumes from Time Period 1 are loaded onto roadways in the study area. The amount of initialization/fill traffic that is on the roadways in the study area at the start of Time Period 1 depends on the scenario and the region being evacuated (see Section 6). There are 1,533 vehicles on the roadways in the study area at the end of fill time for an evacuation of the entire EPZ (Region R03) under Scenario 1 (summer, midweek, midday, with good weather) conditions.

[3] http://www.dot.state.tx.us/apps/statewide_mapping/StatewidePlanningMap.html

3.12 Summary of Demand

A summary of population and vehicle demand is provided in Table 3-12 and Table 3-13, respectively. This summary includes all population groups described in this section. A total of 89,112 people and 44,034 vehicles are considered in this study.

Table 3-1. EPZ Permanent Resident Population

Zone	2010 Population[4]	2020 Population
1A	672	656
1B	337	351
1C	6,871	8,105
1D	11,793	14,713
2A	736	548
2B	364	251
2C	466	717
2D	695	567
2E	70	127
2F	115	153
2G	16	21
2H	431	507
2J	1,202	1,557
3A	134	149
3B	83	122
3C	546	592
3D	363	366
3E	111	129
3F	309	320
4A	59	58
4B	104	108
4C	123	189
4D	181	182
4E	4,261	4,856
4F	1,543	1,509
4G	523	491
4H	73	70
CP	66	283
GL	2,291	2,369
TO	661	803
EPZ TOTAL	**35,199**	**40,869**
EPZ Population Growth (2010-2020):		**16.11%**

[4] The 2010 population shown in the table for Zones 1D, 4Eand 4F reflect the new zone boundaries and will therefore not align with the previous ETE study.

Table 3-2. Permanent Resident Population and Vehicles by Zone

Zone	2020 Population	2020 Resident Vehicles
1A	656	368
1B	351	197
1C	8,105	4,541
1D	14,713	8,018
2A	548	306
2B	251	139
2C	717	400
2D	567	318
2E	127	71
2F	153	86
2G	21	13
2H	507	285
2J	1,557	874
3A	149	85
3B	122	69
3C	592	331
3D	366	204
3E	129	73
3F	320	178
4A	58	33
4B	108	61
4C	189	107
4D	182	102
4E	4,856	2,647
4F	1,509	807
4G	491	274
4H	70	38
CP	283	161
GL	2,369	1,246
TO	803	426
EPZ TOTAL	**40,869**	**22,458**

Table 3-3. Shadow Population and Vehicles by Sector

Sector	2020 Population	Evacuating Vehicles
N	9,577	5,222
NNE	9,905	5,549
NE	1,508	843
ENE	116	65
E	511	287
ESE	195	109
SE	163	90
SSE	175	97
S	148	83
SSW	119	67
SW	178	98
WSW	140	77
W	697	389
WNW	606	342
NW	437	244
NNW	3,189	1,787
TOTAL	**27,664**	**15,349**

Table 3-4. Summary of Transients and Transient Vehicles

Zone	Transients	Transient Vehicles
1A	0	0
1B	20	20
1C	999	891
1D	5,585	3,267
2A	0	0
2B	50	50
2C	4,207	1,354
2D	248	230
2E	150	50
2F	50	36
2G	0	0
2H	0	0
2J	894	438
3A	0	0
3B	966	389
3C	10	4
3D	119	52
3E	0	0
3F	345	98
4A	282	150
4B	0	0
4C	0	0
4D	0	0
4E	475	194
4F	60	60
4G	0	0
4H	0	0
CP	0	0
GL	6,108	2,175
TO	0	0
EPZ TOTAL	**20,568**	**9,458**
Shadow Region[5]	**41**	**41**
STUDY AREA TOTAL	**20,609**	**9,499**

[5] A transient facility in Hood County is located in the Shadow Region. As per the county's request, this facility is included in the study due to the close proximity to the EPZ boundary. Figure 3-6 and Figure 3-7 display the transients and transient vehicles within the EPZ only, therefore, the total numbers shown in these two figures do not align with the study area total numbers in Table 3-4.

Table 3-5. Summary of Employees and Employee Vehicles Commuting into the EPZ

Zone	Employees	Employee Vehicles
1A	0	0
1B	0	0
1C	0	0
1D	293	271
2A	0	0
2B	0	0
2C	0	0
2D	0	0
2E	0	0
2F	0	0
2G	0	0
2H	0	0
2J	0	0
3A	0	0
3B	0	0
3C	0	0
3D	0	0
3E	0	0
3F	0	0
4A	0	0
4B	0	0
4C	0	0
4D	0	0
4E	0	0
4F	0	0
4G	0	0
4H	0	0
CP	241	223
GL	0	0
TO	0	0
EPZ TOTAL	**534**	**494**

Table 3-6. Medical Facility Transit Demand

Zone	Facility Name	Municipality	Capacity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Bus Runs	Mini-Bus Runs	Wheel-chair Bus Runs	Wheel-chair Van Runs	Ambulance Runs
HOOD COUNTY												
1D	Southern Concepts - South Town	Granbury	6	6	6	0	0	1	0	0	0	0
1D	Southern Concepts - Meadowlark	Granbury	4	4	4	0	0	1	0	0	0	0
1D	Harbor Lakes Nursing & Rehab	Granbury	147	75	20	30	25	0	8	0	0	13
1D	Lakestone Terrace Senior Living	Granbury	208	90	78	11	1	0	4	0	0	1
1D	Courtyards at Lake Granbury	Granbury	82	74	44	30	0	0	8	0	0	0
1D	Southern Concepts - Torrey House	Granbury	6	6	6	0	0	1	0	0	0	0
1D	Waterview The Point Independent Living	Granbury	210	210	186	24	0	2	6	0	0	0
1D	Waterview The Cove Assisted Living & Memory Care	Granbury	55	38	24	12	2	0	3	0	0	1
4E	Bridgewater Memory Care	Granbury	52	45	22	23	0	1	0	2	0	0
4E	Lake Granbury Medical Center[6]	Granbury	83	16	12	1	3	Shelter-in-Place				
4E	Granbury Care Center	Granbury	181	145	59	84	2	2	0	6	0	0
4F	Magnolia Court	Granbury	22	18	17	1	0	0	1	0	0	0
4F	Quail Park of Granbury	Granbury	20	13	0	0	13	0	0	0	0	13
4F	Granbury Villa Nursing Center	Granbury	95	62	21	38	3	1	0	0	3	3
		Hood County Subtotal:	*1171*	*802*	*499*	*254*	*49*	*9*	*30*	*8*	*3*	*31*
SOMERVELL COUNTY												
GL	Cherokee Rose Manor	Glen Rose	102	60	37	19	4	2	0	2	0	2
GL	Glen Rose Nursing and Rehab Center	Glen Rose	120	80	50	25	5	2	0	2	0	3
GL	Glen Rose Medical Center-Hospital	Glen Rose	123	84	52	27	5	2	0	2	0	3
		Somervell County Subtotal:	*345*	*224*	*139*	*71*	*14*	*6*	*0*	*6*	*0*	*8*
		TOTAL:	**1,516**	**1,026**	**638**	**325**	**63**	**15**	**30**	**14**	**3**	**39**

[6] Based on discussions with Hood County, Lake Granbury Medical Center shelters-in-place, so no vehicles are required.

Table 3-7. Correction Facility Demand

Zone	Facility Name	Municipality	Capacity	Current Census	Buses Required
SOMERVELL COUNTY					
GL	Somervell County Jail	Glen Rose	54	32	2
		Somervell County Subtotal:	*54*	*32*	*2*
		EPZ TOTAL:	**54**	**32**	**2**

Table 3-8. Transit-Dependent Population Estimates

2020 EPZ Population	Survey Average HH Size with Indicated No. of Vehicles			Estimated No. of Households	Survey Percent HH with Indicated No. of Vehicles			Survey Percent HH with Commuters	Survey Percent HH with Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent Population Requiring Public Transit
	0	1	2		0	1	2						
40,869	0.00	1.66	2.45	15,902	0.00%	12.60%	53.70%	56.20%	42.25%	531	77%	120	0.3%

Table 3-9. School, Preschools/Daycares and Day Camp Population Demand Estimates

Zone	Schools	Enrollment	Buses Required
HOOD COUNTY			
1C	Mambrino Elementary School	604	10
1D	Premier High School	150	3
4E	Lakeside Baptist Academy	100	2
4E	Brawner Intermediate School	400	8
4E	Emma Roberson Elementary School	501	8
4E	Granbury High School	2,029	41
4G	Tolar High School	225	5
TO	Tolar Elementary School	265	5
TO	Tolar Jr. High School	132	3
	Hood County School Subtotal:	*4,406*	*85*
SOMERVELL COUNTY			
2D	North Central Texas Academy	70	2
2H	Brazos River Charter School	135	3
GL	Glen Rose Junior High School	425	9
GL	Glen Rose High School	500	10
GL	Glen Rose Elementary School	500	8
GL	Glen Rose Intermediate School	400	8
	Somervell County School Subtotal:	*2,030*	*40*
	EPZ SCHOOL TOTAL:	***6,436***	***125***
Zone	**Preschools/Daycares**	**Enrollment**	**Buses Required**
HOOD COUNTY			
1C	Rainbow's Promise	55	1
1D	Lakeside WEEschool	59	1
1D	Lil Pirates Daycare	70	2
4E	Cross Town Preschool	18	1
4E	Miss Dee Little Angels	4	1
TO	Tolar Small Steps Childcare & Early Learning Center, LLC	80	2
TO	Little Rattlers Preschool & Childcare	57	1
	Hood County Subtotal:	*343*	*9*
SOMERVELL COUNTY			
2C	Grace Preshool	60	1
2C	Glen Rose Early Head Start	40	1
3D	Little Tigers Learning Center	60	1
GL	Endless Discoveries Child Development Center	60	1
GL	First United Methodist Preschool	60	1
GL	Rockin' D Preschools/daycares	12	1
	Somervell County Subtotal:	*292*	*6*
	EPZ PRESCHOOLS/DAYCARES TOTAL:	***635***	***15***

Zone	Day Camps	Enrollment	Buses Required
HOOD COUNTY			
S.R.	Camp Fire Camp El Tesoro[7]	100	2
	Hood County Subtotal:	*100*	*2*
SOMERVELL COUNTY			
2E	Arrowhead Camp & Retreat Center	450	9
2H	Stevens Ranch	171	3
2J	Riverbend Retreat Center	900	18
GL	Glen Lake Camp & Retreat Center	600	12
	Somervell County Subtotal:	*2,121*	*42*
	EPZ DAY CAMPS TOTAL:	***2,221***	***44***
	SCHOOLS, PRESCHOOLS/DAYCARES, & DAY CAMPS TOTAL:	**9,292**	**184**

Table 3-10. Access and/or Functional Needs Demand Summary

Population Group	Population	Vehicles deployed
Buses	32	1
Wheelchair Vans	23	6
Ambulances	11	6
TOTAL:	**66**	**13**

Table 3-11. CPNPP EPZ External Traffic

Upstream Node	Downstream Node	Road Name	Direction	HPMS AADT[8]	K-Factor[9]	D-Factor[5]	Hourly Volume	External Traffic
8607	1108	US 67	WB	6,221	0.118	0.5	367	734
8285	285	US 67	EB	6,221	0.118	0.5	367	734
8103	903	US 377	WB	12,013	0.116	0.5	697	1,394
8261	1007	US 377	EB	12,013	0.116	0.5	697	1,394
							TOTAL:	**4,256**

[7] Based on discussions with Hood County, Camp Fire Camp El Tesoro evacuates even though located within the Shadow Region.
[8] North Central Texas Council of Governments - Traffic Count Information Systems (2019 AADT was used)
[9] HCM 2016

Table 3-12. Summary of Population Demand[10]

Zone	Residents	Transit-Dependent	Transients	Employees	Special Facilities[11]	Schools, Preschools/Daycares, Day Camps[12]	Special Event	Shadow Population[13]	External Traffic	Total
1A	656	2	0	0	0	0	0	0	0	658
1B	351	1	20	0	0	0	0	0	0	372
1C	8,105	24	999	0	0	659	0	0	0	9,787
1D	14,713	43	5,585	293	503	279	4,167	0	0	25,583
2A	548	2	0	0	0	0	0	0	0	550
2B	251	1	50	0	0	0	0	0	0	302
2C	717	2	4,207	0	0	100	0	0	0	5,026
2D	567	2	248	0	0	70	0	0	0	887
2E	127	1	150	0	0	450	0	0	0	728
2F	153	0	50	0	0	0	0	0	0	203
2G	21	0	0	0	0	0	0	0	0	21
2H	507	1	0	0	0	306	0	0	0	814
2J	1,557	5	894	0	0	900	0	0	0	3,356
3A	149	0	0	0	0	0	0	0	0	149
3B	122	0	966	0	0	0	0	0	0	1,088
3C	592	2	10	0	0	0	0	0	0	604
3D	366	1	119	0	0	60	0	0	0	546
3E	129	0	0	0	0	0	0	0	0	129
3F	320	1	345	0	0	0	0	0	0	666
4A	58	0	282	0	0	0	0	0	0	340
4B	108	1	0	0	0	0	0	0	0	109
4C	189	1	0	0	0	0	0	0	0	190
4D	182	1	0	0	0	0	0	0	0	183
4E	4,856	14	475	0	190	3,052	4,158	0	0	12,745
4F	1,509	4	60	0	93	0	0	0	0	1,666
4G	491	1	0	0	0	225	0	0	0	717
4H	70	0	0	0	0	0	0	0	0	70
CP	283	1	0	241	0	0	0	0	0	525

[10] In addition, since the spatial distribution of the access and/or functional needs population is unknown, they are not included in this table.
[11] Special facilities include medical facilities (not including Lake Granbury Medical Center which shelters-in-place) and Somervell County Jail.
[12] As per discussions with Hood County, Camp Fire Camp El Tesoro evacuates even if within the Shadow Region.
[13] Shadow Population has been reduced to 20%. Refer to Figure 2-1 for additional information.

Zone	Residents	Transit-Dependent	Transients	Employees	Special Facilities[11]	Schools, Preschools/Daycares, Day Camps[12]	Special Event	Shadow Population[13]	External Traffic	Total
GL	2,369	7	6,108	0	256	2,557	0	0	0	11,297
TO	803	2	0	0	0	534	0	0	0	1,339
Shadow Region	0	0	41	0	0	100	2,772	5,533	0	8,446
Total	**40,869**	**120**	**20,609**	**534**	**1,042**	**9,292**	**11,097**	**5,533**	**0**	**89,112**

Table 3-13. Summary of Vehicle Demand[14]

Zone	Residents	Transit-Dependent Buses[15]	Transients[16]	Employees	Special Facilities[17]	Schools, Preschools/Daycares, Day Camp Buses[18]	Special Event	Shadow Population[19]	External Traffic	Total
1A	368	0	0	0	0	0	0	0	0	368
1B	197	0	20	0	0	0	0	0	0	217
1C	4,541	2	891	0	0	22	0	0	0	5,456
1D	8,018	0	3,267	271	83	12	1,389	0	0	13,040
2A	306	2	0	0	0	0	0	0	0	308
2B	139	0	50	0	0	0	0	0	0	189
2C	400	0	1,354	0	0	4	0	0	0	1,758
2D	318	0	230	0	0	4	0	0	0	552
2E	71	0	50	0	0	18	0	0	0	139
2F	86	0	36	0	0	0	0	0	0	122
2G	13	0	0	0	0	0	0	0	0	13
2H	285	2	0	0	0	12	0	0	0	299
2J	874	0	438	0	0	36	0	0	0	1,348
3A	85	0	0	0	0	0	0	0	0	85
3B	69	0	389	0	0	0	0	0	0	458
3C	331	0	4	0	0	0	0	0	0	335
3D	204	2	52	0	0	2	0	0	0	260

[14] Since the spatial distribution of the access and/or functional needs population is unknown, they are not included in this table.
[15] Transit-Dependent Buses represented as two passenger vehicles.
[16] The transient population at Sunnyside RV Park is located within the Shadow Region but will evacuate based on discussions with Hood County.
[17] Special facilities include medical facilities (not including Lake Granbury Medical Center which shelters-in-place) and Somervell County Jail.
[18] Schools, Preschools/daycares, and Day Camp Buses represented as two passenger vehicles and include buses for Camp Fire Camp El Tesoro, even though located within Shadow Region.
[19] Shadow Population has been reduced to 20%. Refer to Figure 2-1 for additional information.

Zone	Residents	Transit-Dependent Buses[15]	Transients[16]	Employees	Special Facilities[17]	Schools, Preschools/Daycares, Day Camp Buses[18]	Special Event	Shadow Population[19]	External Traffic	Total
3E	73	2	0	0	0	0	0	0	0	75
3F	178	0	98	0	0	0	0	0	0	276
4A	33	2	150	0	0	0	0	0	0	185
4B	61	2	0	0	0	0	0	0	0	63
4C	107	2	0	0	0	0	0	0	0	109
4D	102	0	0	0	0	0	0	0	0	102
4E	2,647	4	194	0	22	122	1,386	0	0	4,375
4F	807	2	60	0	23	0	0	0	0	892
4G	274	0	0	0	0	10	0	0	0	284
4H	38	0	0	0	0	0	0	0	0	38
CP	161	0	0	223	0	0	0	0	0	384
GL	1,246	2	2,175	0	36	100	0	0	0	3,559
TO	426	2	0	0	0	22	0	0	0	450
Shadow Region	0	0	41	0	0	4	924	3,070	4,256	8,295
Total	**22,458**	**26**	**9,499**	**494**	**164**	**368**	**3,699**	**3,070**	**4,256**	**44,034**

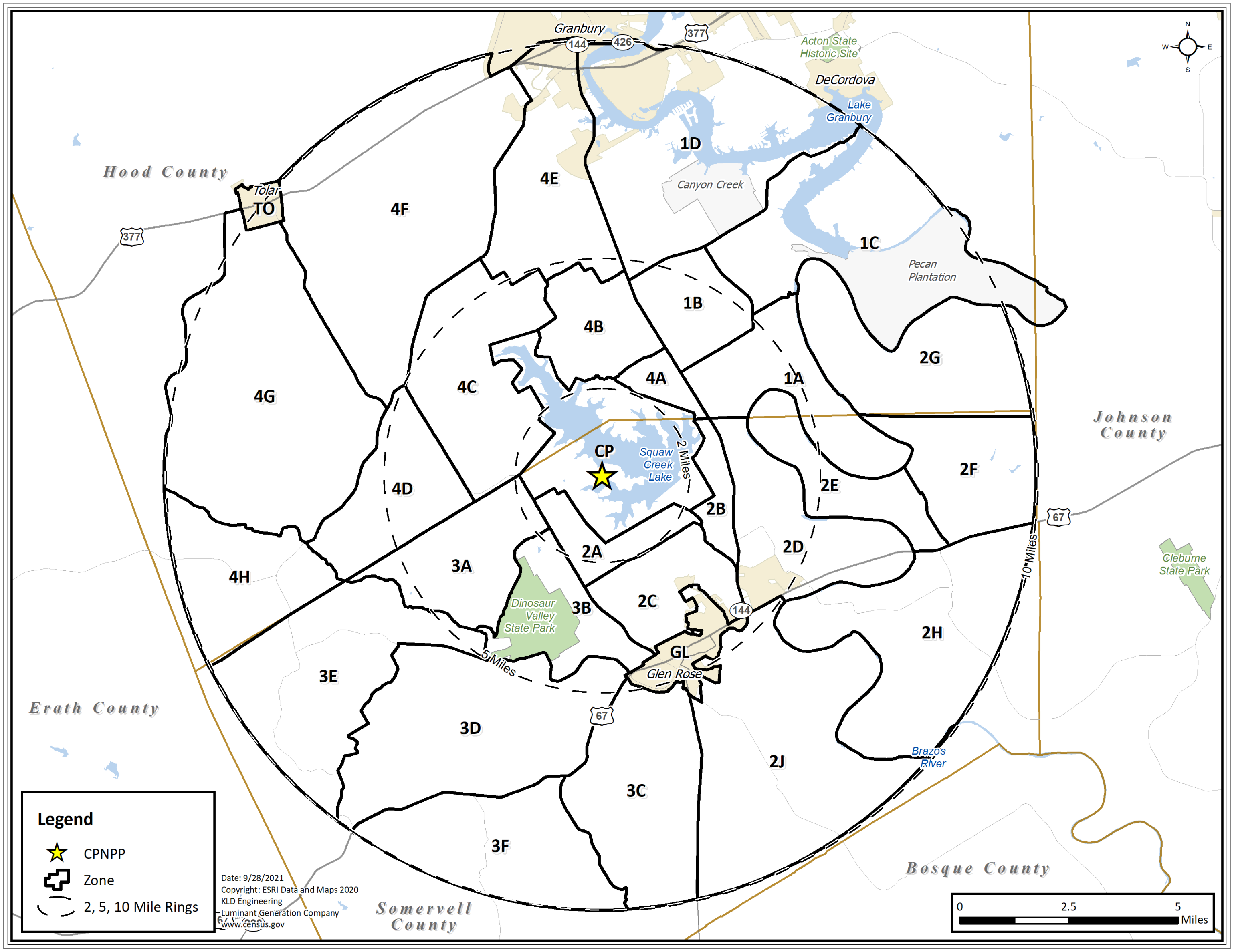
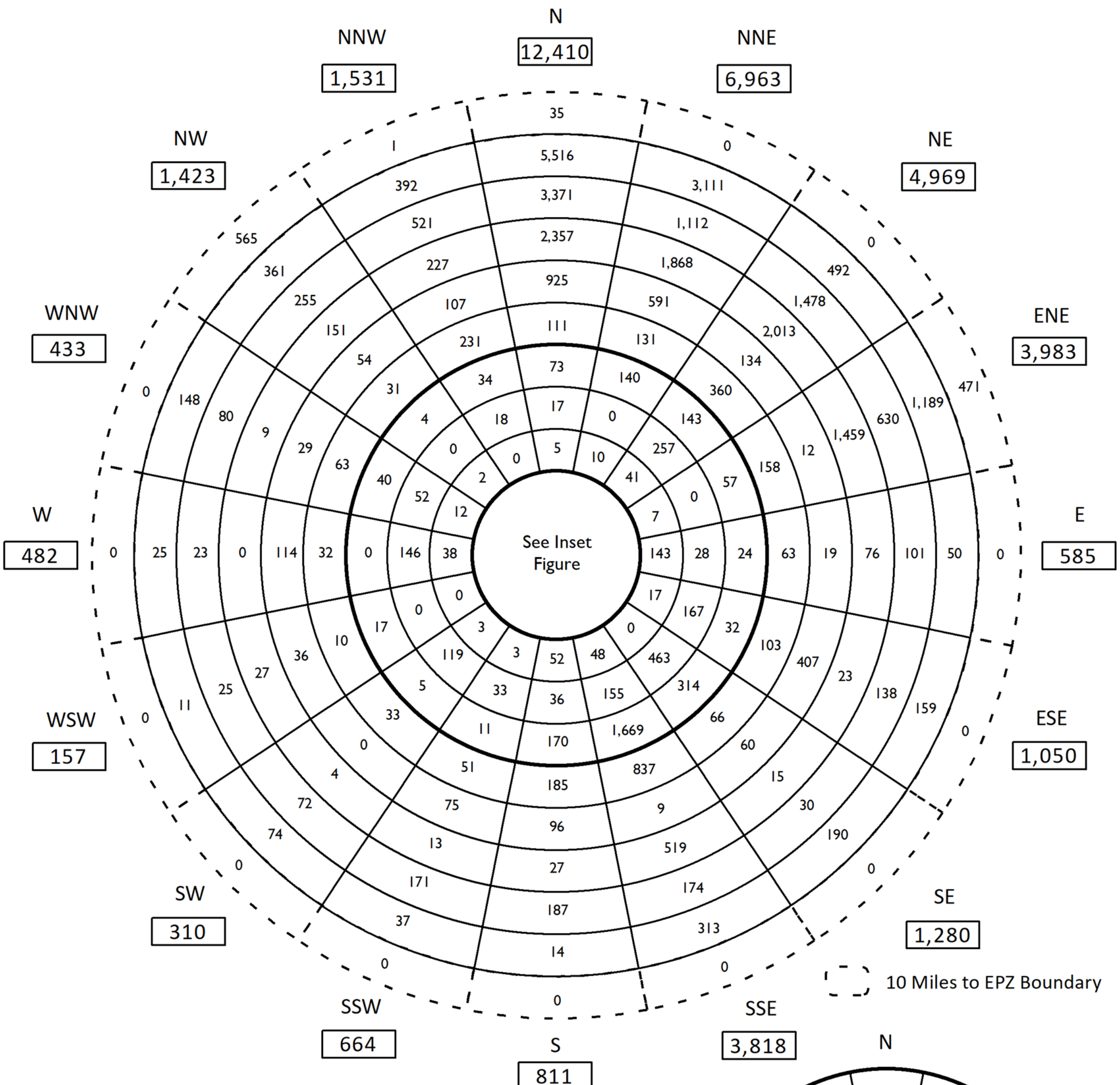


Figure 3-1. Zones Comprising the CPNPP EPZ



2020 Permanent Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	821	821
2 - 3	381	1,202
3 - 4	1,491	2,693
4 - 5	2,733	5,426
5 - 6	2,465	7,891
6 - 7	2,668	10,559
7 - 8	8,788	19,347
8 - 9	8,368	27,715
9 - 10	12,082	39,797
10 - EPZ	1,072	40,869
	Total:	40,869

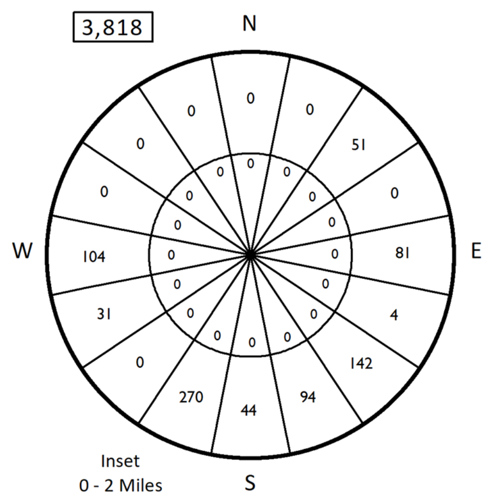
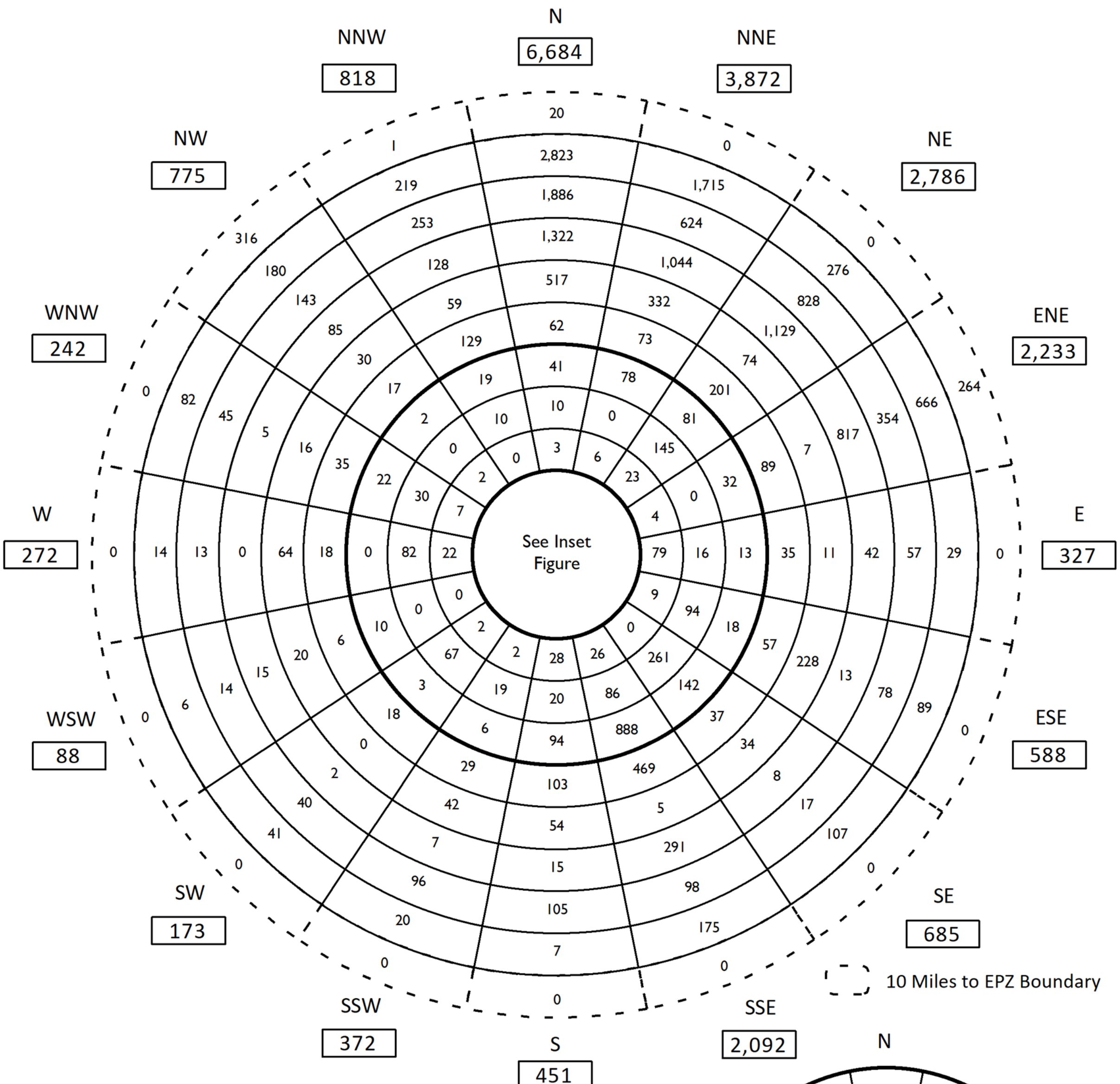


Figure 3-2. Permanent Resident Population by Sector



Resident Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	461	461
2 - 3	213	674
3 - 4	840	1,514
4 - 5	1,449	2,963
5 - 6	1,378	4,341
6 - 7	1,493	5,834
7 - 8	4,923	10,757
8 - 9	4,651	15,408
9 - 10	6,449	21,857
10 - EPZ	601	22,458
	Total:	22,458

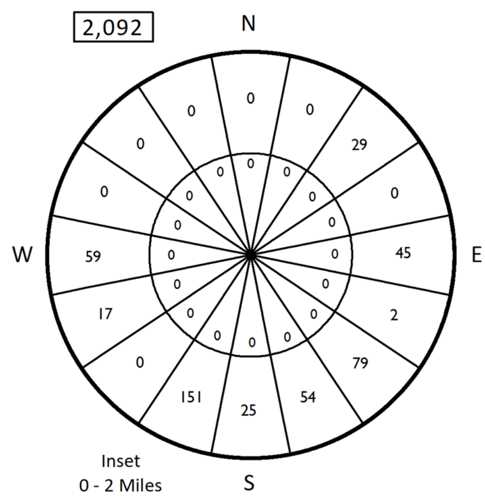
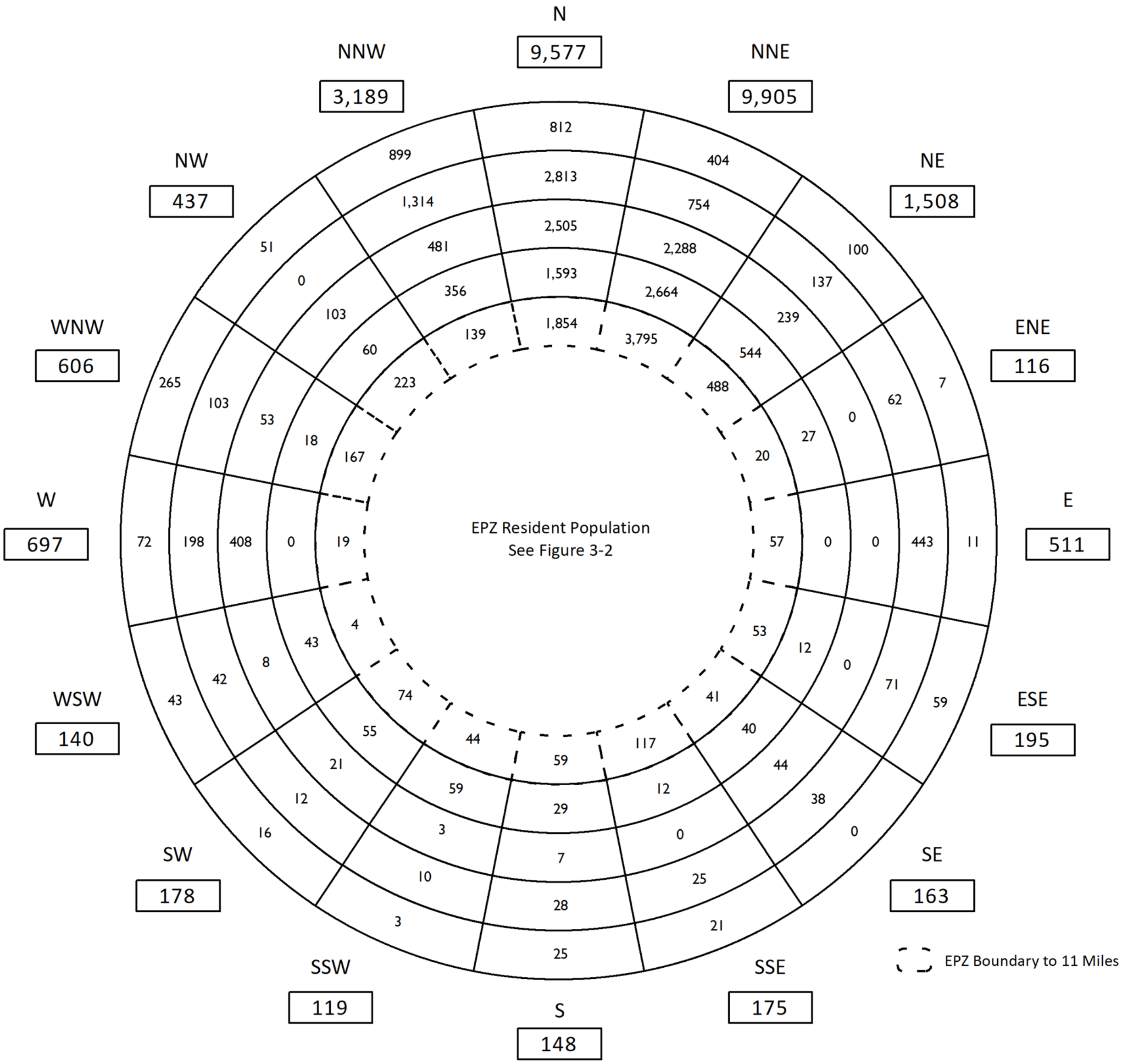


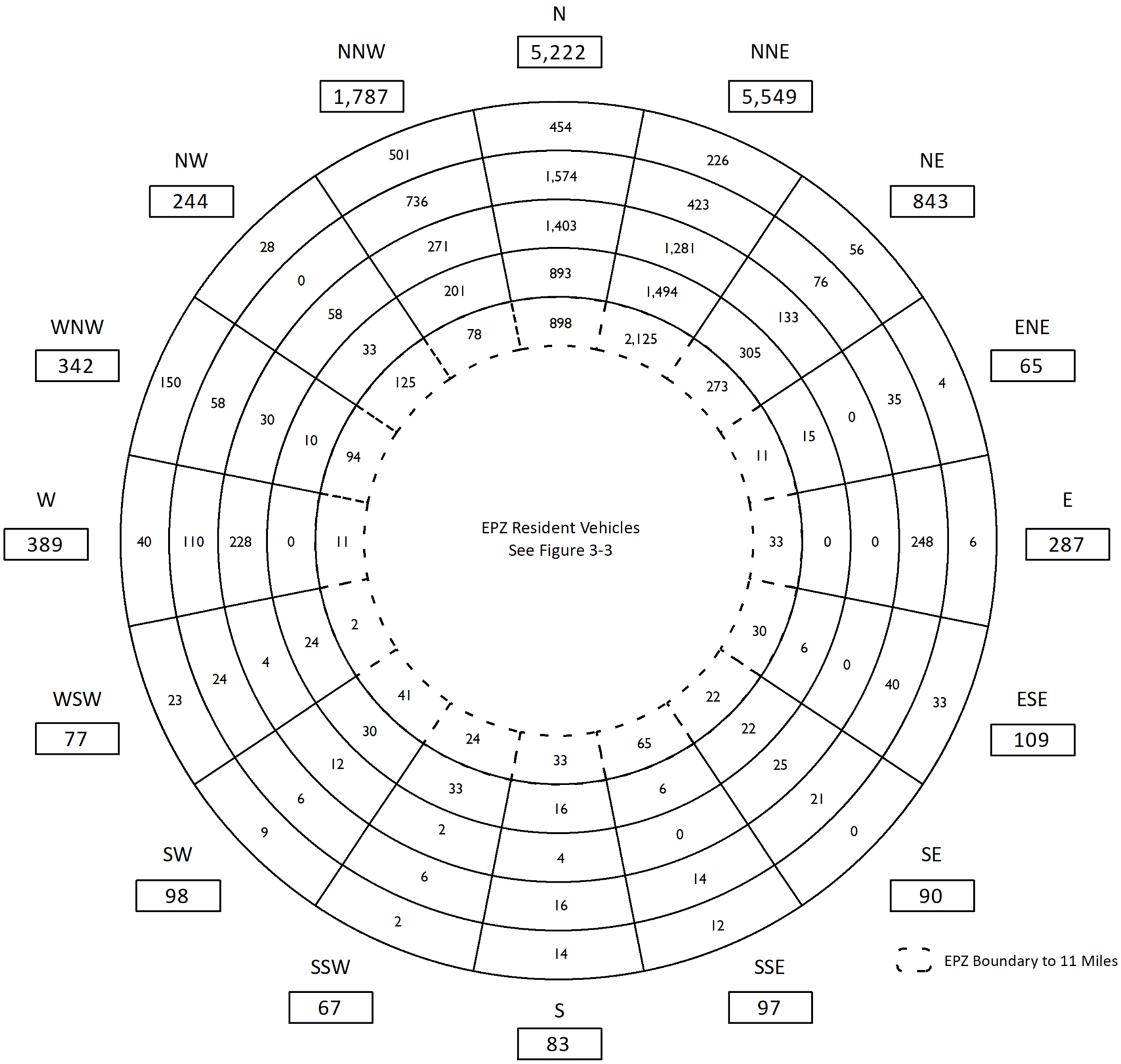
Figure 3-3. Permanent Resident Vehicles by Sector



2020 Shadow Population

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	7,154	7,154
11 - 12	5,512	12,666
12 - 13	6,160	18,826
13 - 14	6,050	24,876
14 - 15	2,788	27,664
	Total:	27,664

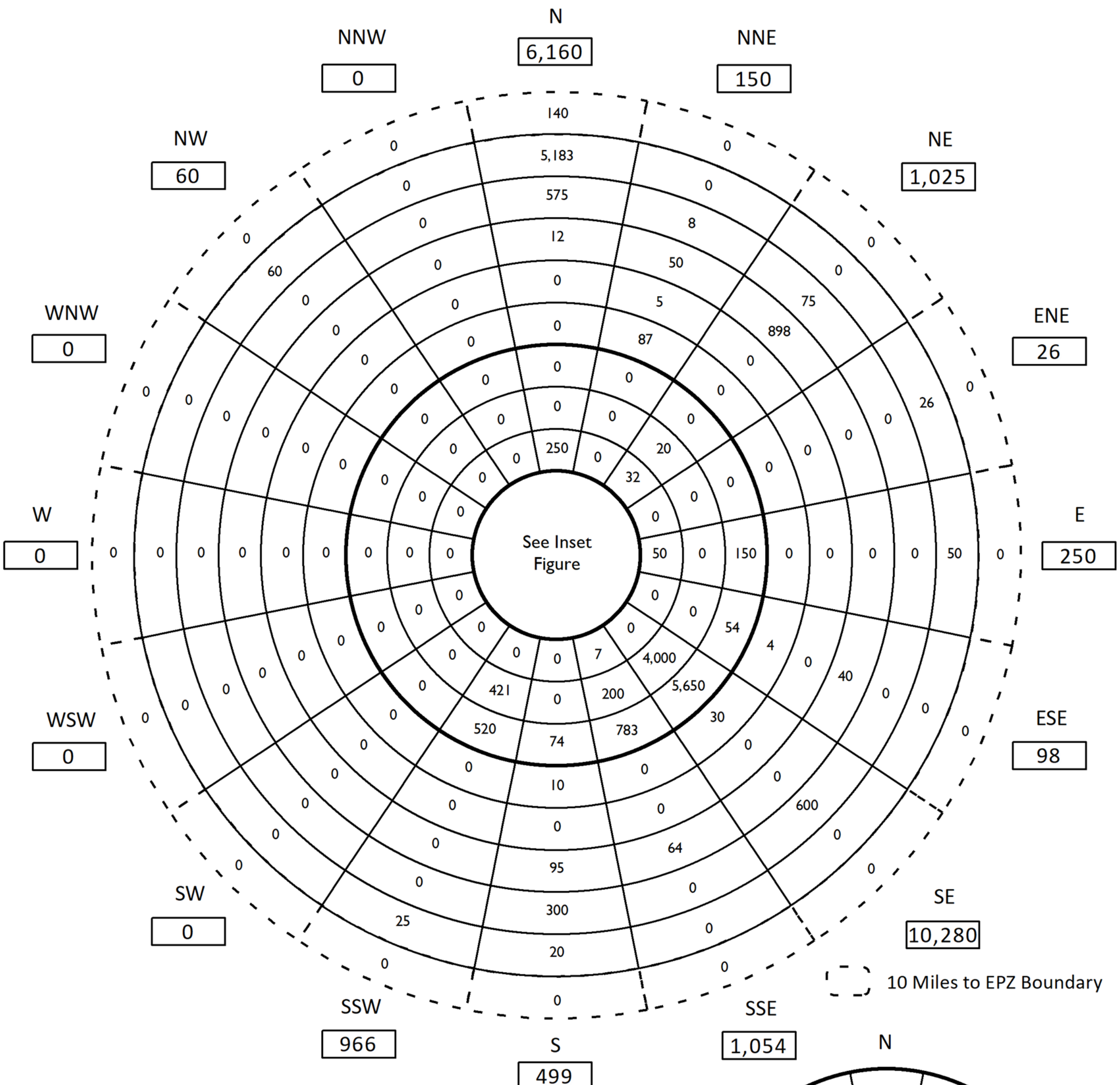
Figure 3-4. Shadow Population by Sector



Shadow Vehicles

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	3,865	3,865
11 - 12	3,088	6,953
12 - 13	3,451	10,404
13 - 14	3,387	13,791
14 - 15	1,558	15,349
	Total:	15,349

Figure 3-5. Shadow Vehicles by Sector



Transients

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	0	0
2 - 3	339	339
3 - 4	4,641	4,980
4 - 5	7,231	12,211
5 - 6	131	12,342
6 - 7	5	12,347
7 - 8	1,159	13,506
8 - 9	1,558	15,064
9 - 10	5,364	20,428
10 - EPZ	140	20,568
	Total:	20,568

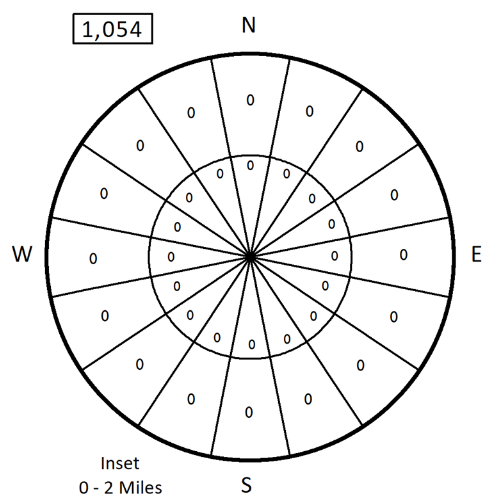
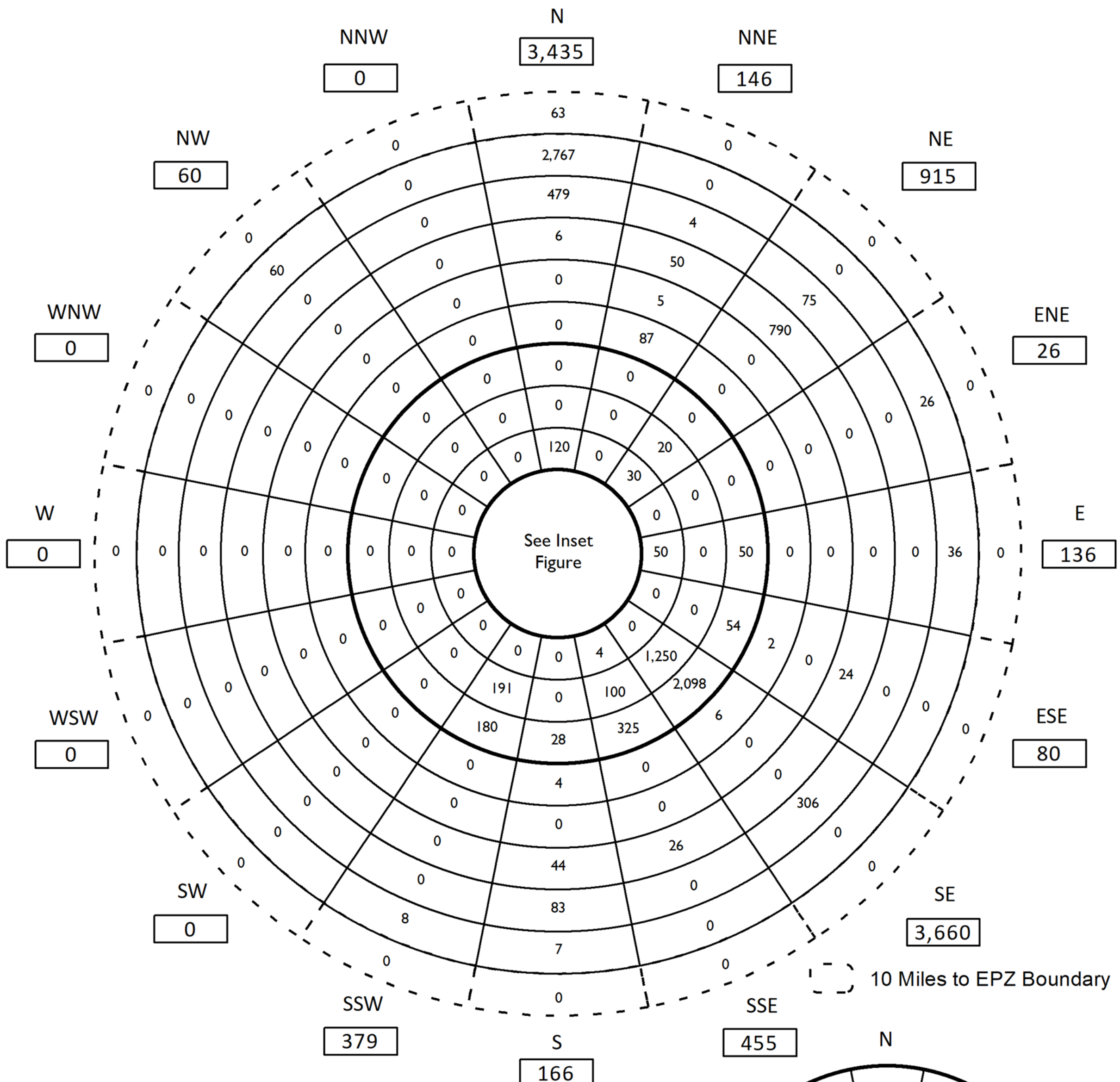


Figure 3-6. Transient Population by Sector



Transient Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	0	0
2 - 3	204	204
3 - 4	1,561	1,765
4 - 5	2,735	4,500
5 - 6	99	4,599
6 - 7	5	4,604
7 - 8	940	5,544
8 - 9	947	6,491
9 - 10	2,904	9,395
10 - EPZ	63	9,458
	Total:	9,458

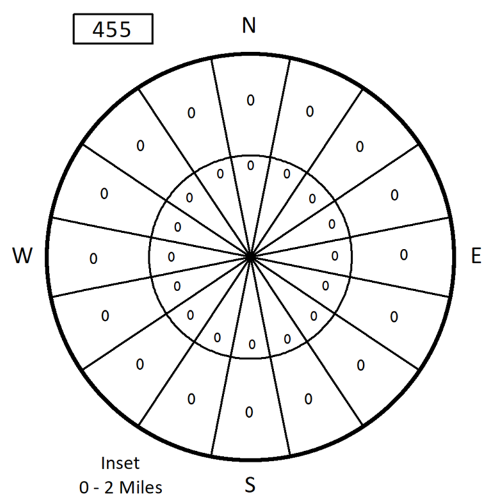
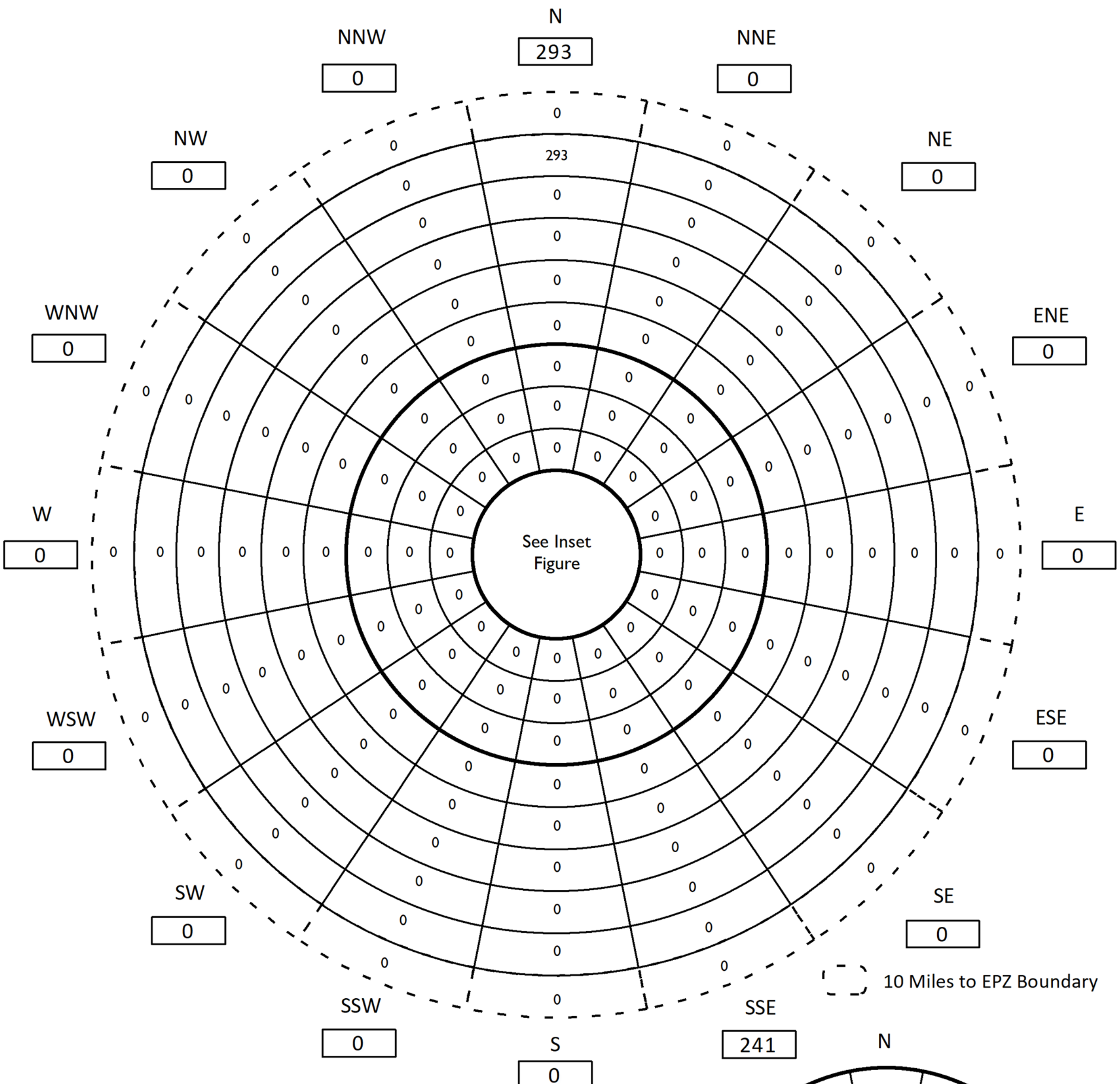


Figure 3-7. Transient Vehicles by Sector



Employees

Miles	Subtotal by Ring	Cumulative Total
0 - 1	241	241
1 - 2	0	241
2 - 3	0	241
3 - 4	0	241
4 - 5	0	241
5 - 6	0	241
6 - 7	0	241
7 - 8	0	241
8 - 9	0	241
9 - 10	293	534
10 - EPZ	0	534
	Total:	534

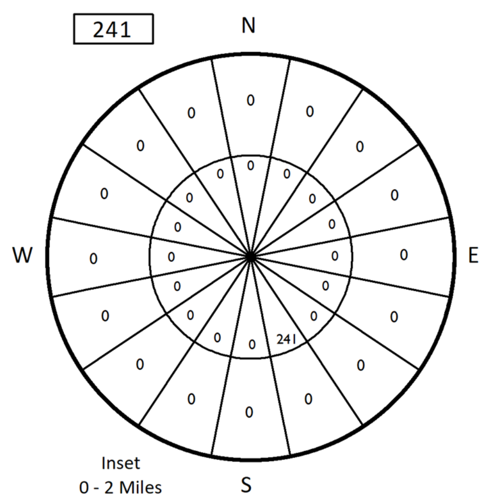
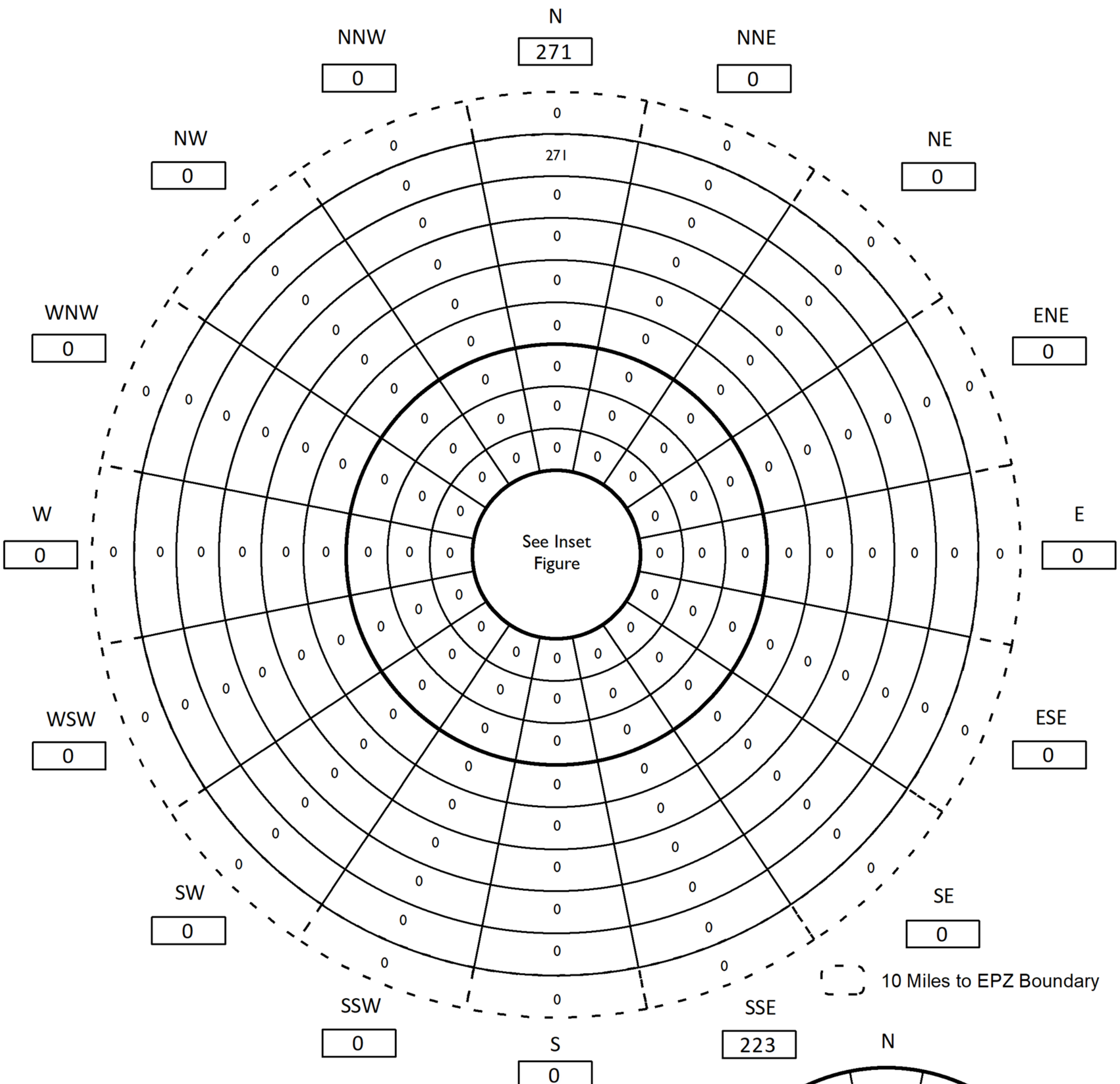


Figure 3-8. Employee Population by Sector



Employee Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	223	223
1 - 2	0	223
2 - 3	0	223
3 - 4	0	223
4 - 5	0	223
5 - 6	0	223
6 - 7	0	223
7 - 8	0	223
8 - 9	0	223
9 - 10	271	494
10 - EPZ	0	494
	Total:	494

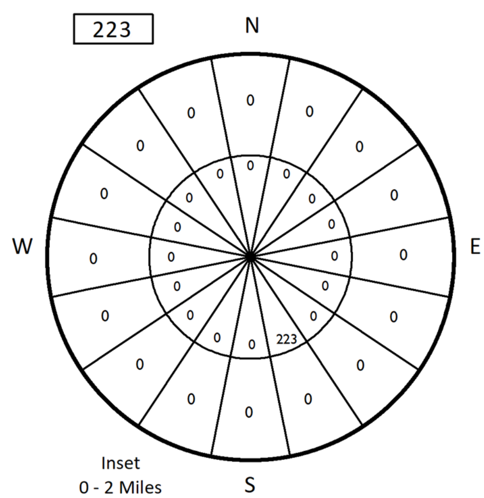


Figure 3-9. Employee Vehicles by Sector

4 ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions, as stated in the 2016 Highway Capacity Manual (HCM 2016). This section discusses how the capacity of the roadway network was estimated.

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

Another concept, closely associated with capacity, is “Service Volume” . Service volume (SV) 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 SV at the upper bound of LOS E, only.

Thus, in simple terms, SV is the maximum traffic that can travel on a road and still maintain a certain perceived level of quality to a driver based on the A, B, C, rating system (LOS). Any additional vehicles above the SV would drop the rating to a lower letter grade.

This distinction is illustrated in Exhibit 12-37 of the HCM 2016. As indicated there, the SV varies with Free Flow Speed (FFS), and LOS. The SV is calculated by the DYNEV II simulation model, based on the specified link attributes, FFS, capacity, control device and traffic demand.

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

- Lane width
- Shoulder width
- Pavement condition
- Horizontal and vertical alignment (curvature and grade)
- Percent truck traffic
- Control device (and timing, if it is a signal)
- Weather conditions (rain, 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 Base Free Flow Speed (BFFS[1]) according to Exhibit 15-7 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

[1] A very rough estimate of BFFS might be taken as the posted speed limit plus 10 mph (HCM 2016 Page 15-15).

of lane or shoulder width were taken. Horizontal and vertical alignment can influence both FFS and capacity. The estimated FFS were measured using the survey vehicle's speedometer and observing local traffic, under free flow conditions. Free flow speeds ranged from 15 to 75 mph in the study area. Capacity is estimated from the procedures of the 2016 HCM. For example, HCM 2016 Exhibit 7-1(b) shows the sensitivity of SV at the upper bound of LOS D to grade (capacity is the Service Volume at the upper bound of LOS E).

The amount of traffic that can flow on a roadway is effectively governed by vehicle speed and spacing. The faster that vehicles can travel when closely spaced, the higher the amount of flow. As discussed in Section 2.6, it is necessary to adjust capacity figures to represent the prevailing conditions. Adverse conditions like inclement weather, construction, and other incidents tend to slow traffic down and often, also increases vehicle-to-vehicle separation, thus decreasing the amount of traffic flow. Based on limited empirical data, weather conditions such as rain reduce the values of free-flow 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. As indicated in Section 2.6, we employ a reduction in free speed and in highway capacity of 10 percent for rain.

Since congestion arising from evacuation may be significant, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Rural highways generally consist of: (1) one or more uniform sections with limited access (driveways, parking areas) characterized by "uninterrupted" flow; and (2) approaches to at-grade intersections where flow can be "interrupted" by a control device or by turning or crossing traffic at the intersection. Due to these differences, separate estimates of capacity must be made for each section. Often, the approach to the intersection is widened by the addition of one or more lanes (turn pockets or turn bays), 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 DYNEV II system.

4.1 Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices. The existing traffic management plans documented in the county emergency plans are extensive and were adopted without change. See Appendix G for more information.

The per-lane capacity of an approach to a signalized intersection can be expressed (simplistically) in the following form:

$$Q_{cap,m} = \left(\frac{3600}{h_m}\right) \times \left(\frac{G-L}{C}\right)_m = \left(\frac{3600}{h_m}\right) \times P_m$$

where:

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

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

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

where:

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

The estimation of h_m for specified values of h_{sat}, F_1, F_2, ... is undertaken within the DYNEV II simulation model by a mathematical model[2]. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

That is, the turn-movement-specific discharge headways are always greater than, or equal to the saturation discharge headway for through vehicles. These headways (or its inverse equivalent, “saturation flow rate”), may be determined by observation or using the procedures of the HCM 2016.

The above discussion is necessarily brief given the scope of this evacuation time estimate (ETE) report and the complexity of the subject of intersection capacity. In fact, Chapters 19, 20 and 21 in the HCM 2016 address this topic. The factors, F_1, F_2,…, influencing saturation flow rate are identified in equation (19-8) of the HCM 2016.

The traffic signals within the EPZ and Shadow Region are modeled using representative phasing plans and phase durations obtained as part of the field data collection. Traffic responsive signal installations allow the proportion of green time allocated (P_m) for each approach to each intersection to be determined by the expected traffic volumes on each approach during evacuation circumstances. The amount of green time (G) allocated is subject to maximum and minimum phase duration constraints; 2 seconds of yellow time are indicated for each signal phase and 1 second of all-red time is assigned between signal phases, typically. If a signal is pre-timed, the yellow and all-red times observed during the road survey are used. A lost time (L) of 2.0 seconds is used for each signal phase in the analysis.

4.2 Capacity Estimation along Sections of Highway

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

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

[2] Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the far-Left Lane of an Approach". Both papers appear in Transportation Research Record 772, 1980. Lieberman, E., Xin, W., “Macroscopic Traffic Modeling for Large-Scale Evacuation Planning”, presented at the TRB 2012 Annual Meeting, January 22-26, 2012.

The value of V_F can be expressed as:

$$V_F = R \times Capacity$$

where:

R = Reduction factor which is less than unity

We have employed a value of R=0.90. The advisability of such a capacity reduction factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[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 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.

Since the principal objective of ETE analyses is to develop a "realistic" estimate of evacuation times, use of the representative value for this capacity reduction factor (R=0.90) is justified. This factor 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. Any breakdowns on rural roads are generally experienced at intersections where other model logic applies, or at lane drops which reduce capacity there. Therefore, the application of a factor of 0.90 is appropriate on rural roads, but rarely, if ever, activated.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. Exhibit 15-46 in the HCM 2016 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 as is the case during an evacuation.

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

The procedure used here was to estimate "section" capacity, V_E, based on observations made traveling over each section of the evacuation network, based on the posted speed limits and travel behavior of other motorists and by reference to the HCM 2016. The DYNEV II simulation model determines for each highway section, represented as a network link, whether its capacity would be limited by the "section-specific" service volume, V_E, or by the intersection-specific capacity. For each link, the model selects the lower value of capacity.

4.3 Application to the CPNPP Study Area

As part of the development of the link-node analysis network for the study area, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

2016 Highway Capacity Manual (HCM 2016)
Transportation Research Board
National Research Council
Washington, D.C.

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

- Two-Lane roads: Local, State
- Multilane Highways (at-grade)
- Freeways

Each of these classifications will be discussed.

4.3.1 Two-Lane Roads

Ref: HCM 2016 Chapter 15

Two lane roads comprise the majority of highways within the study area. The per-lane capacity of a two-lane highway is estimated at 1,700 passenger cars per hour (pc/h). This estimate is essentially independent of the directional distribution of traffic volume except that, for extended distances, the two-way capacity will not exceed 3,200 pc/h. The HCM 2016 procedures then estimate Level of Service (LOS) and Average Travel Speed. The DYNEV II simulation model accepts the specified value of capacity as input and computes average speed based on the time-varying demand: capacity relations.

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

- Most sections of two-lane roads within the study area are classified as “Class I”, with “level terrain”; some are “rolling terrain”.
- “Class II” highways are mostly those within urban and suburban centers.

4.3.2 Multilane Highway

Ref: HCM Chapter 12

Exhibit 12-8 of the HCM 2016 presents a set of curves that indicate a per-lane capacity ranging from approximately 1,900 to 2,200 pc/h, for free-speeds of 45 to 70 mph, respectively. Based on observation, the multilane highways outside of urban areas within the study area service traffic with free speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand and capacity relationship and the impact of control at intersections. A conservative estimate of per-lane capacity of 1,900 pc/h is adopted for this study for multilane highways outside of urban areas, as shown in Appendix K.

4.3.3 Freeways

Ref: HCM 2016 Chapters 10, 12, 13, 14

Chapter 10 of the HCM 2016 describes a procedure for integrating the results obtained in Chapters 12, 13 and 14, which compute capacity and LOS for freeway components. Chapter 10 also presents a discussion of simulation models. The DYNEV II simulation model automatically performs this integration process.

Chapter 12 of the HCM 2016 presents procedures for estimating capacity and LOS for “Basic Freeway Segments". Exhibit 12-37 of the HCM 2016 presents capacity vs. free speed estimates, which are provided below.

Free Speed (mph):	55	60	65	70+
Per-Lane Capacity (pc/h):	2,250	2,300	2,350	2,400

The inputs to the simulation model are highway geometrics, free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships. A conservative estimate of per-lane capacity of 2,250 pc/h is adopted for this study for freeways, as shown in Appendix K.

Chapter 13 of the HCM 2016 presents procedures for estimating capacity, speed, density and LOS for freeway weaving sections. The simulation model contains logic that relates speed to demand volume: capacity ratio. The value of capacity obtained from the computational procedures detailed in Chapter 13 depends on the "Type" and geometrics of the weaving segment and on the "Volume Ratio" (ratio of weaving volume to total volume).

Chapter 14 of the HCM 2016 presents procedures for estimating capacities of ramps and of "merge" areas. There are three significant factors to the determination of capacity of a ramp-freeway junction: The capacity of the freeway immediately downstream of an on-ramp or immediately upstream of an off-ramp; the capacity of the ramp roadway; and the maximum flow rate entering the ramp influence area. In most cases, the freeway capacity is the controlling factor. Values of this merge area capacity are presented in Exhibit 14-10 of the HCM

2016 and depend on the number of freeway lanes and on the freeway free speed. Ramp capacity is presented in Exhibit 14-12 and is a function of the ramp FFS. The DYNEV II simulation model logic simulates the merging operations of the ramp and freeway traffic in accord with the procedures in Chapter 14 of the HCM 2016. If congestion results from an excess of demand relative to capacity, then the model allocates service appropriately to the two entering traffic streams and produces LOS F conditions (The HCM 2016 does not address LOS F explicitly).

4.3.4 Intersections

Ref: HCM 2016 Chapters 19, 20, 21, 22

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapter 19 (signalized intersections), Chapters 20, 21 (un-signalized intersections) and Chapter 22 (roundabouts). The complexity of these computations is indicated by the aggregate length of these chapters. The DYNEV II simulation logic is likewise complex.

The simulation model explicitly models intersections: Stop/yield controlled intersections (both 2-way and all-way) and traffic signal controlled intersections. Where intersections are controlled by fixed time controllers, traffic signal timings are set to reflect average (non-evacuation) traffic conditions. Actuated traffic signal settings respond to the time-varying demands of evacuation traffic to adjust the relative capacities of the competing intersection approaches. All traffic signals within the CPNPP study area (EPZ and Shadow Region) are actuated. Default cycle length of 75 seconds was used for each of these signals.

The model is also capable of modeling the presence of manned traffic control. At specific locations where it is advisable or where existing plans call for overriding existing traffic control to implement manned control, the model will use actuated signal timings that reflect the presence of traffic guides. At locations where a special traffic control strategy (continuous left-turns, contra-flow lanes) is used, the strategy is modeled explicitly. A list that includes the total number of intersections modeled that are unsignalized, signalized, or manned by response personnel is noted in Appendix K.

4.4 Simulation and Capacity Estimation

Chapter 6 of the HCM 2016 is entitled, "HCM and Alternative Analysis Tools." The chapter discusses the use of alternative tools such as simulation modeling to evaluate the operational performance of highway networks. Among the reasons cited in Chapter 6 to consider using simulation as an alternative analysis tool is:

> *"The system under study involves a group of different facilities or travel modes with mutual interactions involving several HCM chapters. Alternative tools are able to analyze these facilities as a single system."*

This statement succinctly describes the analyses required to determine traffic operations across an area encompassing an EPZ operating under evacuation conditions. The model utilized for this study, DYNEV II, is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM 2016 – 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. The DYNEV II simulation model includes some HCM 2016 procedures only for the purpose of estimating capacity.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of these are: (1) FFS; and (2) saturation headway, h_{sat}. The first of these is estimated by direct observation during the road survey; the second is estimated using the concepts of the HCM 2016, as described earlier. These parameters are listed in Appendix K, for each network link.

It is important to note that simulation is a mathematical representation of an assumed set of conditions using the best available knowledge and understanding of traffic flow and available inputs. Simulation should not be assumed to be a prediction of what will happen under any event because a real evacuation can be impacted by an infinite number of things – many of which will differ from these test cases – and many others cannot be taken into account with the tools available.

4.5 Boundary Condition

As illustrated in Figure 1-2 and in Appendix K, the link-node analysis network used for this study is finite. The analysis network does extend well beyond the 15-mile radial study area in some locations in order to model intersections with other major evacuation routes beyond the study area. However, the network does have an end at the destination (exit) nodes as discussed in Appendix C. Beyond these destination nodes, there may be signalized intersections or merge points that impact the capacity of the evacuation routes leaving the study area. Rather than neglect these "boundary conditions," this study assumes a 25% reduction in capacity on two-lane roads (Section 4.3.1 above) and multilane highways (Section 4.3.2 above). There is no reduction in capacity for freeways due to boundary conditions. The 25% reduction in capacity is based on the prevalence of actuated traffic signals in the study area and the fact that the evacuating traffic volume will be more significant than the competing traffic volume at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time.

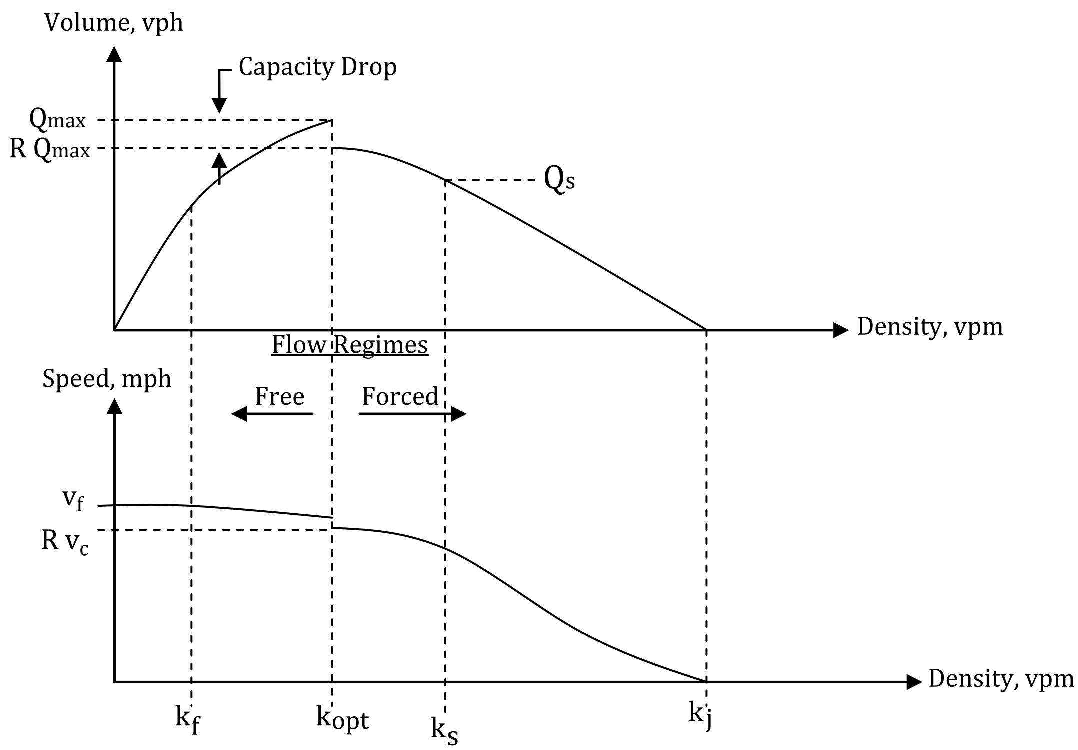


Figure 4-1**. Fundamental Diagrams**

5 ESTIMATION OF TRIP GENERATION TIME

Federal guidance (see NUREG/CR-7002, Rev. 1) recommends that the Evacuation Time Estimate (ETE) study estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the demographic survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

5.1 Background

In general, an accident at a nuclear power plant is characterized by the following Emergency Classification Levels (see Section C of Part IV of Appendix E of 10 CFR 50 for details):

1. Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

At each level, the Federal guidelines specify a set of Actions to be undertaken by the licensee and by the state and local offsite agencies. As a Planning Basis, we will adopt a conservative posture, in accordance with Section 1.2 of NUREG/CR-7002, Rev. 1., that a rapidly escalating accident at the plant wherein evacuation is ordered promptly and no early protective actions have been implemented will be considered in calculating the Trip Generation time. We will assume:

1. The Advisory to Evacuate (ATE) will be announced coincident with the siren notification.
2. Mobilization of the general population will commence within 15 minutes after the siren notification.
3. The ETE are measured relative to the ATE.

We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:

1. Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Section 2.13 of NUREG/CR-6863.
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is likely that a longer time will elapse between the various classes of an emergency. For example, suppose one hour elapses from the siren alert to the ATE. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the Emergency Planning Zone (EPZ) will be lower when the ATE is announced, than at the time of the siren alert. In addition, many will engage in preparation activities to evacuate, in anticipation that an Advisory will be broadcasted. Thus, the time needed to complete the mobilization activities and the number of people remaining to evacuate the EPZ after the ATE, will both be somewhat less than the estimates presented in this

report. Consequently, the ETE presented in this report are higher than the actual evacuation time, if this hypothetical situation were to take place.

The notification process consists of two events:

1. Transmitting information using the alert and notification systems (ANS) available within the EPZ (announcements and alarms broadcast over the plant page-party system, sirens, and EAS broadcasts).
2. Receiving and correctly interpreting the information that is transmitted.

The population within the EPZ is dispersed over an area of approximately 316 square miles and is engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

The amount of elapsed time will vary from one individual to the next depending on where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the EPZ at the time the emergency is declared. These people may be commuters, shoppers and other travelers who reside within the EPZ and who will return to join the other household members upon receiving notification of an emergency.

As indicated in Section 2.13 of NUREG/CR-6863, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the EPZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETE may be computed.

For example, people at home or at work within the EPZ will be notified by siren, and/or tone alert and/or radio (if available). Those well outside the EPZ will be notified by telephone, radio, TV and word-of-mouth, with potentially longer time lags. Furthermore, the spatial distribution of the EPZ population will differ with time of day – families will be united in the evenings but dispersed during the day. In this respect, weekends will differ from weekdays.

As indicated in Section 4.3 of NUREG/CR-7002, Rev. 1, the information required to compute trip generation times is typically obtained from surveys of the EPZ residents. Such a demographic survey was conducted in 2021 in support of this ETE study for this site. Appendix F discusses the survey sampling plan, documents the survey instrument utilized, and provides the survey results. It is important to note that the shape and duration of the evacuation trip mobilization distribution is important at sites where traffic congestion is not expected to cause the ETE to extend beyond the trip generation time period. The remaining discussion will focus on the application of the trip generation data obtained from the demographic survey to the development of the ETE documented in this report.

5.2 Fundamental Considerations

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

Activities are undertaken over a period of time. Activities may be in "series" (i.e., to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	Notification
2	Awareness of Situation
3	Depart Work
4	Arrive Home
5	Depart on Evacuation Trip

Associated with each sequence of events are one or more activities, as outlined in Table 5-1.

These relationships are shown graphically in Figure 5-1.

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

As such, a completed Activity changes the 'state' of an individual (i.e., 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.

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.

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.

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

estimates of the time distributions of all preceding events. For this study, we adopt the conservative posture that all activities will occur in sequence.

In some cases, assuming certain events occur strictly sequential (for instance, commuter returning home before beginning preparation to leave) can result in rather *conservative* (that is, longer) estimates of mobilization times. It is reasonable to expect that at least some parts of these events will overlap for many households, but that assumption is not made in this study.

5.3 Estimated Time Distributions of Activities Preceding Event 5

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

Time Distribution No. 1, Notification Process: Activity 1 → 2

Federal regulations (10CFR50 Appendix E, Item IV.D.3) stipulate, "[t]he design objective of the prompt public alert and notification system shall be to have the capability to essentially complete the initial alerting and initiate notification of the public within the plume exposure pathway EPZ within about 15 minutes". Furthermore, 2019 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness (REP) Program Manual Part V Section B.1 Bullet 3 states, "Notification methods will be established to ensure coverage within 45 minutes of essentially 100% of the population within the entire plume exposure pathway EPZ who may not have received the initial notification."

Given the federal regulations and guidance, and the assumed presence of sirens within the EPZ, it is assumed that 100 percent of the population in the EPZ can be notified within 45 minutes. The assumed distribution for notifying the EPZ population is provided in Table 5-2. The distribution is plotted in Figure 5-2.

Distribution No. 2, Prepare to Leave Work: Activity 2 → 3

It is reasonable to expect that the vast majority of business enterprises within the EPZ will elect to shut down following notification and most employees would leave work quickly. Commuters, who work outside the EPZ could, in all probability, also leave quickly since facilities outside the EPZ would remain open and other personnel would remain. Personnel or farmers responsible for equipment/livestock would require additional time to secure their facility. The distribution of Activity 2 → 3 shown in Table 5-3 reflects data obtained by the demographic survey for employees working inside or outside of the EPZ who returns home prior to evacuating. This distribution is also applicable for residents to leave stores, restaurants, parks, and other locations within the EPZ. This distribution is plotted in Figure 5-2.

Distribution No. 3, Travel Home: Activity 3 → 4

These data are provided directly by those households which responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-4.

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

These data are provided directly by those households which responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-5.

5.4 Calculation of Trip Generation Time Distribution

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

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-6 presents the summing procedure to arrive at each designated distribution.

Table 5-7 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

5.4.1 Statistical Outliers

As already mentioned, some portion of the survey respondents answer "don't know" to some questions or choose to not respond to a question. The mobilization activity distributions are based upon actual responses. But, it is the nature of surveys that a few numeric responses are inconsistent with the overall pattern of results. An example would be a case in which for 500 responses, almost all of them estimate less than two hours for a given answer, but 3 say "four hours" and 4 say "six or more hours".

These "outliers" must be considered: are they valid responses, or so atypical that they should be dropped from the sample?

In assessing outliers, there are three alternatives to consider:

1) Some responses with very long times may be valid, but reflect the reality that the respondent really needs to be classified in a different population subgroup, based upon access and/or functional needs;

2) Other responses may be unrealistic (6 hours to return home from commuting distance, or 2 days to prepare the home for departure);

3) Some high values are representative and plausible, and one must not cut them as part of the consideration of outliers.

The issue of course is how to make the decision that a given response or set of responses are to be considered "outliers" for the component mobilization activities, using a method that objectively quantifies the process.

There is considerable statistical literature on the identification and treatment of outliers singly or in groups, much of which assumes the data is normally distributed and some of which uses non-parametric methods to avoid that assumption. The literature cites that limited work has been done directly on outliers in sample survey responses.

In establishing the overall mobilization time/trip generation distributions, the following principles are used:

1) It is recognized that the overall trip generation distributions are conservative estimates, because they assume a household will do the mobilization activities sequentially, with no overlap of activities;

2) The individual mobilization activities (prepare to leave work, travel home, prepare home) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-6, Table 5-7);

3) Outliers can be eliminated either because the response reflects a special population (e.g., access and/or functional needs, transit dependent) or lack of realism, because the purpose is to estimate trip generation patterns for personal vehicles;

4) To eliminate outliers,
    a) the mean and standard deviation of the specific activity are estimated from the responses,
    b) the median of the same data is estimated, with its position relative to the mean noted,
    c) the histogram of the data is inspected, and
    d) all values greater than 3.5 standard deviations are flagged for attention, taking special note of whether there are gaps (categories with zero entries) in the histogram display.

    In general, only flagged values more than 3.5 standard deviations from the mean are allowed to be considered outliers, with gaps in the histogram expected.

    When flagged values are classified as outliers and dropped, steps "a" to "d" are repeated.

5) As a practical matter, even with outliers eliminated by the above, the resultant histogram, viewed as a cumulative distribution, is not a normal distribution. A typical situation that results is shown below in Figure 5-3.

6) In particular, the cumulative distribution differs from the normal distribution in two key aspects, both very important in loading a network to estimate evacuation times:
    a) Most of the real data is to the left of the "normal" curve above, indicating that the network loads faster for the first 80-85% of the vehicles, potentially causing more (and earlier) congestion than otherwise modeled;

b) The last 10-15% of the real data "tails off" slower than the comparable "normal" curve, indicating that there is significant traffic still loading at later times.

Because these two features are important to preserve, it is the histogram of the data that is used to describe the mobilization activities, not a "normal" curve fit to the data. One could consider other distributions, but using the shape of the *actual* data curve is unambiguous and preserves these important features;

7) With the mobilization activities each modeled according to Steps 1-6, including preserving the features cited in Step 6, the overall (or total) mobilization times are constructed.

This is done by using the data sets and distributions under different scenarios (e.g., commuter returning, no commuter returning). In general, these are additive, using weighting based upon the probability distributions of each element; Figure 5-4 presents the combined trip generation distributions for each population group considered. These distributions are presented on the same time scale. (As discussed earlier, the use of strictly additive activities is a conservative approach, because it makes all activities sequential – travel home from work follows preparation to leave work, preparation for departure follows the return of the commuter, and so forth. In practice, it is reasonable that some of these activities are done in parallel, at least to some extent – for instance, preparation to depart begins by a household member at home while the commuter is still on the road.)

The mobilization distribution results are used in their tabular/graphical form as direct inputs to later computations that lead to the ETE.

The DYNEV II 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 5-8 (Distribution B, Arrive Home, omitted for clarity).

The final time period (15) 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.

5.4.2 Staged Evacuation Trip Generation

As defined in NUREG/CR-7002, Rev. 1, staged evacuation consists of the following:

1. Zones comprising the 2-Mile Region are advised to evacuate immediately.
2. Zones comprising regions extending from 2 to 5 miles downwind are advised to shelter in-place while the 2-Mile Region is cleared.
3. As vehicles evacuate the 2-Mile Region, sheltered people from 2 to 5 miles downwind continue preparation for evacuation.

4. The population sheltering in the 2 to 5 Mile Region are advised to begin evacuating when approximately 90% of those originally within the 2-Mile Region evacuate across the 2-Mile Region boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%.

<u>Assumptions</u>

1. The EPZ population in Zones beyond 5 miles will react as does the population in the 2 to 5-Mile Region; that is, they will first shelter, then evacuate after the 90th percentile ETE for the 2-Mile Region, with the exception of the 20% non-compliance.
2. The population in the Shadow Region beyond the EPZ boundary, extending to approximately 15 miles radially from the plant, will react as they do for all non-staged evacuation scenarios. That is 20% of these households will elect to evacuate with no shelter delay.
3. The transient population will not be expected to stage their evacuation because of the limited sheltering options available to people who may be at parks, on a beach, or at other venues. Also, notifying the transient population of a staged evacuation would prove difficult.
4. Employees will also be assumed to evacuate without first sheltering.

<u>Procedure</u>

1. Trip generation for population groups in the 2-Mile Region will be as computed based upon the results of the demographic survey and analysis.
2. Trip generation for the population subject to staged evacuation will be formulated as follows:
   a. Identify the 90th percentile evacuation time for the Zones comprising the 2-Mile Region. This value, T_{Scen}^*, is obtained from simulation results. It will become the time at which the region being sheltered will be told to evacuate for each scenario.
   b. The resultant trip generation curves for staging are then formed as follows:
      i. The non-shelter trip generation curve is followed until a maximum of 20% of the total trips are generated (to account for shelter non-compliance).
      ii. No additional trips are generated until time T_{Scen}^*
      iii. Following time T_{Scen}^*, the balance of trips are generated:
         1. by stepping up and then following the non-shelter trip generation curve (if T_{Scen}^* is $\leq$ max trip generation time) or
         2. by stepping up to 100% (if T_{Scen}^* is > max trip generation time)
   c. Note: This procedure implies that there may be different staged trip generation distributions for different scenarios, however, that was not the case for this site. NUREG/CR-7002, Rev. 1 uses the statement “approximately 90th percent” as the

time to end staging and begin evacuating. The value of T_{Scen}^* is about 2:30 for all scenarios (see Region R01 in Table 7-1).

3. Staged trip generation distributions are created for the following population groups:
    a. Residents with returning commuters
    b. Residents without returning commuters

Figure 5-5 and Table 5-9 present the staged trip generation distributions for both residents with and without returning commuters and employees/transients.; the 90th percentile 2-Mile Region evacuation time is 150 minutes for all scenarios, on average. At T_{Scen}^*, approximately 20% of the permanent resident population (who normally would have completed their mobilization activities for an un-staged evacuation) advised to shelter has nevertheless departed the area. These people do not comply with the shelter advisory. Also included on the plot are the trip generation distributions for these groups as applied to the regions advised to evacuate immediately.

Since the 90th percentile evacuation time occurs before the end of the trip generation time, after the sheltered region is advised to evacuate, the shelter trip generation distribution rises to meet the balance of the non-staged trip generation distribution. Following time T_{Scen}^*, the balance of staged evacuation trips that are ready to depart are released within 15 minutes. After T_{Scen}^*+15, the remainder of evacuation trips are generated in accordance with the un-staged trip generation distribution.

Figure 5-5 and Table 5-9 provides the trip generation for staged evacuation.

5.4.3 Trip Generation for Waterways and Recreational Areas

Section 8.2 of Comanche Peak Nuclear Power Plant Emergency Plan Manual states that “Squaw Creek Park shall be evacuated using instruction in the Squaw Creek Park Emergency Plan”, which states that park personnel would notify anyone that is in the park.

As discussed in Section 2.3, this study assumes a rapidly escalating general emergency. As indicated in Table 5-2, this study assumes 100% notification in 45 minutes which is consistent with the FEMA REP Manual. Table 5-8 indicates that all transients will have mobilized within 1 hour and 45 minutes. It is assumed that this timeframe is sufficient time for boaters, campers and other transients to return to their vehicles or lodging facilities, pack their belongings and begin their evacuation trip.

Table 5-1. Event Sequence for Evacuation Activities

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

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Percent of Population Notified
0	0.0%
5	7.1%
10	13.3%
15	26.5%
20	46.9%
25	66.3%
30	86.7%
35	91.8%
40	96.9%
45	100.0%

Table 5-3. Time Distribution for Employees to Prepare to Leave Work

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work	Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0.0%	50	91.8%
5	28.3%	55	92.3%
10	45.2%	60	98.8%
15	60.0%	65	99.1%
20	65.1%	70	99.5%
25	68.1%	75	99.8%
30	82.2%	80	99.8%
35	86.7%	85	99.9%
40	88.8%	90	100.0%
45	90.9%		

NOTE: The survey data was normalized to distribute the "Don't know" response. That is, the sample was reduced in size to include only those households who responded to this question. The underlying assumption is that the distribution of this activity for the "Don't know" responders, if the event takes place, would be the same as those responders who provided estimates.

Table 5-4. Time Distribution for Commuters to Travel Home

Elapsed Time (Minutes)	Cumulative Percent Returning Home	Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0.0%	55	87.9%
5	4.5%	60	92.9%
10	14.7%	65	94.0%
15	27.0%	70	95.1%
20	37.7%	75	96.2%
25	45.5%	80	97.2%
30	61.1%	85	98.1%
35	69.9%	90	99.1%
40	74.6%	95	99.4%
45	82.2%	100	99.7%
50	86.0%	105	100.0%

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

Table 5-5. Time Distribution for Population to Prepare to Leave Home

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0.0%
15	2.5%
30	19.1%
45	36.6%
60	61.1%
75	76.3%
90	80.4%
105	83.6%
120	91.5%
135	96.3%
150	97.2%
165	97.7%
180	98.2%
195	100.0%

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

Table 5-6. Mapping Distributions to Events

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

Table 5-7. Description of the Distributions

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ who live outside, and to Transients within the EPZ.
B	Time distribution of commuters arriving home (Event 4).
C	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip (Event 5).
D	Time distribution of residents without commuters returning home, leaving home to begin the evacuation trip (Event 5).

Table 5-8. Trip Generation Histograms for the EPZ Population for Un-staged Evacuation

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period			
		Employees (Distribution A)	Transients (Distribution A)	Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)
1	15	5%	5%	0%	0%
2	15	27%	27%	0%	2%
3	15	33%	33%	0%	9%
4	30	28%	28%	6%	37%
5	15	5%	5%	8%	18%
6	15	2%	2%	13%	11%
7	15	0%	0%	14%	5%
8	15	0%	0%	14%	5%
9	30	0%	0%	21%	9%
10	30	0%	0%	13%	2%
11	30	0%	0%	6%	2%
12	15	0%	0%	2%	0%
13	30	0%	0%	2%	0%
14	30	0%	0%	1%	0%
15	600	0%	0%	0%	0%

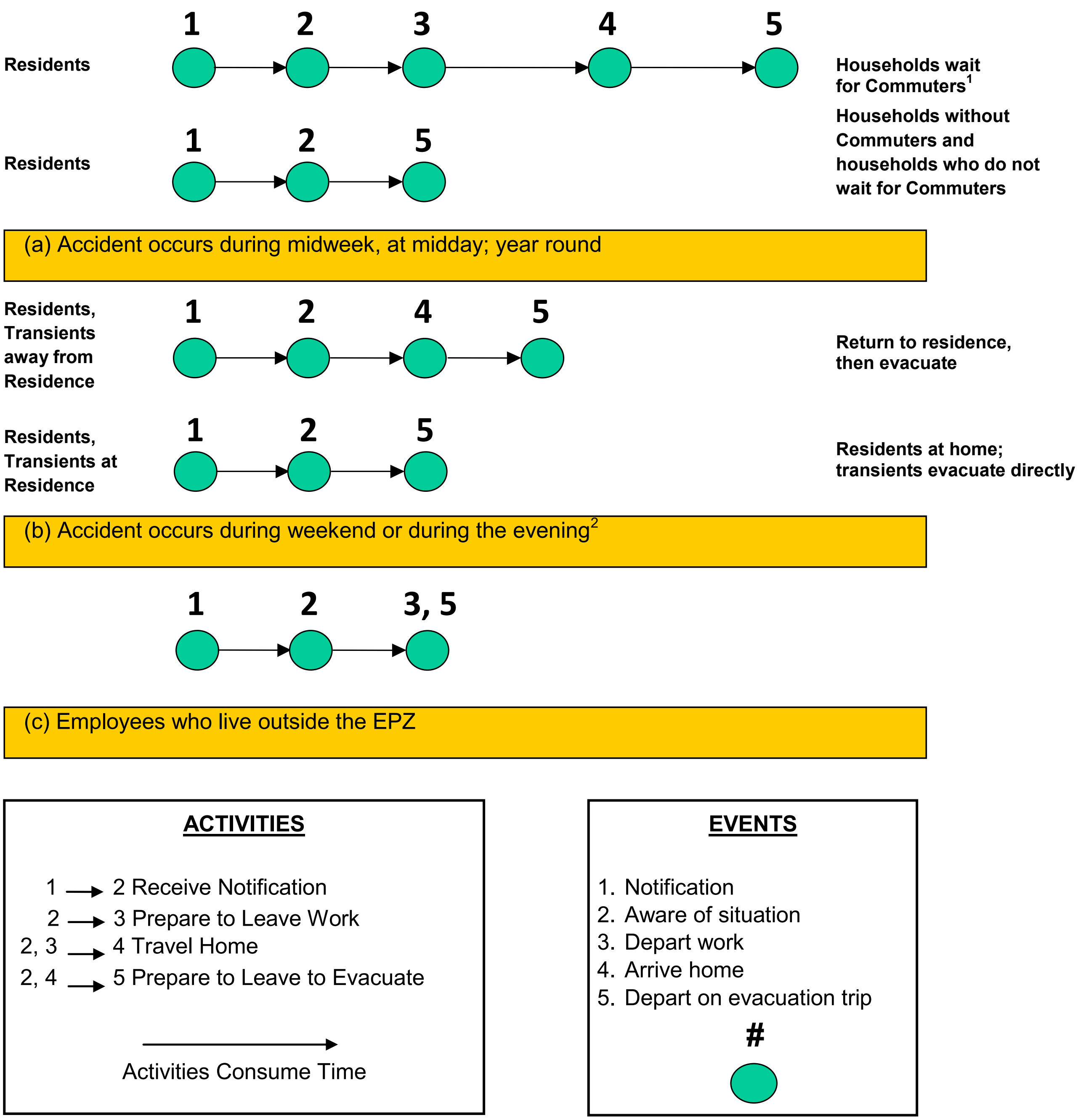
NOTE:

- Shadow vehicles are loaded onto the analysis network (Figure 1-2) using Distribution C for good weather.
- Special event vehicles are loaded using Distribution A.

Table 5-9. Trip Generation Histograms for the EPZ Population for Staged Evacuation

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period[1]	
		Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)
1	15	0%	0%
2	15	0%	0%
3	15	0%	2%
4	30	1%	8%
5	15	2%	3%
6	15	2%	2%
7	15	3%	1%
8	15	3%	1%
9	30	65%	79%
10	30	13%	2%
11	30	6%	2%
12	15	2%	0%
13	30	2%	0%
14	30	1%	0%
15	600	0%	0%

[1] Trip Generation for Employees and Transients (see Table 5-8) is the same for Un-staged and Staged Evacuation.



[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

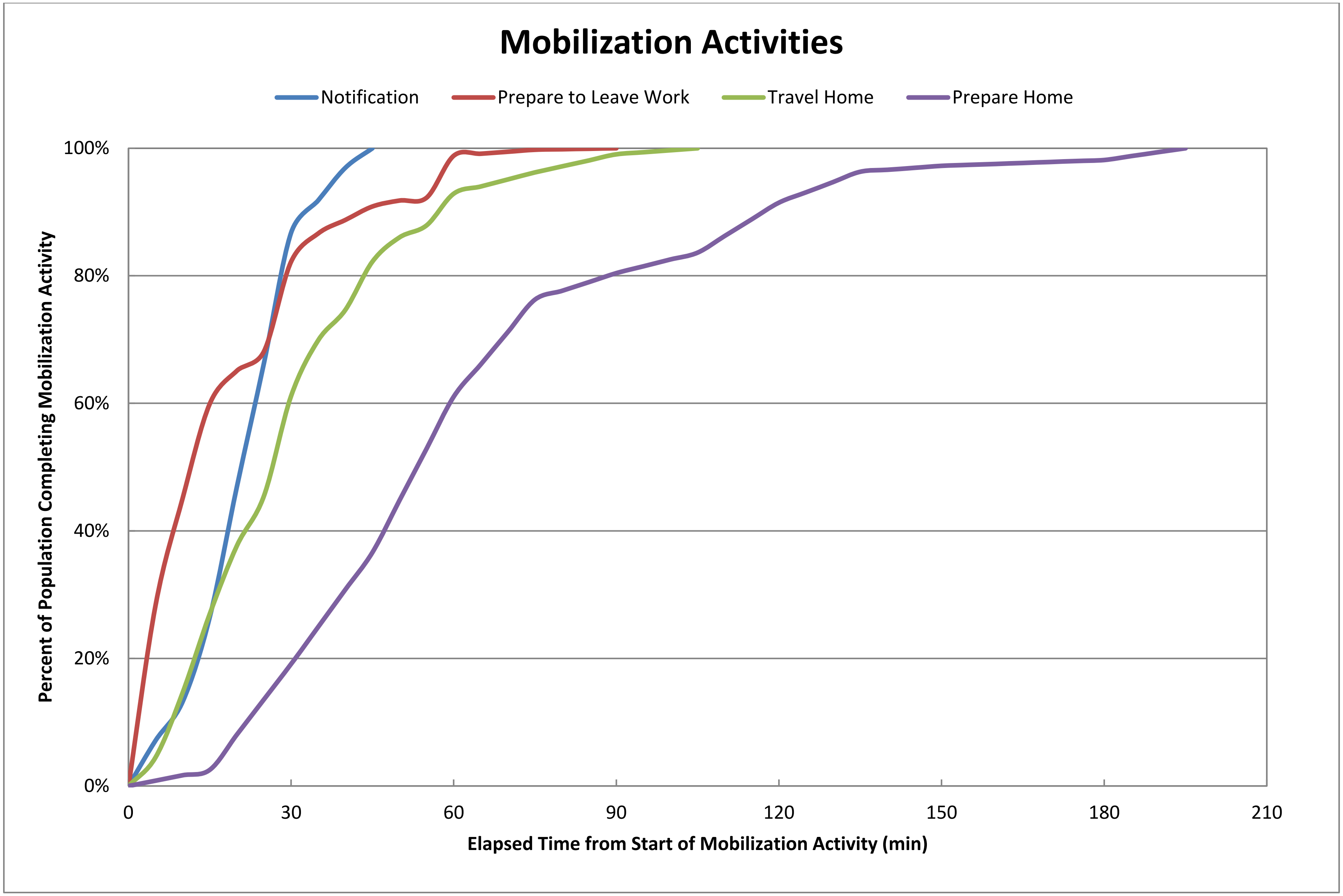


Figure 5-2. Time Distributions for Evacuation Mobilization Activities

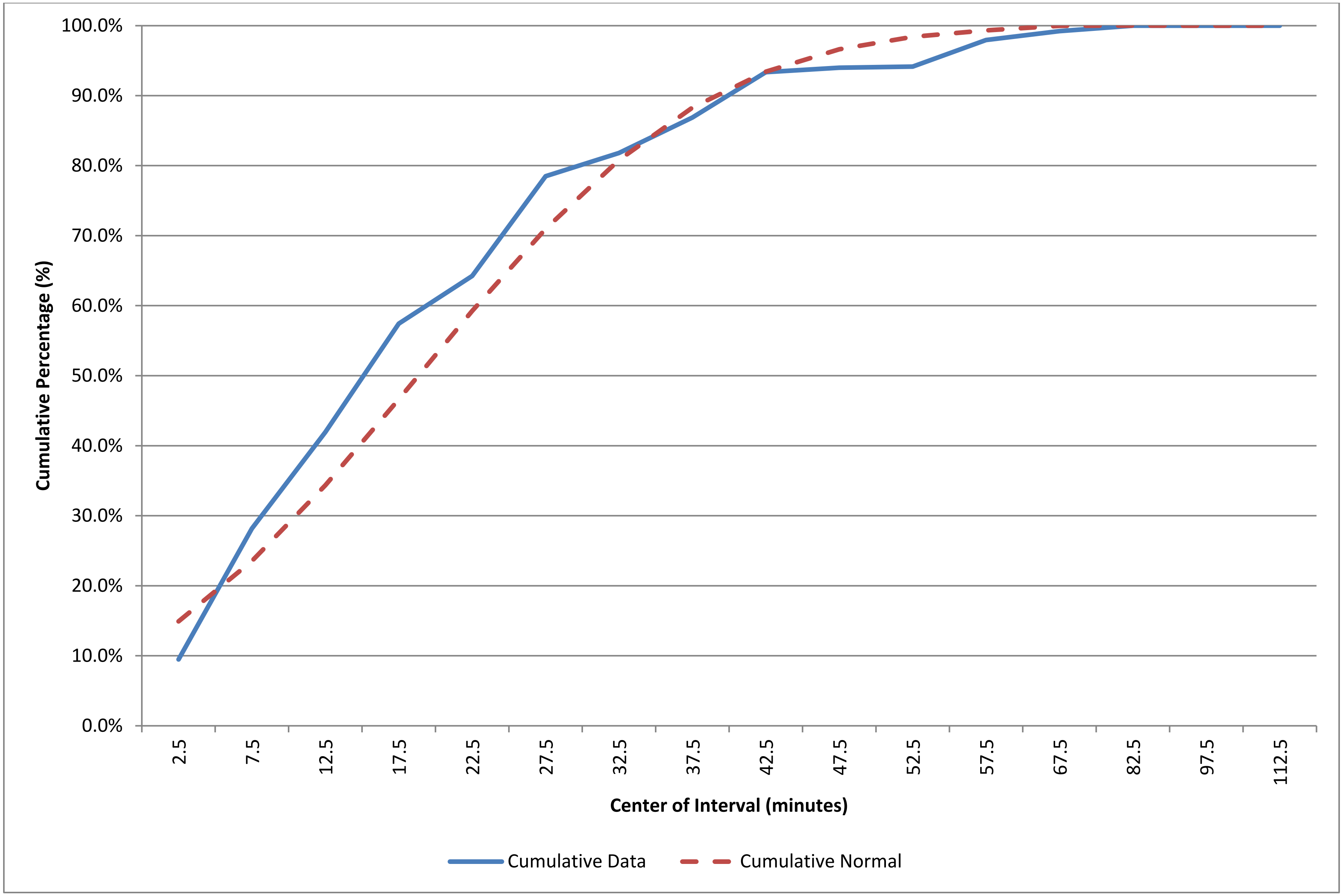


Figure 5-3. Comparison of Data Distribution and Normal Distribution

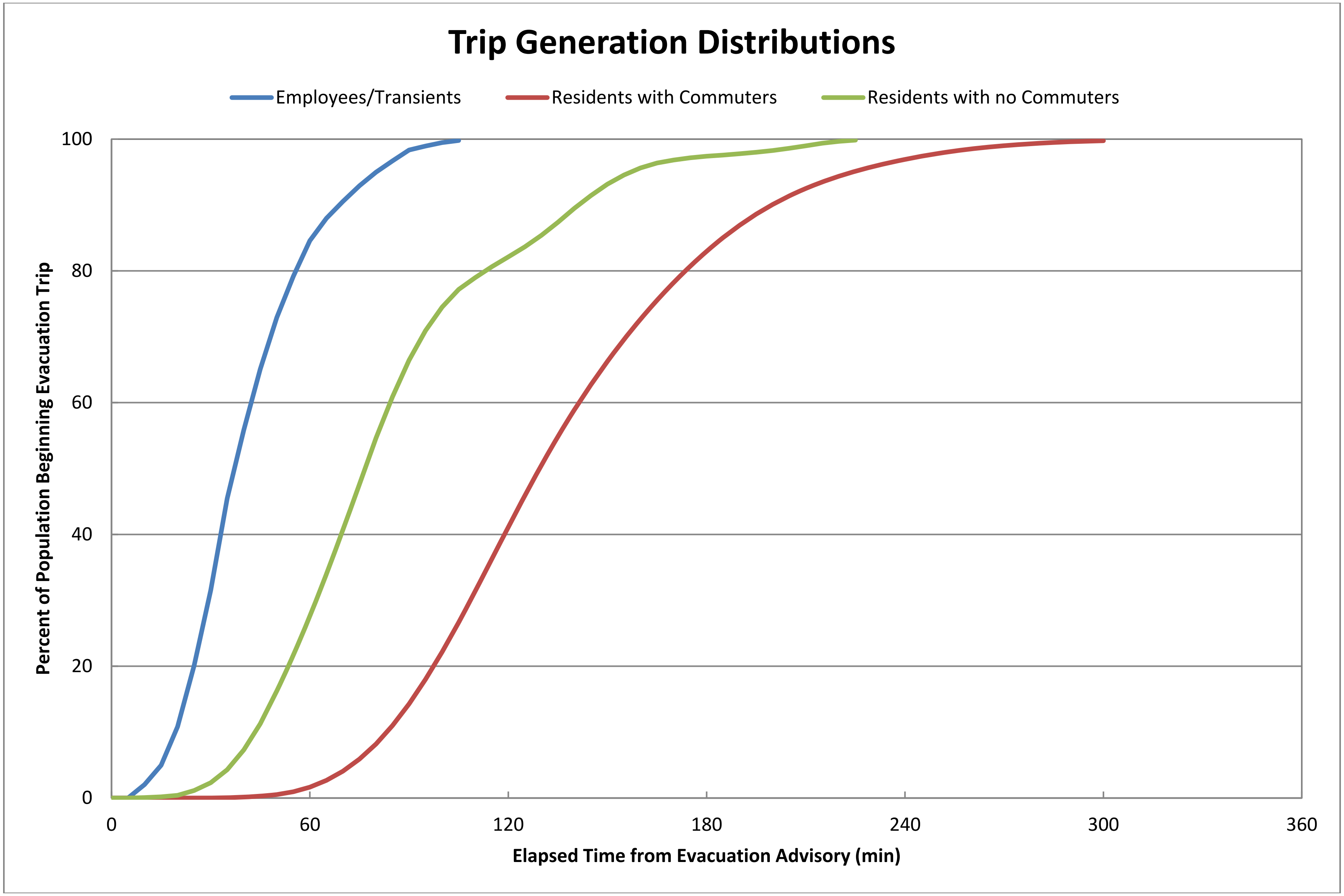


Figure 5-4. Comparison of Trip Generation Distributions

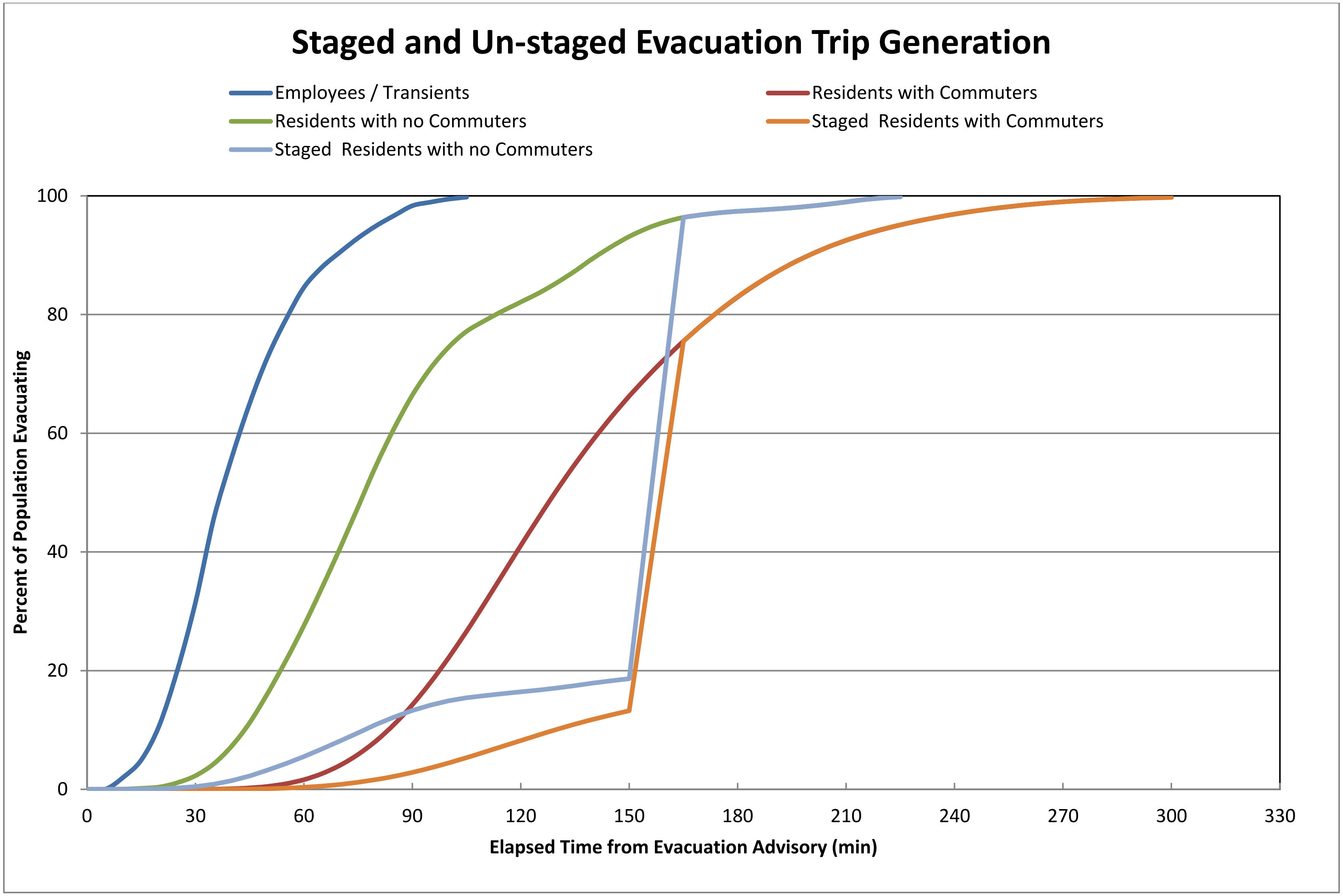


Figure 5-5. Comparison of Staged and Un-staged Trip Generation Distributions in the 2 to 5 Mile Region

6 EVACUATION CASES

An evacuation "case" defines a combination of Evacuation Region and Evacuation Scenario. The definitions of "Region" and "Scenario" are as follows:

Region A grouping of contiguous evacuating Zones that forms either a "keyhole" sector-based area, or a circular area within the EPZ, that must be evacuated in response to a radiological emergency.

Scenario A combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions.

A total of 92 Regions were defined which encompass all the groupings of Zones considered. These Regions are defined in Table 6-1 through Table 6-4. The Zone configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the power plant, and three or five adjoining sectors, each with a central angle of 22.5 degrees, as per NUREG/CR-7002 guidance, Rev. 1 and the CPNPP Protective Action Recommendations Procedure No. EPP-304. The central sector coincides with the wind direction. These sectors extend to 5 miles from the plant (Regions R04 through R17 and Regions R34 through R47) or to the EPZ boundary (Regions R18 through R33 and Regions R48 through R63).

Regions R01, R02 and R03 represent evacuations of circular areas with radii of 2, 5 and 10 miles, respectively. Regions R64, and R65 through R78 are identical to Regions R02, and R04 through R17, respectively for a three-sector keyhole; Regions R79 through R92 are identical to Regions R34 through R47, respectively for a five sector keyhole; however, those Zones between 2 miles and 5 miles are staged until 90% of the 2-Mile Region (Region R01) has evacuated.

A total of 12 Scenarios were evaluated for all Regions. Thus, there are a total of 92 x 12 = 1,104 evacuation cases. Table 6-5 provides a description of all Scenarios.

Each combination of region and scenario implies a specific population to be evacuated. The population group and the vehicle estimates presented in Section 3 and Appendix E are peak values. These peak values are adjusted depending on the Scenario and Region being considered, using Scenario and Region specific percentages; such that the average population is considered for each evacuation case. The Scenario percentages are presented in Table 6-6, while the regional percentages are provided in Table H-1 through Table H-3. Table 6-7 presents the vehicle counts for each scenario for an evacuation of Region R03 – the entire EPZ, based on the scenario percentages in Table 6-6. The percentages presented in Table 6-6 were determined as follows:

The number of residents with commuters during the week (when workforce is at its peak) is equal to 32%, the product of 56.2% (the number of households with at least one commuter – see Figure F-6) and 57.7% (the number of households with a commuter that would await the return of the commuter prior to evacuating – see Figure F-11). See assumption 3 in Section 2.3. It is estimated

for weekend and evening scenarios that 10% of households with returning commuters (32%) will have a commuter at work during those times or approximately 3% (10% x 32% = 3.2%, rounds to 3%) of households.

It can be argued that this estimate of permanent residents overstates, somewhat, the number of evacuating vehicles, especially during the summer. It is certainly reasonable to assert that some portion of the population would be on vacation during the summer and would travel elsewhere. A rough estimate of this reduction can be obtained as follows:

- Assume 50 percent of all households vacation for a period over the summer.
- Assume these vacations, in aggregate, are uniformly dispersed over 10 weeks, i.e., 10 percent of the population is on vacation during each two-week interval.
- Assume half of these vacationers leave the area.

On this basis, the permanent resident population would be reduced by 5 percent in the summer and by a lesser amount in the off-season. Given the uncertainty in this estimate, we elected to apply no reductions in permanent resident population for the summer scenarios to account for residents who may be out of the area.

Employment is assumed to be at its peak (100%) during the winter, midweek, midday scenarios. Employment is reduced slightly (96%) for summer, midweek, midday scenarios. This is based on the estimation that 50% of the employees commuting into the EPZ will be on vacation for a week during the approximate 12 weeks of summer. It is further estimated that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is assumed that only 10% of the employees are working in the evenings and during the weekends.

Transient activity is estimated to be at its peak (100%) during summer weekends and is less (75%) during the week. As shown in Appendix E, there is a significant amount of lodging and campgrounds offering overnight accommodations in the EPZ; offset by any other transient facilities in which evening use is minimal (parks, beaches, golf courses, and other recreational areas) thus, transient activity is estimated to be high during evening hours – 85% for summer and winter. Transient activity on winter weekends is estimated to be 85% and less (55%) during the winter weekday.

As noted in the shadow footnote to Table 6-6, the shadow percentages are computed using a base of 20% (see assumption 7 in Section 2.2); to include the employees within the Shadow Region who may choose to evacuate, the voluntary evacuation is multiplied by a scenario-specific proportion of employees to permanent residents in the Shadow Region. For example, using the values provided in Table 6-7 for Scenario 1, the shadow percentage is computed as follows:

$$20\% \times \left(1 + \frac{474}{7{,}282 + 15{,}176}\right) = 21\%$$

One special event – Fourth of July in Granbury – was considered as Scenario 11 during the summer, weekend, midday, with good weather. Thus, the special event traffic is 100% evacuated for Scenario 11, and 0% for all other scenarios.

Schools and pre-schools/day cares are in session during the winter season, midweek, midday scenarios. It is estimated that summer school enrollment is approximately 10% of enrollment during the regular school year for summer, midweek, midday scenarios. School is not in session during weekends and evenings, thus no buses for school children are needed under those circumstances.

Day camps are set to 100% during the summer, midday, midweek scenarios and is 0% for all other scenarios.

Buses for the transit-dependent population and special facility population (medical facilities and Somervell County Jail) are set to 100% for all scenarios as it is assumed that the transit-dependent and the special facility population are present in the EPZ for all scenarios.

External traffic is estimated to be reduced by 60% during evening scenarios and is 100% for all other scenarios.

Table 6-1. Description of Evacuation Regions – Regions R01 through R17

Region	Site PAR Central Sector	Description	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R01	N/A	2-Mile Region	X					X																								
R02	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R03	N/A	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles (3 Sector Groups)																																
Region	**Site PAR Central Sector**	**Wind Direction From (Degrees)**	**Zone**																													
			CP	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**2C**	**2D**	**2E**	**2F**	**2G**	**2H**	**2J**	**3A**	**3B**	**3C**	**3D**	**3E**	**3F**	**4A**	**4B**	**4C**	**4D**	**4E**	**4F**	**4G**	**4H**	**GLEN ROSE**	**TOLAR**
R04	A	168.75 – 191.24	X		X			X															X	X	X							
R05	B	191.25 – 213.74	X	X	X			X															X	X								
R06	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R07	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R08	E	258.75 – 281.24	X	X				X	X		X	X																				
R09	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R10	G	303.75 – 326.24	X					X	X	X	X																				X	
R11	H, J	326.25 – 11.24	X					X		X								X													X	
R12	K	11.25 – 33.74	X					X		X							X	X													X	
R13	L	33.75 – 56.24	X					X									X	X								X						
R14	M	56.25 – 78.74	X					X									X	X							X	X						
R15	N	78.75 – 101.24	X					X									X								X	X						
R16	P	101.25 – 123.74	X					X																	X	X						
R17	Q, R	123.75 – 168.74	X					X																X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 6-2. Description of 3 Sector Evacuation Regions – Regions 18 through R33

Evacuate 2-Mile Region and Downwind to EPZ Boundary (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R18	A	168.75 – 191.24	X		X	X	X	X															X	X	X		X	X				
R19	B	191.25 – 213.74	X	X	X	X	X	X						X									X	X			X					
R20	C	213.75 – 236.24	X	X	X	X	X	X	X		X	X		X									X	X								
R21	D	236.25 – 258.74	X	X	X	X		X	X		X	X	X	X									X									
R22	E	258.75 – 281.24	X	X		X		X	X		X	X	X	X	X																	
R23	F	281.25 – 303.74	X					X	X	X	X	X	X		X	X															X	
R24	G	303.75 – 326.24	X					X	X	X	X				X	X			X												X	
R25	H	326.25 – 348.74	X					X		X					X	X		X	X	X		X									X	
R26	J	348.75 – 11.24	X					X		X						X		X	X	X		X									X	
R27	K	11.25 – 33.74	X					X		X							X	X	X	X	X	X									X	
R28	L	33.75 – 56.24	X					X									X	X		X	X	X				X				X		
R29	M	56.25 – 78.74	X					X									X	X		X	X				X	X			X	X		
R30	N	78.75 – 101.24	X					X									X				X				X	X		X	X	X		
R31	P	101.25 – 123.74	X					X																	X	X		X	X	X		X
R32	Q	123.75 – 146.24	X					X																X	X		X	X	X			X
R33	R	146.25 – 168.74	X				X	X																X	X		X	X				X
Zone(s) Evacuate																	Zone(s) Shelter-in-Place															

Table 6-3. Description of 5-Sector Evacuation Regions – Regions R34 through R63

Evacuate 2-Mile Region and Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R34	A	168.75 – 191.24	X	X	X			X															X	X	X							
R35	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R36	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R37	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R38	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R39	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R40	H	326.25 – 348.74	X					X	X	X	X							X													X	
R41	J	348.75 – 11.24	X					X		X							X	X													X	
R42	K	11.25 – 33.74	X					X		X							X	X								X					X	
R43	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R44	M, N	56.25 – 101.24	X					X									X	X							X	X						
R45	P	101.25 – 123.74	X					X									X							X	X	X						
R46	Q	123.75 – 146.24	X					X																X	X	X						
R47	R	146.25 – 168.74	X		X			X															X	X	X							

Evacuate 2-Mile Region and Downwind to EPZ Boundary (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R48	A	168.75 – 191.24	X	X	X	X	X	X						X									X	X	X		X	X				X
R49	B	191.25 – 213.74	X	X	X	X	X	X	X		X	X		X									X	X	X		X	X				
R50	C	213.75 – 236.24	X	X	X	X	X	X	X		X	X	X	X									X	X			X					
R51	D	236.25 – 258.74	X	X	X	X	X	X	X		X	X	X	X	X								X	X								
R52	E	258.75 – 281.24	X	X	X	X		X	X	X	X	X	X	X	X	X							X								X	
R53	F	281.25 – 303.74	X	X		X		X	X	X	X	X	X	X	X	X			X												X	
R54	G	303.75 – 326.24	X					X	X	X	X	X	X		X	X		X	X	X		X									X	
R55	H	326.25 – 348.74	X					X	X	X	X				X	X		X	X	X		X									X	
R56	J	348.75 – 11.24	X					X		X					X	X	X	X	X	X	X	X									X	
R57	K	11.25 – 33.74	X					X		X						X	X	X	X	X	X	X				X				X	X	
R58	L	33.75 – 56.24	X					X		X							X	X	X	X	X	X			X	X			X	X	X	
R59	M	56.25 – 78.74	X					X									X	X		X	X	X			X	X		X	X	X		
R60	N	78.75 – 101.24	X					X									X	X		X	X				X	X		X	X	X		X
R61	P	101.25 – 123.74	X					X									X				X			X	X	X	X	X	X	X		X
R62	Q	123.75 – 146.24	X				X	X																X	X	X	X	X	X	X		X
R63	R	146.25 – 168.74	X		X	X	X	X															X	X	X		X	X	X			X

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 6-4. Description of Staged Evacuation Regions – Regions R64 through R92

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (3 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R64	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R65	A	168.75 – 191.24	X		X			X															X	X	X							
R66	B	191.25 – 213.74	X	X	X			X															X	X								
R67	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R68	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R69	E	258.75 – 281.24	X	X				X	X		X	X																				
R70	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R71	G	303.75 – 326.24	X					X	X	X	X																				X	
R72	H, J	326.25 – 11.24	X					X		X								X													X	
R73	K	11.25 – 33.74	X					X		X							X	X													X	
R74	L	33.75 – 56.24	X					X									X	X								X						
R75	M	56.25 – 78.74	X					X									X	X							X	X						
R76	N	78.75 – 101.24	X					X									X								X	X						
R77	P	101.25 – 123.74	X					X																	X	X						
R78	Q, R	123.75 – 168.74	X					X																X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
N/A	N/A	5-Mile Region	Refer to Region R64																													
R79	A	168.75 – 191.24	X	X	X			X															X	X	X							
R80	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R81	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R82	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R83	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R84	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R85	H	326.25 – 348.74	X					X	X	X	X							X													X	
R86	J	348.75 – 11.24	X					X		X							X	X													X	
R87	K	11.25 – 33.74	X					X		X							X	X								X					X	
R88	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R89	M, N	56.25 – 101.24	X					X									X	X							X	X						
R90	P	101.25 – 123.74	X					X									X							X	X	X						
R91	Q	123.75 – 146.24	X					X																X	X	X						
R92	R	146.25 – 168.74	X		X			X															X	X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

Table 6-5. Evacuation Scenario Definitions

Scenario	Season[1]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Weekend	Midday	Good	Special Event: Fourth of July in Granbury
12	Summer	Midweek	Midday	Good	Roadway Impact: Single Lane Closure on US 377 NB and on US 67 NB

[1] Winter means that school is in session, at normal enrollment levels (also applies to spring and autumn). Summer means that school is in session at summer school enrollment levels (lower than normal enrollment).

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

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Event	Special Facilities	Texas Amphi-theatre	Day Camps	School Buses	Transit Buses	External Through Traffic
1	32%	68%	96%	75%	20%	0%	100%	0%	100%	10%	100%	100%
2	32%	68%	96%	75%	20%	0%	100%	0%	100%	10%	100%	100%
3	3%	97%	10%	100%	20%	0%	100%	0%	0%	0%	100%	100%
4	3%	97%	10%	100%	20%	0%	100%	0%	0%	0%	100%	100%
5	3%	97%	10%	85%	20%	0%	100%	0%	0%	0%	100%	40%
6	32%	68%	100%	55%	20%	0%	100%	0%	0%	100%	100%	100%
7	32%	68%	100%	55%	20%	0%	100%	0%	0%	100%	100%	100%
8	3%	97%	10%	85%	20%	0%	100%	100%	0%	0%	100%	100%
9	3%	97%	10%	85%	20%	0%	100%	100%	0%	0%	100%	100%
10	3%	97%	10%	85%	20%	0%	100%	100%	0%	0%	100%	40%
11	3%	97%	10%	100%	20%	100%	100%	0%	0%	0%	100%	100%
12	32%	68%	96%	75%	20%	0%	100%	0%	100%	10%	100%	100%

Resident Households with Commuters.........Households of EPZ residents who await the return of commuters prior to beginning the evacuation trip.
Resident Households with No Commuters ...Households of EPZ residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.
Employees..EPZ employees who live outside the EPZ
Transients ....People who are in the EPZ at the time of an accident for recreational or other (non-employment) purposes.
Shadow ....Residents and employees in the shadow region (outside of the EPZ) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 20% relocation of shadow residents along with a proportional percentage of shadow employees.
Special Event ....Additional vehicles in the EPZ due to the identified special event.
Special Facilities ....Vehicles-equivalents present on the road during the evacuation servicing medical facilities and Somervell County jail (1 bus is equivalent to 2 passenger vehicles)
Texas Amphitheatre...................................... Facility is open on weekends during the months of April and September through November, therefore it was only considered on winter weekends.
Day Camps... Day camps are open only on weekdays during the summer. Vehicle-equivalents present on the road during evacuation servicing day camps (1 bus is equivalent to 2 passenger vehicles).
School and Transit Buses ....Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).
External Through Traffic .... .Traffic passing through the EPZ on major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately 2 hours after the evacuation begins.

Table 6-7. Vehicle Estimates by Scenario[2]

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Event	Special Facilities[3]	Texas Amphi-theatre	Day Camps	School Buses	Transit Buses	External Through Traffic	Total Scenario Vehicles
1	7,282	15,176	474	6,187	3,135	0	164	0	88	28	26	4,256	36,816
2	7,282	15,176	474	6,187	3,135	0	164	0	88	28	26	4,256	36,816
3	728	21,730	49	8,249	3,076	0	164	0	0	0	26	4,256	38,278
4	728	21,730	49	8,249	3,076	0	164	0	0	0	26	4,256	38,278
5	728	21,730	49	7,012	3,076	0	164	0	0	0	26	1,702	34,487
6	7,282	15,176	494	4,537	3,137	0	164	0	0	280	26	4,256	35,352
7	7,282	15,176	494	4,537	3,137	0	164	0	0	280	26	4,256	35,352
8	728	21,730	49	7,012	3,076	0	164	1,250	0	0	26	4,256	38,291
9	728	21,730	49	7,012	3,076	0	164	1,250	0	0	26	4,256	38,291
10	728	21,730	49	7,012	3,076	0	164	1,250	0	0	26	1,702	35,737
11	728	21,730	49	8,249	3,076	3,699	164	0	0	0	26	4,256	41,977
12	7,282	15,176	474	6,187	3,135	0	164	0	88	28	26	4,256	36,816

[2] Vehicle estimates are for an evacuation of the entire EPZ (Region R03)
[3] This includes medical facilities and the Somervell County Jail.

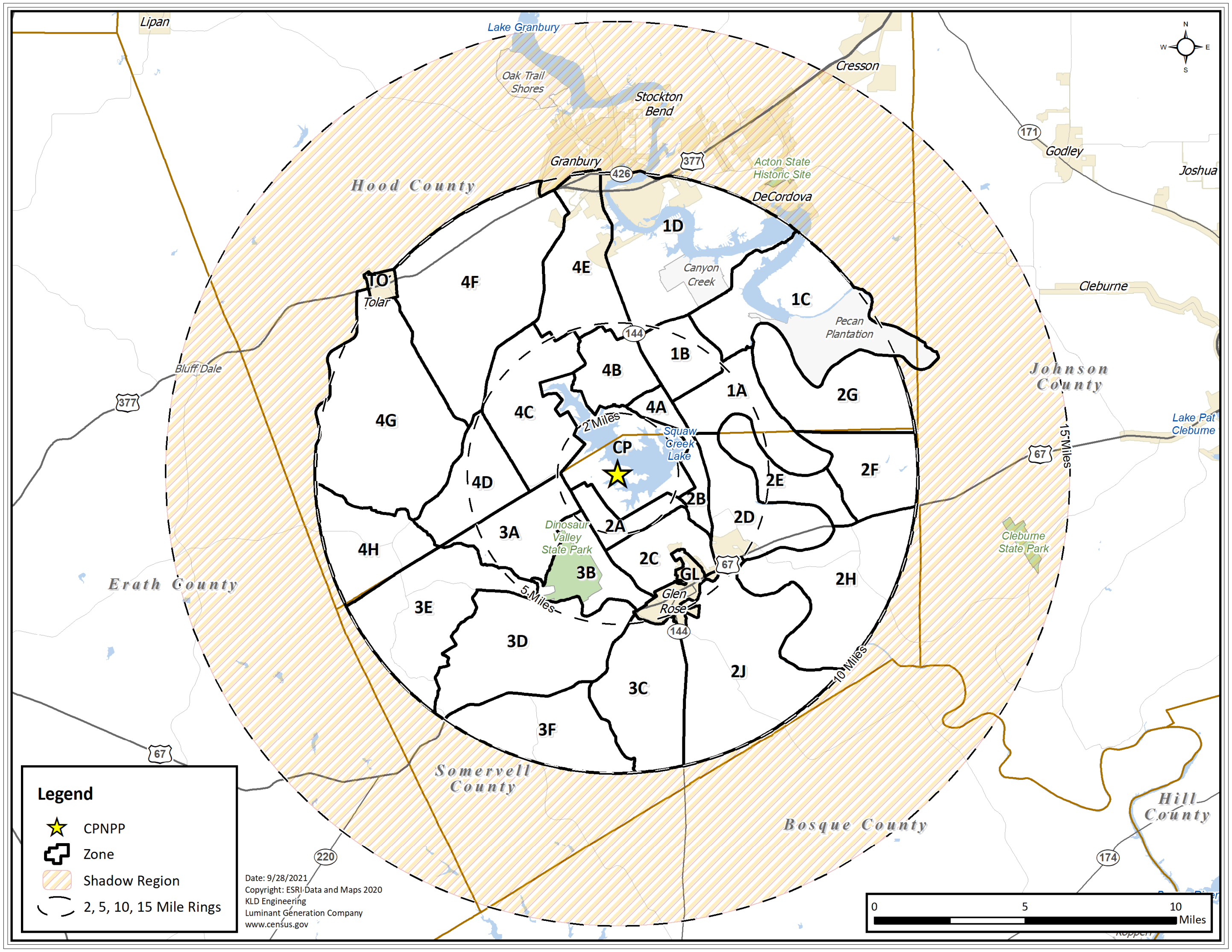


Figure 6-1. CPNPP EPZ Zones

7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 92 Evacuation Regions within the CPNPP EPZ, and the 12 Evacuation Scenarios discussed in Section 6.

The ETE for all Evacuation Cases are presented in Table 7-1 and Table 7-2. These tables present the estimated times to clear the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios. The ETE of the 2-Mile Region in both staged and un-staged regions are presented in Table 7-3 and Table 7-4. Table 7-5 through Table 7-8 defines the Evacuation Regions considered. The tabulated values of ETE are obtained from the DYNEV II model outputs which are generated at 5-minute intervals.

7.1 Voluntary Evacuation and Shadow Evacuation

"Voluntary evacuees" are permanent residents within the EPZ in Zones for which an Advisory to Evacuate (ATE) has not been issued, yet who elect to evacuate. "Shadow evacuation" is the voluntary outward movement of some permanent residents from the Shadow Region (outside the EPZ) for whom no protective action recommendation has been issued. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for the CPNPP EPZ addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the EPZ, 20% of permanent residents located in Zones outside of the Evacuation Region, who are not advised to evacuate, are assumed to elect to evacuate. Similarly, it is assumed that 20% of those permanent residents in the Shadow Region will choose to leave the area.

Figure 7-2 presents the area identified as the Shadow Region. This region extends radially from the plant to cover a region between the EPZ boundary and approximately 15 miles. The population and number of evacuating vehicles in the Shadow Region were estimated using the same methodology that was used for permanent residents within the EPZ (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 27,664 permanent residents reside in the Shadow Region; 20% of them would evacuate. See Table 6-8 for the number of evacuating vehicles from the Shadow Region.

Traffic generated within this Shadow Region, including external-external traffic (See Section 3.10), traveling away from the plant location, has the potential for impeding evacuating vehicles from within the Evacuation Region. All ETE calculations include this shadow traffic movement.

7.2 Staged Evacuation

As defined in NUREG/CR-7002, Rev. 1, staged evacuation consists of the following:

1. Zones comprising the 2-Mile Region are advised to evacuate immediately.

2. Zones comprising regions extending from 2 to 5 miles downwind are advised to shelter in-place while the 2-Mile Region is cleared.
3. As vehicles evacuate the 2-Mile Region, people from 2 to 5 miles downwind continue preparation for evacuation while they shelter.
4. The population sheltering in the 2 to 5 miles is advised to begin evacuating when approximately 90% of those originally within the 2-Mile Region evacuate across the 2-Mile Region boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%.

See Section 5.4.2 for additional information on staged evacuation.

7.3 Patterns of Traffic Congestion during Evacuation

Figure 7-3 through Figure 7-8 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R03) is advised to evacuate during the summer, midweek, midday scenario under good weather conditions (Scenario 1).

Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (HCM 2016, page 5-5):

> The HCM uses LOS F to define operations that have either broken down (i.e., demand exceeds capacity) or have reached a point that most users would consider unsatisfactory, as described by a specified service measure value (or combination of service measure values). However, analysts may be interested in knowing just how bad the LOS F condition is, particularly for planning applications where different alternatives may be compared. Several measures are available for describing individually, or in combination, the severity of a LOS F condition:
>
> - *Demand-to-capacity ratios* describe the extent to which demand exceeds capacity during the analysis period (e.g., by 1%, 15%).
> - *Duration of LOS F* describes how long the condition persists (e.g., 15 min, 1 h, 3 h).
> - *Spatial extent measures* describe the areas affected by LOS F conditions. They include measures such as the back of queue, and the identification of the specific intersection approaches or system elements experiencing LOS F conditions.

All highway "links" which experience LOS F are delineated in these figures by a thick red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population centers and traffic bottlenecks.

At 45 minutes after the ATE, Figure 7-3 displays significant traffic congestion (LOS F) within the population center of Granbury and Pecan Plantation. Tolar is starting to display some congestion along US 377. Significant congestion on TX 144 and Water Edge Road approaching US 377. US 377 northbound is also significantly congested (LOS F) as it is the major evacuation route towards Fort Worth/Dallas. The roads within Pecan Plantation exhibit congestion, especially on Monticello Drive northbound as evacuees approach a roundabout (reducing roadway capacity

and speed) to evacuate from Pecan Plantation. Note that there is no traffic congestion exhibited within the 2-Mile Region and remains free of congestion throughout the entire evacuation.

At 1 hour and 45 minutes after the ATE, Figure 7-4 displays traffic congestion within the EPZ, north of the plant, has intensified. At this time, Farm to Market (FM) 56 in Tolar is exhibiting significant congestion when approaching US 377. Additional roadways within Granbury are now showing significant congestion. The congestion on TX 144 northbound has worsened and expanded. This causes additional roads like Contrary Creek Road and Knob Hill Drive accessing TX 144 to exhibit congestion as well. Areas north and east of Granbury, outside of the study area (EPZ and Shadow Region) is also experiencing traffic congestion, especially along FM 51 northbound, US 377 northbound (near Cresson) and FM 167 with the intersection of FM 51. In the Shadow Region, within the population center of Bluff Dale, significant congestion exists on US 377 southbound. Minor congestion exists along US 67, east and west of Glen Rose, as the external traffic has not diverted (see discussion in Section 3.10) at this time. At this point, all of the employees and transients have mobilized and 50% of evacuees have successfully evacuated the EPZ.

At 2 hour and 50 minutes after the ATE, Figure 7-5 displays significant congestion continuing within Granbury, Tolar, Bluff Dale and Pecan Plantation. At this point, no delays on US 67 exists. US 377 westbound is congested within Tolar due to the stop control with FM 56. TX 144 continues to be congested along with roads near Canyon Creek (Contrary Creek Road, Knob Hill Drive and FM 310) trying to access TX 144. FM 167 northbound from the population center of DeCordova, within the Shadow Region is operating at LOS F trying to access US 377 northbound. Congestion and delays within the 5-Mile Region has now cleared. At this point, 92% of evacuees have mobilized and 79% have successfully evacuated the EPZ.

At 3 hours and 35 minutes after the ATE, Figure 7-6 displays significant congestion continues in Tolar (along US 377), Granbury (along TX 144), Contrary Creek Road and Knob Hill Drive as evacuees are trying to access TX 144. Congestion continues in Cresson along US 377 and CR 171 and on FM 51 and FM 167. Congestion with Pecan Planation has now cleared. At this point, 93% of evacuees have successfully evacuated the EPZ.

At 4 hours and 10 minutes after the ATE, Figure 7-7 displays that within Tolar, DeCordova, Canyon Creek the congestion has cleared. Congestion still exists along TX 144 northbound as evacuees try to access US 377 and continue north of US 377. Significant congestion (LOS F) continues outside of the study area within Cresson on FM 171 southbound, FM 51, FM 167 and in Bluff Dale. At this point, 98% of evacuees have successfully evacuated the EPZ.

At 4 hours and 30 minutes after the ATE, Figure 7-8 displays that the EPZ and Shadow Region is now clear of traffic congestion. All roadways in the EPZ are now operating at LOS A. Therefore, any evacuee who departs after this time encounters no traffic congestion or delays within the EPZ or Shadow Region. At this time, approximately 99% of the evacuees have mobilized and 99% of evacuees have successfully evacuated the EPZ. This indicates that the trip generation plus the time to travel to the EPZ boundary (5 hours and 10 minutes) is dictating the 100^{th} percentile ETE. The only congestion that is still visible outside of the study area, along FM 167, d FM 51 and near Cresson, which clears 20 minutes later at 4 hours and 50 minutes after the ATE.

7.4 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-9 through Figure 7-20. These figures display the rate at which traffic flows out of the indicated areas for the case of an evacuation of the full EPZ (Region R03) under the indicated conditions. One figure is presented for each scenario considered.

As indicated in Figure 7-9 through Figure 7-20, there is typically a long "tail" to these distributions due to congestion until approximately 4 hours and 30 minutes and then parallels the trip generation time (plus 10 minutes travel time to EPZ boundary) for all scenarios and regions except for the special event (Scenario 11) and roadway impact (Scenario 12) scenarios for Regions that include Zones 1C, 1D and 4E, where congestion exists within the EPZ. Vehicles begin to evacuate an area slowly at first, as people respond to the ATE at different rates. Then traffic demand builds rapidly (slopes of curves increase). When the system becomes congested, traffic exits the EPZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand.

This decline in aggregate flow rate, towards the end of the process, is characterized by these curves flattening and gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes equally so that all will service traffic near capacity levels and all will clear at the same time. For this ideal situation, all curves would retain the same slope until the end of mobilization time – thus minimizing evacuation time. In reality, this ideal is generally unattainable reflecting the spatial variation in population density, mobilization rates and in highway capacity over the EPZ.

7.5 Evacuation Time Estimate Results

Table 7-1 and Table 7-2 present the ETE values for all 92 Evacuation Regions and all 12 Evacuation Scenarios. Table 7-3 and Table 7-4 present the ETE values for the 2-Mile Region for both staged and un-staged keyhole regions downwind to 5 miles. The tables are organized as follows:

Table	Contents
7-1	The ETE represents the elapsed time required for 90% of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios.
7-2	The ETE represents the elapsed time required for 100% of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios.
7-3	The ETE represents the elapsed time required for 90% of the population within the 2-Mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations of additional Zones downwind in the keyhole Region.
7-4	The ETE represents the elapsed time required for 100% of the population within the 2-Mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations of additional Sectors downwind in the keyhole Region.

The animation snapshots described in Section 7.3 reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in Figure 7-3 through Figure 7-8. Majority of the congestion, located in the EPZ, are within population centers which are beyond the 2-Mile Region and 5-Mile Region; this is reflected in the ETE statistics:

- The 2-Mile Region (Region R01) consists of equal number of plant employees and permanent residents, approximately. Even though employees mobilize quickly (within 105 minutes), the permanent residents with commuters take much longer to mobilize (300 minutes), as shown in Figure 5-4. As such, the 90th percentile ETE for the 2-Mile Region (R01) ranges between 2:25 (hours:minutes) and 2:40 for all scenarios, which mimics the combination of the quick mobilizing employees and the slow mobilizing permanent residents with commuters.
- The 5-Mile Region (Region R02) ETE range between 2:10 and 2:30. The 5-Mile Region consists of more evacuating vehicles when compared to Region R02, and some of these vehicles are from the number of transients and special facilities which mobilize quicker than permanent residents with commuters. As such, the 90th percentile ETE is at most 15 minutes shorter than Region R01. In addition, a lot of the additional evacuating vehicles are within Glen Rose, where congestion is minimal and does not delay vehicles evacuating out of Glen Rose, allowing the 90th percentile ETE to be reached sooner.
- The 90th percentile ETE for the full EPZ (Regions R03) ranges between 3:15 and 4:35. This is at most 1 hours and 25 minutes longer than Region R02 in all non-special scenarios (1:55 and 2:10 for special event and roadway impact scenario, respectively). This is due to the additional population and heavy congestion located in Tolar, Granbury and Pecan Plantation, delaying evacuees and prolonging ETE.
- The 100th percentile ETE for all non-special Scenarios in all Regions parallel mobilization time, as the congestion within the EPZ dissipates, speed and capacity reductions no longer exist, as displayed in Figure 7-8 and discussed in Section 7.3. The 100th percentile ETE ranges from 5:00 to 5:10 (mobilization time plus 10 minutes to travel out of the EPZ) for all non-special scenarios and special scenario regions that do not contain Zones 1C, 1D and/or 4E. For Scenarios 11 (Special Event) and 12 (Roadway Impact), some regions are not dictated by the mobilization time but the congestion within the EPZ, in particularly in Granbury and on US 377, as discussed below. As such, the 100th percentile ETE ranges for these cases range from 5:35 to 6:20.

Comparison of Scenarios 3 and 11 in Table 7-1 and in Table 7-2 indicate that the Special Event – Fourth of July in Granbury – the 90th percentile ETE remains the same or increases at most by 40 minutes. The 100th percentile ETE remains the same or increases as much as 45 minutes. As discussed in Section 7.3 and shown in Figure 7-7 through Figure 7-8, significant congestion exists within Granbury, which includes Zone 1C, 1D and/or 4E. The additional 3,699 vehicles present for the Fourth of July holiday increases local congestion in Granbury, so for regions that include either Zones 1C, 1D and/or 4E the 90th and 100th percentile ETE increases, while Regions that do not include these Zones are dictated by the trip generation (plus 10-minute travel time to EPZ boundary).

Comparison of Scenarios 1 and 12 in Table 7-1 and in Table 7-2 indicate that the roadway impact – a single lane on US 377 Northbound (NB) from TX 144 to slightly east of FM 167 and a single lane on US 67 NB from FM 205 to TX 144 and Somervell CR 316 to CR 1119 – remains the same for all Regions, except those that include Zones 1C, 1D and/or 4E. For Regions that include Zones 1C, 1D, and/or 4E, the 90th and 100th percentile ETE increases by 1 hour and 10 minutes and 55 minutes, respectively. As discussed in Section 7.3, the area of Granbury and US 377 are significantly congested until about 4 hours and 30 minutes after the ATE, as such, a closure on US 377 northbound significantly reduces the capacity of US 377, prolonging the traffic congestion, delaying vehicles and prolonging ETE. Regions that include Zones only near US 67, the 90th and 100th percentile ETE remain the same, as the congestion on US 67 is limited so there is excess capacity to handle the single lane closure.

7.6 Staged Evacuation Results

Table 7-3 and Table 7-4 present a comparison of the ETE compiled for the concurrent (un-staged) and staged evacuation studies. Note that Regions R64 and R65 through R78 are the same geographic areas as Regions R02 and R04 through R17, respectively. Also, Regions R79 through R92 are identical to Regions R34 through R47, respectively. The times shown in Table 7-3 and Table 7-4 are when the 2-Mile Region is 90% clear and 100% clear, respectively.

The objective of a staged evacuation is to show that the ETE for the 2-Mile Region can be significantly reduced (30 minutes of 25%, whichever is less) without significantly impacting people beyond the 2 Mile Region. In all cases, as shown in Table 7-3 and Table 7-4, the 90th and 100th percentile ETE for the 2-Mile Region is unchanged when a staged evacuation is implemented. As discussed in Section 7.3, there is no congestion within the 2-Mile Region and minimal congestion within the 5-Mile Region (on US 67 and FM 2425) until 2 hours and 50 minutes after the ATE. In addition, the congestion beyond 5 miles does not extend upstream to the extent that it penetrates within 2 miles of the plant, so evacuees from within the 2-Mile Region are not impeded. Therefore, staging provides no benefits to these evacuees from within the 2-Mile Region.

To determine the effect of staged evacuation on residents beyond the 2-Mile Region, the ETE are compared for Regions R64 and Region R65 through R78 with Regions R02 and R04 through R17, respectively, and R79 through R92 with Regions R34 through R47, respectively in Table 7-1 and Table 7-2. A comparison of ETE between these similar regions reveals that staging increases the ETE for those in the 2 to 5-mile area by at most 40 minutes in the 90th percentile ETE and has no impact on the 100th percentile. The increase in the 90th percentile ETE is due to the evacuating vehicles, beyond the 2-Mile Region, sheltering and delaying the start of their evacuation. As shown in Figure 5-5, staging the evacuation causes a significant "spike" (sharp increase) in mobilization (trip-generation rate) of evacuating vehicles. This spike oversaturates evacuation routes, which increases traffic congestion and prolongs ETE.

Therefore, staging the evacuation provides no benefits to evacuees from within the 2-Mile Region and adversely impacts evacuees located beyond the 2 miles radially from the plant.

7.7 Guidance on Using ETE Tables

The user first determines the percentile of population for which the ETE is sought (The NRC guidance calls for the 90th percentile). The applicable value of ETE within the chosen table may then be identified using the following procedure:

- Identify the applicable **Scenario (Step 1)**:
  - Season
    - Summer
    - Winter (also Autumn and Spring)
  - Day of Week
    - Midweek
    - Weekend
  - Time of Day
    - Midday
    - Evening
  - Weather Condition
    - Good Weather
    - Rain
  - Special Event
    - Fourth of July in Granbury
  - Roadway Impact
    - A single lane closure on US 377 northbound and on US 67 northbound.
  - Evacuation Staging
    - No, Staged Evacuation is not considered
    - Yes, Staged Evacuation is considered

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

- The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (2) and (4) apply.
- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (7) and (9) apply.
- The seasons are defined as follows:
  - Summer assumes schools are in session at summer school enrollment levels (lower than normal enrollment).
  - Winter (includes Spring and Autumn) considers that schools are in session at normal enrollment levels.
- Time of Day: Midday implies the time over which most commuters are at work or are travelling to/from work.

- With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region** and the **Number of Sectors (3 or 5)** used to define a keyhole Region **(Step 2):**
  - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of Site PAR Central Sector and degrees: <u>from</u> A/168.75° - 191.24°, B/191.25° - 213.74°, …
  - Determine the distance that the Evacuation Region will extend from the nuclear power plant. The applicable distances and their associated candidate Regions are given below:
    - 2 Miles (Region R01)
    - To 5 Miles (Regions R02, R04 – R17, R34 – R47 or R64 – R78 and R79 – R92)
    - To EPZ Boundary (Regions R03, R18 – R33 or R48 – R63)
  - Enter Table 7-5 through Table 7-8 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from the plant. Select the Evacuation Region identifier in that row, based on the azimuth direction of the plume, from the first column of the Table.
- Determine the **ETE Table** based on the **percentile** selected. Then, for the **Scenario** identified in Step 1 and the **Evacuation Region** and **Number of Sectors** identified in Step 2, proceed as follows:
  - The columns of Table 7-1 are labeled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number defined in Step 1.
  - Identify the row in this table that provides ETE values for the Region identified in Step 2.
  - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours: Minutes.

<u>Example</u>

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

- Sunday, August 14th at 4:00 AM.
- It is raining.
- Wind direction is from the 33.75° – 56.24° (Site PAR Central Sector L).
- Wind speed is such that the distance to be evacuated is judged to be a 2-Mile Region and keyhole to the EPZ boundary with a width of 3 sectors.
- The desired ETE is that value needed to evacuate 90 percent of the population from within the impacted Region.
- A staged evacuation is not desired.

Table 7-1 is applicable because the 90th percentile ETE is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of circumstances to Scenario 4.
2. Enter Table 7-6 and locate the Region described as “Evacuate 2-Mile Region and Downwind to the EPZ Boundary (3 Sector Groups)” for wind direction from the 33.75° – 56.24°. Read Region R28 in the first column of that row.

3. Enter Table 7-1 to locate the data cell containing the value of ETE for Scenario 4 and Region R28. This data cell is in column (4) and in the row for Region R28; it contains the ETE value of **2:10**.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R02	2:25	2:25	2:15	2:20	2:10	2:30	2:30	2:25	2:30	2:15	2:15	2:25
R03	3:25	3:45	3:35	3:45	3:15	3:20	3:40	3:30	3:45	3:15	4:10	4:35
2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	2:40	2:40	2:25	2:25	2:25	2:40	2:45	2:25	2:25	2:25	2:25	2:40
R05	2:40	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:40
R06	2:25	2:25	2:10	2:10	2:15	2:25	2:30	2:10	2:10	2:15	2:10	2:25
R07	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R08	2:15	2:20	2:10	2:10	2:10	2:20	2:20	2:10	2:10	2:10	2:10	2:15
R09	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R10	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R11	2:20	2:20	2:10	2:10	2:15	2:25	2:25	2:10	2:15	2:05	2:10	2:20
R12	2:15	2:20	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R13	2:35	2:35	2:15	2:15	2:15	2:35	2:35	2:15	2:15	2:15	2:15	2:35
R14	2:35	2:35	2:15	2:15	2:15	2:35	2:40	2:15	2:15	2:15	2:15	2:35
R15	2:50	2:50	2:30	2:30	2:30	2:50	2:50	2:30	2:30	2:30	2:30	2:50
R16	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R17	2:40	2:40	2:25	2:25	2:25	2:40	2:40	2:25	2:25	2:25	2:25	2:40
2-Mile Region and Keyhole to EPZ Boundary (3 Sector Groups)												
R18	3:30	3:50	3:40	4:00	3:20	3:20	3:40	3:35	3:50	3:20	4:20	4:40
R19	3:25	3:40	3:35	3:50	3:15	3:20	3:35	3:25	3:45	3:15	3:55	4:45
R20	3:15	3:20	3:10	3:20	2:55	3:05	3:10	3:05	3:20	2:55	3:20	4:10
R21	3:05	3:10	2:45	2:50	2:50	3:05	3:10	2:45	2:50	2:45	2:45	3:05
R22	2:55	3:00	2:40	2:45	2:45	3:00	3:05	2:40	2:45	2:45	2:40	2:55

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R23	2:25	2:25	2:20	2:20	2:10	2:30	2:30	2:30	2:35	2:20	2:20	2:25
R24	2:25	2:25	2:20	2:20	2:10	2:30	2:30	2:25	2:35	2:15	2:20	2:25
R25	2:25	2:25	2:10	2:15	2:10	2:25	2:30	2:25	2:30	2:10	2:10	2:25
R26	2:25	2:25	2:10	2:10	2:10	2:25	2:30	2:20	2:25	2:10	2:10	2:25
R27	2:25	2:25	2:10	2:15	2:10	2:25	2:25	2:20	2:25	2:10	2:10	2:20
R28	2:20	2:20	2:10	2:10	2:15	2:20	2:25	2:10	2:10	2:15	2:10	2:20
R29	2:25	2:25	2:15	2:15	2:20	2:25	2:25	2:15	2:15	2:15	2:15	2:25
R30	2:20	2:20	2:10	2:15	2:15	2:20	2:20	2:10	2:15	2:15	2:10	2:20
R31	2:30	2:30	2:20	2:20	2:20	2:30	2:30	2:20	2:20	2:20	2:20	2:30
R32	2:35	2:35	2:20	2:25	2:25	2:35	2:35	2:20	2:25	2:25	2:40	2:40
R33	3:05	3:25	3:10	3:30	2:55	3:00	3:15	3:10	3:25	2:55	3:45	4:25
2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R35	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R36	2:25	2:25	2:10	2:10	2:15	2:25	2:25	2:10	2:10	2:15	2:10	2:25
R37	2:25	2:25	2:15	2:20	2:10	2:25	2:25	2:25	2:35	2:15	2:15	2:25
R38	2:20	2:20	2:15	2:20	2:10	2:20	2:25	2:25	2:35	2:15	2:15	2:20
R39	2:20	2:20	2:15	2:20	2:05	2:20	2:20	2:25	2:30	2:15	2:15	2:20
R40	2:20	2:20	2:15	2:20	2:05	2:20	2:20	2:25	2:30	2:15	2:15	2:20
R41	2:15	2:15	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R42	2:15	2:20	2:05	2:10	2:05	2:20	2:20	2:20	2:20	2:05	2:05	2:15
R43	2:15	2:15	2:05	2:10	2:00	2:15	2:20	2:20	2:20	2:05	2:05	2:15
R44	2:30	2:30	2:00	2:00	2:05	2:35	2:35	2:05	2:05	2:05	2:00	2:30
R45	2:45	2:45	2:25	2:25	2:25	2:45	2:45	2:25	2:25	2:25	2:25	2:45
R46	2:45	2:45	2:25	2:30	2:30	2:45	2:45	2:30	2:30	2:30	2:30	2:45
R47	2:40	2:40	2:25	2:25	2:25	2:40	2:45	2:25	2:25	2:25	2:25	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
2-Mile Region and Keyhole to EPZ Boundary (5 Sector Groups)												
R48	3:35	3:55	3:40	4:05	3:25	3:35	3:50	3:40	3:55	3:25	4:20	4:45
R49	3:30	3:45	3:40	4:00	3:20	3:25	3:45	3:35	3:50	3:20	4:10	4:50
R50	3:20	3:35	3:30	3:45	3:15	3:20	3:30	3:25	3:45	3:15	3:50	4:50
R51	3:15	3:25	3:15	3:30	2:55	3:05	3:10	3:05	3:25	3:00	3:25	4:00
R52	2:50	2:55	2:30	2:35	2:35	2:55	2:55	2:40	2:45	2:30	2:30	2:50
R53	2:50	2:55	2:30	2:35	2:35	2:55	2:55	2:40	2:45	2:30	2:35	2:50
R54	2:30	2:30	2:20	2:25	2:15	2:30	2:30	2:30	2:35	2:20	2:20	2:30
R55	2:30	2:30	2:20	2:20	2:15	2:30	2:30	2:30	2:35	2:20	2:20	2:30
R56	2:25	2:25	2:20	2:20	2:10	2:25	2:30	2:30	2:35	2:20	2:20	2:25
R57	2:25	2:25	2:10	2:15	2:10	2:30	2:30	2:20	2:25	2:10	2:10	2:25
R58	2:25	2:30	2:10	2:15	2:10	2:30	2:30	2:20	2:25	2:10	2:10	2:25
R59	2:20	2:20	2:10	2:15	2:15	2:20	2:20	2:10	2:15	2:15	2:10	2:20
R60	2:20	2:25	2:15	2:15	2:15	2:25	2:25	2:15	2:15	2:15	2:15	2:25
R61	2:35	2:35	2:25	2:25	2:25	2:35	2:35	2:20	2:25	2:25	2:40	2:40
R62	3:10	3:25	3:10	3:30	2:55	3:05	3:20	3:10	3:25	2:55	3:45	4:25
R63	3:35	3:50	3:40	4:00	3:15	3:25	3:45	3:35	3:55	3:20	4:15	4:50
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (3 Sector Groups)												
R64	2:45	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:50	2:45	2:45	2:45
R65	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
R66	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:50
R67	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R68	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R69	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:35	2:40	2:35	2:40
R70	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45
R71	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R72	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R73	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:40	2:35	2:35	2:40
R74	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R75	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R76	2:55	2:55	2:45	2:45	2:45	2:55	2:55	2:45	2:45	2:45	2:45	2:55
R77	2:50	2:50	2:40	2:45	2:40	2:50	2:50	2:40	2:45	2:40	2:40	2:50
R78	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (5 Sector Groups)												
R79	2:50	2:50	2:45	2:50	2:45	2:50	2:50	2:45	2:50	2:45	2:45	2:50
R80	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45	2:45
R81	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:40	2:45	2:45	2:40	2:45
R82	2:45	2:45	2:45	2:45	2:45	2:45	2:50	2:45	2:50	2:45	2:45	2:45
R83	2:45	2:45	2:40	2:45	2:45	2:45	2:50	2:45	2:50	2:40	2:40	2:45
R84	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:45	2:50	2:40	2:40	2:45
R85	2:45	2:45	2:40	2:45	2:45	2:45	2:45	2:45	2:50	2:40	2:40	2:45
R86	2:40	2:40	2:35	2:35	2:40	2:40	2:40	2:35	2:40	2:35	2:35	2:40
R87	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R88	2:40	2:40	2:40	2:40	2:40	2:40	2:40	2:35	2:40	2:40	2:40	2:40
R89	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	2:40	2:40	2:45
R90	2:50	2:55	2:50	2:50	2:50	2:55	2:55	2:50	2:50	2:50	2:50	2:50
R91	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50
R92	2:50	2:50	2:45	2:45	2:45	2:50	2:50	2:45	2:45	2:45	2:45	2:50

Table 7-2. Time to Clear the Indicated Area of 100 Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R02	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R03	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:55	6:20
2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R06	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R07	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R08	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R09	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R10	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R11	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R12	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R13	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R14	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R15	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R16	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R17	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
2-Mile Region and Keyhole to EPZ Boundary (3 Sector Groups)												
R18	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:45	6:00
R19	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	6:05
R20	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R21	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R22	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R23	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R24	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R25	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R26	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R27	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R28	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R29	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R30	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R31	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R32	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R33	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:45
2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R35	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R36	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R37	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R38	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R39	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R40	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R41	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R42	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R43	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R44	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R45	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R46	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R47	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
2-Mile Region and Keyhole to EPZ Boundary (5 Sector Groups)												
R48	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:55	6:10
R49	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:35	6:20
R50	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:15	6:20
R51	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R52	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R53	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R54	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R55	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R56	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R57	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R58	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R59	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R60	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R61	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10
R62	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:40
R63	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:10	5:50	6:00
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (3 Sector Groups)												
R64	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R65	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R66	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R67	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R68	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R69	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R70	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R71	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R72	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R73	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R74	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R75	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R76	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R77	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R78	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Keyhole to 5 Miles (5 Sector Groups)												
R79	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R80	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R81	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R82	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R83	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R84	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R85	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R86	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R87	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R88	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R89	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R90	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R91	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05
R92	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05	5:05

Table 7-3. Time to Clear 90 Percent of the 2-Mile Region within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R02	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R05	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R06	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R07	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R08	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R09	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R10	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R11	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R12	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R13	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R14	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R15	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R16	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R17	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R35	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R36	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R37	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R38	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R39	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R40	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R41	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R42	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R43	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R44	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R45	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R46	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R47	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Staged Evacuation - 5-Mile Region												
R64	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R65	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R66	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R67	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R68	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R69	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R70	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R71	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R72	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R73	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R74	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R75	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R76	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R77	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R78	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R79	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R80	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R81	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R82	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R83	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R84	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R85	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R86	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R87	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R88	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R89	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R90	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R91	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40
R92	2:35	2:35	2:25	2:30	2:25	2:35	2:35	2:25	2:30	2:25	2:30	2:40

Table 7-4. Time to Clear *__100__* Percent of the 2-Mile Region within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ												
R01	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R02	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R04	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R05	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R06	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R07	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R08	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R09	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R10	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R11	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R12	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R13	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R14	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R15	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R16	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R17	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Un-Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R34	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R35	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R36	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R37	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R38	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact
R39	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R40	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R41	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R42	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R43	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R44	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R45	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R46	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R47	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Staged Evacuation - 5-Mile Region												
R64	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (3 Sector Groups)												
R65	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R66	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R67	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R68	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R69	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R70	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R71	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R72	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R73	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R74	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R75	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R76	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R77	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R78	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

	Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Region	**Midday**		**Midday**		**Evening**	**Midday**		**Midday**		**Evening**	**Midday**	**Midday**
	Good Weather	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Good Weather**	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Special Event**	**Roadway Impact**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles (5 Sector Groups)												
R79	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R80	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R81	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R82	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R83	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R84	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R85	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R86	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R87	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R88	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R89	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R90	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R91	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
R92	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00

Table 7-5. Description of Evacuation Regions – Regions R01 through R17

Radial Regions																																
Region	Site PAR Central Sector	Description	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R01	N/A	2-Mile Region	X					X																								
R02	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R03	N/A	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R04	A	168.75 – 191.24	X		X			X															X	X	X							
R05	B	191.25 – 213.74	X	X	X			X															X	X								
R06	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R07	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R08	E	258.75 – 281.24	X	X				X	X		X	X																				
R09	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R10	G	303.75 – 326.24	X					X	X	X	X																				X	
R11	H, J	326.25 – 11.24	X					X		X								X													X	
R12	K	11.25 – 33.74	X					X		X							X	X													X	
R13	L	33.75 – 56.24	X					X									X	X								X						
R14	M	56.25 – 78.74	X					X									X	X							X	X						
R15	N	78.75 – 101.24	X					X									X								X	X						
R16	P	101.25 – 123.74	X					X																	X	X						
R17	Q, R	123.75 – 168.74	X					X																X	X							
Zone(s) Evacuate															Zone(s) Shelter-in-Place																	

Table 7-6. Description of 3 Sector Evacuation Regions – Regions R18 through R33

Evacuate 2-Mile Region and Downwind to EPZ Boundary (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R18	**A**	168.75 – 191.24	X		X	X	X	X															X	X	X		X	X				
R19	**B**	191.25 – 213.74	X	X	X	X	X	X						X									X	X			X					
R20	**C**	213.75 – 236.24	X	X	X	X	X	X	X		X	X		X									X	X								
R21	**D**	236.25 – 258.74	X	X	X	X		X	X		X	X	X	X									X									
R22	**E**	258.75 – 281.24	X	X		X		X	X		X	X	X	X	X																	
R23	**F**	281.25 – 303.74	X					X	X	X	X	X	X		X	X															X	
R24	**G**	303.75 – 326.24	X					X	X	X	X				X	X			X												X	
R25	**H**	326.25 – 348.74	X					X		X					X	X		X	X	X		X									X	
R26	**J**	348.75 – 11.24	X					X		X						X		X	X	X		X									X	
R27	**K**	11.25 – 33.74	X					X		X							X	X	X	X	X	X									X	
R28	**L**	33.75 – 56.24	X					X									X	X		X	X	X				X				X		
R29	**M**	56.25 – 78.74	X					X									X	X		X	X				X	X			X	X		
R30	**N**	78.75 – 101.24	X					X									X				X				X	X		X	X	X		
R31	**P**	101.25 – 123.74	X					X																	X	X		X	X	X		X
R32	**Q**	123.75 – 146.24	X					X																X	X		X	X	X			X
R33	**R**	146.25 – 168.74	X				X	X																X	X		X	X				X
Zone(s) Evacuate																	Zone(s) Shelter-in-Place															

Table 7-7. Description of 5-Sector Evacuation Regions – Regions R34 through R63

Evacuate 2-Mile Region and Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R34	A	168.75 – 191.24	X	X	X			X															X	X	X							
R35	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R36	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R37	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R38	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R39	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R40	H	326.25 – 348.74	X					X	X	X	X							X													X	
R41	J	348.75 – 11.24	X					X		X							X	X													X	
R42	K	11.25 – 33.74	X					X		X							X	X								X					X	
R43	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R44	M, N	56.25 – 101.24	X					X									X	X							X	X						
R45	P	101.25 – 123.74	X					X									X							X	X	X						
R46	Q	123.75 – 146.24	X					X																X	X	X						
R47	R	146.25 – 168.74	X		X			X															X	X	X							

Evacuate 2-Mile Region and Downwind to EPZ Boundary (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R48	A	168.75 – 191.24	X	X	X	X	X	X						X									X	X	X		X	X				X
R49	B	191.25 – 213.74	X	X	X	X	X	X	X		X	X		X									X	X	X		X	X				
R50	C	213.75 – 236.24	X	X	X	X	X	X	X		X	X	X	X									X	X			X					
R51	D	236.25 – 258.74	X	X	X	X	X	X	X		X	X	X	X	X								X	X								
R52	E	258.75 – 281.24	X	X	X	X		X	X	X	X	X	X	X	X	X							X								X	
R53	F	281.25 – 303.74	X	X		X		X	X	X	X	X	X	X	X	X			X												X	
R54	G	303.75 – 326.24	X					X	X	X	X	X	X		X	X		X	X	X		X									X	
R55	H	326.25 – 348.74	X					X	X	X	X				X	X		X	X	X		X									X	
R56	J	348.75 – 11.24	X					X		X					X	X	X	X	X	X	X	X									X	
R57	K	11.25 – 33.74	X					X		X						X	X	X	X	X	X	X				X				X	X	
R58	L	33.75 – 56.24	X					X		X							X	X	X	X	X	X			X	X			X	X	X	
R59	M	56.25 – 78.74	X					X									X	X		X	X	X			X	X		X	X	X		
R60	N	78.75 – 101.24	X					X									X	X		X	X				X	X		X	X	X		X
R61	P	101.25 – 123.74	X					X									X				X			X	X	X	X	X	X	X		X
R62	Q	123.75 – 146.24	X				X	X																X	X	X	X	X	X	X		X
R63	R	146.25 – 168.74	X		X	X	X	X															X	X	X		X	X	X			X

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table 7-8. Description of Staged Evacuation Regions – Regions R64 through R92

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (3 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
R64	N/A	5-Mile Region	X	X	X			X	X	X	X	X					X	X					X	X	X	X					X	
R65	A	168.75 – 191.24	X		X			X															X	X	X							
R66	B	191.25 – 213.74	X	X	X			X															X	X								
R67	C	213.75 – 236.24	X	X	X			X	X		X	X											X	X								
R68	D	236.25 – 258.74	X	X	X			X	X		X	X											X									
R69	E	258.75 – 281.24	X	X				X	X		X	X																				
R70	F	281.25 – 303.74	X					X	X	X	X	X																			X	
R71	G	303.75 – 326.24	X					X	X	X	X																				X	
R72	H, J	326.25 – 11.24	X					X		X								X													X	
R73	K	11.25 – 33.74	X					X		X							X	X													X	
R74	L	33.75 – 56.24	X					X									X	X								X						
R75	M	56.25 – 78.74	X					X									X	X							X	X						
R76	N	78.75 – 101.24	X					X									X								X	X						
R77	P	101.25 – 123.74	X					X																	X	X						
R78	Q, R	123.75 – 168.74	X					X																X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (5 Sector Groups)

Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GLEN ROSE	TOLAR
N/A	N/A	5-Mile Region	Refer to Region R64																													
R79	A	168.75 – 191.24	X	X	X			X															X	X	X							
R80	B	191.25 – 213.74	X	X	X			X	X		X	X											X	X	X							
R81	C, D	213.75 – 258.74	X	X	X			X	X		X	X											X	X								
R82	E	258.75 – 281.24	X	X	X			X	X	X	X	X											X								X	
R83	F	281.25 – 303.74	X	X				X	X	X	X	X																			X	
R84	G	303.75 – 326.24	X					X	X	X	X	X						X													X	
R85	H	326.25 – 348.74	X					X	X	X	X							X													X	
R86	J	348.75 – 11.24	X					X		X							X	X													X	
R87	K	11.25 – 33.74	X					X		X							X	X								X					X	
R88	L	33.75 – 56.24	X					X		X							X	X							X	X					X	
R89	M, N	56.25 – 101.24	X					X									X	X							X	X						
R90	P	101.25 – 123.74	X					X									X							X	X	X						
R91	Q	123.75 – 146.24	X					X																X	X	X						
R92	R	146.25 – 168.74	X		X			X															X	X	X							

Zone(s) Evacuate | Zone(s) Shelter-in-Place | Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate

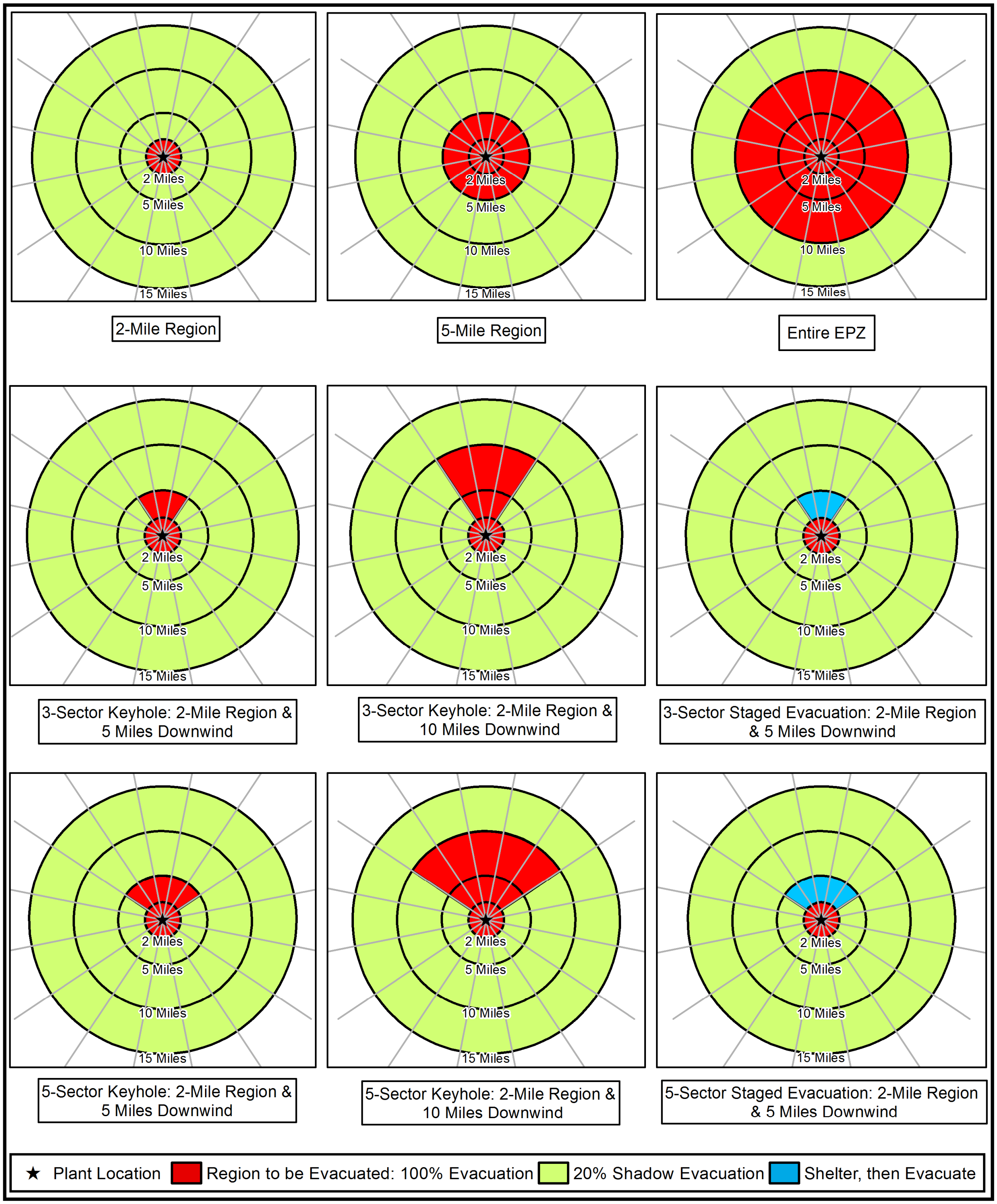


Figure 7-1. Voluntary Evacuation Methodology

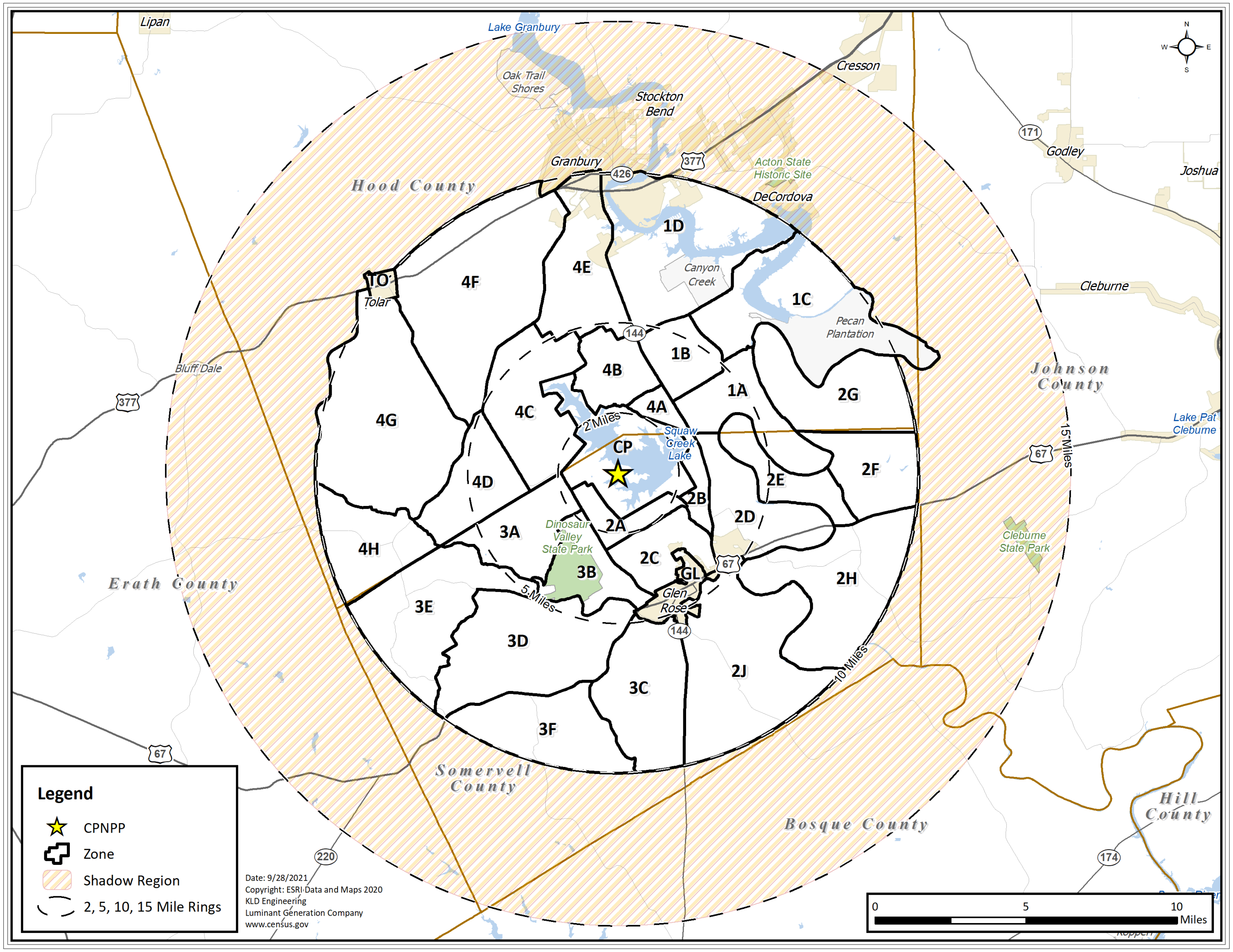


Figure 7-2. CPNPP Shadow Region

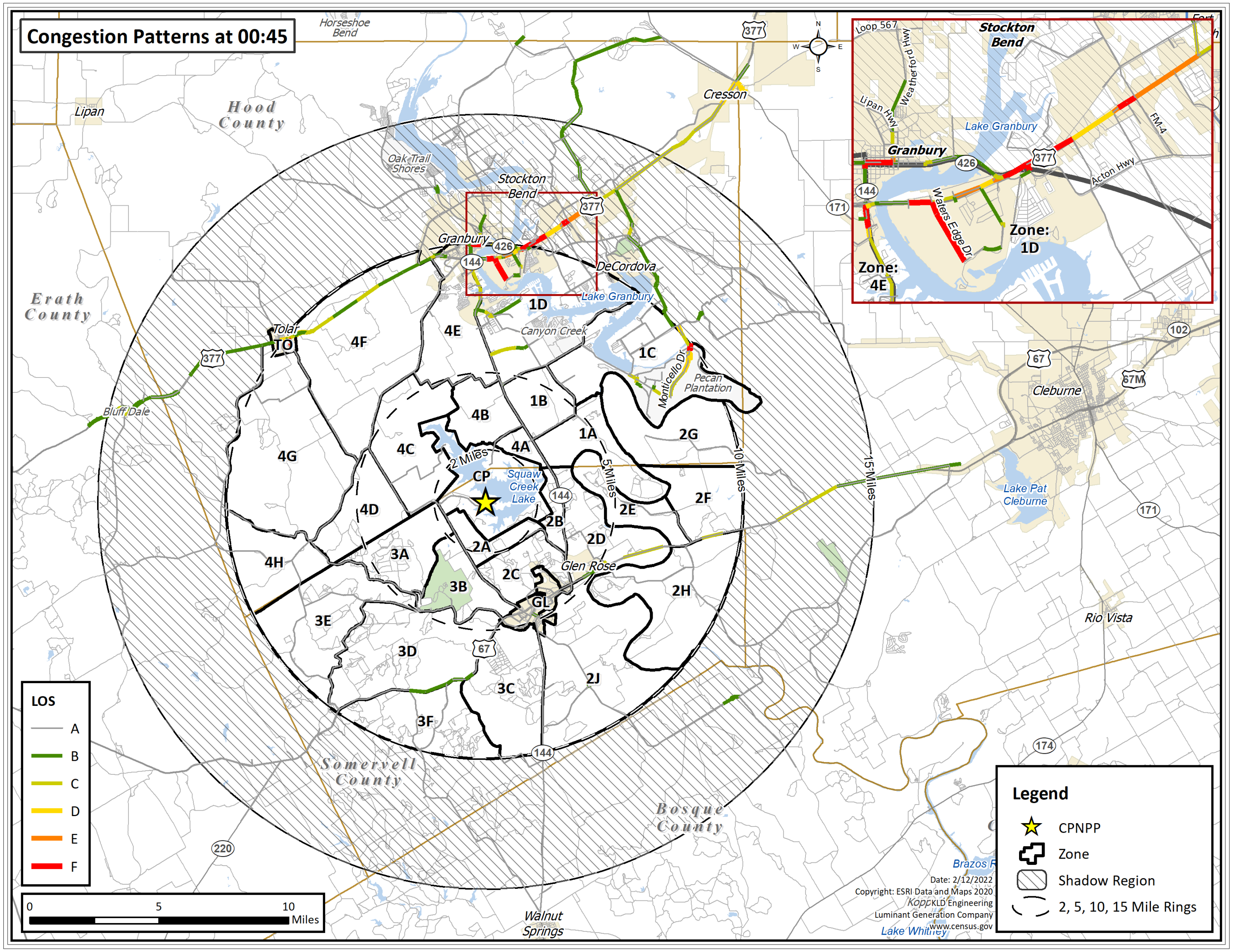


Figure 7-3. Congestion Patterns at 45 Minutes after the Advisory to Evacuate

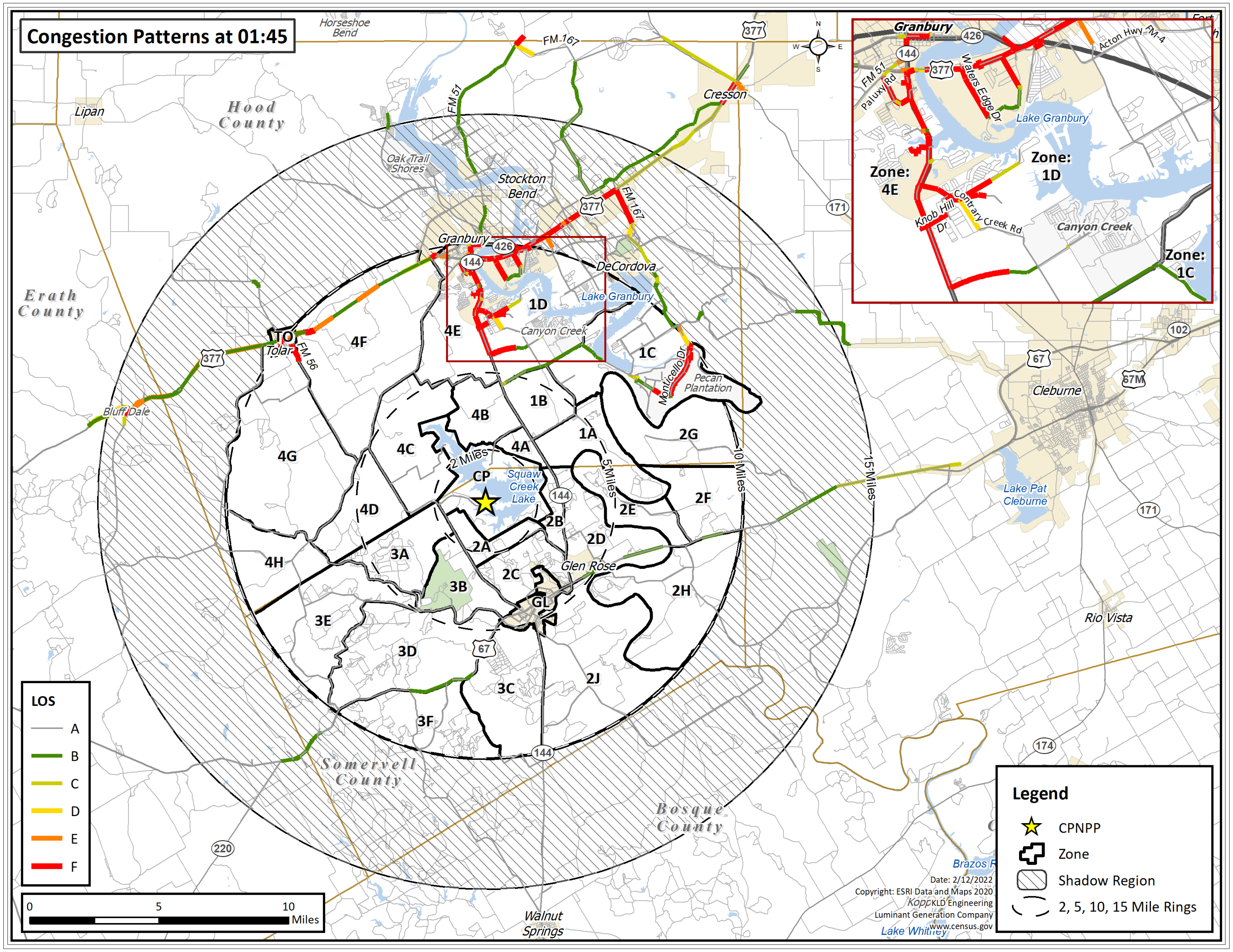


Figure 7-4. Congestion Patterns at 1 Hour and 45 minutes after the Advisory to Evacuate

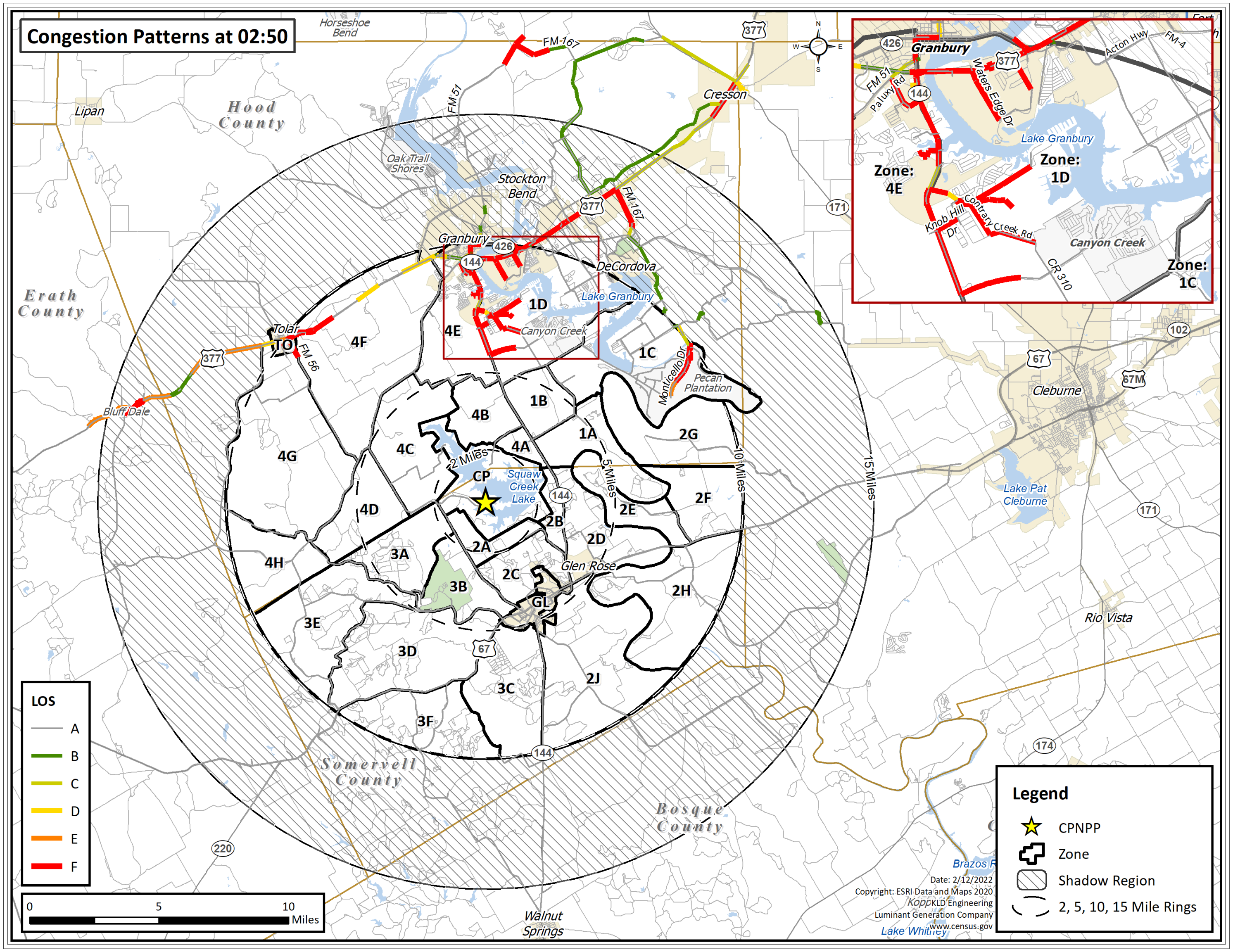


Figure 7-5. Congestion Patterns at 2 Hours and 50 Minutes after the Advisory to Evacuate

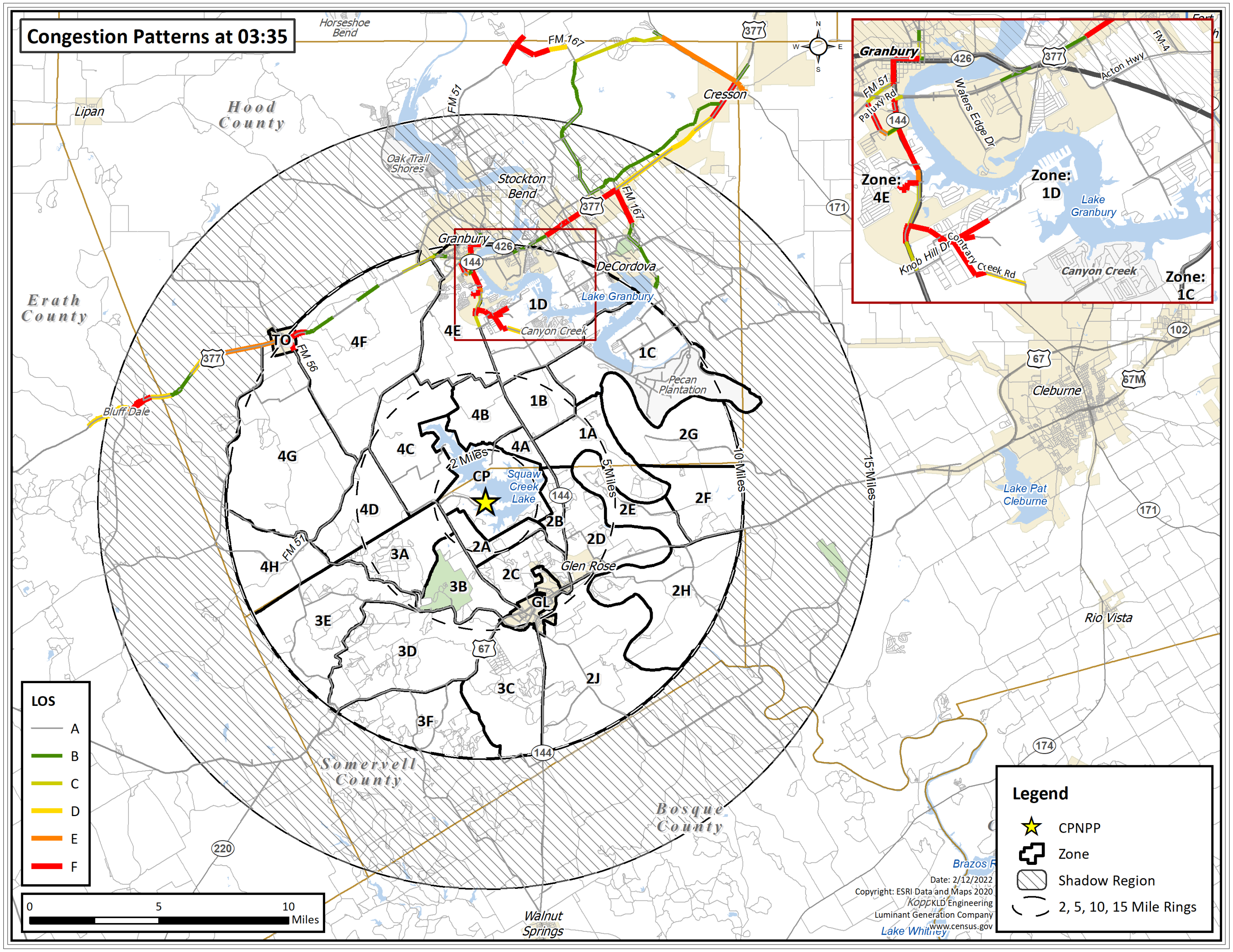


Figure 7-6. Congestion Patterns at 3 Hours and 35 minutes after the Advisory to Evacuate

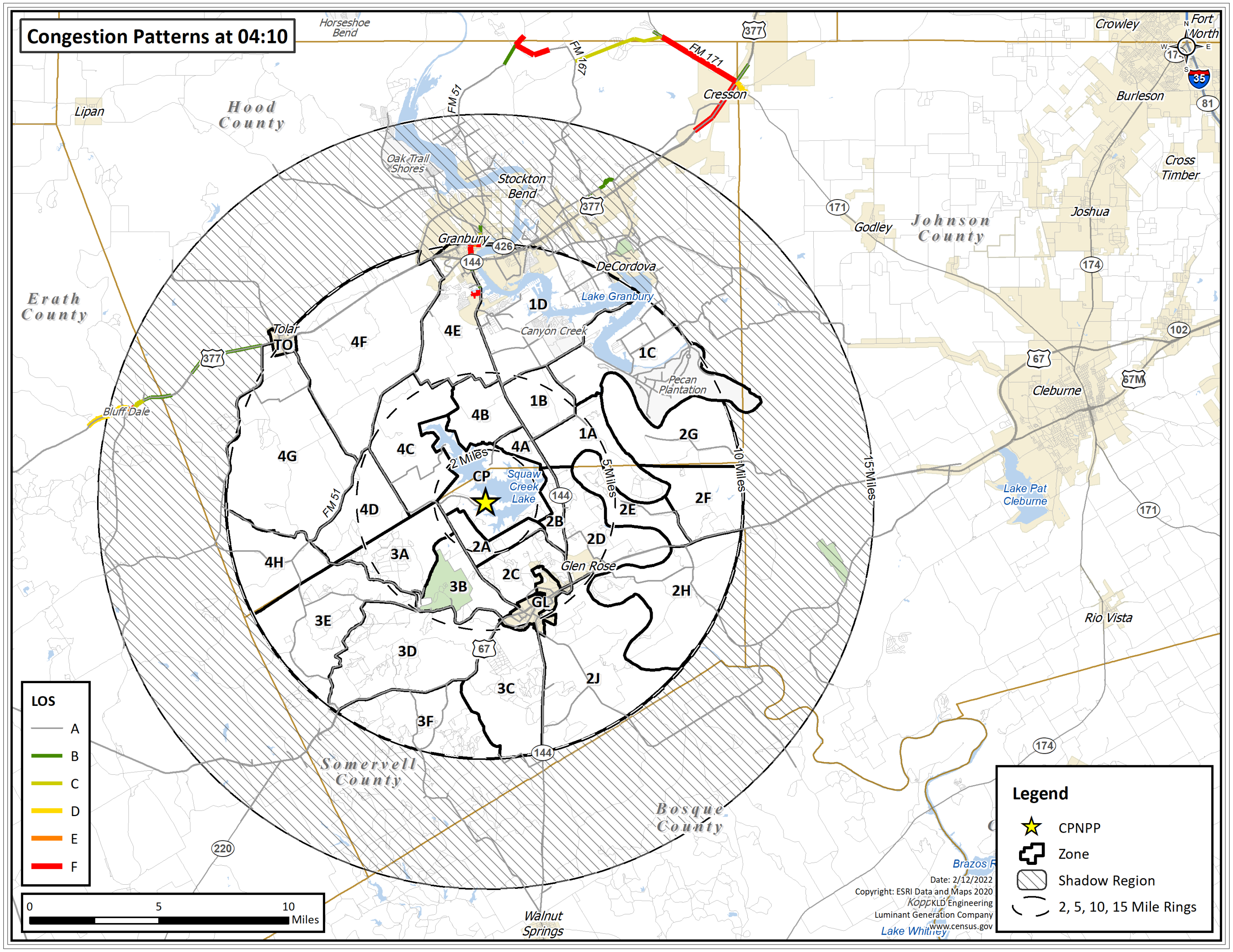


Figure 7-7. Congestion Patterns at 4 Hours and 10 Minutes after the Advisory to Evacuate

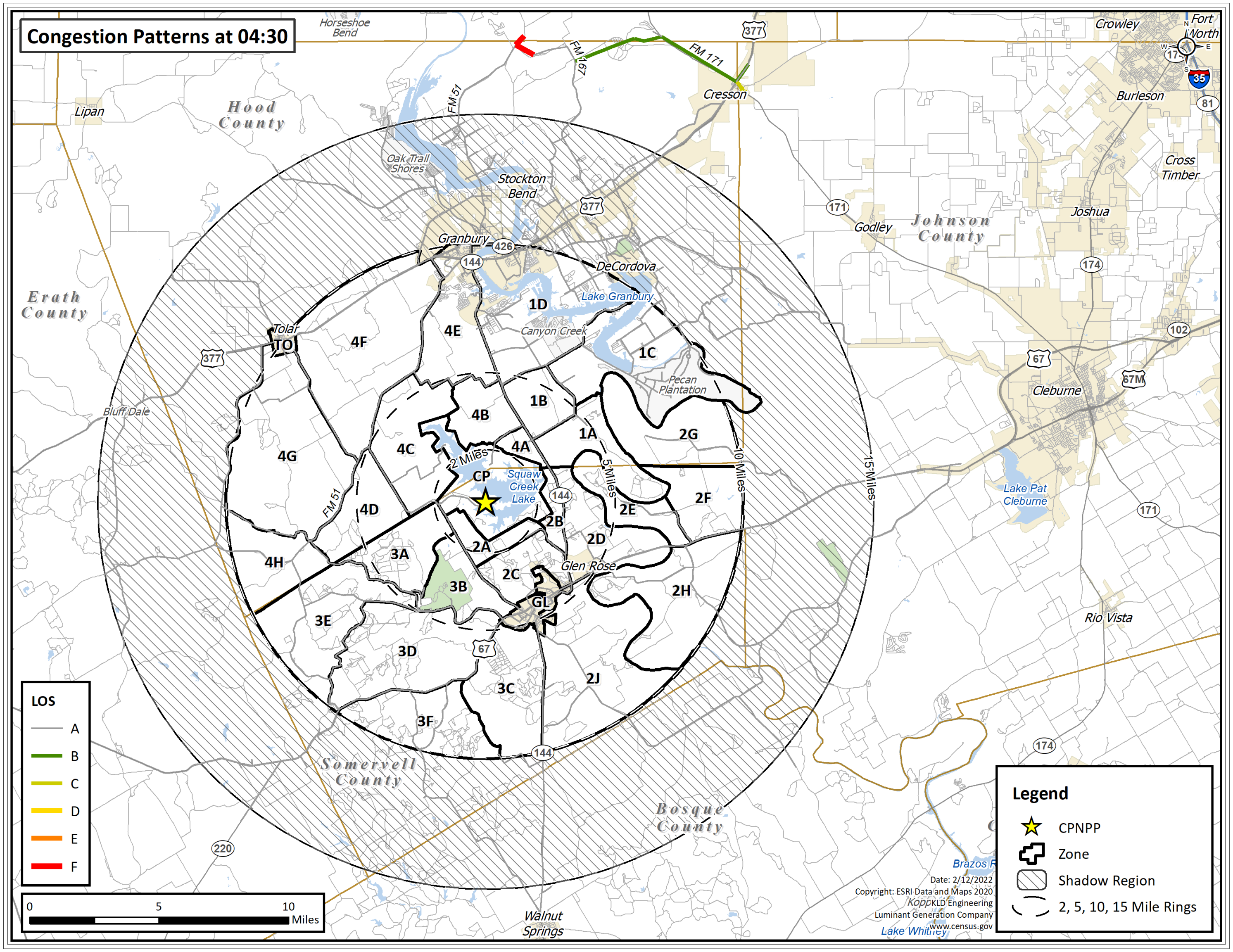


Figure 7-8. Congestion Patterns at 4 Hours and 30 Minutes after the Advisory to Evacuate

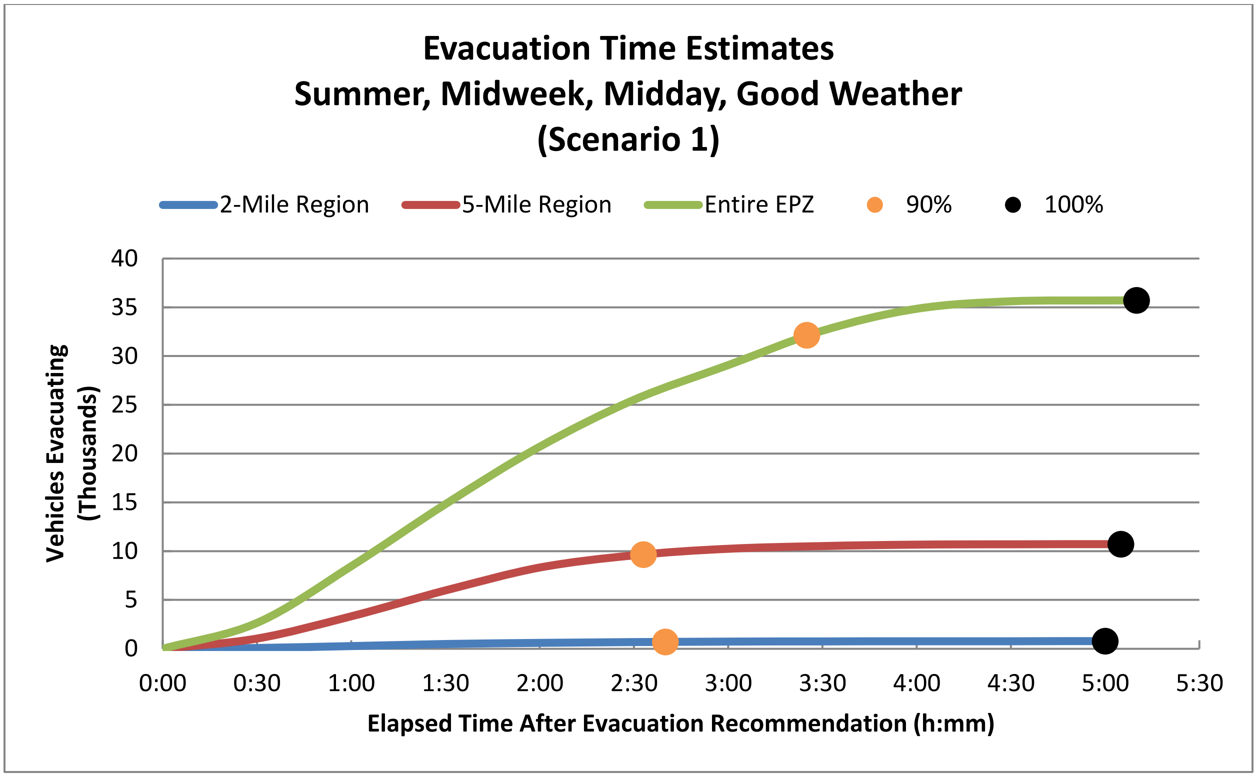


Figure 7-9. Evacuation Time Estimates - Scenario 1 for Region R03

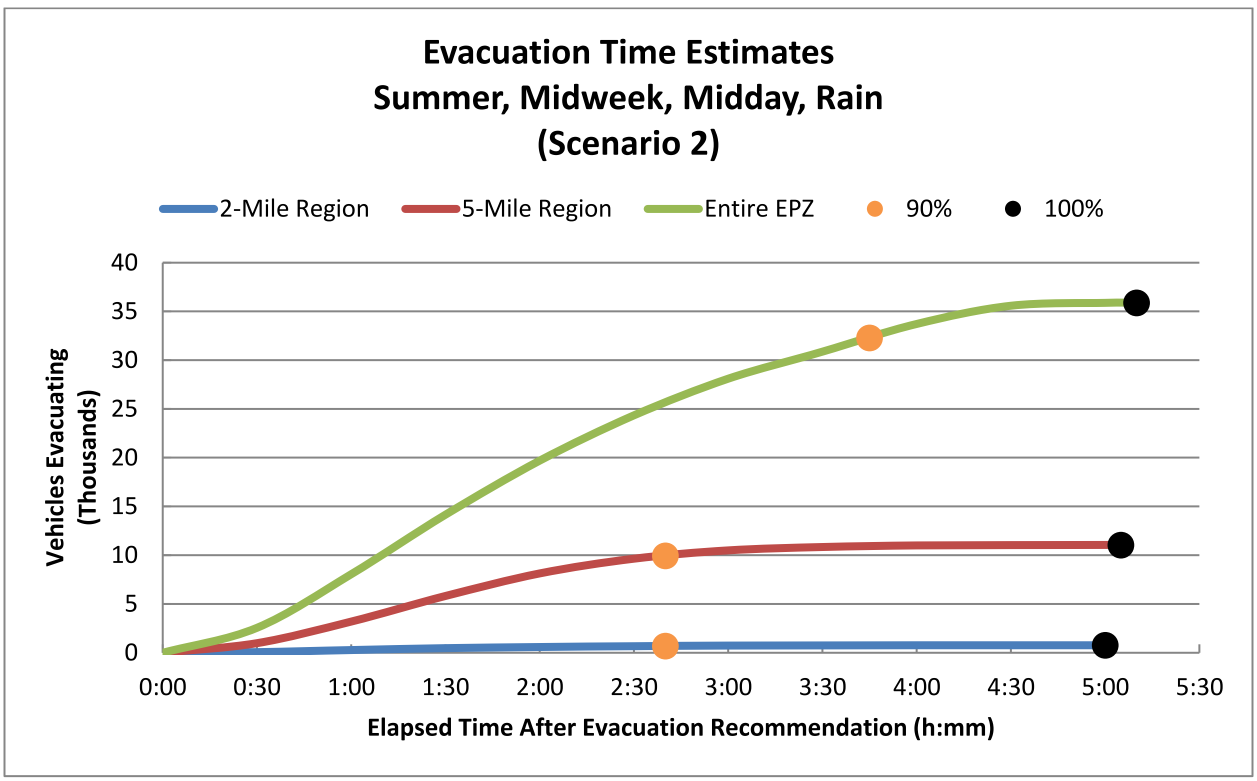


Figure 7-10. Evacuation Time Estimates - Scenario 2 for Region R03

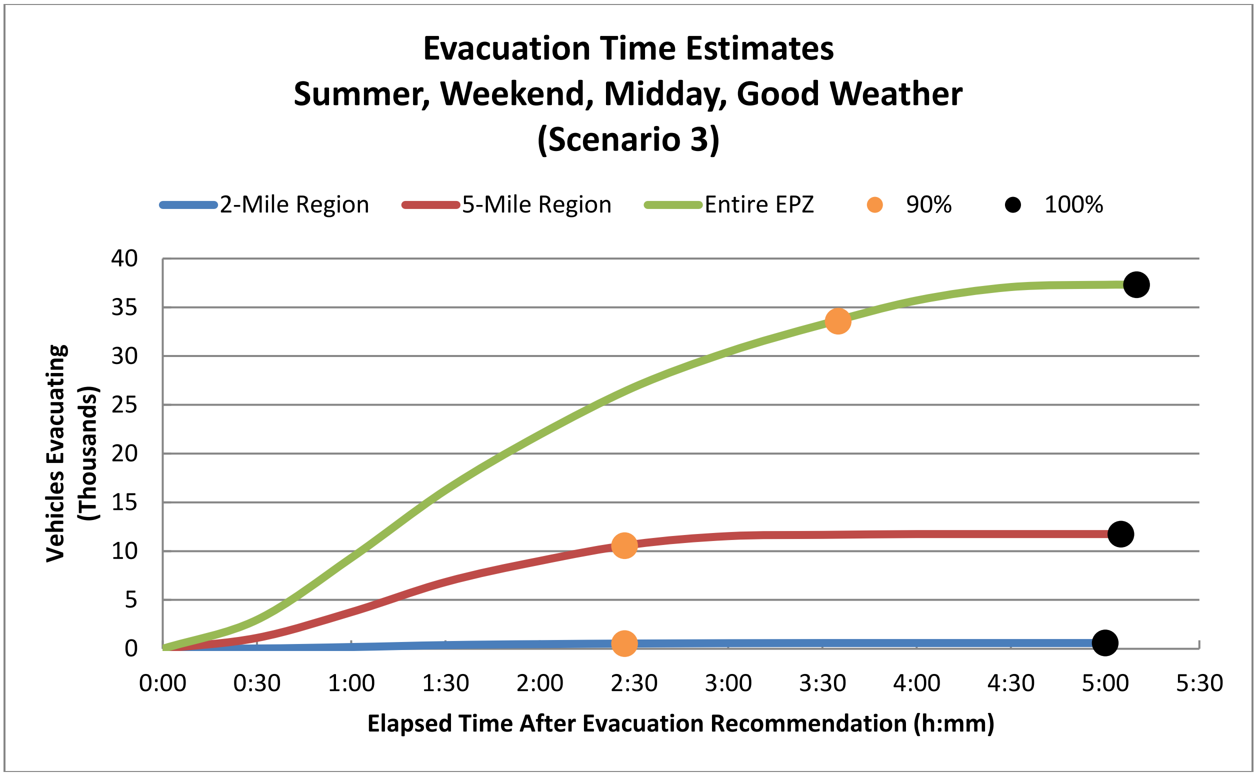


Figure 7-11. Evacuation Time Estimates - Scenario 3 for Region R03

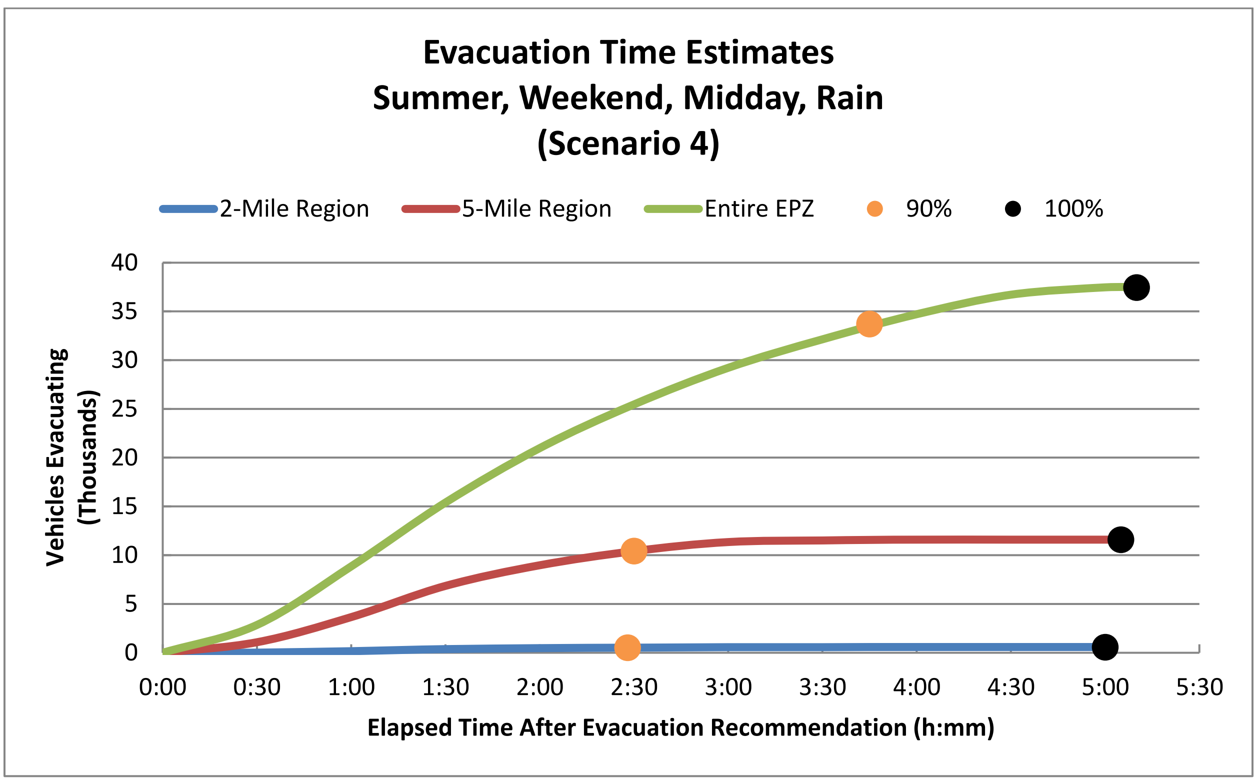


Figure 7-12. Evacuation Time Estimates - Scenario 4 for Region R03

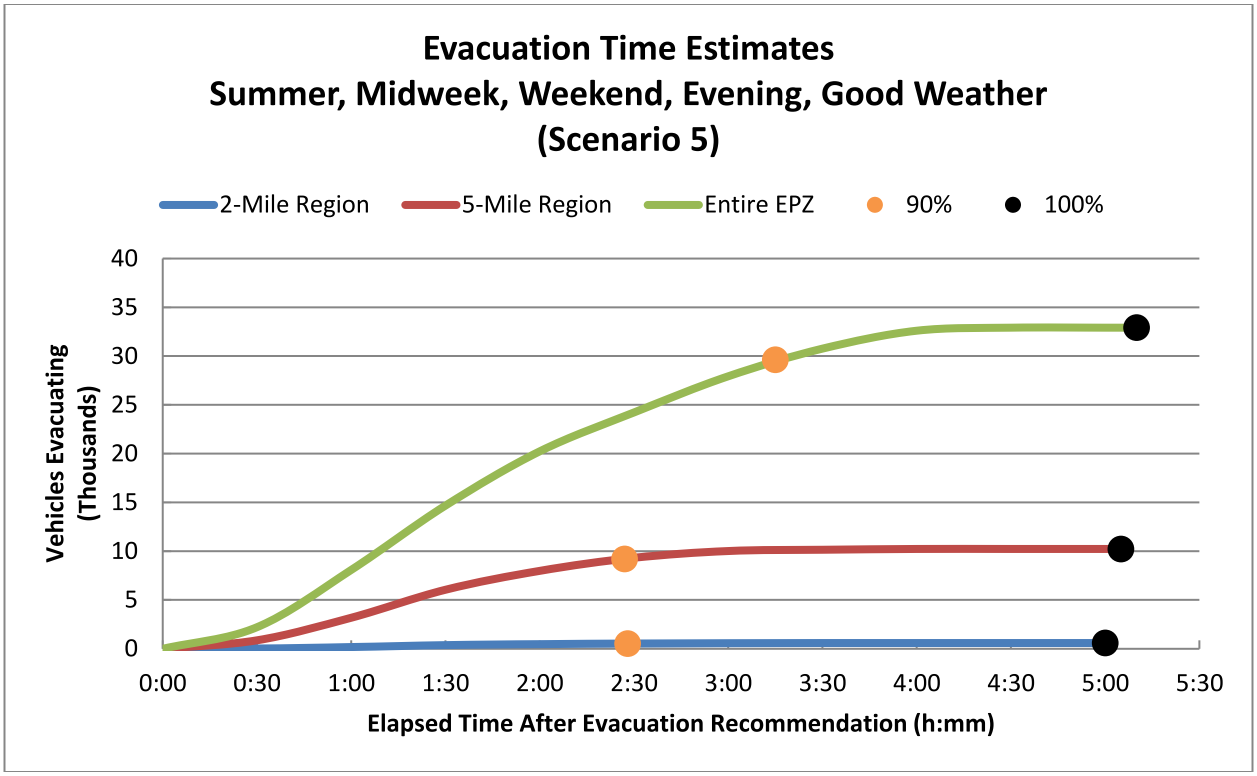


Figure 7-13. Evacuation Time Estimates - Scenario 5 for Region R03

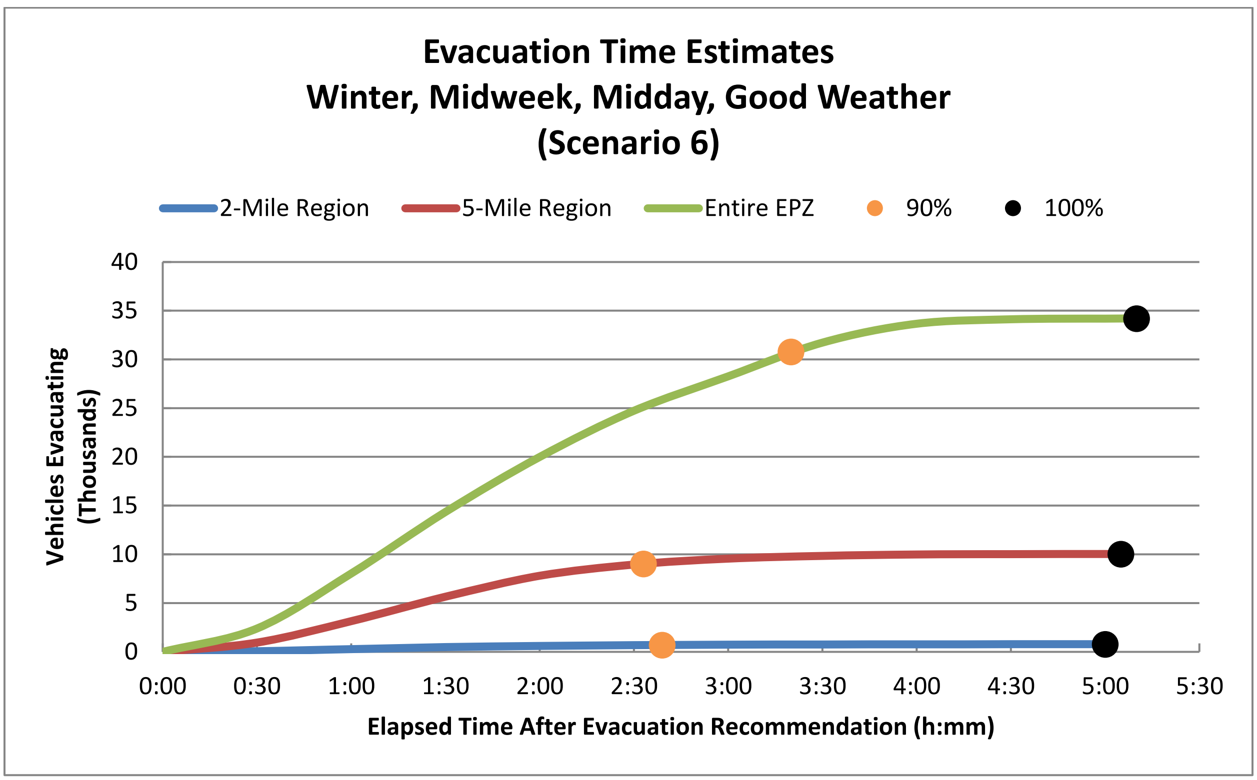


Figure 7-14. Evacuation Time Estimates - Scenario 6 for Region R03

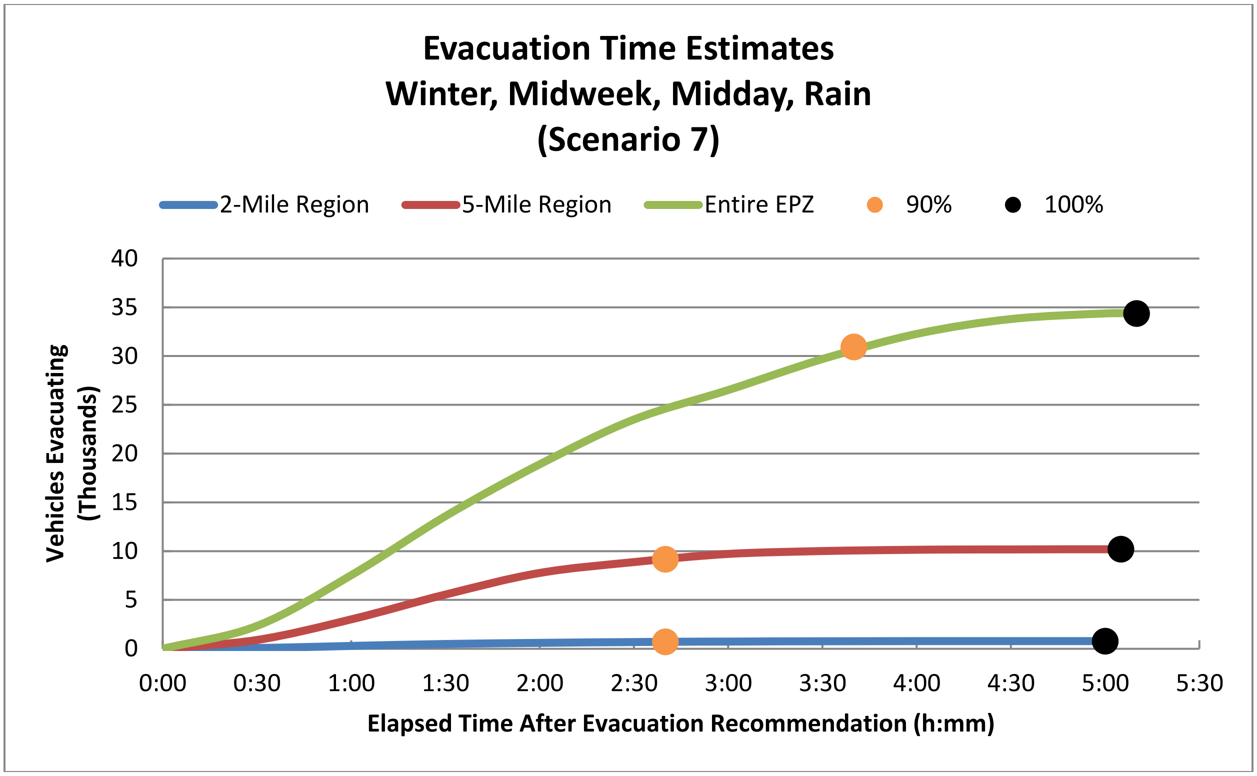


Figure 7-15. Evacuation Time Estimates - Scenario 7 for Region R03

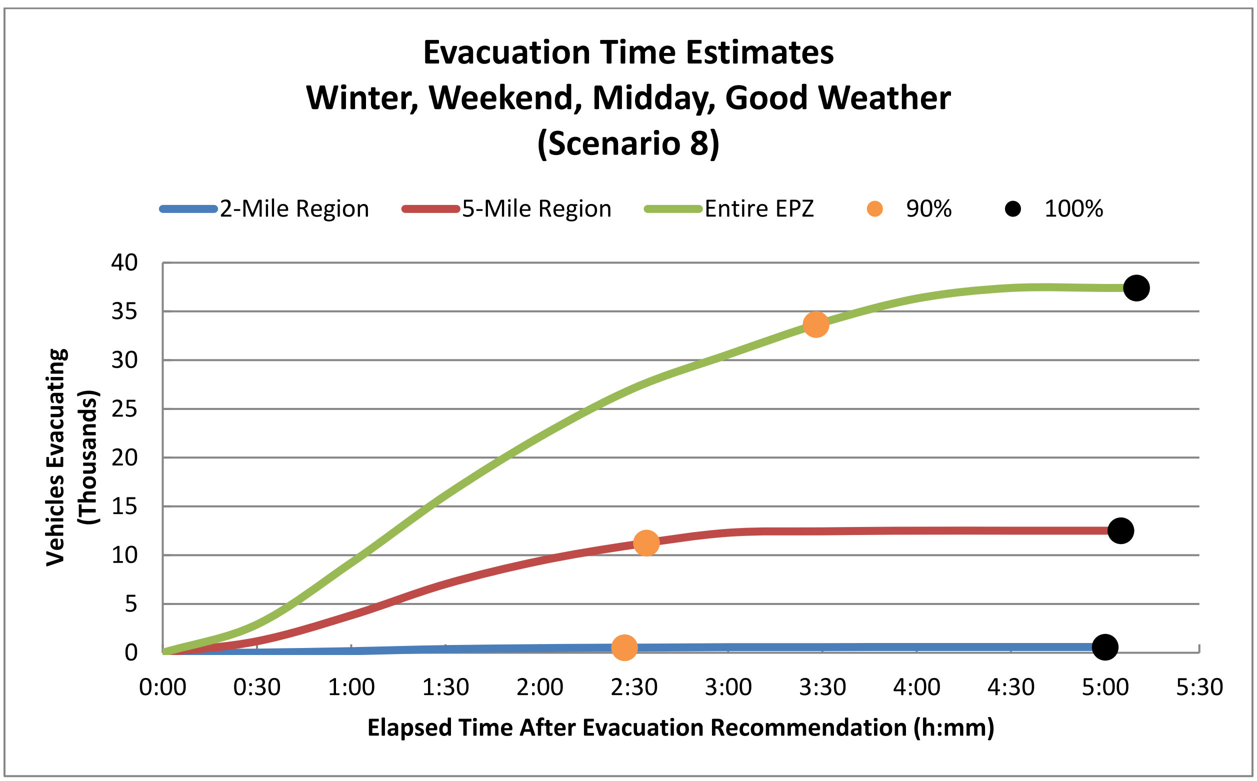


Figure 7-16. Evacuation Time Estimates - Scenario 8 for Region R03

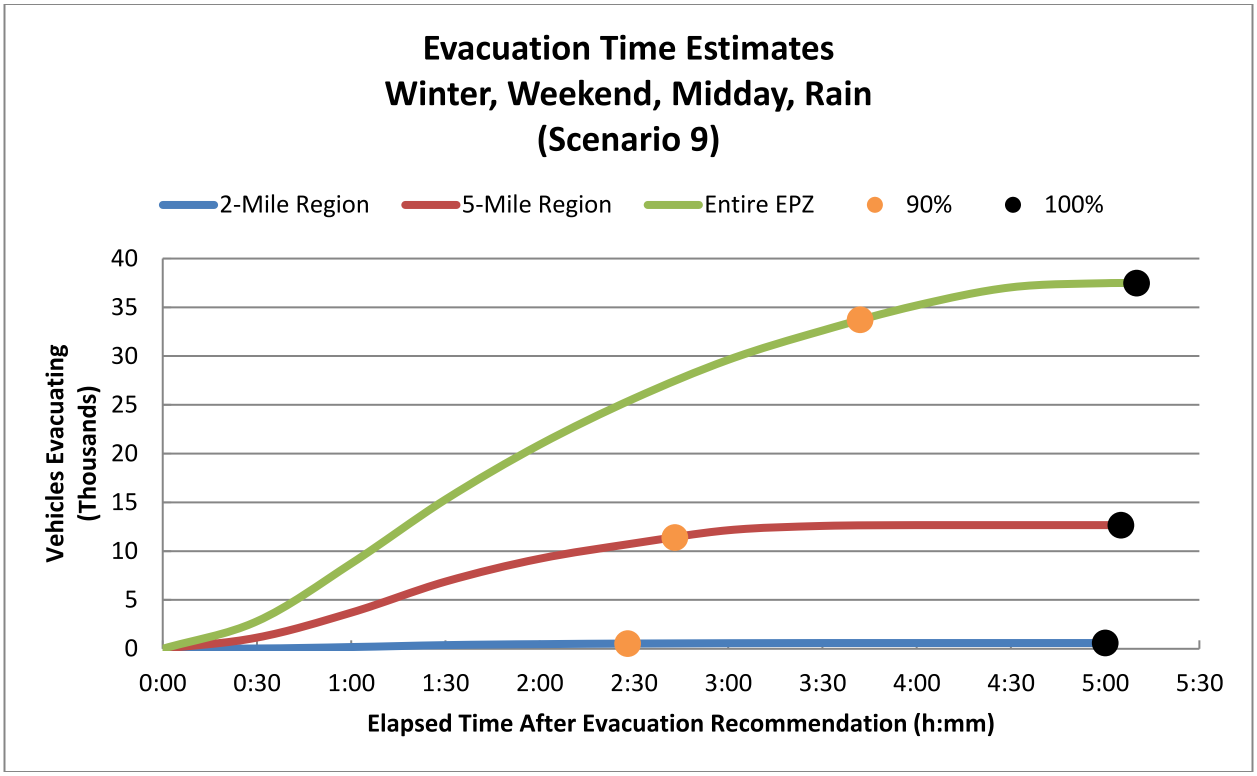


Figure 7-17. Evacuation Time Estimates - Scenario 9 for Region R03

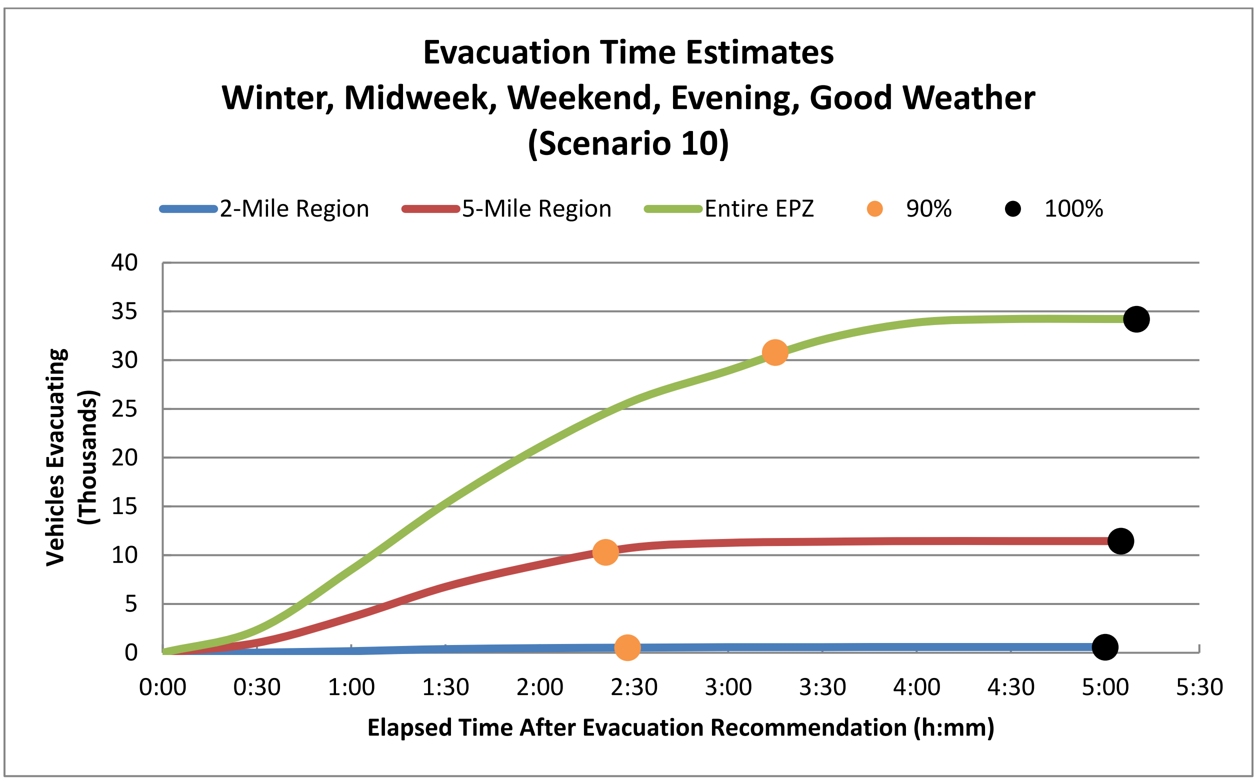


Figure 7-18. Evacuation Time Estimates - Scenario 10 for Region R03

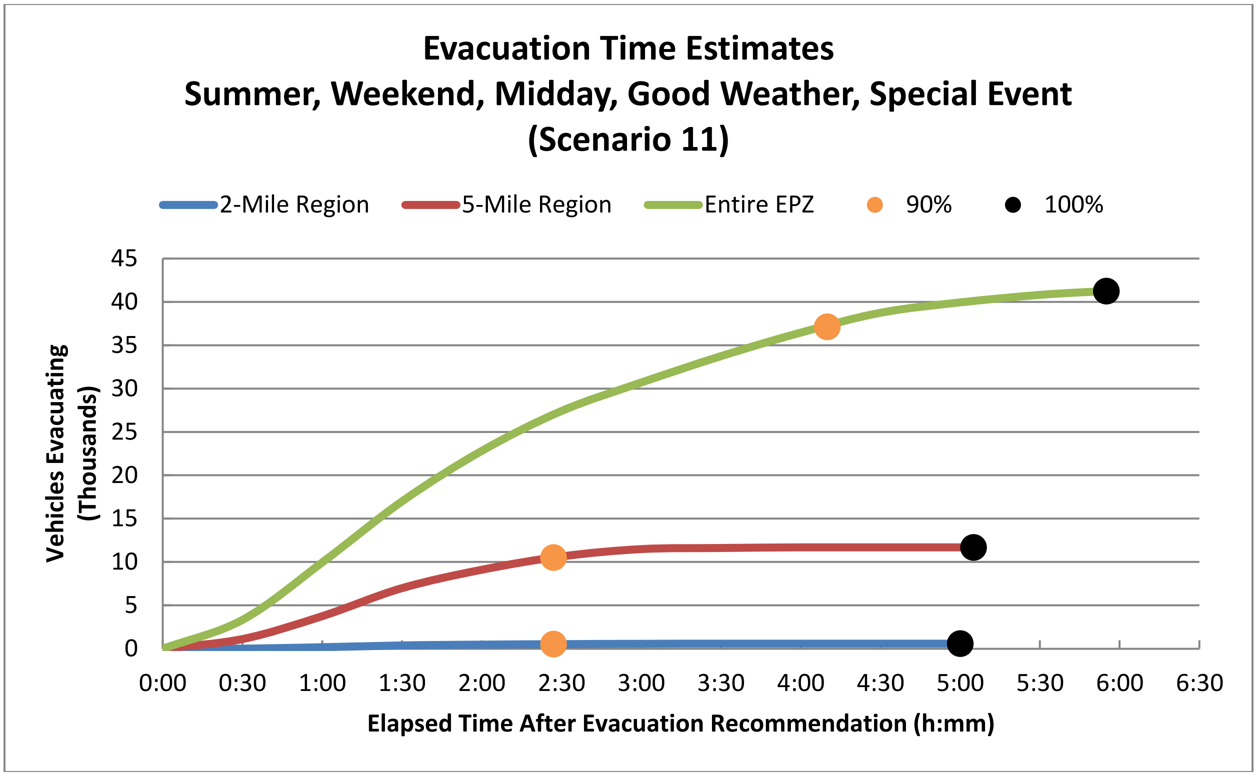


Figure 7-19. Evacuation Time Estimates - Scenario 11 for Region R03

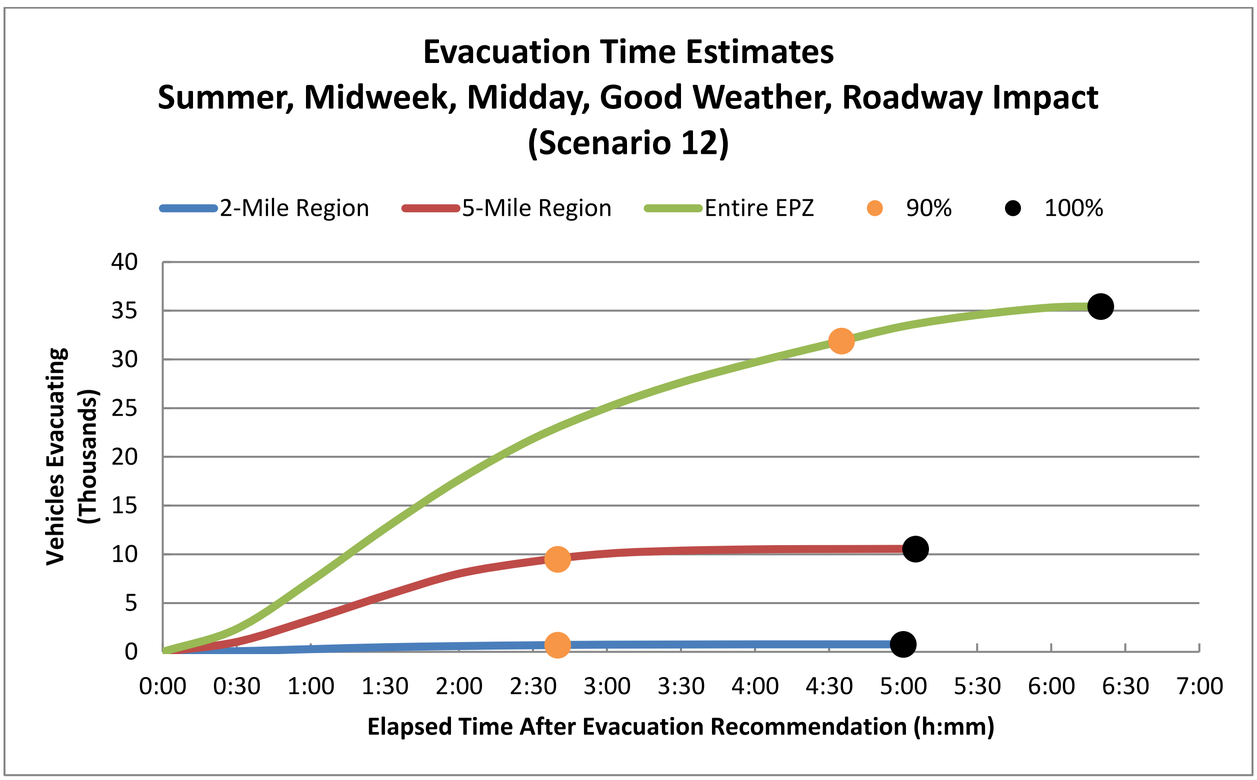


Figure 7-20. Evacuation Time Estimates - Scenario 12 for Region R03

8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES

This section details the analyses applied and the results obtained in the form of evacuation time estimates (ETE) for transit vehicles (buses, wheelchair buses and ambulances). The demand for transit service reflects the needs of three population groups:

- residents with no vehicles available,
- residents of special facilities such as schools, preschool/daycares, day camps, medical facilities, correctional facilities; and
- the access and/or functional needs population.

These transit vehicles mix with the general evacuation traffic that is comprised mostly of "passenger cars" (pc's). The presence of each transit vehicle in the evacuating traffic stream is represented within the modeling paradigm described in Appendix D as equivalent to two pc's. This equivalence factor represents the longer size and more sluggish operating characteristics of a transit vehicle, relative to those of a pc.

Transit vehicles must be mobilized in preparation for their respective evacuation missions. Specifically:

- Bus drivers must be alerted
- They must travel to the bus depot
- They must be briefed there and assigned to a route or facility

These activities consume time. As discussed in Item 4 of Section 2.4, it is estimated that bus mobilization time will be evacuated within 90 minutes (except for Glen Rose ISD and Granbury ISD, which will be within 10 minutes) extending from the Advisory to Evacuate (ATE), to the time when buses first arrive at the facility to be evacuated, which was provided by the counties within the EPZ. The location of bus depots impacts the time to travel from the bus depots to the facilities being evacuated. Locations of bus depots were not identified in this study. Rather, the offsite agencies were asked to factor the location of the depots and the distance to the EPZ into the estimate of mobilization time.

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents, neighbors, relatives and friends to pick up children from school prior to the arrival of buses, so that they may join their families. Virtually all studies of evacuations have concluded that this "bonding" process of uniting families is universally prevalent during emergencies and should be anticipated in the planning process. The current public information disseminated to residents of the CPNPP EPZ indicates that schoolchildren will be evacuated to a relocation school at emergency action classifications of Site Area Emergency or higher, and that parents should pick schoolchildren up at relocation schools.

As discussed in Section 2, this study assumes a rapidly escalating event at the plant, wherein evacuation is ordered promptly, and no early protective actions have been implemented. Therefore, children are evacuated directly to the relocation schools. Picking up children at school could add to traffic congestion at the schools, delaying the departure of the buses evacuating

schoolchildren. These buses may have to return in a subsequent "wave" to the EPZ to evacuate the transit-dependent population. This report provides estimates of the number of buses required, under the assumption that no children will be picked up by their parents (in accordance with NUREG/CR-7002, Rev. 1), to present an upper bound estimate of buses required.

The procedure for computing transit-dependent ETE is to:

- Estimate demand for transit service (discussed in Section 3).
- Estimate time to perform all transit functions.
- Estimate route travel times to the EPZ boundary and to the reception centers or relocation schools.

8.1 ETE for Transit Dependent People

The EPZ bus resources are assigned to evacuating schoolchildren (if schools, preschools/daycares and day camps are in session at the time of the ATE) as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat "inefficient", or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the reception center after completing their first evacuation trip, to complete a "second wave" providing transportation service to evacuees. For this reason, the ETE for the transit-dependent population will be calculated for both a single wave transit evacuation and for two waves. Of course, if the impacted Evacuation Region is other than R03 (the entire EPZ), or if schools are not in session, then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply. A list of available transportation resources was from the previous study, from the counties and located within the emergency plans and is shown in Table 8-1. It is assumed that there are enough drivers available to man all resources listed in Table 8-1.

When school evacuation needs are satisfied, subsequent assignments of buses to service the transit-dependent population should be sensitive to their mobilization time. Clearly, the buses should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive.

The ETEs for transit trips were developed using both good weather and adverse weather conditions. Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

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

Mobilization time is the elapsed time from the ATE until the time the buses arrive at the facility to be evacuated or to their designated route. Based on discussions with the offsite agencies, for a rapidly escalating radiological emergency with no observable indication before the fact, school bus drivers would require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities (10 minutes for Glen Rose ISD and Granbury ISD). Mobilization time is slightly longer in adverse weather – 100 minutes when raining (20 minutes for Glen Rose ISD and Granbury ISD).

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As shown in Figure 5-4 (Residents with no Commuters), 87.3 percent of the evacuees will complete their mobilization when the buses begin their routes, approximately 135 minutes after the ATE for good weather. Mobilization time is longer in adverse weather - 145 minutes - in rain to account for slower travel speeds and reduced roadway capacity.

Activity: Board Passengers (C→D)

As discussed in Section 2.4, a loading time of 15 minutes (20 minutes for rain) for school buses is used. A loading time of 10 minutes (15 minutes for rain) was used for Glen Rose ISD and Granbury ISD buses.

For multiple stops along a pick-up route (transit-dependent bus routes) estimation of travel time must allow for the delay associated with stopping and starting at each pick-up point. 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 = 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 = 50 seconds: a generous value for a single passenger, carrying personal items, to board per stop
- v = 25 mph = 37 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 1 minute per stop. Allowing 30 minutes pick-up time per bus run implies 30 stops per run, for good weather. It is assumed that bus acceleration and speed will be less in rain (40 minutes per bus).

Activity: Travel to EPZ Boundary (D→E)

Transportation resources available were provided by the EPZ county emergency management agencies. Table 8-1 summarizes the available capacity of transportation resources. Also included in the table is the transportation resource capacity needed to evacuate schools, preschools/daycares, day camps, medical facilities, transit-dependent population, access and/or functional needs population (discussed below in Section 8.2) and correctional facilities (discussed below in Section 8.3). The capacity for buses and wheelchair accessible vehicles varied between the different transportation providers, therefore the total number of ambulatory and wheelchair-bound individuals that can be serviced by each entity is also provided in Table 8-1.

These numbers indicate there are not enough resources available to evacuate all population groups in a single wave, except for those requiring wheelchair buses and mini buses.

Evacuation of Schools

The buses servicing the schools are ready to begin their evacuation trips at 105 minutes (20 minutes for Glen Rose ISD and Granbury ISD) after the ATE – 90 minutes mobilization time plus 15 minutes loading time (10 minutes mobilization time plus 10 minutes loading time for Glen Rose ISD and Granbury ISD) – in good weather. The UNITES software discussed in Section 1.3 was used to define bus routes along the most likely path from a school or preschool/daycare being evacuated to the EPZ boundary, traveling toward the appropriate relocation school or reception center.

This is done in UNITES interactively selecting the series of from the school to the EPZ boundary. Each bus route is given an identification number and is written to the DYNEV II input stream. DYNEV computes the route length and outputs the average speed for each 5-minute interval, for each bus route. The specified bus routes are documented in Section 10 in Table 10-2 (refer to the maps of the link-node analysis network in Appendix K for node locations). Data provided by DYNEV during the appropriate timeframe depending on the mobilization and loading times (i.e., 100 to 105 minutes after the ATE for good weather) were used to compute the average speed for each route, as follows:

$$Average\ Speed\ \left(\frac{mi.}{hr}\right)$$
$$= \left[\frac{\sum_{i=1}^{n} length\ of\ link\ i\ (mi)}{\sum_{i=1}^{n}\left\{Delay\ on\ link\ i\ (min.) + \frac{length\ of\ link\ i\ (mi.)}{current\ speed\ on\ link\ i\ \left(\frac{mi.}{hr.}\right)} \times \frac{60\ min.}{1\ hr.}\right\}}\right] \times \frac{60\ min.}{1\ hr.}$$

The average speed computed (using this methodology) for the buses servicing each of the schools and preschools/daycares in the EPZ is shown in Table 8-2 and Table 8-3 for school and preschool/daycare evacuation. The travel time to the EPZ boundary was computed for each bus using the computed average speed and the distance to the EPZ boundary along the most likely route out of the EPZ. The travel time from the EPZ boundary to the host school was computed assuming an average speed of 50 mph and 45 mph for good weather and rain respectively. Speeds were reduced in Table 8-2 and Table 8-3 to 50 mph (45 mph for rain– 10% decrease). Section 548.201 of the Texas Transportation Code indicates that 50 mph is the maximum speed that school buses without a commercial motor vehicle (CMV) inspection can travel on a highway numbered by the United States or State of Texas, including Farm to Market (FM) roadways.

Table 8-2 (good weather) and Table 8-3 (rain) present the following ETEs (rounded up to the nearest 5 minutes) for schools and preschools/daycares in the EPZ:

1. The elapsed time from the ATE until the bus exits the EPZ; and

2. The elapsed time until the bus reaches the host school.

The evacuation time out of the EPZ can be computed as the sum of times associated with Activities A→B→C, C→D, and D→E (For example: 10 min. + 10 + 7 = 0:30 for Mambrino Elementary School, with good weather, rounded up to the nearest 5 minutes).

The average single-wave ETE, for schools and preschool/daycares, is significantly less than the 90th percentile ETE for evacuation of the general population in the entire EPZ (Region R03) under winter, midweek, midday, good weather (Scenario 6) conditions and will not impact protective action decision making.

The evacuation time to the Relocation School (R.S) is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time. For example: 0:30 + 0:35 = 1:05 for Mambrino Elementary School, rounded up to the nearest 5 minutes).

As shown in Table 8-1, there is a shortfall of school buses for evacuation of children in a single wave, if the entire EPZ is evacuated at once (a highly unlikely event). As such, a second-wave evacuation may be needed for some schools and preschools/daycares. Due to the large number of schools/preschools/daycares in the EPZ, second-wave ETEs were not computed for each school/preschools/daycare. Rather, the following representative ETE is provided to estimate the additional time needed for a second wave evacuation of schools. The travel time from the R.S. back to the EPZ boundary and then back to the school was computed assuming an average speed of 50 mph (good weather) and 45 mph (rain) as buses will be traveling counter to evacuating traffic. Times and distances are based on averages for all schools in the EPZ for good weather:

- School buses arrive at the R.S. at 1:45 (see average value in Table 8-2)
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes
- Bus returns to facility: 33 minutes (average distance to R.S. (21.5 miles) + average distance to EPZ boundary (5.7 miles at 50 mph))
- Loading Time: 30 minutes
- Bus completes second wave of service along route: 23 minutes (average distance to EPZ boundary (5.7 miles) at network wide average speed at 3:05 (15.1 mph))
- Bus exits EPZ at time 1:45 + 0:15 + 0:33 + 0:30 + 0:23 = 3:30 (rounded up to nearest 5 minutes) after the ATE.

Given the average single-wave ETE for schools is 1:45 (see Table 8-2); a second wave evacuation would require an additional 1 hour and 45 minutes on average. The average second-wave ETE of schools is 5 minutes longer than the 90th percentile ETE of the full EPZ during a winter, midweek, midday scenario (Scenario 6). This is an insignificant difference and is not likely to impact protective action decision making.

Day Camp Evacuation

The peak season for day camps is when schools are in session at summer enrollment, thus school buses will be available to evacuate the day camps in a single wave. Table 8-4 and Table 8-5 present the single wave ETE for day camps. The bus mobilization time is estimated as 90 minutes, similar to schools and preschool/daycares within the EPZ. The buses are assumed to travel to the nearest reception center, which is the Cleburne Senior Center. Table 8-4 (good weather) and

Table 8-5 (rain) present the following ETE (rounded up to the nearest 5 minutes) for day camps in the EPZ:

1. The elapsed time from the ATE until the bus exits the EPZ; and
2. The elapsed time until the bus reaches the reception center.

The evacuation time out of the EPZ can be computed as the sum of times associated with Activities A→B→C, C→D, and D→E (For example: 90 min. + 15 + 8 = 1:55 for Arrowhead Camp & Retreat Center, with good weather). The evacuation time to the reception center is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time. For example: 1:55 + 0:16 = 2:15 rounded to the nearest 5 minutes.

The average single-wave ETE, for day camps, is significantly less (1 hour and 15 minutes) than the 90th percentile ETE for evacuation of the general population in the entire EPZ (Region R03) under summer, midweek, midday, good weather (Scenario 1) conditions and will not impact protective action decision making.

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

A detailed computation of transit dependent people was done and is discussed in Section 3.6. The total number of transit dependent people per Zone was determined using a weighted distribution based on population. See Table 3-9 for the distribution used. The number of buses required to evacuate this population was determined by the capacity of 30 people per bus. The county emergency plans do not identify pre-defined bus routes or pick-up points to service the transit-dependent population in the EPZ. There is 12 routes designed by KLD (as discussed in Section 10) and shown graphically in Figure 10-2 and described in Table 10-1, to service the major routes through each Zone. Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ. It is assumed that residents will walk to the nearest major roadway and flag down a passing bus, and that they can arrive at the roadway within the 135-minute bus mobilization time (good weather). Mobilization time is 10 minutes longer in rain to account for slower travel speeds and reduced roadway capacity.

As previously discussed, a pickup time of 30 minutes (good weather) is estimated for 30 individual stops to pick up passengers, with an average of one minute of delay associated with each stop. Longer pickup times of 40 minutes are used for rain.

The travel distance along the respective pick-up routes within the EPZ is estimated using the UNITES software. Bus travel times within the EPZ uses average speeds computed by DYNEV, using the aforementioned methodology that was used for school evacuation.

For example, the ETE for one (1) bus servicing Route 32 - Zone 3D, 3F and 3C – is computed as 135 + 9 + 30 = 2:55 for good weather (rounded up to nearest 5 minutes). Here, 9 minutes is the time to travel 7.9 miles at 50.0 mph, the average speed output by the model for this route starting at 135 minutes.

The average single-wave ETE (3 hours and 20 minutes) for the transit dependent people is equal to the general population 90th percentile ETE for the evacuation of the entire EPZ under winter,

midweek, midday, good weather (Scenario 6) conditions. Hence, ETE is not likely to impact protective action decision making.

The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers, as previously discussed and shown in Table 8-1.

Activity: Travel to Reception Centers (E→F)

The distances from the EPZ boundary to the reception centers are measured using GIS software along the most likely route from the EPZ exit point to the reception center. The reception centers are mapped in Figure 10-4. For a single-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. Assumed bus speeds of 50 mph and 45 mph for good weather and rain, respectively, will be applied for this activity for buses servicing the transit-dependent population.

For a second-wave evacuation, the ETE for buses must be considered separately, since it could exceed the ETE for the general population.

Activity: Passengers Leave Bus (F→G)

A bus can empty within 5 minutes. The driver takes a 10-minute break.

Activity: Bus Returns to Route for Second Wave Evacuation (G→C)

The buses assigned to return to the EPZ to perform a "second wave" evacuation of transit-dependent evacuees will be those that have already evacuated transit-dependent people who mobilized more quickly. The first wave of transit-dependent people departs the bus, and the bus then returns to the EPZ, travels to its route and proceeds to pick up more transit-dependent evacuees along the route. The travel time back to the EPZ is equal to the travel time to the reception center.

The second wave ETE for the bus route servicing Route 32 – 3D, 3F and 3C – is computed as follows for good weather:

- Bus arrives at reception center at 3:23 in good weather (2:55 to exit EPZ + 28-minute travel time to reception center).
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to EPZ, drives to the start of the route and completes second route: 28 minutes (equal to travel time to reception center) + 9.5 minutes (equal to travel time to start of route, i.e., 7.9 miles @ 50 mph) + 9 minutes (equal to travel time complete second route) = 47 minutes
- Bus completes pick-ups along route: 30 minutes.
- Bus exits EPZ at time 2:55 + 0:28 + 0:15 + 0:46+ 0:30 = 4:55 (rounded up to nearest 5 minutes) after the ATE.

The ETE for the completion of the second wave for all transit-dependent bus routes are provided in Table 8-6 and Table 8-7.

The average ETE (5 hours and 15 minutes) for a second-wave evacuation of transit-dependent people is 1 hour 55 minutes longer than the ETE for the general population at the 90th percentile

for an evacuation of the entire EPZ (Region R03) under winter, midweek, midday, good weather conditions (Scenario 6) and could impact the protective action decision making.

The relocation of transit-dependent evacuees from the reception centers to congregate care centers, if the counties decide to do so, is not considered in this study.

Evacuation of Medical Facilities

The evacuations of the medical facilities are similar to a school evacuation except:

- Buses are assigned on the basis of 30 persons to allow for staff to accompany the patients.
- Minibuses are assigned on the basis of 25 ambulatory and 4 wheelchair-bound per vehicle.
- Wheelchair buses can accommodate 15 patients.
- Wheelchair vans can accommodate 4 patients.
- Ambulances can accommodate 2 patients.
- The passenger loading times will be approximately one (1) minute per ambulatory person to account for the time to move a person from inside the facility to the vehicles. Loading times of 5 minutes and 15 minutes per patient are assumed for wheelchair bound patients, and bedridden patients, respectively.

Table 3-8, in Section 3, and Table 8-1 indicate that 15 bus runs, 30 minibus runs, 14 wheelchair bus runs, 3 wheelchair van run and 39 ambulance runs are needed to service all of the medical facilities in the EPZ.

According to Table 8-1, the counties can collectively provide 118 buses, 33 minibuses, 30 wheelchair accessible buses, 3 wheelchair accessible vans and 11 ambulances. There is a sufficient number of minibuses and wheelchair accessible buses available for some wheelchair bound and ambulatory patients. Even though Table 8-1 indicates that there are enough buses for ambulatory patients at the medical facilities, the total number of buses available is shared among other population groups (children at schools/childcare facilities and access and/or functional needs population) resulting in a shortfall of buses. In addition, there is a shortfall in wheelchair vans and ambulances for to evacuate the wheelchair bound and bedridden patients in a single-wave. Thus, a second wave evacuation was computed.

It is estimated that mobilization time for medical facilities averages 90 minutes in good weather (100 minutes in rain). Specially trained medical support staff (working their regular shift) will be on-site to assist in the evacuation of patients. Additional staff (if needed) could be mobilized over this same 90-minute timeframe.

Table 8-8 and Table 8-9 summarize the ETE for medical facilities within the EPZ for good weather and rain. Average speeds output by the model for Scenario 6 (Scenario 7 for rain) Region 3, capped at 50 mph (45 mph for rain), are used to compute travel time to EPZ boundary. The travel time to the EPZ boundary is computed by dividing the distance to the EPZ boundary by the average travel speed. The ETE is the sum of the mobilization time, total passenger loading time, and travel time out of the EPZ boundary. Concurrent loading on multiple buses/minibuses, wheelchair buses/vans, and ambulances at capacity is assumed such that the maximum loading

times for buses/minibuses is 30 minutes, wheelchair buses/vans is 75 minutes and ambulances are 30 minutes. All ETE are rounded up to the nearest 5 minutes.

For example, the calculation of ETE for the Courtyards at Lake Granbury with 44 ambulatory and 30 wheelchair-bound residents (assuming concurrent loading of multiple vehicles) during good weather is:

ETE: 90 + (30 x 1) + 5 = 125 min. or 2:05 rounded up to the nearest 5 minutes.

It is assumed that the medical facility population is directly evacuated to appropriate host medical facilities outside of the EPZ. Relocation of this population to permanent facilities and/or passing through the reception/care center before arriving at the host facility are not considered in this analysis.

The average single wave ETE (2 hours and 15 minutes) for all medical facilities in good weather is 1 hour and 5 minutes shorter than the 90th percentile ETE for the evacuation of the general population from Region R03 during Scenario 6 (3 hours and 20 minutes) conditions and will not impact protective action decision making.

In the event there is a shortfall of transport vehicles at the medial facilities within the EPZ, a second-wave ETE is computed. Due to the large number of medical facilities in the EPZ, second wave ETE was not computed for each medical facility and transport vehicle. Rather, the following representative ETE is provided to estimate the additional time needed for a second wave using ambulatory buses. Times and distances are based on medical facility-wide averages. A second-wave ETE is computed as follows for good weather:

- Buses arrive at Reception Center (R.C.) at 2:40 (2:15 average ETE from Table 8-8 plus 24 minute average travel time to R.C. calculated from Table 8-6)
- Bus discharges passengers: 5 minutes
- Bus Driver Takes a Rest: 10 minutes
- Bus returns to EPZ and travels back to the facility to complete second route: 31 minutes (average distance to R.C. (19.8 miles) from Table 8-6 plus average distance to EPZ boundary (5.5 miles) from Table 8-8) @ 50 mph)
- Remaining patients loaded on bus (maximum): 30 minutes
- Bus travels to EPZ boundary: 15 minutes (average distance from medical facilities to EPZ boundary (5.5 miles) at network wide speed at 22.5 mph (taken at 4 hours; congestion has not cleared in the EPZ)
- Bus exits EPZ at time 2:40 + 0:05 + 0:10 + 0:31 + 0:30 + 0:15 = 4:15 (rounded to nearest 5 minutes) after the ATE.

The average ETE (4 hours and 15 minutes) for a second wave evacuation of patients within the EPZ is 55 minutes longer than the ETE for the general population at the 90th percentile for an evacuation of the entire EPZ (Region R03) under winter, midweek, midday, good weather (Scenario 6) conditions and will impact the protective action decision making.

8.2 ETE for Access and/or Functional Needs Population

The access and/or functional needs population registered within the EPZ was provided by the offsite agencies. Table 8-10 summarizes the ETE for access and/or functional needs population, also discussed in Section 3.9. The table is categorized by type of vehicle required and then broken down by weather conditions (good weather and rain). The table takes into consideration the deployment of multiple vehicles (not filled to capacity) to reduce the number of stops per vehicle. Due to the limitations on driving for access and/or functional needs persons, it assumed they will be picked up from their homes. Furthermore, it is conservatively assumed that ambulatory and wheelchair bound access and/or functional needs households are spaced 3 miles apart and bedridden households are spaced 5 miles apart. Van and bus speeds approximate 20 mph between households and ambulance speeds approximate 30 mph in good weather (10% slower in rain). Mobilization times of 135 minutes were used (145 minutes for rain). Loading times of 1 minute per person are assumed for ambulatory people, 5 minutes for wheelchair bound people and 15 minutes per person are assumed for bedridden people. The last household is assumed to be 5 miles from the EPZ boundary, and the network-wide average speed, capped at 50 mph (45 mph for rain), after the last pickup is used to compute travel time.

The ETE is computed by summing mobilization time, loading time at first household, travel to subsequent households, loading time at subsequent households, and travel time to the EPZ boundary. All ETE are rounded to the nearest 5 minutes.

For example, assuming no more than one access and/or functional needs person per household implies that 32 ambulatory households need to be serviced. While only 2 buses are needed from a capacity perspective, if 4 buses are deployed to service these households, then each would require at most 8 stops. The following outlines the ETE calculations for a bus:

1. Assume 4 buses are deployed, each with at most 8 stops, to service a total of 32 households.
2. The ETE is calculated as follows:
    a. Buses arrive at the first pickup location: 135 minutes
    b. Load household members at first pickup: 1 minute
    c. Travel to subsequent pickup locations: 7 @ 9 minutes (3 miles @ 20 mph) = 63 minutes
    d. Load household members at subsequent pickup locations: 7 @ 1 minute = 7 minutes
    e. Travel to EPZ boundary: 16 minutes (5 miles @ 19.1 mph – network wide average speed at this time).

ETE: 135 + 1 + 63 + 7 + 16 = 3:45 rounded to the nearest 5 minutes

The average ETE for a single wave evacuation of the access and/or functional needs population within the EPZ is 30 minutes longer than the general population ETE at the 90th percentile for an evacuation of the entire EPZ (Region R03), during Scenario 6 conditions. Therefore, the evacuation of the access and/or functional needs population could impact the protective action decision-making.

As the number of buses, wheelchair vans and ambulances are not enough a second wave ETE was computed, see Table 8-11. The following outlines the ETE calculations for a second wave of the ambulatory access and/or functional needs population in good weather using school buses after the schools have been evacuated (see Table 8-2):

a. School buses arrive at reception center: 2:15 on average (Table 8-2)
b. Unload patients: 5 minutes
c. Driver takes 10-minute rest: 10 minutes.
d. Travel time back to EPZ: 30 minutes (average time of "Travel Time from EPZ Bdry to R.S. From Table 8-2 rounded to nearest 5 minutes).
e. Travel to All Stops: 72 minutes (3 miles @ 20 mph)
f. Total Loading time at all stops: 8 minutes
g. Travel time to EPZ boundary = 17 minutes (5 miles @ 17.4 mph – network wide average speed at this time)

ETE: 2:15 + 0:05 + 0:10 +0: 30 + 1:12 + 0:08 + 0:17 = 4:40 (rounded up to the nearest 5 minutes)

The average ETE for a second-wave evacuation of the access and/or functional needs population within the EPZ is 2 hours and 20 minutes longer than the general population ETE at the 90th percentile for an evacuation of the entire EPZ (Region R03), during Scenario 6 conditions. Therefore, the evacuation of the access and/or functional needs population could impact the protective action decision-making.

8.3 ETE for Correctional Facility

As detailed in Table 3-7 and Table E-9, there is one correctional facility within the EPZ – Somervell County Jail. The total inmate population at this facility is 32 persons. A total of two (2) buses are needed to evacuate the this facility, based on a capacity of 30 inmates per bus. Mobilization time is assumed to be 90 minutes (100 minutes in rain). It is estimated that it takes 30 minutes to load the inmates (1-min per inmate) onto a bus and the two (2) buses can be loaded in parallel. Thus, the total loading time is estimated at approximately 30 minutes for good weather (35 minutes in rain). Using GIS software, the shortest route from the facility to the EPZ boundary, traveling away from the plant, is 8 miles. As shown in Table 8-12, the travel time to traverse 8 miles is 10 minutes (8 miles @ 50 mph [network wide average speed at this time]) in good weather, 11 minutes in rain. All ETE are rounded to the nearest 5 minutes.

Good Weather ETE: 90 + 30 + 10 = 2:10 after the ATE

Rain ETE: 100 + 35 + 11 = 2:30 after the ATE

Table 8-12 summarizes the ETE for Somervell County Jail. The average single wave ETE (2 hours and 20 minutes) for Somervell County Jail is less than the ETE for the general population at the 90th percentile for an evacuation of the entire EPZ (Region R03), during Scenario 6 conditions. As such, there is no impact to the protective action decision making.

Table 8-1. Summary of Transportation Resources

Transportation Resources	Buses	Mini-buses	Wheel-chair Buses	Wheel-chair Van	Vans	Cars	Ambu-lances	Total Fleet Capacity		
								Ambu-latory	Wheelchair-Bound	Bed-ridden
Resources Available										
Granbury ISD	64	17	17	0	0	12	0	4,934	60	0
Tolar ISD	12	1	1	0	0	0	0	843	4	0
Lipan ISD	7	1	1	0	2	0	0	538	4	0
North Central Texas Academy	2	2	0	0	10	0	0	380	0	0
Rainbow's Promise	0	0	0	0	3	0	0	45	0	0
Transit System - Hood County	0	6	6	2	1	0	0	120	40	0
Southern Concepts - South Town	0	0	0	0	1	0	0	6	0	0
Southern Concepts - Torrey House	0	0	0	0	1	0	0	6	0	0
Courtyards at Lake Granbury	0	1	1	0	0	1	0	18	0	0
Granbury Villa Nursing Center	0	0	1	0	1	0	0	10	10	0
Waterview Assisted Living	0	1	1	0	0	0	0	22	4	0
Quail Park Assisted Living	0	1	1	0	0	1	0	15	2	0
Lakestone Terrace	0	1	1	0	0	1	0	15	2	0
Pecan Plantation EMS	0	0	0	0	0	0	3	0	3	3
Texas EMS	0	0	0	0	0	0	6	0	6	6
North Central Texas Trauma Regional Advisory Council (NCTTRAC)	0	0	0	0	0	0	2	0	0	42
Glen Rose ISD	30	0	0	0	4	0	0	160	0	0
Somervell Co. SO	0	0	0	0	1	0	0	10	0	0
Transit System - Somervell County	0	2	0	0	4	5	0	82	0	0
Brazos River Charter School[1]	2	0	0	0	0	0	0	28	0	0
Cherokee Rose Manor[1]	0	0	0	0	1	0	0	16	0	0
Cherokee Rose Manor - Granbury[1]	1	0	0	0	0	0	0	30	0	0

[1] Transportation resources available at this facility is from the previous ETE study, updated data was not provided.

Transportation Resources	Buses	Mini-buses	Wheel-chair Buses	Wheel-chair Van	Vans	Cars	Ambu-lances	Total Fleet Capacity		
								Ambu-latory	Wheelchair-Bound	Bed-ridden
Cherokee Rose Manor - Stephenville[2]	0	0	0	0	1	0	0	12	0	0
Glen Rose Medical Center Nursing Home[2]	0	0	0	1	0	0	0	0	4	0
Expo Center	0	0	0	0	1	0	0	15	0	0
TOTAL:	**118**	**33**	**30**	**3**	**31**	**20**	**11**	**7,305**	**139**	**51**
Resources Needed										
School, Preschool/Daycare, and Day Camp Transportation Needs (see Table 3.9):	184	0	0	0	0	0	0	9,292	0	0
Medical Facility Transportation Needs (see Table 3-6):	15	30	14	3	0	0	39	638	325	63
Access and/or Functional Needs Population Transportation Needs (see Table 3-10):	1	0	0	6	0	0	6	32	23	11
Correctional Facility Transportation Needs (see Table 3-7) :	2	0	0	0	0	0	0	32	0	0
Transit-Dependent Transportation Needs (see Table 3-8, Section 3.6):	13	0	0	0	0	0	0	120	0	0
TOTAL TRANSPORTATION NEEDS:	**215**	**30**	**14**	**9**	**0**	**0**	**45**	**10,114**	**348**	**74**

[2] Transportation resources available at this facility is from the previous ETE study, updated data was not provided.

Table 8-2. School and Preschool/Daycare Evacuation Time Estimates - Good Weather

School/Preschool/Daycare	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
HOOD COUNTY									
Mambrino Elementary School	10	10	5.1	43.3	7	**0:30**	29.2	35	**1:05**
Premier High School	90	15	0.7	4.3	10	**1:55**	27.6	33	**2:30**
Lakeside Baptist Academy	90	15	4.2	5.2	49	**2:35**	27.6	33	**3:10**
Brawner Intermediate School	10	10	2.9	34.6	5	**0:25**	27.6	33	**1:00**
Emma Roberson Elementary School	90	15	8.8	5.3	99	**3:25**	27.6	33	**4:00**
Granbury High School	10	10	7.7	50.0	9	**0:30**	21.2	25	**0:55**
Tolar High School	90	15	0.2	39.7	0	**1:45**	20.8	25	**2:10**
Tolar Elementary School	90	15	0.9	8.1	7	**1:55**	20.8	25	**2:20**
Tolar Jr. High School	90	15	0.9	8.1	7	**1:55**	20.8	25	**2:20**
Rainbow's Promise	90	15	10.3	7.4	83	**3:10**	27.6	33	**3:45**
Lakeside WEEschool	90	15	4.7	5.2	55	**2:40**	27.6	33	**3:15**
Lil Pirates Daycare	90	15	0.2	3.5	3	**1:50**	27.6	33	**2:25**
Cross Town Preschool	90	15	2.7	4.5	36	**2:25**	27.6	33	**3:00**
Miss Dee Little Angels	90	15	2.9	4.5	39	**2:25**	27.6	33	**3:00**
Tolar Small Steps Childcare & Early Learning Center, LLC	90	15	0.6	26.1	1	**1:50**	20.8	25	**2:15**
Little Rattlers Preschool & Childcare	90	15	0.4	26.1	1	**1:50**	20.8	25	**2:15**
SOMERVELL COUNTY									
North Central Texas Academy	90	15	9.9	50.0	12	**2:00**	13.8	17	**2:20**
Brazos River Charter School	90	15	3.2	50.0	4	**1:50**	13.8	17	**2:10**
Glen Rose Junior High School	10	10	10.1	48.9	12	**0:35**	23.3	28	**1:05**
Glen Rose High School	10	10	8.7	49.2	11	**0:35**	23.3	28	**1:05**
Glen Rose Elementary School	10	10	9.1	48.2	11	**0:35**	23.3	28	**1:05**
Glen Rose Intermediate School	10	10	9.1	48.2	11	**0:35**	23.3	28	**1:05**

School/Preschool/Daycare	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
Grace Preschool	90	15	10.4	49.5	13	**2:00**	13.0	16	**2:20**
Glen Rose Early Head Start	90	15	9.6	49.5	12	**2:00**	13.0	16	**2:20**
Little Tigers Learning Center	90	15	10.4	49.5	13	**2:00**	13.0	16	**2:20**
Endless Discoveries Child Development Center	90	15	8.0	49.3	10	**1:55**	13.0	16	**2:15**
First United Methodist Preschool	90	15	9.1	49.5	11	**2:00**	13.0	16	**2:20**
Rockin' D Day Care	90	15	8.3	49.5	10	**1:55**	13.0	16	**2:15**
Maximum for EPZ:						**3:25**	**Maximum:**		**4:00**
Average for EPZ:						**1:45**	**Average:**		**2:15**

Table 8-3. School and Preschool/Daycare Evacuation Time Estimates - Rain

School/Preschool/Daycare	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
HOOD COUNTY									
Mambrino Elementary School	20	15	5.1	38.9	8	**0:45**	29.2	39	**1:25**
Premier High School	100	20	0.7	3.9	11	**2:15**	27.6	37	**2:55**
Lakeside Baptist Academy	100	20	4.2	3.3	76	**3:20**	27.6	37	**4:00**
Brawner Intermediate School	20	15	2.9	24.5	7	**0:45**	27.6	37	**1:25**
Emma Roberson Elementary School	100	20	8.8	4.5	117	**4:00**	27.6	37	**4:40**
Granbury High School	20	15	7.7	45.0	10	**0:45**	21.2	28	**1:15**
Tolar High School	100	20	0.2	35.7	0	**2:00**	20.8	28	**2:30**
Tolar Elementary School	100	20	0.9	8.0	7	**2:10**	20.8	28	**2:40**
Tolar Jr. High School	100	20	0.9	8.0	7	**2:10**	20.8	28	**2:40**
Rainbow's Promise	100	20	10.3	5.7	109	**3:50**	27.6	37	**4:30**
Lakeside WEEschool	100	20	4.7	3.3	84	**3:25**	27.6	37	**4:05**
Lil Pirates Daycare	100	20	0.2	2.5	5	**2:05**	27.6	37	**2:45**
Cross Town Preschool	100	20	2.7	3.3	49	**2:50**	27.6	37	**3:30**
Miss Dee Little Angels	100	20	2.9	3.0	58	**3:00**	27.6	37	**3:40**
Tolar Small Steps Childcare & Early Learning Center, LLC	100	20	0.6	29.6	1	**2:05**	20.8	28	**2:35**
Little Rattlers Preschool & Childcare	100	20	0.4	29.6	1	**2:05**	20.8	28	**2:35**
SOMERVELL COUNTY									
North Central Texas Academy	100	20	9.9	45.0	13	**2:15**	13.8	18	**2:35**
Brazos River Charter School	100	20	3.2	45.0	4	**2:05**	13.8	18	**2:25**
Glen Rose Junior High School	20	15	10.1	29.1	21	**1:00**	23.3	31	**1:35**
Glen Rose High School	20	15	8.7	31.5	17	**0:55**	23.3	31	**1:30**
Glen Rose Elementary School	20	15	9.1	43.0	13	**0:50**	23.3	31	**1:25**

School/Preschool/Daycare	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ETA to R.S. (hr:min)
Glen Rose Intermediate School	20	15	9.1	43.0	13	**0:50**	23.3	31	**1:25**
Grace Preschool	100	20	10.4	45.0	14	**2:15**	13.0	17	**2:35**
Glen Rose Early Head Start	100	20	9.6	45.0	13	**2:15**	13.0	17	**2:35**
Little Tigers Learning Center	100	20	10.4	45.0	14	**2:15**	13.0	17	**2:35**
Endless Discoveries Child Development Center	100	20	8.0	45.0	11	**2:15**	13.0	17	**2:35**
First United Methodist Preschool	100	20	9.1	45.0	12	**2:15**	13.0	17	**2:35**
Rockin' D Day Care	100	20	8.3	45.0	11	**2:15**	13.0	17	**2:35**
					Maximum for EPZ:	**4:00**		**Maximum:**	**4:40**
					Average for EPZ:	**2:10**		**Average:**	**2:40**

Table 8-4. Day Camp Evacuation Time Estimates – Good Weather

Day Camp	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.C. (mi.)	Travel Time from EPZ Bdry to R.C. (min)	ETA to R.C. (hr:min)
HOOD COUNTY									
Camp Fire Camp El Tesoro[3]	90	15	0.0	0.0	0	**1:45**	20.6	25	**2:10**
SOMERVELL COUNTY									
Arrowhead Camp & Retreat Center	90	15	6.5	50.0	8	**1:55**	13.0	16	**2:15**
Stevens Ranch	90	15	4.2	50.0	5	**1:50**	13.0	16	**2:10**
Riverbend Retreat Center	90	15	2.9	50.0	3	**1:50**	23.4	28	**2:20**
Glen Lake Camp & Retreat Center	90	15	8.6	49.9	10	**1:55**	13.0	16	**2:15**
					Maximum for EPZ:	**1:55**		**Maximum:**	**2:20**
					Average for EPZ:	**1:55**		**Average:**	**2:15**

Table 8-5. Day Camp Evacuation Time Estimates - Rain

Day Camp	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.C. (mi.)	Travel Time from EPZ Bdry to R.C. (min)	ETA to R.C. (hr:min)
HOOD COUNTY									
Camp Fire Camp El Tesoro[3]	100	20	0.0	0.0	0	**2:00**	20.6	27	**2:30**
SOMERVELL COUNTY									
Arrowhead Camp & Retreat Center	100	20	6.5	45.0	9	**2:10**	13.0	17	**2:30**
Stevens Ranch	100	20	4.2	45.0	6	**2:10**	13.0	17	**2:30**
Riverbend Retreat Center	100	20	2.9	45.0	4	**2:05**	23.4	31	**2:40**
Glen Lake Camp & Retreat Center	100	20	8.6	45.0	11	**2:15**	13.0	17	**2:35**
					Maximum for EPZ:	**2:15**		**Maximum:**	**2:40**
					Average for EPZ:	**2:10**		**Average:**	**2:35**

[3] Camp Fire Camp El Tesoro is located in the Shadow Region. Hood County personnel indicated this day camp would evacuate in the event of an emergency at the CPNPP.

Table 8-6. Transit-Dependent Evacuation Time Estimates - Good Weather

Route Number	Bus Number	Single-Wave						Second-Wave						
		Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
32	1	135	7.9	50.0	9	30	**2:55**	23.3	28	5	10	47	30	**4:55**
33	1	135	8.9	50.0	11	30	**3:00**	13.0	16	5	10	37	30	**4:40**
34	1	135	2.3	50.0	3	30	**2:50**	13.0	16	5	10	22	30	**4:15**
35	1	135	13.2	50.0	16	30	**3:05**	23.3	28	5	10	60	30	**5:20**
36	1	135	14.1	10.9	78	30	**4:05**	20.8	25	5	10	59	30	**6:15**
37	1	135	6.7	4.7	86	30	**4:15**	20.8	25	5	10	41	30	**6:10**
38	2	135	4.3	6.0	43	30	**3:30**	23.7	28	5	10	40	30	**5:25**
40	1	135	10.7	50.0	13	30	**3:00**	13.0	16	5	10	42	30	**4:45**
43	1	135	7.1	7.9	54	30	**3:40**	23.7	28	5	10	45	30	**5:40**
44	1	135	3.7	3.5	64	30	**3:50**	20.8	25	5	10	35	30	**5:35**
45	1	135	5.9	41.5	9	30	**2:55**	23.3	28	5	10	43	30	**4:55**
46	1	135	1.0	33.2	2	30	**2:50**	18.4	22	5	10	25	30	**4:25**
						Maximum ETE:	**4:15**						**Maximum ETE:**	**6:15**
						Average ETE:	**3:20**						**Average ETE:**	**5:15**

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

		Single-Wave						Second-Wave						
Route Number	Bus Number	Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
32	1	145	7.9	45.0	11	40	**3:20**	23.3	31	5	10	51	40	**5:40**
33	1	145	8.9	45.0	12	40	**3:20**	13.0	17	5	10	40	40	**5:15**
34	1	145	2.3	45.0	3	40	**3:10**	13.0	17	5	10	23	40	**4:45**
35	1	145	13.2	45.0	18	40	**3:25**	23.3	31	5	10	64	40	**5:55**
36	1	145	14.1	13.1	65	40	**4:10**	20.8	28	5	10	64	40	**6:40**
37	1	145	6.7	5.9	69	40	**4:15**	20.8	28	5	10	45	40	**6:25**
38	2	145	4.3	4.0	65	40	**4:10**	23.7	32	5	10	43	40	**6:20**
40	1	145	10.7	45.0	14	40	**3:20**	13.0	17	5	10	44	40	**5:20**
43	1	145	7.1	5.2	82	40	**4:30**	23.7	32	5	10	50	40	**6:50**
44	1	145	3.7	7.0	32	40	**3:40**	20.8	28	5	10	38	40	**5:45**
45	1	145	5.9	37.6	9	40	**3:15**	23.3	31	5	10	47	40	**5:30**
46	1	145	1.0	30.8	2	40	**3:10**	18.4	25	5	10	28	40	**5:00**
						Maximum ETE:	**4:30**						**Maximum ETE:**	**6:50**
						Average ETE:	**3:40**						**Average ETE:**	**5:50**

Table 8-8. Medical Facility Evacuation Time Estimates - Good Weather

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
HOOD COUNTY								
Southern Concepts - South Town	Ambulatory	90	1	6	6	1.0	14	**1:50**
Southern Concepts - Meadowlark	Ambulatory	90	1	4	4	1.0	17	**1:55**
Harbor Lakes Nursing & Rehab	Ambulatory	90	1	20	20	1.3	2	**1:55**
	Wheelchair bound	90	5	30	75	1.3	2	**2:50**
	Bedridden	90	15	25	30	1.3	2	**2:05**
Lakestone Terrace Senior Living	Ambulatory	90	1	78	30	1.4	2	**2:05**
	Wheelchair bound	90	5	11	55	1.4	2	**2:30**
	Bedridden	90	15	1	15	1.4	2	**1:50**
Courtyards at Lake Granbury	Ambulatory	90	1	44	30	0.5	5	**2:05**
	Wheelchair bound	90	5	30	75	0.5	4	**2:50**
Southern Concepts - Torrey House	Ambulatory	90	1	6	6	1.3	2	**1:40**
Waterview The Point Independent Living	Ambulatory	90	1	186	30	11.9	17	**2:20**
	Wheelchair bound	90	5	24	75	11.9	18	**3:05**
Waterview The Cove Assisted Living & Memory Care	Ambulatory	90	1	24	24	11.9	18	**2:15**
	Wheelchair bound	90	5	12	60	11.9	17	**2:50**
	Bedridden	90	15	2	30	11.9	18	**2:20**
Bridgewater Memory Care	Ambulatory	90	1	22	22	1.4	25	**2:20**
	Wheelchair bound	90	5	23	75	1.4	15	**3:00**
Granbury Care Center	Ambulatory	90	1	59	2	2.9	42	**2:15**
	Wheelchair bound	90	5	84	10	2.9	39	**2:20**
	Bedridden	90	15	2	30	2.9	30	**2:30**
Magnolia Court	Ambulatory	90	1	17	2	4.3	42	**2:15**
	Wheelchair bound	90	5	1	5	4.3	42	**2:20**
	Bedridden	90	15	13	30	4.3	31	**2:35**

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Granbury Villa Nursing Center	Ambulatory	90	1	21	2	2.5	11	**1:45**
	Wheelchair bound	90	5	38	10	2.5	9	**1:50**
	Bedridden	90	15	3	30	2.5	11	**2:15**
SOMERVELL COUNTY								
Cherokee Rose Manor	Ambulatory	90	1	37	2	16.5	20	**1:55**
	Wheelchair bound	90	5	19	10	16.5	20	**2:00**
	Bedridden	90	15	4	30	16.5	20	**2:20**
Glen Rose Nursing and Rehab Center	Ambulatory	90	1	50	2	6.4	8	**1:40**
	Wheelchair bound	90	5	25	10	6.4	8	**1:50**
	Bedridden	90	15	5	30	6.4	8	**2:10**
Glen Rose Medical Center-Hospital	Ambulatory	90	1	52	2	8.2	12	**1:45**
	Wheelchair bound	90	5	27	10	8.2	10	**1:50**
	Bedridden	90	15	5	30	8.2	10	**2:10**
							Maximum ETE:	**3:05**
							Average ETE:	**2:15**

Table 8-9. Medical Facility Evacuation Time Estimates – Rain

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
HOOD COUNTY								
Southern Concepts - South Town	Ambulatory	100	1	6	6	1.0	17	**2:05**
Southern Concepts - Meadowlark	Ambulatory	100	1	4	4	1.0	20	**2:05**
Harbor Lakes Nursing & Rehab	Ambulatory	100	1	20	20	1.3	2	**2:05**
	Wheelchair bound	100	5	30	75	1.3	2	**3:00**
	Bedridden	100	15	25	30	1.3	2	**2:15**
Lakestone Terrace Senior Living	Ambulatory	100	1	78	30	1.4	2	**2:15**
	Wheelchair bound	100	5	11	55	1.4	2	**2:40**
	Bedridden	100	15	1	15	1.4	2	**2:00**
Courtyards at Lake Granbury	Ambulatory	100	1	44	30	0.5	3	**2:15**
	Wheelchair bound	100	5	30	75	0.5	5	**3:00**
Southern Concepts - Torrey House	Ambulatory	100	1	6	6	1.3	2	**1:50**
Waterview The Point Independent Living	Ambulatory	100	1	186	30	11.9	20	**2:30**
	Wheelchair bound	100	5	24	75	11.9	18	**3:15**
Waterview The Cove Assisted Living & Memory Care	Ambulatory	100	1	24	24	11.9	20	**2:25**
	Wheelchair bound	100	5	12	60	11.9	19	**3:00**
	Bedridden	100	15	2	30	11.9	20	**2:30**
Bridgewater Memory Care	Ambulatory	100	1	22	22	1.4	25	**2:30**
	Wheelchair bound	100	5	23	75	1.4	25	**3:20**
Granbury Care Center	Ambulatory	100	1	59	2	2.9	45	**2:30**
	Wheelchair bound	100	5	84	10	2.9	45	**2:35**
	Bedridden	100	15	2	30	2.9	34	**2:45**
Magnolia Court	Ambulatory	100	1	17	2	4.3	45	**2:30**
	Wheelchair bound	100	5	1	5	4.3	45	**2:30**
	Bedridden	100	15	13	30	4.3	34	**2:45**

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Granbury Villa Nursing Center	Ambulatory	100	1	21	2	2.5	11	**1:55**
	Wheelchair bound	100	5	38	10	2.5	10	**2:00**
	Bedridden	100	15	3	30	2.5	8	**2:20**
SOMERVELL COUNTY								
Cherokee Rose Manor	Ambulatory	100	1	37	2	16.5	22	**2:05**
	Wheelchair bound	100	5	19	10	16.5	22	**2:15**
	Bedridden	100	15	4	30	16.5	22	**2:35**
Glen Rose Nursing and Rehab Center	Ambulatory	100	1	50	2	6.4	9	**1:55**
	Wheelchair bound	100	5	25	10	6.4	9	**2:00**
	Bedridden	100	15	5	30	6.4	9	**2:20**
Glen Rose Medical Center-Hospital	Ambulatory	100	1	52	2	8.2	12	**1:55**
	Wheelchair bound	100	5	27	10	8.2	11	**2:05**
	Bedridden	100	15	5	30	8.2	11	**2:25**
							Maximum ETE:	**3:20**
							Average ETE:	**2:25**

Table 8-10. Access and/or Functional Needs Population Evacuation Time Estimates

Vehicle Type	People Requiring Vehicle	Vehicles deployed	Stops	Weather Conditions	Mobiliza-tion Time (min)	Loading Time at 1st Stop (min)	Travel to Subsequent Stops (min)	Total Loading Time at Subsequent Stops (min)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Buses	32	4	8	Good	135	1	63	7	16	**3:45**
				Rain	145		70		20	**4:05**
Wheelchair Vans	23	6	4	Good	135	5	27	15	18	**3:20**
				Rain	145		30		25	**3:40**
Ambulances	11	6	2	Good	135	15	10	15	20	**3:15**
				Rain	145		11		25	**3:35**
Maximum ETE:										**4:05**
Average ETE:										**3:40**

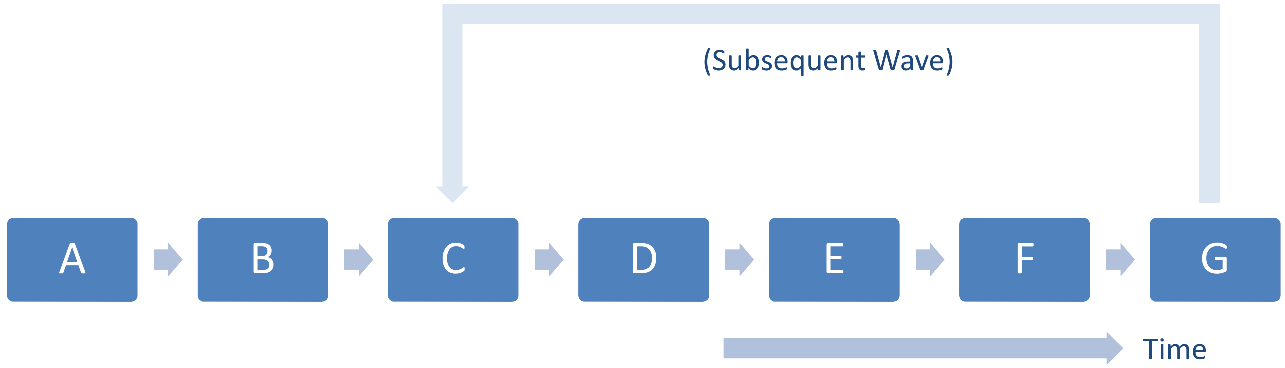
Table 8-11. Access and/or Functional Needs Population Evacuation Time Estimates - Second Wave for the Ambulatory, Wheelchair Bound and Bedridden

Vehicle Type	People Requiring Vehicle	Vehicles deployed	Stops	Weather Conditions	One Wave ETE[1] [4](hr:min)	Unload Passengers (min)	Driver Rest (min)	Travel Time Back to EPZ[5] (min)	Travel to All Stops (min)	Total Loading Time at All Stops (min)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Buses	32	4	8	Good	2:15	5	10	30	72	8	17	**4:40**
				Rain	2:40	5	10	30	80		21	**5:15**
Wheelchair Vans	23	6	4	Good	2:15	5	10	30	72	20	17	**4:50**
				Rain	2:40	5	10	30	80		21	**5:30**
Ambulances	11	6	2	Good	2:15	5	10	30	80	30	17	**5:10**
				Rain	2:40	5	10	30	88		21	**5:45**
Maximum ETE:												**5:45**
Average ETE:												**5:15**

4 Average ETA to Relocation School from Table 8-2 through Table 8-3, respectively
5 Average of travel time from EPZ boundary to Reception Center for good and rain weather conditions. from Table 8-2 and Table 8-3, respectively, rounded up to the nearest 5 minutes).

Table 8-12. Correctional Facility Evacuation Time Estimates

Correctional Facility	Weather Conditions	Mobilization (min)	Number of Inmates	Number of Buses	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Somervell County Jail	Good	90	32	2	30	8.0	10	**2:10**
	Rain	100			35		11	**2:30**
							Maximum ETE:	**2:30**
							Average ETE:	**2:20**



Event	
A	Advisory to Evacuate
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Pick-up Route
D	Bus Departs for Reception Center
E	Bus Exits Region
F	Bus Arrives at Reception Center/Host Facility
G	Bus Available for “Second Wave” Evacuation Service
Activity	
A→B	Driver Mobilization
B→C	Travel to Facility or to Pick-up Route
C→D	Passengers Board the Bus
D→E	Bus Travels Towards Region Boundary
E→F	Bus Travels Towards Reception Center Outside the EPZ
F→G	Passengers Leave Bus; Driver Takes a Break

Figure 8-1. Chronology of Transit Evacuation Operations

9 TRAFFIC MANAGEMENT STRATEGY

This section discusses the suggested Traffic Management Plan (TMP) that is designed to expedite the movement of evacuating traffic. The resources required to implement the TMP include:

- Personnel with the capabilities of performing the planned control functions of traffic guides (preferably, not necessarily, law enforcement officers).
- The Manual on Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA) of the U.S.D.O.T. provides guidance for Traffic Control Devices to assist these personnel in the performance of their tasks. All state and most county transportation agencies have access to the MUTCD, which is available online: http://mutcd.fhwa.dot.gov which provides access to the official PDF version.
- A written plan that defines all Traffic Control Point (TCP) and Access Control Point (ACP locations, provides necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

The functions to be performed in the field are:

1. <u>Facilitate</u> evacuating traffic movements that safely expedite travel out of the EPZ.
2. <u>Discourage</u> traffic movements that move evacuating vehicles in a direction which takes them significantly closer to the power plant, or which interferes with the efficient flow of other evacuees.

The terms "facilitate" and "discourage" are employed rather than "enforce" and "prohibit" to indicate the need for flexibility in performing the traffic control function. There are always legitimate reasons for a driver to prefer a direction other than that indicated.

For example:

- A driver may be traveling home from work or from another location, to join other family members prior to evacuating.
- An evacuating driver may be travelling to pick up a relative, or other evacuees.
- The driver may be an emergency worker entering the area being evacuated to perform an important emergency service.

The implementation of a TMP <u>must</u> also be flexible enough for the application of sound judgment by the traffic guide.

The TMP is the outcome of the following process:

1. The detailed traffic and access control tactics discussed in the Somervell County Emergency Evacuation Traffic Management Plan, dated April 2013 and the shapefiles provided directly by Hood County, serve as the basis of the TMP, as per NUREG/CR-7002, Rev 1.

2. The ETE analysis treated all controlled intersections that are existing TCP or ACP locations in the offsite agency plans as being controlled by actuated signals. Appendix K identifies the number of intersections that were modeled as TCPs.
3. Evacuation simulations were run using DYNEV II to predict traffic congestion during evacuation (see Section 7.3 and Figure 7-3 through Figure 7-8). These simulations help to identify the best routing and critical intersections that experience pronounced congestion during evacuation. Any critical intersections that would benefit from traffic or access control which are not already identified in the existing offsite agency plans are examined. No additional TCPs or ACPs were identified as part of this study.
4. Prioritization of TCPs and ACPs.
    a. Application of traffic and access control at some TCPs and ACPs will have a more pronounced influence on expediting traffic movements than at other TCPs and ACPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located farther from the power plant. Key locations for manual traffic control (MTC) were analyzed and their impact to ETE was quantified, as per NUREG/CR-7002, Rev. 1. See Appendix G for more detail.

Appendix G documents the existing TMP and list of priority TCPs using the process enumerated above.

9.1 Assumptions

The following are assumptions made for this study:

- The ETE calculations documented in Sections 7 and 8 assume that the TMP is implemented during evacuation.
- The ETE calculations reflect the assumptions that all "external-external" trips are interdicted and diverted after 2 hours have elapsed from the Advisory to Evacuate (ATE).
- All transit vehicles and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCPs and ACPs.
- Study Assumptions 1 and 2 in Section 2.5 discuss TCP and ACP operations.

9.2 Additional Considerations

The use of Intelligent Transportation Systems (ITS) technologies can reduce the manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) can also be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center or relocation school information. As stated earlier, DMS placed outside of the EPZ will warn motorists to avoid using routes that may conflict with the flow of evacuees away from the power plant. Highway Advisory Radio (HAR) can be used to broadcast information to evacuees during egress through their vehicles stereo

systems. Automated Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins their trip, while the on-board navigation systems (GPS units) and smartphones can be used to provide information during the evacuation trip.

These are only several examples of how ITS technologies can benefit the evacuation process. Considerations should be given that ITS technologies can be used to facilitate the evacuation process, and any additional signage placed should consider evacuation needs.

10 EVACUATION ROUTES AND RECEPTION CENTERS

10.1 Evacuation Routes

Evacuation routes are comprised of two distinct components:

- Routing from a Zone being evacuated to the boundary of the Evacuation Region and thence out of the Emergency Planning Zone (EPZ).
- Routing of transit-dependent evacuees (schools, day care centers, day camps, medical facilities, correctional facilities, employees, transients or residents who do not own or have access to a private vehicles) from the EPZ boundary to reception centers or relocation schools.

Evacuees will select routes within the EPZ in such a way as to minimize their exposure to risk. This expectation is met by the DYNEV II model routing traffic away from the location of the plant to the extent practicable. The DTRAD model satisfies this behavior by routing traffic so as to balance traffic demand relative to the available highway capacity to the extent possible. See Appendices B through D for further discussion. The major evacuation routes for the EPZ are presented in Figure 10-1. These routes will be used by the general population evacuating in private vehicles, and by the transit-dependent population evacuating in buses. Transit-dependent evacuees will be routed to reception centers or relocation school. General population may evacuate to either a general reception center or some alternate destination (e.g., lodging facility, relative's home, campground) outside the EPZ.

The routing of transit-dependent evacuees from the EPZ boundary to reception centers is designed to minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary. The 12 bus routes shown graphically in Figure 10-2, Figure 10-3 and described in Table 10-1 were designed by KLD, as no pre-established transit-dependent bus routes exist within the county emergency plans. The routes were designed to service the transit-dependent population within each Zone. This does not imply that these exact routes would be used in an emergency. It is assumed that residents will walk along to the nearest major roadway routes to flag down a passing bus, and that they can arrive at the roadway within the 135-minute bus mobilization time (good weather). These routes are only used in this study for the purpose of computing ETE.

Schools, day care centers, day camps, medical facilities and correctional facilities were routed along the most likely path from the facility being evacuated to the EPZ boundary, traveling toward the nearest reception center or relocation school.

The specified bus routes for all the transit-dependent population are documented in Table 10-2 (refer to the maps of the link-node analysis network in Appendix K for node locations). This study does not consider the transport of evacuees from reception centers to congregate care centers, if the counties do make the decision to relocate evacuees.

10.2 Reception Centers

According to the current public information to EPZ residents, evacuees will be directed to reception centers. Figure 10-4 presents a map showing the reception centers and relocation school for evacuees. Transit-dependent evacuees are transported to the nearest reception center for each county.

Table 10-3 presents a list of the relocation schools for each evacuating school, day care center and day camp in the EPZ. It is assumed that the children at these facilities will be taken to the appropriate relocation schools and will be subsequently picked up by parents or guardians. No children at these facilities will be picked up by parents prior to the arrival of the buses.

Table 10-1. Summary of Transit-Dependent Bus Routes

Route	No. of Buses	Route Description	Length (mi.)
32	1	Service Zones 3D, 3F and 3C: Along U.S. 67 West from FM 205 to U.S 377 and to Henderson Jr. High School	31.2
33	1	Service Zones GL, 2J, 2D: Along U.S. 67 East from Bo Gibbs Blvd to Cleburne High School	21.8
34	1	Service Zones 2E, 2H, 2F: Along U.S. 67 East from FM 199 to Cleburne High School	15.3
35	1	Service Zones 3B, 2C, 3A, 2A: Along FM 56 South from FM 1007 to U.S 67 and along U.S 67 West to U.S 377 and to Henderson Jr. High School	36.5
36	1	Service Zones 4C, 4D, CP: Along FM 56 North from FM 1018 to U.S 377 and along U.S 377 West to Henderson Jr. High School	34.9
37	1	Service Zones 4G, 4F: Along FM 56 North from Rainbow Hill Rd to U.S 377 and along U.S 377 West to Henderson Jr. High School	27.5
38	2	Service Zones 4E, 1D: Along FM 144 North from Contrary Creek Rd to U.S 377 and along U.S 377 East to Benbrook YMCA	28.0
40	1	Service Zones 4A, 1A, 2B: Along FM 144 South from FM 302 to U.S 67 and along U.S 67 East to Cleburne High School	23.7
43	1	Service Zones 4B, 1B: Along FM 144 North from Neri Rd to U.S 377 and along U.S 377 East to Benbrook YMCA	30.8
44	1	Service Zone TO: Along U.S 377 West from FM 216 to Henderson Jr. High School	24.5
45	1	Service Zone 3E: Along FM 51 South from FM 205 to U.S 377 and along U.S 377 West to Henderson Jr. High School	29.2
46	1	Service Zone 1C: Along FM 309 East to FM 306 and along FM 306 East to FM 1131 to FM 4 East to Cleburne High School	19.4
Total:	**13**		

Table 10-2. Bus Route Descriptions

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
1	Premier High School	181, 188, 121, 772, 125, 112
2	Glen Rose High School	357, 356, 978, 960, 340, 1076, 341, 1275, 1273, 1002, 378, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
3	Brazos River Charter School	595, 594, 592, 593, 603, 1091, 1066, 1101
4	North Central Texas Academy	991, 990, 399, 392, 393, 383, 382, 402, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
5	Granbury Care Center	145, 149, 963, 160, 159, 153, 165, 166, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
6	Rainbow's Promise Lakeside WEEschool Lakeside Baptist Academy	432, 431, 419, 1147, 997, 418, 998, 784, 420, 452, 421, 422, 509, 514, 513, 508, 507, 1277, 505, 1127, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
7	Little Rattlers Preschool & Childcare Tolar Small Steps Childcare & Early Learning Center, LLC	245, 244, 255
8	Cross Town Preschool Miss Dee Little Angels Lil Pirates Daycare	150, 512, 511, 510, 507, 1277, 505, 1127, 166, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
9	Harbor Lakes Nursing & Rehab	181, 188, 121, 772, 125, 112
10	Lakestone Terrace Senior Living	178, 175, 127, 188, 121, 772, 125, 112
11	Waterview The Point Independent Living	130, 1070, 129, 1071
12	Mambrino Elementary School	436, 437, 457, 458, 477, 478, 479, 480, 487, 449, 450
13	Stevens Ranch	595, 594, 592, 593, 603, 1091, 1066, 1101
14	Glen Lake Camp & Retreat Center	376, 1003, 377, 409, 1001, 378, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
15	Arrowhead Camp & Retreat Center	726, 725, 724, 723, 722, 721, 593, 603, 1091, 1066, 1101
16	Riverbend Retreat Center	582, 583, 633, 634
17	Waterview The Cove Assisted Living & Memory Care	130, 1070, 129
18	Bridgewater Memory Care	1051, 505, 1127, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
19	Magnolia Court	553, 552, 549, 548, 912, 512, 150, 962, 963, 160, 159, 153, 165, 166, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
20	Quail Park of Granbury	553, 552, 549, 548, 912, 512, 150, 962, 963, 160, 159, 153, 165, 166, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
21	Brawner Intermediate School	511, 510, 507, 1277, 505, 1127, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
22	Granbury High School	233, 223, 225, 227, 226, 231, 229, 230, 232, 238, 1078, 237, 1079, 236, 235, 1019, 234, 247, 244
23	Southern Concepts - South Town	181, 188, 121, 772, 125, 112
24	Courtyards at Lake Granbury	188, 121, 772, 125, 112

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
25	Granbury Villa Nursing Center	553, 552, 549, 548, 912, 512, 150, 962, 149, 145, 143, 144
26	Southern Concepts - Torrey House	149, 145, 143, 148, 132, 131, 1073, 130, 1070
27	Glen Rose Medical Center-Hospital	409, 1001, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
28	Glen Rose Nursing and Rehab Center	375, 374, 373, 1004, 333, 334, 335, 336, 576, 1141, 1142, 338, 587, 934, 588
29	Southern Concepts - Meadowlark	185, 127, 188, 121, 772, 125, 112
30	Emma Roberson Elementary School	519, 511, 510, 507, 1277, 505, 1127, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
31	Cherokee Rose Manor	765, 379, 1000, 378, 1002, 1273, 1275, 341, 1076, 340, 960, 978, 356, 339, 323, 974, 322, 321, 320, 319, 1059, 318, 958, 1100, 302, 301, 300, 299, 1098, 1099, 298, 297, 292, 914
32	Transit Dependent Zones 3D, 3F, 3C	322, 321, 320, 319, 1059, 318, 958, 1100, 302, 301, 300, 299, 1098, 1099, 298, 297, 292, 914
33	Transit Dependent Zones GL (Glen Rose), 2J, 2D	341, 1275, 1273, 1002, 378, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
34	Transit Dependent Zones 2E, 2H, 2F	592, 593, 603, 1091, 1066, 1101
35	Transit Dependent Zones 3B, 2C, 3A, 2A	365, 364, 363, 362, 361, 342, 959, 960, 978, 356, 339, 323, 974, 322, 321, 320, 319, 1059, 318, 958, 1100, 302, 301, 300, 299, 1098, 1099, 298, 297, 292, 914
36	Transit Dependent Zones 4C, 4D, CP	368, 571, 369, 1171, 569, 568, 567, 961, 566, 565, 561, 563, 564, 562, 243, 242, 241, 240, 239, 1049, 234, 247, 244
37	Transit Dependent Zones 4G, 4F	562, 243, 242, 241, 240, 239, 1049, 234, 247, 244
38	Transit Dependent Zones 4E, 1D	422, 509, 514, 513, 508, 507, 1277, 505, 1127, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
39	Tolar High School	1032, 262, 255, 1014
40	Transit Dependent Zones 4A, 1A, 2B	770, 410, 993, 411, 412, 400, 990, 399, 392, 393, 383, 382, 402, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
41	Tolar Elementary School Tolar Jr. High School	708, 244, 255, 1014
42	Somervell County Jail	1046, 771, 765, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101
43	Transit Dependent Zones 4B, 1B	413, 999, 1067, 418, 998, 784, 420, 452, 421, 422, 509, 514, 513, 508, 507, 1277, 505, 1127, 166, 1145, 506, 170, 171, 173, 174, 176, 175, 127, 188, 121, 772, 125, 112
44	Transit Dependent Zone TO (Tolar)	708, 244, 255
45	Transit Dependent Zone 3E	652, 1033, 653, 654, 1034, 655, 656, 1035, 657, 658, 659, 660, 661, 662, 296, 295, 294, 292, 914
46	Transit Dependent Zone 1C	487, 449, 448
47	Glen Rose Junior High School	1276, 1275, 1273, 1002, 378, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
48	Glen Rose Elementary School Glen Rose Intermediate School	358, 359, 976, 977, 360, 332, 333, 334, 335, 336, 576, 1141, 1142, 338, 587, 934, 588
49	Grace Preschool Glen Rose Early Head Start Little Tigers Learning Center Endless Discoveries Child Development Center First United Methodist Preschool Rockin' D Day Care	322, 974, 323, 339, 356, 978, 960, 340, 1076, 341, 1275, 1273, 1002, 378, 1000, 379, 380, 403, 381, 404, 384, 971, 969, 385, 968, 386, 591, 592, 593, 603, 1091, 1066, 1101

Table 10-3. Relocation Schools for Schools, Day Cares and Day Camps

School, Day Care, Day Camp	Relocation School
Mambrino Elementary School	Western Hills High School
Premier High School	
Lakeside Baptist Academy	
Brawner Intermediate School	
Emma Roberson Elementary School	
Rainbow's Promise	
Lakeside WEEschool	
Lil Pirates Daycare	
Cross Town Preschool	
Miss Dee Little Angels	
Granbury High School	Henderson Junior High School
Tolar High School	
Tolar Elementary School	
Tolar Jr. High School	
Glen Rose Junior High School	
Glen Rose High School	
Glen Rose Elementary School	
Glen Rose Intermediate School	
Tolar Small Steps Childcare & Early Learning Center, LLC	
Little Rattlers Preschool & Childcare	
North Central Texas Academy	Cleburne High School
Brazos River Charter School	
Grace Preschool	
Glen Rose Early Head Start	
Little Tigers Learning Center	
Endless Discoveries Child Development Center	
First United Methodist Preschool	
Rockin' D Day Care	
Camp Fire Camp El Tesoro	
Arrowhead Camp & Retreat Center	
Stevens Ranch	
Riverbend Retreat Center	
Glen Lake Camp & Retreat Center	

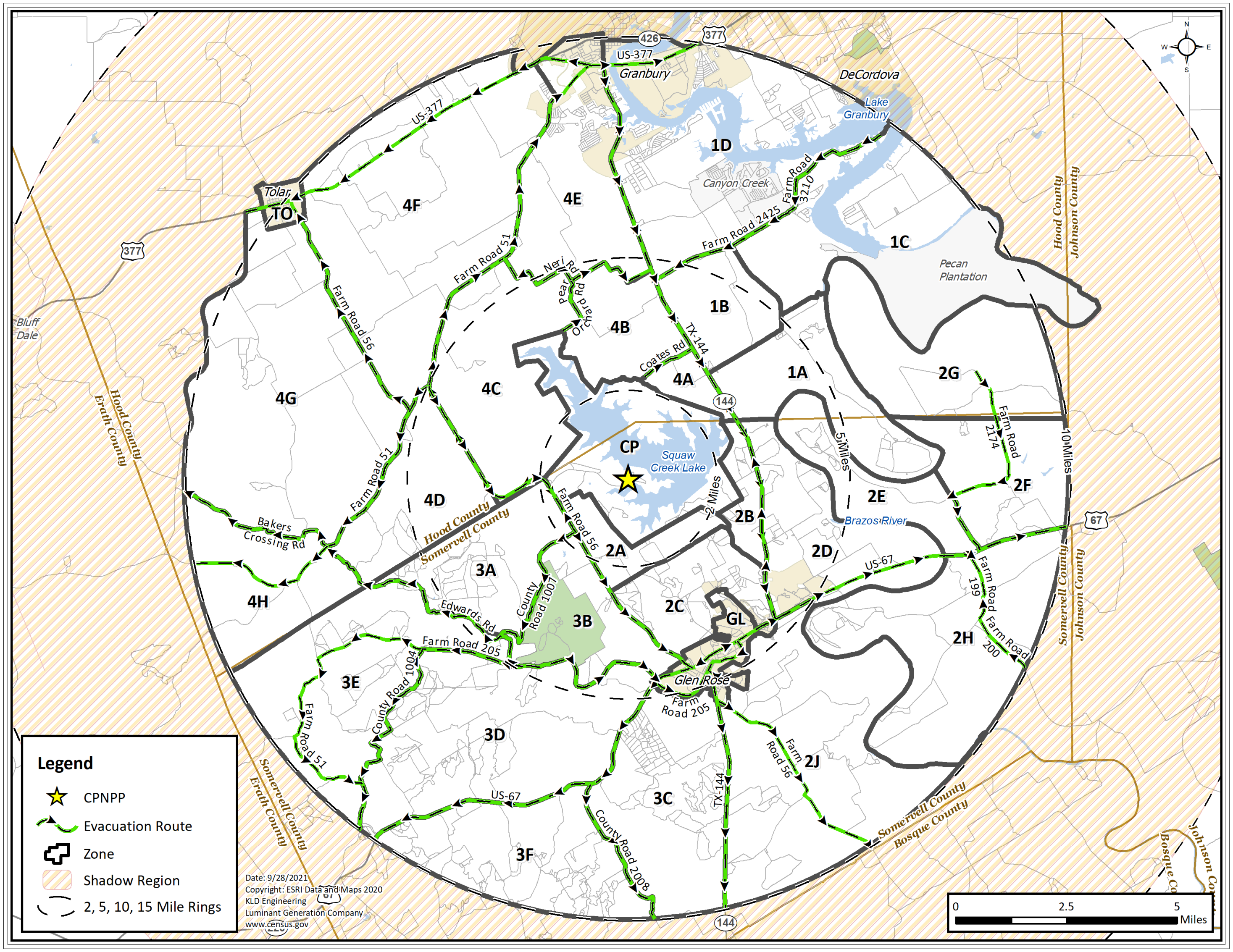


Figure 10-1. Evacuation Route Map

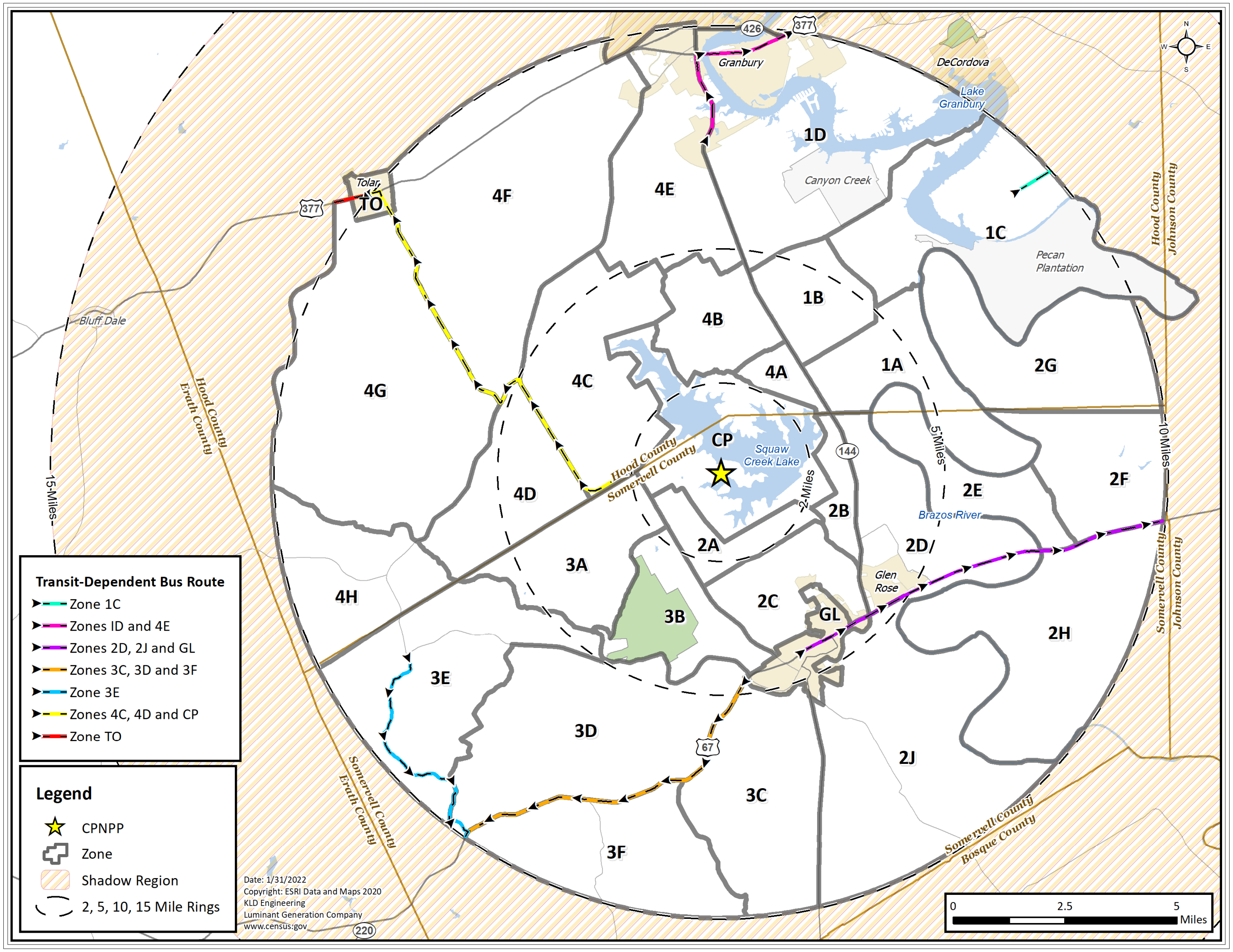


Figure 10-2. Transit Dependent Bus Routes

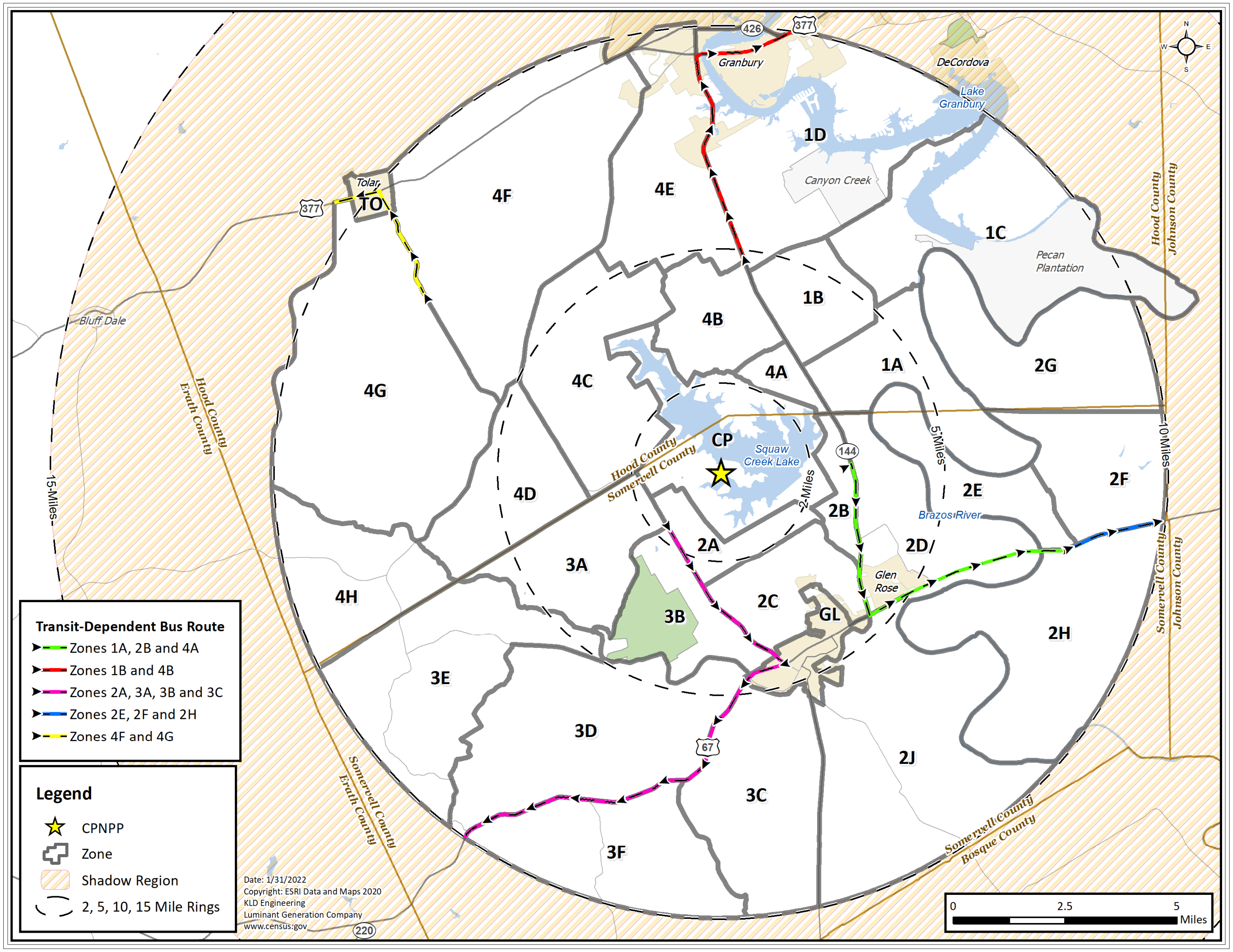


Figure 10-3. Transit Dependent Bus Routes

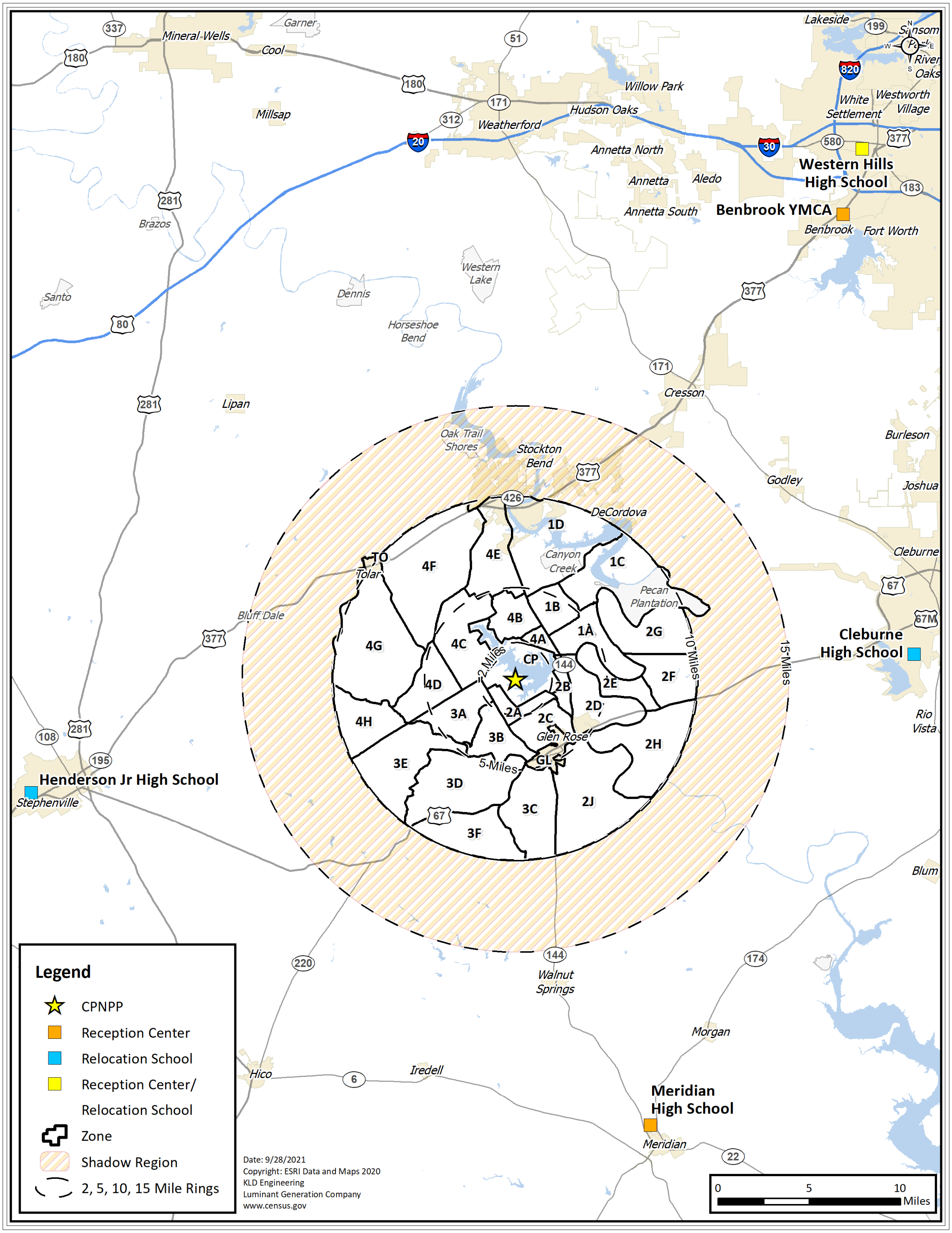


Figure 10-4. General Population Reception Centers and Relocation Schools

APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

Table A-1. Glossary of Traffic Engineering Terms

Term	Definition
Analysis Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Link	A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics.
Measures of Effectiveness	Statistics describing traffic operations on a roadway network.
Node	A network node generally represents an intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link.
Origin	A location attached to a network link, within the EPZ or Shadow Region, where trips are generated at a specified rate in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations.
Prevailing Roadway and Traffic Conditions	Relates to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.).
Service Rate	Maximum rate at which vehicles, executing a specific turn maneuver, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps) or vph.
Service Volume	Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service (The Service Volume at the upper bound of Level of Service, E, equals Capacity). Service Volume is usually expressed as vph.
Signal Cycle Length	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. A signal phase is comprised of a sequence of signal intervals, usually green, yellow, red.

Term	Definition
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds.
Traffic (Trip) Assignment	A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time.
Traffic Density	The number of vehicles that occupy one lane of a roadway section of specified length at a point in time, expressed as vehicles per mile (vpm).
Traffic (Trip) Distribution	A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes.
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness.
Traffic Volume	The number of vehicles that pass over a section of roadway in one direction, expressed in vph. Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail, pedestrian and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vph or in vehicles.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

DTRAD: Dynamic Traffic Assignment and Distribution Model

B. DYNAMIC TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

This appendix describes the integrated dynamic trip assignment and distribution model named DTRAD (Dynamic TRaffic Assignment and Distribution) that is expressly designed for use in analyzing evacuation scenarios. DTRAD employs logit-based path-choice principles and is one of the models of the DYNEV II System. The DTRAD module implements path-based *Dynamic Traffic Assignment* (DTA) so that time dependent Origin-Destination (O-D) trips are "assigned" to routes over the network based on prevailing traffic conditions.

To apply the DYNEV II System, the analyst must specify the highway network, link capacity information, the time-varying volume of traffic generated at all origin centroids and, optionally, a set of accessible candidate destination nodes on the periphery of the Emergency Planning Zone (EPZ) for selected origins. DTRAD calculates the optimal dynamic trip distribution (i.e., trip destinations) and the optimal dynamic trip assignment (i.e., trip routing) of the traffic generated at each origin node traveling to its set of candidate destination nodes, so as to minimize evacuee travel "cost."

B.1 Overview of Integrated Distribution and Assignment Model

The underlying premise is that the selection of destinations and routes is intrinsically coupled in an evacuation scenario. That is, people in vehicles seek to travel out of an area of potential risk as rapidly as possible by selecting the "best" routes. The model is designed to identify these "best" routes in a manner that realistically distributes vehicles from origins to destinations and routes them over the highway network, in a consistent and optimal manner, reflecting evacuee behavior.

For each origin, a set of "candidate destination nodes" is selected by the software logic and by the analyst to reflect the desire by evacuees to travel away from the power plant and to access major highways. The specific destination nodes within this set that are selected by travelers and the selection of the connecting paths of travel, are both determined by DTRAD. This determination is made by a logit-based path choice model in DTRAD, so as to minimize the trip "cost", as discussed later.

The traffic loading on the network and the consequent operational traffic environment of the network (density, speed, throughput on each link) vary over time as the evacuation takes place. The DTRAD model, which is interfaced with the DYNEV simulation model, executes a succession of "sessions" wherein it computes the optimal routing and selection of destination nodes for the conditions that exist at that time.

B.2 Interfacing the DYNEV Simulation Model with DTRAD

The DYNEV II system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. An algorithm was developed to support the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next. Another algorithm executes a "mapping" from the specified "geometric" network (link-node analysis network) that represents the physical highway system, to a "path" network that represents the vehicle [turn] movements. DTRAD computations are performed on the "path" network: DYNEV simulation model, on the "geometric" network.

B.2.1 DTRAD Description

DTRAD is the DTA module for the DYNEV II System.

When the road network under study is large, multiple routing options are usually available between trip origins and destinations. The problem of loading traffic demands and propagating them over the network links is called Network Loading and is addressed by DYNEV II using macroscopic traffic simulation modeling. Traffic assignment deals with computing the distribution of the traffic over the road network for given O-D demands and is a model of the route choice of the drivers. Travel demand changes significantly over time, and the road network may have time dependent characteristics, e.g., time-varying signal timing or reduced road capacity because of lane closure, or traffic congestion. To consider these time dependencies, DTA procedures are required.

The DTRAD DTA module represents the dynamic route choice behavior of drivers, using the specification of dynamic origin-destination matrices as flow input. Drivers choose their routes through the network based on the travel cost they experience (as determined by the simulation model). This allows traffic to be distributed over the network according to the time-dependent conditions. The modeling principles of DTRAD include:

- It is assumed that drivers not only select the best route (i.e., lowest cost path) but some also select less attractive routes. The algorithm implemented by DTRAD archives several "efficient" routes for each O-D pair from which the drivers choose.
- The choice of one route out of a set of possible routes is an outcome of "discrete choice modeling". Given a set of routes and their generalized costs, the percentages of drivers that choose each route is computed. The most prevalent model for discrete choice modeling is the logit model. DTRAD uses a variant of Path-Size-Logit model (PSL). PSL overcomes the drawback of the traditional multinomial logit model by incorporating an additional deterministic path size correction term to address path overlapping in the random utility expression.

- DTRAD executes the traffic assignment (TA) algorithm on an abstract network representation called "the path network" which is built from the actual physical link-node analysis network. This execution continues until a stable situation is reached: the volumes and travel times on the edges of the path network do not change significantly from one iteration to the next. The criteria for this convergence are defined by the user.
- Travel “cost” plays a crucial role in route choice. In DTRAD, path cost is a linear summation of the generalized cost of each link that comprises the path. The generalized cost for a link, a, is expressed as

  $$c_a = \alpha t_a + \beta l_a + \gamma s_{a,}$$

  where c_a is the generalized cost for link a and α, β, and γ are cost coefficients for link travel time, distance, and supplemental cost, respectively. Distance and supplemental costs are defined as invariant properties of the network model, while travel time is a dynamic property dictated by prevailing traffic conditions. The DYNEV simulation model computes travel times on all edges in the network and DTRAD uses that information to constantly update the costs of paths. The route choice decision model in the next simulation iteration uses these updated values to adjust the route choice behavior. This way, traffic demands are dynamically re-assigned based on time dependent conditions. The interaction between the DTRAD TA and DYNEV II simulation models is depicted in Figure B-1. Each round of interaction is called a Traffic Assignment Session (TA session). A TA session is composed of multiple iterations, marked as loop B in the figure.
- The supplemental cost is based on the “survival distribution” (a variation of the exponential distribution).The Inverse Survival Function is a “cost” term in DTRAD to represent the potential risk of travel toward the plant:

  $s_a = - \beta \ln (p), 0 \leq p \leq l ; \beta > 0$

  $p = \frac{d_n}{d_0}$

  d_n = Distance of node, n, from the plant
  d_0 =Distance from the plant where there is zero risk
  β = Scaling factor

  The value of d_o = 11.3 miles, the outer distance of the EPZ. Note that the supplemental cost, $s_{a,}$ of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

B.2.2 Network Equilibrium

In 1952, John Wardrop wrote:

> *Under equilibrium conditions traffic arranges itself in congested networks in such a way that no individual trip-maker can reduce his path costs by switching routes.*

The above statement describes the "User Equilibrium" definition, also called the "Selfish Driver Equilibrium". It is a hypothesis that represents a [hopeful] condition that evolves over time as drivers search out alternative routes to identify those routes that minimize their respective "costs". It has been found that this "equilibrium" objective to minimize costs is largely realized by most drivers who routinely take the same trip over the same network at the same time (i.e., commuters). Effectively, such drivers "learn" which routes are best for them over time. Thus, the traffic environment "settles down" to a near-equilibrium state.

Clearly, since an emergency evacuation is a sudden, unique event, it does not constitute a long-term learning experience which can achieve an equilibrium state. Consequently, DTRAD was not designed as an equilibrium solution, but to represent drivers in a new and unfamiliar situation, who respond in a flexible manner to real-time information (either broadcast or observed) in such a way as to minimize their respective costs of travel.

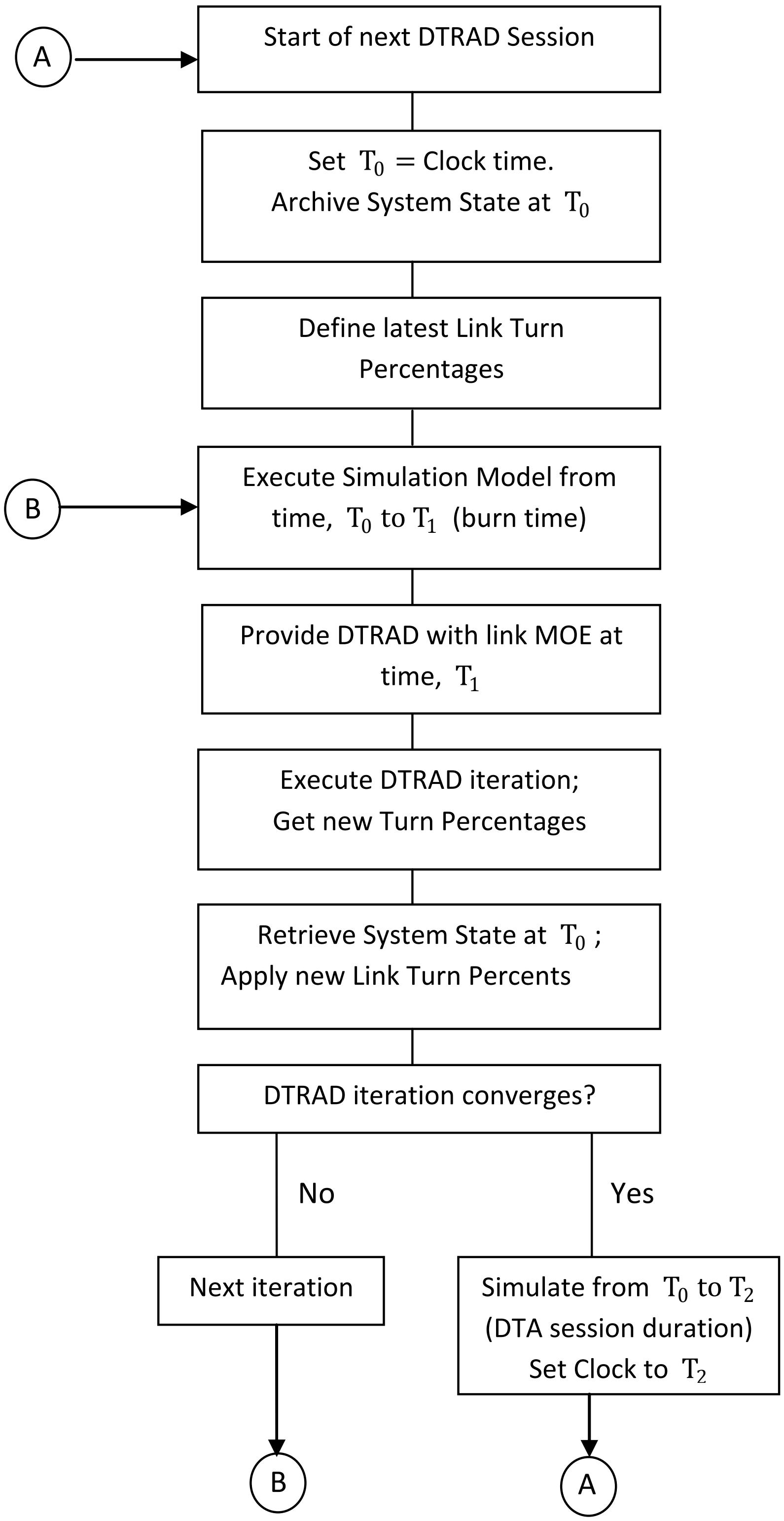


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

This appendix describes the DYNEV traffic simulation model. The DYNEV traffic simulation model is a *macroscopic* model that describes the operations of traffic flow in terms of aggregate variables: vehicles, flow rate, mean speed, volume, density, queue length, *on each link*, for each turn movement, during each Time Interval (simulation time step). The model generates trips from "sources" and from Entry Links and introduces them onto the analysis network at rates specified by the analyst based on the mobilization time distributions. The model simulates the movements of all vehicles on all network links over time until the network is empty. At intervals, the model outputs Measures of Effectiveness (MOE) such as those listed in Table C-1.

Model Features Include:

- Explicit consideration is taken of the variation in density over the time step; an iterative procedure is employed to calculate an average density over the simulation time step for the purpose of computing a mean speed for moving vehicles.
- Multiple turn movements can be serviced on one link; a separate algorithm is used to estimate the number of (fractional) lanes assigned to the vehicles performing each turn movement, based, in part, on the turn percentages provided by the Dynamic TRaffic Assignment and Distribution (DTRAD) model.
- At any point in time, traffic flow on a link is subdivided into two classifications: queued and moving vehicles. The number of vehicles in each classification is computed. Vehicle spillback, stratified by turn movement for each network link, is explicitly considered and quantified. The propagation of stopping waves from link to link is computed within each time step of the simulation. There is no "vertical stacking" of queues on a link.
- Any link can accommodate "source flow" from zones via side streets and parking facilities that are not explicitly represented. This flow represents the evacuating trips that are generated at the source.
- The relation between the number of vehicles occupying the link and its storage capacity is monitored every time step for every link and for every turn movement. If the available storage capacity on a link is exceeded by the demand for service, then the simulator applies a "metering" rate to the entering traffic from both the upstream feeders and source node to ensure that the available storage capacity is not exceeded.
- A "path network" that represents the specified traffic movements from each network link is constructed by the model; this path network is utilized by the DTRAD model.
- A two-way interface with DTRAD: (1) provides link travel times; (2) receives data that translates into link turn percentages.
- Provides MOE to animation software, Evacuation Animator (EVAN).
- Calculates Evacuation Time Estimates (ETE) statistics.

All traffic simulation models are data-intensive. Table C-2 outlines the necessary input data elements.

To provide an efficient framework for defining these specifications, the physical highway environment is represented as a network. The unidirectional links of the network represent roadway sections: rural, multi-lane, urban streets or freeways. The nodes of the network generally represent intersections or points along a section where a geometric property changes (e.g., a lane drop, change in grade or free flow speed).

Figure C-1 is an example of a small network representation. The freeway is defined by the sequence of links, (20,21), (21,22), and (22,23). Links (8001, 19) and (3, 8011) are Entry and Exit links, respectively. An arterial extends from node 3 to node 19 and is partially subsumed within a grid network. Note that links (21,22) and (17,19) are grade-separated.

C.1 Methodology

C.1.1 The Fundamental Diagram

It is necessary to define the fundamental diagram describing flow-density and speed-density relationships. Rather than "settling for" a triangular representation, a more realistic representation that includes a "capacity drop", (I-R)Q_{max}, at the critical density when flow conditions enter the forced flow regime, is developed and calibrated for each link. This representation, shown in Figure C-2, asserts a constant free speed up to a density, k_f, and then a linear reduction in speed in the range, $k_f \leq k \leq k_c = 45$ vpm, the density at capacity. In the flow-density plane, a quadratic relationship is prescribed in the range, $k_c < k \leq k_s = 95$ vpm which roughly represents the "stop-and-go" condition of severe congestion. The value of flow rate, Q_s, corresponding to k_s, is approximated at $0.7\,RQ_{max}$. A linear relationship between k_s and k_j completes the diagram shown in Figure C-2. Table C-3 is a glossary of terms.

The fundamental diagram is applied to <u>moving</u> traffic on every link. The specified calibration values for each link are: (1) Free speed, v_f ; (2) Capacity, Q_{max} ; (3) Critical density, $k_c = 45$ vpm ; (4) Capacity Drop Factor, R = 0.9 ; (5) Jam density, k_j . Then, $v_c = \frac{Q_{max}}{k_c}$, $k_f = k_c - \frac{(V_f - V_c)\,k_c^2}{Q_{max}}$. Setting $\bar{k} = k - k_c$, then $Q = RQ_{max} - \frac{RQ_{max}}{8333}\,\bar{k}^2$ for $0 \leq \bar{k} \leq \bar{k}_s = 50$. It can be shown that $Q = \left(0.98 - 0.0056\,\bar{k}\right) RQ_{max}$ for $\bar{k}_s \leq \bar{k} \leq \bar{k}_j$, where $\bar{k}_s = 50$ and $\bar{k}_j = 175$.

C.1.2 The Simulation Model

The simulation model solves a sequence of "unit problems". Each unit problem computes the movement of traffic on a link, for each specified turn movement, over a specified time interval (TI) which serves as the simulation time step for all links. Figure C-3 is a representation of the unit problem in the time-distance plane. Table C-3 is a glossary of terms that are referenced in the following description of the unit problem procedure.

The formulation and the associated logic presented below are designed to solve the unit problem for each sweep over the network (discussed below), for each turn movement serviced on each link that comprises the evacuation network, and for each TI over the duration of the evacuation.

Given = $Q_b, M_b, L, TI, E_0, LN, {}^{G}/_{C}, h, L_v, R_0, L_c, E, M$
Compute = O, Q_e, M_e
Define $O = O_Q + O_M + O_E$; $E = E_1 + E_2$

1. For the first sweep, s = 1, of this TI, get initial estimates of mean density, k_0, the R – factor, R_0 and entering traffic, E_0, using the values computed for the final sweep of the prior TI. For each subsequent sweep, $s > 1$, calculate $E = \sum_i P_i\ O_i + S$ where P_i, O_i are the relevant turn percentages from feeder link, i , and its total outflow (possibly metered) over this TI; S is the total source flow (possibly metered) during the current TI. Set iteration counter, n = 0, $k = k_0$, and $E = E_0$.

2. Calculate $v(k)$ such that $k \leq 130$ using the analytical representations of the fundamental diagram.
   Calculate $\text{Cap} = \frac{Q_{max}(TI)}{3600}\left({}^{G}/_{C}\right) LN$, in vehicles, this value may be reduced due to metering
   Set $R = 1.0$ if ${}^{G}/_{C} < 1$ or if $k \leq k_c$; Set $R = 0.9$ only if ${}^{G}/_{C} = 1$ and $k > k_c$
   Calculate queue length, $L_b = Q_b \frac{L_v}{LN}$

3. Calculate $t_1 = TI - \frac{L}{V}$. If $t_1 \prec 0$, set $t_1 = E_1 = O_E = 0$; Else, $E_1 = E\ \frac{t_1}{TI}$.

4. Then $E_2 = E - E_1$; $t_2 = TI - t_1$

5. If $Q_b \geq \text{Cap}$, then
   $O_Q = \text{Cap}, O_M = O_E = 0$
   If $t_1 > 0$, then
   $Q'_e = Q_b + M_b + E_1 - \text{Cap}$
   Else
   $Q'_e = Q_b - \text{Cap}$
   End if
   Calculate Q_e and M_e using Algorithm A (below)

6. Else $(Q_b \prec \text{Cap})$
   $O_Q = Q_b$, $\text{RCap} = \text{Cap} - O_Q$

7. If $M_b \leq \text{RCap}$, then

8. If $t_1 > 0$, $O_M = M_b, O_E = \min\left(\text{RCap} - M_b, \frac{t_1\ \text{Cap}}{TI}\right) \geq 0$
   $Q'_e = E_1 - O_E$
   If $Q'_e > 0$, then
   Calculate Q_e, M_e with Algorithm A

Else

$Q_e = 0\,,\ M_e = E_2$

End if

Else $(t_1 = 0)$

$O_M = \left(\frac{v(TI)-L_b}{L-L_b}\right) M_b$ and $O_E = 0$

$M_e = M_b - O_M + E\,;\ Q_e = 0$

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$, then

$O_M = RCap\,,\ Q'_e = M_b - O_M + E_1$

Calculate Q_e and M_e using Algorithm A

10. Else $(t_1 = 0)$

$M_d = \left[\left(\frac{v(TI)-L_b}{L-L_b}\right) M_b\right]$

If $M_d > RCap$, *then*

$O_M = RCap$

$Q'_e = M_d - O_M$

Apply Algorithm A to calculate Q_e and M_e

Else

$O_M = M_d$

$M_e = M_b - O_M + E$ and $Q_e = 0$

End if

End if

End if

End if

11. Calculate a new estimate of average density, $\bar{k}_n = \frac{1}{4}[k_b + 2\,k_m + k_e]$,

where k_b = density at the beginning of the TI

k_e = density at the end of the TI

k_m = density at the mid-point of the TI

All values of density apply only to the moving vehicles.

If $\left|\bar{k}_n - \bar{k}_{n-1}\right| > \epsilon$ and $n < N$

where $N =$ max number of iterations, and ϵ is a convergence criterion, then

12. set $n = n + 1$, and return to step 2 to perform iteration, n, using $k = \bar{k}_n$.

End if

Computation of unit problem is now complete. Check for excessive inflow causing spillback.

13. If $Q_e + M_e > \frac{(L-W)\,LN}{L_v}$, then

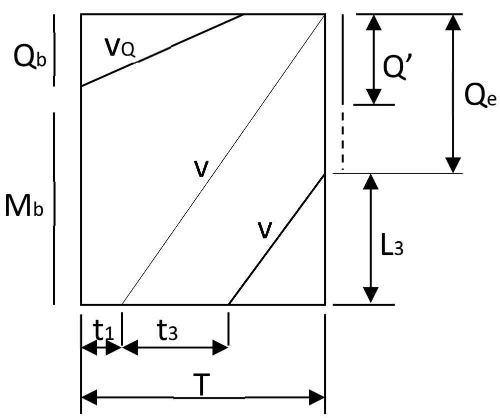
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W)\cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

$$M = 1 - \frac{SB}{(E+S)} \geq 0\text{, where M is the metering factor (over all movements).}$$

This metering factor is assigned appropriately to all feeder links and to the source flow, to be applied during the next network sweep, discussed later.

Algorithm A

This analysis addresses the flow environment over a TI during which moving vehicles can join a standing or discharging queue. For the case shown, $Q_b \leq Cap$, with $t_1 > 0$ and a queue of length, Q'_e, formed by that portion of M_b and E that reaches the stop-bar within the TI, but could not discharge due to inadequate capacity. That is, $Q_b + M_b + E_1 > Cap$. This queue length, $Q'_e = Q_b + M_b + E_1 - Cap$ can be extended to Q_e by traffic entering the approach during the current TI, traveling at speed, v, and reaching the rear of the queue within the TI. A portion of the entering vehicles, $E_3 = E\,\frac{t_3}{TI}$, will likely join the queue. This analysis calculates t_3, Q_e and M_e for the input values of L, TI, v, E, t, L_v, LN, Q'_e .



When $t_1 > 0$ and $Q_b \leq Cap$:

Define: $L'_e = Q'_e\,\frac{L_v}{LN}$. From the sketch, $L_3 = v(TI - t_1 - t_3) = L - (Q'_e + E_3)\frac{L_v}{LN}$.

Substituting $E_3 = \frac{t_3}{TI}\,E$ yields: $-vt_3 + \frac{t_3}{TI}\,E\,\frac{L_v}{LN} = L - v(TI - t_1) - L'_e$. Recognizing that the first two terms on the right hand side cancel, solve for t_3 to obtain:

$$t_3 = \frac{L'_e}{\left[v - \frac{E}{TI}\,\frac{L_v}{LN}\right]} \qquad \text{such that} \quad 0 \leq t_3 \leq TI - t_1$$

If the denominator, $\left[v - \frac{E}{TI}\,\frac{L_v}{LN}\right] \leq 0$, set $t_3 = TI - t_1$.

Then, $Q_e = Q'_e + E\,\frac{t_3}{TI}$, $M_e = E\left(1 - \frac{t_1 + t_3}{TI}\right)$

The complete Algorithm A considers all flow scenarios; space limitation precludes its inclusion, here.

C.1.3 Lane Assignment

The "unit problem" is solved for each turn movement on each link. Therefore it is necessary to calculate a value, $\mathrm{LN_x}$, of allocated lanes for each movement, x. If in fact all lanes are specified by, say, arrows painted on the pavement, either as full lanes or as lanes within a turn bay, then the problem is fully defined. If however there remain un-channelized lanes on a link, then an analysis is undertaken to subdivide the number of these physical lanes into turn movement specific virtual lanes, LN_x.

C.2 Implementation

C.2.1 Computational Procedure

The computational procedure for this model is shown in the form of a flow diagram as Figure C-4. As discussed earlier, the simulation model processes traffic flow for each link independently over TI that the analyst specifies; it is usually 60 seconds or longer. The first step is to execute an algorithm to define the sequence in which the network links are processed so that as many links as possible are processed after their feeder links are processed, within the same network sweep. Since a general network will have many closed loops, it is not possible to guarantee that every link processed will have all of its feeder links processed earlier.

The processing then continues as a succession of time steps of duration, TI, until the simulation is completed. Within each time step, the processing performs a series of "sweeps" over all network links; this is necessary to ensure that the traffic flow is synchronous over the entire network. Specifically, the sweep ensures continuity of flow among all the network links; in the context of this model, this means that the values of E, M, and S are all defined for each link such that they represent the synchronous movement of traffic from each link to all of its outbound links. These sweeps also serve to compute the metering rates that control spillback.

Within each sweep, processing solves the "unit problem" for each turn movement on each link. With the turn movement percentages for each link provided by the DTRAD model, an algorithm allocates the number of lanes to each movement serviced on each link. The timing at a signal, if any, applied at the downstream end of the link, is expressed as a G/C ratio, the signal timing needed to define this ratio is an input requirement for the model. The model also has the capability of representing, with macroscopic fidelity, the actions of actuated signals responding to the time-varying competing demands on the approaches to the intersection.

The solution of the unit problem yields the values of the number of vehicles, O, that discharge from the link over the time interval and the number of vehicles that remain on the link at the end of the time interval as stratified by queued and moving vehicles: $\mathrm{Q_e}$ and $\mathrm{M_e}$. The procedure considers each movement separately (multi-piping). After all network links are processed for a given network sweep, the updated consistent values of entering flows, E; metering rates, M; and source flows, S are defined so as to satisfy the "no spillback" condition. The procedure then performs the unit problem solutions for all network links during the following sweep.

Experience has shown that the system converges (i.e., the values of E, M and S "settle down" for all network links) in just two sweeps if the network is entirely under-saturated or in four sweeps in the presence of extensive congestion with link spillback. (The initial sweep over each link uses the final values of E and M, of the prior TI). At the completion of the final sweep for a TI, the procedure computes and stores all MOEs for each link and turn movement for output purposes. It then prepares for the following time interval by defining the values of $\mathrm{Q_b}$ and $\mathrm{M_b}$ for the start of the next TI as being those values of $\mathrm{Q_e}$ and $\mathrm{M_e}$ at the end of the prior TI. In this manner, the simulation model processes the traffic flow over time until the end of the run. Note that there is no space-discretization other than the specification of network links.

C.2.2 Interfacing with Dynamic Traffic Assignment (DTRAD)

The **DYNEV II** system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. Thus, an algorithm was developed to identify an appropriate set of destination nodes for each origin based on its location and on the expected direction of travel. This algorithm also supports the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next.

Figure B-1 depicts the interaction of the simulation model with the DTRAD model in the **DYNEV II** system. As indicated, **DYNEV II** performs a succession of DTRAD "sessions"; each such session computes the turn link percentages for each link that remain constant for the session duration, $[\mathrm{T_0}, \mathrm{T_2}]$, specified by the analyst. The end product is the assignment of traffic volumes from each origin to paths connecting it with its destinations in such a way as to minimize the network-wide cost function. The output of the DTRAD model is a set of updated link turn percentages which represent this assignment of traffic.

As indicated in Figure B-1, the simulation model supports the DTRAD session by providing it with operational link MOE that are needed by the path choice model and included in the DTRAD cost function. These MOE represent the operational state of the network at a time, $\mathrm{T_1} \leq \mathrm{T_2}$, which lies within the session duration, $[\mathrm{T_0}, \mathrm{T_2}]$. This "burn time", $\mathrm{T_1} - \mathrm{T_0}$, is selected by the analyst. For each DTRAD iteration, the simulation model computes the change in network operations over this burn time using the latest set of link turn percentages computed by the DTRAD model. Upon convergence of the DTRAD iterative procedure, the simulation model accepts the latest turn percentages provided by the Dynamic Traffic Assignment (DTA) model, returns to the origin time, $\mathrm{T_0}$, and executes until it arrives at the end of the DTRAD session duration at time, $\mathrm{T_2}$. At this time the next DTA session is launched and the whole process repeats until the end of the **DYNEV II** run.

Additional details are presented in Appendix B.

Table C-1. Selected Measures of Effectiveness Output by DYNEV II

Measure	Units	Applies To
Vehicles Discharged	Vehicles	Link, Network, Exit Link
Speed	Miles/Hours (mph)	Link, Network
Density	Vehicles/Mile/Lane	Link
Level of Service	LOS	Link
Content	Vehicles	Network
Travel Time	Vehicle-hours	Network
Evacuated Vehicles	Vehicles	Network, Exit Link
Trip Travel Time	Vehicle-minutes/trip	Network
Capacity Utilization	Percent	Exit Link
Attraction	Percent of total evacuating vehicles	Exit Link
Max Queue	Vehicles	Node, Approach
Time of Max Queue	Hours:minutes	Node, Approach
Route Statistics	Length (mi); Mean Speed (mph); Travel Time (min)	Route
Mean Travel Time	Minutes	Evacuation Trips; Network

Table C-2. Input Requirements for the DYNEV II Model

HIGHWAY NETWORK

- Links defined by upstream and downstream node numbers
- Link lengths
- Number of lanes (up to 9) and channelization
- Turn bays (1 to 3 lanes)
- Destination (exit) nodes
- Network topology defined in terms of downstream nodes for each receiving link
- Node Coordinates (X,Y)
- Nuclear Power Plant Coordinates (X,Y)

GENERATED TRAFFIC VOLUMES

- On all entry links and source nodes (origins), by Time Period

TRAFFIC CONTROL SPECIFICATIONS

- Traffic signals: link-specific, turn movement specific
- Signal control treated as fixed time or actuated
- Location of traffic control points (these are represented as actuated signals)
- Stop and Yield signs
- Right-turn-on-red (RTOR)
- Route diversion specifications
- Turn restrictions
- Lane control (e.g., lane closure, movement-specific)

DRIVER'S AND OPERATIONAL CHARACTERISTICS

- Driver's (vehicle-specific) response mechanisms: free-flow speed, discharge headway
- Bus route designation.

DYNAMIC TRAFFIC ASSIGNMENT

- Candidate destination nodes for each origin (optional)
- Duration of DTA sessions
- Duration of simulation "burn time"
- Desired number of destination nodes per origin

INCIDENTS

- Identify and Schedule of closed lanes
- Identify and Schedule of closed links

Table C-3. Glossary

Cap	The maximum number of vehicles, of a particular movement, that can discharge from a link within a time interval.
E	The number of vehicles, of a particular movement, that enter the link over the time interval. The portion, E_{TI}, can reach the stop-bar within the TI.
G/C	The green time: cycle time ratio that services the vehicles of a particular turn movement on a link.
h	The mean queue discharge headway, seconds.
k	Density in vehicles per lane per mile.
$\bar{k}$	The average density of <u>moving</u> vehicles of a particular movement over a TI, on a link.
L	The length of the link in feet.
L_b , L_e	The queue length in feet of a particular movement, at the [beginning, end] of a time interval.
LN	The number of lanes, expressed as a floating point number, allocated to service a particular movement on a link.
L_v	The mean effective length of a queued vehicle including the vehicle spacing, feet.
M	Metering factor (Multiplier): 1.
M_b , M_e	The number of moving vehicles on the link, of a particular movement, that are moving at the [beginning, end] of the time interval. These vehicles are assumed to be of equal spacing, over the length of link upstream of the queue.
O	The total number of vehicles of a particular movement that are discharged from a link over a time interval.
O_Q , O_M , O_E	The components of the vehicles of a particular movement that are discharged from a link within a time interval: vehicles that were Queued at the beginning of the TI; vehicles that were Moving within the link at the beginning of the TI; vehicles that Entered the link during the TI.
P_x	The percentage, expressed as a fraction, of the total flow on the link that executes a particular turn movement, x.

Q_b , Q_e	The number of queued vehicles on the link, of a particular turn movement, at the [beginning, end] of the time interval.
Q_{max}	The maximum flow rate that can be serviced by a link for a particular movement in the absence of a control device. It is specified by the analyst as an estimate of link capacity, based upon a field survey, with reference to the Highway Capacity Manual (HCM) 2016.
R	The factor that is applied to the capacity of a link to represent the "capacity drop" when the flow condition moves into the forced flow regime. The lower capacity at that point is equal to RQ_{max} .
RCap	The remaining capacity available to service vehicles of a particular movement after that queue has been completely serviced, within a time interval, expressed as vehicles.
S_x	Service rate for movement x, vehicles per hour (vph).
t_1	Vehicles of a particular turn movement that enter a link over the first t_1 seconds of a time interval, can reach the stop-bar (in the absence of a queue down-stream) within the same time interval.
TI	The time interval, in seconds, which is used as the simulation time step.
v	The mean speed of travel, in feet per second (fps) or miles per hour (mph), of moving vehicles on the link.
v_Q	The mean speed of the last vehicle in a queue that discharges from the link within the TI. This speed differs from the mean speed of moving vehicles, v.
W	The width of the intersection in feet. This is the difference between the link length which extends from stop-bar to stop-bar and the block length.

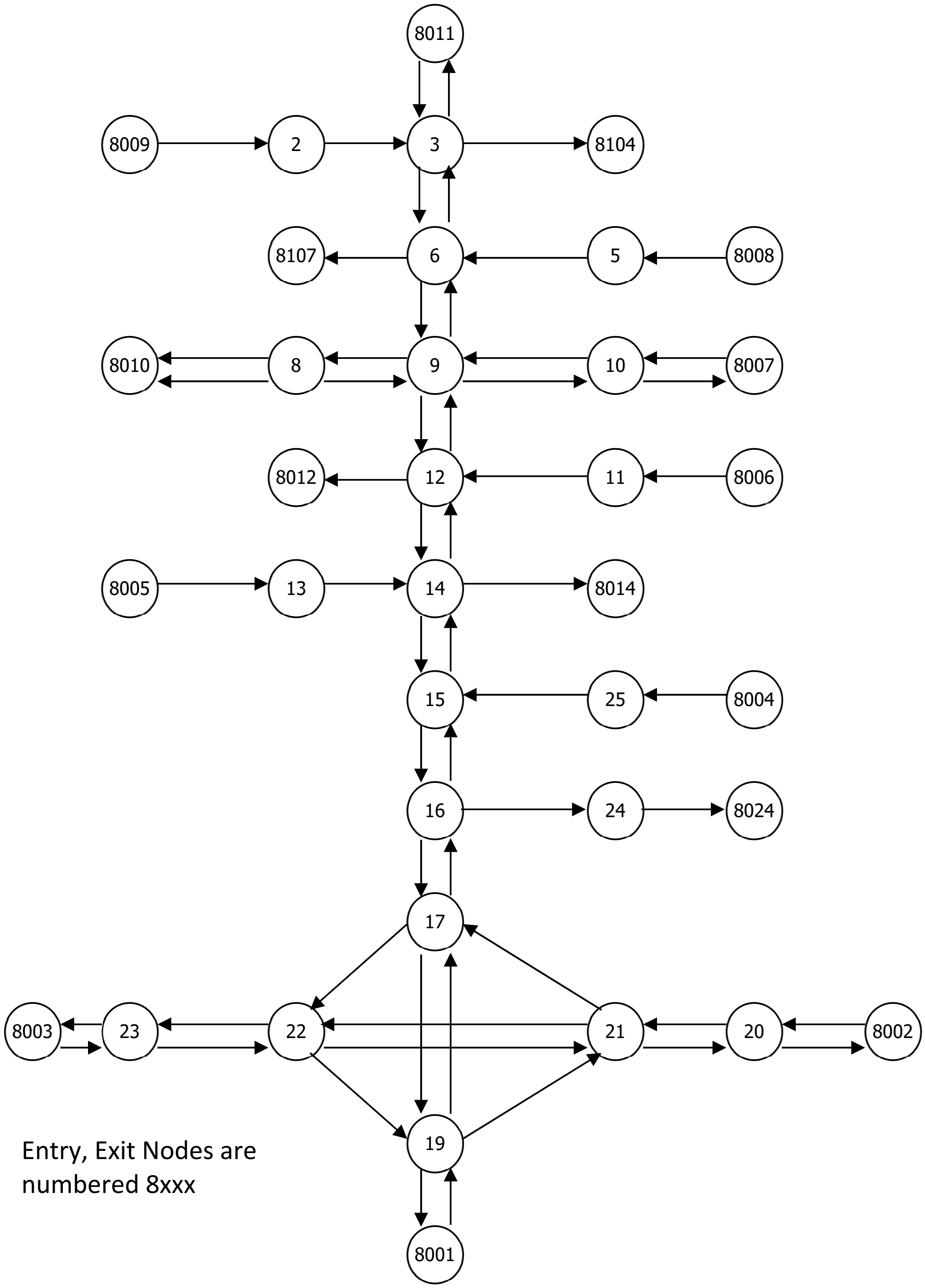


Figure C-1. Representative Analysis Network

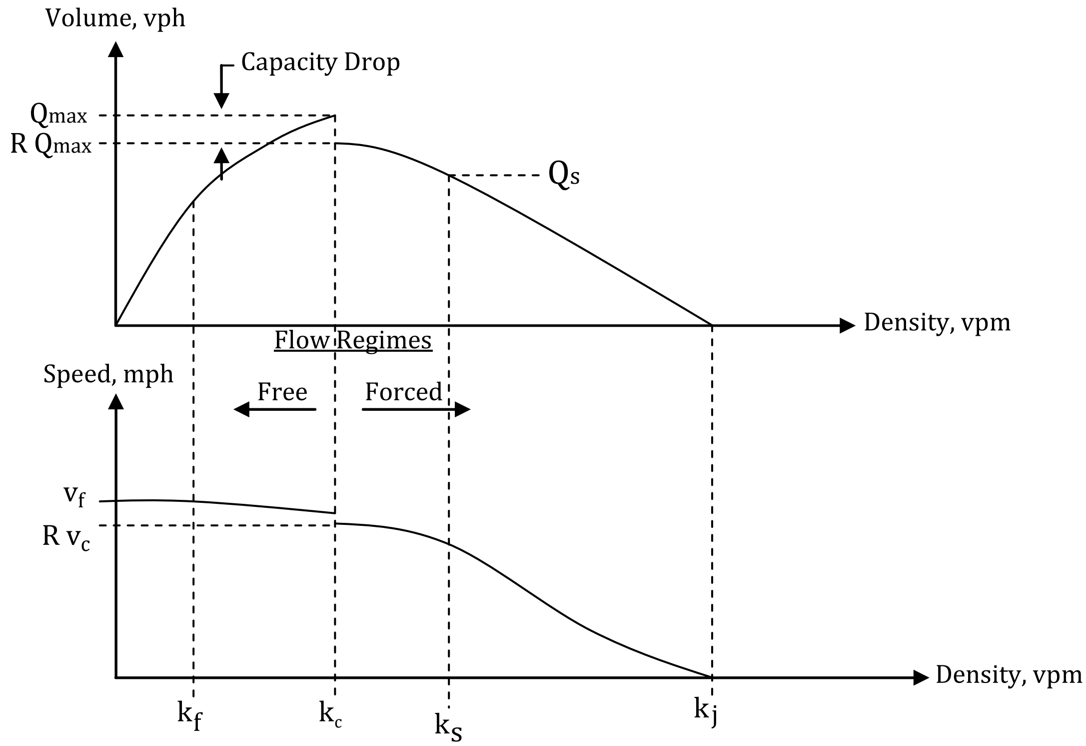


Figure C-2. Fundamental Diagrams

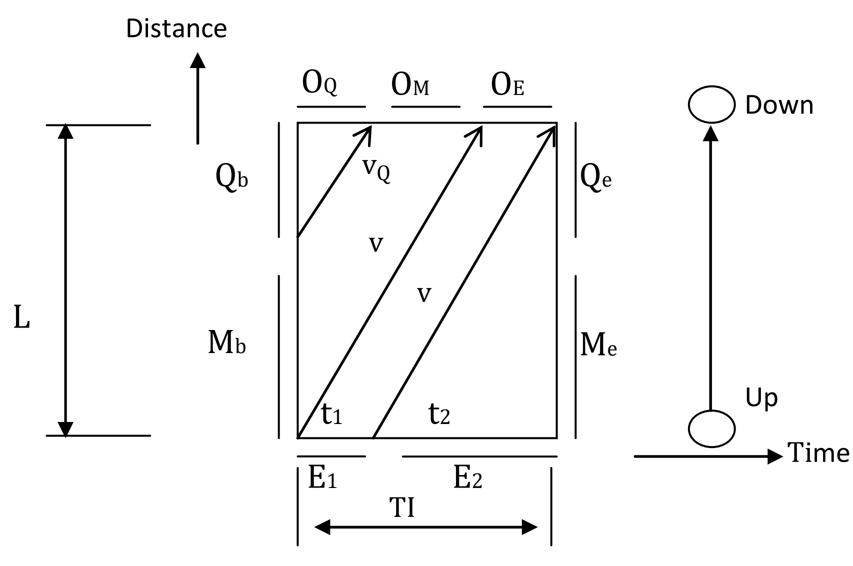


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

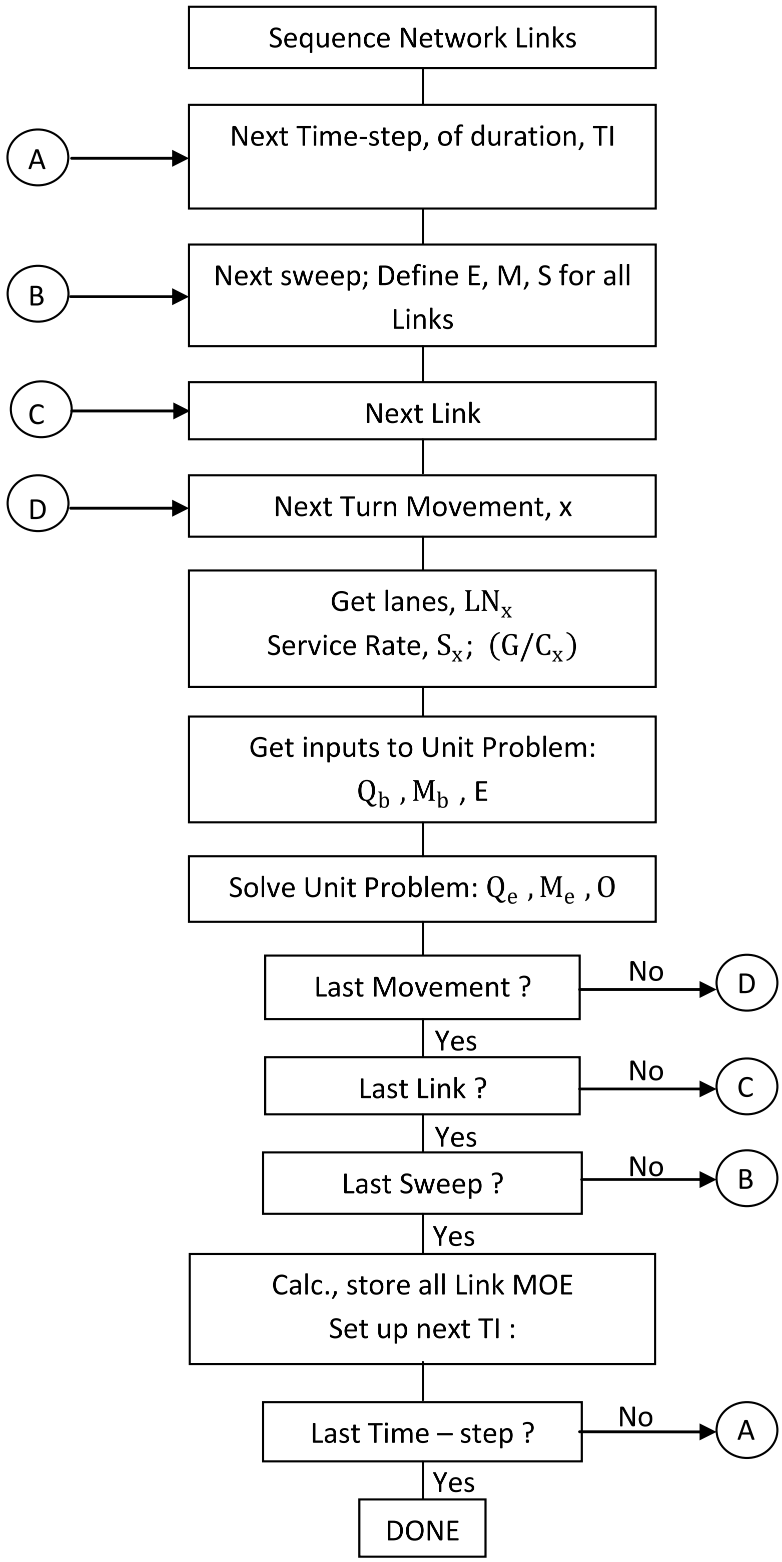


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

APPENDIX D

Detailed Description of Study Procedure

D. DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute Evacuation Time Estimates (ETE). The individual steps of this effort are represented as a flow diagram in Figure D-1. Each numbered step in the description that follows corresponds to the numbered element in the flow diagram.

Step 1

The first activity was to obtain Emergency Planning Zone (EPZ) boundary information and create a geographical information system (GIS) base map. The base map extends beyond the Shadow Region which extends approximately 15 miles (radially) from the power plant location. The base map incorporates the local roadway topology, a suitable topographic background and the EPZ and Zone boundaries.

Step 2

The 2020 Census block population information was obtained in GIS format. This information was used to determine the permanent resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. Employee and transient data were obtained from local/state emergency management agencies. Information concerning schools, daycares, day camps, access and/or functional needs population, medical and correctional facilities within the EPZ was obtained from county emergency management agencies. In addition, transportation resources available during the emergency were also provided by the counties. Wherever the data is unavailable, internet searches and phone calls were done to gather the data. If still unresolved, data from the 2012 ETE study was used.

Step 3

A kickoff meeting was conducted with major stakeholders (state and county emergency managers, on-site and off-site utility emergency managers). The purpose of the kickoff meeting was to present an overview of the work effort, identify key agency personnel, and indicate the data requirements for the study. Specific requests for information were presented to county emergency managers. Unique features of the study area were discussed to identify the local concerns that should be addressed by the ETE study.

Step 4

Next, a physical survey of the roadway system in the study area was conducted to determine the geometric properties of the highway sections, the channelization of lanes on each section of roadway, whether there are any turn restrictions or special treatment of traffic at intersections, the type and functioning of traffic control devices, gathering signal timings for pre-timed traffic signals (if any exist within the study area), and to make the necessary observations needed to estimate realistic values of roadway capacity. Roadway characteristics were also verified using aerial imagery.

Step 5

A demographic survey of households within the EPZ was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the EPZ population, for this study. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the most recent UNITES software (see Section 1.3) developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4) and information obtained from aerial imagery. Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. The 2020 permanent resident population (Step 2) were overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 7

The EPZ is subdivided into 30 Zones. Based on wind direction and speed, Regions (groupings of Zones) that may be advised to evacuate, were developed.

The need for evacuation can occur over a range of time-of-day, day-of-week, seasonal and weather-related conditions. Scenarios were developed to capture the variation in evacuation demand, highway capacity and mobilization time, for different time of day, day of the week, time of year, and weather conditions.

Step 8

The input stream for the DYNEV II model, which integrates the dynamic traffic assignment and distribution model, DTRAD, with the evacuation simulation model, was created for a prototype evacuation case – the evacuation of the entire EPZ for a representative scenario.

Step 9

After creating this input stream, the DYNEV II System was executed on the prototype evacuation case to compute evacuating traffic routing patterns consistent with the appropriate NRC guidelines. DYNEV II contains an extensive suite of data diagnostics which check the completeness and consistency of the input data specified. The analyst reviews all warning and error messages produced by the model and then corrects the database to create an input stream that properly executes to completion.

The model assigns destinations to all origin centroids consistent with a (general) radial evacuation of the EPZ and Shadow Region. The analyst may optionally supplement and/or replace these model-assigned destinations, based on professional judgment, after studying the topology of the analysis highway network. The model produces link and network-wide measures of effectiveness as well as estimates of evacuation time.

Step 10

The results generated by the prototype evacuation case are critically examined. The examination includes observing the animated graphics (using the EVAN software – see Section 1.3) and reviewing the statistics output by the model. This is a labor-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the results.

Essentially, the approach is to identify those bottlenecks in the network that represent locations where congested conditions are pronounced and to identify the cause of this congestion. This cause can take many forms, either as excess demand due to high rates of trip generation, improper routing, a shortfall of capacity, or as a quantitative flaw in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are satisfactory; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment and experience based upon the results obtained in previous applications of the model and a comparison of the results of the latest prototype evacuation case iteration with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 13. Otherwise, proceed to Step 11.

Step 11

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, adding routes (which are paved and traversable) that were not previously modelled but may assist in an evacuation and increase the available roadway network capacity, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 12

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 11. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 13

Evacuation of transit-dependent evacuees and special facilities are included in the evacuation analysis. Fixed routing for transit buses and for school buses, ambulances, mini-buses, wheelchair buses and wheelchair vans are introduced into the final prototype evacuation case data set. DYNEV II generates route-specific speeds over time for use in the estimation of evacuation times for the transit dependent and special facility population groups.

Step 14

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the highway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 15

All evacuation cases are executed using the DYNEV II System to compute ETE. Once results are available, quality control procedures are used to assure the results were consistent, dynamic routing is reasonable, and traffic congestion/bottlenecks are addressed properly.

Step 16

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes are used to compute ETEs for transit-dependent permanent residents, schools, hospitals, and other special facilities.

Step 17

The simulation results are analyzed, tabulated and graphed. The results are then documented, as required by NUREG/CR-7002, Rev. 1.

Step 18

Following the completion of documentation activities, the ETE criteria checklist (see Appendix N) is completed. An appropriate report reference is provided for each criterion provided in the checklist.

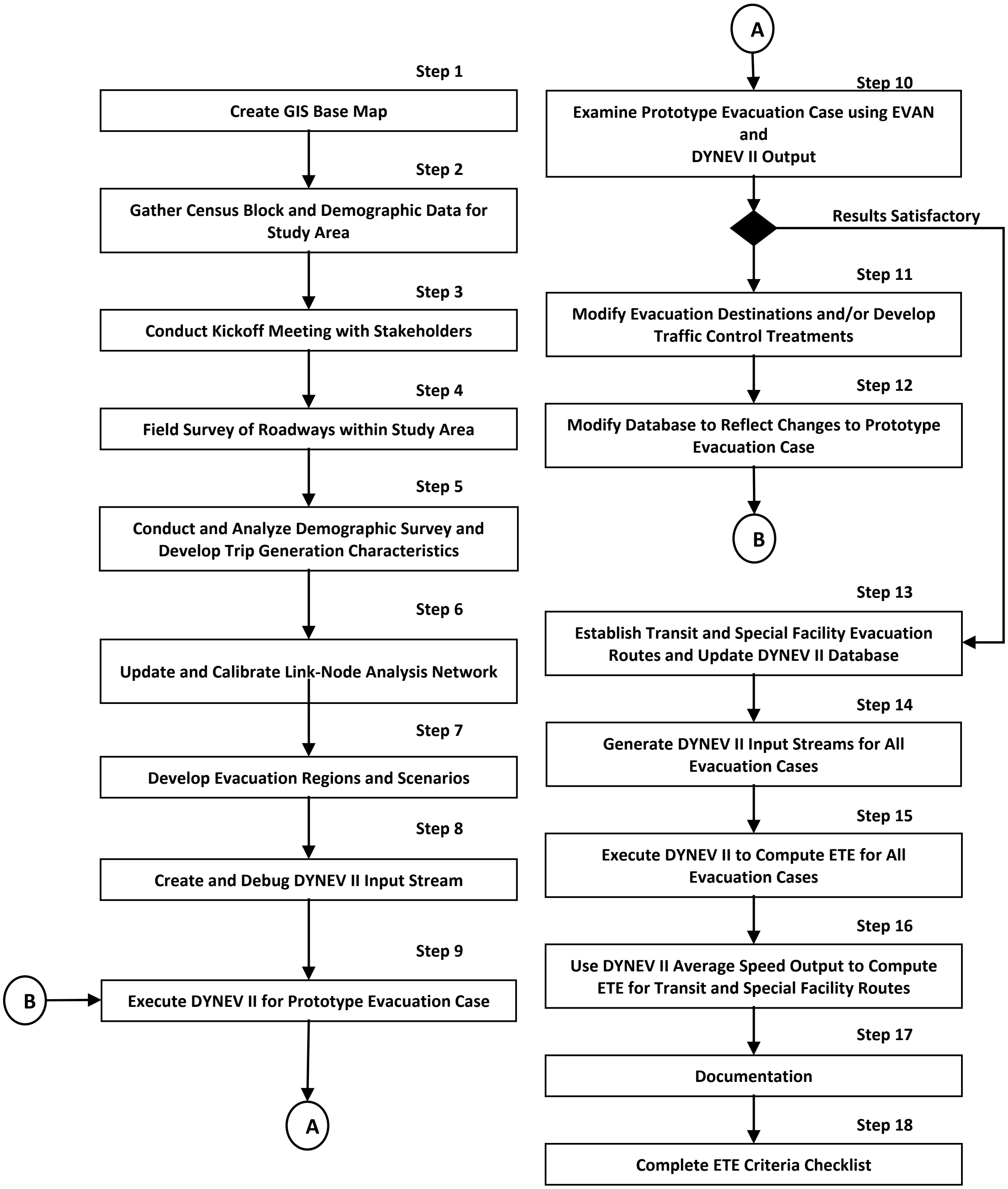


Figure D-1. Flow Diagram of Activities

APPENDIX E

Facility Data

E. FACILITY DATA

The following tables list population information, as of November 2021, for special facilities, transient attractions and major employers that are located within the CPNPP EPZ. Special facilities are defined as schools, preschools/daycares, day camps, medical facilities, and correctional facilities. Transient population data is included in the tables for campgrounds, golf courses, marinas, parks, other recreational areas, lodging facilities and major retail facilities. Employment data is included in the table for major employers.

Each table is grouped by county. The location of the facility is defined by its straight-line distance (miles) and direction (magnetic bearing) from the center point of the plant. Maps of each school, preschool/daycare, day camp, medical facility, major employer, campground, golf course, marina, park, other recreational area, lodging facility, major retail facility and correctional facility are also provided.

Table E-1. Schools within the EPZ

Zone	Distance (miles)	Direction	School Name	Street Address	Municipality	Enrollment
HOOD COUNTY						
1C	6.9	NE	Mambrino Elementary School	3835 Mambrino Hwy	Granbury	604
1D	9.5	N	Premier High School	883 Harbor Lakes Dr	Granbury	150
4E	7.4	N	Lakeside Baptist Academy	3410 Glen Rose Hwy	Granbury	100
4E	8.8	N	Brawner Intermediate School	1520 S Meadow Dr	Granbury	400
4E	8.8	N	Emma Roberson Elementary School	1500 Misty Meadow Dr	Granbury	501
4E	9.8	N	Granbury High School	2000 W Pearl St	Granbury	2,029
4G	10.3	WNW	Tolar High School	301 Rock Church Rd	Tolar	225
TO	9.7	NW	Tolar Elementary School	401 E 7th St	Tolar	265
TO	9.8	NW	Tolar Jr. High School	401 E 7th St	Tolar	132
					Hood County Subtotal:	*4,406*
SOMERVELL COUNTY						
2D	3.1	E	North Central Texas Academy	3846 N Hwy 144	Granbury	70
2H	8.5	ESE	Brazos River Charter School	1964 S FM 199	Nemo	135
GL	4.5	SSE	Glen Rose Junior High School	805 College St	Glen Rose	425
GL	4.8	SSE	Glen Rose High School	900 Stadium Dr	Glen Rose	500
GL	4.9	SSE	Glen Rose Elementary School	601 Stadium Dr	Glen Rose	500
GL	4.9	SSE	Glen Rose Intermediate School	201 Allen Dr	Glen Rose	400
					Somervell County Subtotal:	*2,030*
					EPZ TOTAL:	**6,436**

Table E-2. Preschools/Daycares within the EPZ

Zone	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Enroll-ment
HOOD COUNTY						
1C	6.7	NNE	Rainbow's Promise	2727 Mambrino Hwy	Granbury	55
1D	7.2	N	Lakeside WEEschool	500 W Bluebonnet Dr	Granbury	59
1D	9.9	N	Lil Pirates Daycare	309 Western Hills Trail	Granbury	70
4E	8.9	N	Cross Town Preschool	1400 N Meadows Dr	Granbury	18
4E	9.8	N	Miss Dee Little Angels	301 S Ables St	Granbury	4
TO	10.2	NW	Tolar Small Steps Childcare & Early Learning Center, LLC	9010 W US-377	Tolar	80
TO	10.2	NW	Little Rattlers Preschool & Childcare	9015 US-377	Tolar	57
					Hood County Subtotal:	*343*
SOMERVELL COUNTY						
2C	3.7	SSE	Grace Preschool	2008 N FM 56	Glen Rose	60
2C	4.2	SSE	Glen Rose Early Head Start	1190 N FM 56	Glen Rose	40
3D	4.9	S	Little Tigers Learning Center	1073 Co Rd 1001	Glen Rose	60
GL	4.3	SE	Endless Discoveries Child Development Center	200 Commerce St	Glen Rose	60
GL	4.6	SSE	First United Methodist Preschool	405 NE Barnard St	Glen Rose	60
GL	4.6	SSE	Rockin' D Day Care	1111 Robin St	Glen Rose	12
					Somervell County Subtotal:	*292*
					EPZ TOTAL:	**635**

Table E-3. Day Camps within the Study Area[1]

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Enroll-ment
HOOD COUNTY						
S.R.[2]	10.3	NE	Camp Fire Camp El Tesoro	7710 Fall Creek Hwy	Granbury	100
					Hood County Subtotal:	*100*
SOMERVELL COUNTY						
2E	4.5	E	Arrowhead Camp & Retreat Center	5236 FM 199	Cleburne	450
2H	8.4	ESE	Stevens Ranch	4602 FM 200	Nemo	171
2J	8.4	SE	Riverbend Retreat Center	1232 CR 411B	Glen Rose	900
GL	4.7	SSE	Glen Lake Camp & Retreat Center	1102 NE Barnard St	Glen Rose	600
					Somervell County Subtotal:	*2,121*
					EPZ TOTAL:	**2,221**

Table E-4. Medical Facilities within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Capa-city	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
HOOD COUNTY										
1D	9.4	N	Southern Concepts - South Town	1400 Fifth St	Granbury	6	6	6	0	0
1D	9.4	N	Southern Concepts - Meadowlark	900 Meadowlark Ln	Granbury	4	4	4	0	0
1D	9.4	N	Harbor Lakes Nursing & Rehab	1300 2nd St	Granbury	147	75	20	30	25
1D	9.5	N	Lakestone Terrace Senior Living	916 E Hwy 377	Granbury	208	90	78	11	1
1D	9.6	N	Courtyards at Lake Granbury	801 Calinco Dr	Granbury	82	74	44	30	0
1D	9.8	N	Southern Concepts - Torrey House	400 Torrey St	Granbury	6	6	6	0	0
1D	9.9	N	Waterview The Point Independent Living	100 Watermark Blvd	Granbury	210	210	186	24	0
1D	10.0	N	Waterview The Cove Assisted Living & Memory Care	101 Watermark Blvd	Granbury	55	38	24	12	2
4E	9.3	N	Bridgewater Memory Care	900 Autumn Ridge Dr	Granbury	52	45	22	23	0
4E	9.3	N	Lake Granbury Medical Center[3]	1310 Paluxy Hwy	Granbury	83	16	12	1	3

[1] Day camps typically last 1-2 weeks during the summer. Refer to Section 8 for the ETE calculation for these transit dependents.
[2] Camp Fire Camp El Tesoro is located in S.R. (Shadow Region). As per the discussion with Hood County, this day camp will evacuate due to the close proximity to the EPZ boundary.
[3] As per Hood County EMA, Lake Granbury Medical Center will shelter in place.

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Capa-city	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
4E	9.8	N	Granbury Care Center	301 S Park St	Granbury	181	145	59	84	2
4F	8.5	NNW	Magnolia Court	2310 Paluxy Hwy	Granbury	22	18	17	1	0
4F	8.5	NNW	Quail Park of Granbury	2300 Paluxy Hwy	Granbury	20	13	0	0	13
4F	8.6	NNW	Granbury Villa Nursing Center	2124 Paluxy Hwy	Granbury	95	62	21	38	3
					Hood County Subtotal:	*1,171*	*802*	*499*	*254*	*49*
SOMERVELL COUNTY										
GL	4.3	SE	Cherokee Rose Manor	203 Bo Gibbs Blvd	Glen Rose	102	60	37	19	4
GL	4.5	SSE	Glen Rose Nursing and Rehab Center	1021 Holden St	Glen Rose	120	80	50	25	5
GL	4.5	SSE	Glen Rose Medical Center-Hospital	1021 Holden St	Glen Rose	123	84	52	27	5
					Somervell County Subtotal:	*345*	*224*	*139*	*71*	*14*
					EPZ TOTAL:	**1,516**	**1,026**	**638**	**325**	**63**

Table E-5. Major Employers within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Employees (Max Shift)	% Employees Commuting into the EPZ	Employees Commuting into the EPZ	Employee Vehicles Commuting into the EPZ
HOOD COUNTY									
1D	9.2	N	Wal-Mart Supercenter	735 Hwy 377	Granbury	325	90%	293	271
					Hood County Subtotal:	*325*	*-*	*293*	*271*
SOMERVELL COUNTY									
CP	-	-	Comanche Peak Nuclear Power Plant[4]	Hill City Hwy	Glen Rose	750	32%	241	223
					Somervell County Subtotal:	*750*	*-*	*241*	*223*
					EPZ TOTAL:	**1,075**	**-**	**534**	**494**

[4] As per Vistra Operations Company LLC (Vistra OpCo), staffing at the plant consists of 3 employers: Vistra OpCo, DZ, and Allied Universal.

Table E-6. Recreational Areas within the Study Area

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Facility Type	Transients	Vehicles
HOOD COUNTY								
1B	3.1	NE	Lone Star RV Ranch	8905 Glen Rose Hwy	Granbury	Campground	20	20
1C	7.2	NE	Pecan Planation Golf Course	8650 Westover Ct	Granbury	Golf Course	300	300
1C	7.2	NE	Pecan Plantation Marina	4600 W Wedgefield Rd	Granbury	Marina	100	100
1C	7.8	NE	De Cordova Dam Park	7608 Rollins Rd	Granbury	Park	198	90
1C	8.0	NE	Nutcracker Golf Club	9500 Orchard Dr	Granbury	Golf Course	300	300
1C	8.5	NE	Lake Granbury RV Ranch	7001 Deer Hollow Ct	Granbury	Campground	75	75
1C	9.4	ENE	Pecan Plantation RV Park	10000 Ravenswood Rd	Granbury	Campground	26	26
1D	6.0	NNE	Granbury RV Resort	1800 Mambrino Hwy	Granbury	Campground	87	87
1D	6.9	NNE	Rustic Ranch RV Camp	2515 Williamson Rd	Granbury	Campground	5	5
1D	7.6	NNE	Indian Harbor Marina	1413 Blackhawk Cir	Granbury	Marina	50	50
1D	8.1	N	Indian Harbour RV Park	3819 Gila Cir	Granbury	Campground	150	150
1D	8.2	N	Lake Granbury Marina (Stumpy's)	2323 S Morgan St	Granbury	Marina	100	100
1D	8.4	N	Rough Creek Park	Rough Creek Estates	Granbury	Park	175	79
1D	8.9	N	Harbor Lakes Golf Club	2100 Clubhouse Dr	Granbury	Golf Course	150	150
1D	9.4	N	The Dock on Lake Granbury	1003 White Cliff	Granbury	Marina	48	24
4A	2.2	N	Squaw Creek Park	2300 CR 213	Granbury	Park	250	120
4A	2.8	NE	Midway Pines RV Park	9322 Glen Rose Hwy	Granbury	Campground	32	30
4E	9.9	N	Brazos Drive In	1800 W Pearl St	Glen Rose	Theater	321	125
4E	10.1	N	Granbury City Park	116 W Bridge St	Granbury	Park	140	63
4F	9.3	NW	Jacks Trailer Park	6514 W US Hwy 377	Tolar	Campground	20	20
4F	9.3	NW	Park Place RV Ranch	6300 US-377	Tolar	Campground	40	40
S.R.[5]	9.7	NNW	Sunnyside RV Park	2600 W US Hwy 377	Granbury	Campground	41	41
						Hood County Subtotal:	*2,628*	*1,995*
SOMERVELL COUNTY								
2B	2.8	E	Jurassic RV Park	4621 Glen Rose Hwy	Glen Rose	Campground	50	50
2C	3.1	SSE	Wheeler Branch Park Reservoir	2099 Co Rd 301	Glen Rose	Park	200	100
2C	3.1	SE	Texas Amphitheatre	5000 Texas Dr	Glen Rose	Other	4,000	1,250
2D	4.6	SE	Squaw Valley Golf Course	2439 Hwy 67	Glen Rose	Golf Course	150	150

[5] Sunnyside RV Park is located in the Shadow Region but within the 10-mile radius. As per the discussion with Hood County, this facility is included in the study due to the close proximity to the EPZ boundary.

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Facility Type	Transients	Vehicles
2D	5.0	ESE	Rainbow Village RV Park	1018 Co Rd 303	Rainbow	Campground	54	54
2E	4.5	E	Arrowhead Camp & Retreat Center	5236 FM 199	Cleburne	Campground	150	50
2F	9.8	E	Cedar Break RV Park	8895 Hwy 67	Cleburne	Campground	50	36
2J	5.0	SE	Tres Rios RV Resort	2322 CR 312	Glen Rose	Campground	200	100
2J	8.4	SE	Riverbend Retreat Center	1232 CR 411B	Glen Rose	Campground	600	306
3B	3.7	SSW	Dinosaur Valley State Park	1629 Park Rd 59	Glen Rose	Park	421	191
3B	4.1	SSW	Dinosaur Valley RV Park	1099 Park Rd 59	Glen Rose	Campground	320	80
3B	4.2	SSE	Flint Canyon RV Park	1321 N FM 56	Glen Rose	Campground	25	18
3B	4.2	SSW	Dinosaur World	1058 Park Rd 59	Glen Rose	Museum	200	100
3D	7.0	S	Cedar Ridge RV Park	4475 W Hwy 67	Glen Rose	Campground	95	44
3F	8.2	S	Earth Promise DBA Fossil Rim Wildlife Center	2299 CR 2008	Glen Rose	Park	300	83
GL	4.1	SE	Soccer Complex	1501 Texas Dr	Glen Rose	Park	Local visitors only	
GL	4.3	SE	Somervell County Expo Center	202 Bo Gibbs Blvd	Glen Rose	Other, Not Listed	4,800	1,655
GL	4.7	SSE	Oakdale Park	1019 NE Barnard St	Glen Rose	Park	200	91
GL	4.7	S	Barnard Street RV Park	1900 SW Barnard St	Glen Rose	Campground	50	20
GL	4.7	SSE	Big Rocks Park	1014 NE Barnard St	Glen Rose	Park	100	50
GL	4.8	SSE	Paluxy Heritage Park	100 Matthews St	Glen Rose	Park	Local visitors only	
						Somervell County Subtotal:	*11,965*	*4,428*
						EPZ TOTAL:	**14,593**	**6,423**

Table E-7. Lodging Facilities within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
HOOD COUNTY							
1D	7.9	N	Lake House at Cedar Cove	1303 Comanche Cove Ct	Granbury	12	6
1D	8.1	NNE	Bakers Bunk House	3313 Midway Ct	Granbury	8	4
1D	9.5	N	Days Inn Granbury	1201 N Plaza Dr	Granbury	108	50
1D	9.5	N	La Quinta Inn and Suites	880 Harbor Lakes Dr	Granbury	171	57
1D	9.5	N	Classic Inn	1209 N Plaza Dr	Granbury	44	22
1D	9.5	N	Comfort Suites	903 Harbor Lakes Dr	Granbury	208	69
1D	9.5	N	Quality Inn & Suites	800 Harbor Lakes Dr	Granbury	171	57
1D	9.5	N	Granbury Inn and Suites	1339 N Plaza Dr	Granbury	80	40
1D	9.6	N	Blue Heron B&B	511 S Baker St	Granbury	6	3
1D	9.8	N	Holiday Inn Express & Suites Granbury	1515 N Plaza Dr	Granbury	211	96
1D	9.8	N	Inn on Lake Granbury	205 W Doyle St	Granbury	33	16
1D	9.8	N	Best Western	1517 N Plaza Dr	Granbury	165	55
1D	9.8	N	Captains House	123 W Doyle St	Granbury	4	2
1D	9.8	N	Granbury Gardens Bed & Breakfast	321 W Doyle St	Granbury	8	4
1D	9.9	N	Lake View Inn	1451 E Pearl St	Granbury	74	37
1D	9.9	N	Granbury Convention Center	621 E Pearl St	Granbury	1,500	885
1D	9.9	N	Hilton Garden Inn	635 E Pearl St	Granbury	93	74
1D	9.9	N	The Granbury on West Pearl	103 W Pearl St	Granbury	8	2
4E	9.5	N	Historic Sheriffs Carriage House	703 Spring St	Granbury	4	2
4E	10.0	N	Pomegranate House and Cottages Bed and Breakfast	1002 W Pearl St	Granbury	10	4
					Hood County Subtotal:	*2,918*	*1,485*
SOMERVELL COUNTY							
2C	2.9	SSE	Popejoy Haus Cabins	1943 CR 321	Glen Rose	7	4
2D	5.2	ESE	Glen Rose Cottage	3279 E Hwy 67	Rainbow	4	2
2D	7.2	ESE	Riverside Cottages on the Brazos	1140 CR 315	Glen Rose	40	24
2J	6.0	SE	Cedars on the Brazos	2920 CR 413	Glen Rose	30	6
2J	7.8	SSE	CJ's Country Cabins & RV Park	3454 FM 56 S	Glen Rose	64	26
3C	5.3	S	Anderson Creek Cabins	1442 Moody Ln	Glen Rose	10	4
3D	4.4	S	Paluxy Riverbed Cabins	1319 FM 205	Glen Rose	8	4
3D	4.9	S	Kozy Cabins	1443 US 67	Glen Rose	16	4
3F	9.1	SSW	The Lodge at Fossil Rim	3022 CR 2010	Glen Rose	25	8

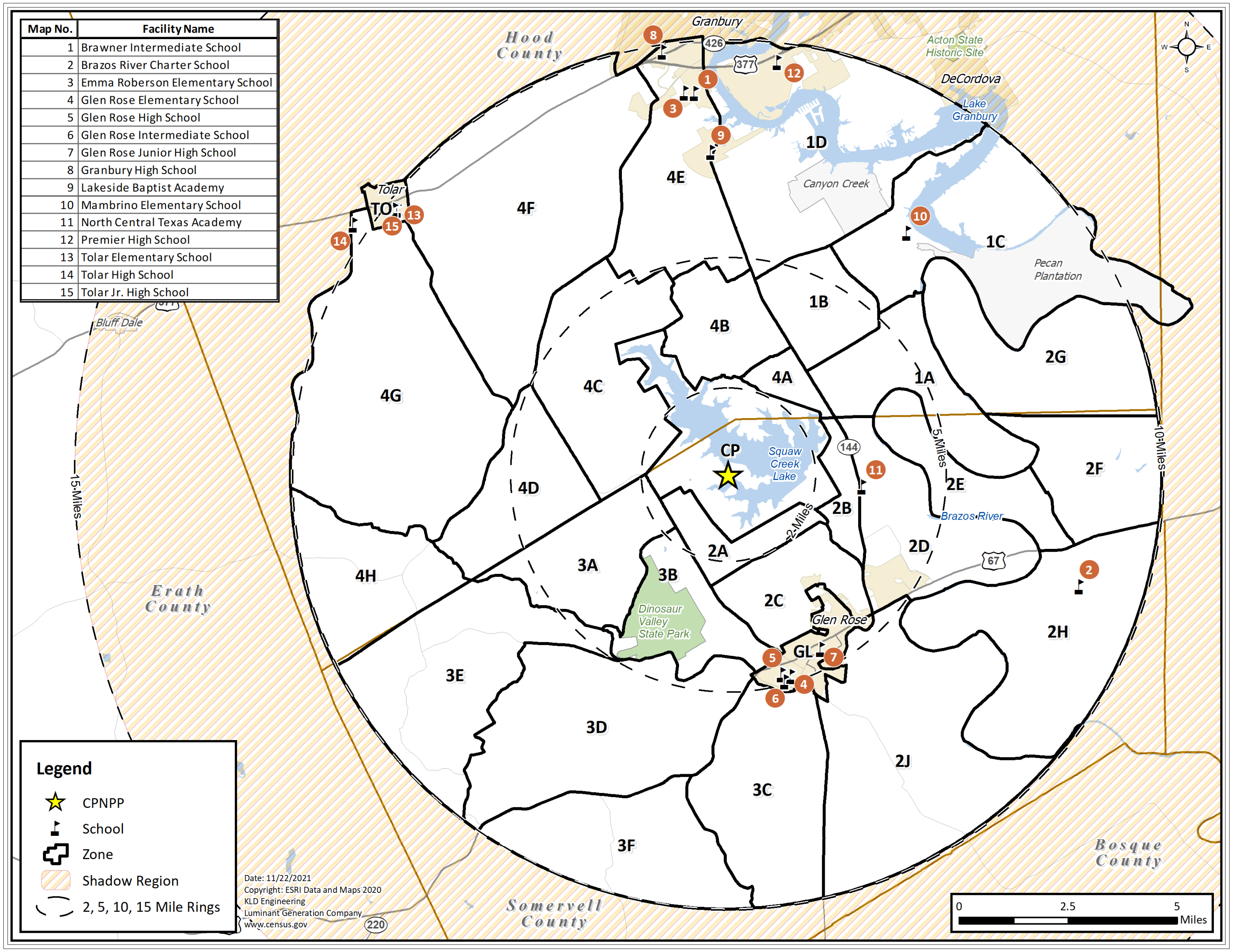
Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
3F	9.3	S	Fossil Rim Safari Campground	3022 CR 2010	Glen Rose	20	7
GL	4.4	SE	Best Western Dinosaur Valley Inn & Suites	1311 NE Big Bend Trail	Glen rose	200	60
GL	4.4	SSE	La Quinta Inn & Suites Glen Rose	101 West Bo Gibbs Blvd	Glen Rose	242	58
GL	4.4	SE	Comfort Inn & Suites	1615 NE Big Bend Trail	Glen Rose	200	80
GL	4.5	SE	Quality Inn & Suites	1614 N Big Bend Trail	Glen Rose	100	53
GL	4.5	SSE	Live Oak Bed and Breakfast	200 Live Oak St	Glen Rose	10	4
GL	4.6	SSE	Glen Rose Inn & Suites	300 SW Big Bend Trail	Glen Rose	95	60
GL	4.8	SSE	Country Woods Inn	420 Grand Ave	Glen Rose	45	12
GL	4.8	SSE	Inn On The River	205 SW Barnard St	Glen Rose	60	30
GL	4.8	SSE	PriceHouse Inn	304 SW Barnard St	Glen Rose	6	2
					Somervell County Subtotal:	*1,182*	*448*
					EPZ TOTAL:	**4,100**	**1,933**

Table E-8. Major Retail Facilities within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	% Transients Commuting into the EPZ	Transients	Vehicles
HOOD COUNTY								
1D	9.1	N	Brookshires Brothers	1301 S Morgan St	Granbury	10%	23	15
1D	9.3	N	Cinergy Cinemas	1201 Waters Edge Dr	Granbury	30%	20	13
1D	9.3	N	Lowe's	1021 E US Hwy 377	Granbury	5%	500	200
1D	9.3	N	Home Depot #6571	415 E Hwy 377	Granbury	5%	302	201
1D	9.3	N	Wal-Mart Supercenter	735 E Hwy 377	Granbury	75%	1,011	674
1D	9.7	N	HomeGoods	1420 E Hwy 377	Granbury	20%	60	40
					Hood County Subtotal:	-	*1,916*	*1,143*
					EPZ TOTAL:	-	**1,916**	**1,143**

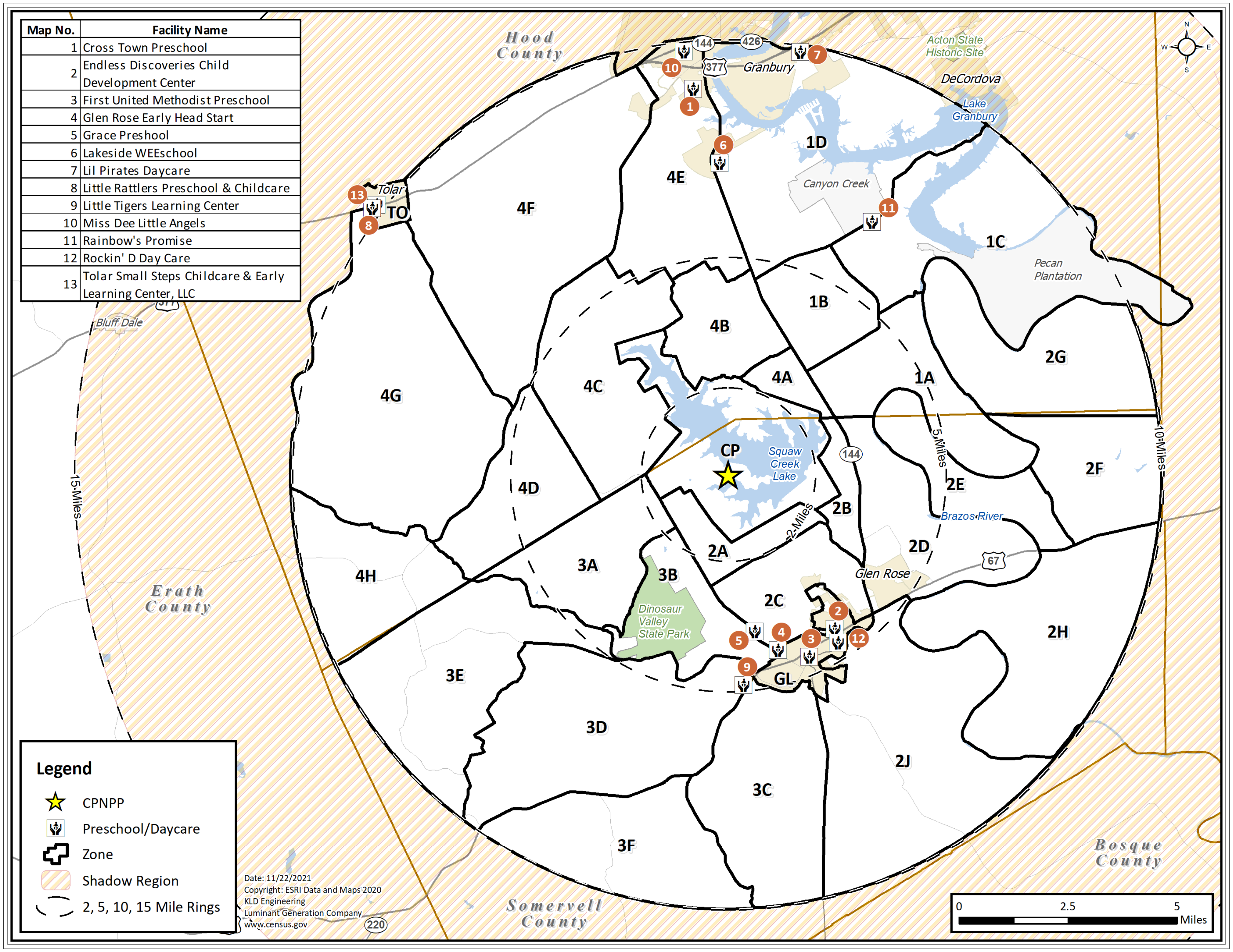
Table E-9. Correctional Facilities within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Cap-acity	Current Census
SOMERVELL COUNTY							
GL	4.0	SSE	Somervell County Jail	750 Gibbs Blvd	Glen Rose	54	32
					Somervell County Subtotal:	*54*	*32*
					EPZ TOTAL:	**54**	**32**



Map No.	Facility Name
1	Brawner Intermediate School
2	Brazos River Charter School
3	Emma Roberson Elementary School
4	Glen Rose Elementary School
5	Glen Rose High School
6	Glen Rose Intermediate School
7	Glen Rose Junior High School
8	Granbury High School
9	Lakeside Baptist Academy
10	Mambrino Elementary School
11	North Central Texas Academy
12	Premier High School
13	Tolar Elementary School
14	Tolar High School
15	Tolar Jr. High School

Figure E-1. Schools within the EPZ



Map No.	Facility Name
1	Cross Town Preschool
2	Endless Discoveries Child Development Center
3	First United Methodist Preschool
4	Glen Rose Early Head Start
5	Grace Preshool
6	Lakeside WEEschool
7	Lil Pirates Daycare
8	Little Rattlers Preschool & Childcare
9	Little Tigers Learning Center
10	Miss Dee Little Angels
11	Rainbow's Promise
12	Rockin' D Day Care
13	Tolar Small Steps Childcare & Early Learning Center, LLC

Figure E-2. Preschools and Daycares within the EPZ

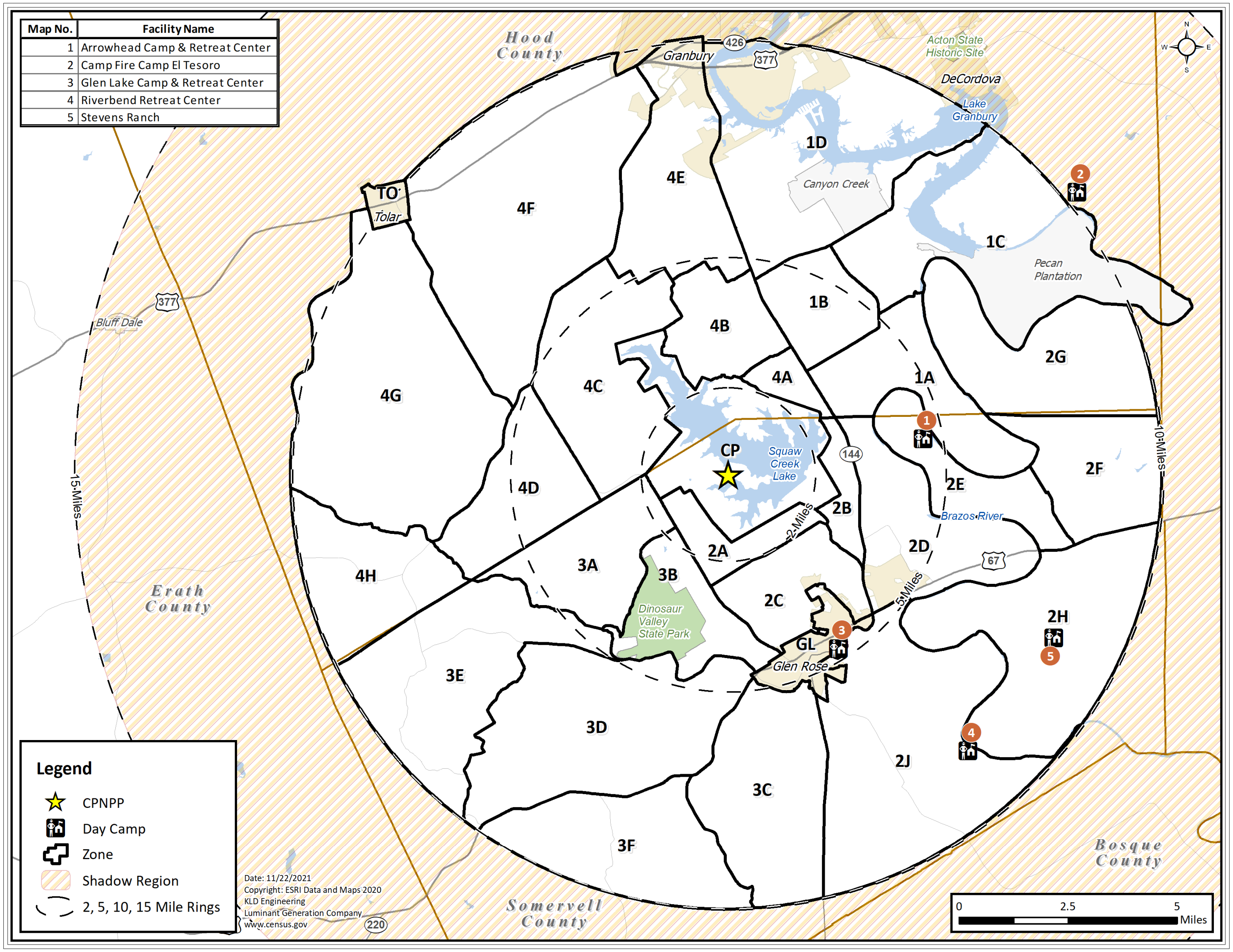
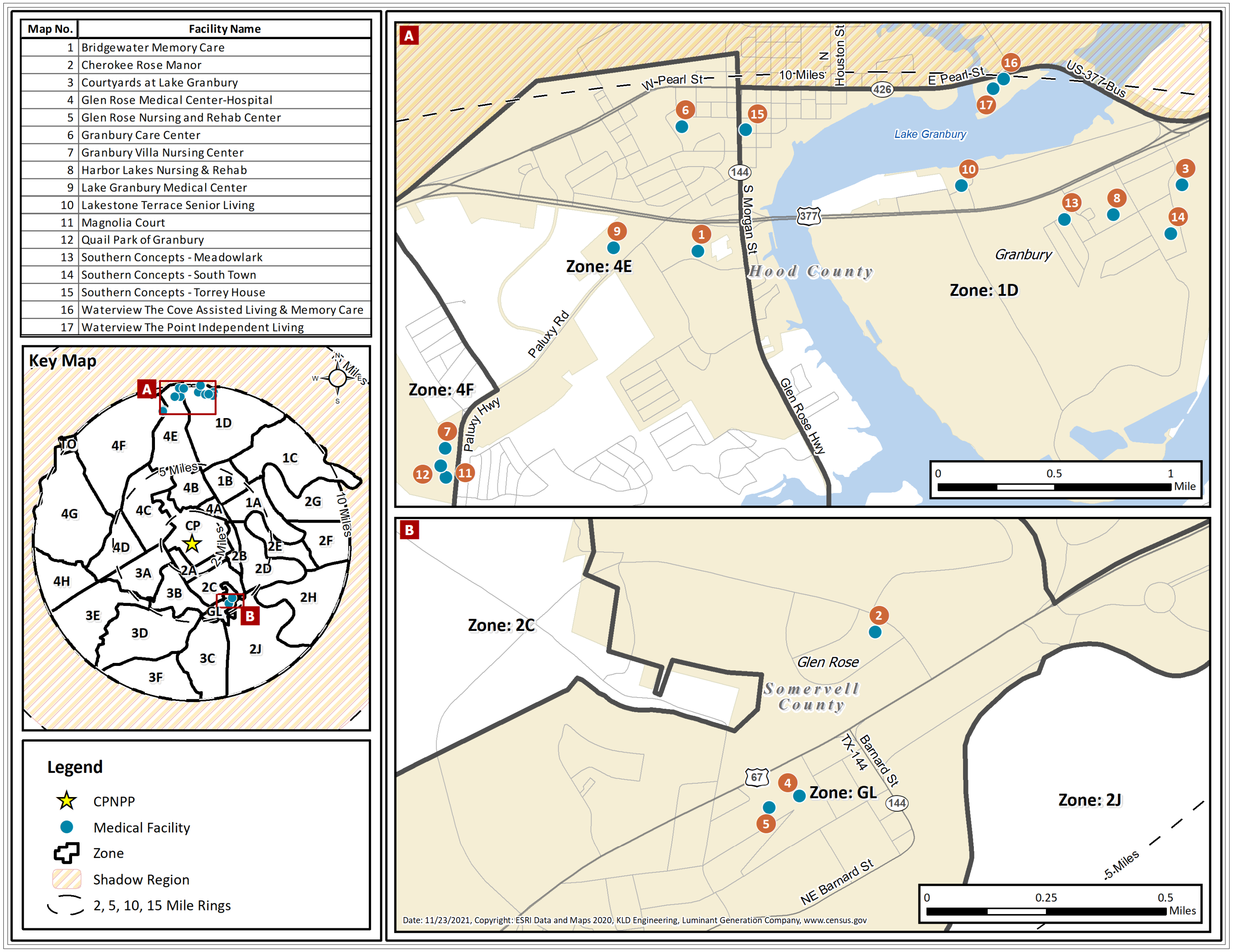


Figure E-3. Day Camps within the Study Area



Map No.	Facility Name
1	Bridgewater Memory Care
2	Cherokee Rose Manor
3	Courtyards at Lake Granbury
4	Glen Rose Medical Center-Hospital
5	Glen Rose Nursing and Rehab Center
6	Granbury Care Center
7	Granbury Villa Nursing Center
8	Harbor Lakes Nursing & Rehab
9	Lake Granbury Medical Center
10	Lakestone Terrace Senior Living
11	Magnolia Court
12	Quail Park of Granbury
13	Southern Concepts - Meadowlark
14	Southern Concepts - South Town
15	Southern Concepts - Torrey House
16	Waterview The Cove Assisted Living & Memory Care
17	Waterview The Point Independent Living

Figure E-4. Medical Facilities within the EPZ

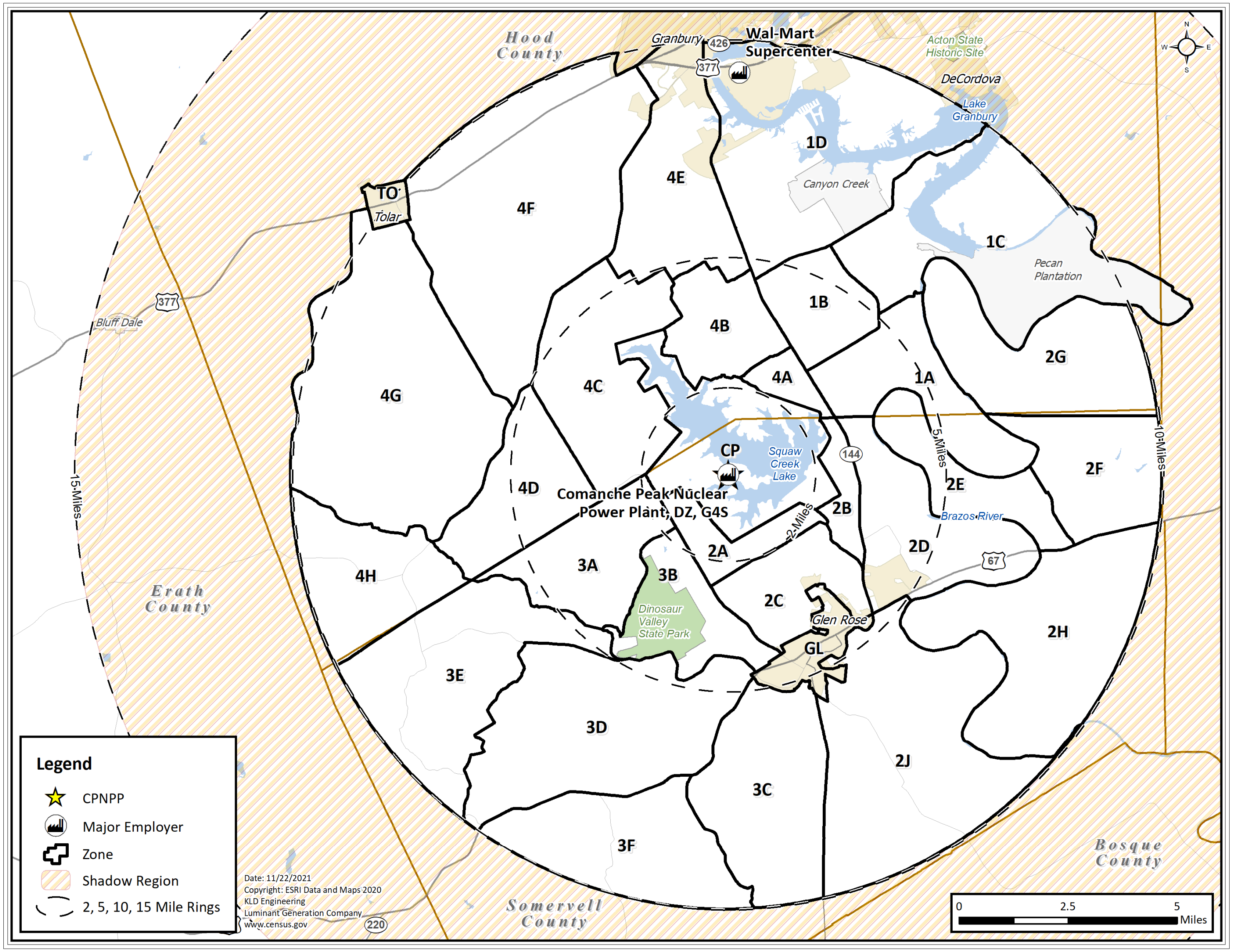


Figure E-5. Major Employers within the EPZ

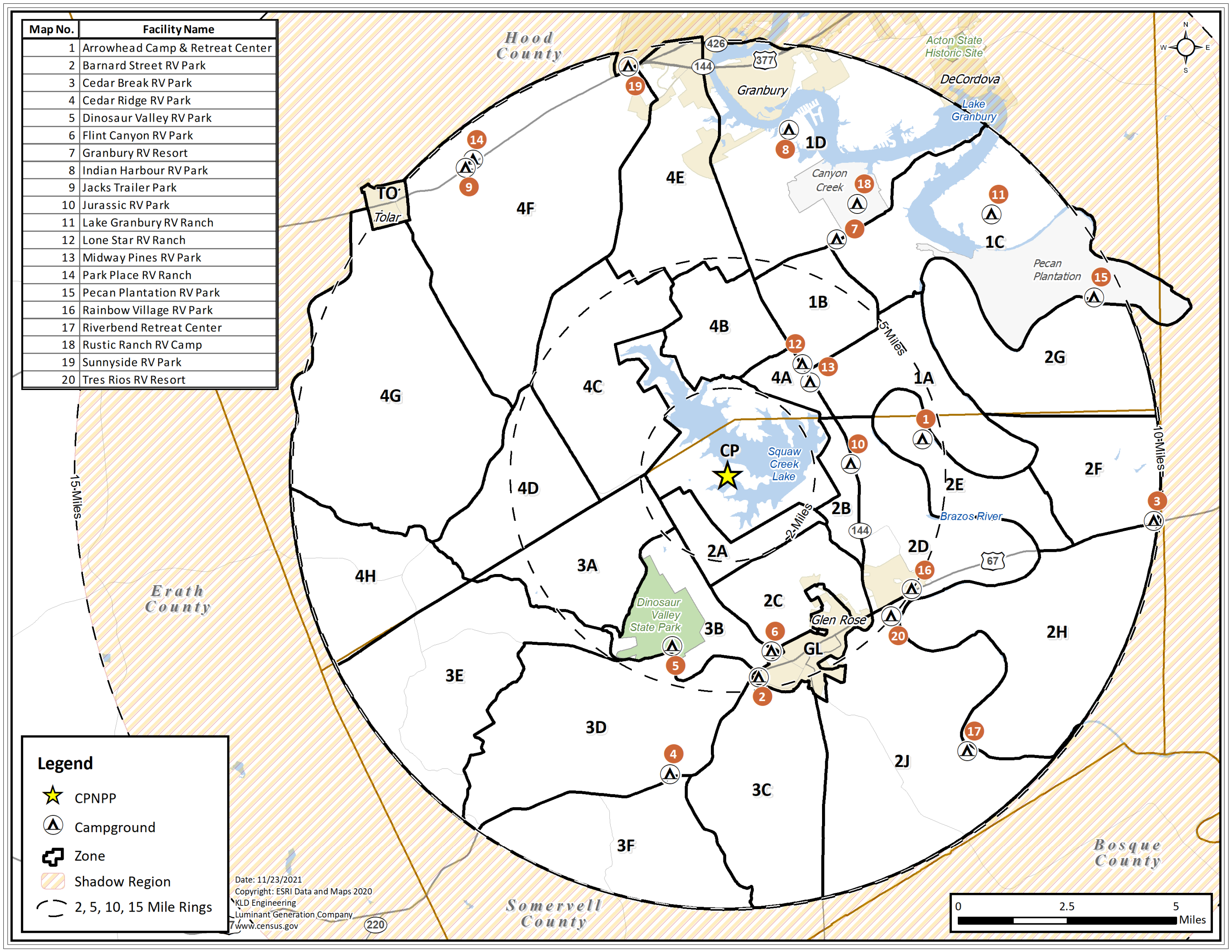


Figure E-6. Campgrounds within the EPZ

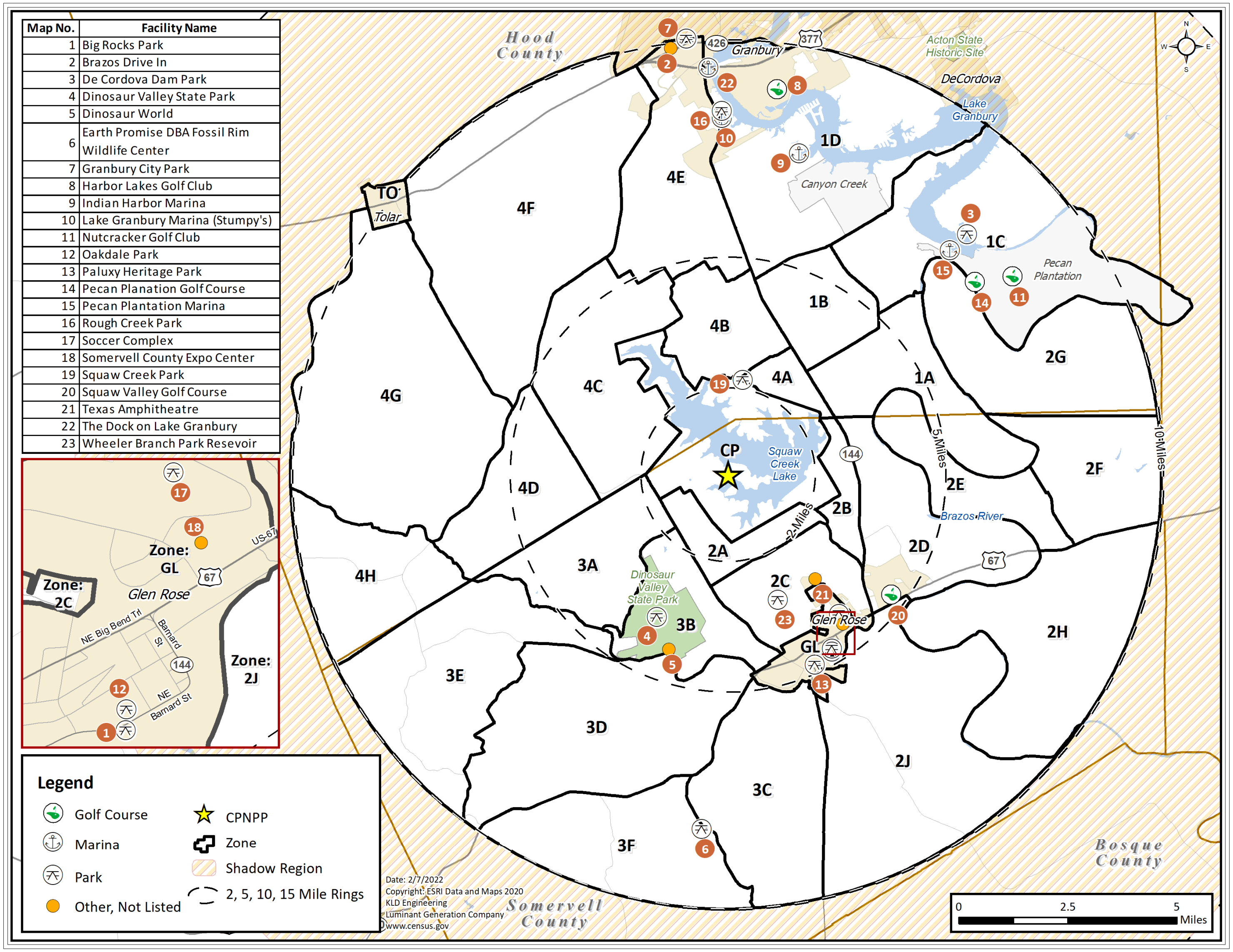


Figure E-7. Golf Courses, Marinas, Parks and Other Recreational Areas within the Study Area

Map No.	Facility Name
1	Anderson Creek Cabins
2	Bakers Bunk House
3	Best Western
4	Best Western Dinosaur Valley Inn & Suites
5	Blue Heron B&B
6	Captains House
7	Cedars on the Brazos
8	CJ's Country Cabins & RV Park
9	Classic Inn
10	Comfort Inn & Suites
11	Comfort Suites
12	Country Woods Inn
13	Days Inn Granbury
14	Fossil Rim Safari Campground
15	Glen Rose Cottage
16	Glen Rose Inn & Suites
17	Granbury Convention Center
18	Granbury Gardens Bed & Breakfast
19	Granbury Inn and Suites
20	Hilton Garden Inn
21	Historic Sheriffs Carriage House
22	Holiday Inn Express & Suites Granbury
23	Inn on Lake Granbury
24	Inn On The River
25	Kozy Cabins
26	La Quinta Inn & Suites Glen Rose
27	La Quinta Inn and Suites
28	Lake House at Cedar Cove
29	Lake View Inn
30	Live Oak Bed and Breakfast
31	Paluxy River Bed Cabins
32	Pomegranate House and Cottages Bed and Breakfast
33	Popejoy Haus Cabins
34	PriceHouseInn
35	Quality Inn & Suites
36	Quality Inn & Suites
37	Riverside Cottages on the Brazos
38	The Granbury on West Pearl
39	The Lodge at Fossil Rim

Legend

- CPNPP
- Lodging Facility
- Zone
- Shadow Region
- 2, 5, 10, 15 Mile Rings

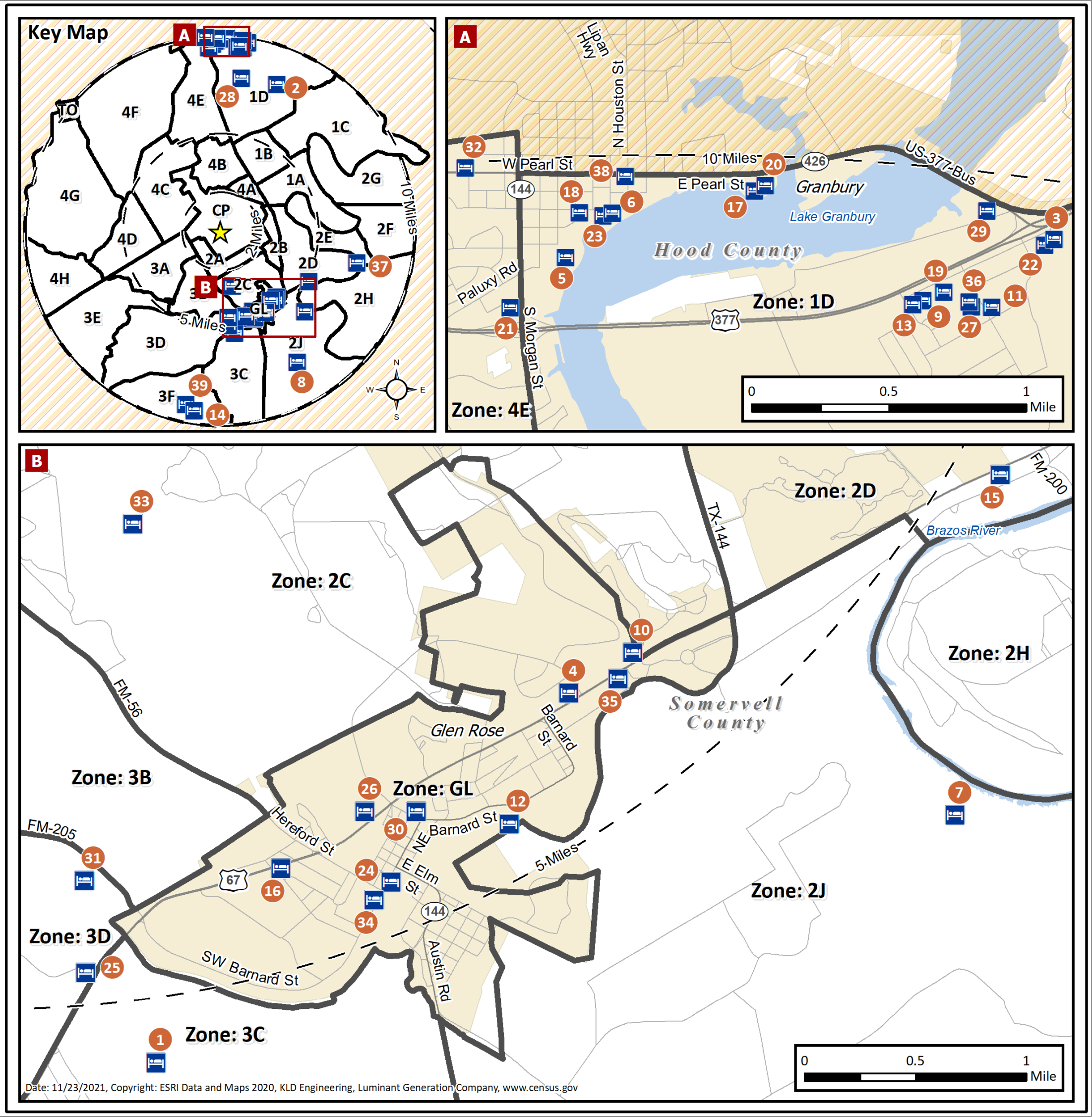


Figure E-8. Lodging Facilities within the EPZ

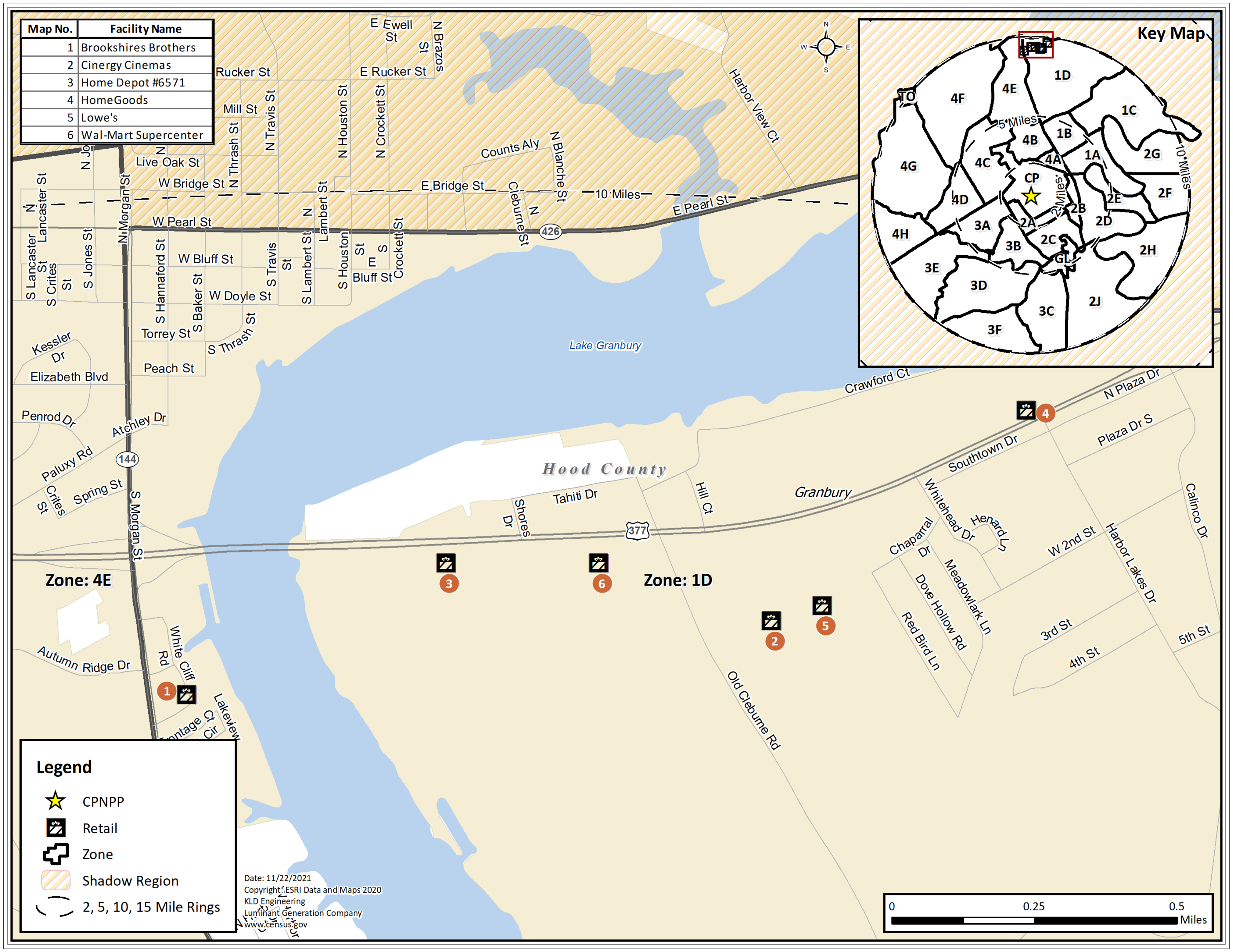


Figure E-9. Major Retail Facilities within the EPZ

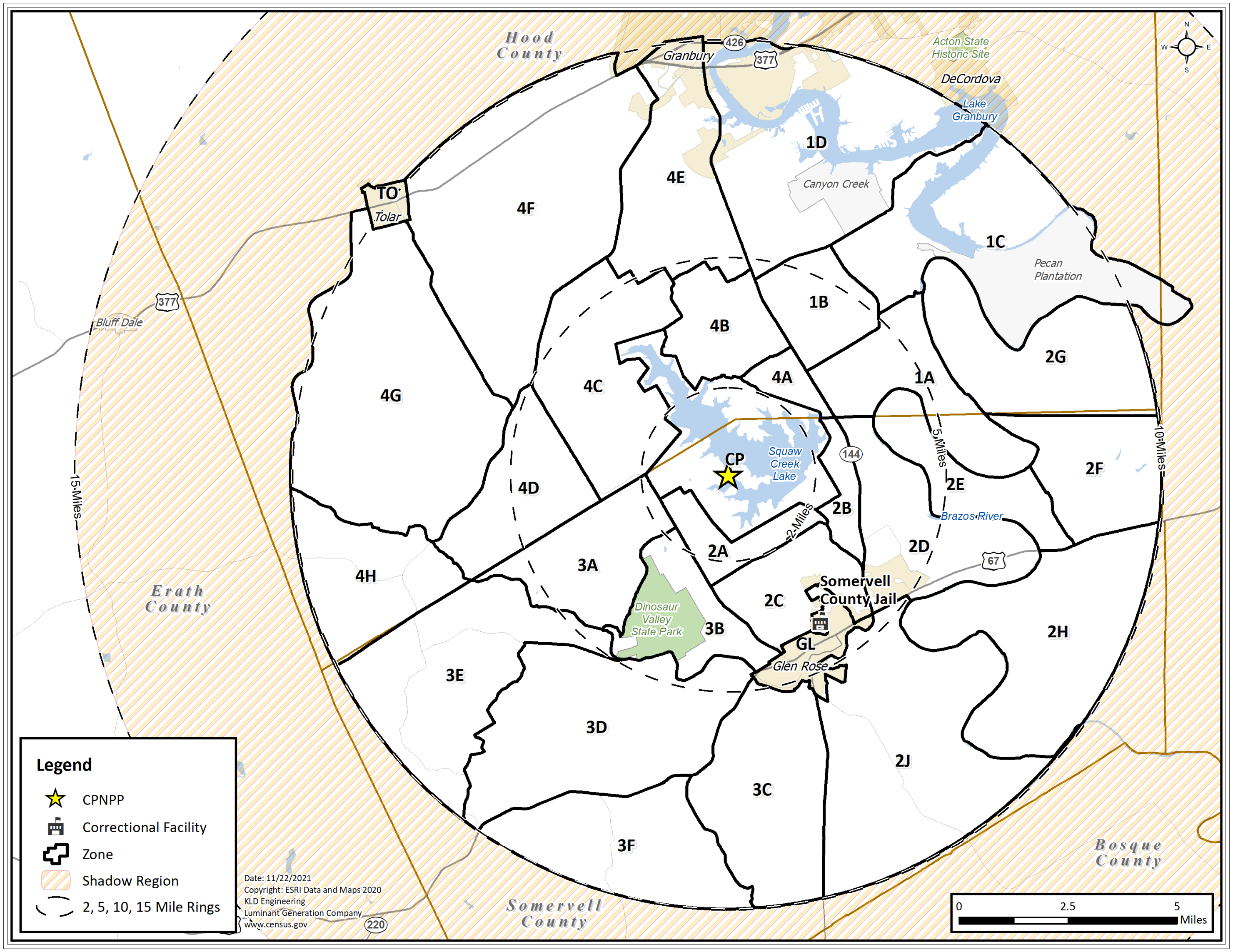


Figure E-10. Correctional Facilities within the EPZ

APPENDIX F

Demographic Survey

F. DEMOGRAPHIC SURVEY

F.1 Introduction

The development of evacuation time estimates (ETE) for the Comanche Peak Nuclear Power Plant (CPNPP) Emergency Planning Zone (EPZ) requires the identification of travel patterns, car ownership, and household size of the population within the EPZ. Demographic information can be obtained from Census data. The use of this data has several limitations when applied to emergency planning. First, the Census data do not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data do not contain attitudinal responses needed from the population of the EPZ and consequently may not accurately represent the anticipated behavioral characteristics of the evacuating populace.

These concerns are addressed by conducting a demographic survey of a representative sample of the EPZ population. The survey is designed to elicit information from the public concerning family demographics and estimates of response times to well defined events. The design of the survey includes a limited number of questions of the form "What would you do if …?" and other questions regarding activities with which the respondent is familiar ("How long does it take you to …?").

F.2 Survey Instrument and Sampling Plan

Attachment A presents the final survey instrument used for the demographic survey. A draft of the instrument was submitted to stakeholders for comment. Comments were received and the survey instrument was modified accordingly, prior to conducting the survey.

Following the completion of the instrument, a sampling plan was developed. Since the demographic survey discussed herein was performed in March 2021 and the 2020 Census data had not been released, 2010 Census data was used to develop the sampling plan.

A sample size of approximately 459 **completed** survey forms yield results with a sampling error of ±4.5% at the 95% confidence level. The sample must be drawn from the EPZ population. Consequently, a list of zip codes in the EPZ was developed using geographic information system (GIS) software. This list is shown in Table F-1. Along with each zip code, an estimate of the population and number of households in each area was determined by overlaying 2010 Census data and the EPZ boundary, again using GIS software. The proportional number of desired completed survey interviews for each area was identified, as shown in Table F-1. Note that the average household size computed in Table F-1 was an estimate for sampling purposes and was not used in the ETE study.

The results of the survey slightly exceeded the sampling plan. A total of 460 **completed** samples were obtained corresponding to a sampling error of ±4.5% at the 95% confidence level based on the 2010 Census data. The number of samples obtained within each zip code is also shown in Table F-1.

F.3 Survey Results

The results of the survey fall into two categories. First, the household demographics of the area can be identified. Demographic information includes such factors as household size, automobile ownership, and automobile availability. The distributions of the time to perform certain pre-evacuation activities are the second category of survey results. These data are processed to develop the trip generation distributions used in the evacuation modeling effort, as discussed in Section 5.

A review of the survey instrument reveals that several questions have a "Decline to State" entry for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a "Decline to State" response or who refuses to answer a few questions. To address the issue of occasional "Decline to State" 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 "Decline to State" responses are ignored, and the distributions are based upon the positive data that is acquired.

F.3.1 Household Demographic Results

Household Size

Figure F-1 presents the distribution of household size within the EPZ, based on the responses to the demographic survey. According to the responses, the average household contains 2.57 people. The estimated average household size from the 2020 Census data is 2.46 people, which is in good agreement with the results of the demographic survey. The percent difference between the 2020 Census data and survey data is 4.47%, which is consistent with the sampling error of 4.5%, as discussed in Section F.2.

Automobile Ownership

The average number of automobiles available per household in the EPZ is 2.32. It should be noted that all households within the EPZ have access to an automobile according to the demographic survey. The distribution of automobile ownership is presented in Figure F-2. Figure F-3 and Figure F-4 present the automobile availability by household size.

Ridesharing

Approximately 77% of the households surveyed responded that they would share a ride with a neighbor, relative, or friend if a car was not available to them when advised to evacuate in the event of an emergency, as shown in Figure F-5.

Commuters

Figure F-6 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data shows an average of 0.96 commuters per household in the EPZ, and 56% of households have at least one commuter.

Commuter Travel Modes

Figure F-7 presents the mode of travel that commuters use on a daily basis. The vast majority (91%) of commuters use their private automobiles to travel to work or college. The data shows an average of 1.08 commuters per vehicle, assuming 2 people per vehicle – on average – for carpools.

Impact of COVID-19 on Commuters

Figure F-8 presents the distribution of the number of commuters in each household that were temporarily impacted by the COVID-19 pandemic. The data shows an average of 0.59 commuters per household were affected by the COVID-19 pandemic. Approximately 66% of households indicated that no commuter in their household had a work and/or school commute that was temporarily impacted by the COVID-19 pandemic; 20% indicated one commuter was impacted; 7% indicated two commuters were impacted; 2% indicated three commuters were impacted and 4% indicated four or more commuters were impacted.

Functional or Transportation Needs

Figure F-9 presents the distribution of the number of individuals with functional or transportation need. The survey result shows that approximately 11.5% of households have functional or transportation needs. Of those with functional or transportation needs, 30% require a bus, 55% require a wheelchair accessible van, 2% require an ambulance and 13% indicated that they would require other accommodations.

F.3.2 Evacuation Response

Questions were asked to gauge the population's response to an emergency. These are now discussed:

"How many vehicles would your household use during an evacuation?" The response is shown in Figure F-10. On average, evacuating households would use 1.44 vehicles.

"Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, 57.7% said they would await the return of other family members before evacuating and 42.3% indicated that they would not await the return of other family members, as shown in Figure F-11.

"Emergency officials advise you to shelter-in-place in an emergency because you are not in the area of risk. Would you?" This question is designed to elicit information regarding compliance with instructions to shelter-in-place. The results, as shown in Figure F-12, indicate that 88.6% of households who are advised to shelter-in-place would do so; the remaining 11.4% would choose to evacuate the area.

Note the baseline ETE study assumes 20% of households will not comply with the shelter advisory, as per Section 2.5.2 of NUREG/CR-7002, Rev. 1. Thus, the data obtained above is significantly lower than the federal guidance recommendation. A sensitivity study was conducted to estimate the impact of shadow evacuation non-compliance to a shelter advisory on ETE – see Appendix M.

"Emergency officials advise you to shelter-in-place now in an emergency and possibly evacuate later while people in other areas of are advised to evacuate now. Would you?" This question is designed to elicit information specifically related to the possibility of a staged evacuation. That is, asking a population to shelter-in-place now and then to evacuate after a specified period of time. As shown in Figure F-13, results indicate that 74.8% of households would follow instructions and delay the start of evacuation until advised, while the balance of 25.2% would choose to begin evacuating immediately.

"Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?" This question is designed to elicit information regarding the destination of evacuees in case of an evacuation. Approximately 49% of households indicated that they would evacuate to a friend or relatives' home, 5% to a reception center, 17% to a hotel, motel, or campground, 5% to a second or seasonal home, 2% to another city/state and the remaining 22% indicated other location/don't know to this question, as shown in Figure F-14. It should be noted that no households indicated they would not evacuate, according to the survey.

"If you had a pet and/or animal, what would you do with your pet and/or animal if you had to evacuate?" Based on responses from the survey, 72.5% of households have a family pet, as shown in Figure F-15. Of the households with pets, 31% indicated that they would take their pets with them to a shelter, 66% indicated that they would take their pets somewhere else and only 3% would leave their pet at home, as shown in Figure F-16. Of the households that would evacuate with their pets, 95% indicated that they have sufficient room in their vehicle to evacuate with their pet(s)/animal(s).

"What type of pet(s) and/or animal(s) do you have?" Based on responses from the survey, 86% of households have a household pet (dog, cat, bird, reptile, or fish), 13% of households have farm animals (horse, chicken, goat, pig, etc.), and 1% have other small pets/animals.

F.3.3 Time Distribution Results

The survey asked several questions about the amount of time it takes to perform certain pre-evacuation activities. These activities involve actions taken by residents during the course of their day-to-day lives. Thus, the answers fall within the realm of the responder's experience.

The mobilization distributions provided below are the result of having applied the analysis described in Section 5.4.1 on the component activities of the mobilization.

As discussed in Section F.3.1 and shown in Figure F-8, the majority of respondents indicated no commuters were impacted by the COVID-19 pandemic; therefore the results for the time distribution of commuters (time to prepare to leave work/college and time to travel home from work/college) were used as is in this study.

"How long does it take the commuter to complete preparation for leaving work?" Figure F-17 presents the cumulative distribution; in all cases, the activity is completed by 90 minutes. Approximately 82% can leave within 30 minutes.

"How long would it take the commuter to travel home?" Figure F-18 presents the work to home travel time for the EPZ. About 82 % of commuters can arrive home within 45 minutes of leaving work; all within 105 minutes (1 hour and 45 minutes).

"How long would it take the family to pack clothing, secure the house, and load the car?" Figure F-19 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities.

The distribution shown in Figure F-19 has a long "tail." About 91% of households can be ready to leave home within 120 minutes; the remaining households require up to an additional hour and 15 minutes.

F.3.4 Emergency Communications

"At your place of residence, how reliable is your cell phone signal?" This question is designed to elicit information regarding the ability to be notified in case of an evacuation.

Approximately 82% of households indicated that they have very reliable signal to receive texts and phone calls, 5.4% indicated that their signal is reliable for text messages only, 9.6% indicated that they do not always receive cell communications at their residence, and 3% indicated that they do not have cell service at their residence, as shown in Figure F-20.

"Emergency management officials in your state may send text messages, similar to AMBER Alerts, with emergency directions for the public during a radiological emergency at the Comanche Peak Nuclear Power Plant. How likely would you be to take action on these directions, if you received the message?" This question is designed to elicit information regarding the likelihood of an individual to take action based on emergency management officials' guidelines.

Approximately 76% of households indicated that they are highly likely to take action on these directions, about 21.5% indicated likely, 2% indicated neither likely nor unlikely, 0.4% indicated unlikely or highly unlikely for them to take action on emergency management officials' directions, as shown in Figure F-21.

"Which of the following emergency communication methods do you think is most likely to alert you at your residence?" This question is designed to elicit information regarding the most efficient way to alert residents within the EPZ.

Approximately 74% of households indicated that a text message from emergency officials would be most likely to alert them at their residence, 15% indicated that a siren sounding near their home would likely to alter them, 6% indicated an alert broadcast on the TV, 3% and information on Twitter or Facebook or other method would be the most likely to alert those at their residence, and 2% indicated that a phone call/text message from a family member, friend or neighbor would be the most likely way to alert them at their residence, as shown in Figure F-22.

Table F-1. CPNPP Demographic Survey Sampling Plan

Zip Code	EPZ Population (2010)	EPZ Households within Zip Code (2010)	Expected Sample	Current Demographic Survey Samples Obtained
76033	15	7	0	4
76043	6685	2394	77	26
76044	14892	6301	203	156
76048	10151	4256	137	251
76049	653	254	8	6
76070	590	206	7	4
76077	142	61	2	2
76476	2071	772	25	11
Total	**35,199**	**14,251**	**459**	**460**
		Average Household Size:	**2.47**	

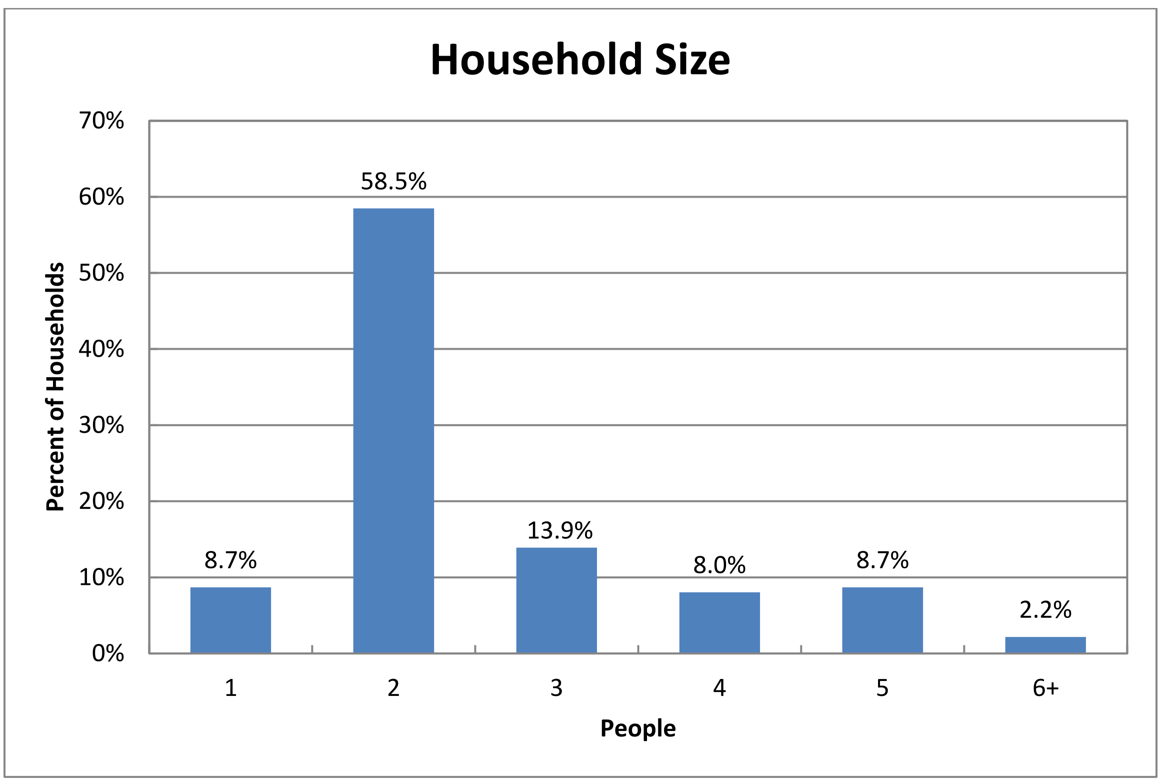


Figure F-1. Household Size in the EPZ

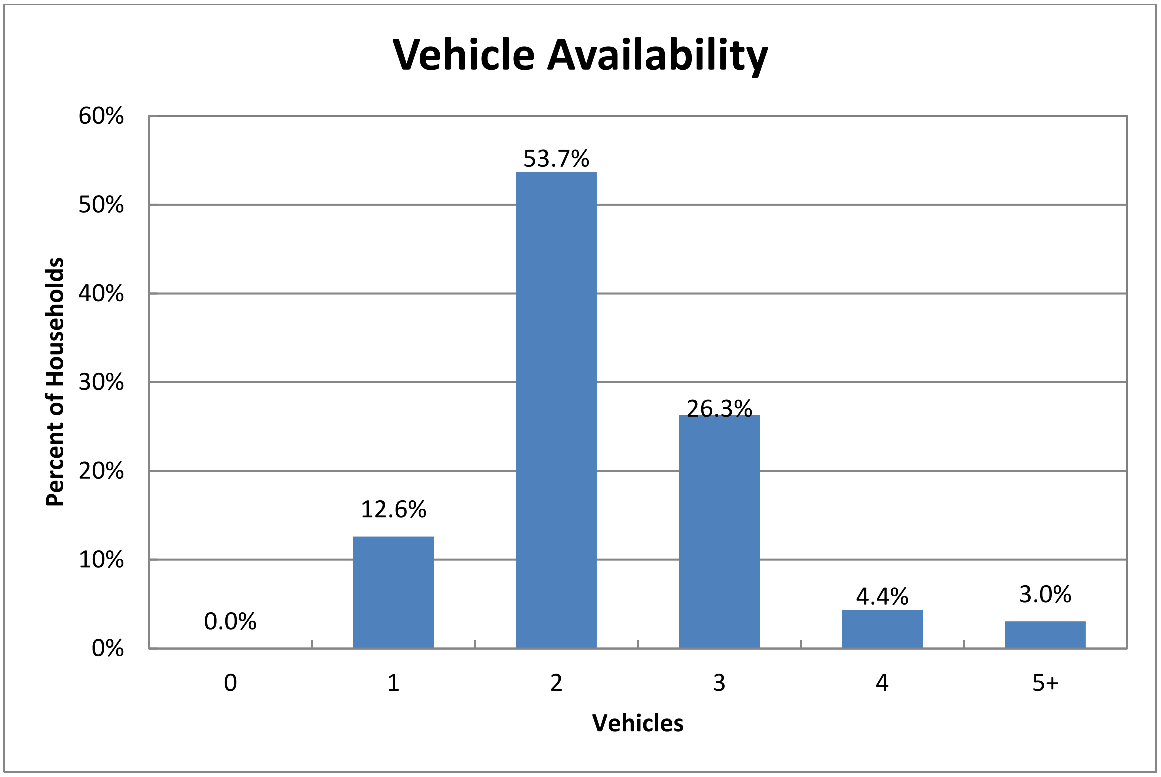


Figure F-2. Vehicle Availability

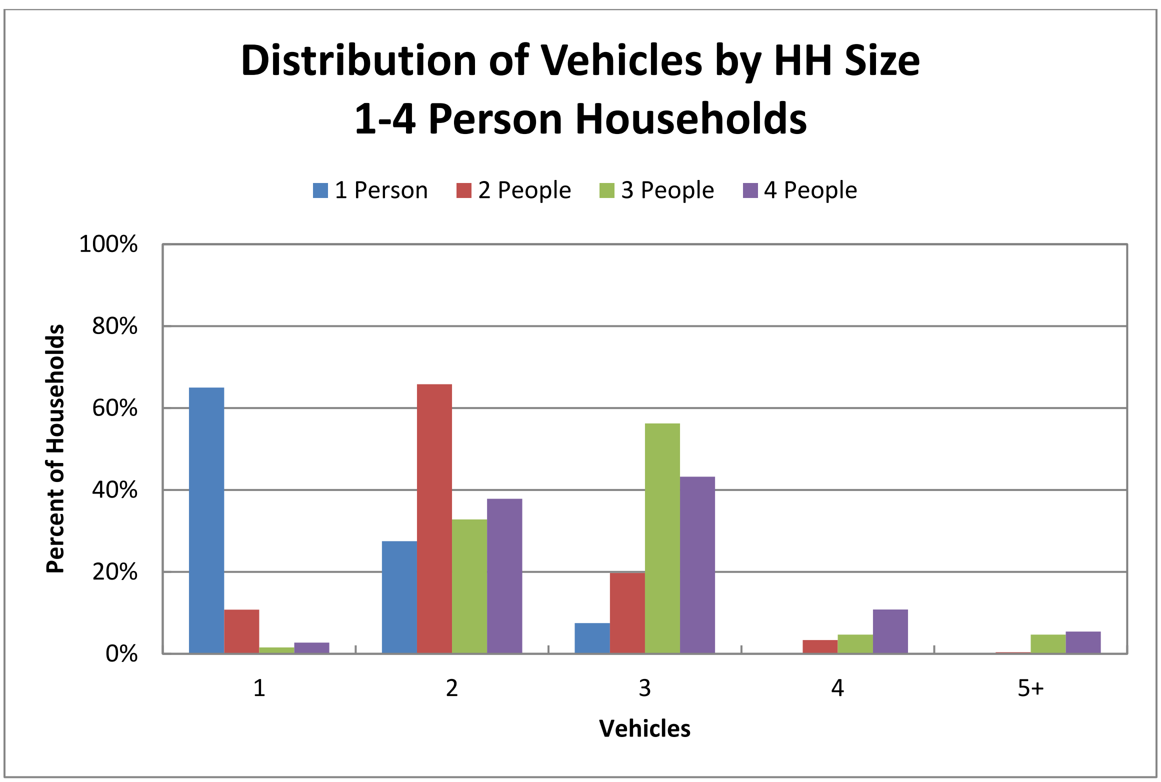


Figure F-3. Vehicle Availability - 1 to 4 Person Households

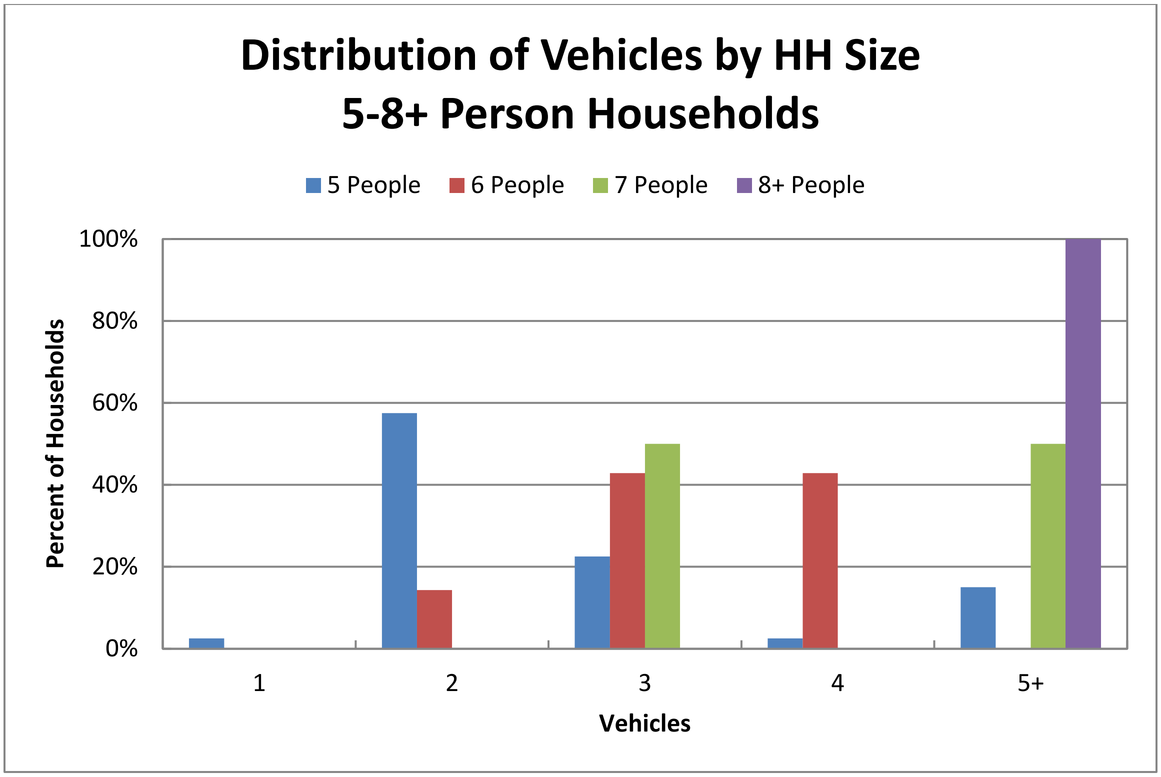


Figure F-4. Vehicle Availability - 5 to 8+ Person Households

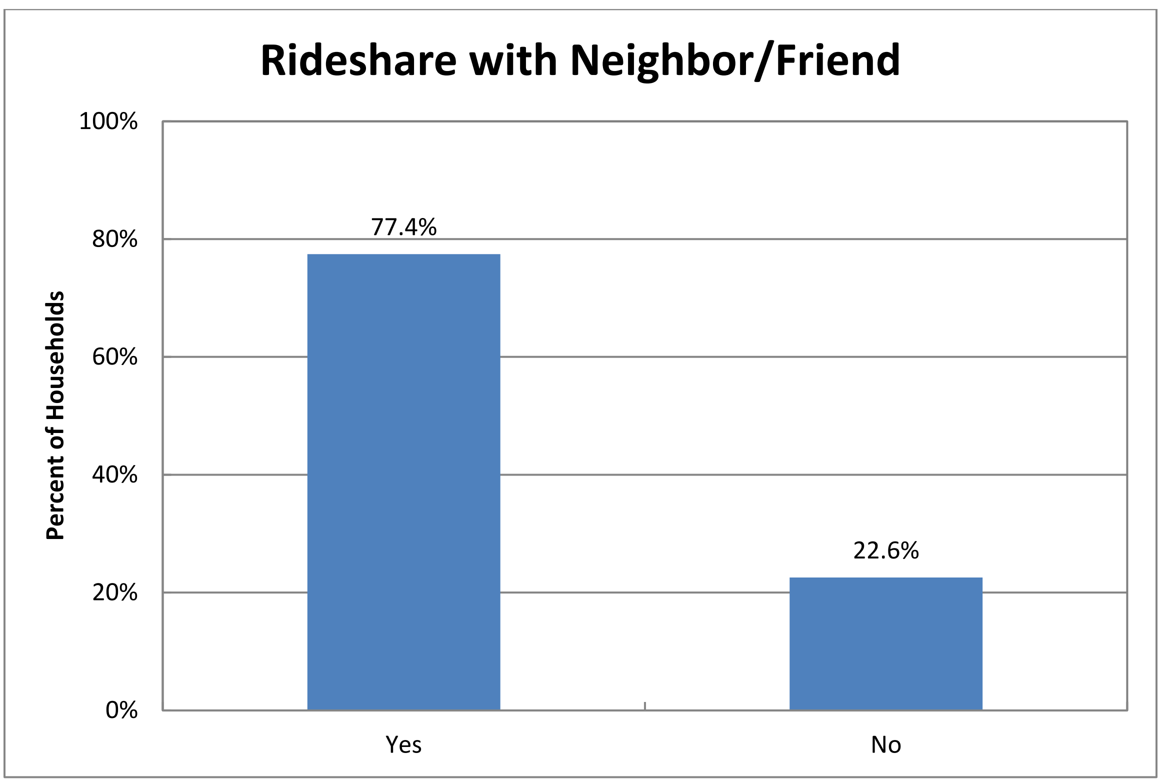


Figure F-5. Household Ridesharing Preference

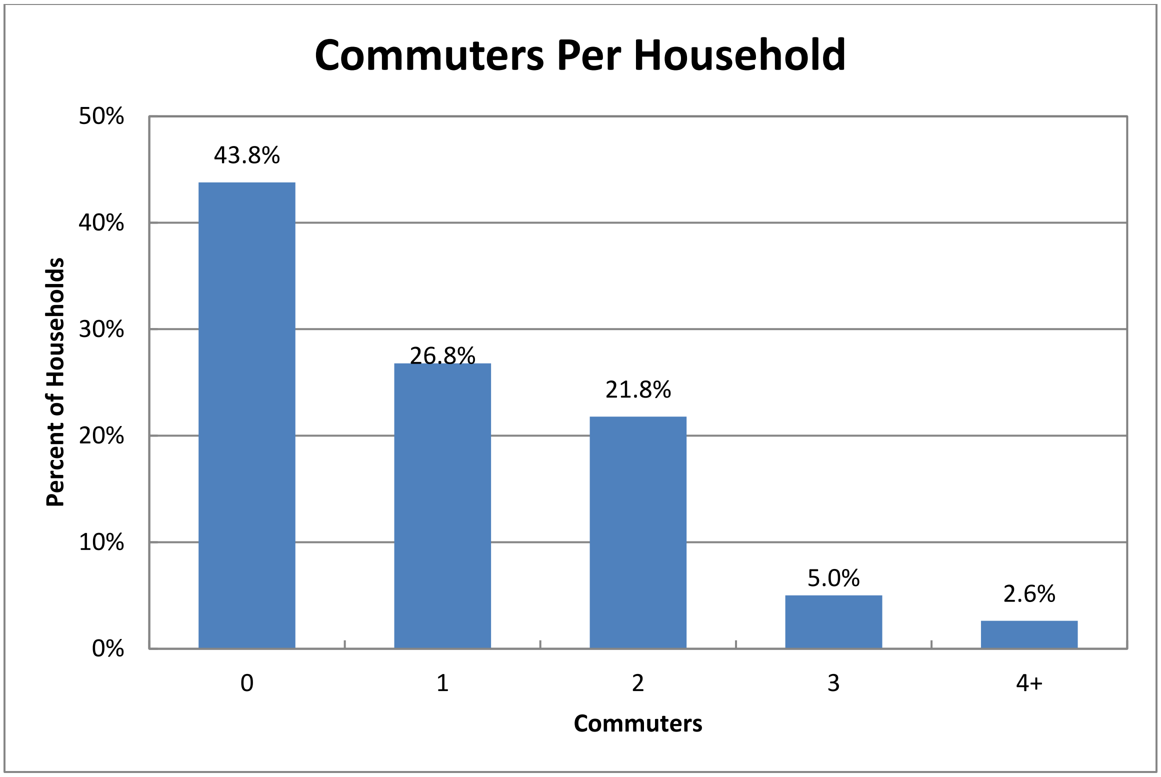


Figure F-6. Commuters per Households in the EPZ

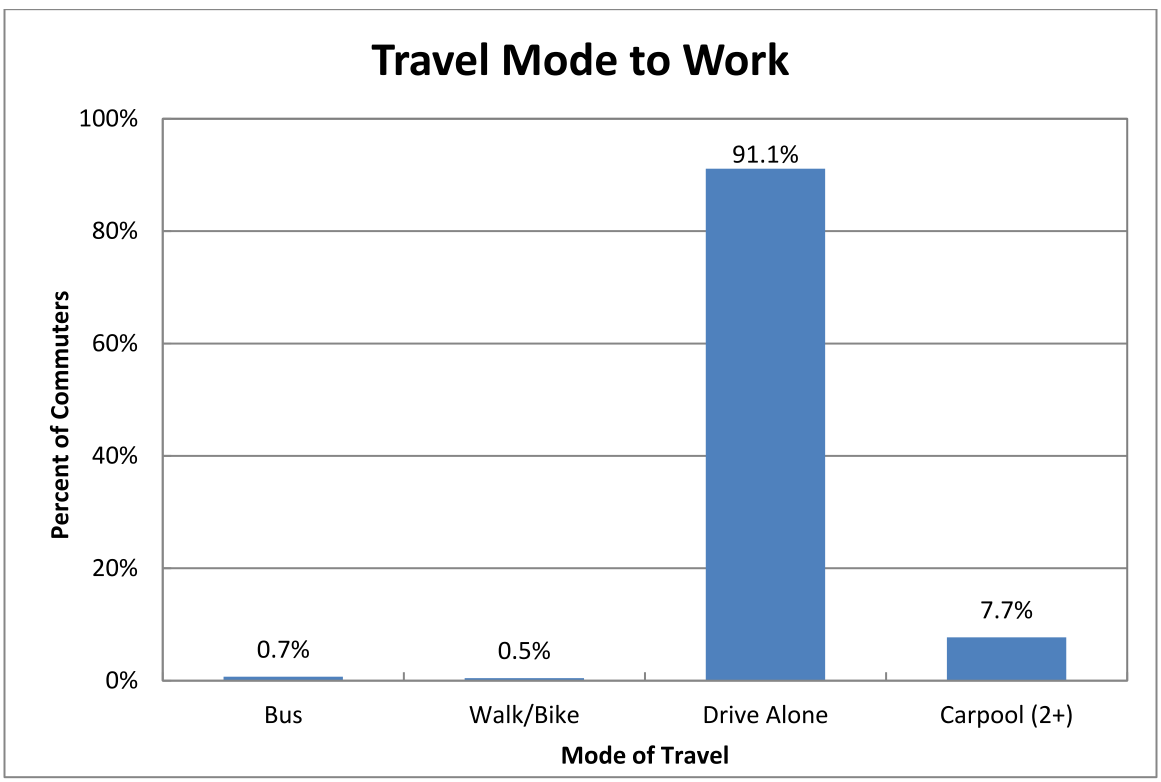


Figure F-7. Modes of Travel in the EPZ

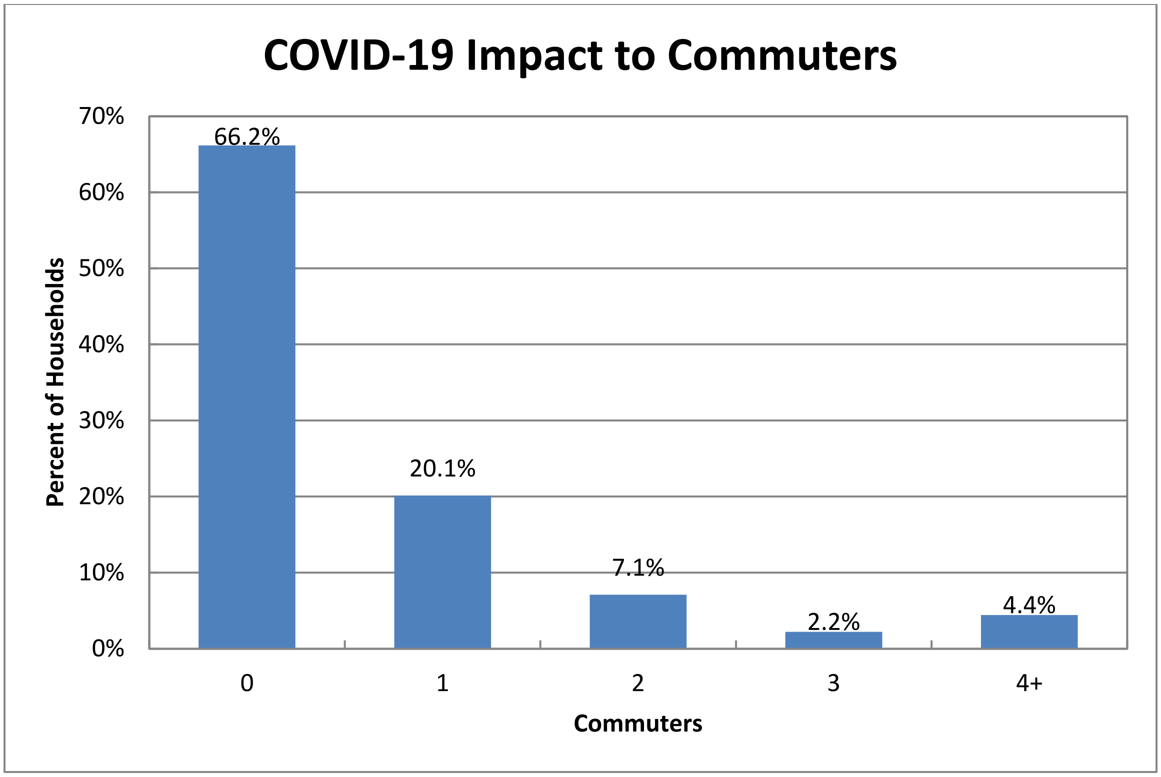


Figure F-8. Commuters Impacted by COVID-19

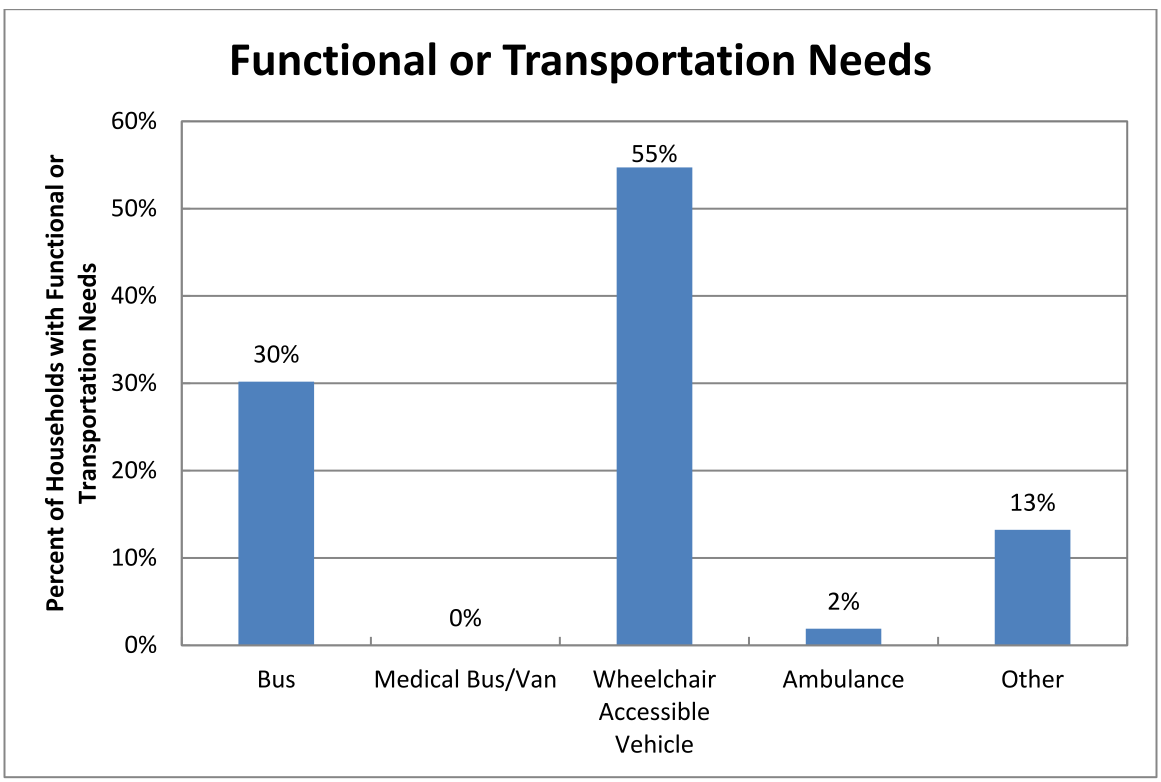


Figure F-9. Households with Functional or Transportation Needs

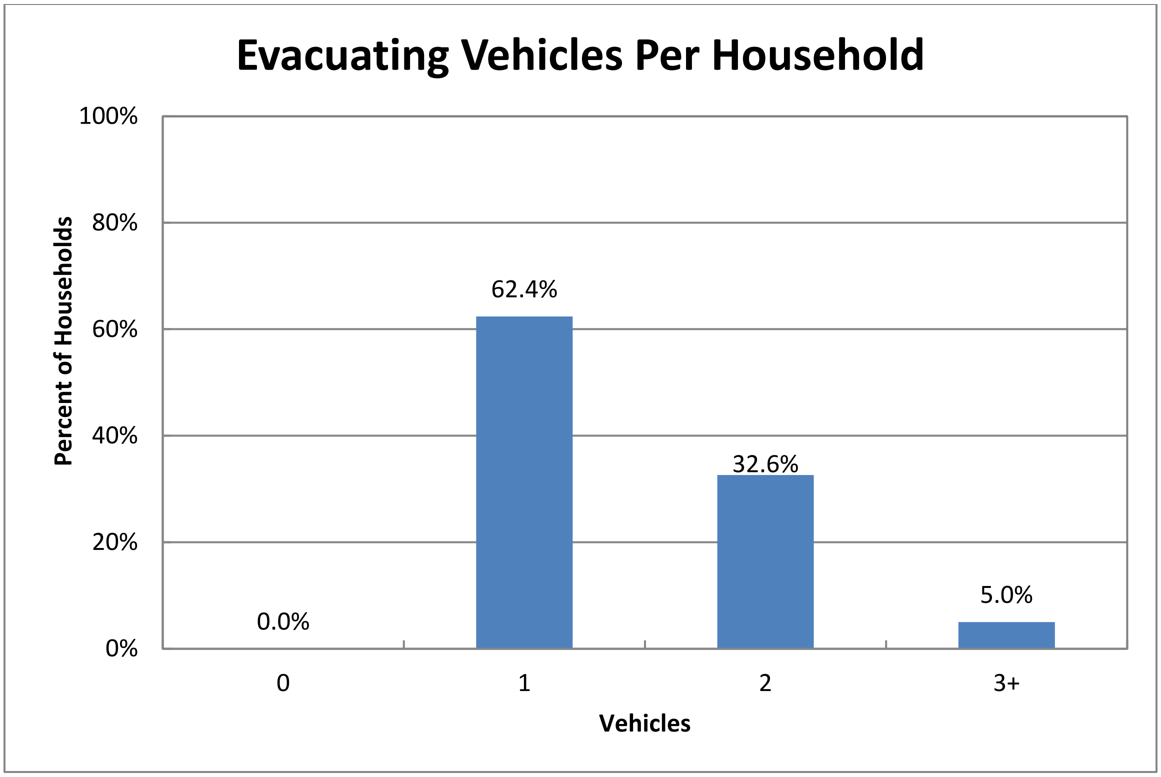


Figure F-10. Number of Vehicles Used for Evacuation

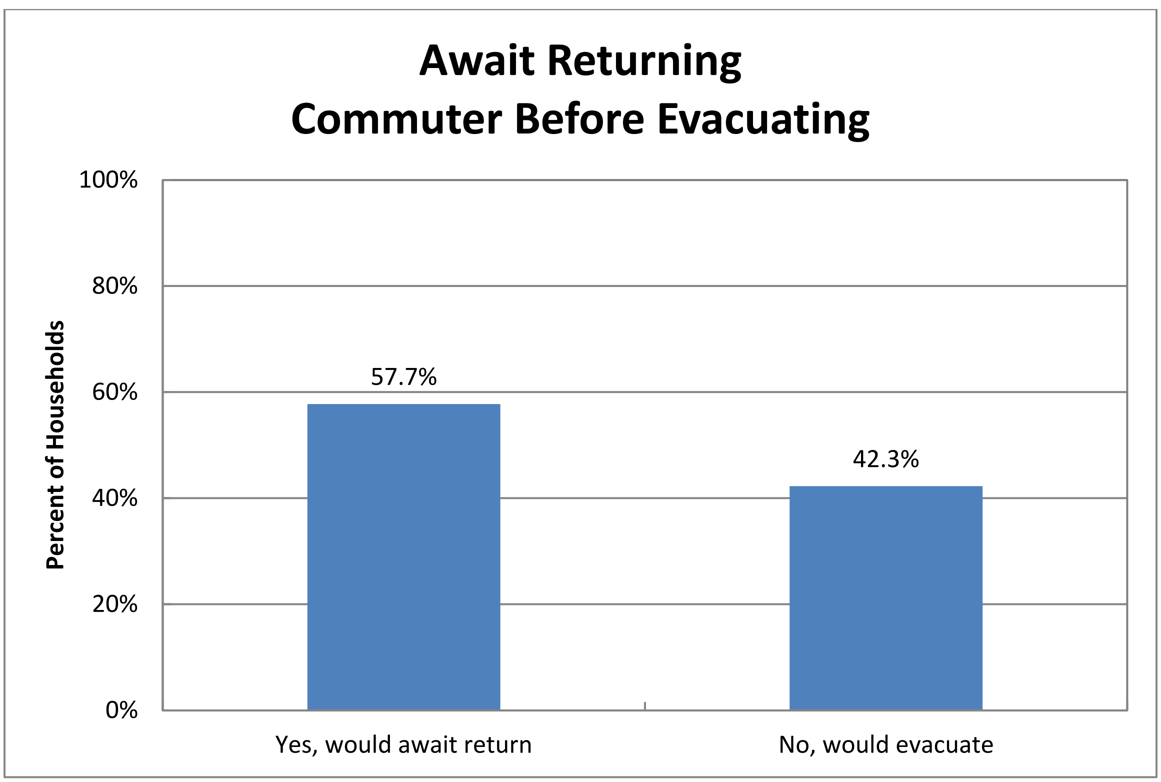


Figure F-11. Percent of Households that Await Returning Commuter Before Evacuating

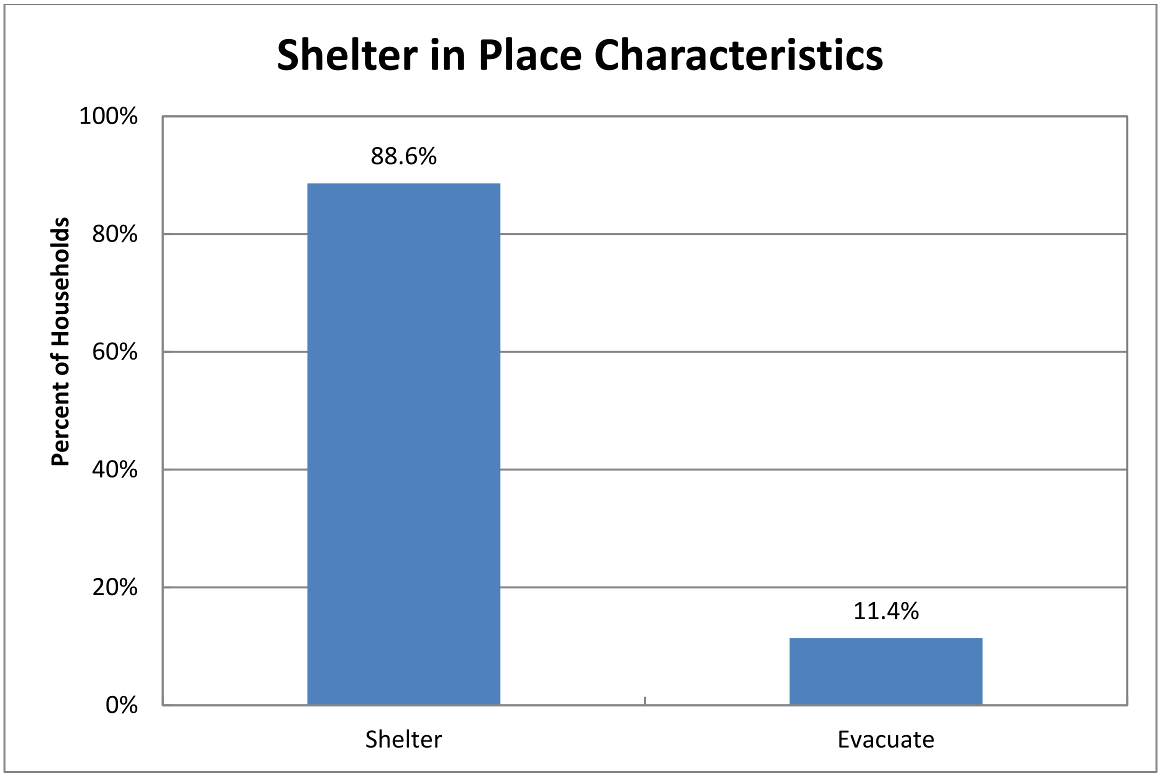


Figure F-12. Shelter in Place Characteristics

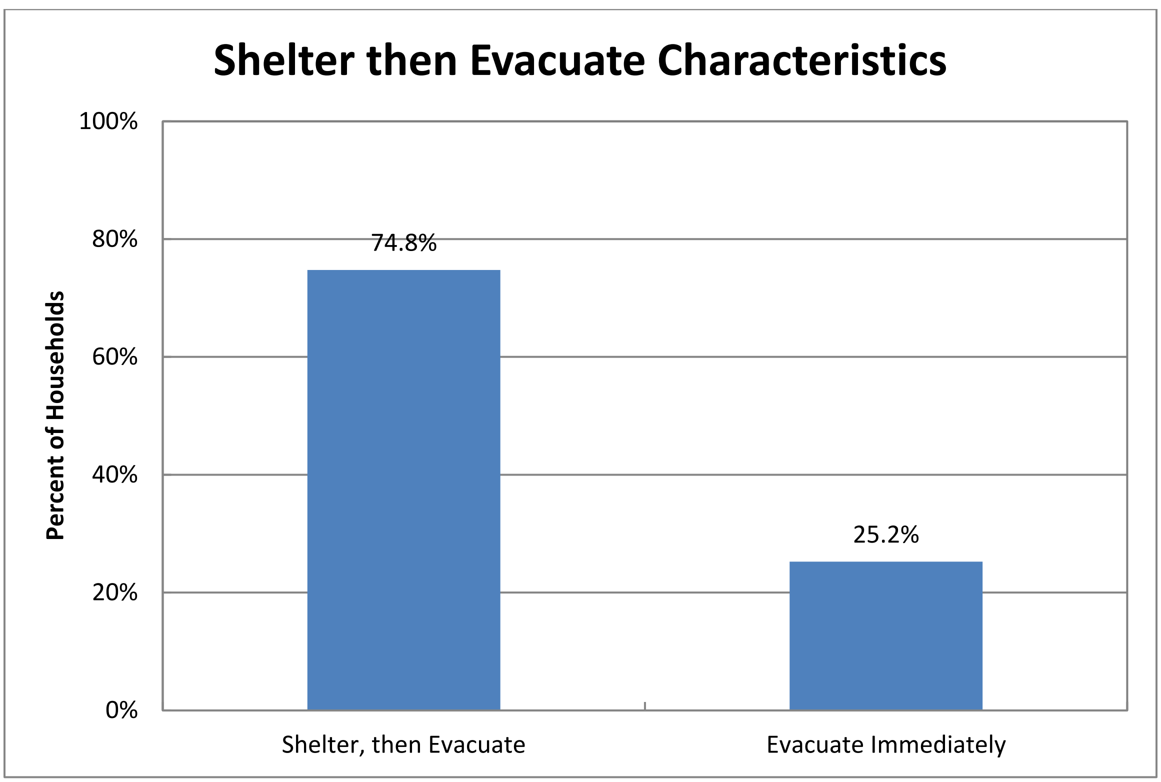


Figure F-13. Shelter in Place Characteristics – Staged Evacuation

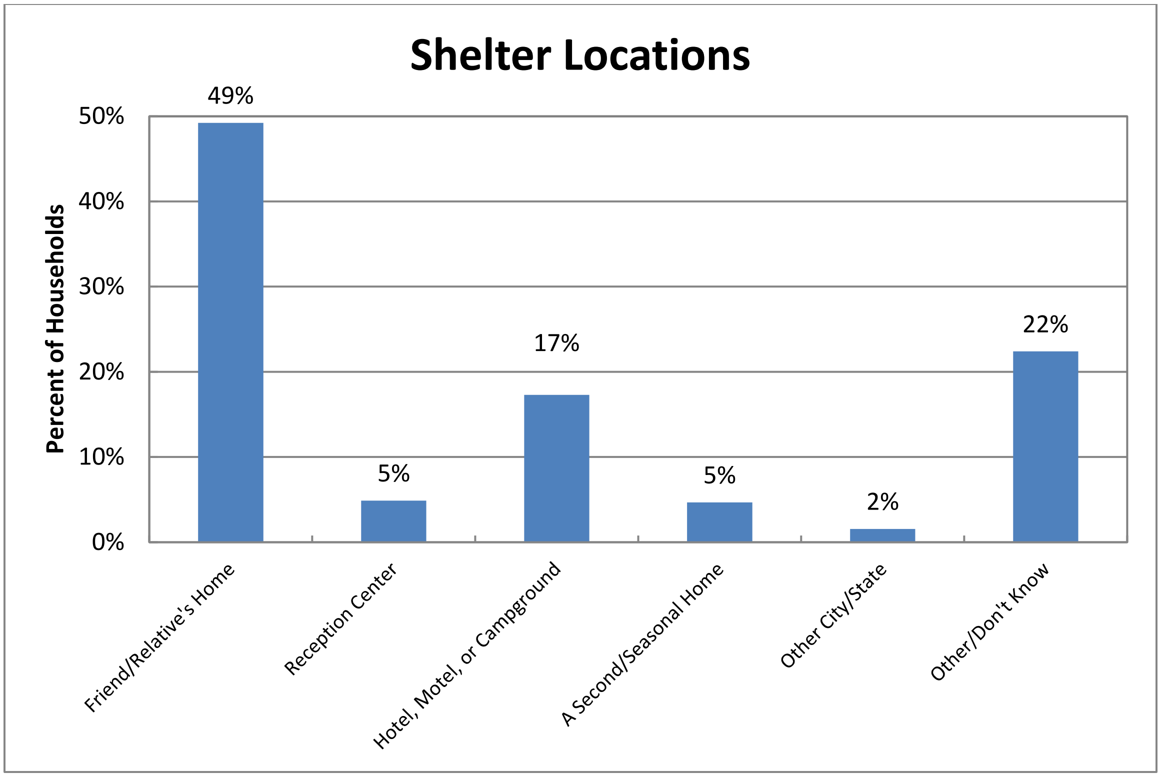


Figure F-14. Shelter Locations

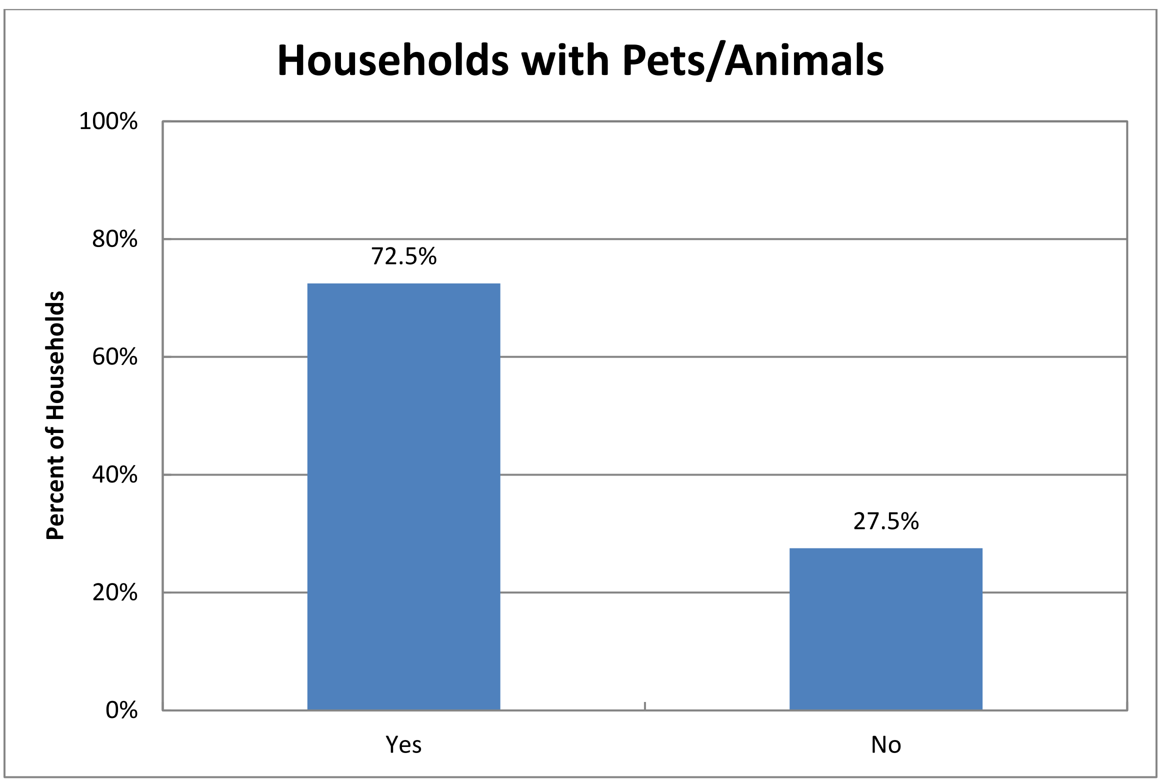


Figure F-15. Households with Pets/Animals

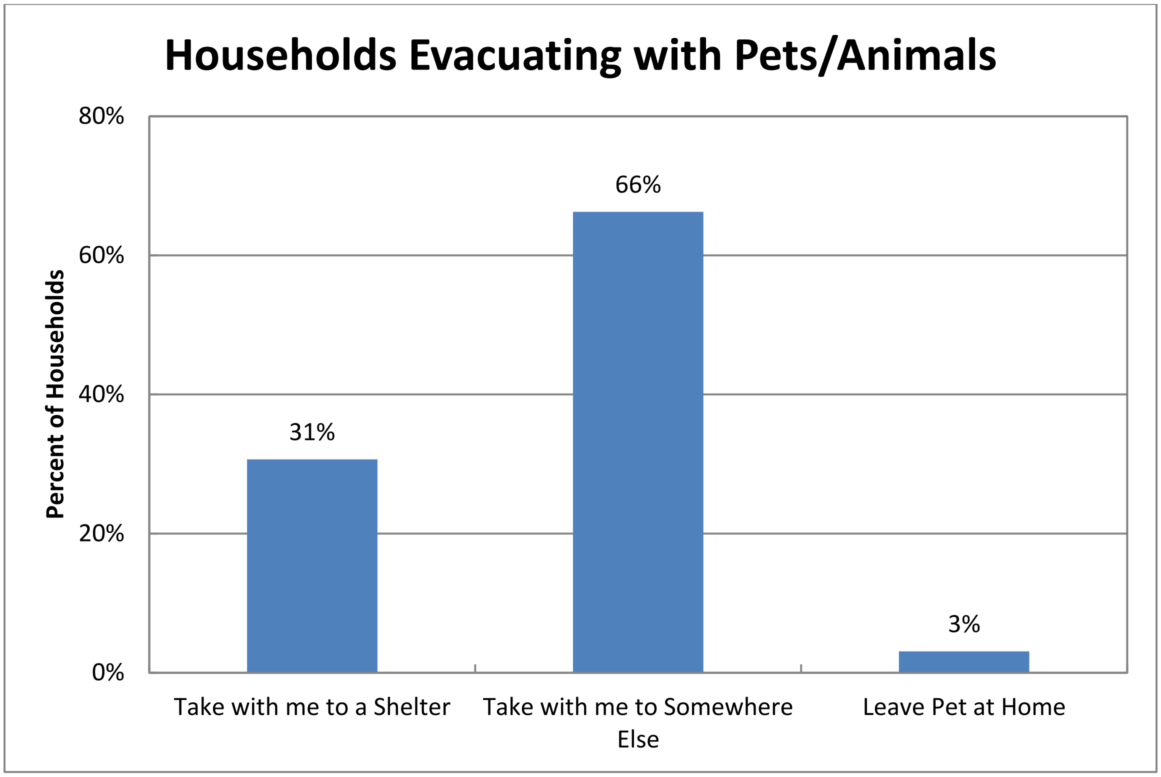


Figure F-16. Households Evacuating with Pets/Animals

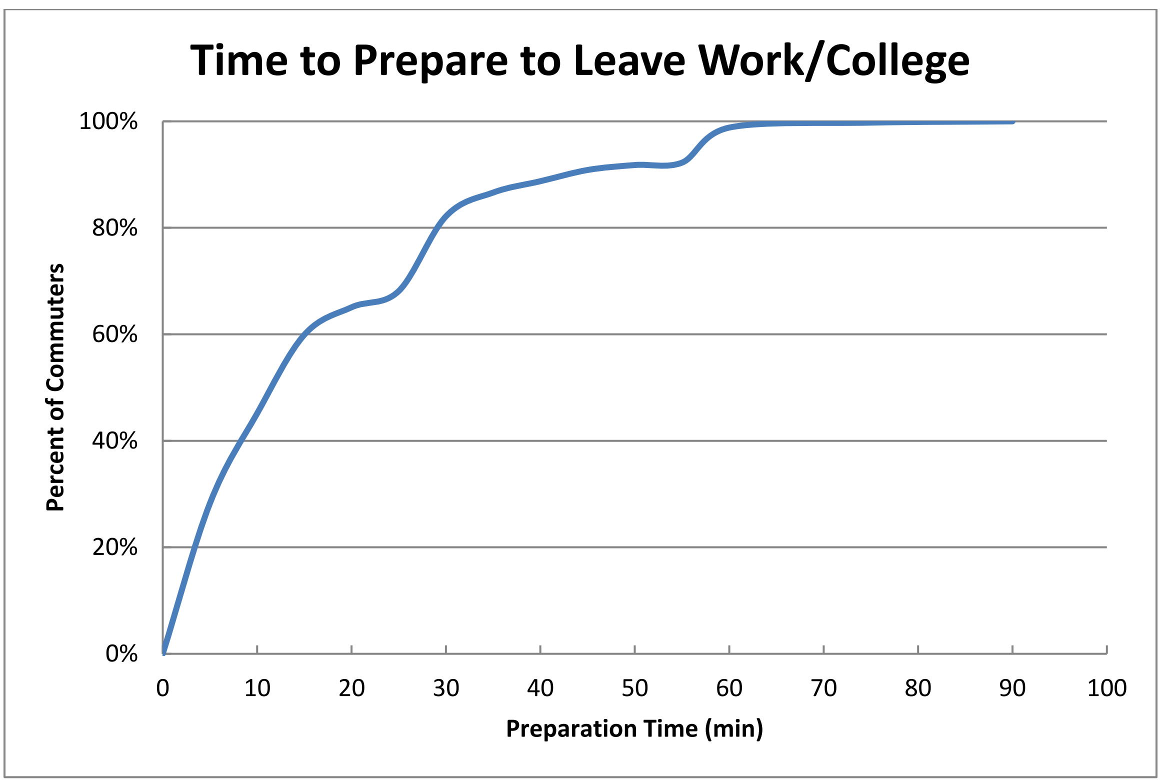


Figure F-17. Time Required to Prepare to Leave Work/College

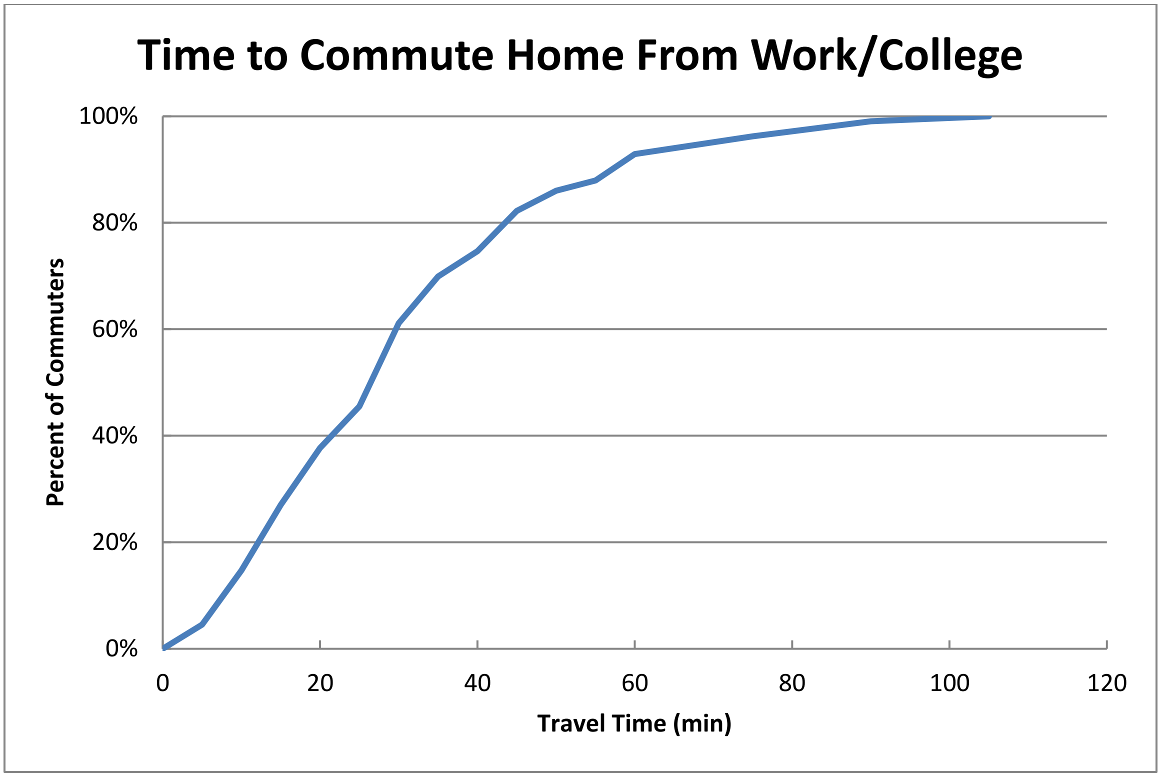


Figure F-18. Work/College to Home Travel Time

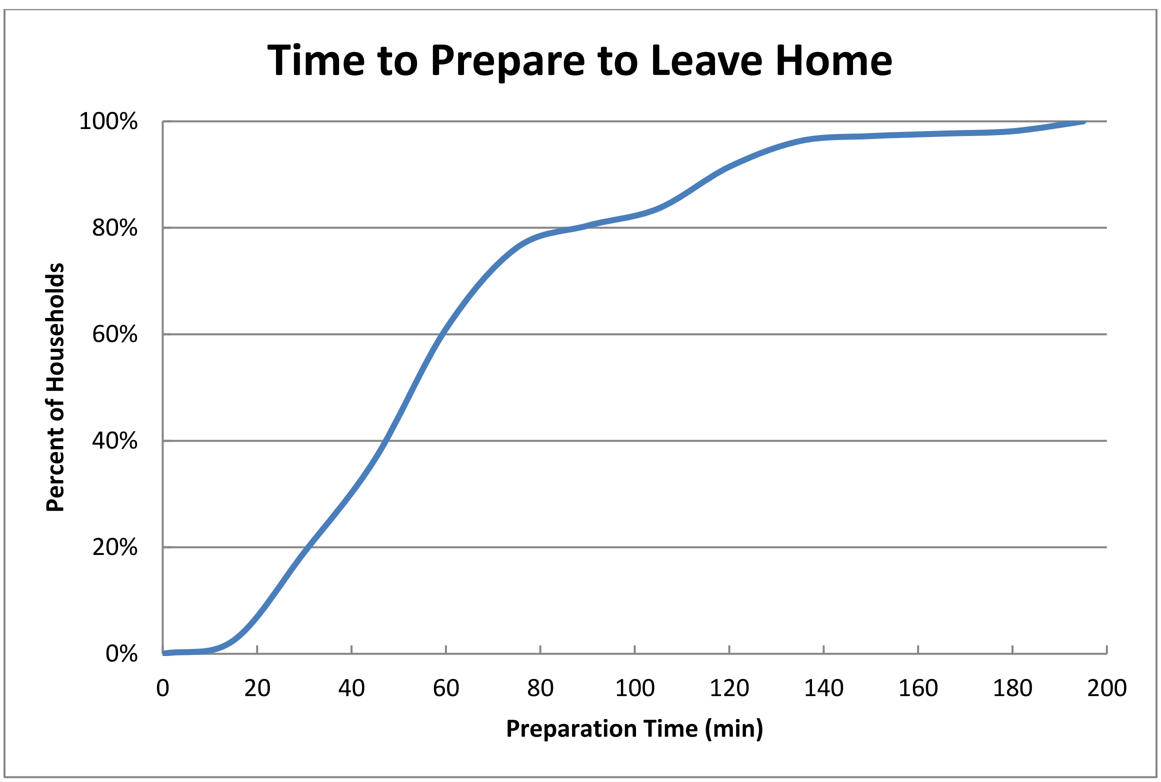


Figure F-19. Time to Prepare Home for Evacuation

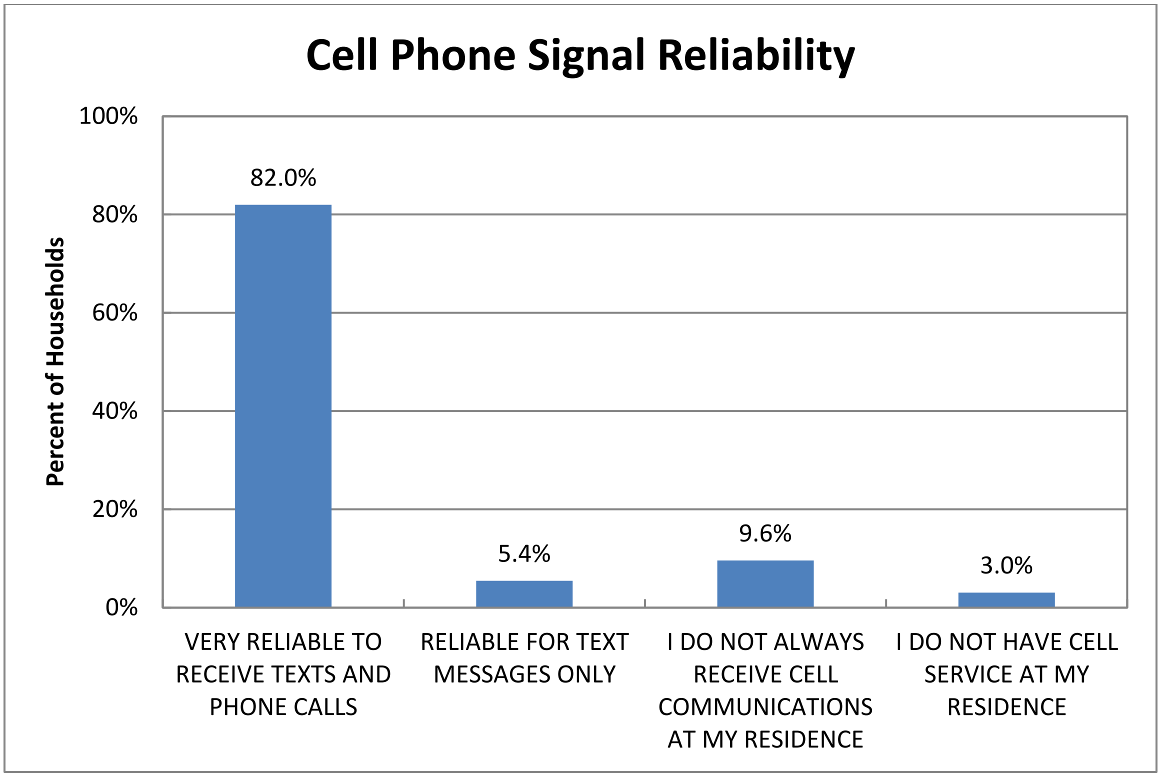


Figure F-20. Cell Phone Signal Reliability

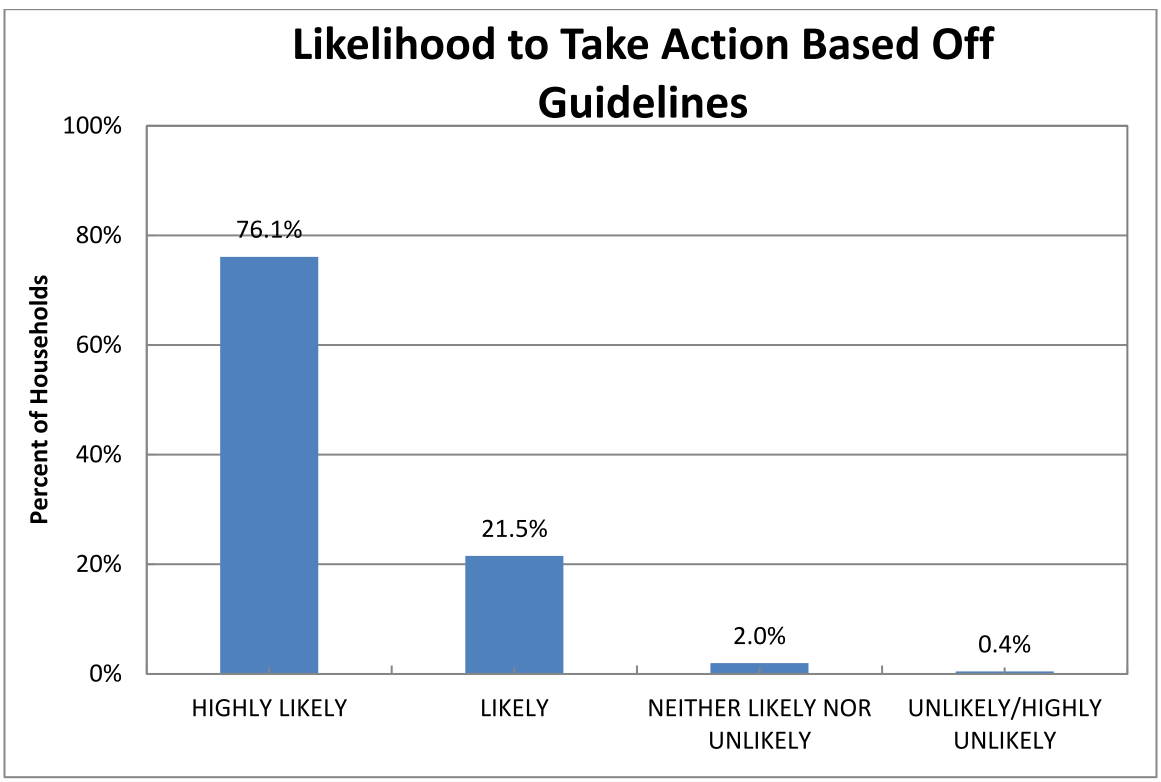


Figure F-21. Likelihood to Take Action Based off Emergency Management Officials Guidelines

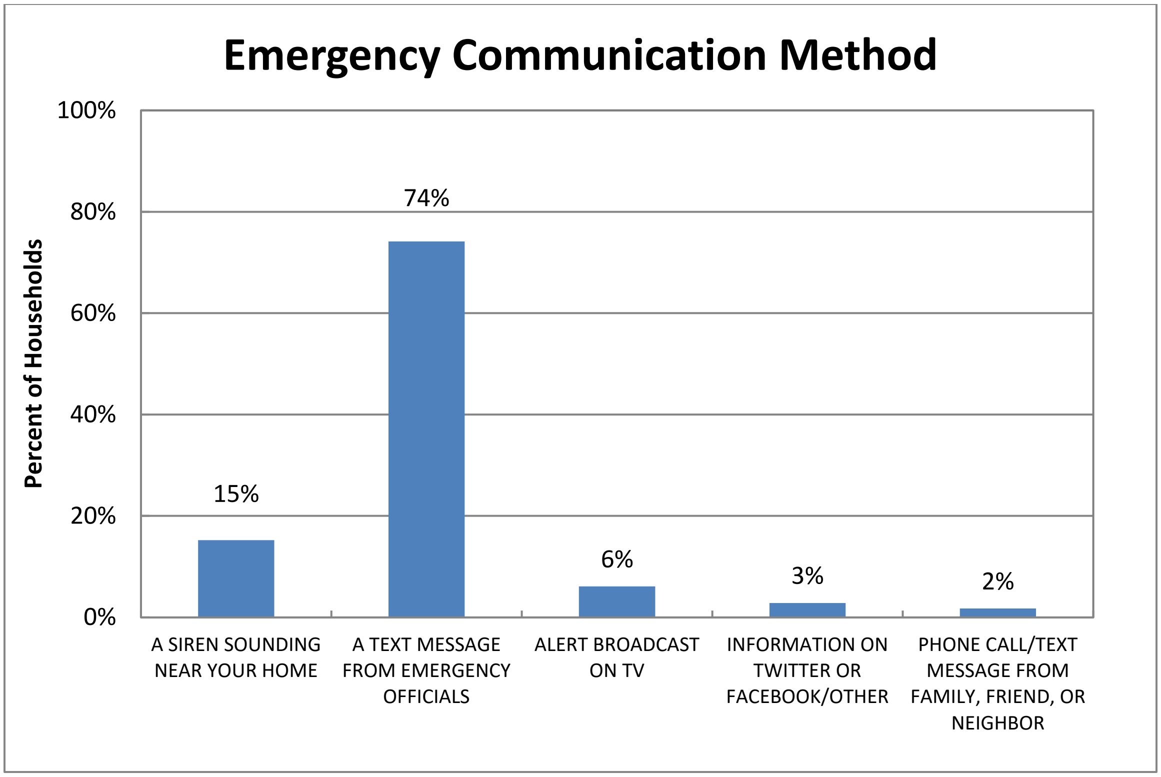


Figure F-22. Emergency Communication

ATTACHMENT A

Demographic Survey Instrument

Comanche Peak Nuclear Power Plant Demographic Survey

* Required

Purpose

The purpose of this survey is to identify local behavior during emergency situations. The information gathered in this survey will be shared with the counties of Hood and Somervell emergency planning personnel to enhance emergency response plans in your area. Your responses will greatly contribute to local emergency preparedness. **Please only complete one survey per household. Please have the head of the household (18 years or older) complete the survey.** Do not provide your name or any personal information, and the survey will take less than 5 minutes to complete.

1. 1. What is your gender?

   Mark only one oval.

   - Male
   - Female
   - Decline to State
   - Other: ____________________

2. 2. What is your home zip code? *

   ____

3. 3A. In total, how many running cars, or other vehicles are usually available to the household?

   Mark only one oval.

   - ONE
   - TWO
   - THREE
   - FOUR
   - FIVE
   - SIX
   - SEVEN
   - EIGHT
   - NINE OR MORE
   - ZERO (NONE)
   - DECLINE TO STATE

4. 3B. In an emergency, could you get a ride out of the area with a neighbor or friend?

   Mark only one oval.

   - YES
   - NO
   - DECLINE TO STATE

5. 4. How many vehicles would your household use during an evacuation?

   Mark only one oval.

   - ONE
   - TWO
   - THREE
   - FOUR
   - FIVE
   - SIX
   - SEVEN
   - EIGHT
   - NINE OR MORE
   - ZERO (NONE)
   - I WOULD EVACUATE BY BICYCLE
   - I WOULD EVACUATE BY BUS
   - DECLINE TO STATE

6. 5. How many people usually live in this household?

Mark only one oval.

- ONE
- TWO
- THREE
- FOUR
- FIVE
- SIX
- SEVEN
- EIGHT
- NINE
- TEN
- ELEVEN
- TWELVE
- THIRTEEN
- FOURTEEN
- FIFTEEN
- SIXTEEN
- SEVENTEEN
- EIGHTEEN
- NINETEEN OR MORE
- DECLINE TO STATE

Skip to question 7

COVID-19

7. 6. How many people in your household have a work and/or school commute that has been temporarily impacted due to the COVID-19 pandemic?

Mark only one oval.

- ZERO (NONE)
- ONE
- TWO
- THREE
- FOUR OR MORE
- DECLINE TO STATE

Commuters

8. 7. How many people in the household normally (during non-COVID conditions) commute to a job, or to college on a daily basis? *

Mark only one oval.

- ZERO (NONE) *Skip to question 53*
- ONE *Skip to question 9*
- TWO *Skip to question 10*
- THREE *Skip to question 11*
- FOUR OR MORE *Skip to question 12*
- DECLINE TO STATE *Skip to question 53*

Mode of Travel

9. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

	Bus	Walk/Bicycle	Drive Alone	Carpool-2 or more people	Don't know
Commuter 1					

Skip to question 13

Mode of Travel

10. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

	Bus	Walk/Bicycle	Drive Alone	Carpool-2 or more people	Don't know
Commuter 1					
Commuter 2					

Skip to question 15

Mode of Travel

11. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

	Bus	Walk/Bicycle	Drive Alone	Carpool-2 or more people	Don't know
Commuter 1					
Commuter 2					
Commuter 3					

Skip to question 19

Mode of Travel

12. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

	Bus	Walk/Bicycle	Drive Alone	Carpool-2 or more people	Don't know
Commuter 1					
Commuter 2					
Commuter 3					
Commuter 4					

Skip to question 25

Travel Home From Work/College

13. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

14. If Over 2 Hours for Question 9-1, Specify Here
leave blank if your answer for Question 9-1, is under 2 hours.

____

Skip to question 33

Travel Home From Work/College

15. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

16. If Over 2 Hours for Question 9-1, Specify Here
leave blank if your answer for Question 9-1, is under 2 hours.

____

17. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

18. If Over 2 Hours for Question 9-2, Specify Here
leave blank if your answer for Question 9-2, is under 2 hours.

____

Skip to question 35

Travel Home From Work/College

19. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

20. If Over 2 Hours for Question 9-1, Specify Here

leave blank if your answer for Question 9-1, is under 2 hours.

21. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

22. If Over 2 Hours for Question 9-2, Specify Here

leave blank if your answer for Question 9-2, is under 2 hours.

23. 9-3. How much time on average, would it take Commuter #3 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

24. If Over 2 Hours for Question 9-3, Specify Here

leave blank if your answer for Question 9-3, is under 2 hours.

Skip to question 39

Travel Home From Work/College

25. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

26. If Over 2 Hours for Question 9-1, Specify Here

leave blank if your answer for Question 9-1, is under 2 hours.

27. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

28. If Over 2 Hours for Question 9-2, Specify Here

leave blank if your answer for Question 9-2, is under 2 hours.

29. 9-3. How much time on average, would it take Commuter #3 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

30. If Over 2 Hours for Question 9-3, Specify Here

leave blank if your answer for Question 9-3, is under 2 hours.

31. 9-4. How much time on average, would it take Commuter #4 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

32. If Over 2 Hours for Question 9-4, Specify Here

leave blank if your answer for Question 9-4, is under 2 hours.

Skip to question 45

Preparation to leave Work/College

33. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

34. If Over 2 Hours for Question 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

Skip to question 53

Preparation to leave Work/College

35. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

36. If Over 2 Hours for Question 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

37. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

38. If Over 2 Hours for Question 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

Skip to question 53

Preparation to leave Work/College

39. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

40. If Over 2 Hours for Question 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

41. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

42. If Over 2 Hours for Question 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

43. 10-3. Approximately how much time would it take Commuter #3 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

44. If Over 2 Hours for Question 10-3, Specify Here

leave blank if your answer for Question 10-3, is under 2 hours.

____

Skip to question 53

Preparation to leave Work/College

45. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

46. If Over 2 Hours for Question 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

____

47. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

48. If Over 2 Hours for Question 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

49. 10-3. Approximately how much time would it take Commuter #3 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

50. If Over 2 Hours for Question 10-3, Specify Here

leave blank if your answer for Question 10-3, is under 2 hours.

51. 10-4. Approximately how much time would it take Commuter #4 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

52. If Over 2 Hours for Question 10-4, Specify Here

leave blank if your answer for Question 10-4, is under 2 hours.

___

Skip to question 53

Additional Questions

53. 11. If you were advised by local authorities to evacuate, how much time would it take the household to pack clothing, medications, secure the house, load the car, and complete preparations prior to evacuating the area?

Mark only one oval.

- LESS THAN 15 MINUTES
- 15-30 MINUTES
- 31-45 MINUTES
- 46 MINUTES - 1 HOUR
- 1 HOUR TO 1 HOUR 15 MINUTES
- 1 HOUR 16 MINUTES TO 1 HOUR 30 MINUTES
- 1 HOUR 31 MINUTES TO 1 HOUR 45 MINUTES
- 1 HOUR 46 MINUTES TO 2 HOURS
- 2 HOURS TO 2 HOURS 15 MINUTES
- 2 HOURS 16 MINUTES TO 2 HOURS 30 MINUTES
- 2 HOURS 31 MINUTES TO 2 HOURS 45 MINUTES
- 2 HOURS 46 MINUTES TO 3 HOURS
- 3 HOURS TO 3 HOURS 15 MINUTES
- 3 HOURS 16 MINUTES TO 3 HOURS 30 MINUTES
- 3 HOURS 31 MINUTES TO 3 HOURS 45 MINUTES
- 3 HOURS 46 MINUTES TO 4 HOURS
- 4 HOURS TO 4 HOURS 15 MINUTES
- 4 HOURS 16 MINUTES TO 4 HOURS 30 MINUTES
- 4 HOURS 31 MINUTES TO 4 HOURS 45 MINUTES
- 4 HOURS 46 MINUTES TO 5 HOURS
- 5 HOURS TO 5 HOURS 30 MINUTES
- 5 HOURS 31 MINUTES TO 6 HOURS
- OVER 6 HOURS
- WILL NOT EVACUATE
- DECLINE TO STATE

54. If Over 6 Hours for Question 11, Specify Here

leave blank if your answer for Question 11, is under 6 hours.

____

55. 12. Please specify the number of people in your household who require Functional or Transportation needs in an evacuation:

Mark only one oval per row.

	0	1	2	3	4	More than 4
Bus	⬭	⬭	⬭	⬭	⬭	⬭
Medical Bus/Van	⬭	⬭	⬭	⬭	⬭	⬭
Wheelchair Accessible Vehicle	⬭	⬭	⬭	⬭	⬭	⬭
Ambulance	⬭	⬭	⬭	⬭	⬭	⬭
Other	⬭	⬭	⬭	⬭	⬭	⬭

56. Specify "Other" Transportation Need Below

____

57. 13. Please choose one of the following:

Mark only one oval.

- ⬭ I would await the return of household members to evacuate together.
- ⬭ I would evacuate independently and meet other household members later.
- ⬭ Decline to State

58. 14A. Emergency officials advise you to shelter-in-place in an emergency because you are not in the area of risk. Would you:

Mark only one oval.

- ⬭ SHELTER-IN-PLACE
- ⬭ EVACUATE
- ⬭ DECLINE TO STATE

59. 14B. Emergency officials advise you to shelter-in-place now in an emergency and possibly evacuate later while people in other areas are advised to evacuate now. Would you:

Mark only one oval.

- ⬭ SHELTER-IN-PLACE
- ⬭ EVACUATE
- ⬭ DECLINE TO STATE

60. 14C. Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?

Mark only one oval.

- ⬭ A RELATIVE'S OR FRIEND'S HOME
- ⬭ A RECEPTION CENTER
- ⬭ A HOTEL, MOTEL OR CAMPGROUND
- ⬭ A SECOND/SEASONAL HOME
- ⬭ WOULD NOT EVACUATE
- ⬭ DON'T KNOW
- ⬭ OTHER (Specify Below)
- ⬭ DECLINE TO STATE

61. Fill in OTHER answers for question 14C

____

Pet Questions

62. 15A. Do you have any pet(s) and/or animal(s)?

Mark only one oval.

- ( ) YES
- ( ) NO *Skip to question 66*
- ( ) DECLINE TO STATE *Skip to question 66*

Pet Questions

63. 15B. What type of pet(s) and/or animal(s) do you have?

Check all that apply.

- [ ] DOG
- [ ] CAT
- [ ] BIRD
- [ ] REPTILE
- [ ] HORSE
- [ ] FISH
- [ ] CHICKEN
- [ ] GOAT
- [ ] PIG
- [ ] OTHER SMALL PETS/ANIMALS (Specify Below)
- [ ] OTHER LARGE PETS/ANIMALS (Specify Below)
- [ ] DECLINE TO STATE

Other: [ ] ______________________________

Pet Questions

64. 15C. What would you do with your pet(s) and/or animal(s) if you had to evacuate?

Mark only one oval.

- ( ) TAKE PET WITH ME TO A SHELTER
- ( ) TAKE PET WITH ME SOMEWHERE ELSE
- ( ) LEAVE PET AT HOME *Skip to question 66*
- ( ) DECLINE TO STATE *Skip to question 66*

Pet Questions

65. 15D. Do you have sufficient room in your vehicle(s) to evacuate with your pet(s) and/or animal(s)?

Mark only one oval.

- ( ) YES
- ( ) NO
- ( ) WILL USE A TRAILER
- ( ) DECLINE TO STATE
- ( ) Other: ______________________________

Emergency Communications

66. 16A. At your place of residence, how reliable is your cell phone signal?

Mark only one oval.

- ( ) VERY RELIABLE TO RECEIVE TEXTS AND PHONE CALLS
- ( ) RELIABLE FOR TEXT MESSAGES ONLY
- ( ) I DO NOT ALWAYS RECEIVE CELL COMMUNICATIONS AT MY RESIDENCE
- ( ) I DO NOT HAVE CELL SERVICE AT MY RESIDENCE

67. 16B. Emergency management officials in your state may send text messages, similar to AMBER Alerts, with emergency directions for the public if a radiological emergency were to occur at Comanche Peak Nuclear Power Plant. How likely would you be to take action on these directions, if you received the message?

Mark only one oval.

- HIGHLY LIKELY
- LIKELY
- NEITHER LIKELY NOR UNLIKELY
- UNLIKELY
- HIGHLY UNLIKELY

68. 16C. Which of the following emergency communication methods do you think is most likely to alert you at your residence?

Mark only one oval.

- A SIREN SOUNDING NEAR YOUR HOME
- A TEXT MESSAGE FROM EMERGENCY OFFICIALS
- ALERT BROADCAST ON RADIO
- ALERT BROADCAST ON TV
- INFORMATION ON TWITTER OR FACEBOOK
- PHONE CALL/TEXT MESSAGE FROM FAMILY, FRIEND, OR NEIGHBOR
- OTHER

69. Fill in OTHER answers for question 16C

APPENDIX G

Traffic Management Plan

G. TRAFFIC MANAGEMENT PLAN

NUREG/CR-7002, Rev. 1 indicates that the existing Traffic Control Points (TCPs) and Access Control Points (ACPs) identified by the offsite agencies should be used in the evacuation simulation modeling. The traffic and access control plans for the Emergency Planning Zone (EPZ) are described in the Somervell County Emergency Evacuation Traffic management Plan, dated April 2013 and the shapefiles (of TCP/ACP locations) provided directly by Hood County.

These plans were reviewed and the TCPs and ACPs were modeled accordingly.

G.1 Traffic Control and Access Control Points

As discussed in Section 9, TCPs at intersections (which are controlled) are modeled as actuated signals. If an intersection has a pre-timed signal, stop, or yield control, and the intersection is identified as a TCP, the control type was changed to an actuated signal in the DYNEV II system, in accordance with Section 3.3 of NUREG/CR-7002, Rev. 1. TCPs at existing actuated traffic signalized intersections were essentially left alone except where modifications to green time allocation were deemed necessary.

It is assumed that ACPs will be established within 2 hours of the Advisory to Evacuate (ATE) to discourage through travelers from using major through routes which traverse the EPZ. According to the counties' emergency plans, the law enforcement coordinators will coordinate ACP activation.

As discussed in Section 3.10, external traffic was considered on the major routes that traverse the study area – US 377 and US 67 – in this analysis. It can be seen, in Figure G-1, that the majority of the TCPs/ACPs are along US 67 and there are two are located on US 377. The generation of these external trips (4,256 vehicles during day conditions, 1,702 vehicles in evening conditions) ceased at 120 minutes after the ATE in the simulation to represent the diversion of traffic at these TCP locations.

This study did not identify any additional intersections that should be designated as TCP or ACP, as there is limited congestion along US 67 and significant congestion on US 377. Any additional TCP/ACP would not be beneficial. The existing county traffic management plans are adequate.

Table K-1 provides the number of nodes with each control type. If the existing control was changed due to the point being a TCP or ACP, the control type is indicated as a TCP/ACP in Table K-1. The TCPs and ACPs within the study area are mapped as green dots in Figure G-1.

G.2 Analysis of Key TCP and ACP Locations

As discussed in Section 5.2 of NUREG/CR-7002, Rev. 1, manual traffic control (MTC) at intersections could benefit from ETE analysis. The TCP and ACP locations contained within the TMP were analyzed to determine key locations where MTC would be most useful and can be readily implemented. As previously mentioned, signalized intersections that were actuated based on field data collection were essentially left as actuated traffic signals in the model, with

modifications to green time allocation as needed. Other controlled intersections (pre-timed signals, stop signs and yield signs) were changed to actuated traffic signals to represent the MTC that would be implemented according to the traffic management plan.

Table G-1 shows a list of the intersections that were identified as TCPs or ACPs in the TMP that were not previously actuated signals, including the type of control that currently exists at each location. To determine the impact of MTC at these locations, a summer, midweek, midday, good weather scenario (Scenario 1) evacuation of the entire EPZ (Region R03) was simulated wherein these intersections were left as is (without MTC). The results were compared to the results presented in Section 7. There was no difference in the 90th and 100th percentile ETEs, when MTC was not present at these intersections. The remaining TCPs and ACPs were left as actuated signals in the model and, therefore, had no impact to ETE.

As shown in Figure 7-3 through Figure 7-8, the southern portion of the EPZ experiences little traffic congestion. As such, the TCPs and ACPs in the southern portion of the EPZ do very little to help the ETE. The Hood County TMP does not have many TCP/ACPs designated in the northern portion of the EPZ, most are located within the Shadow Region north of the plant, so removing them do very little to help the ETE. In addition, the northeastern and northwestern portion of the EPZ experiences significant traffic congestion. Heavy traffic flows exist in both the east and west directions as vehicles evacuate the area. When heavy traffic persists in competing directions, MTC provides little to no benefit since both approaches need equal amounts of green time. As a result, the TCPs and ACPs in the northeastern and northwestern portion of the EPZ do very little to help the ETE as well.

In addition, traffic congestion clears prior to the completion of trip generation. The 100th percentile ETE is dictated by mobilization (plus 10 minutes to travel to EPZ boundary). As such, the impact of MTC at TCPs and ACPs will have no impact on the 100th percentile ETE.

While TCPs and ACPs are not necessary to evacuate the EPZ expediently, staffing these locations does still provide value during an evacuation such as guiding those evacuees who are not familiar with the area and serving as fixed point surveillance (if there is an incident on one of the major evacuation routes).

Table G-1 List of Key TCP/ACP Locations

TCP/ACP	UNITES Node #	Previous Control
Hood County - 01	255	Stop Control
Hood County - 02/Somervell County - 01	592	No Control
Hood County - 03/Somervell County - 02	292	Stop Control
Hood County - 05	287	No Control
Hood County - 06	207	No Control
Hood County - 10	689	No Control
Hood County - 11	1146	No Control
Hood County - 12/Somervell County - 03	595	No Control
Hood County - 13	580	No Control
Hood County - 14/ Somervell County - 04	587	No Control
Hood County - 15/Somervell County - 05	300	No Control
Hood County - 16	20	Stop Control
Somervell County - 06	736	No Control
Somervell County - 07	744	No Control
Somervell County - 08	768	No Control
Somervell County - 09	323	Stop Control
Somervell County - 10	342	No Control
Somervell County - 11	364	No Control
Somervell County - 12	367	No Control
Somervell County - 13	723	No Control
Somervell County - 14	365	No Control
Somervell County - 15	392	No Control
Somervell County - 16	336	No Control
Somervell County - 17	385	Stop Control
Somervell County - 18	338	Stop Control
Somervell County - 19	588	No Control
Somervell County - 20	333	Stop Control
Somervell County - 21	1066	No Control
Somervell County - 22	591	No Control
Somervell County - 23	958	No Control
Somervell County - 24	379	Stop Control

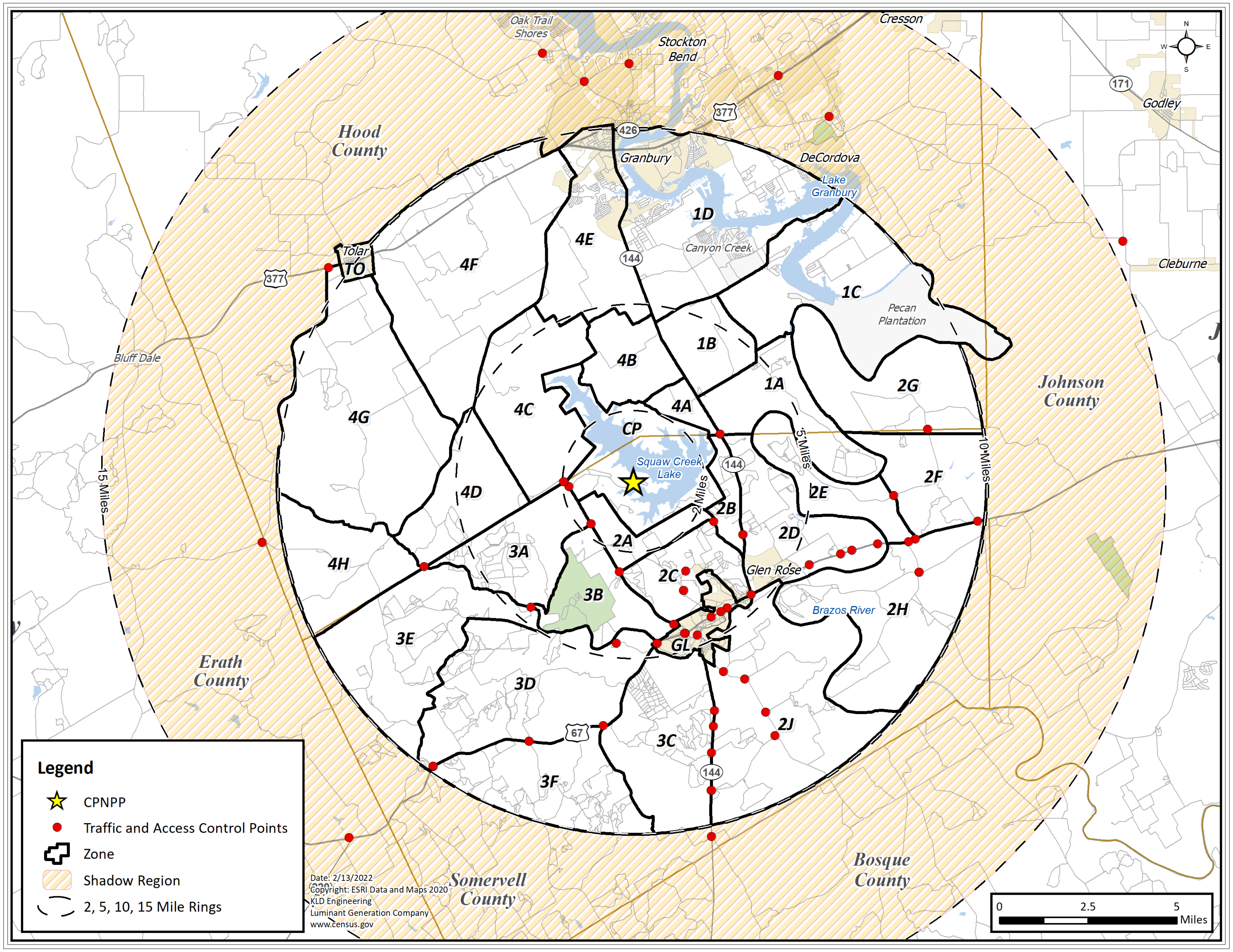


Figure G-1. Traffic and Access Control Points for the CPNPP Site

APPENDIX H

Evacuation Regions

H EVACUATION REGIONS

This appendix presents the evacuation percentages for each Evacuation Region (Table H-1 through Table H-3) and maps of all Evacuation Regions (Figure H-1 through Figure H-92). The percentages presented in these tables are based on the methodology discussed in assumption 7 of Section 2.2 and shown in Figure 2-1.

Note the baseline ETE study assumes 20 percent of households will not comply with the shelter advisory, as per Section 2.5.2 of NUREG/CR-7002, Rev. 1.

Table H-1. Percent of Zone Population Evacuating for Regions R01 through R33

Radial Regions																																
Region	Site PAR Central Sector	Description	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
R01	N/A	2-Mile Region	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R02	N/A	5-Mile Region	100%	100%	100%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	100%	20%
R03	N/A	Full EPZ	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Evacuate 2-Mile Region and Downwind to 5 Miles (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
R04	A	168.75 – 191.24	100%	20%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R05	B	191.25 – 213.74	100%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R06	C	213.75 – 236.24	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R07	D	236.25 – 258.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R08	E	258.75 – 281.24	100%	100%	20%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R09	F	281.25 – 303.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R10	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R11	H, J	326.25 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R12	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R13	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%
R14	M	56.25 – 78.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R15	N	78.75 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R16	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R17	Q, R	123.75 – 168.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%
Evacuate 2-Mile Region and Downwind to EPZ Boundary (3 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	Zone																													
			CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
R18	A	168.75 – 191.24	100%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%
R19	B	191.25 – 213.74	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%
R20	C	213.75 – 236.24	100%	100%	100%	100%	100%	100%	100%	20%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R21	D	236.25 – 258.74	100%	100%	100%	100%	20%	100%	100%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R22	E	258.75 – 281.24	100%	100%	20%	100%	20%	100%	100%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R23	F	281.25 – 303.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R24	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R25	H	326.25 – 348.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R26	J	348.75 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	100%	20%	100%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R27	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R28	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	20%	20%	100%	20%	20%	20%	100%	20%	20%
R29	M	56.25 – 78.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	100%	100%	20%	20%	100%	100%	20%	20%
R30	N	78.75 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	100%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	20%
R31	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	100%
R32	Q	123.75 – 146.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	20%	100%
R33	R	146.25 – 168.74	100%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	100%

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table H-2. Percent of Zone Population Evacuating for Regions R34 through R63

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
Evacuate 2-Mile Region and Downwind to 5 Miles (5 Sector Groups)																																
R34	A	168.75 – 191.24	100%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R35	B	191.25 – 213.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R36	C, D	213.75 – 258.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R37	E	258.75 – 281.24	100%	100%	100%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R38	F	281.25 – 303.74	100%	100%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R39	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R40	H	326.25 – 348.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R41	J	348.75 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R42	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	100%	20%
R43	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	100%	20%
R44	M, N	56.25 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R45	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%
R46	Q	123.75 – 146.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%
R47	R	146.25 – 168.74	100%	20%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
Evacuate 2-Mile Region and Downwind to EPZ Boundary (5 Sector Groups)																																
Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
R48	A	168.75 – 191.24	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	100%	100%	20%	20%	20%	100%
R49	B	191.25 – 213.74	100%	100%	100%	100%	100%	100%	100%	20%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%
R50	C	213.75 – 236.24	100%	100%	100%	100%	100%	100%	100%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%
R51	D	236.25 – 258.74	100%	100%	100%	100%	100%	100%	100%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R52	E	258.75 – 281.24	100%	100%	100%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R53	F	281.25 – 303.74	100%	100%	20%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R54	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	20%	100%	100%	20%	100%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R55	H	326.25 – 348.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R56	J	348.75 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R57	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	100%	20%	20%	20%	100%	100%	20%
R58	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	20%	20%	100%	100%	20%	20%	100%	100%	100%	20%
R59	M	56.25 – 78.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	100%	20%	20%
R60	N	78.75 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	100%	100%	20%	100%	100%	100%	20%	100%
R61	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	100%	20%	100%
R62	Q	123.75 – 146.24	100%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	100%	20%	100%
R63	R	146.25 – 168.74	100%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	100%	100%	100%	20%	20%	100%

Zone(s) Evacuate | Zone(s) Shelter-in-Place

Table H-3. Percent of Zone Population Evacuating for Regions R64 through R92

Region	Site PAR Central Sector	Wind Direction From (Degrees)	CP	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2J	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	4E	4F	4G	4H	GL	TO
Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (3 Sector Groups)																																
R64	N/A	5-Mile Region	100%	100%	100%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	100%	20%
R65	A	168.75 – 191.24	100%	20%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R66	B	191.25 – 213.74	100%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R67	C	213.75 – 236.24	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R68	D	236.25 – 258.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R69	E	258.75 – 281.24	100%	100%	20%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R70	F	281.25 – 303.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R71	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R72	H, J	326.25 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R73	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R74	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%
R75	M	56.25 – 78.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R76	N	78.75 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R77	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R78	Q, R	123.75 – 168.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%
Zone(s) Evacuate			Zone(s) Shelter-in-Place														Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate															
Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles (5 Sector Groups)																																
N/A	N/A	5-Mile Region	Refer to Region R64																													
R79	A	168.75 – 191.24	100%	100%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R80	B	191.25 – 213.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
R81	C, D	213.75 – 258.74	100%	100%	100%	20%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%
R82	E	258.75 – 281.24	100%	100%	100%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R83	F	281.25 – 303.74	100%	100%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R84	G	303.75 – 326.24	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R85	H	326.25 – 348.74	100%	20%	20%	20%	20%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R86	J	348.75 – 11.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%
R87	K	11.25 – 33.74	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	100%	20%
R88	L	33.75 – 56.24	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	100%	20%
R89	M, N	56.25 – 101.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	20%	20%	20%	20%	20%	20%
R90	P	101.25 – 123.74	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%
R91	Q	123.75 – 146.24	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%
R92	R	146.25 – 168.74	100%	20%	100%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%
Zone(s) Evacuate			Zone(s) Shelter-in-Place														Zones(s) Shelter-in-Place until 90% ETE for R01, then Evacuate[1]															

1. Twenty percent (20%) of population in these Zones will not comply with the shelter advisory, as per Section 2.5.2 of NUREG/CR-7002, Rev. 1. Once 90% of the 2-Mile Region has evacuated, the remaining population in these Zones will evacuate.

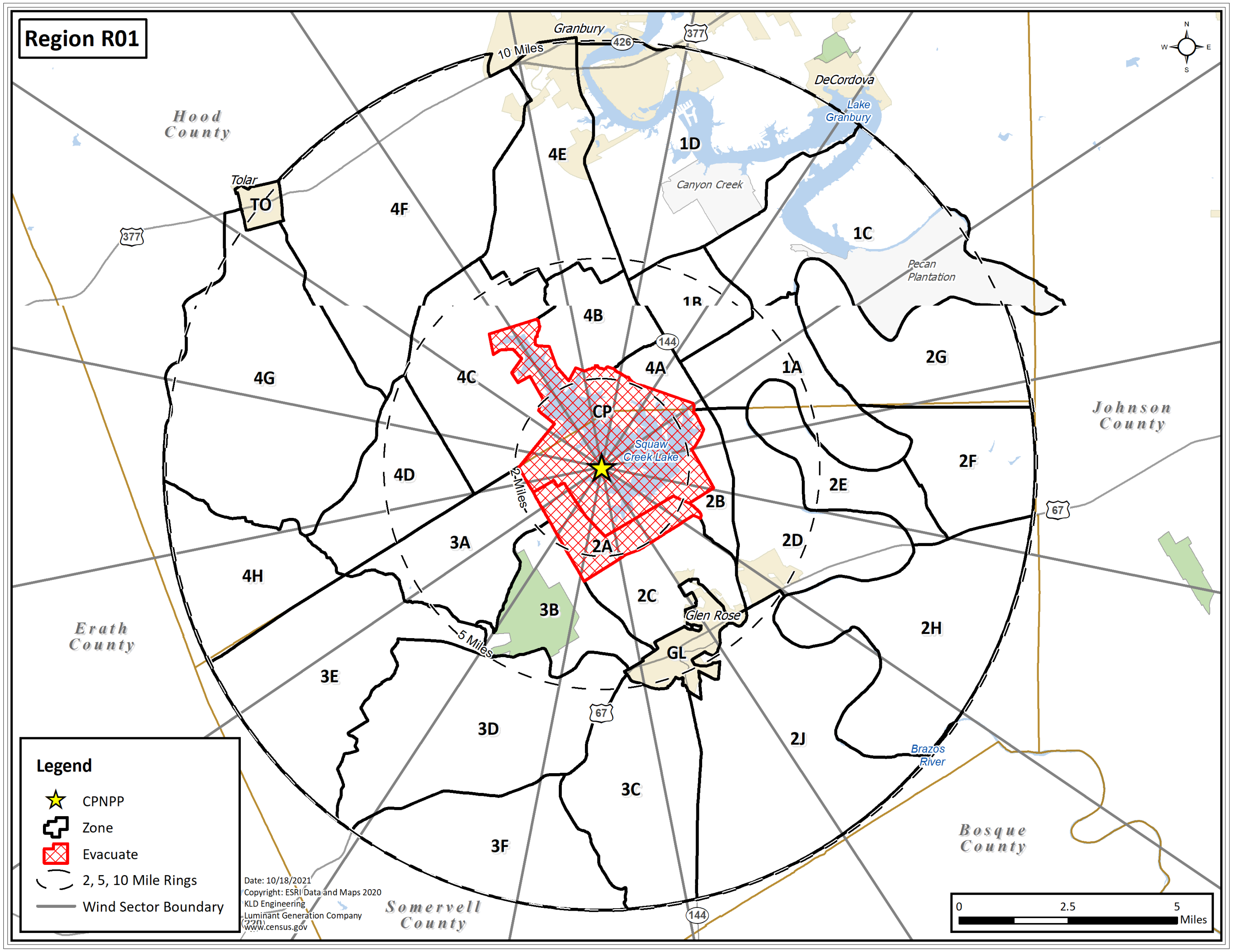


Figure H-1. Region R01

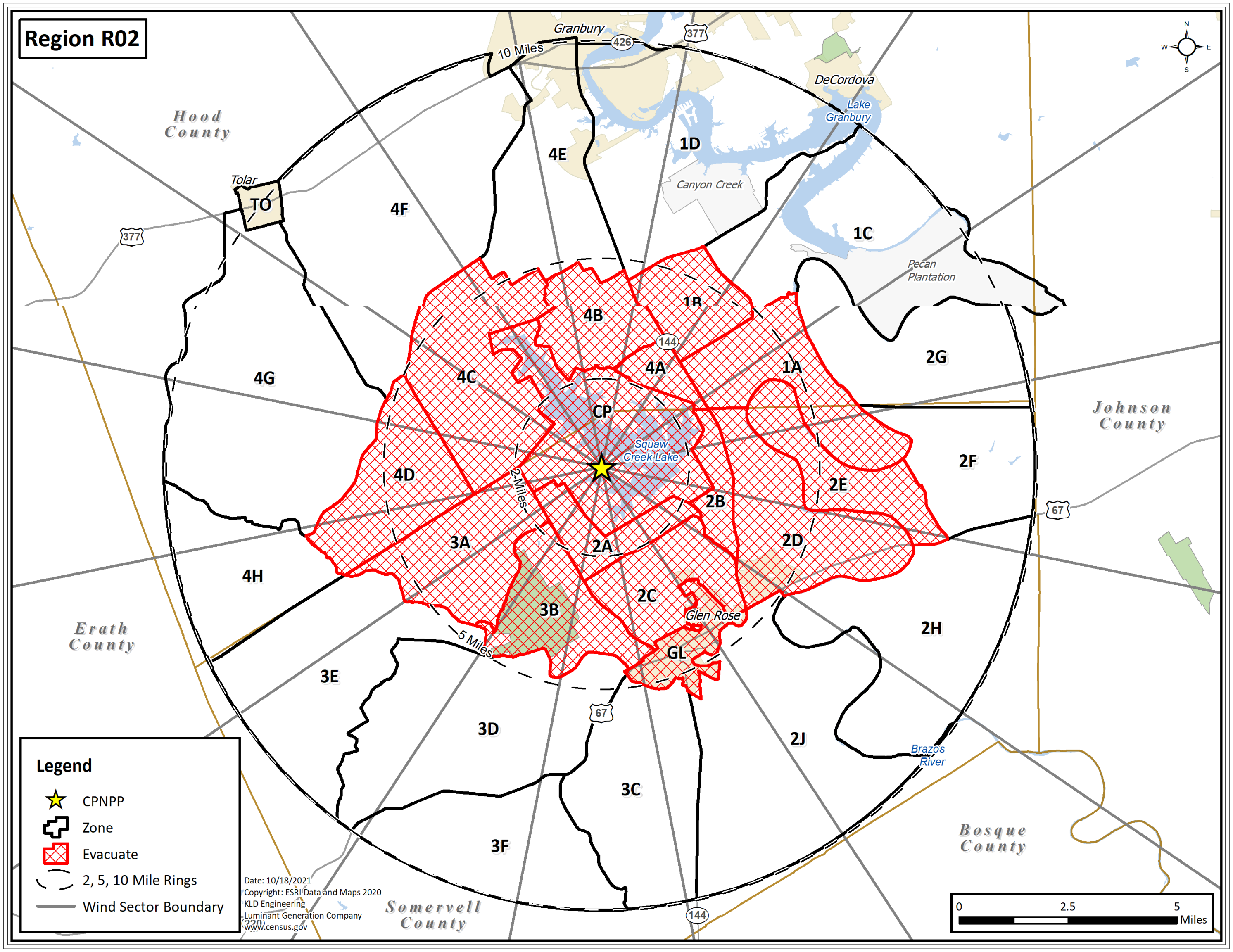


Figure H-2. Region R02

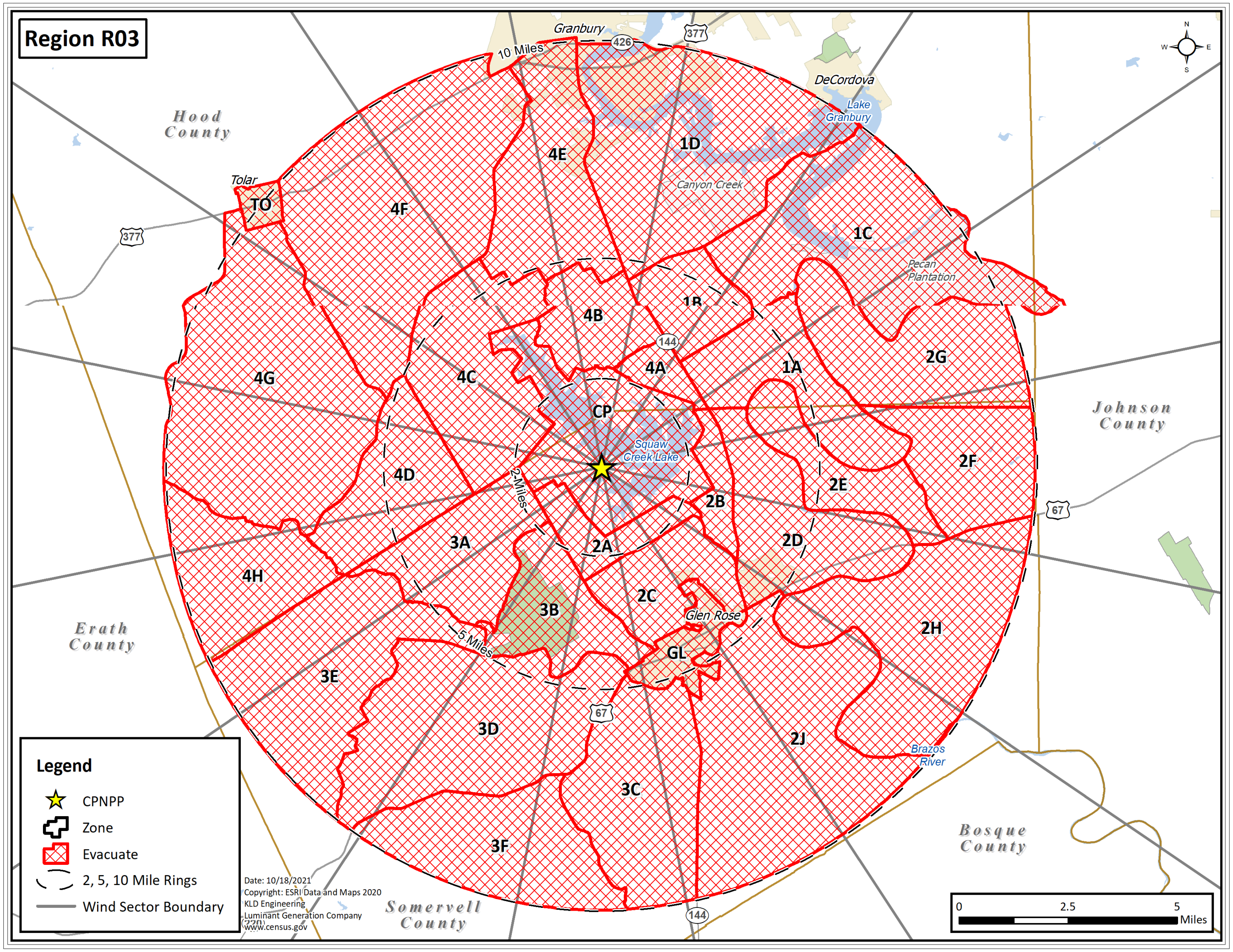


Figure H-3. Region R03

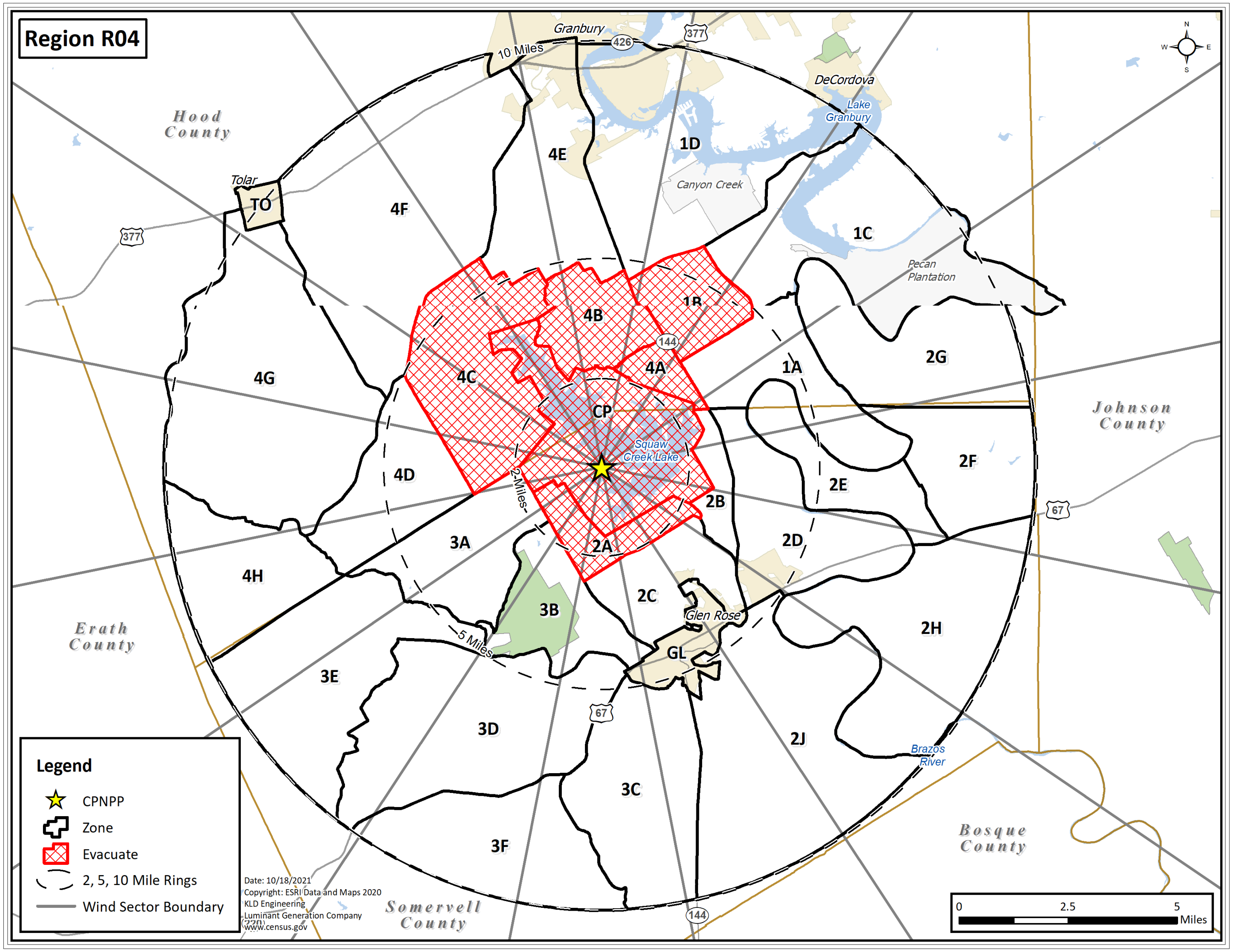


Figure H-4. Region R04

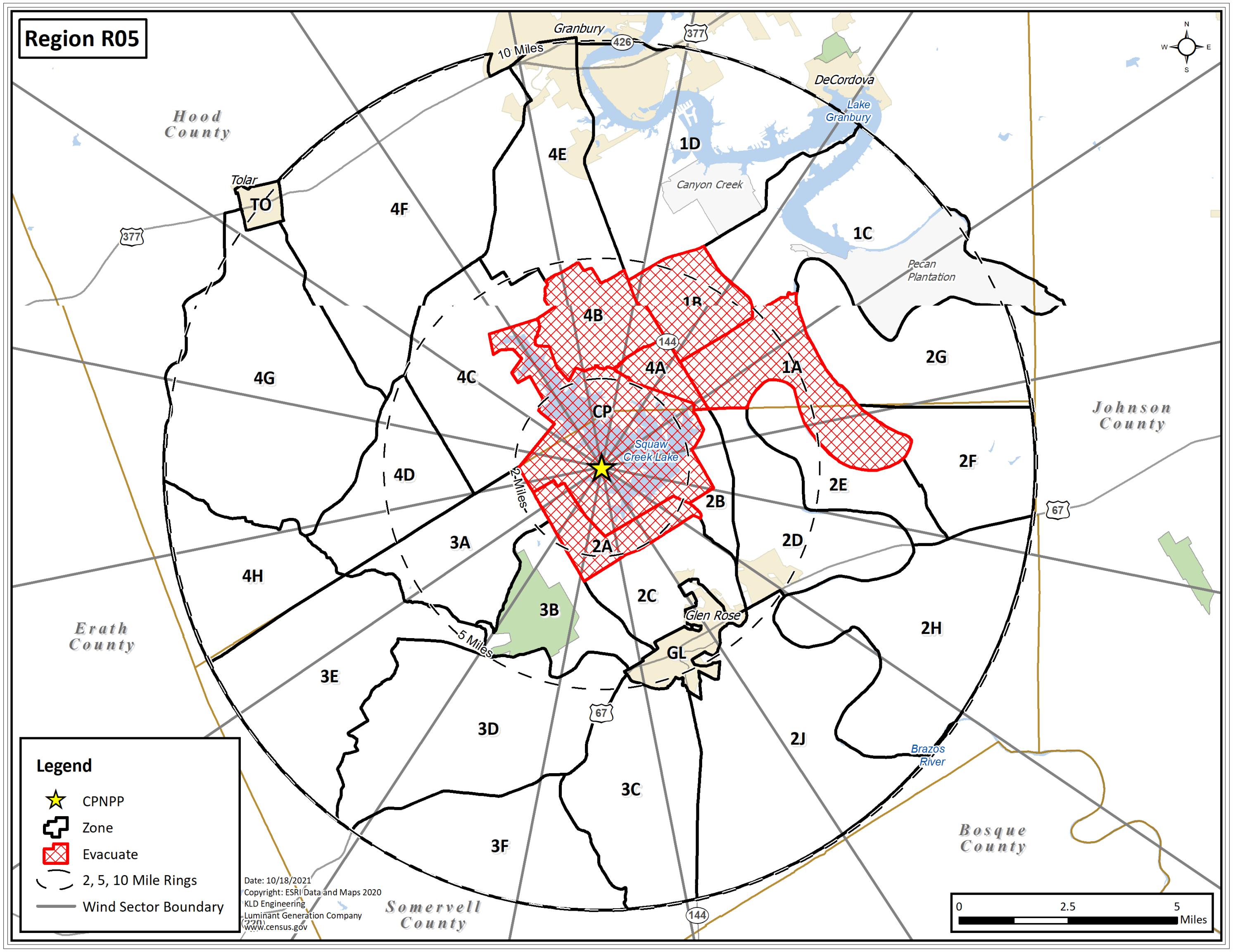


Figure H-5. Region R05

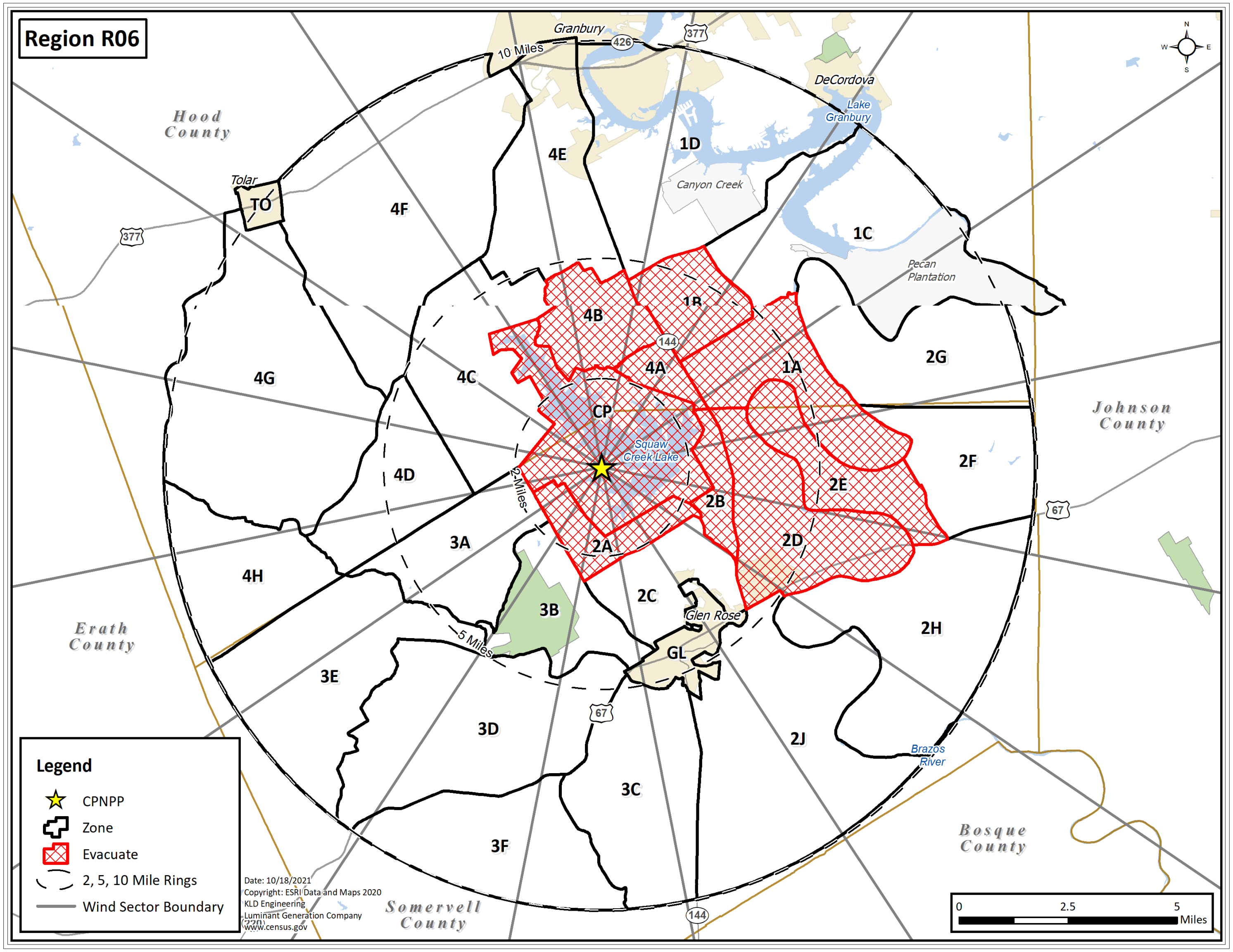


Figure H-6. Region R06

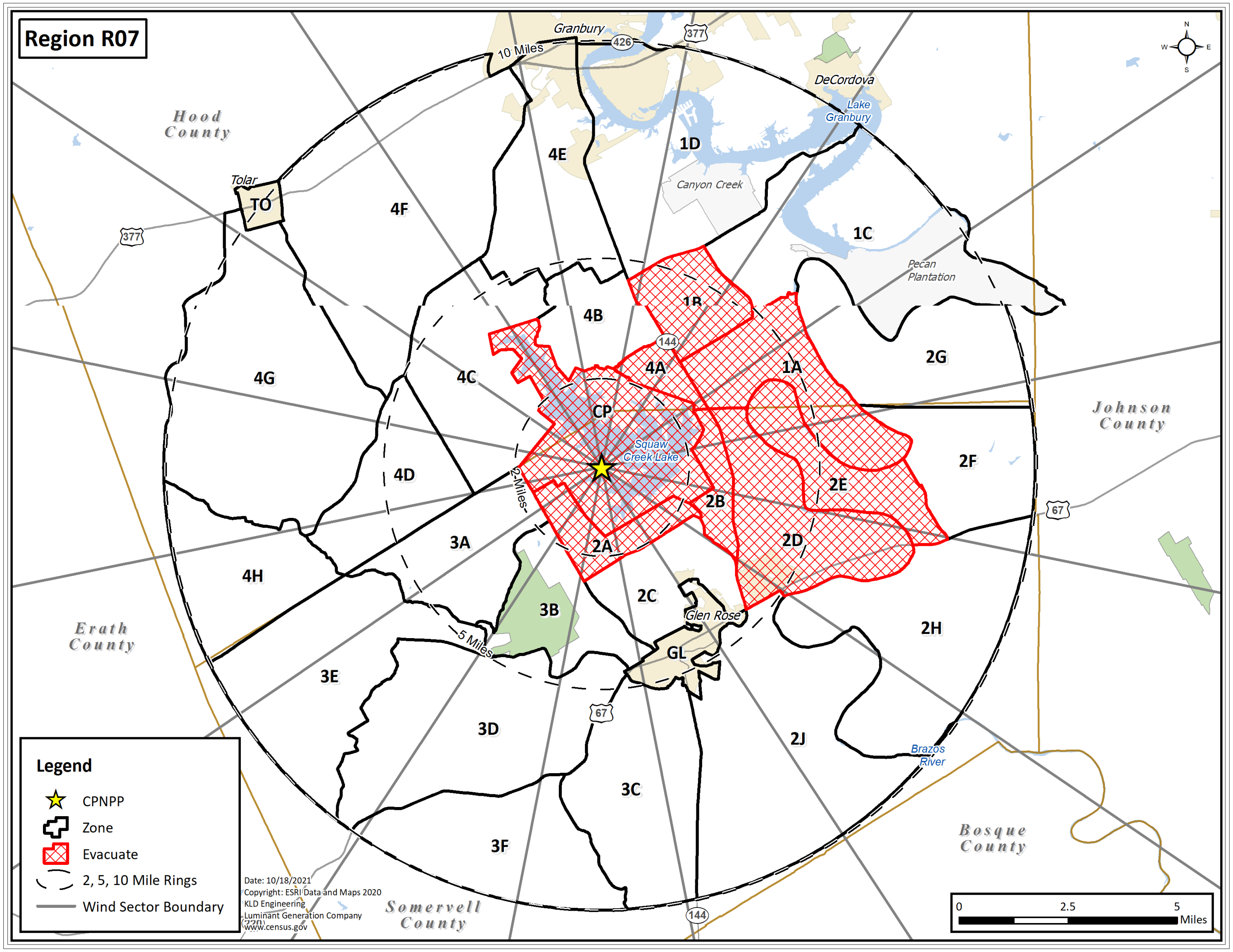


Figure H-7. Region R07

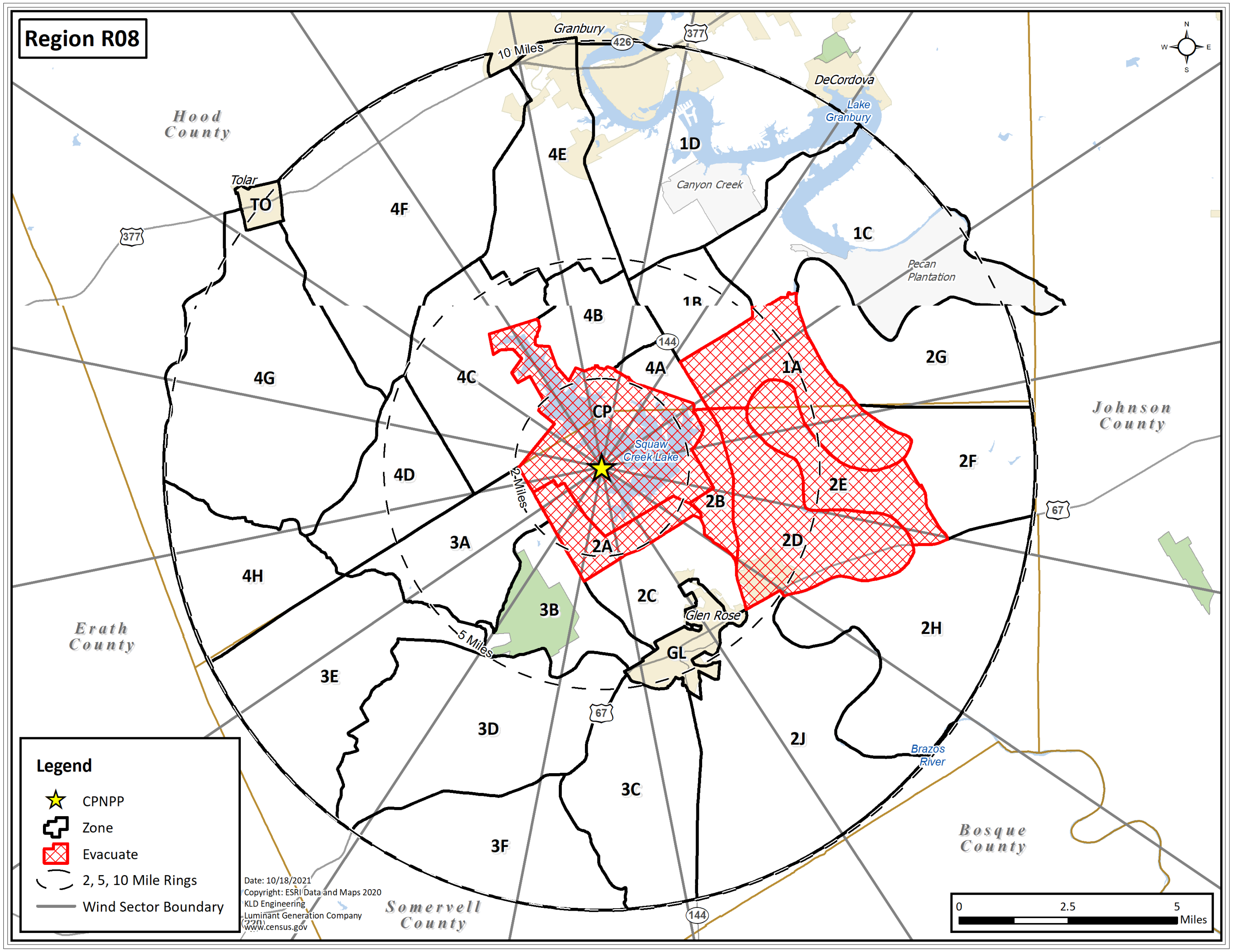


Figure H-8. Region R08

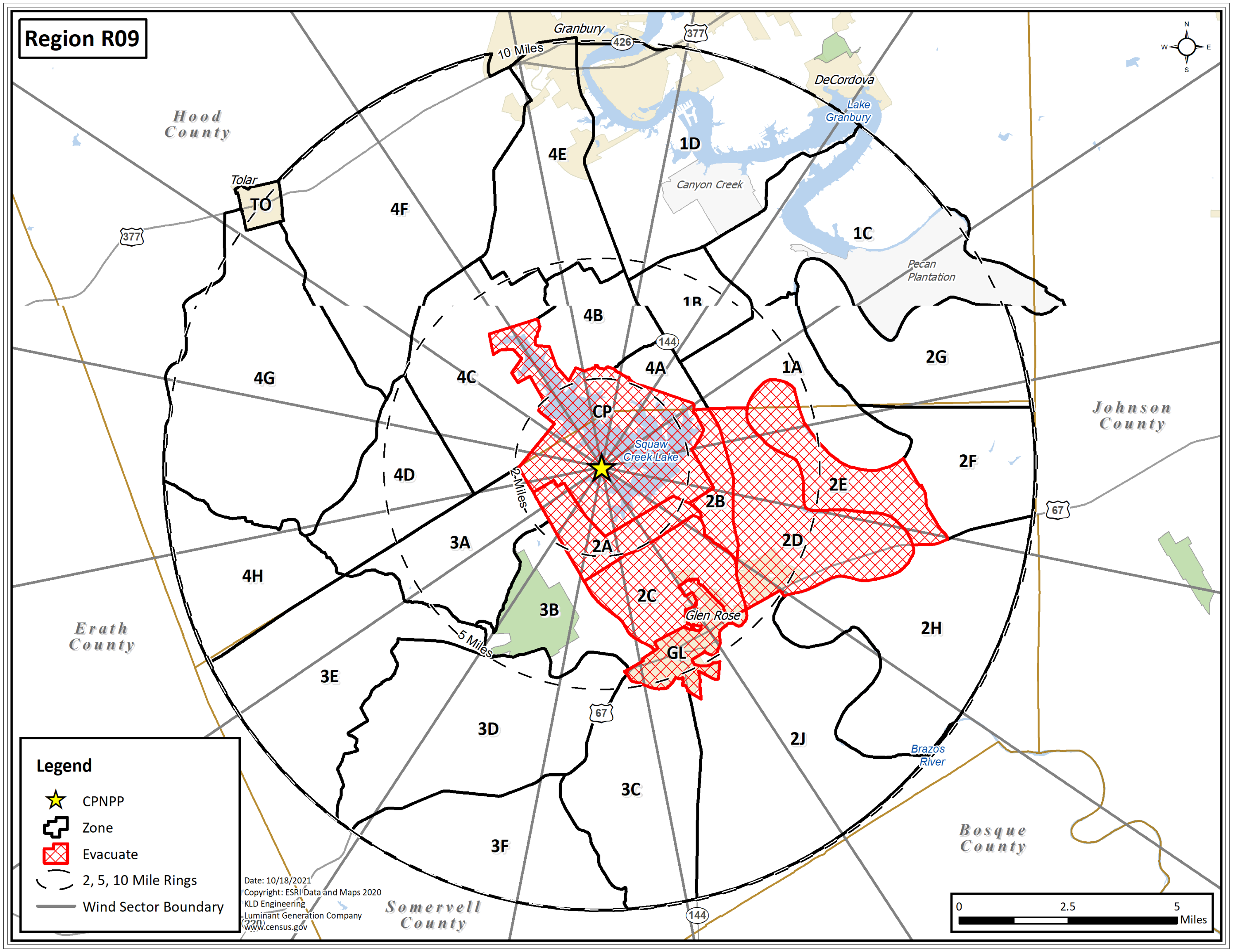


Figure H-9. Region R09

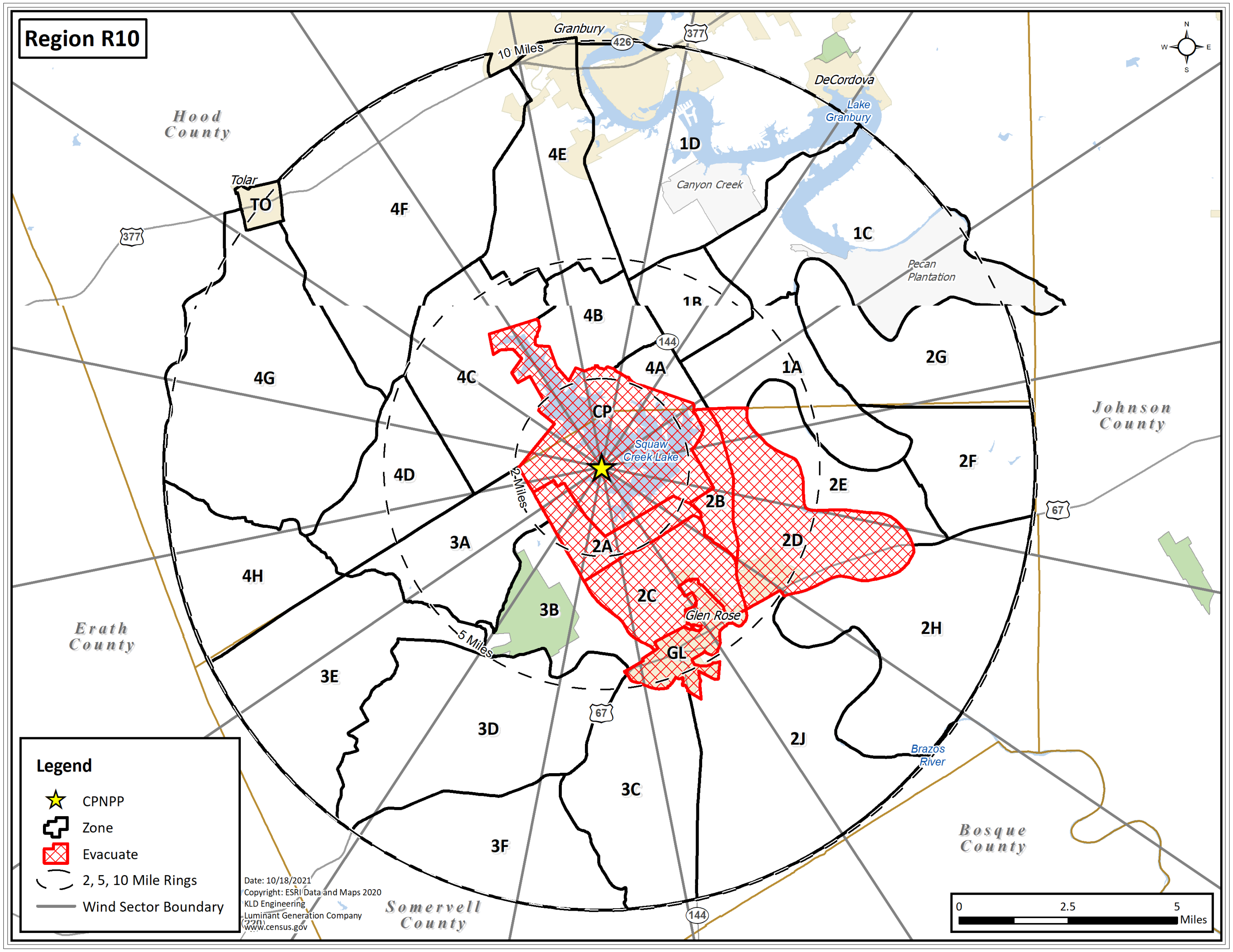


Figure H-10. Region R10

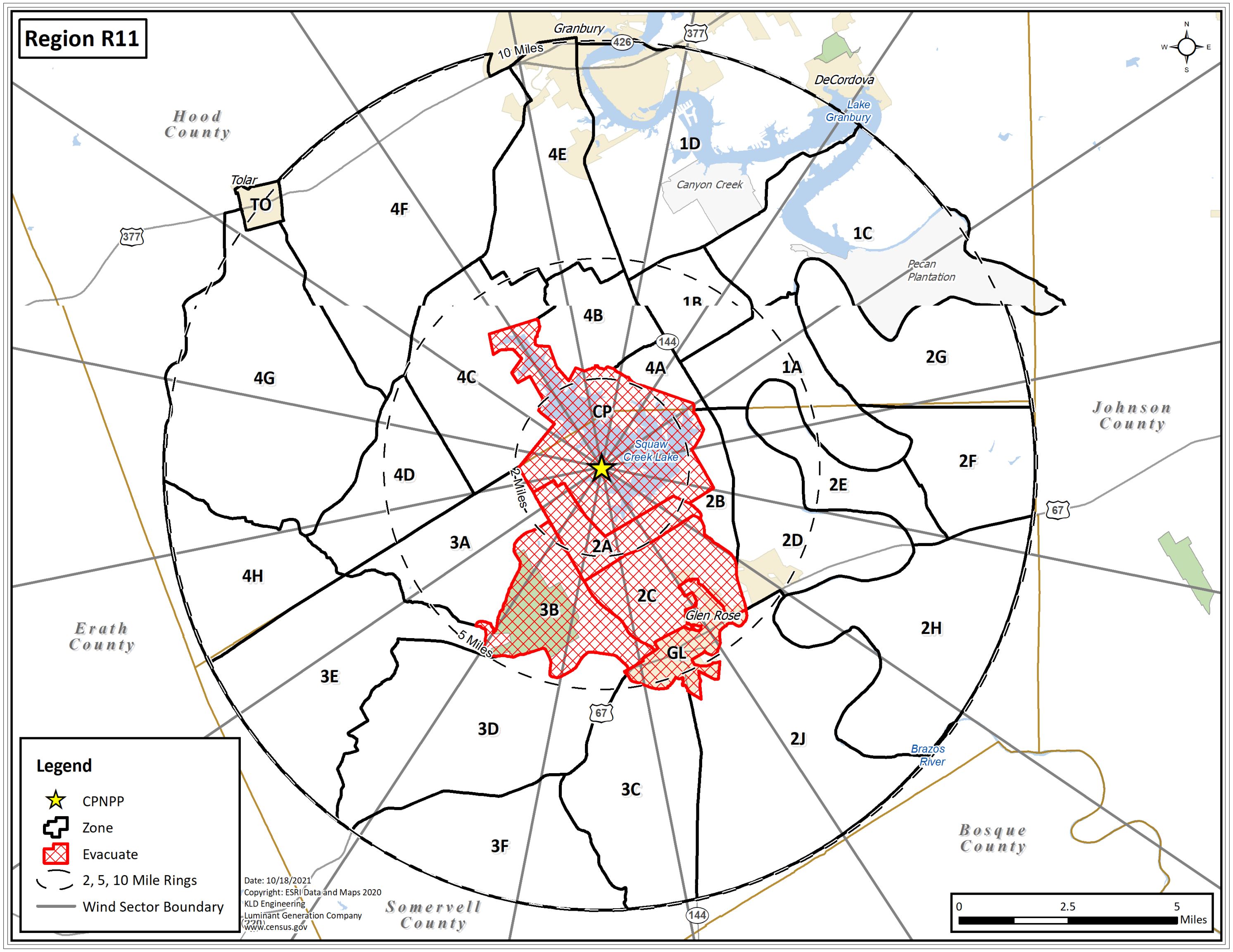


Figure H-11. Region R11

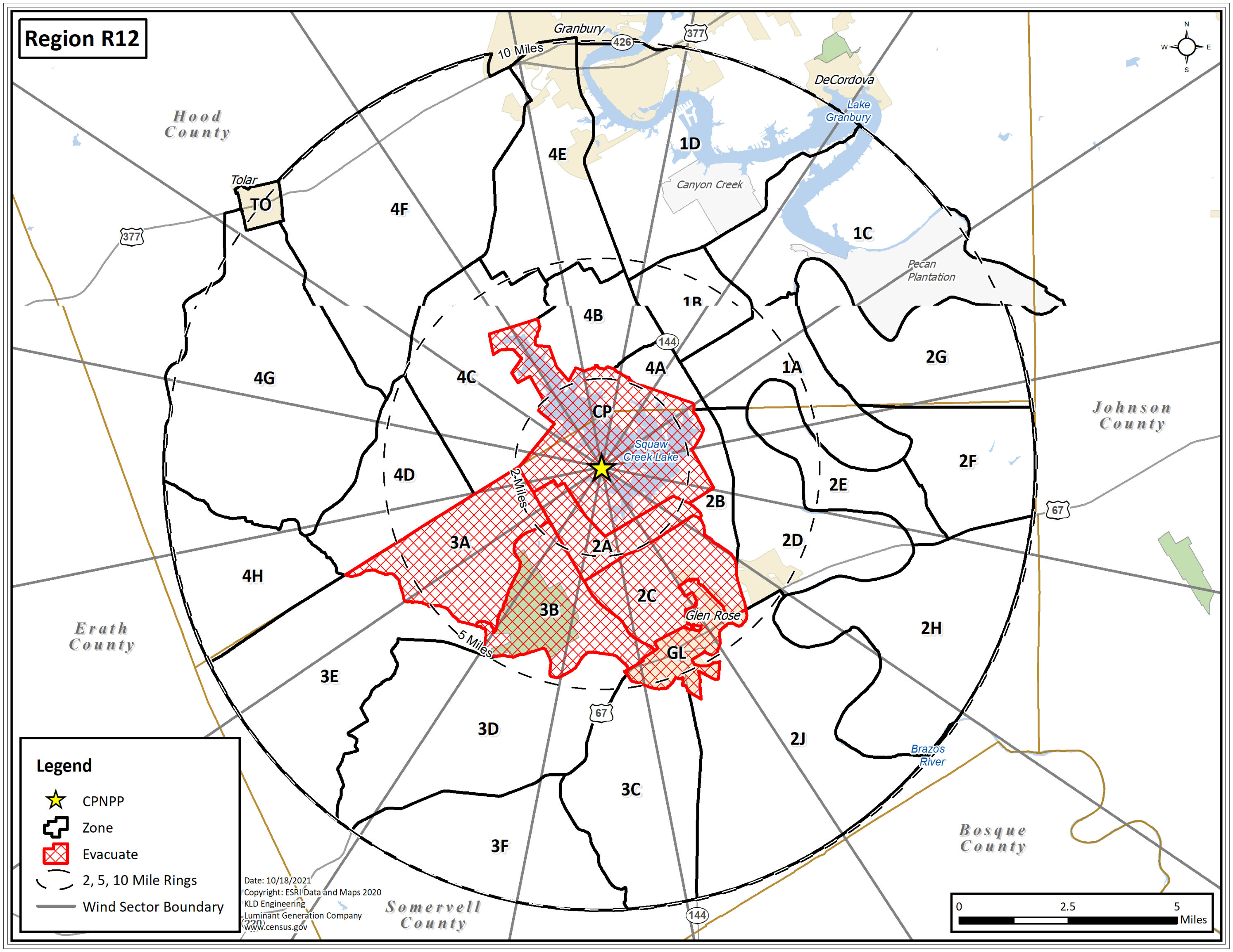


Figure H-12. Region R12

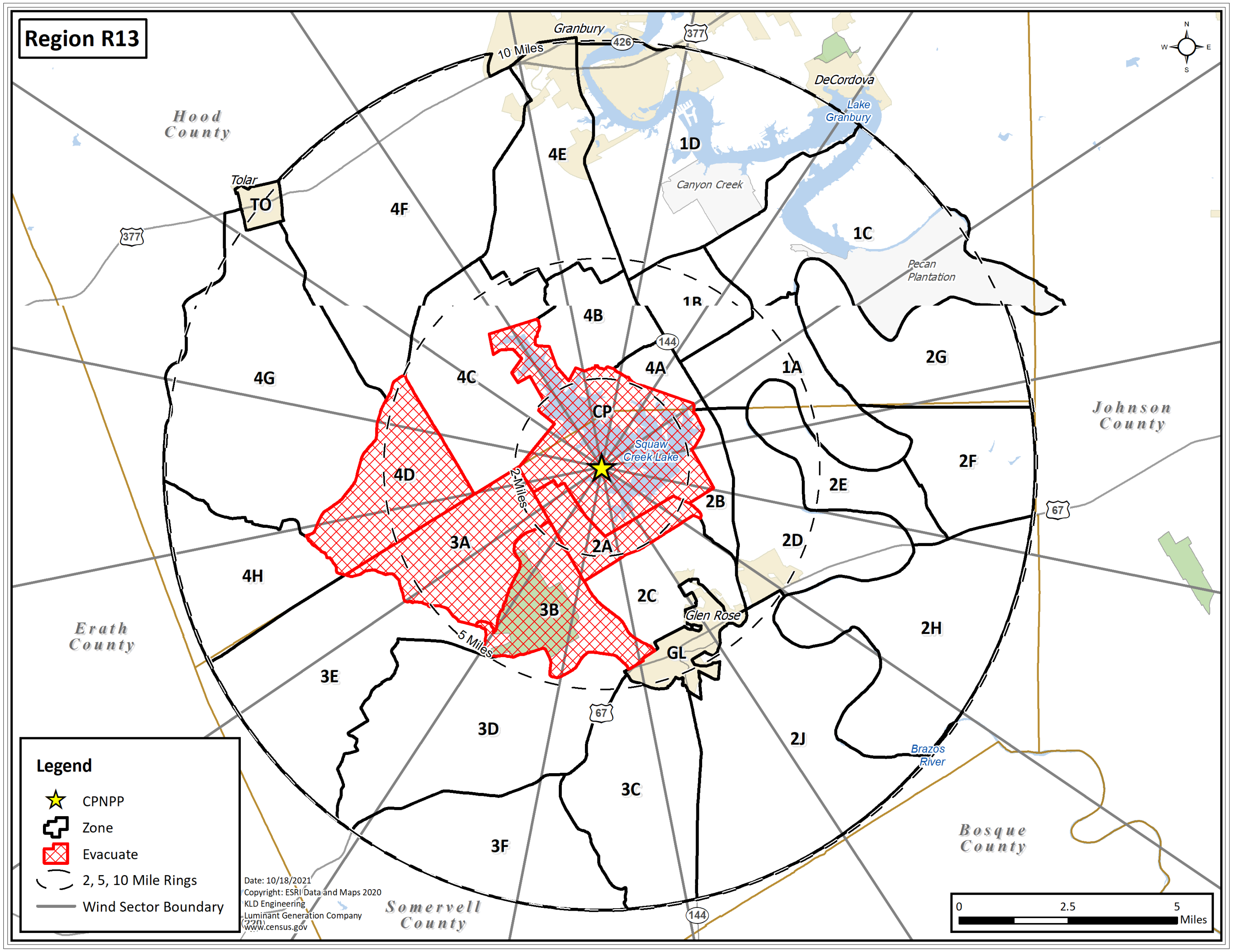


Figure H-13. Region R13

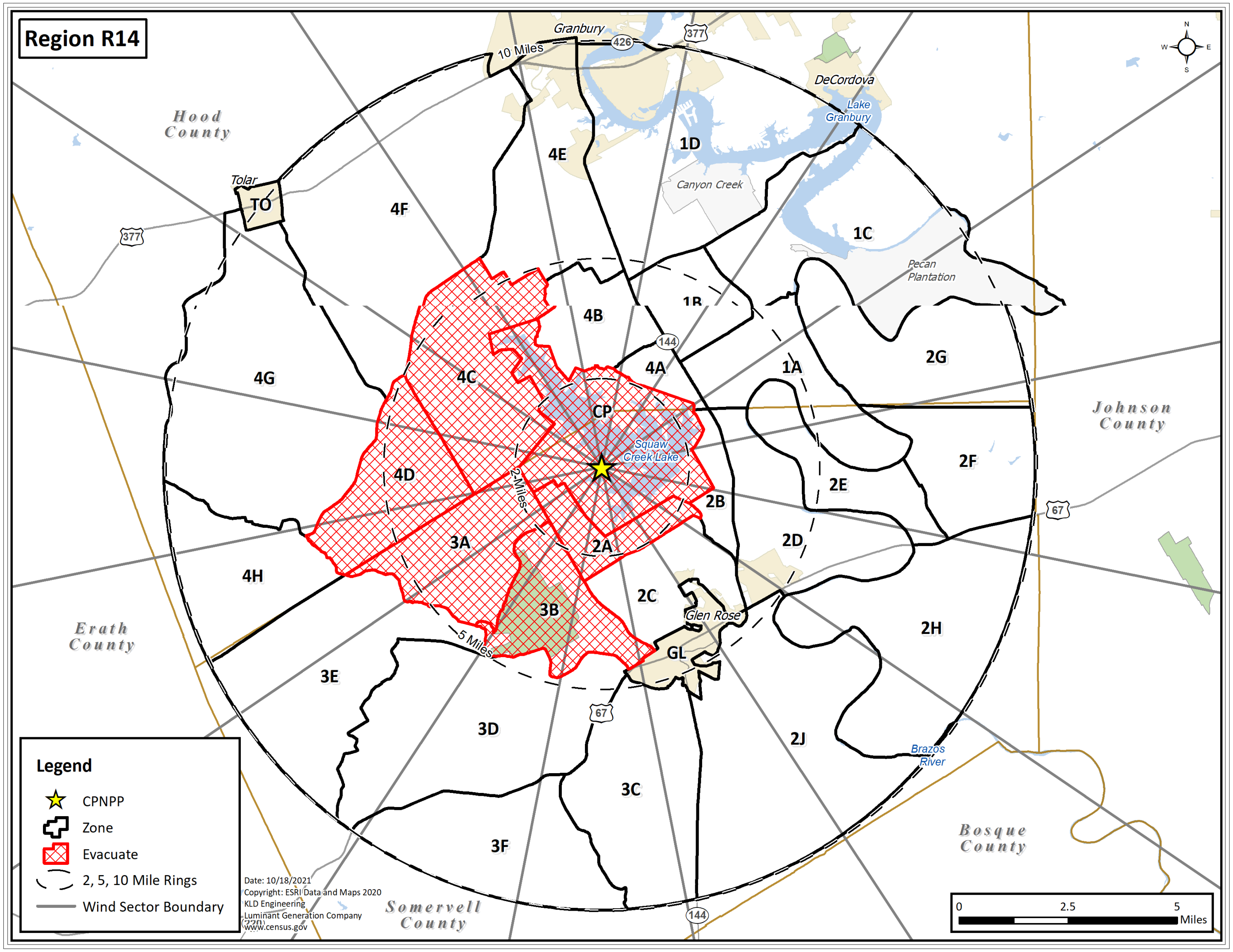


Figure H-14. Region R14

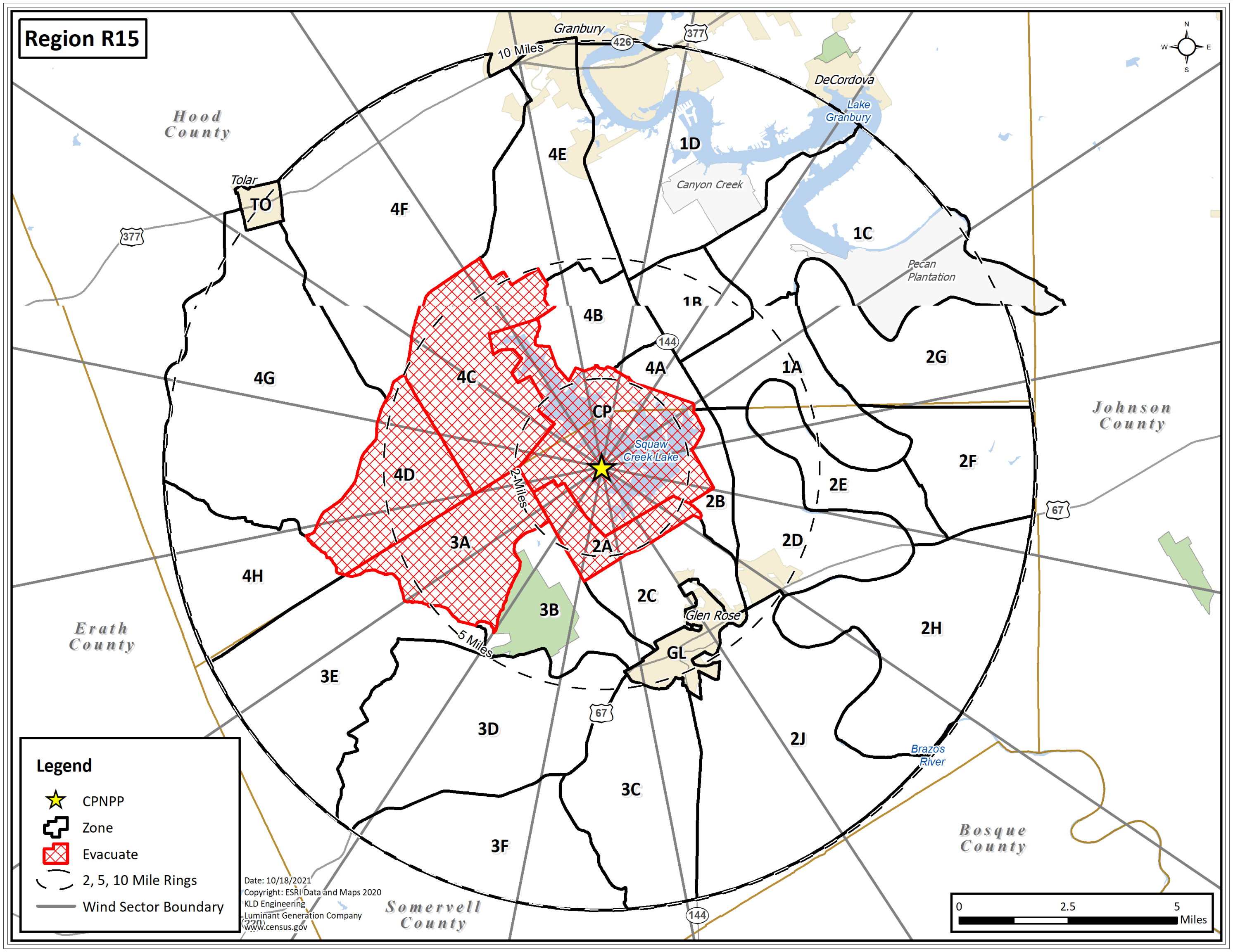


Figure H-15. Region R15

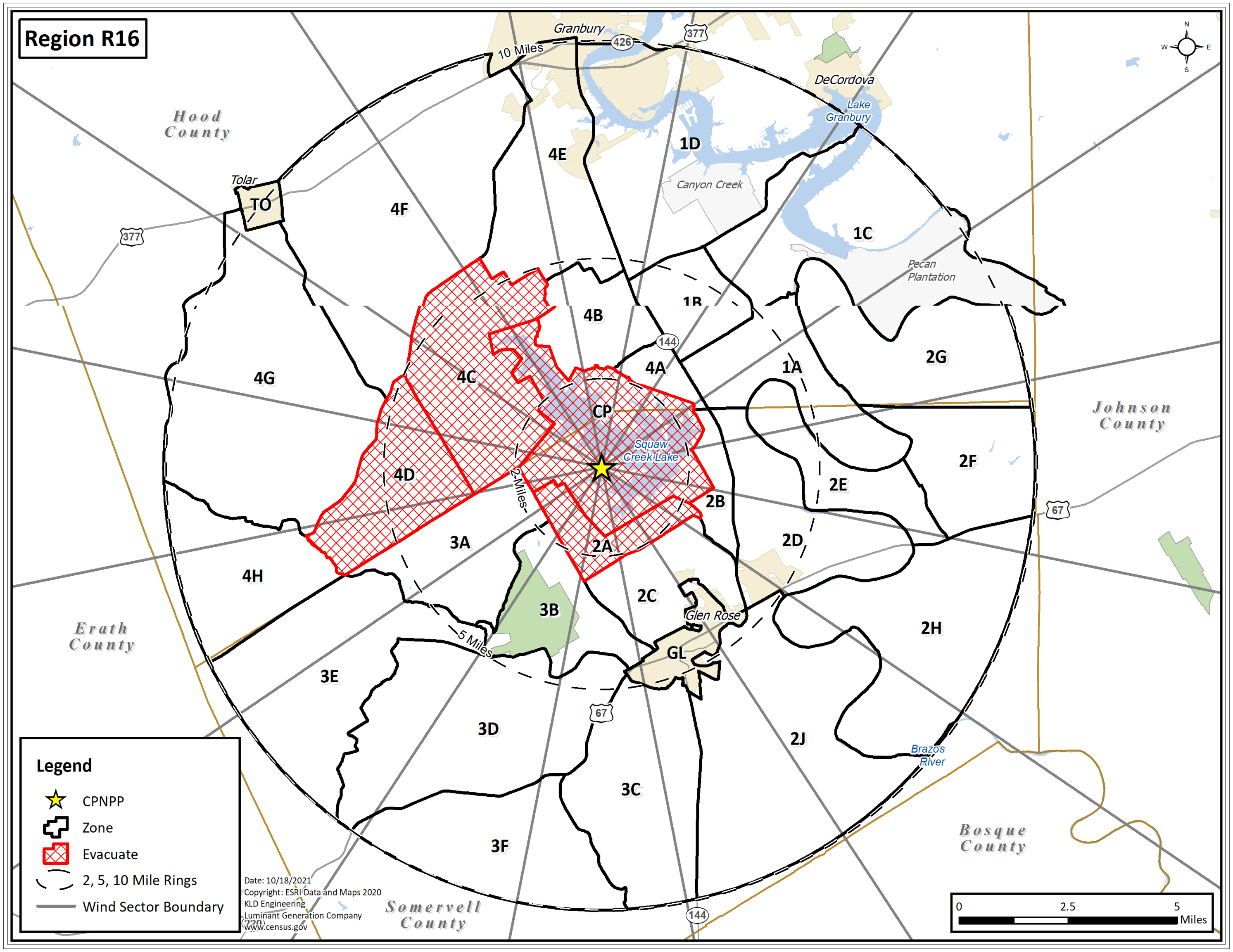


Figure H-16. Region R16

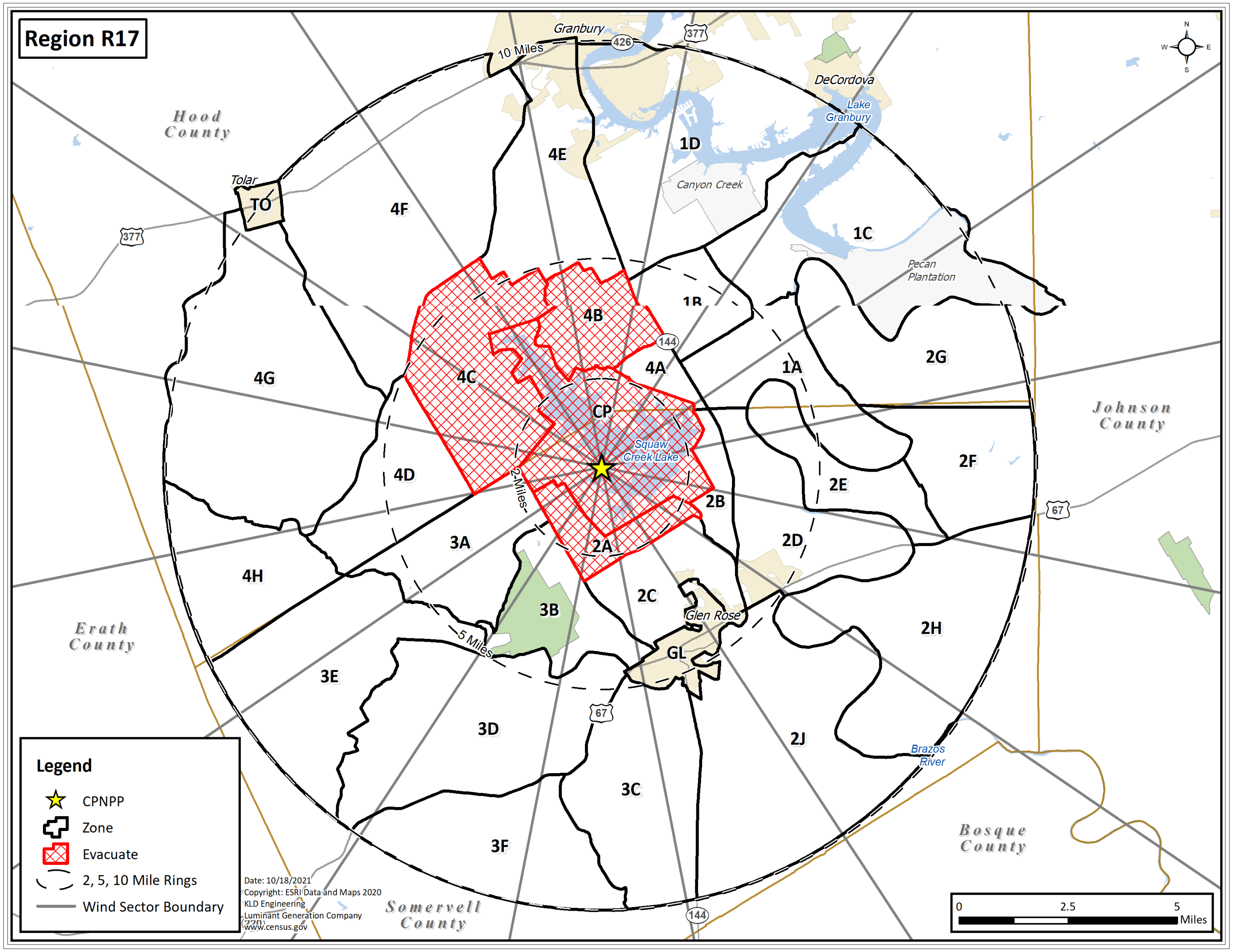


Figure H-17. Region R17

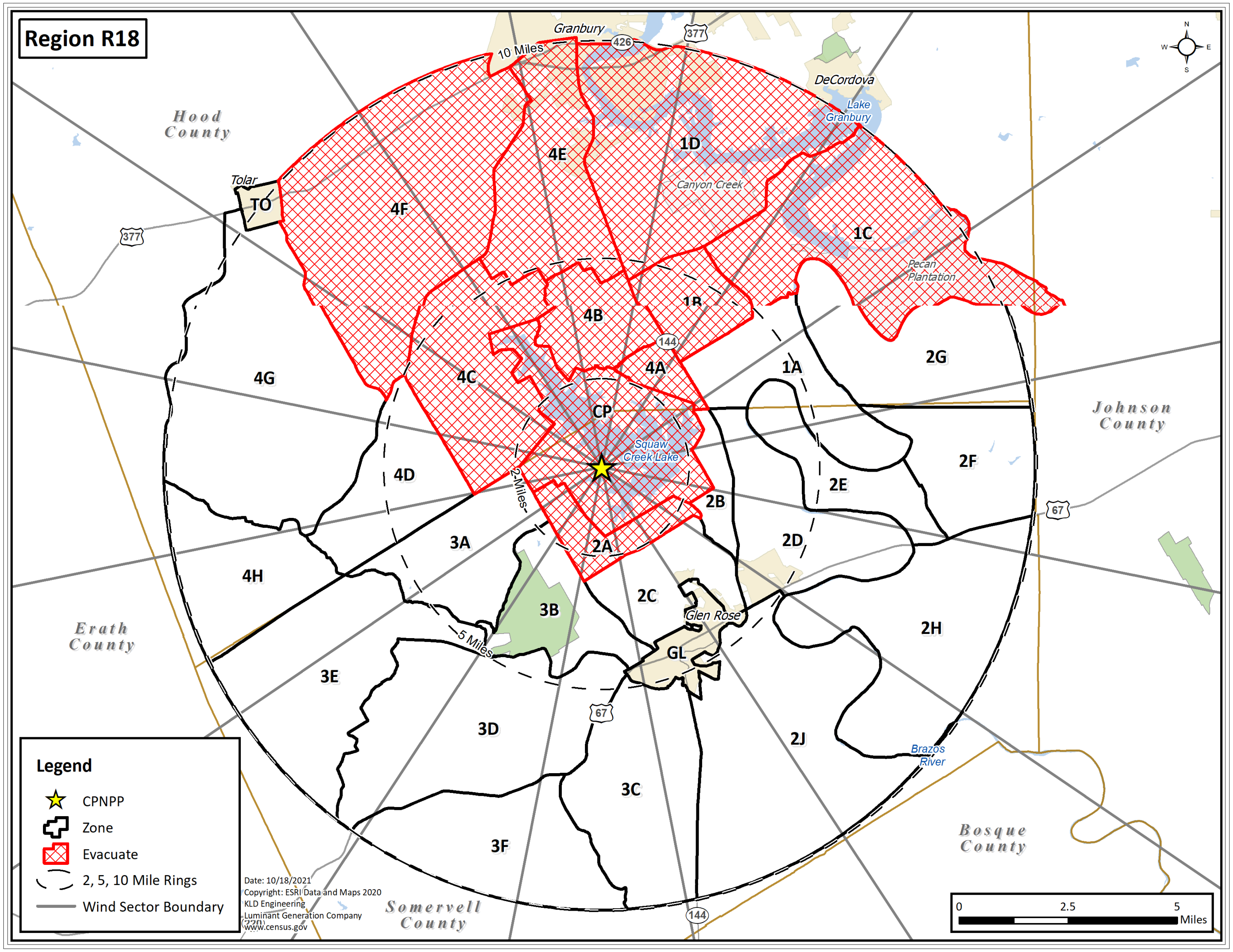


Figure H-18. Region R18

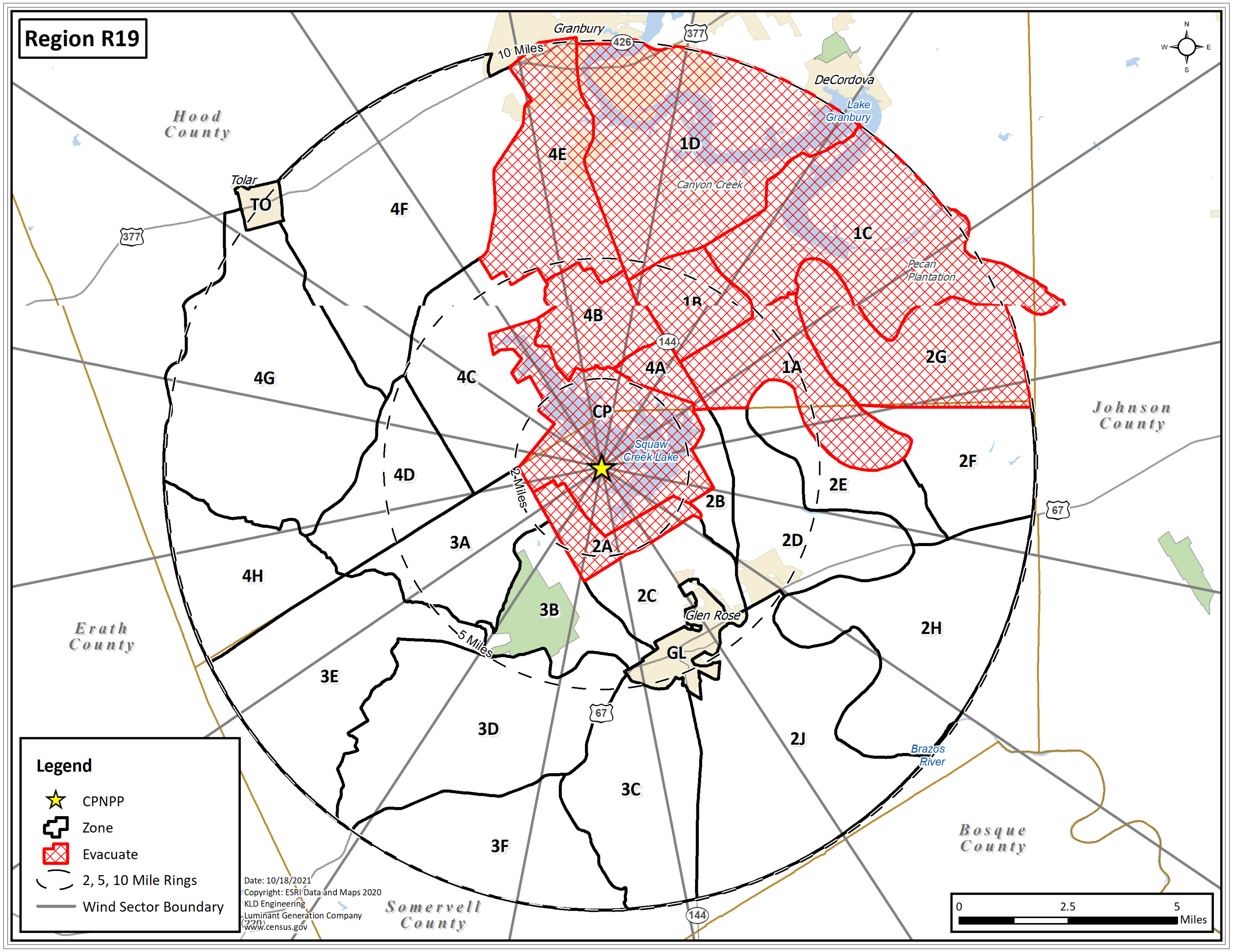


Figure H-19. Region R19

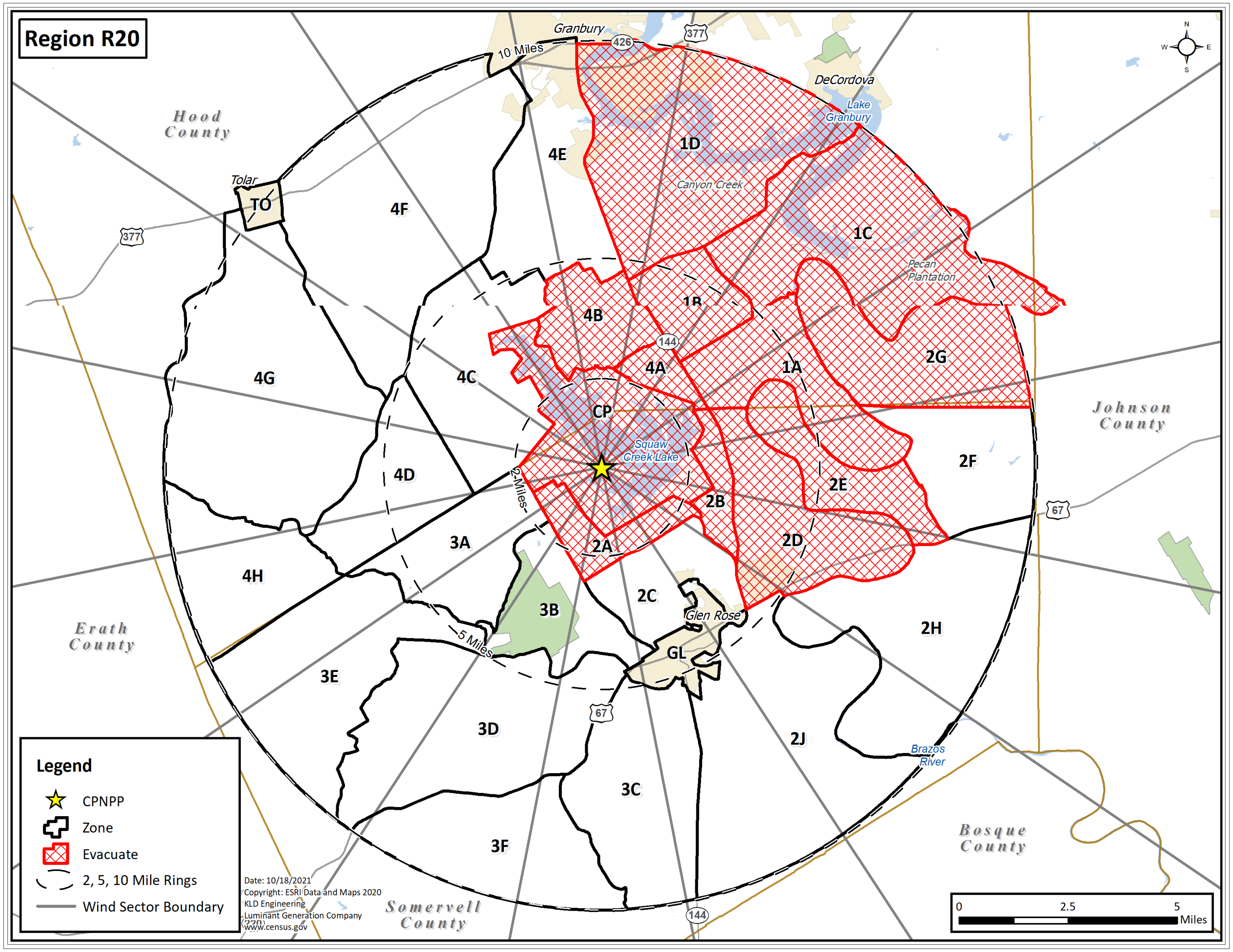


Figure H-20. Region R20

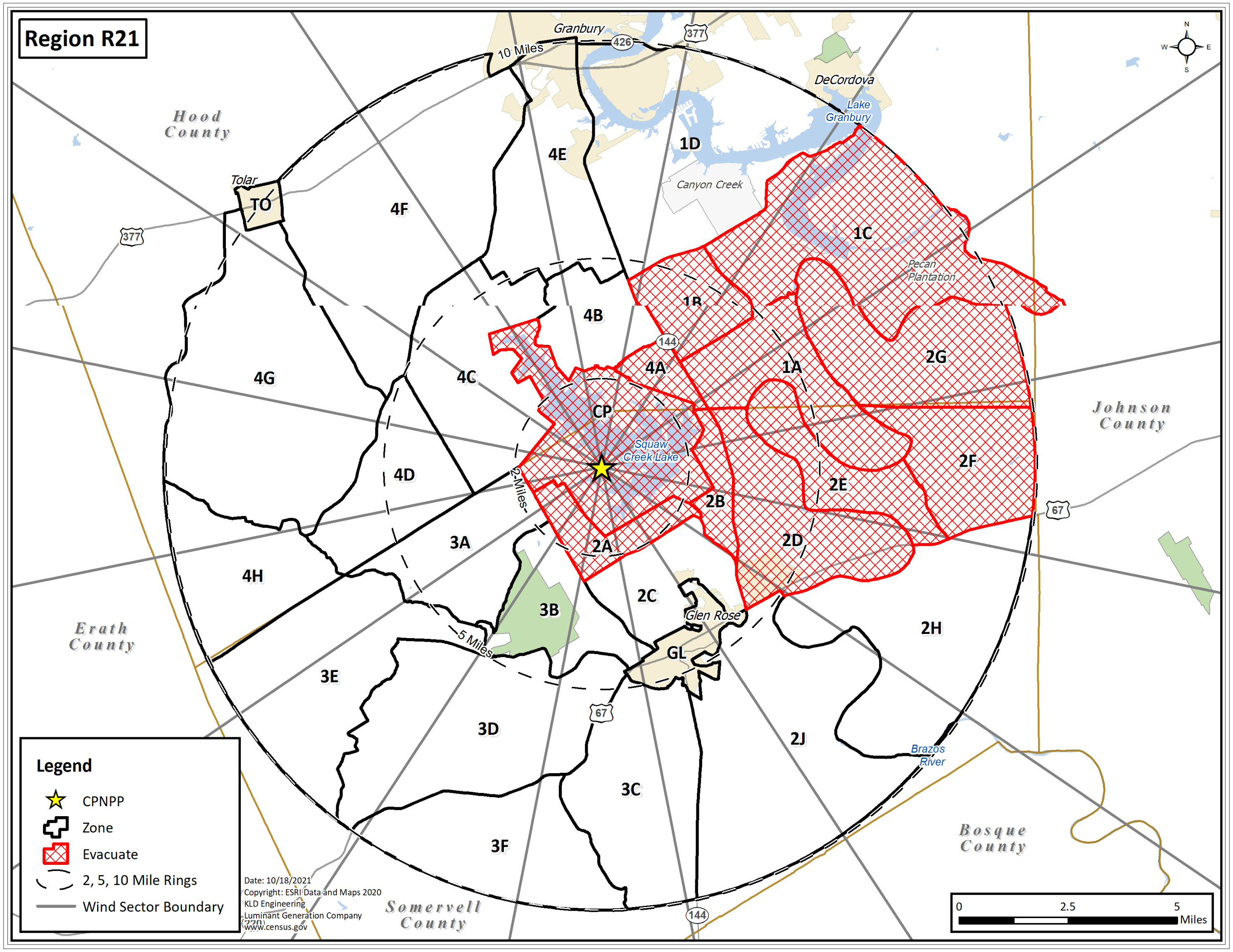


Figure H-21. Region R21

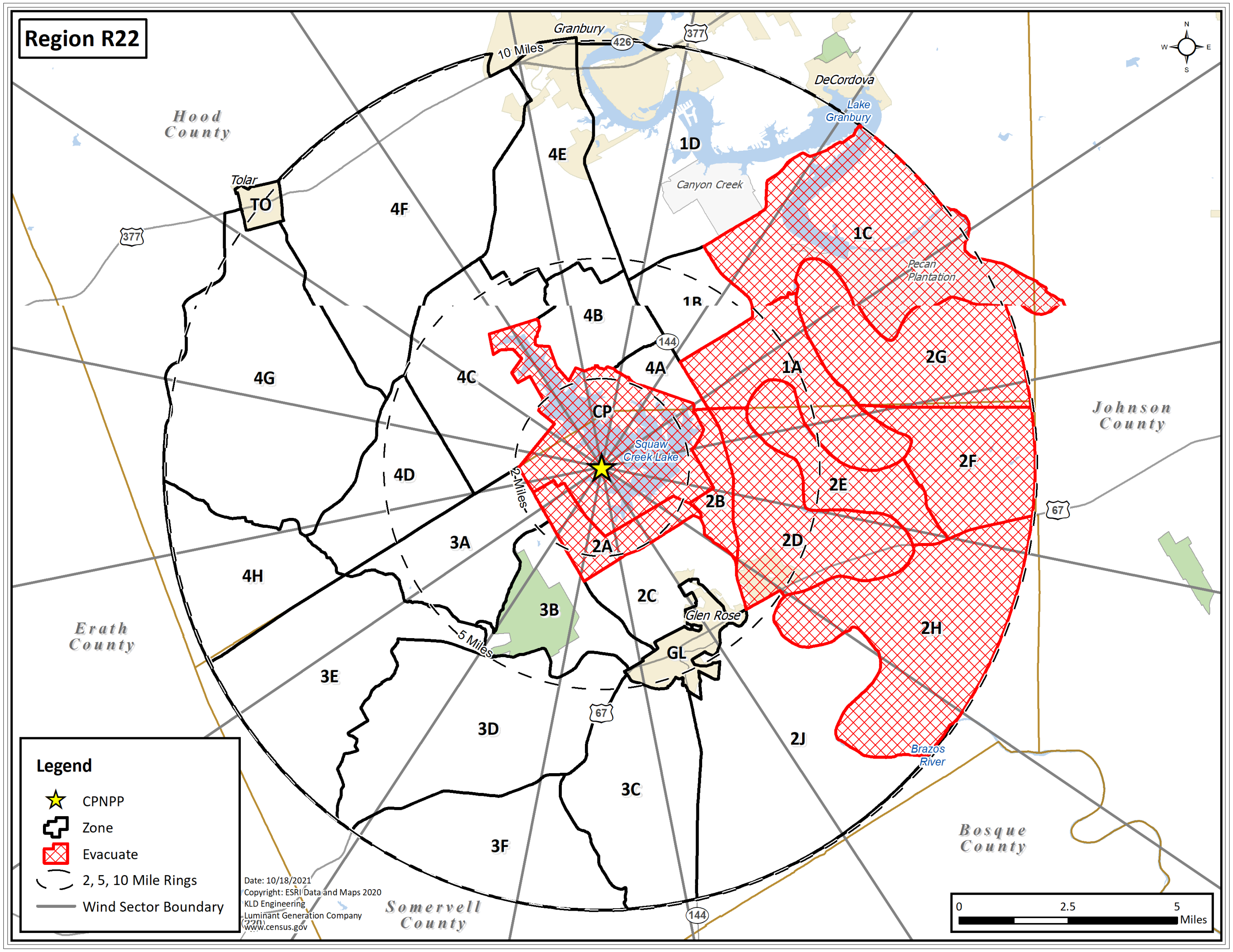


Figure H-22. Region R22

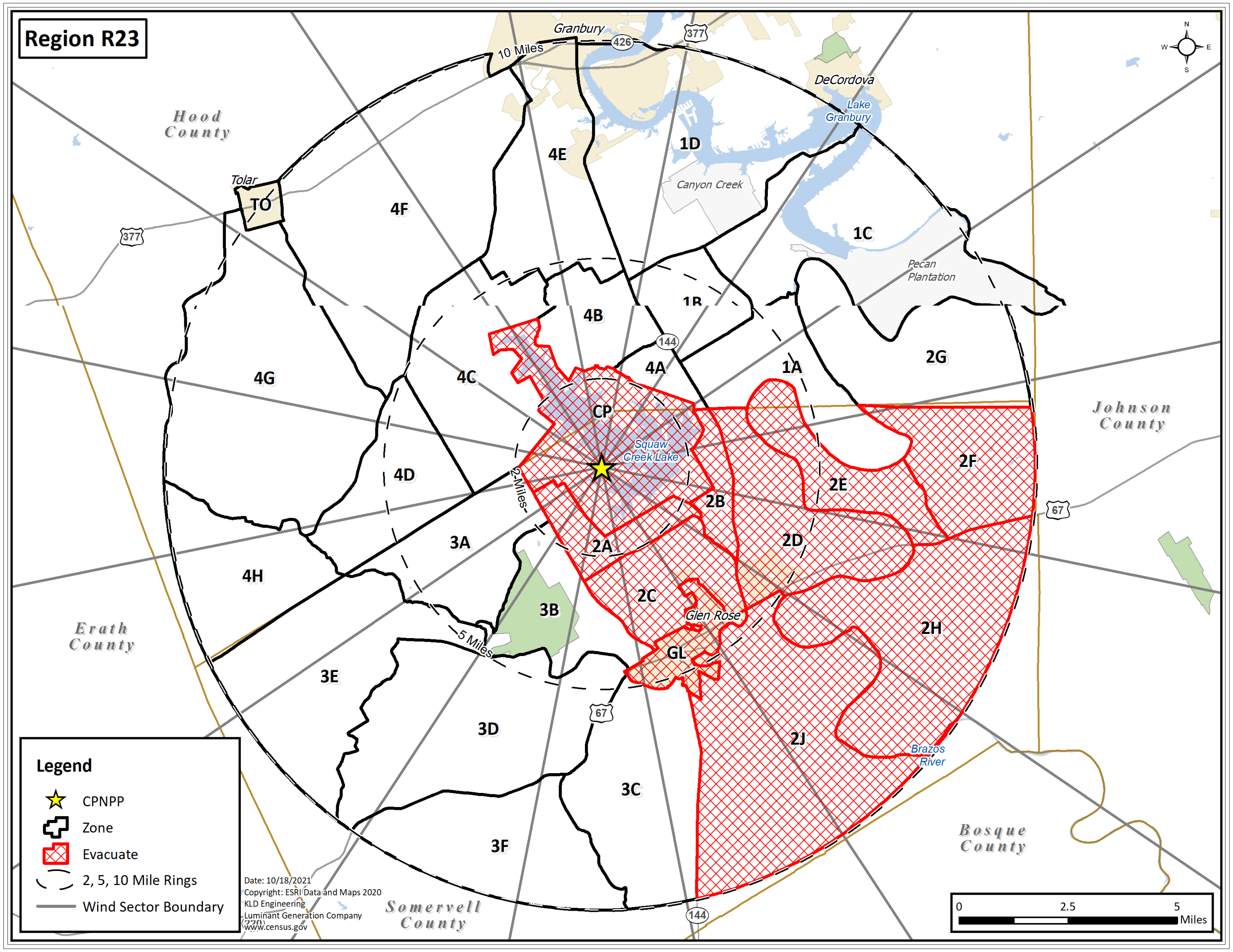


Figure H-23. Region R23

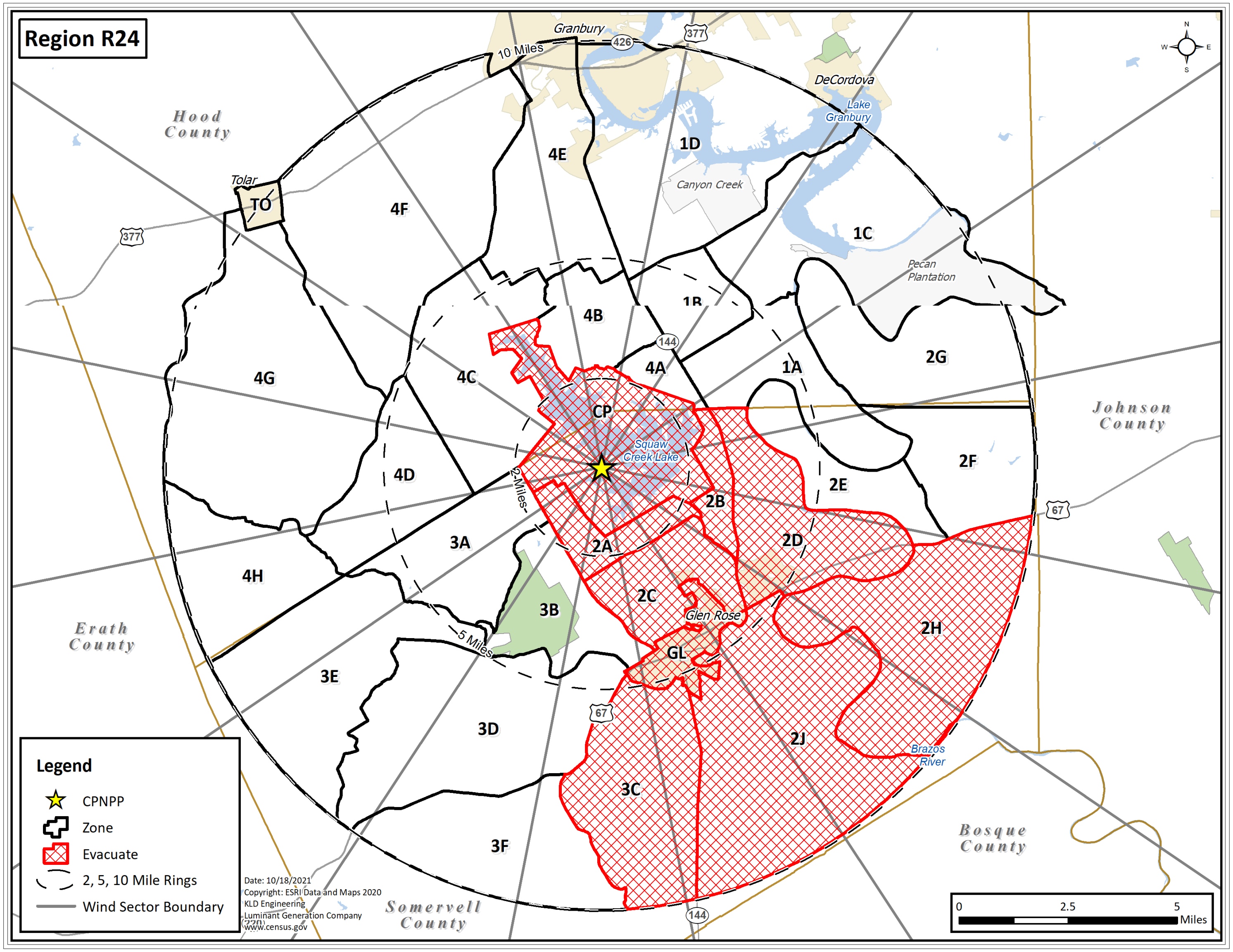


Figure H-24. Region R24

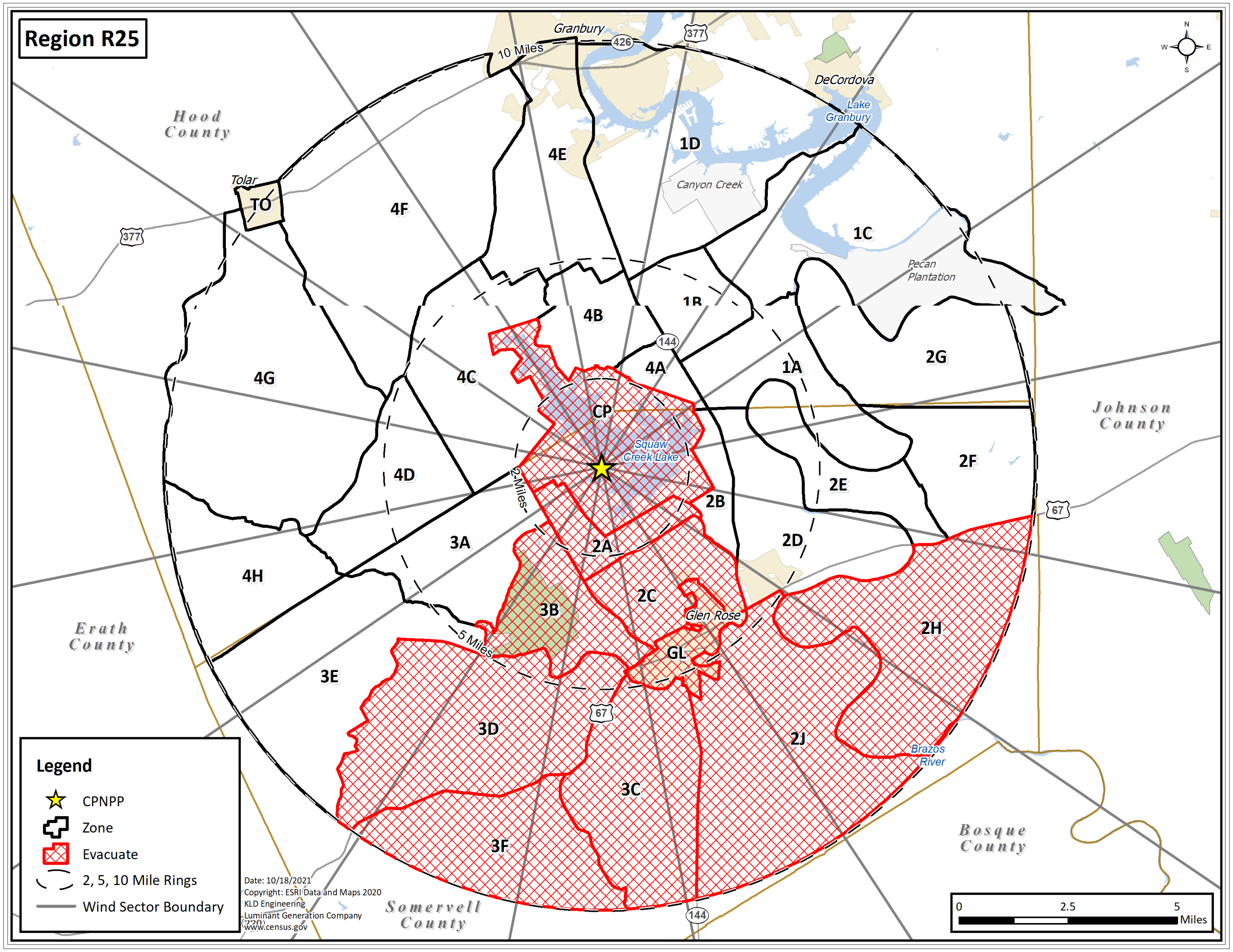


Figure H-25. Region R25

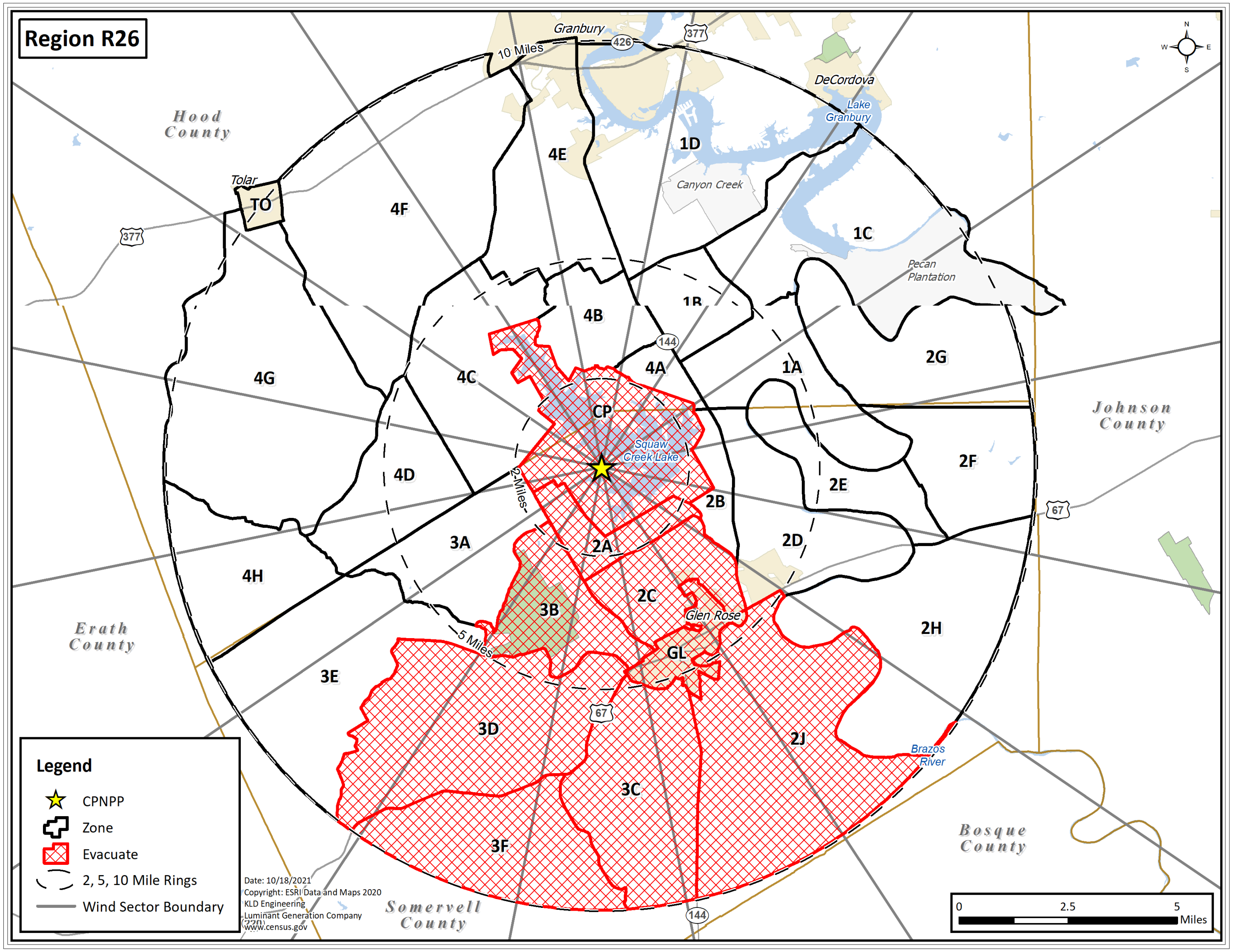
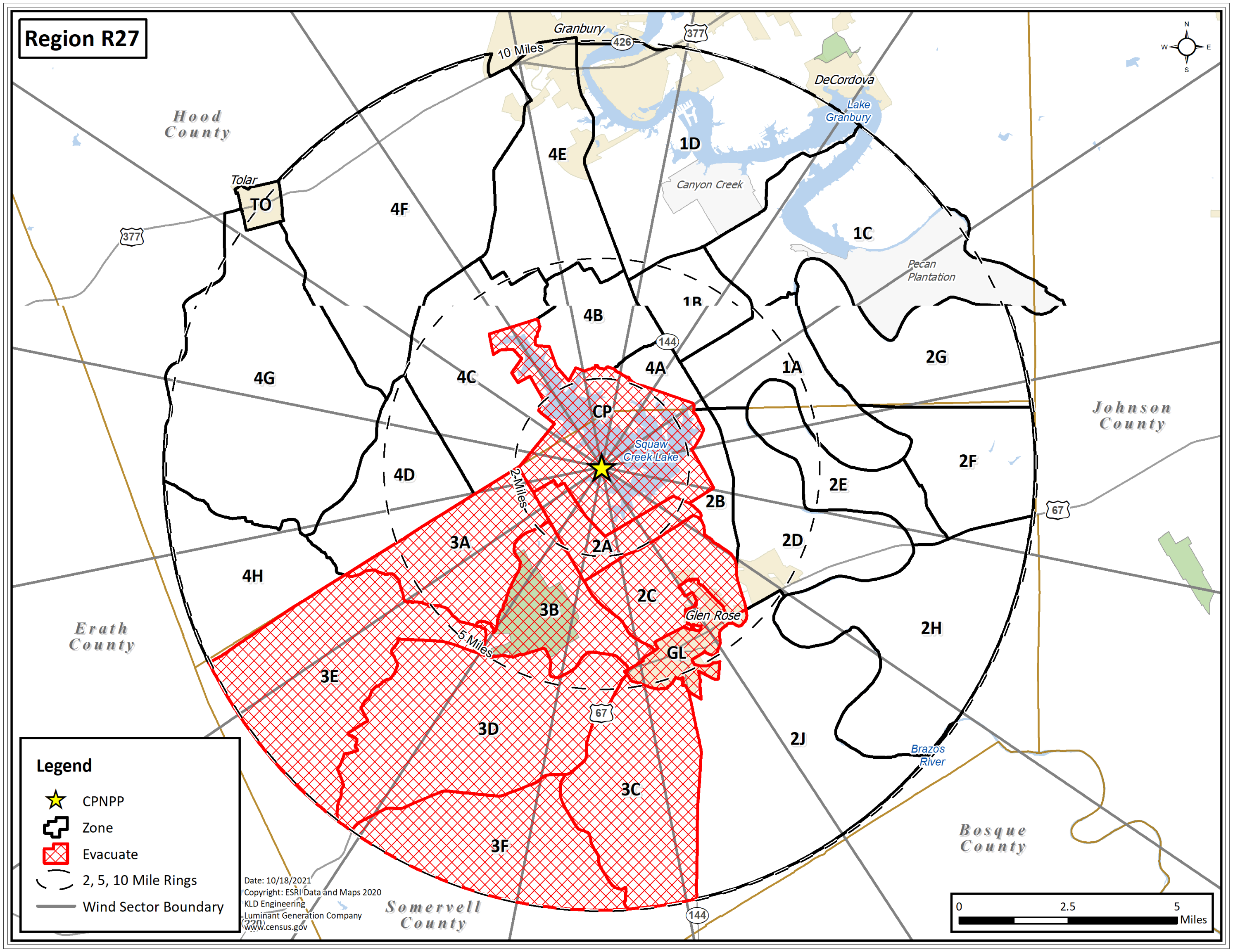


Figure H-26. Region R26



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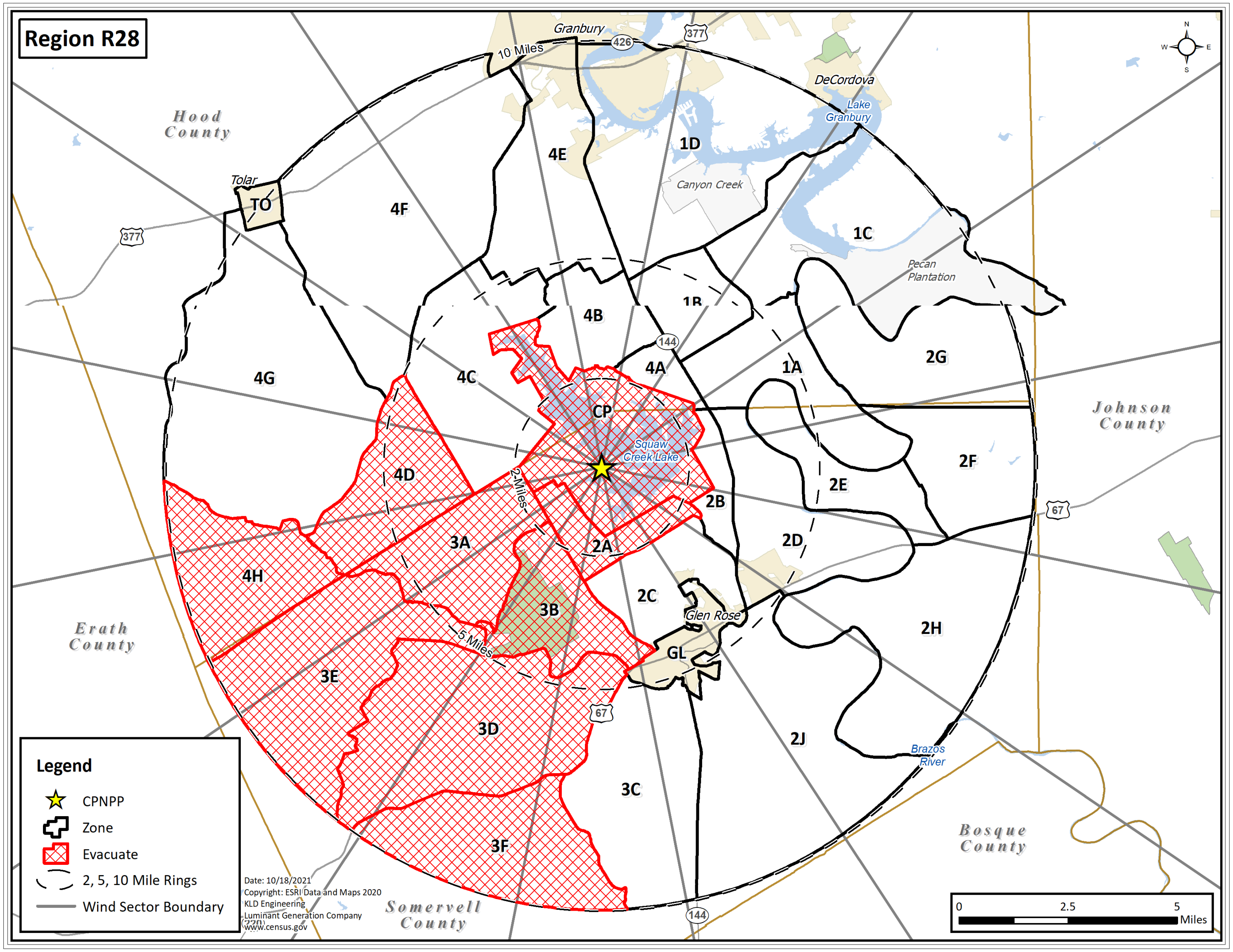

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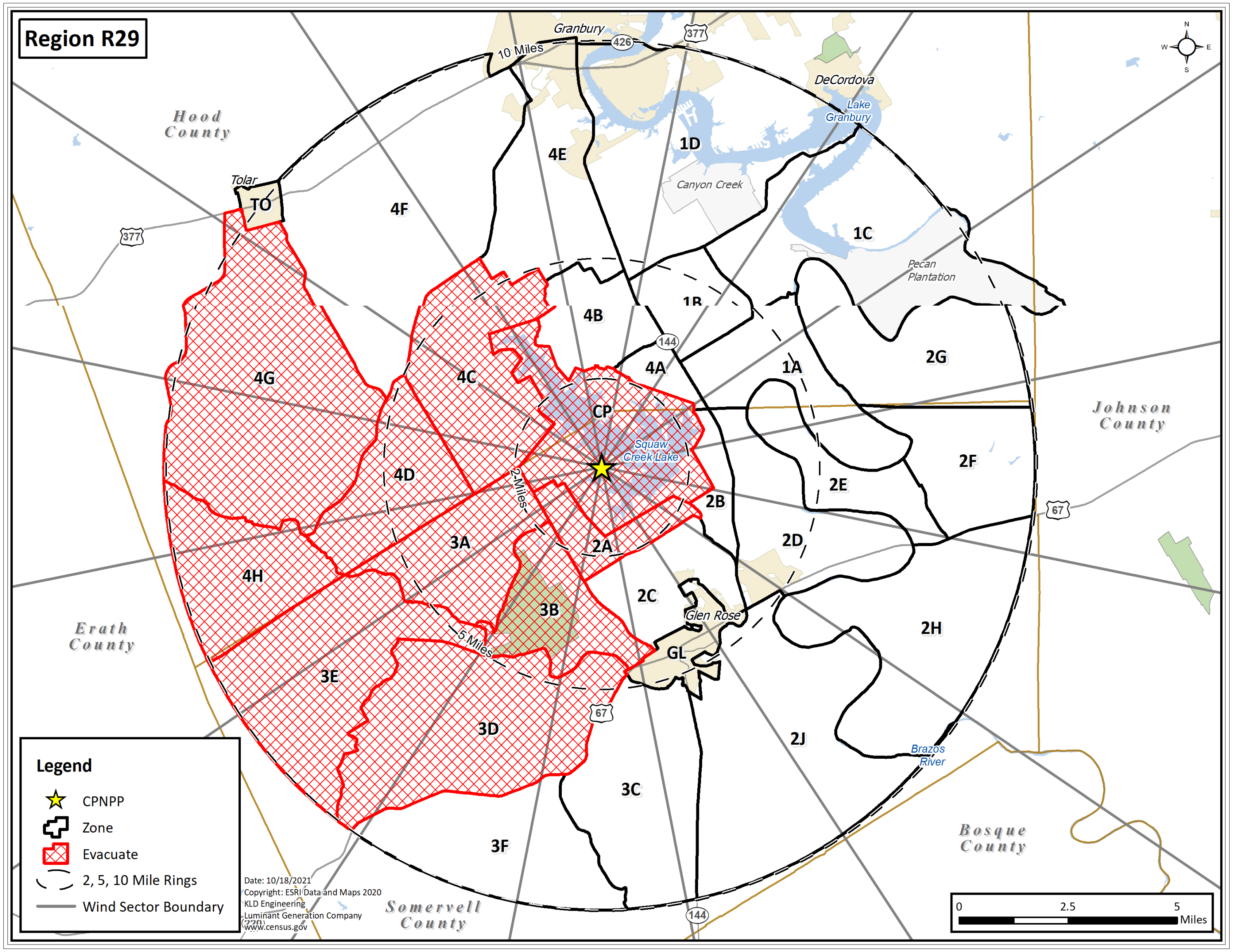

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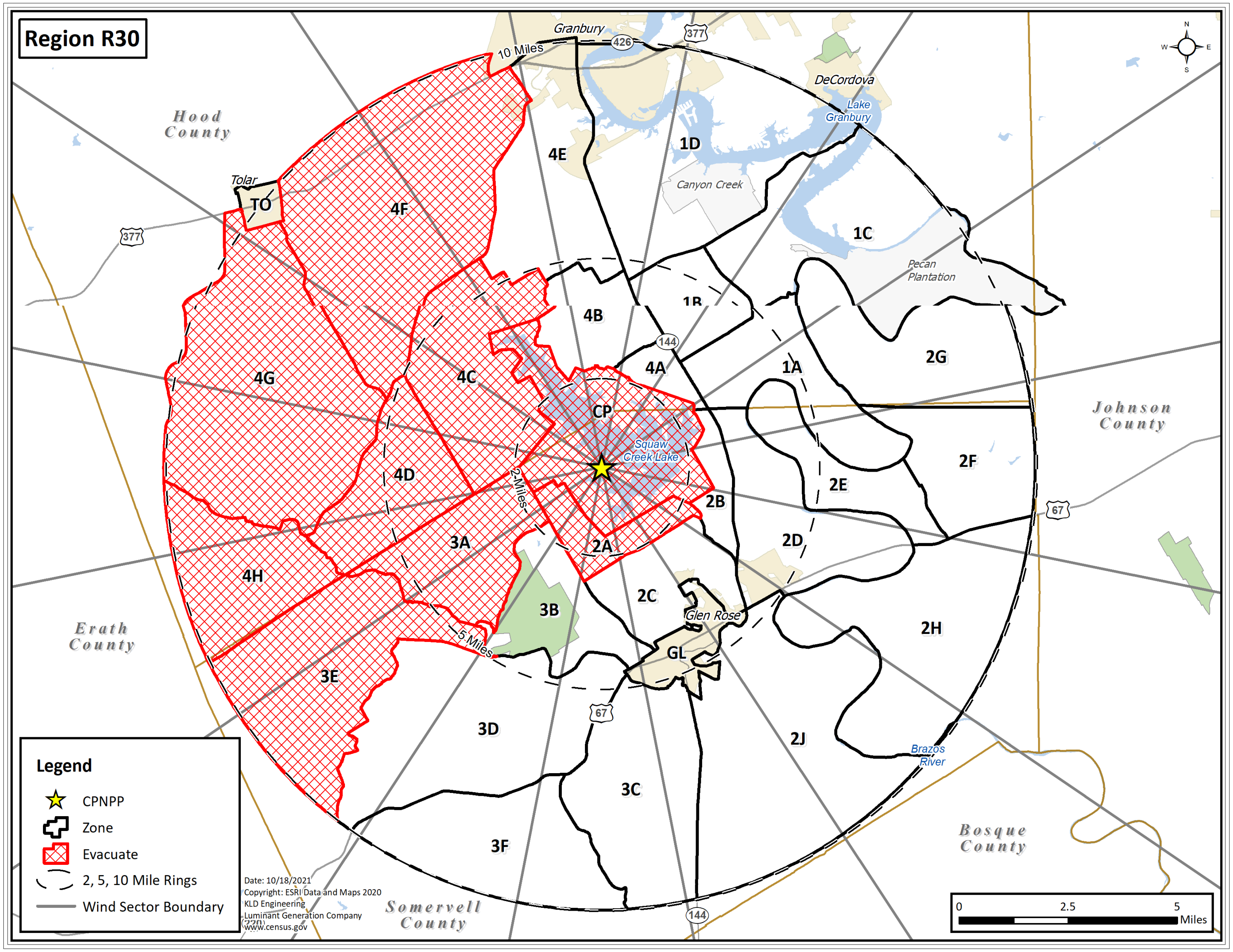

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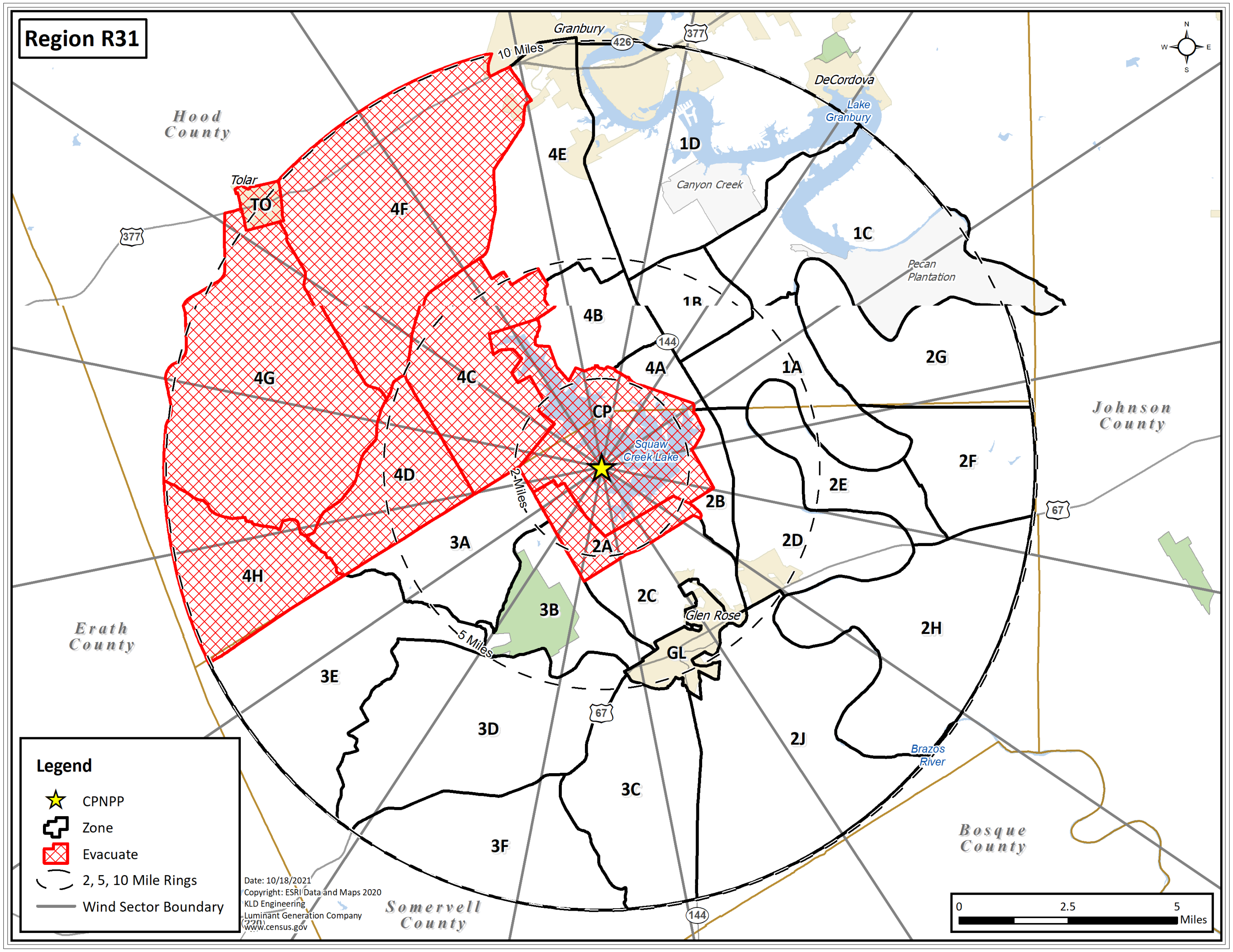

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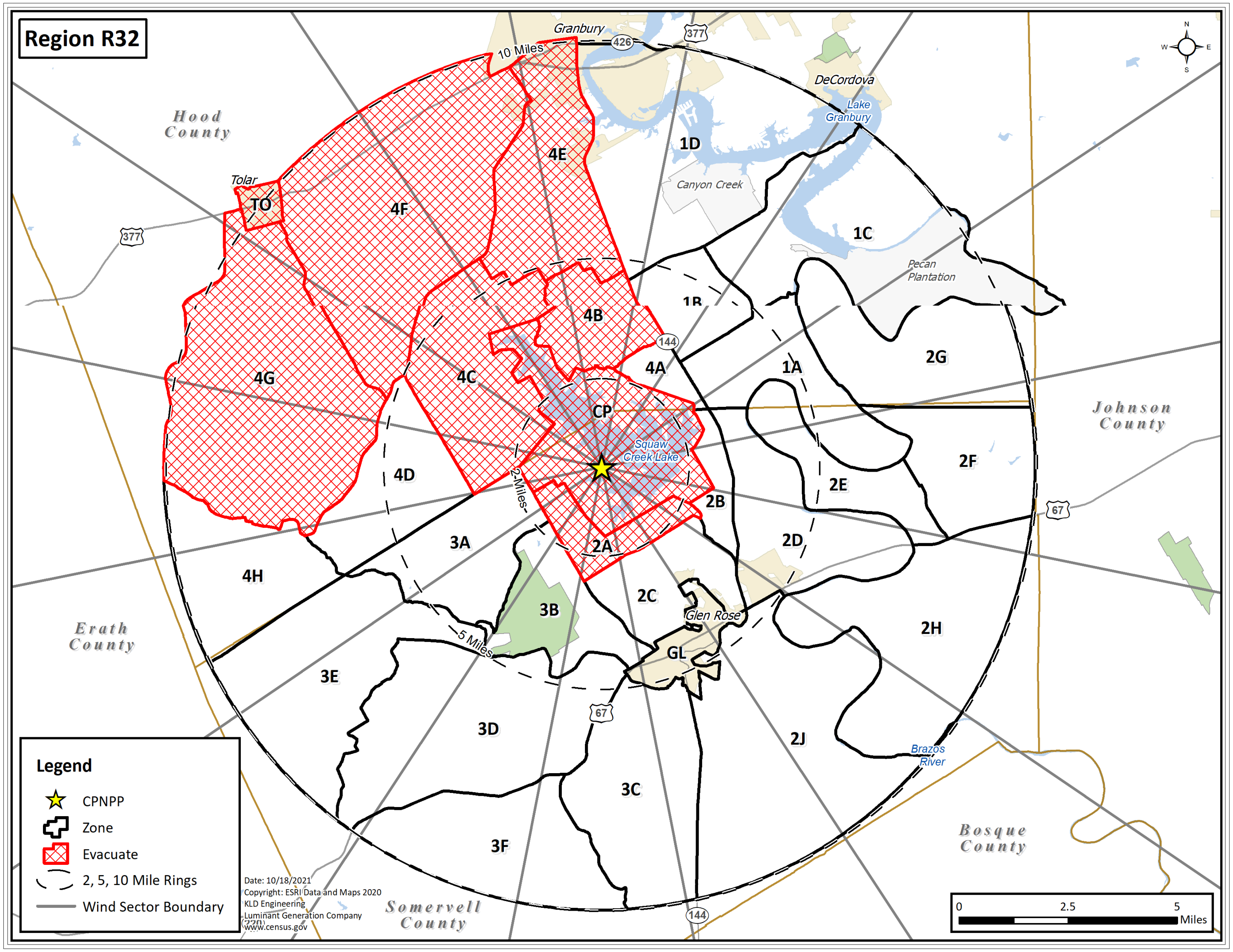

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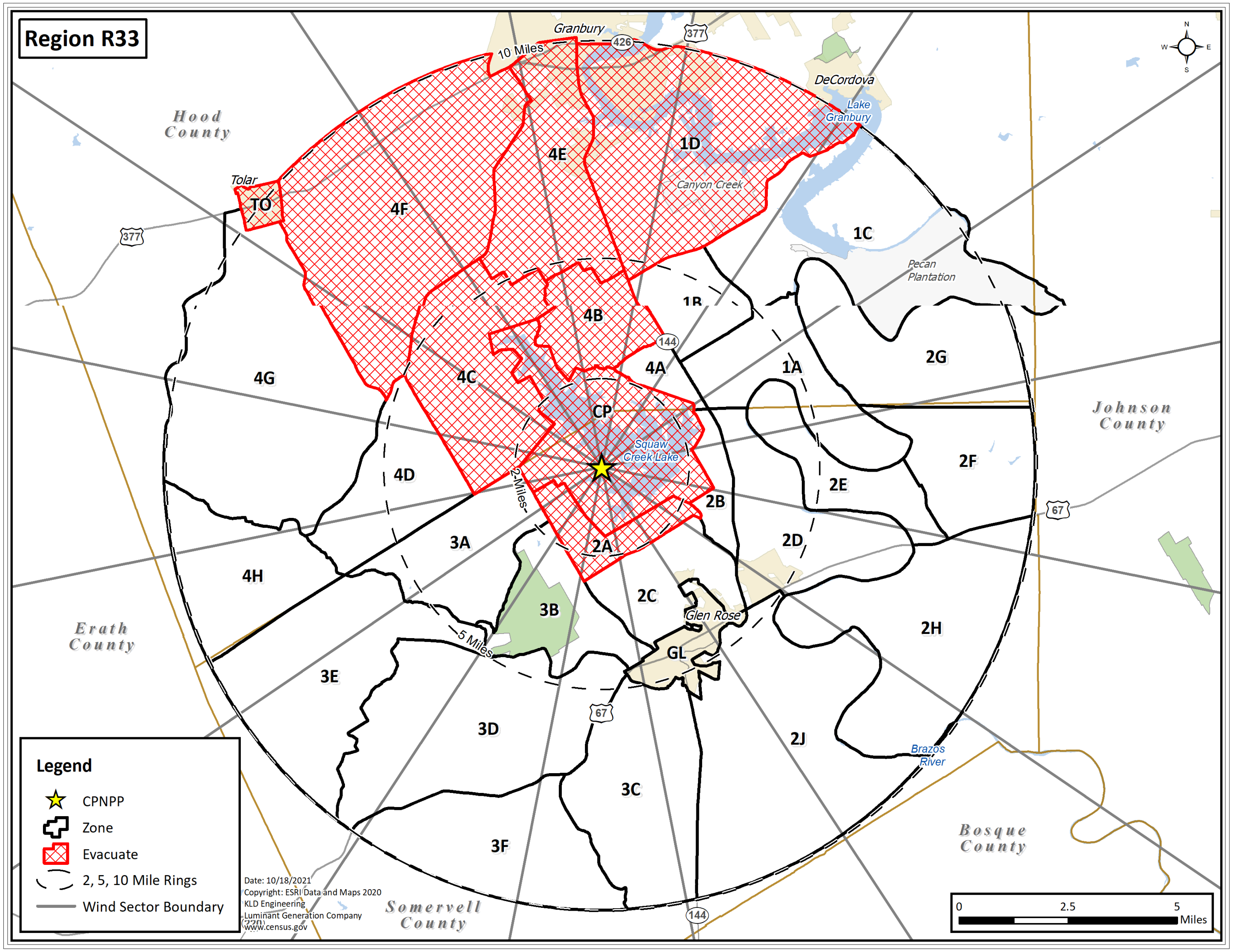

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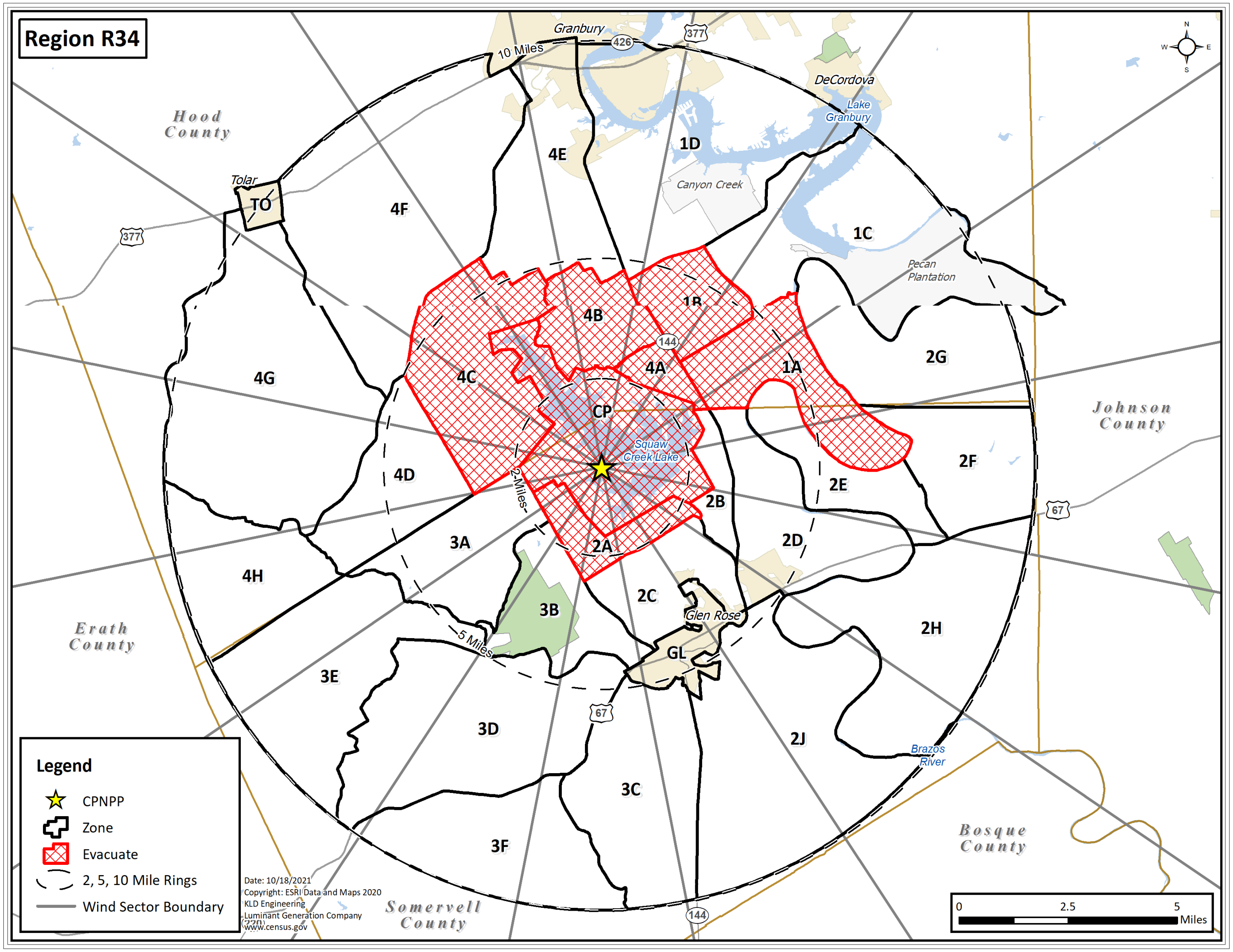

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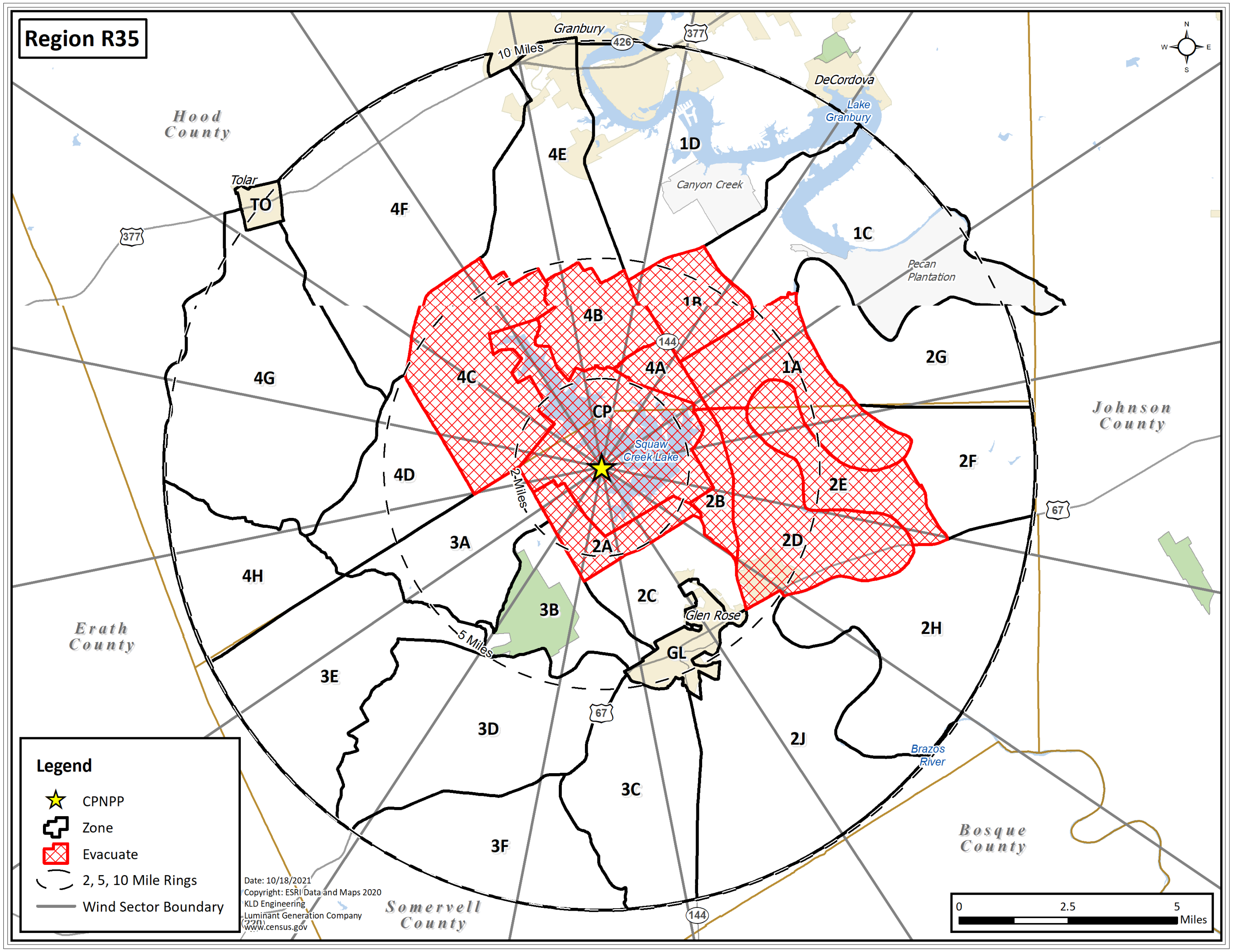

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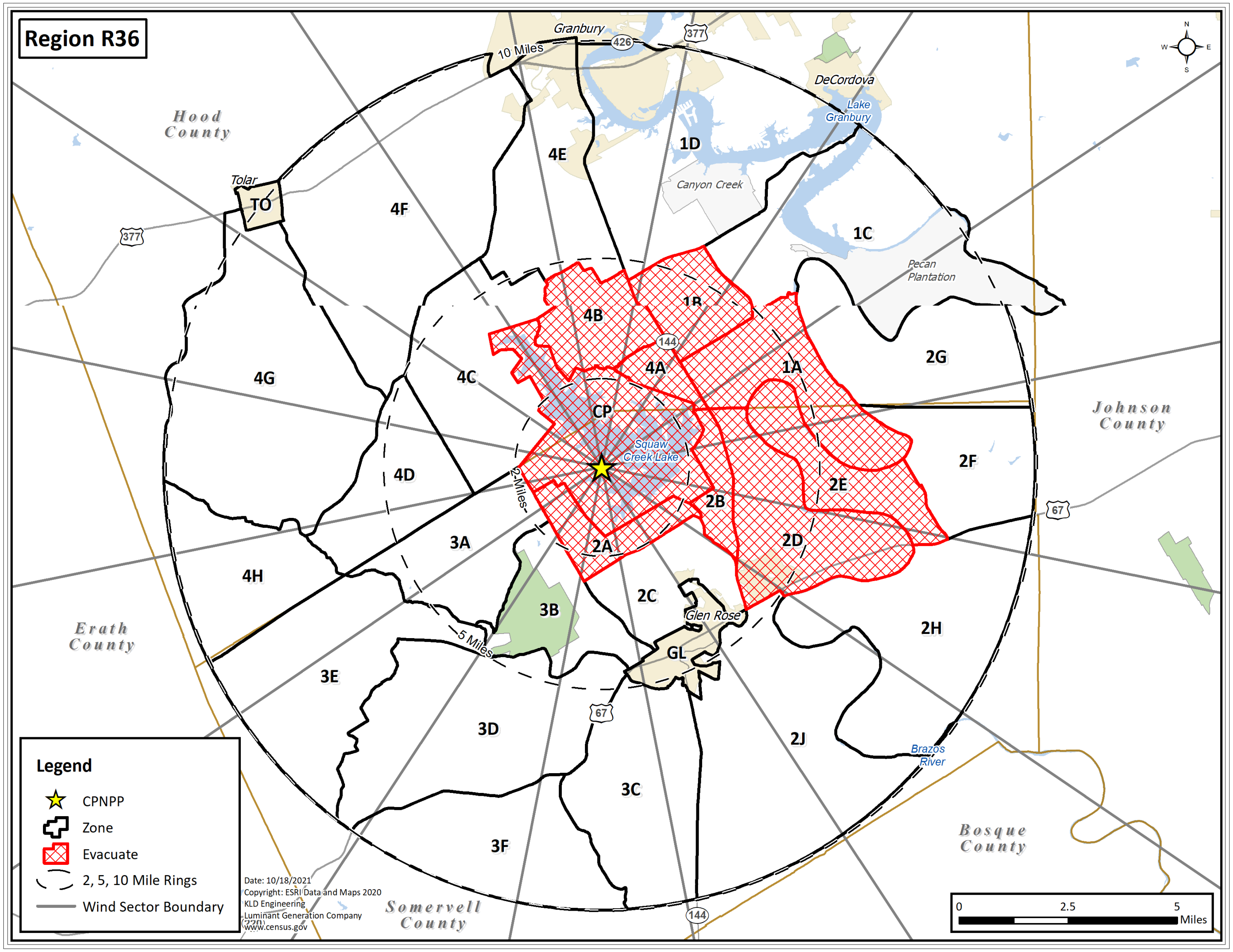

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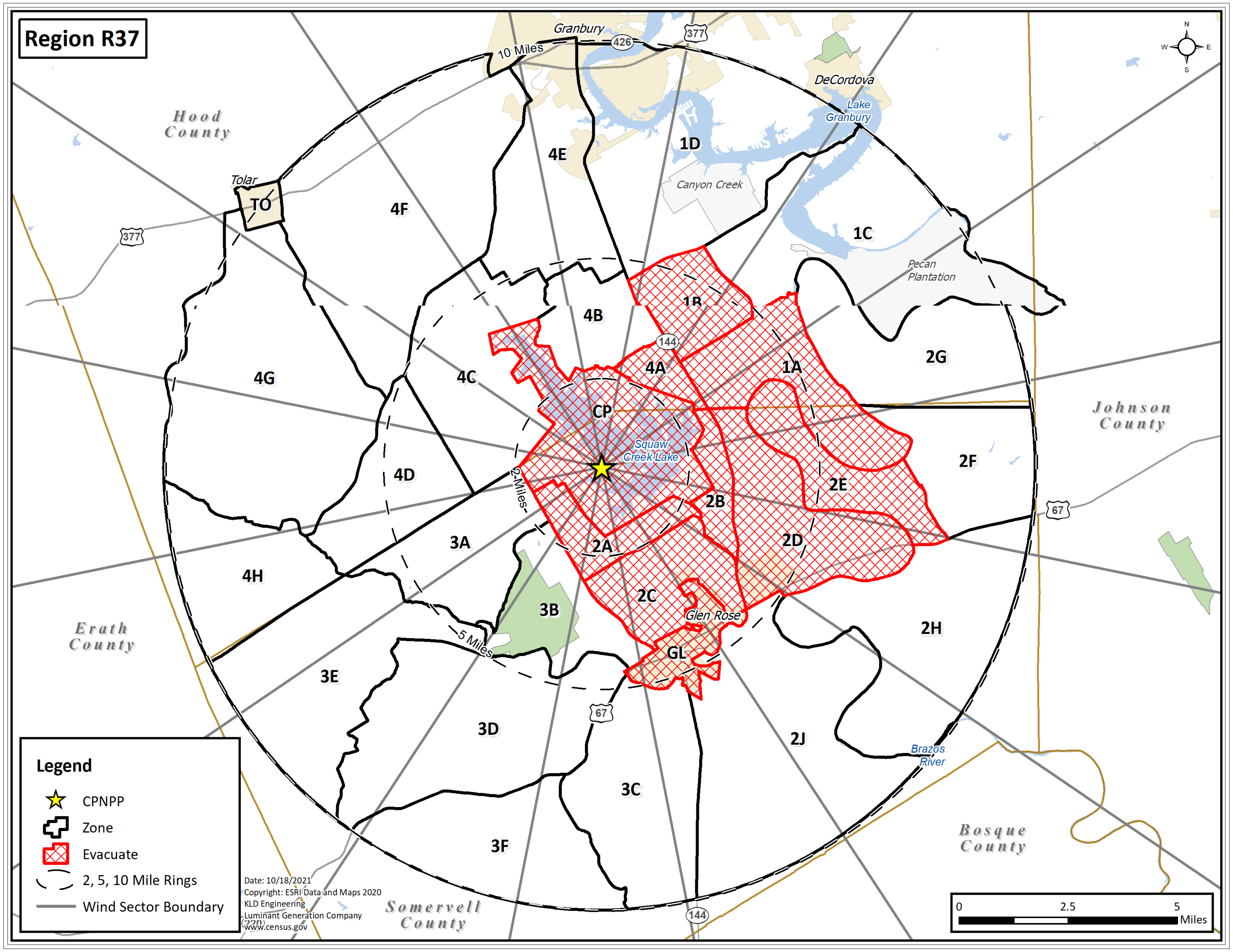

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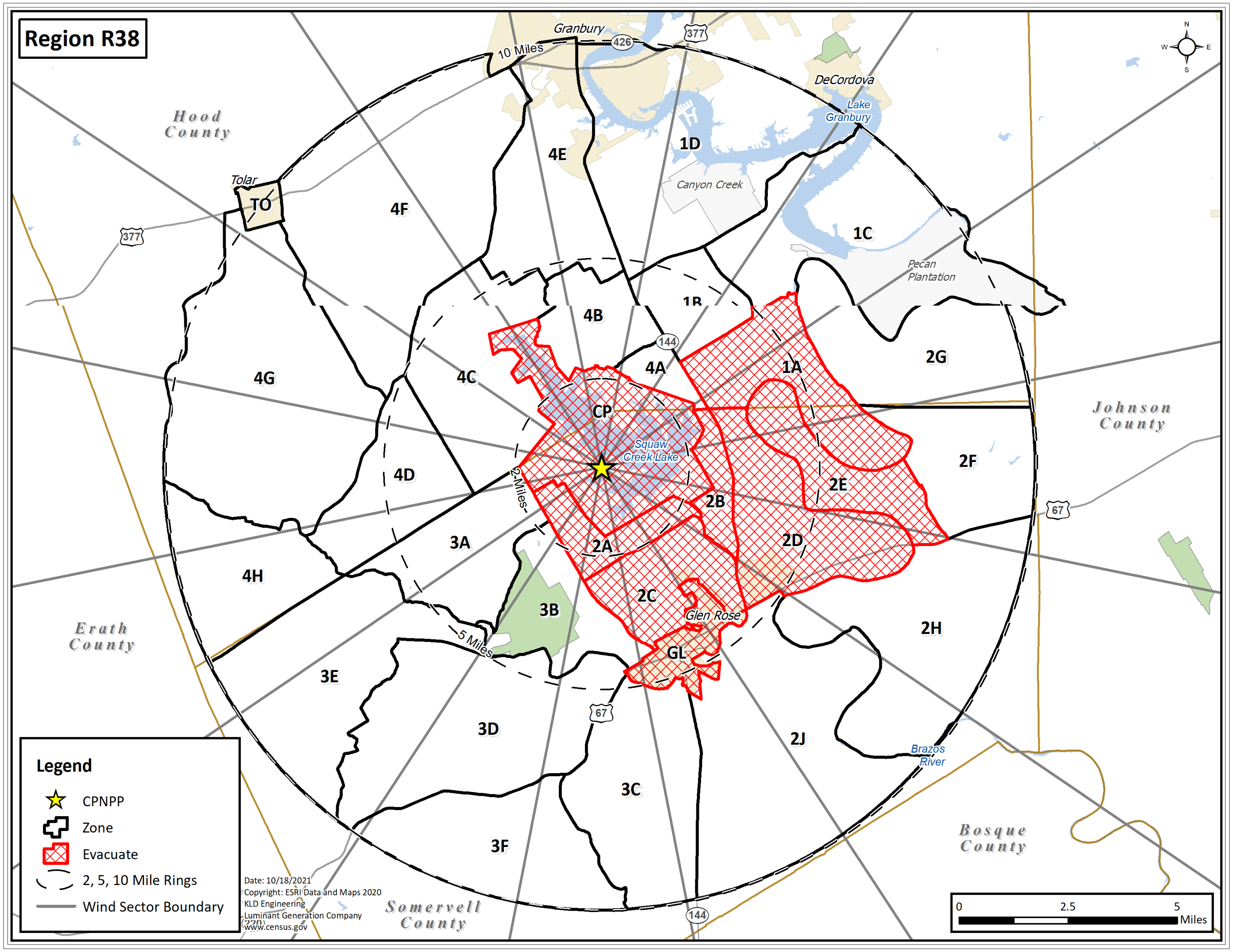

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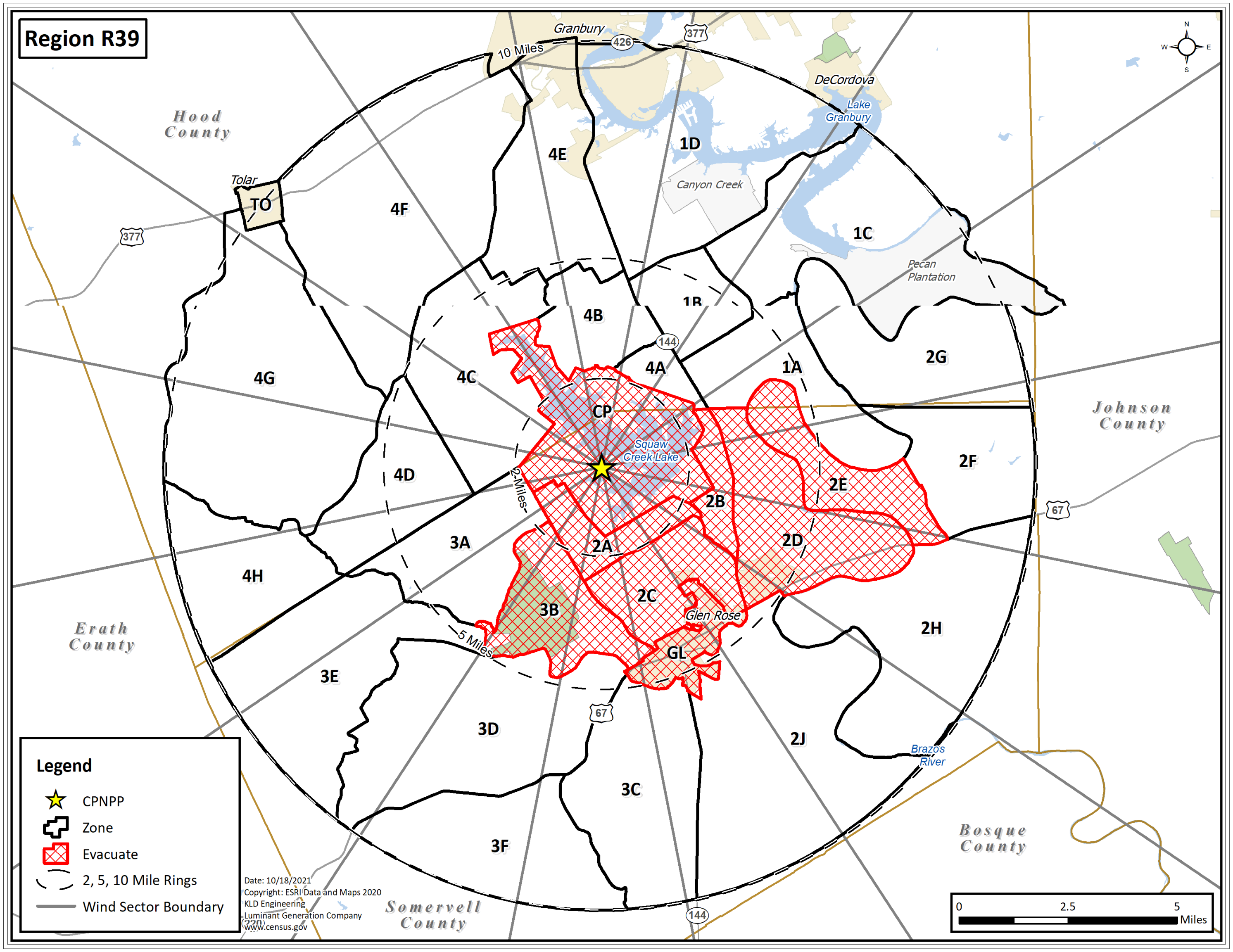

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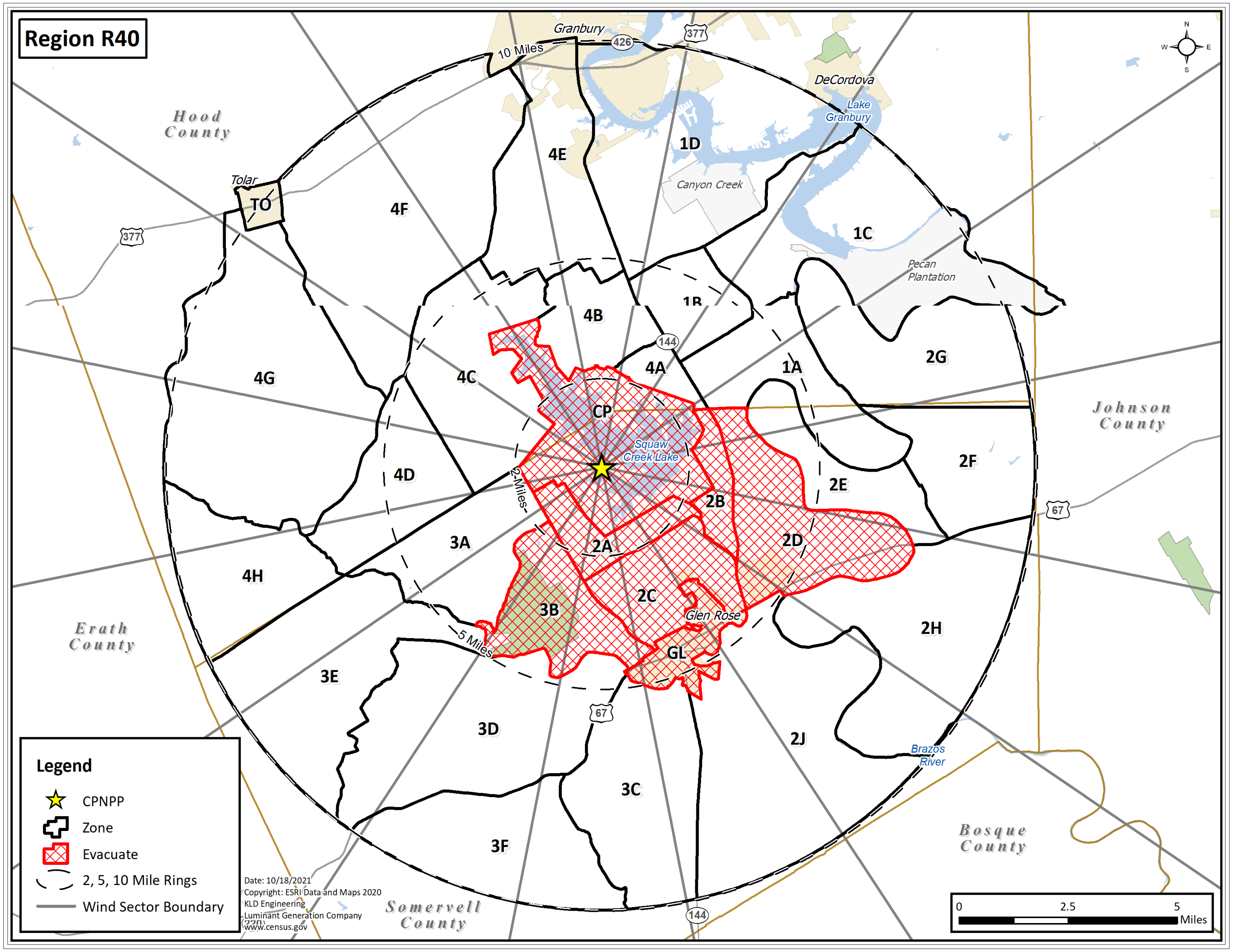

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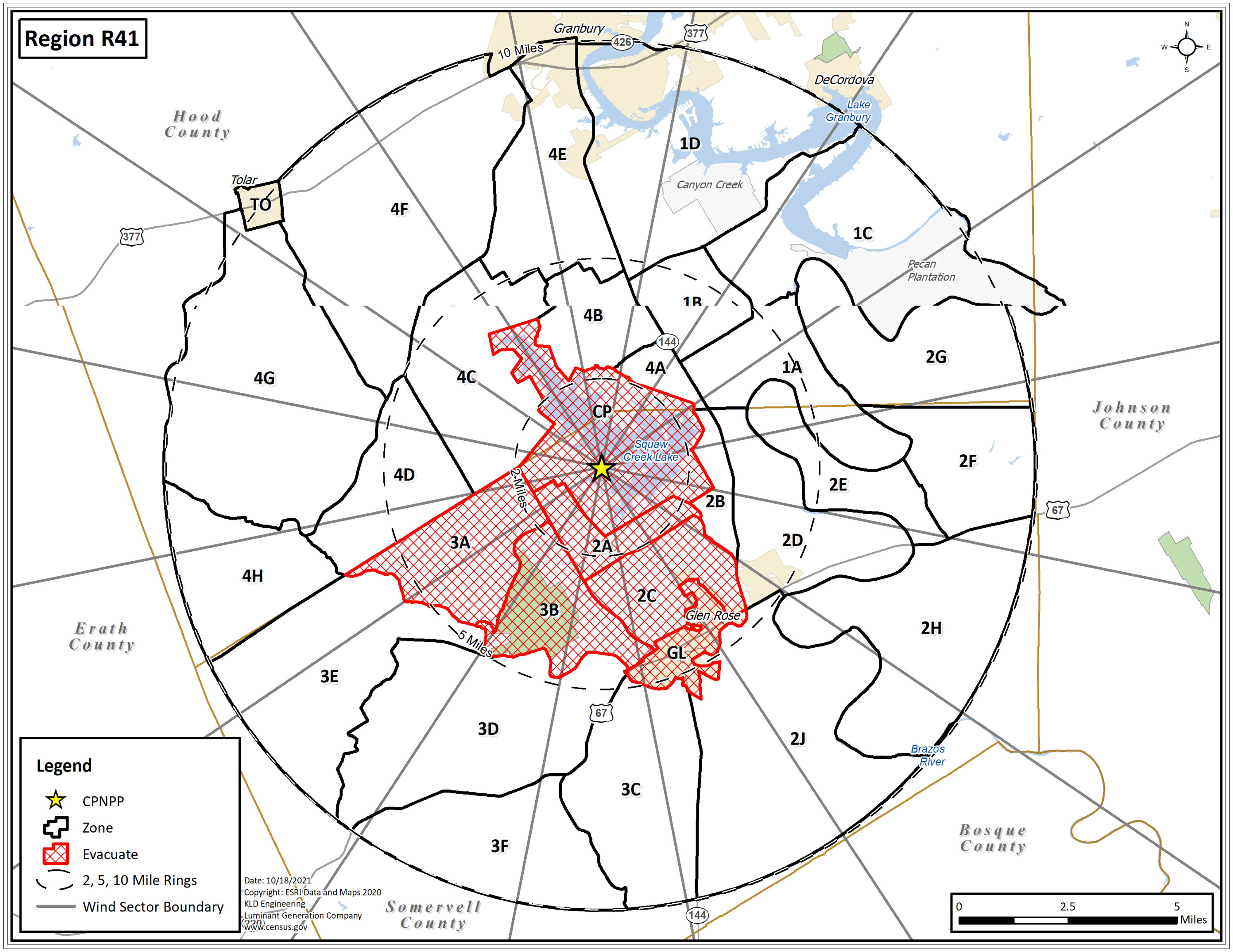

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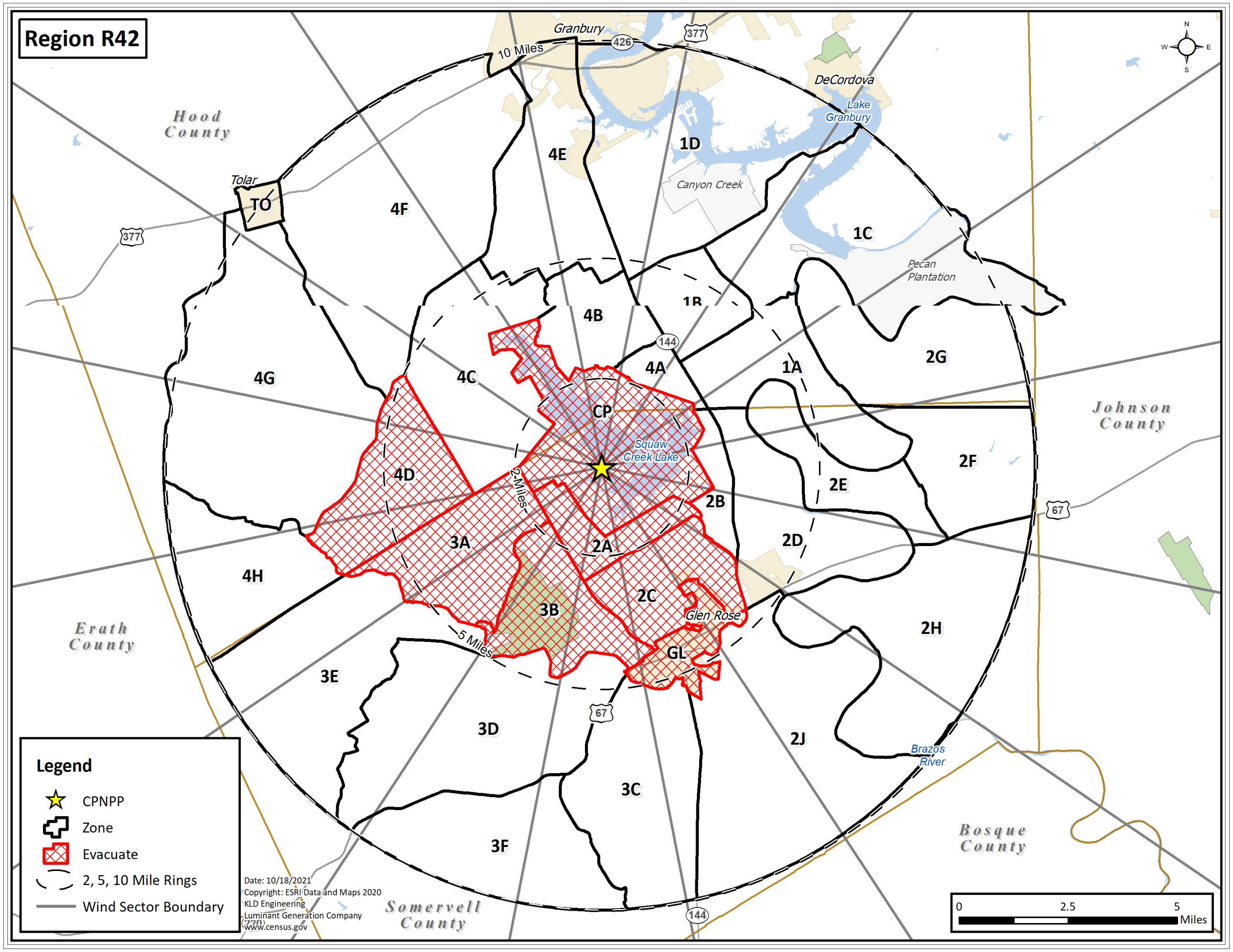

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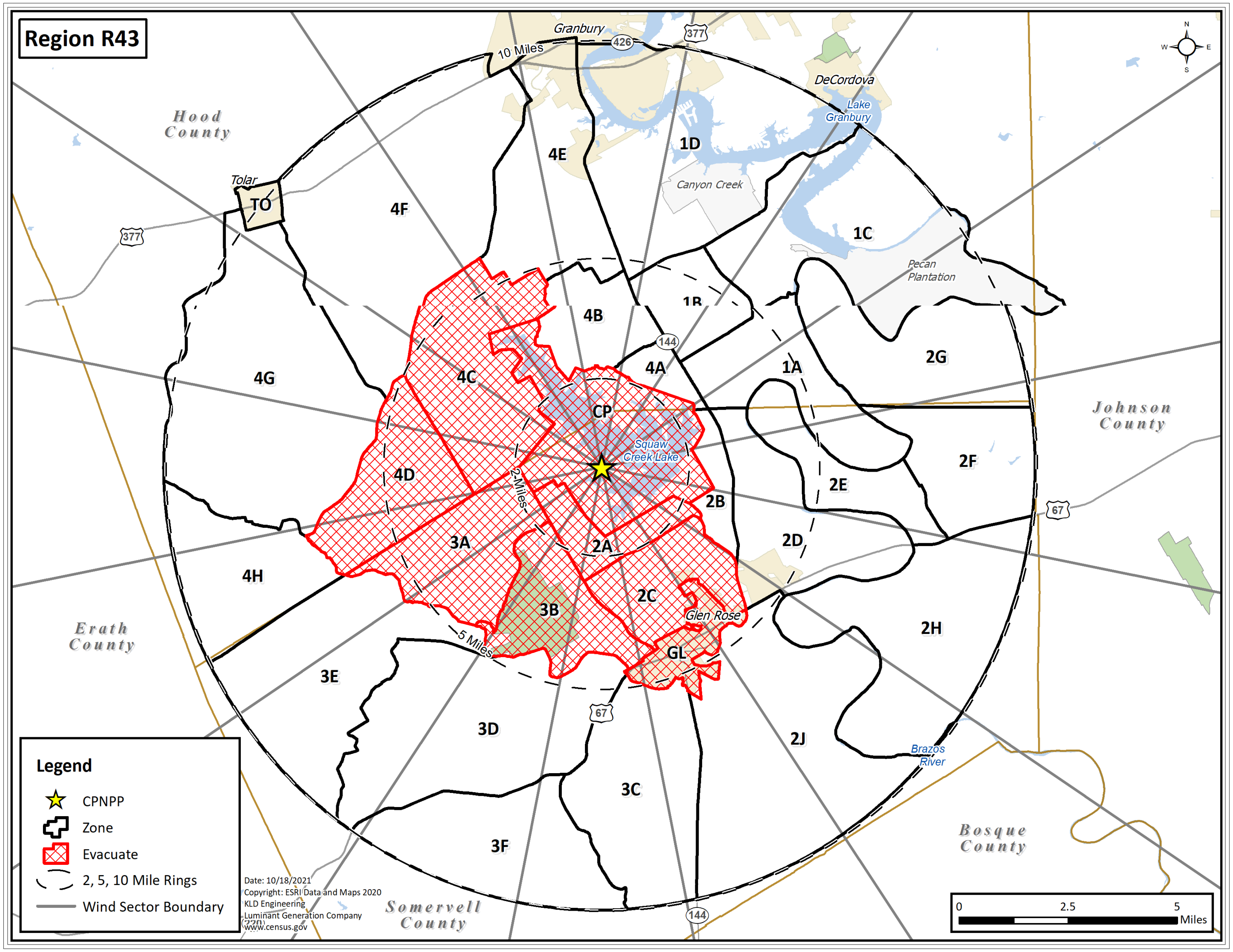

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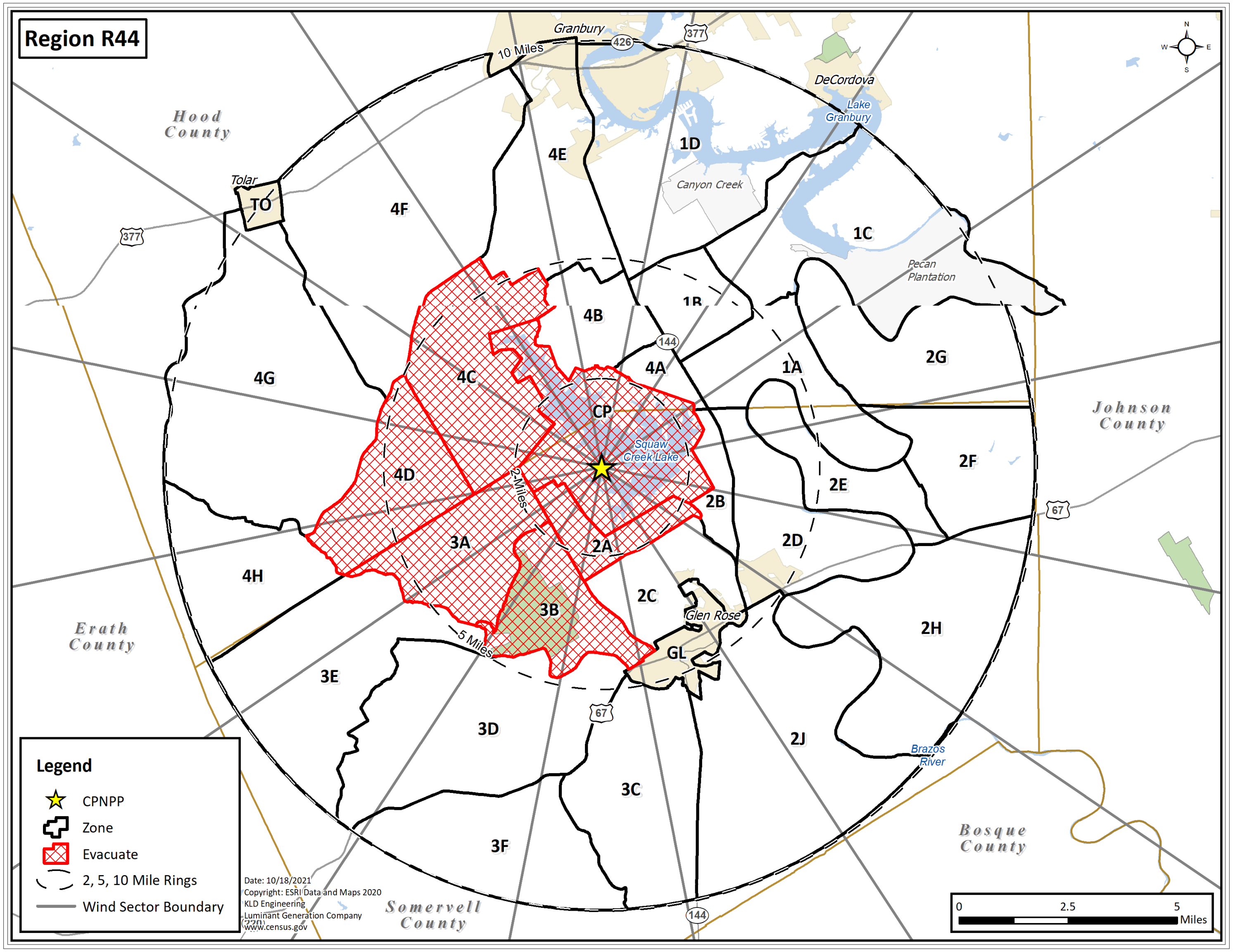

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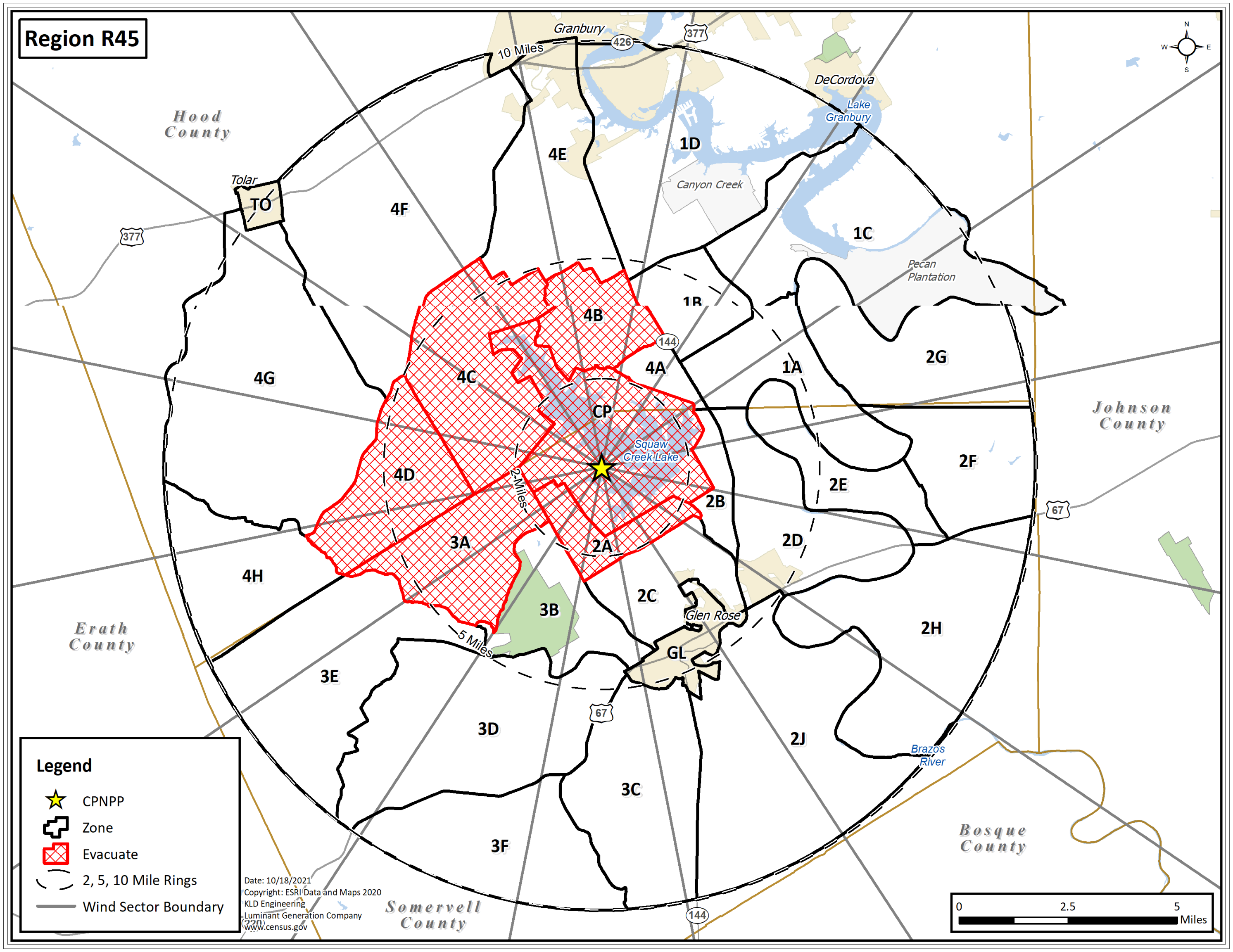

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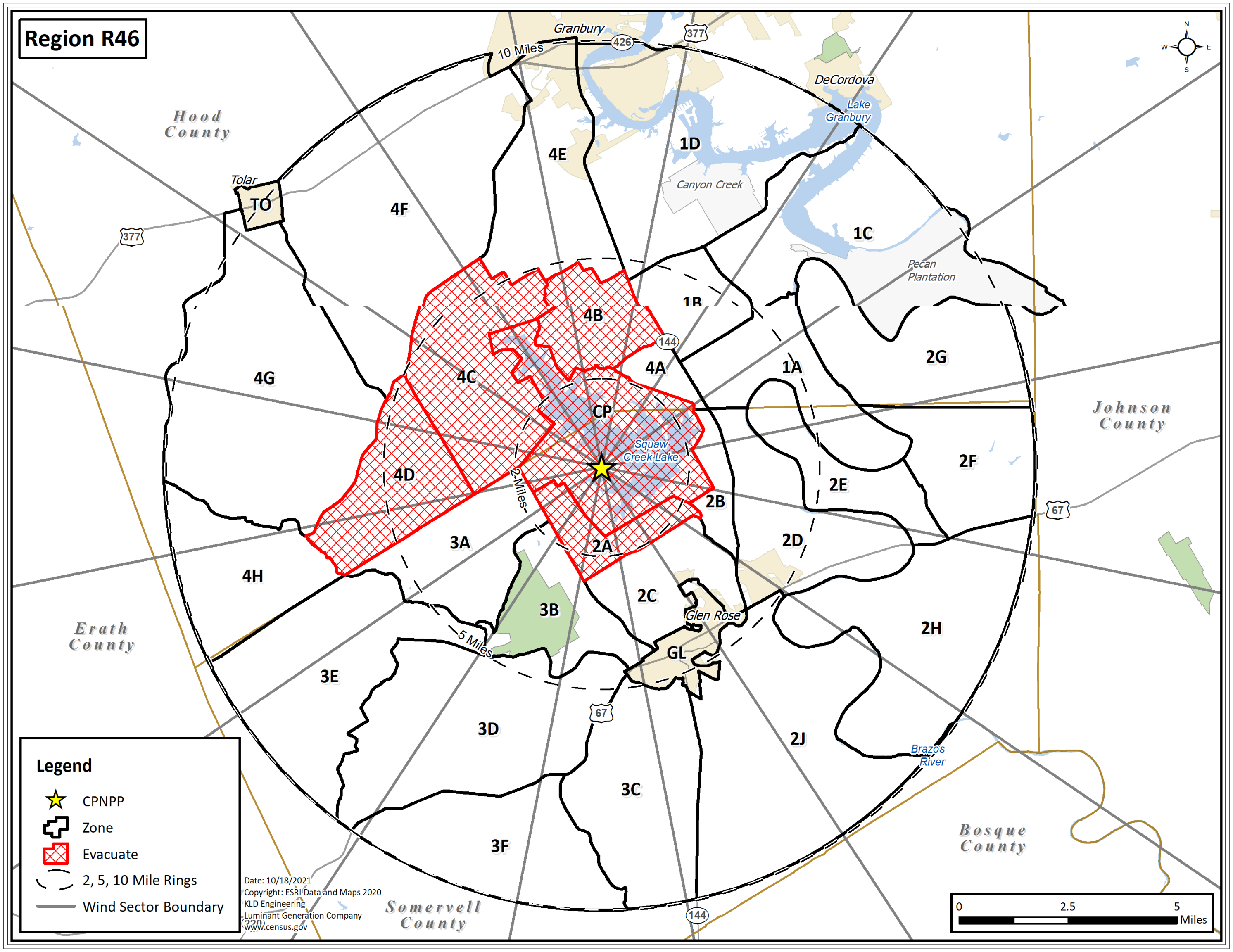

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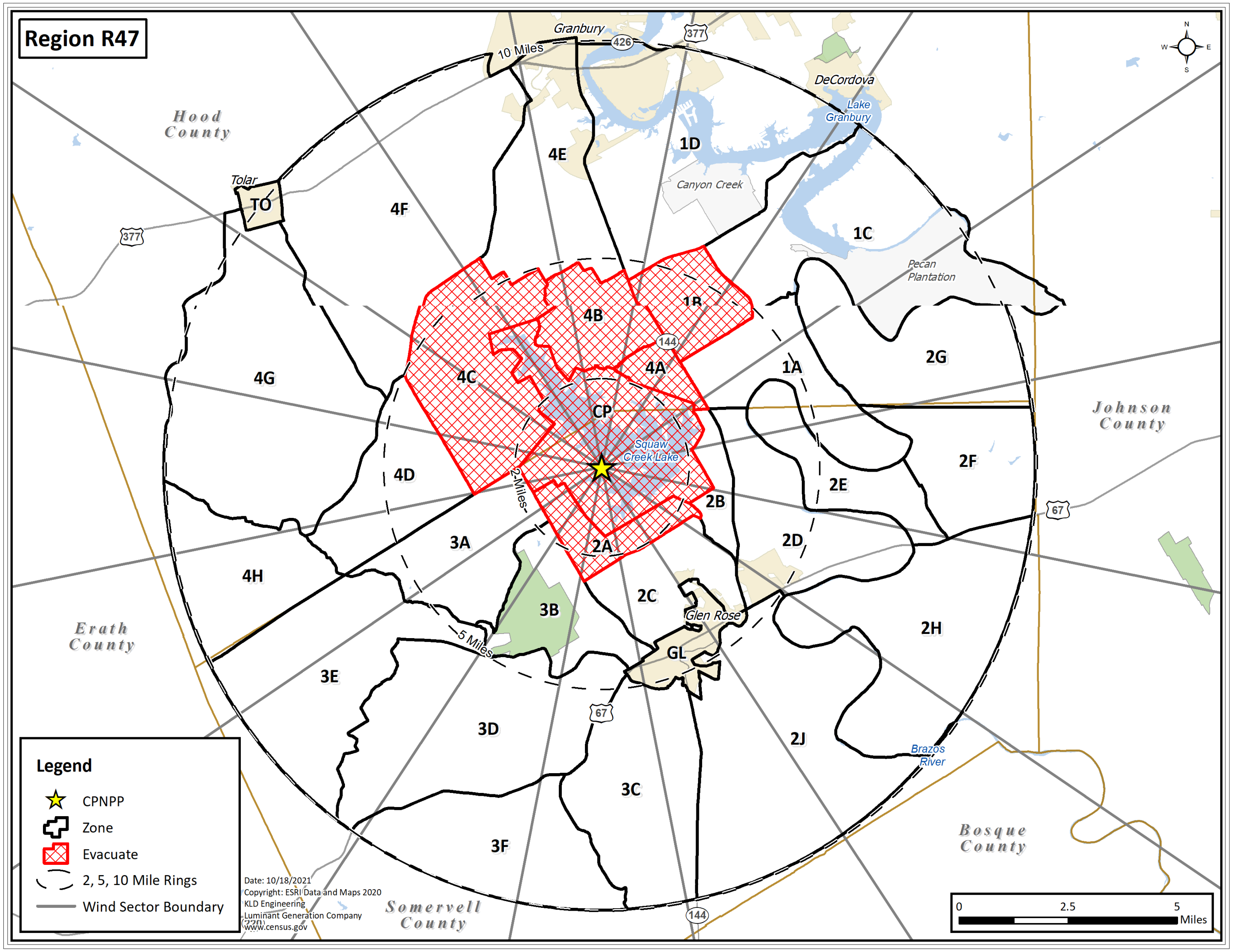

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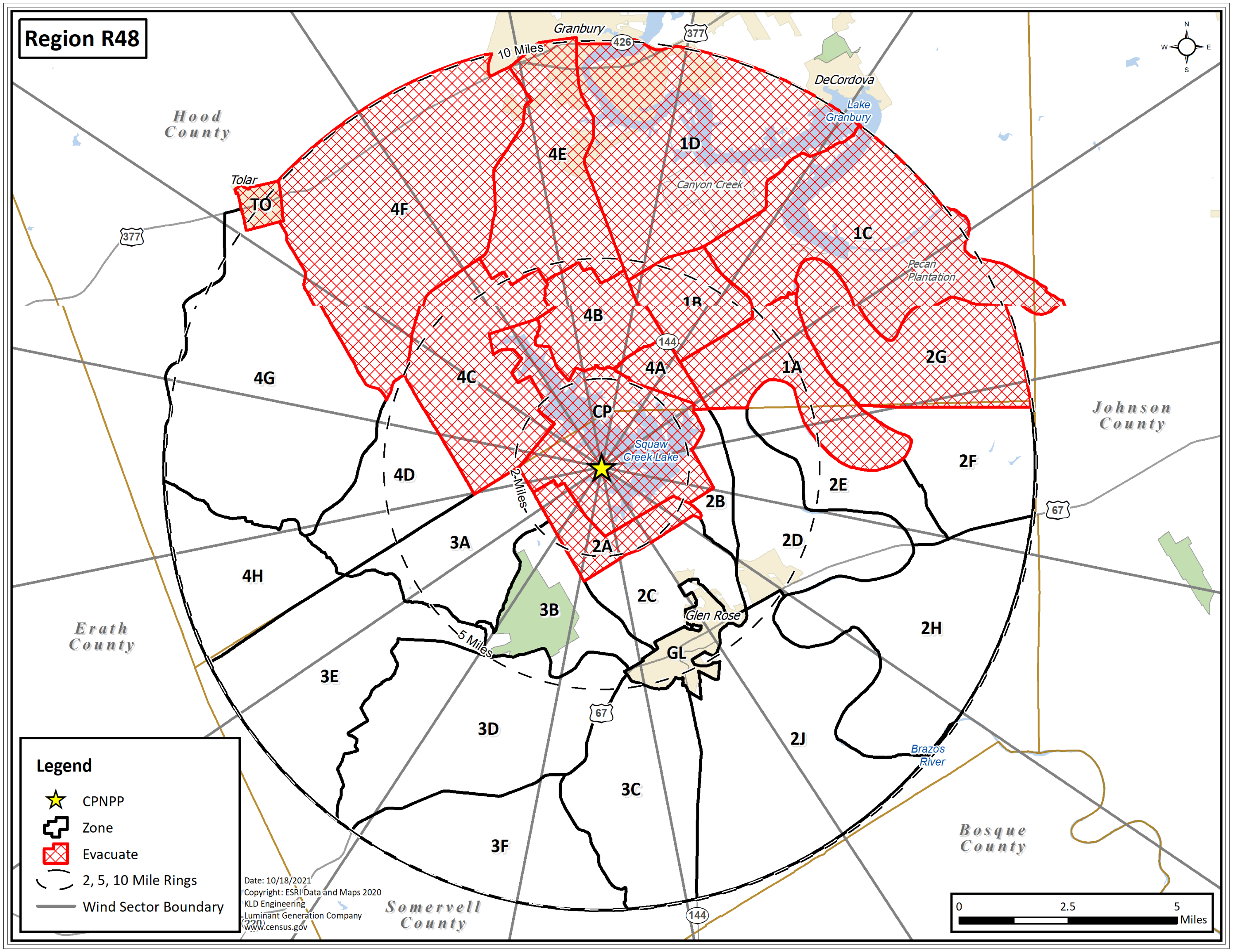

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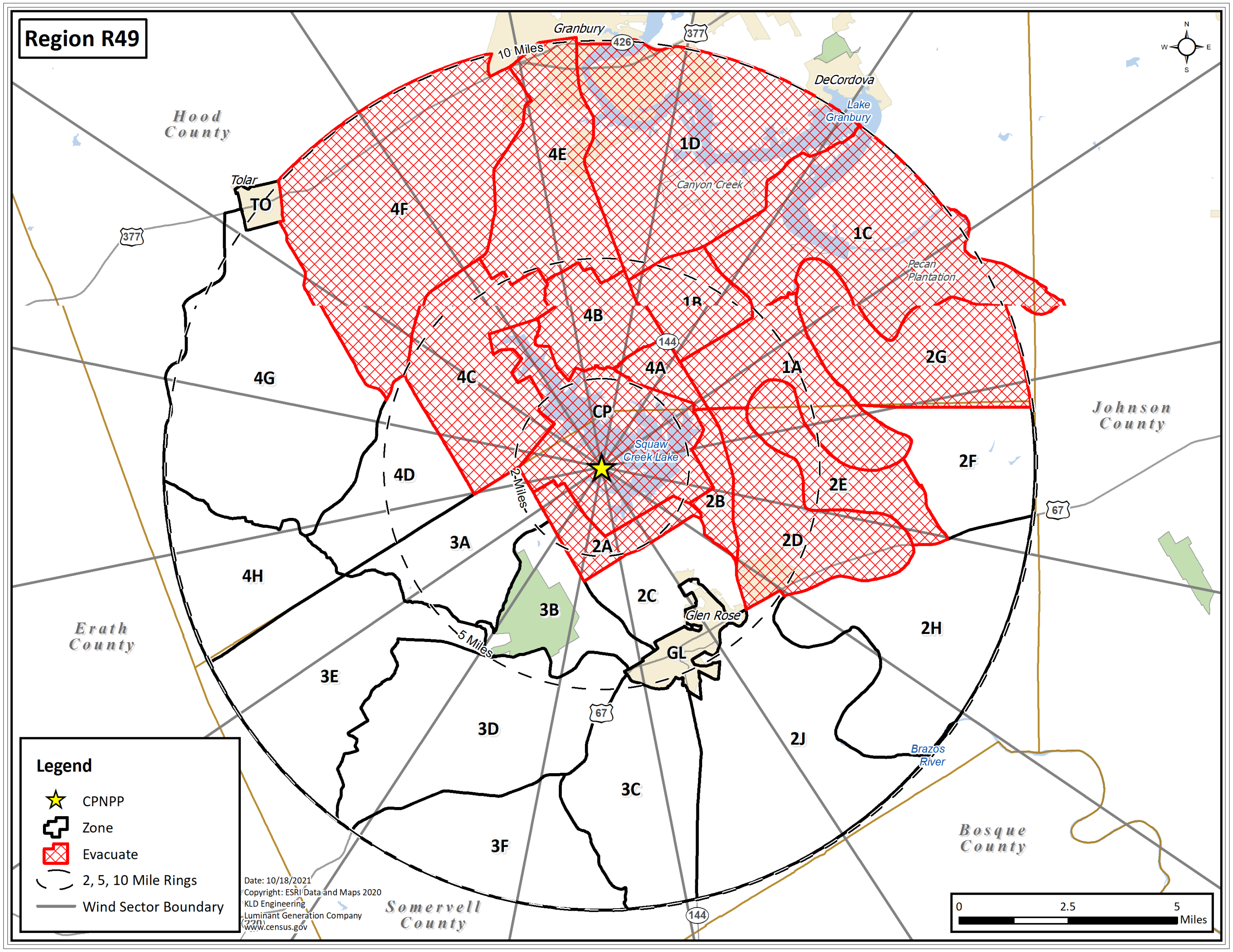

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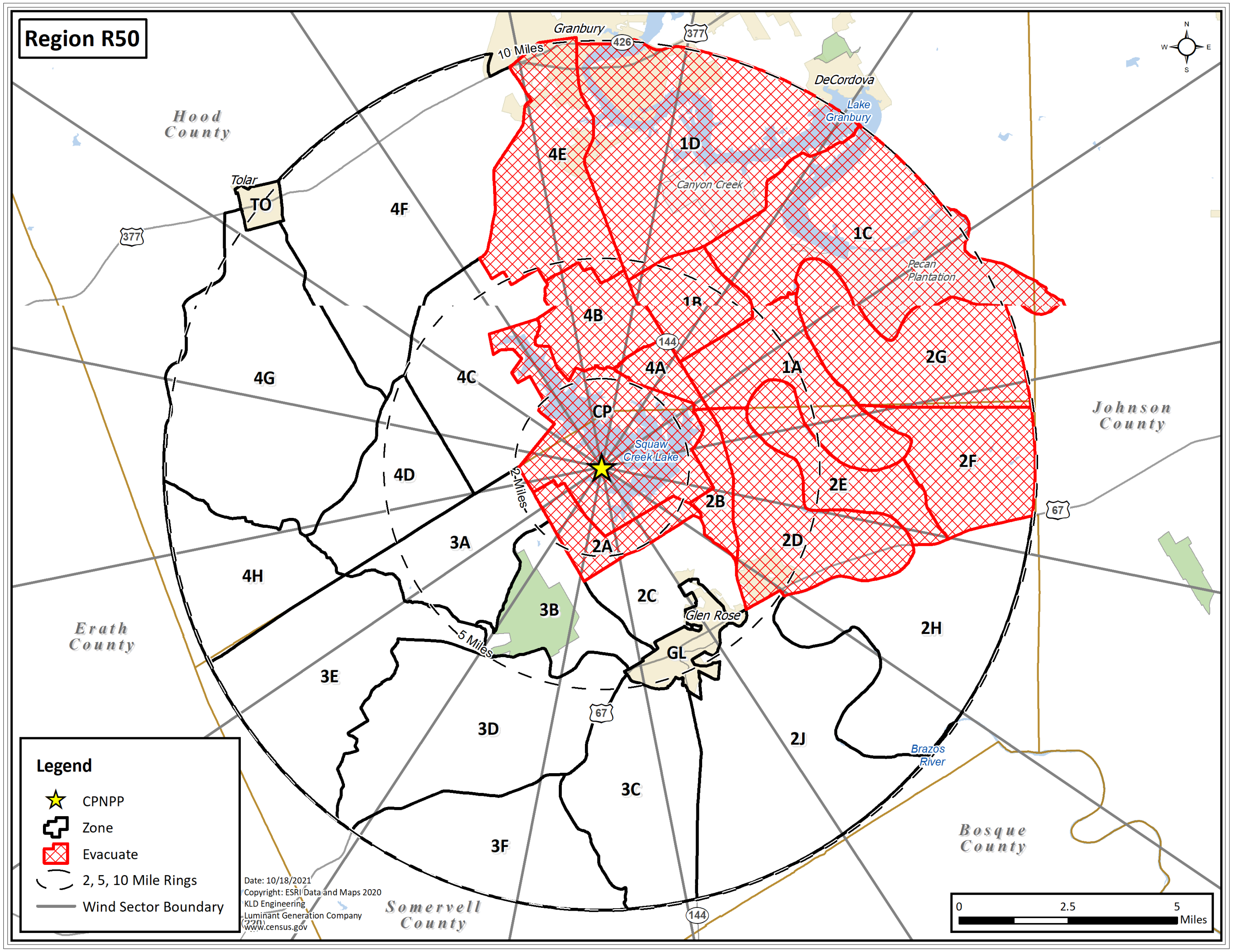

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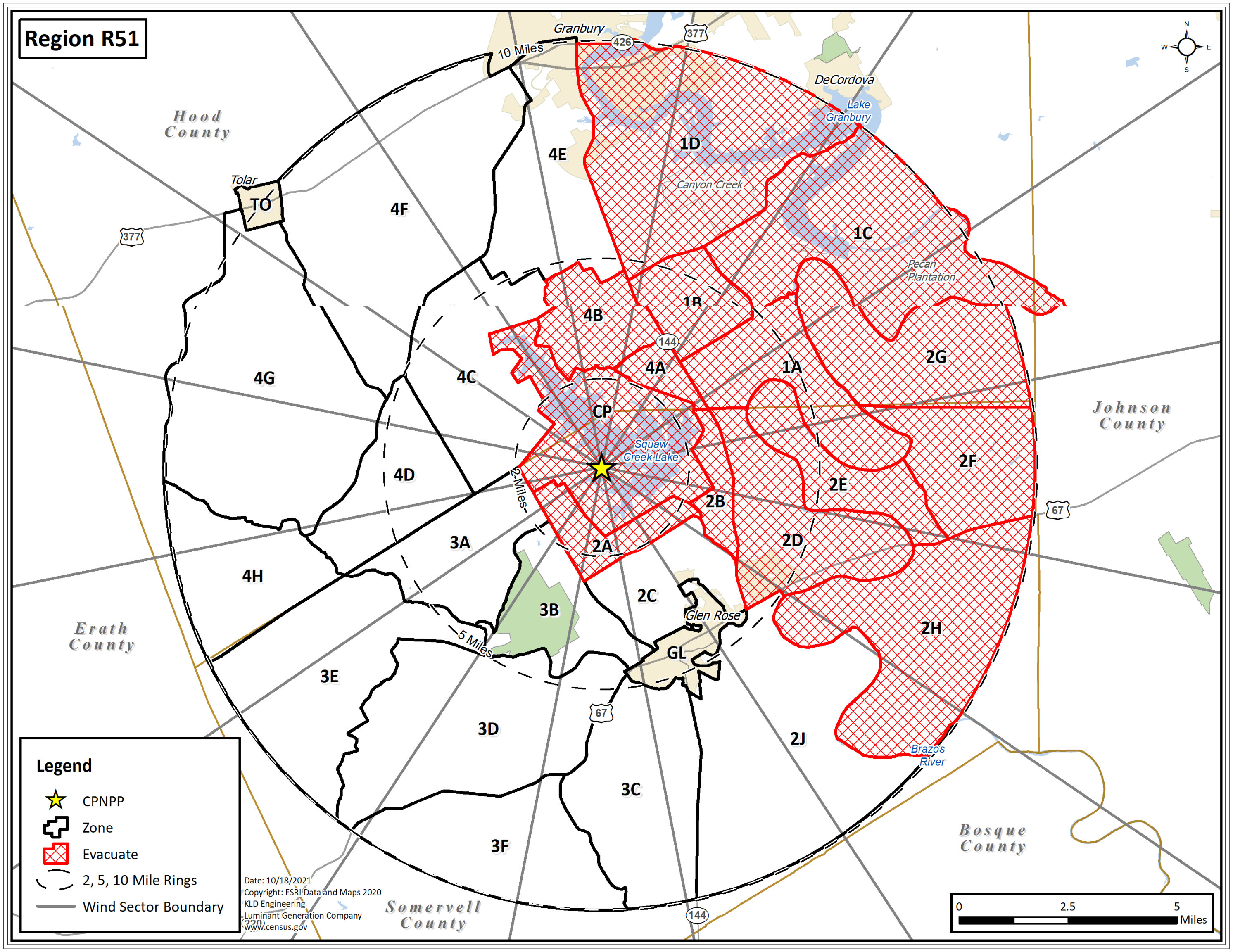

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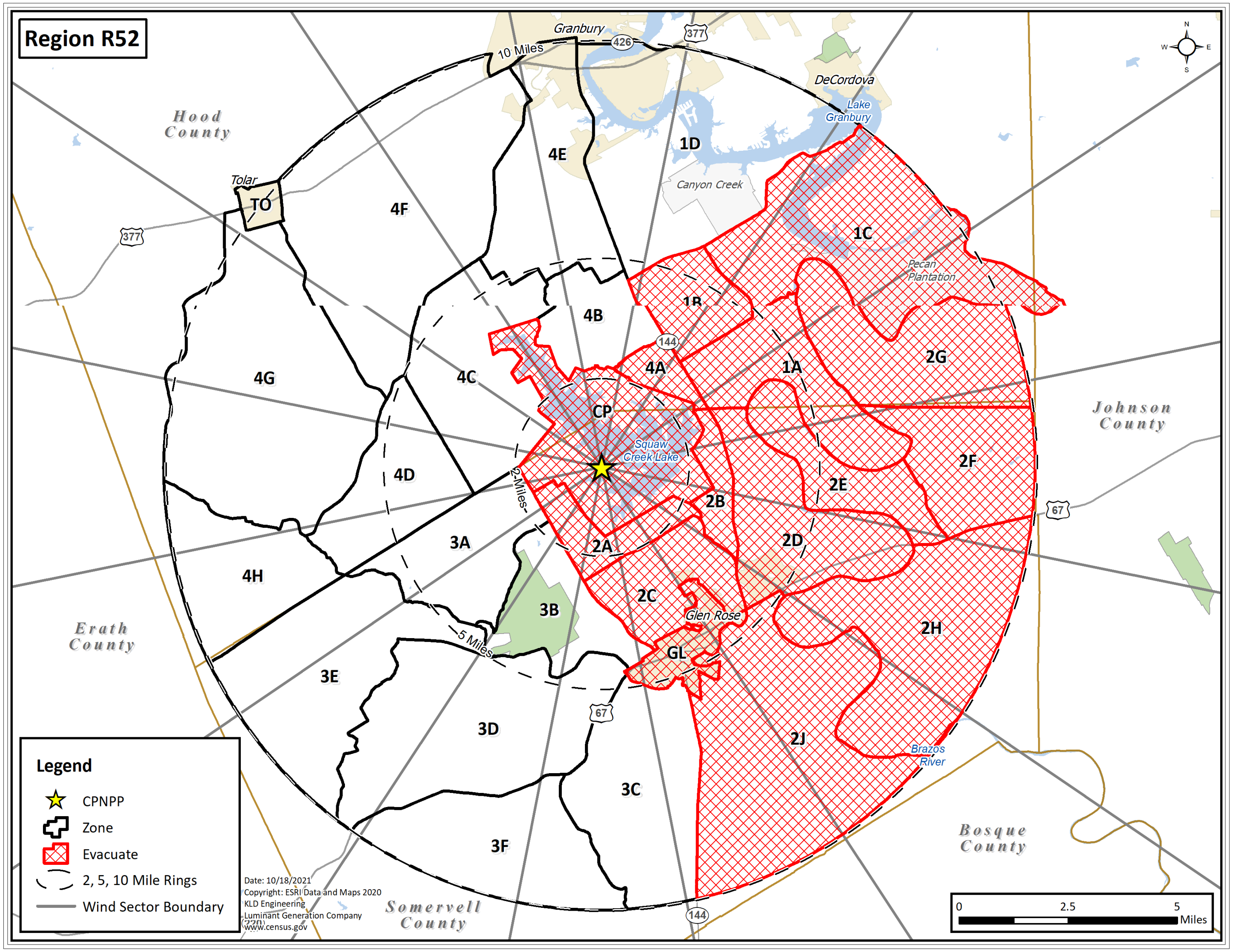

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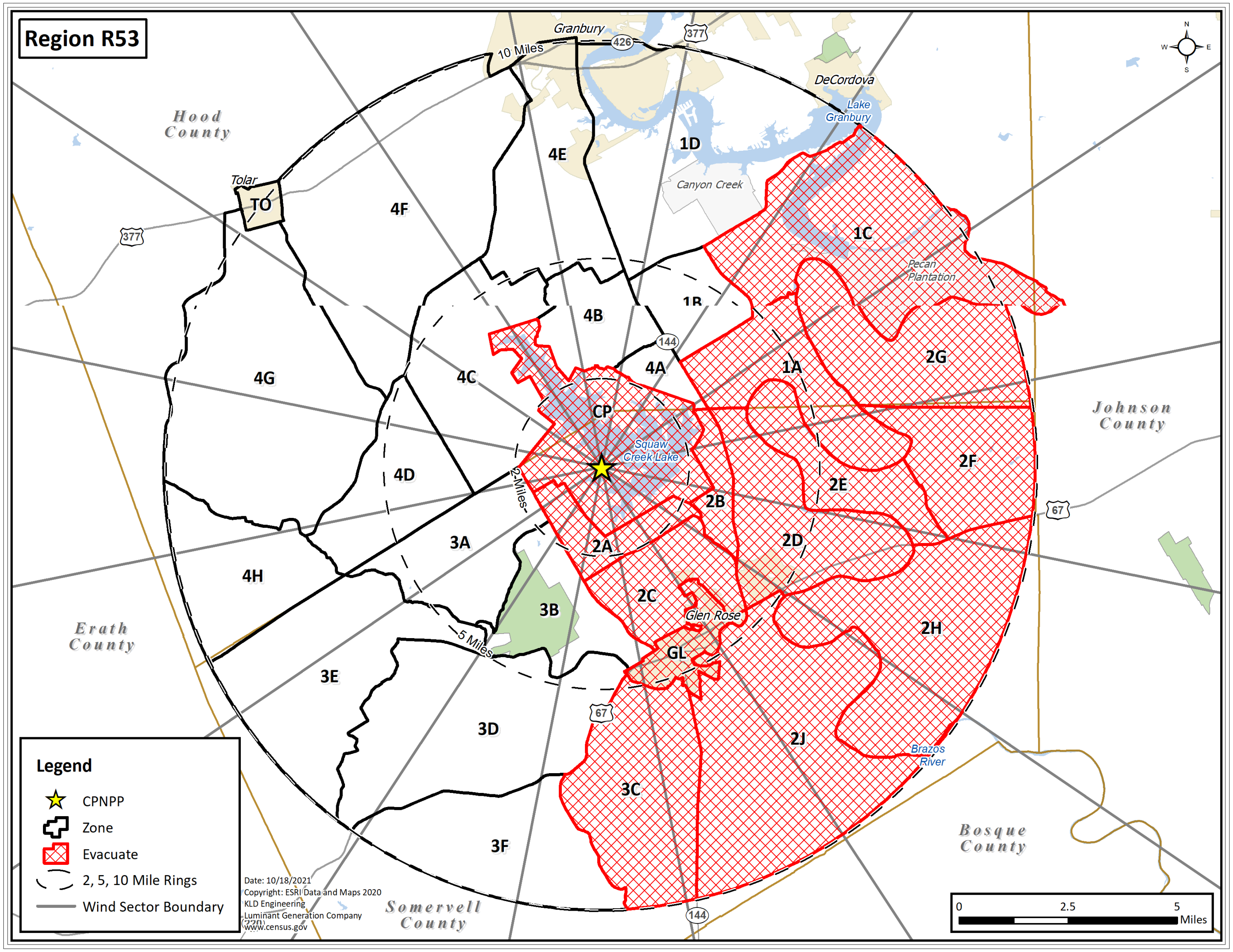

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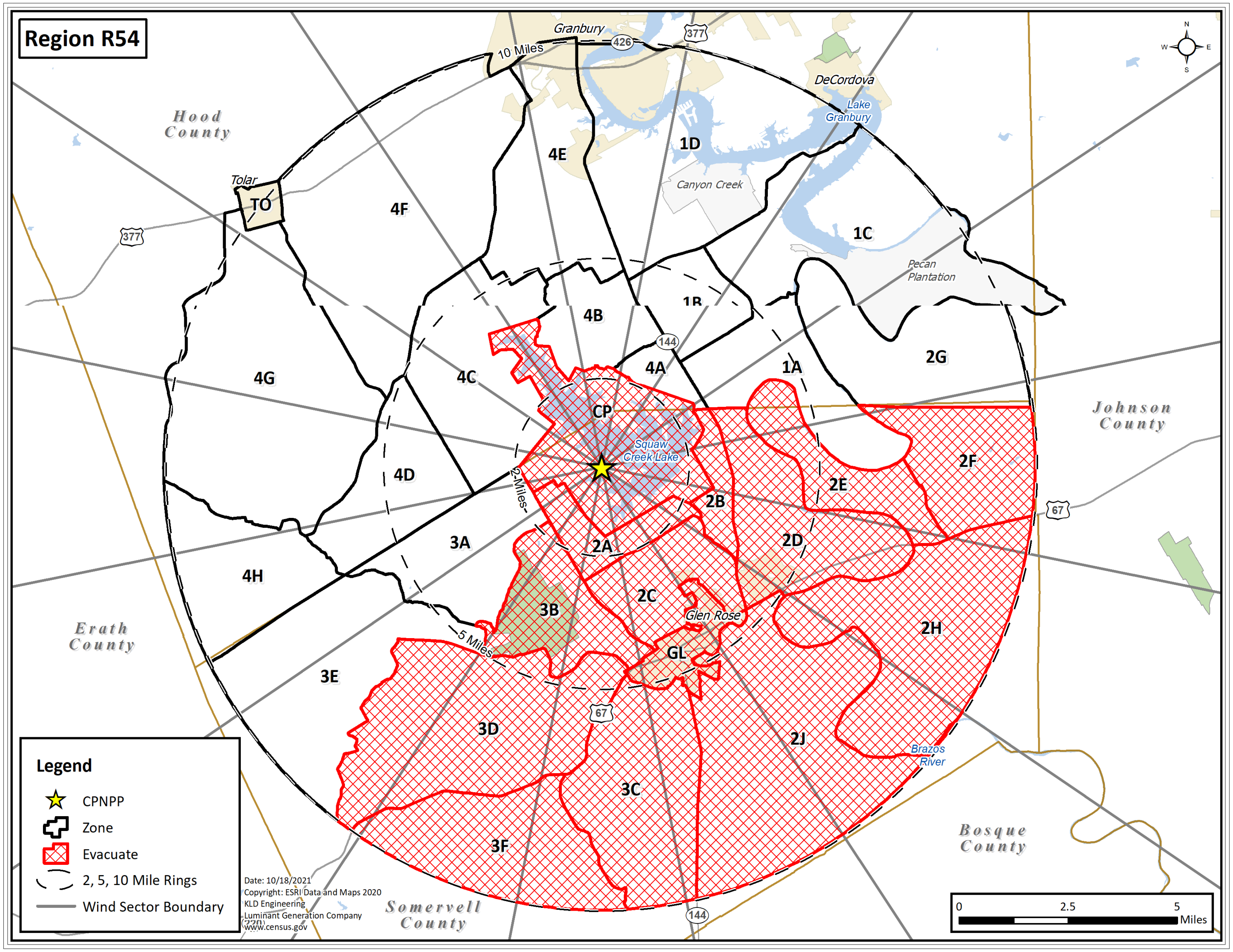

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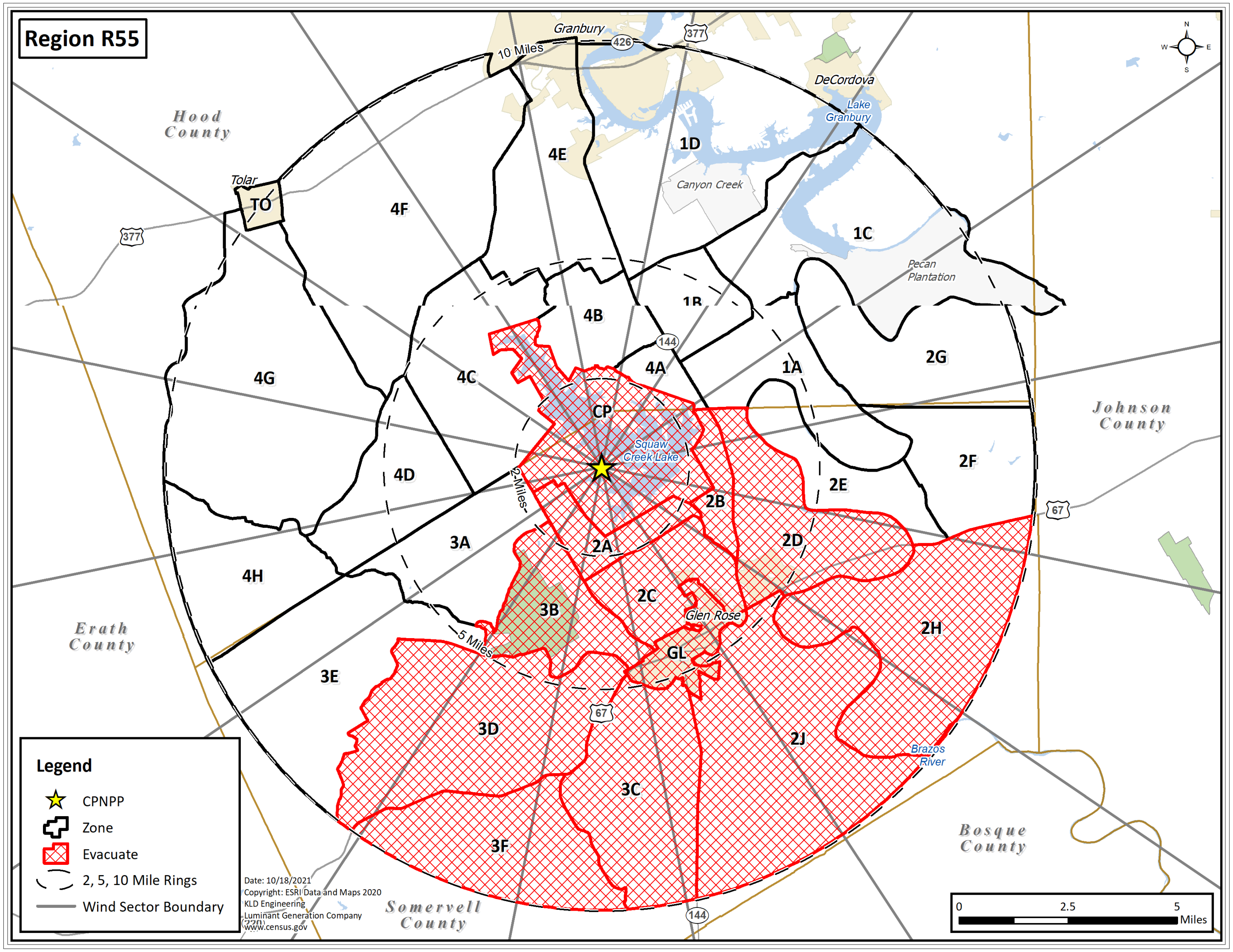

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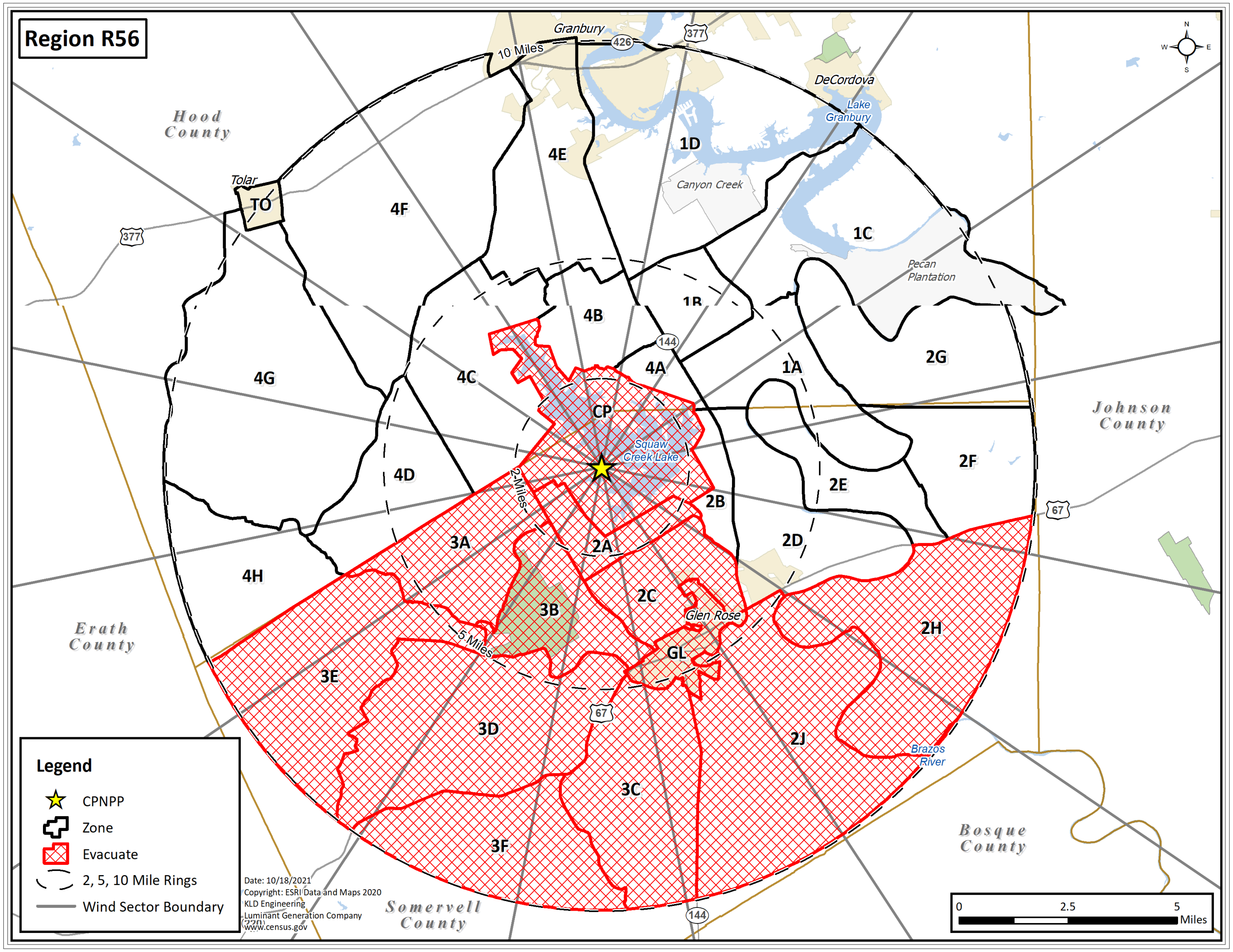

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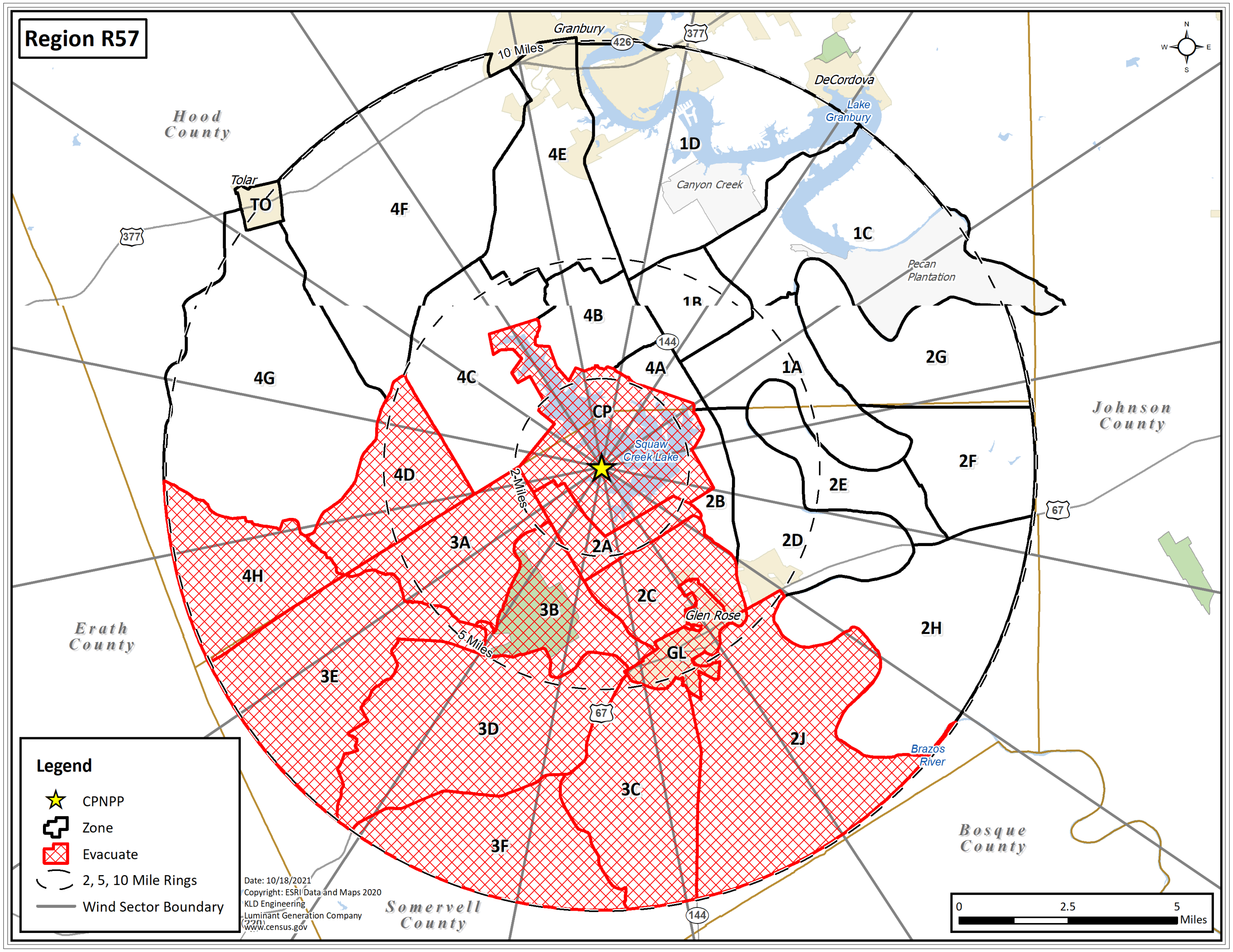

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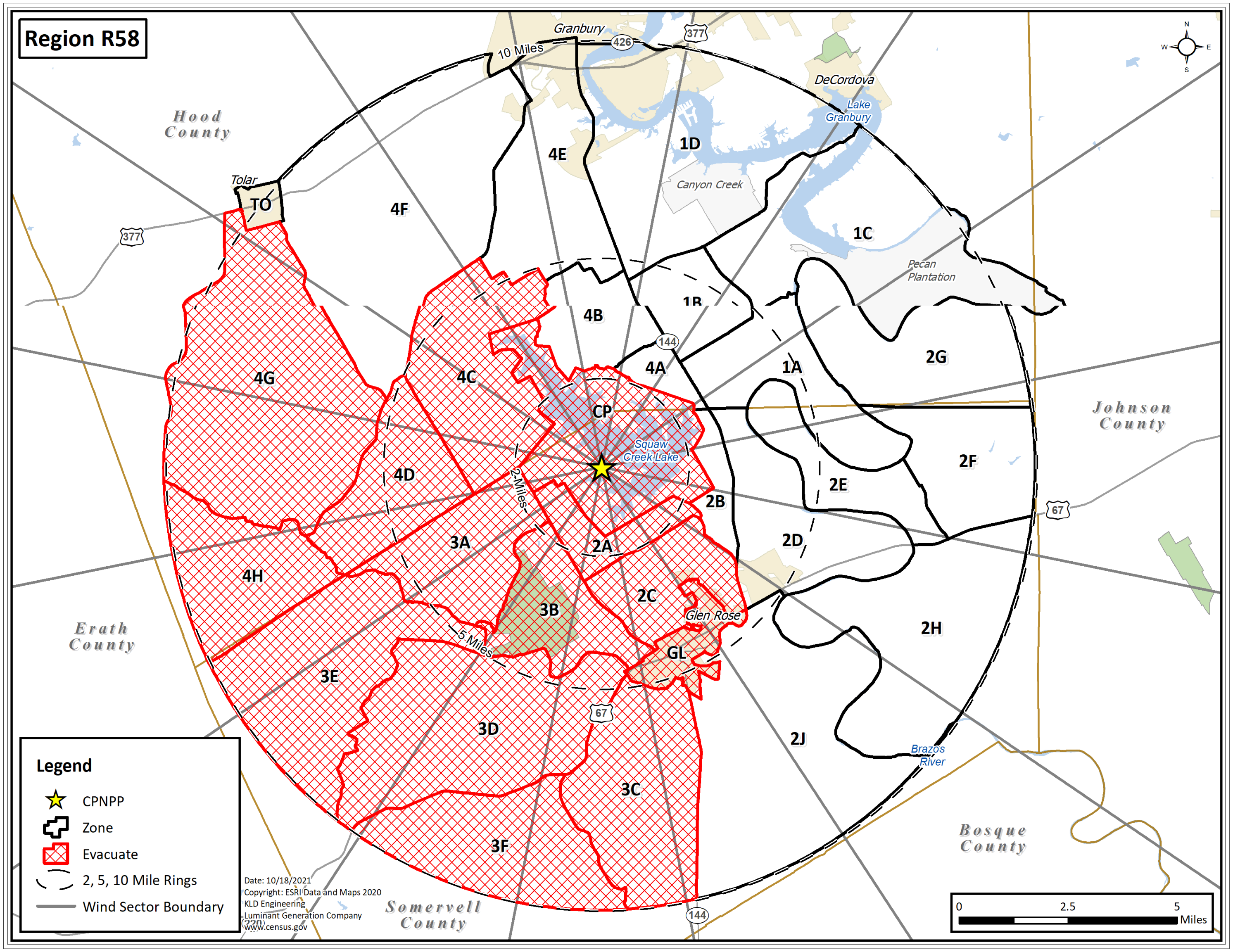

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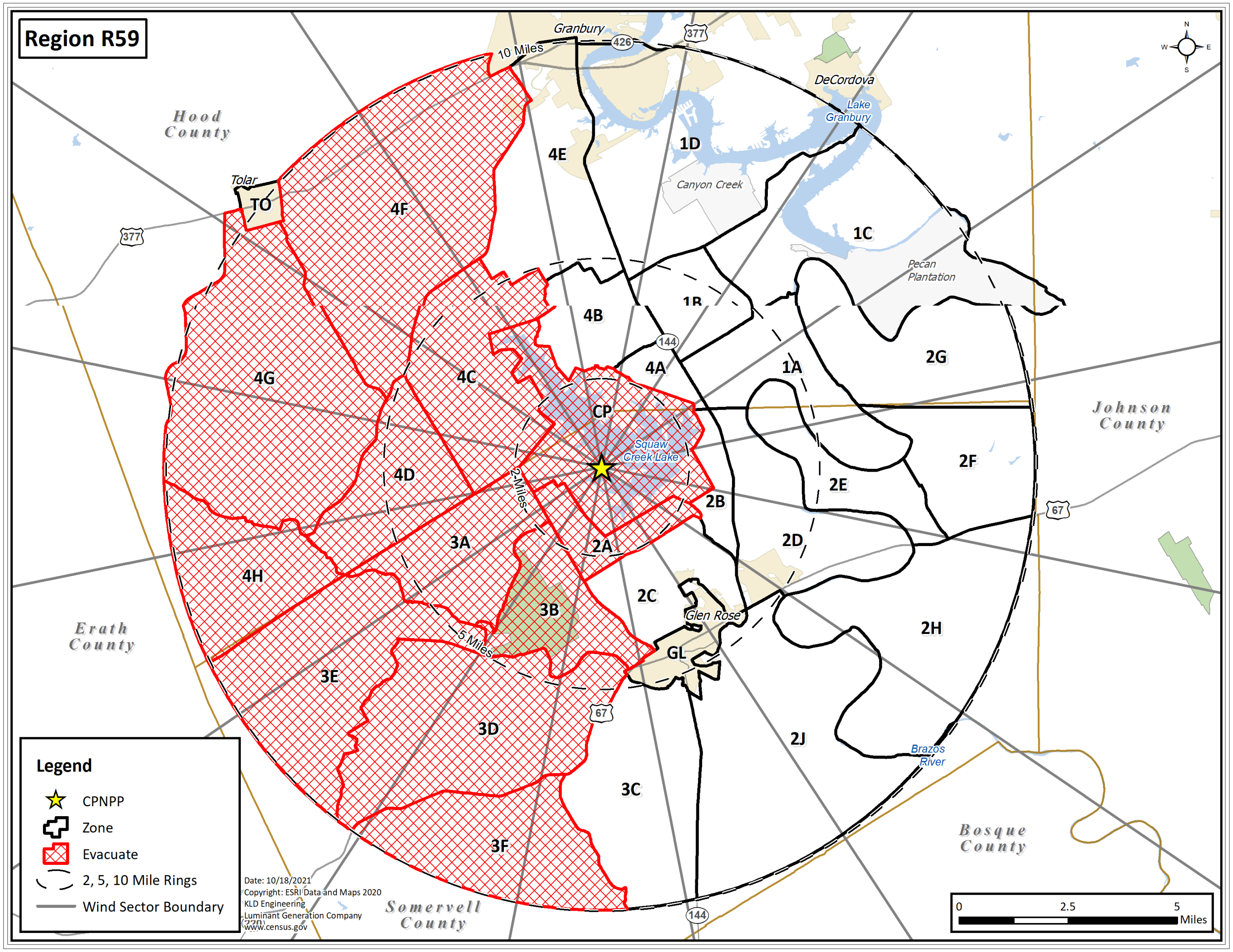

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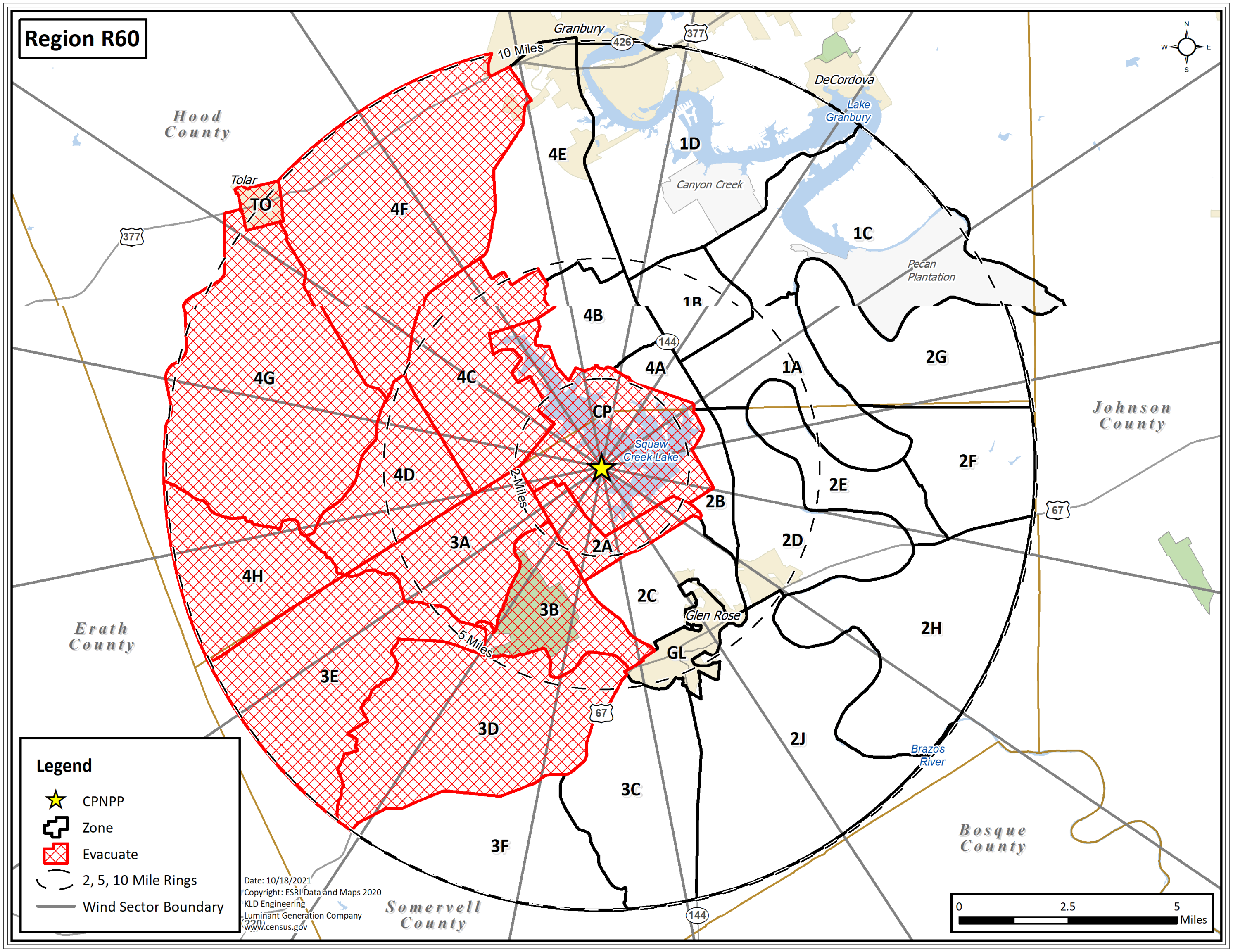

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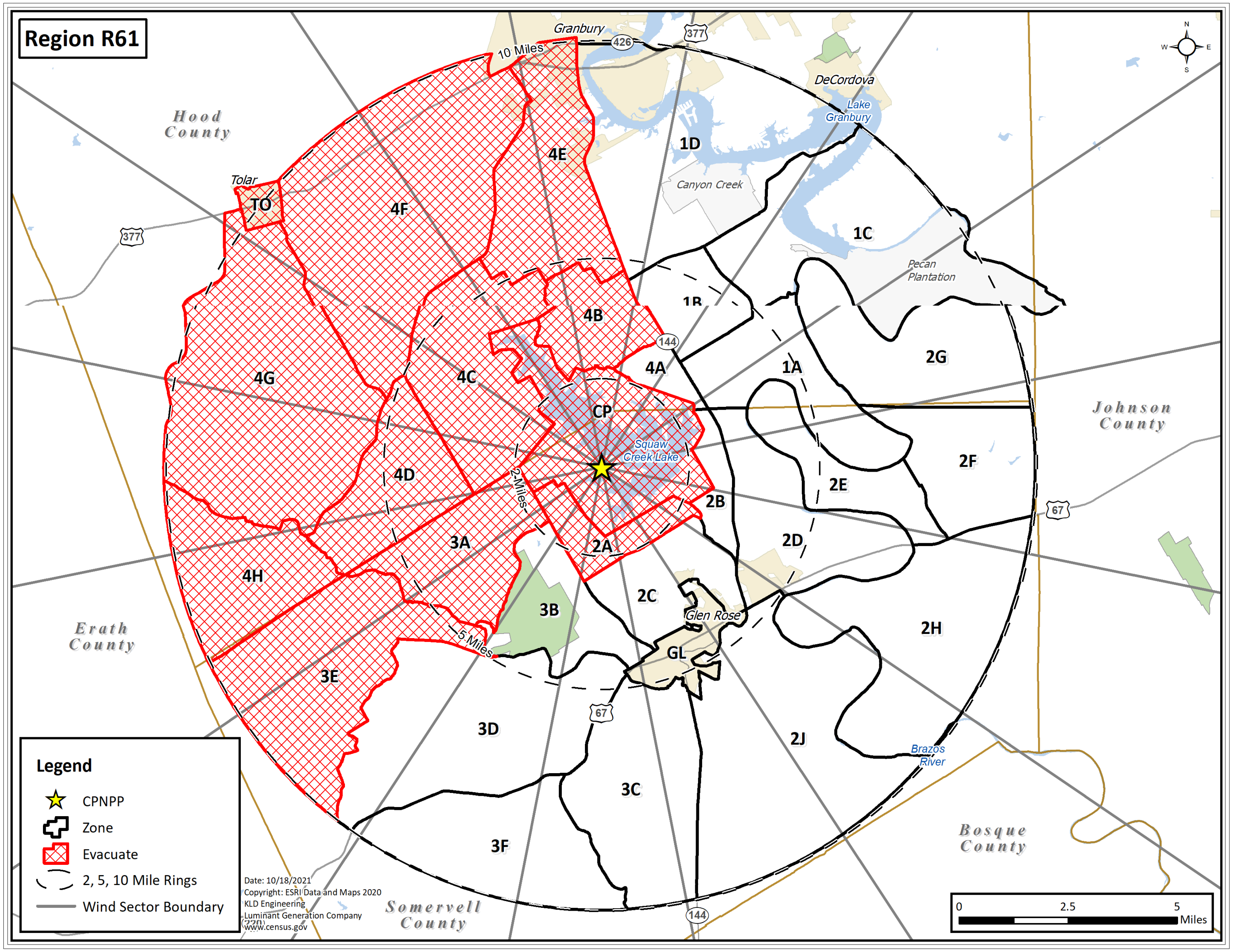
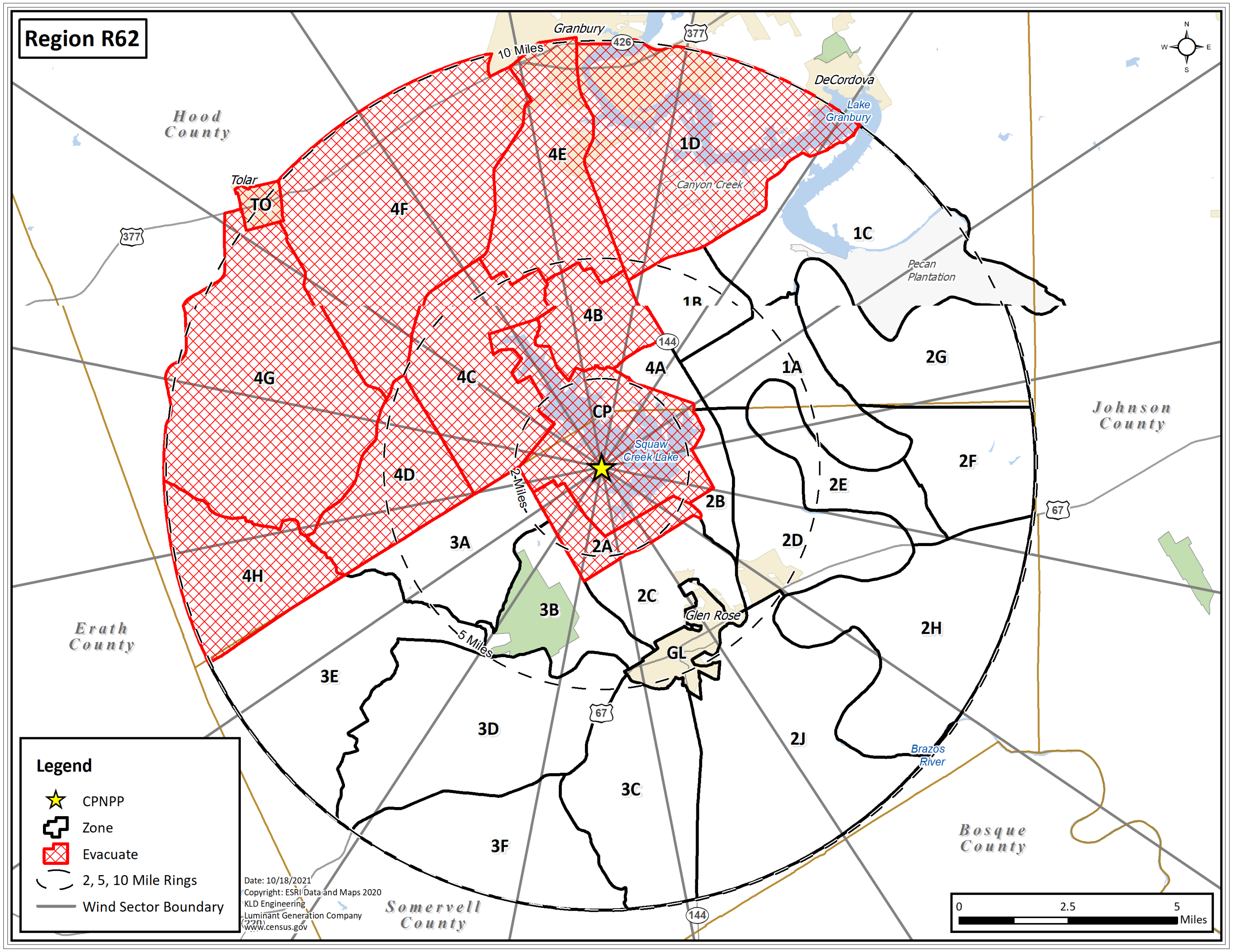


Figure H-61. Region R61



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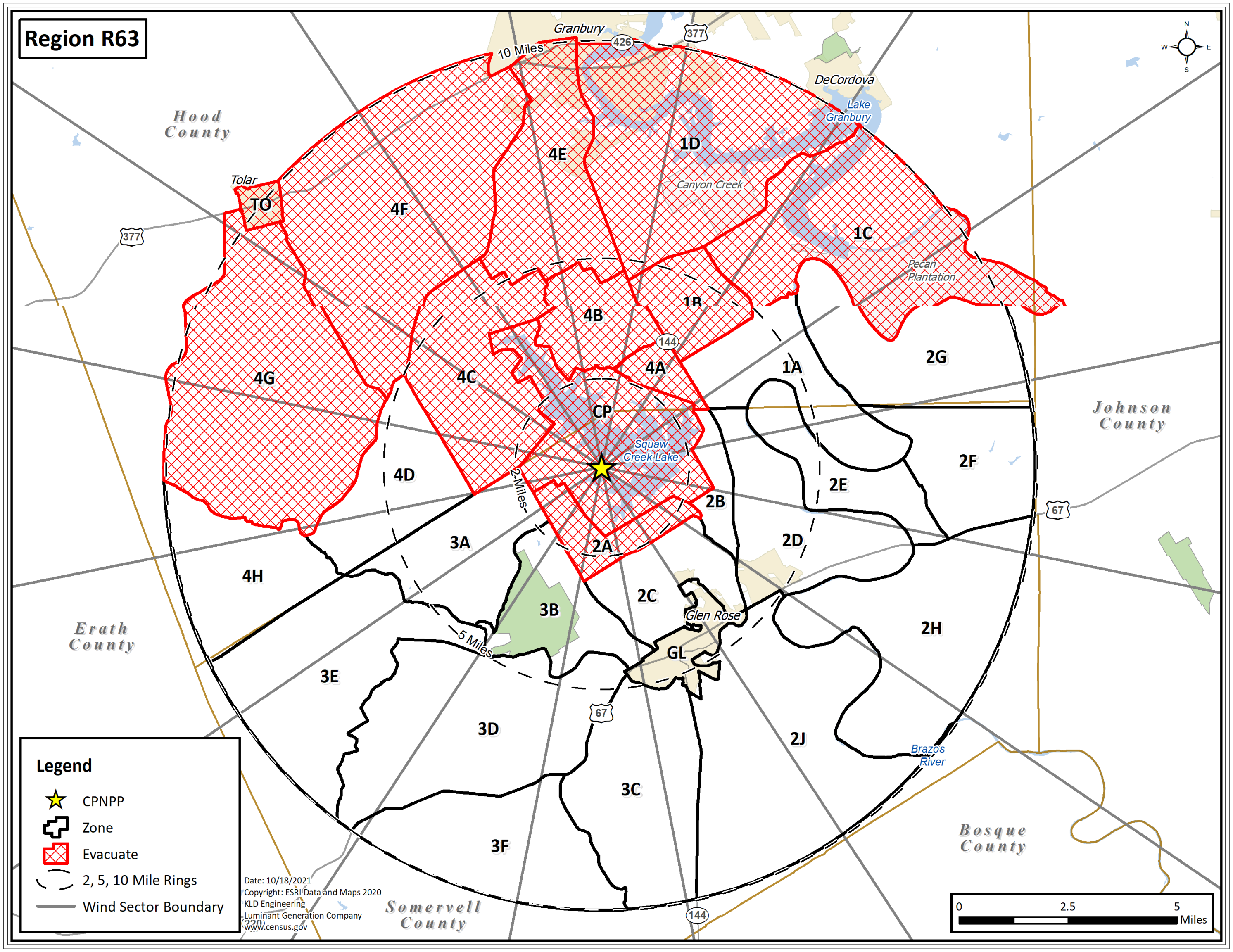


Figure H-63. Region R63

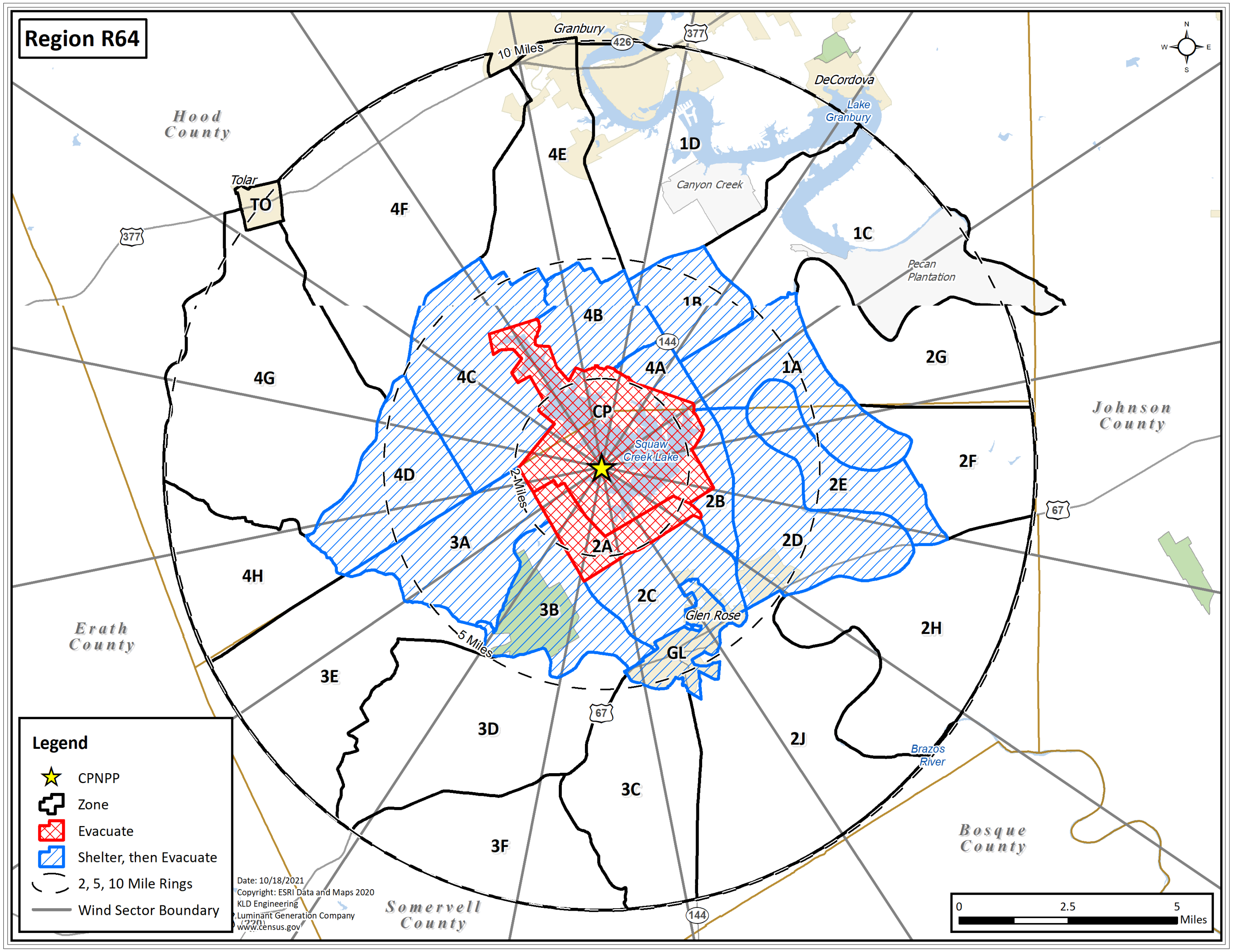
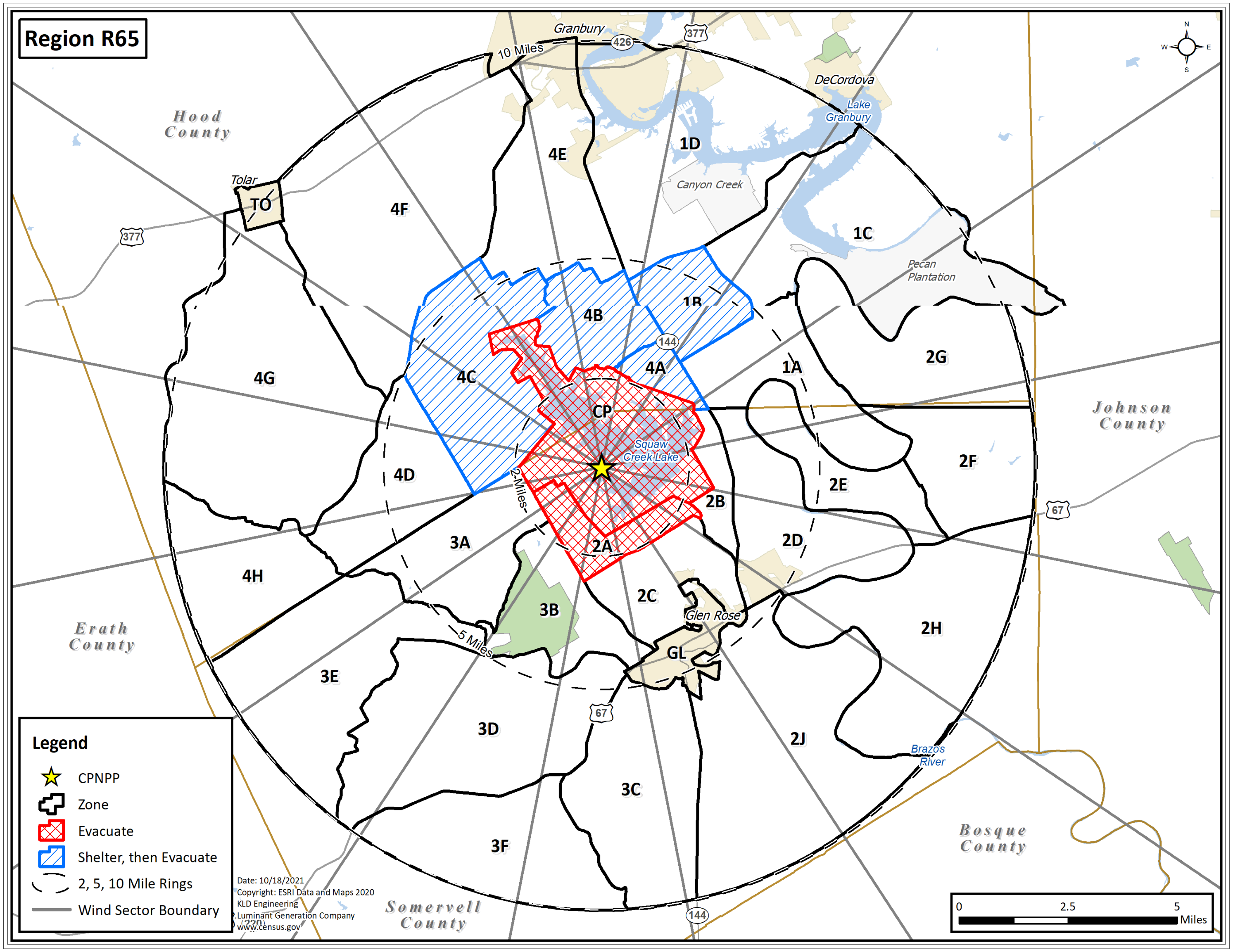


Figure H-64. Region R64



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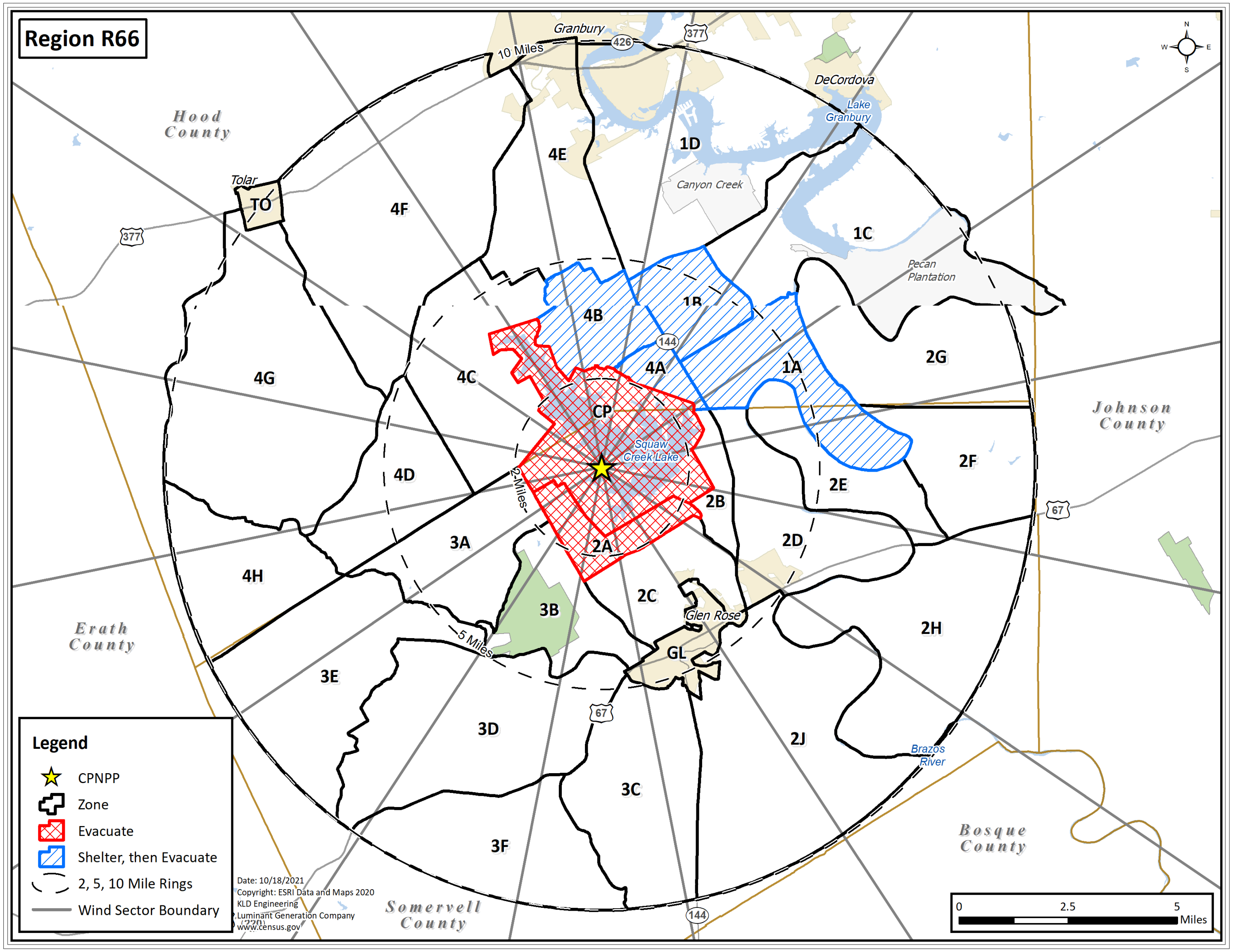

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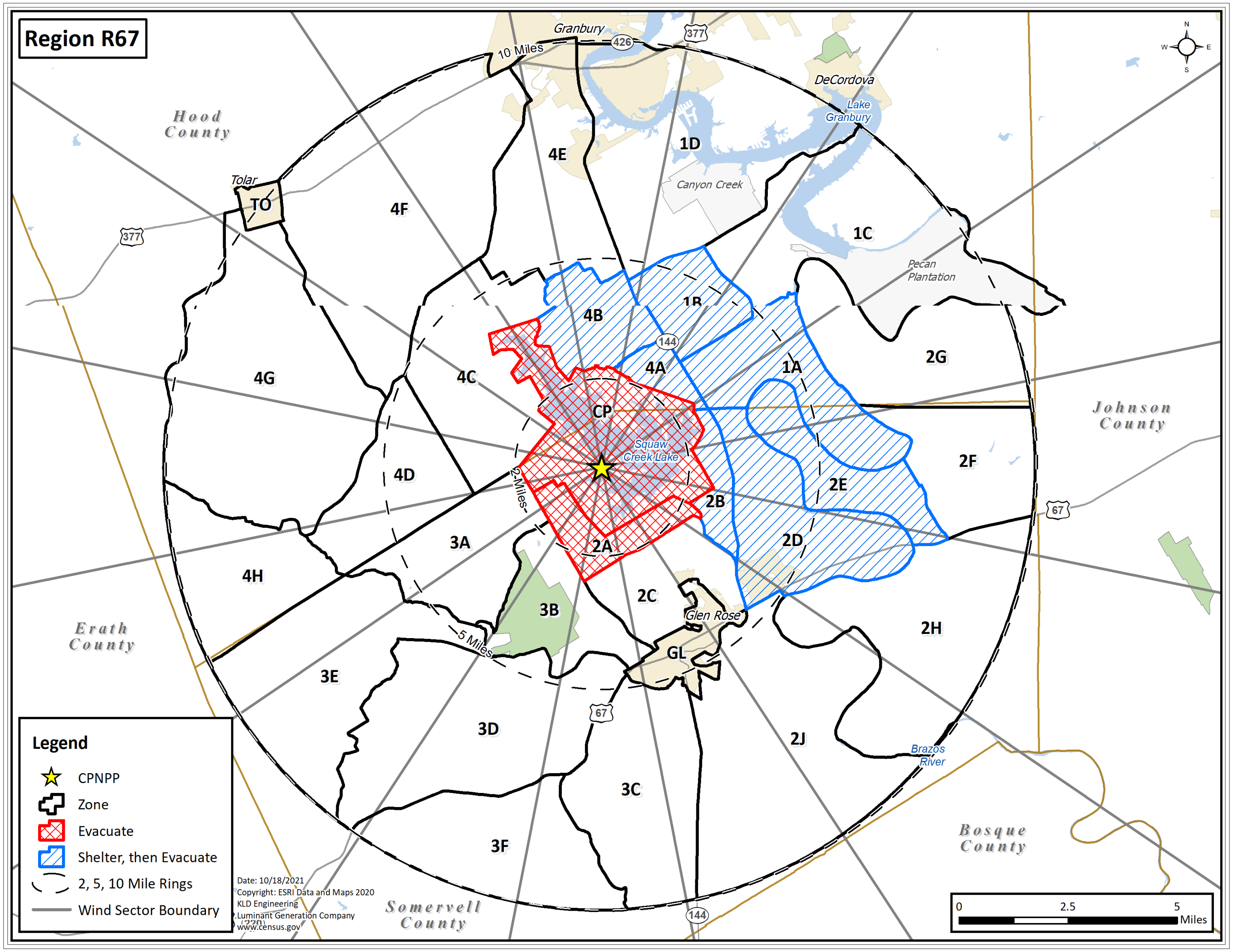

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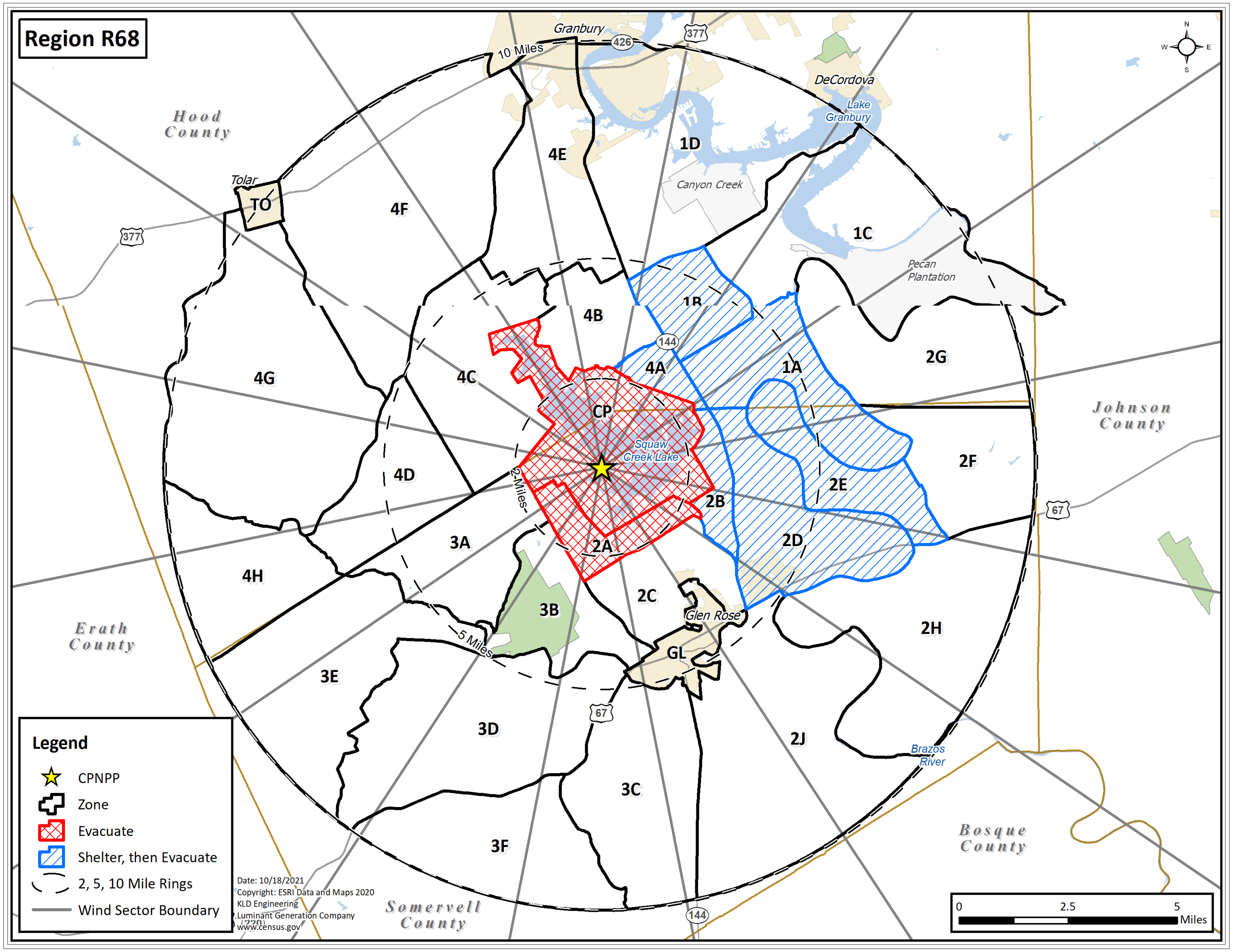
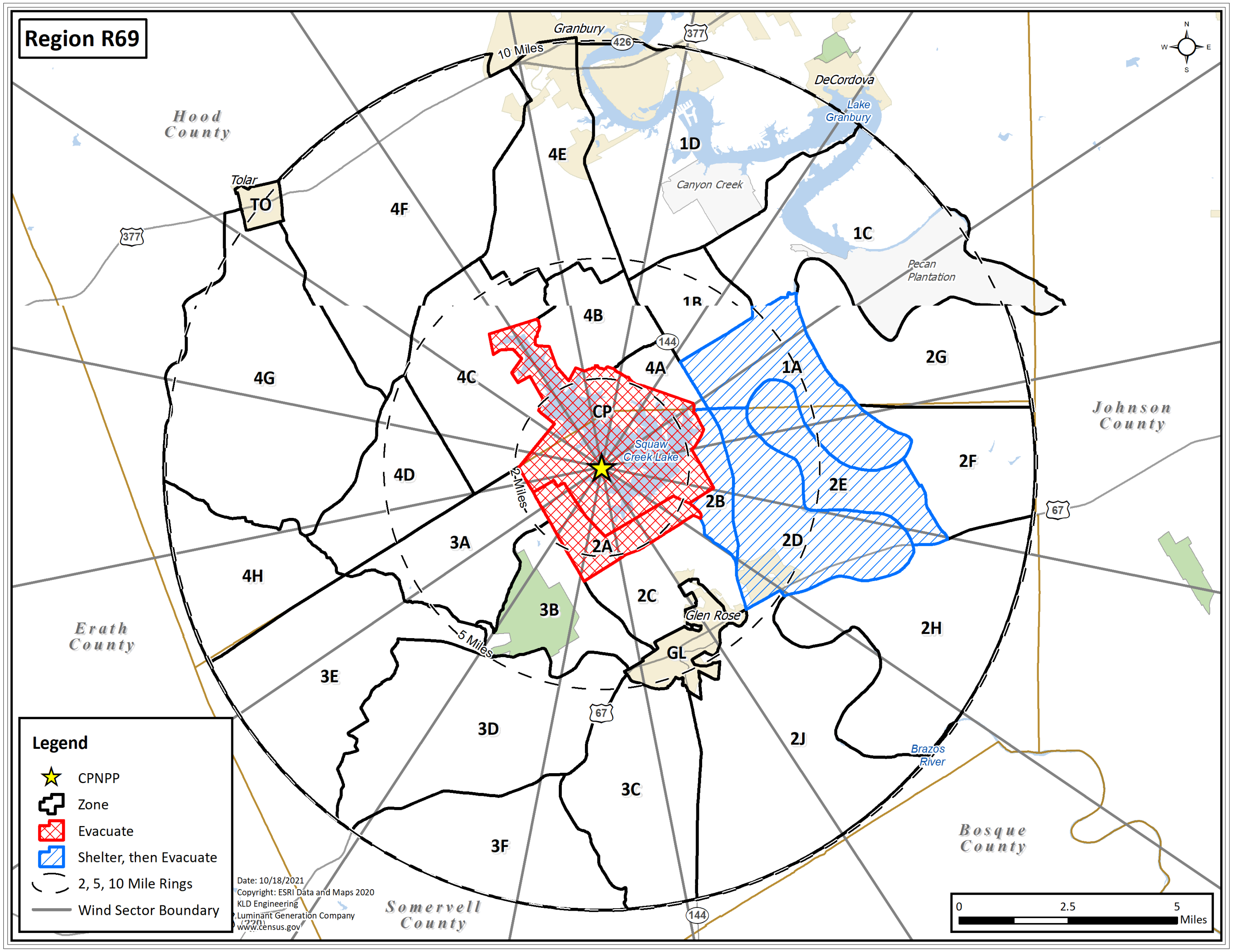


Figure H-68. Region R68



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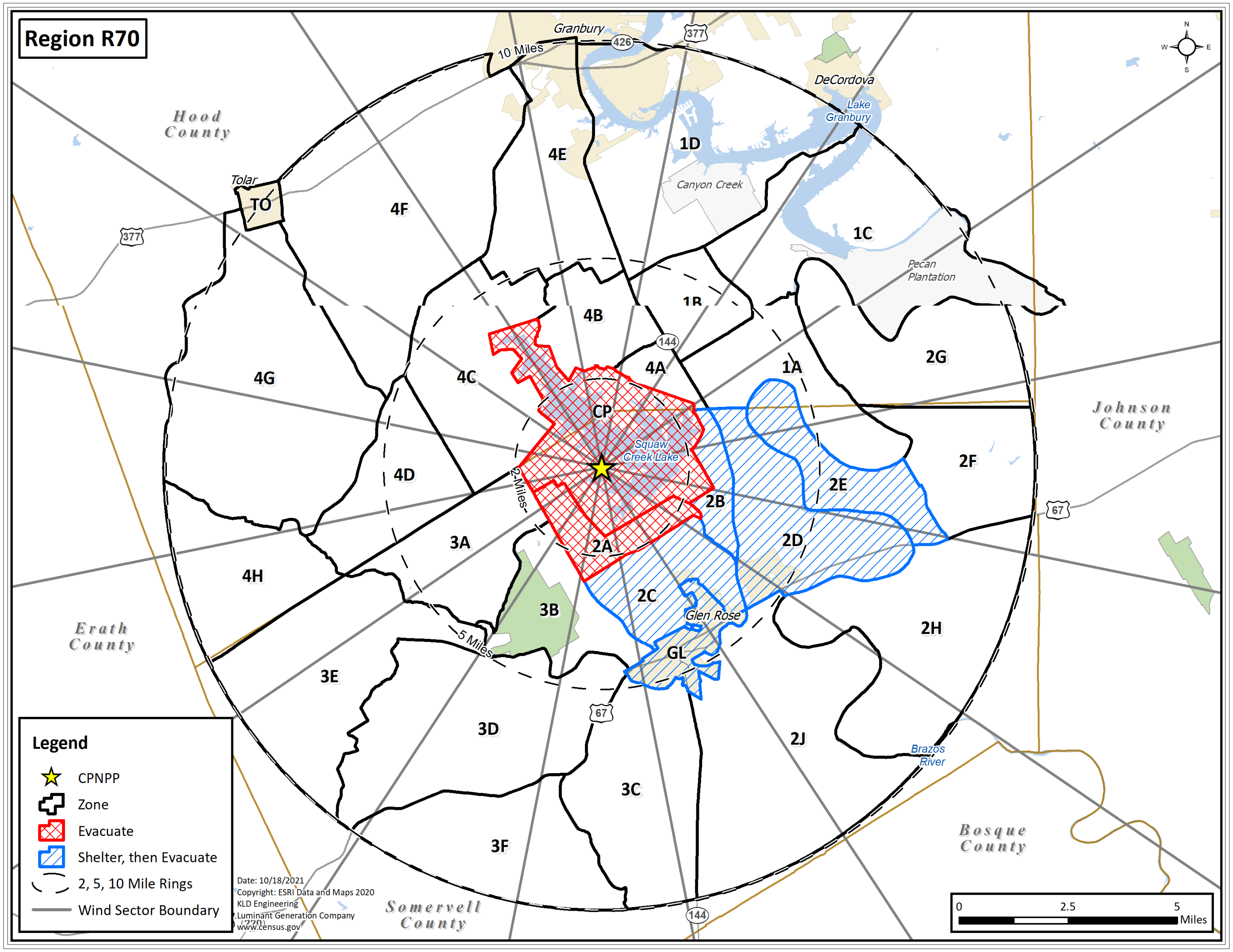


Figure H-70. Region R70

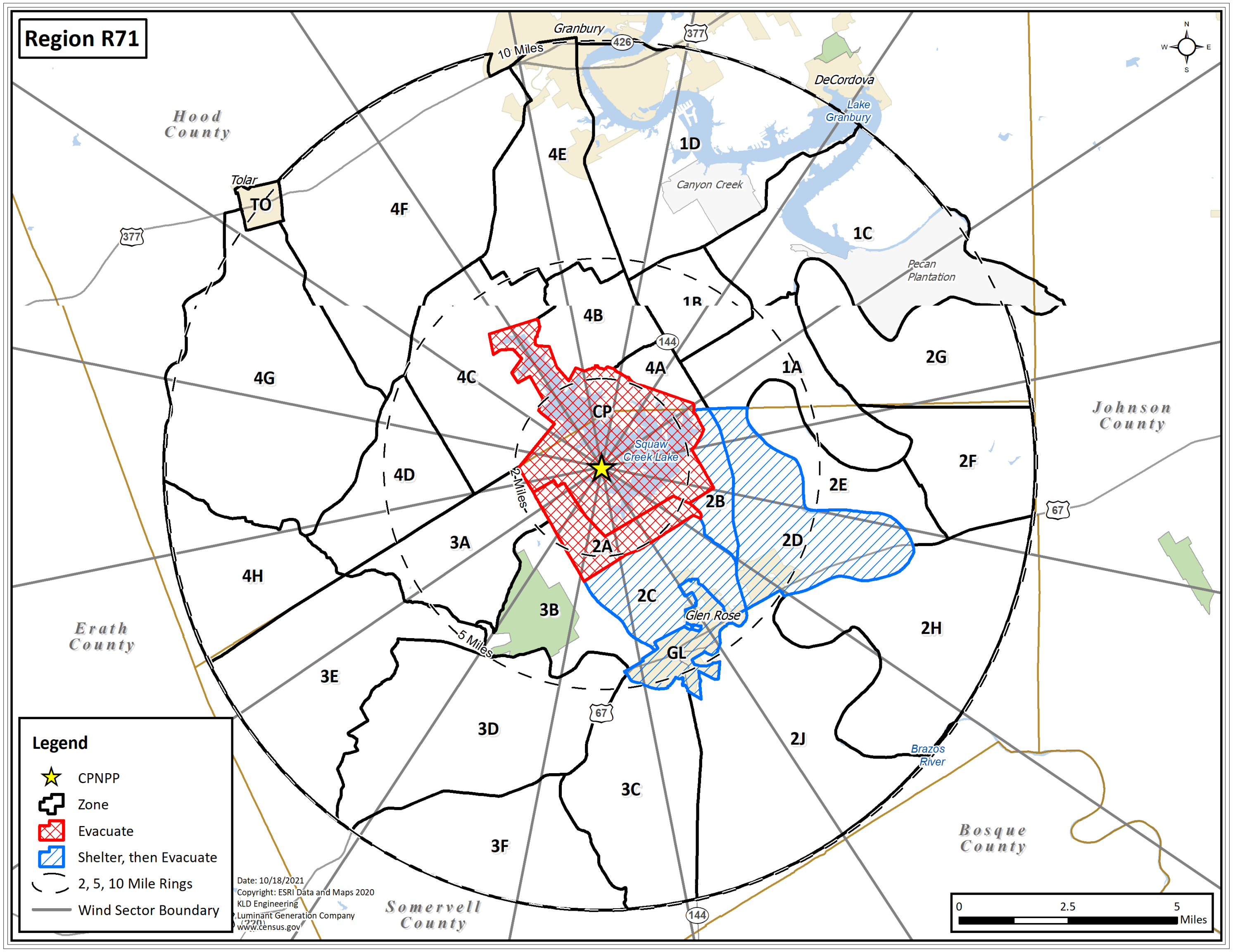
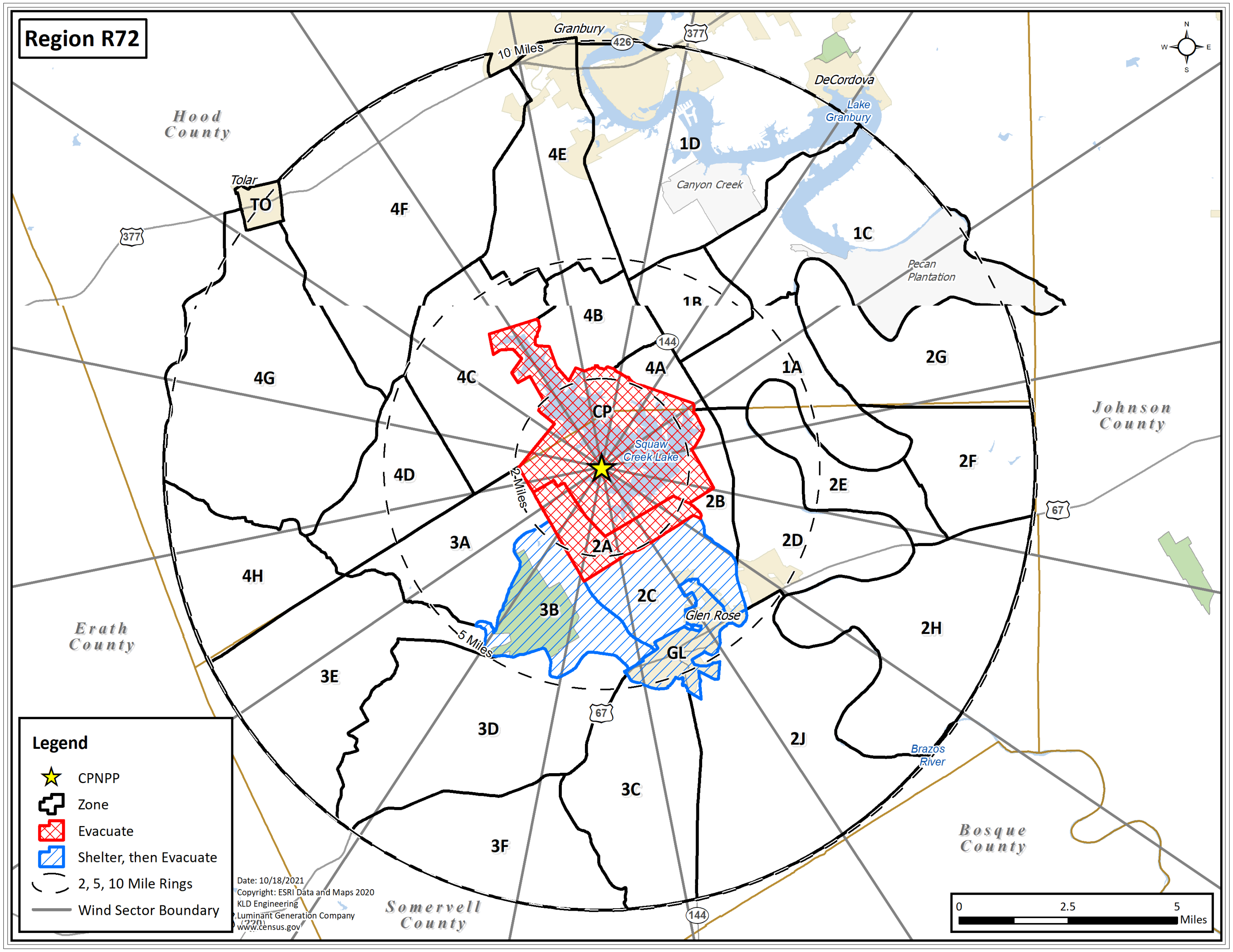


Figure H-71. Region R71



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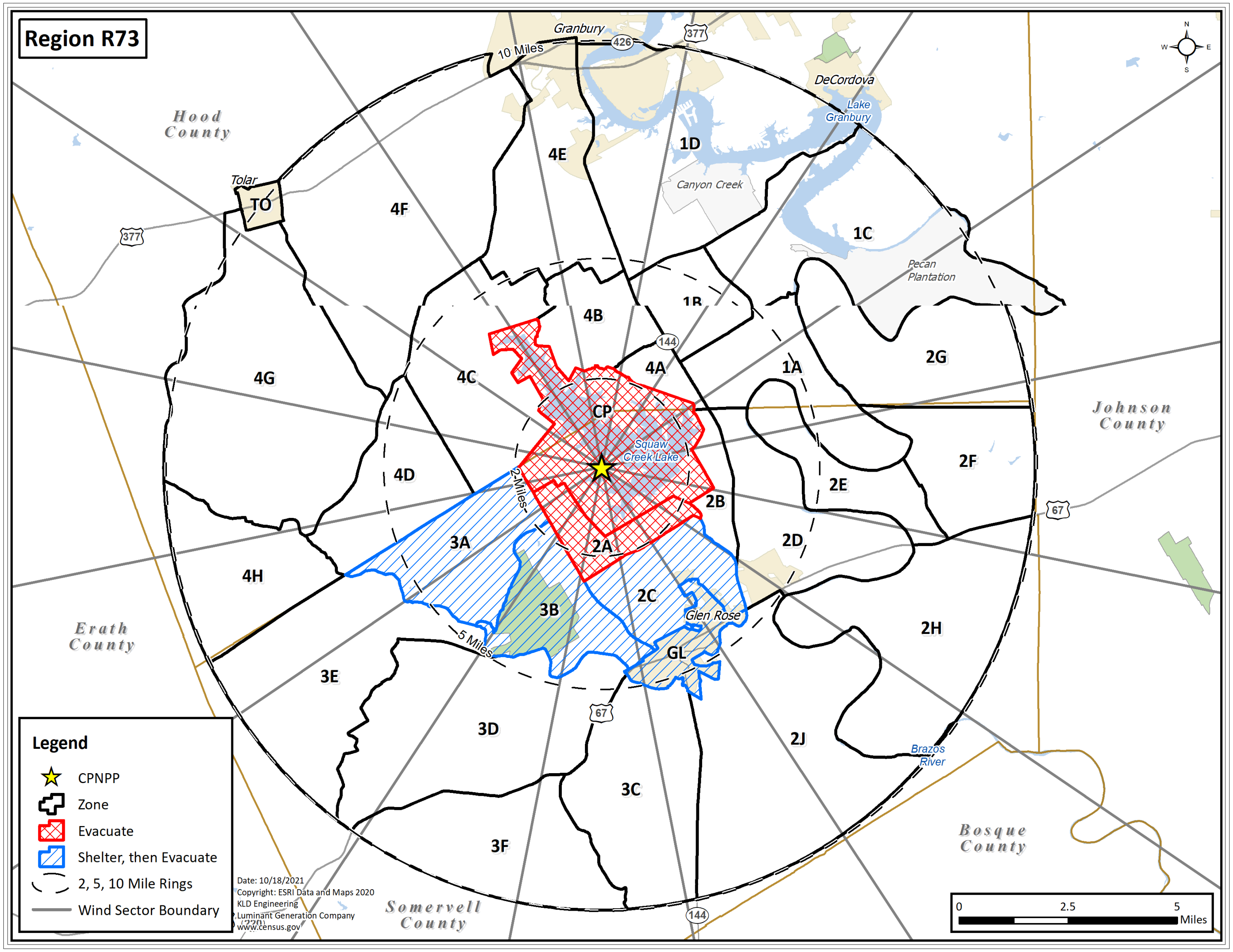
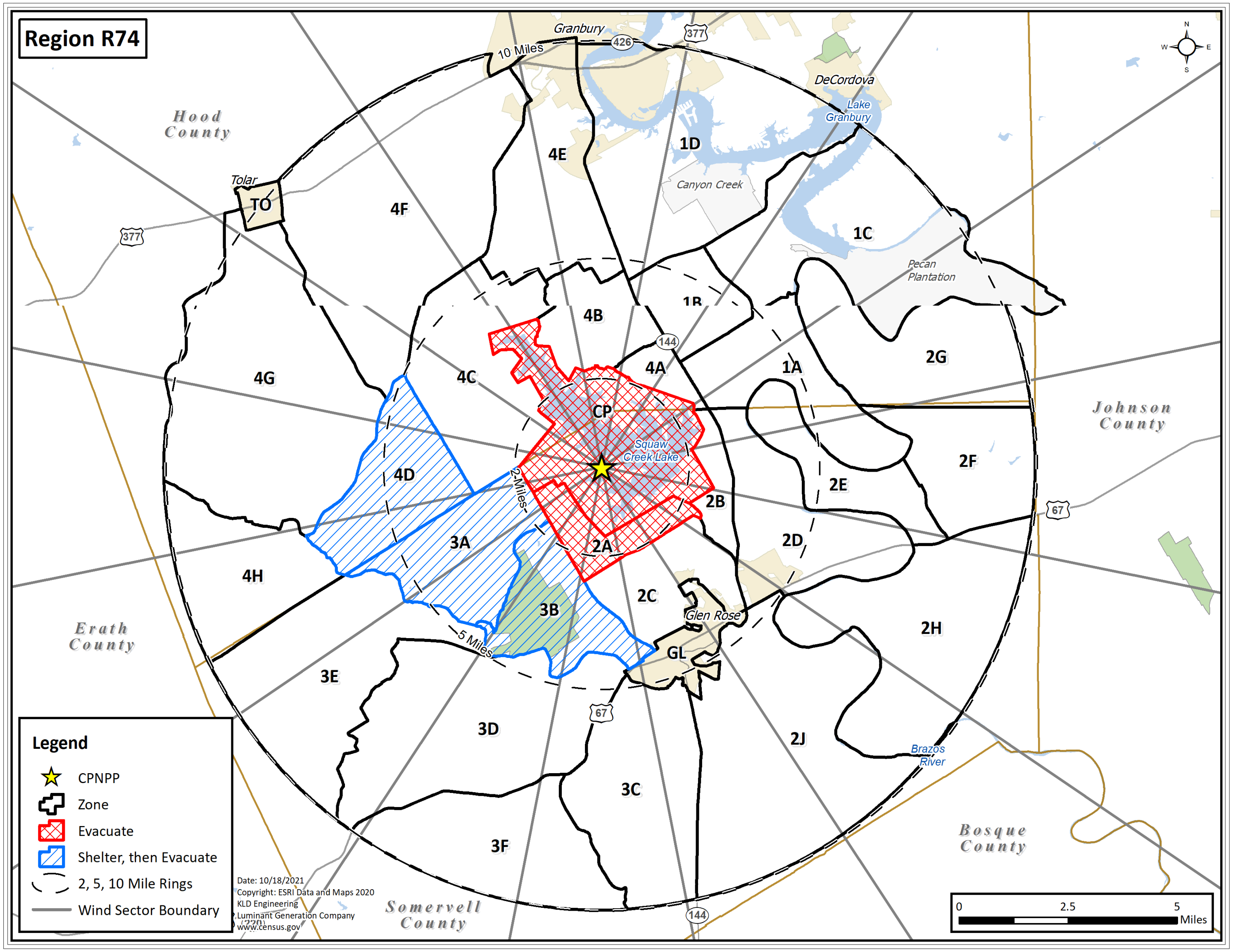


Figure H-73. Region R73



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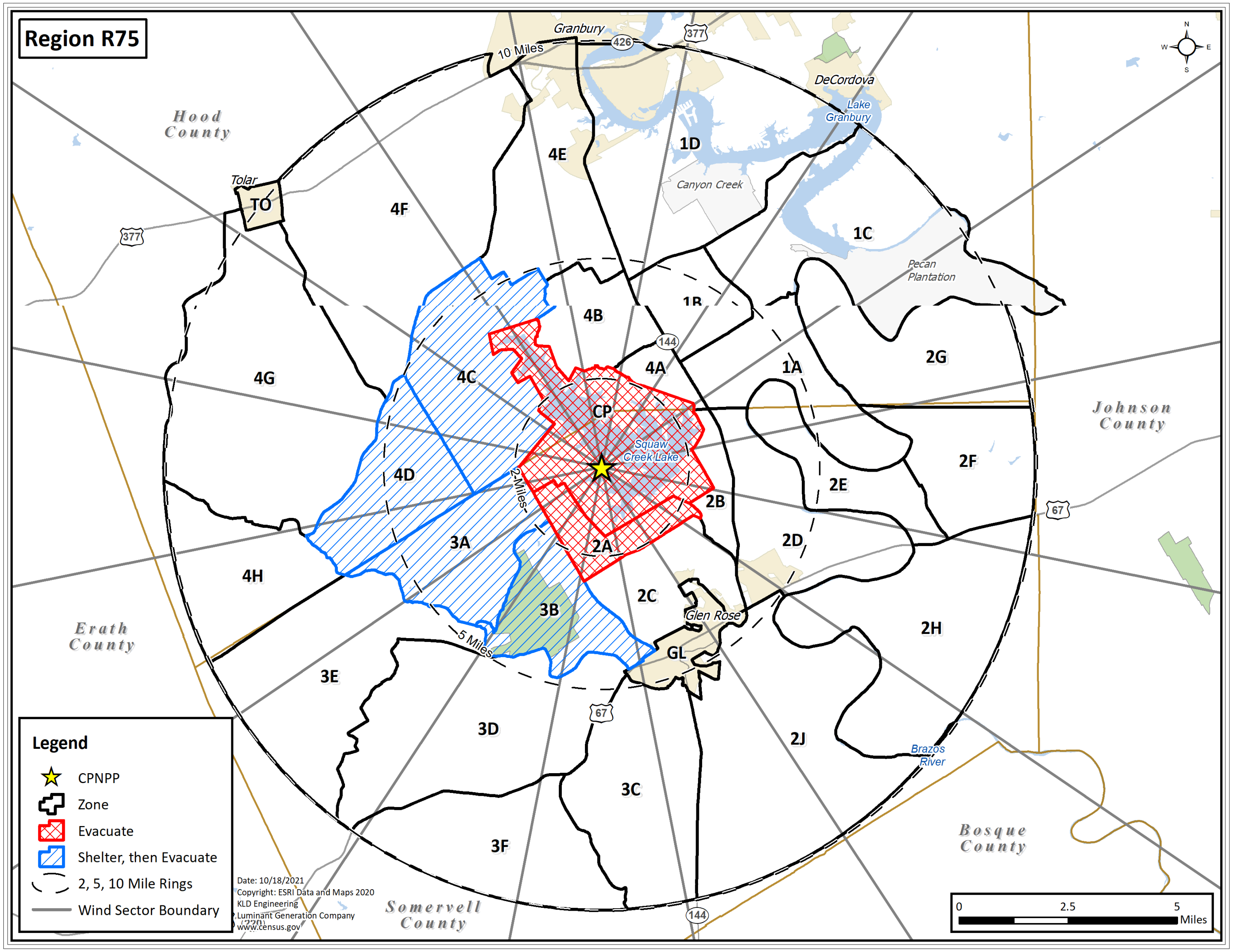
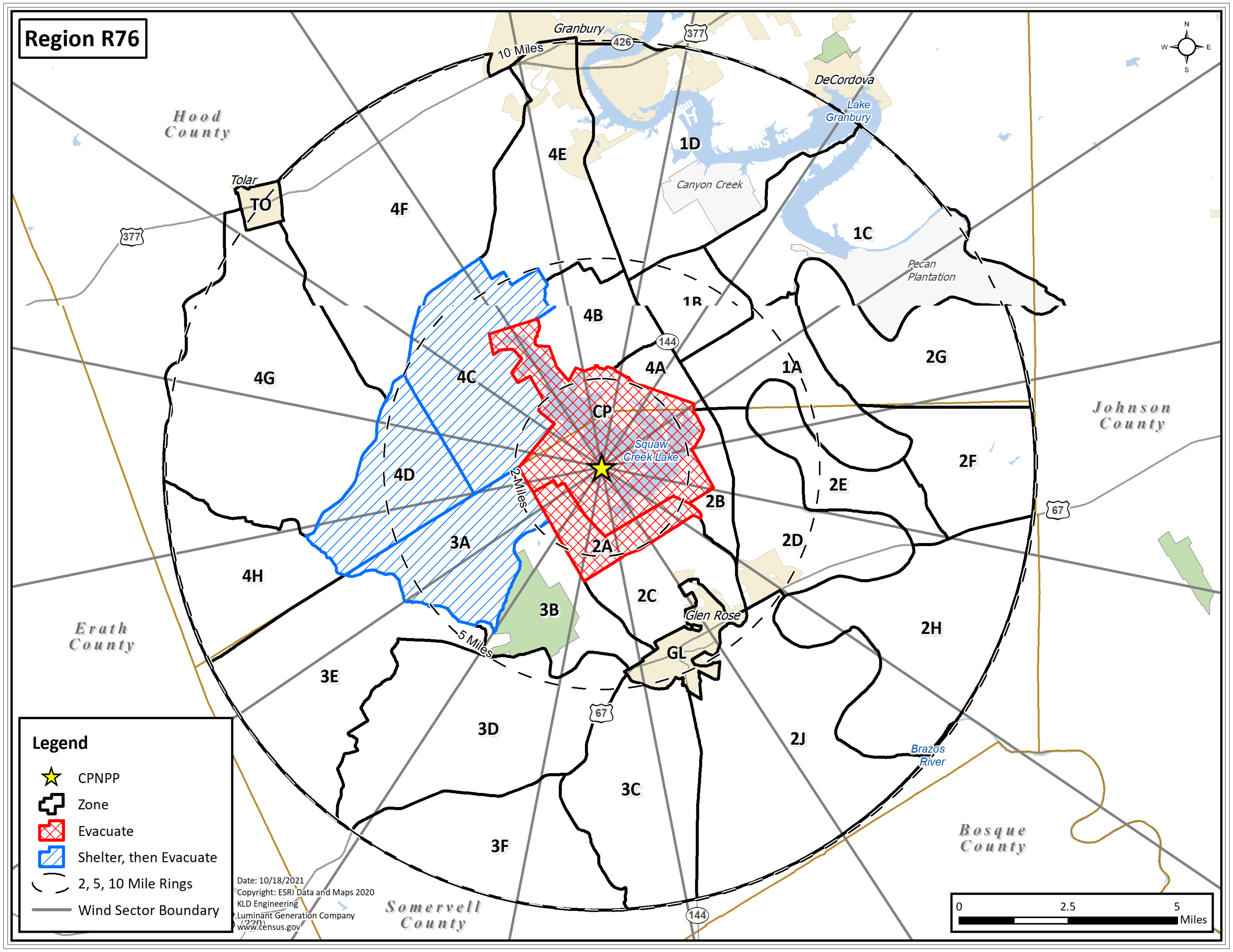


Figure H-75. Region R75



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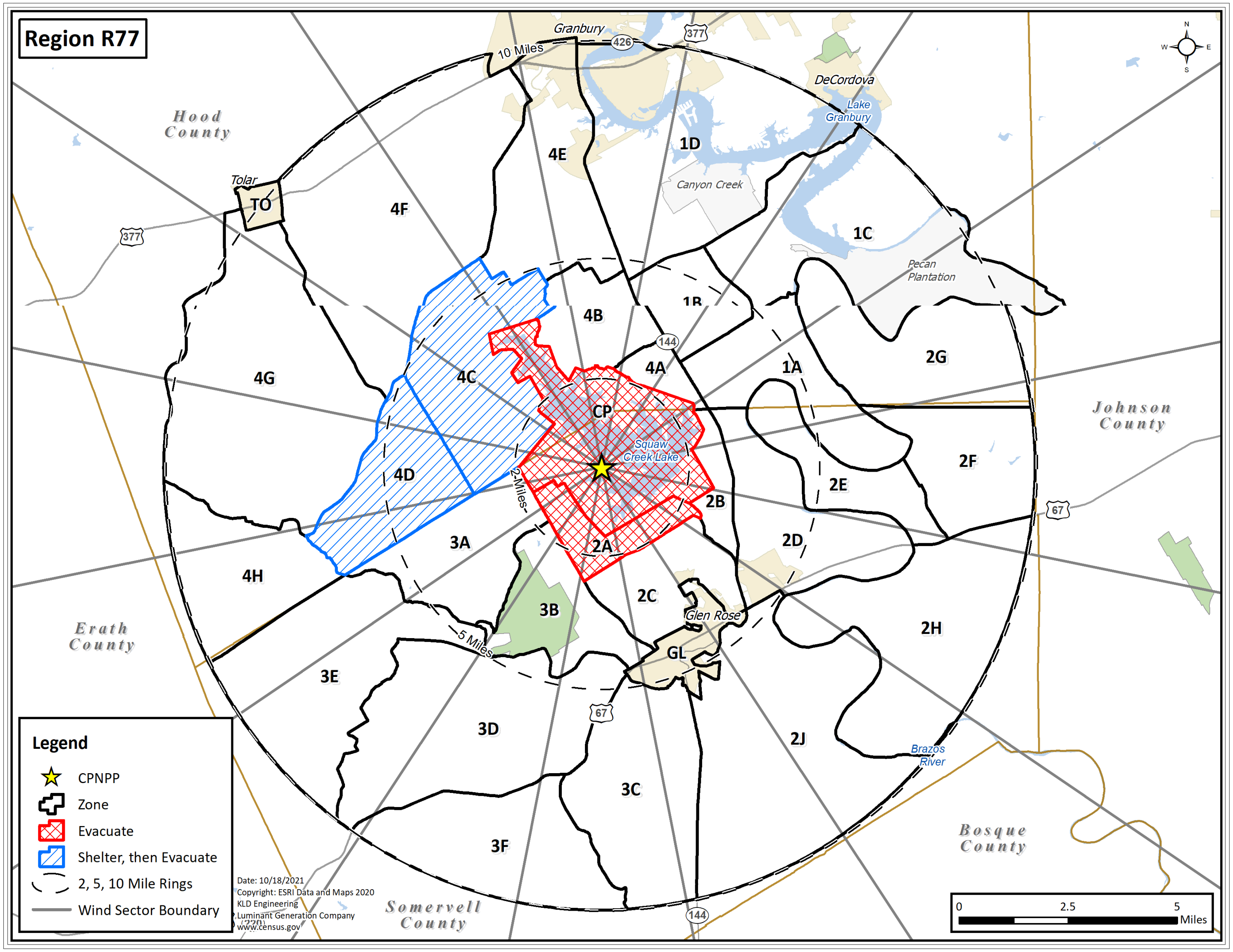

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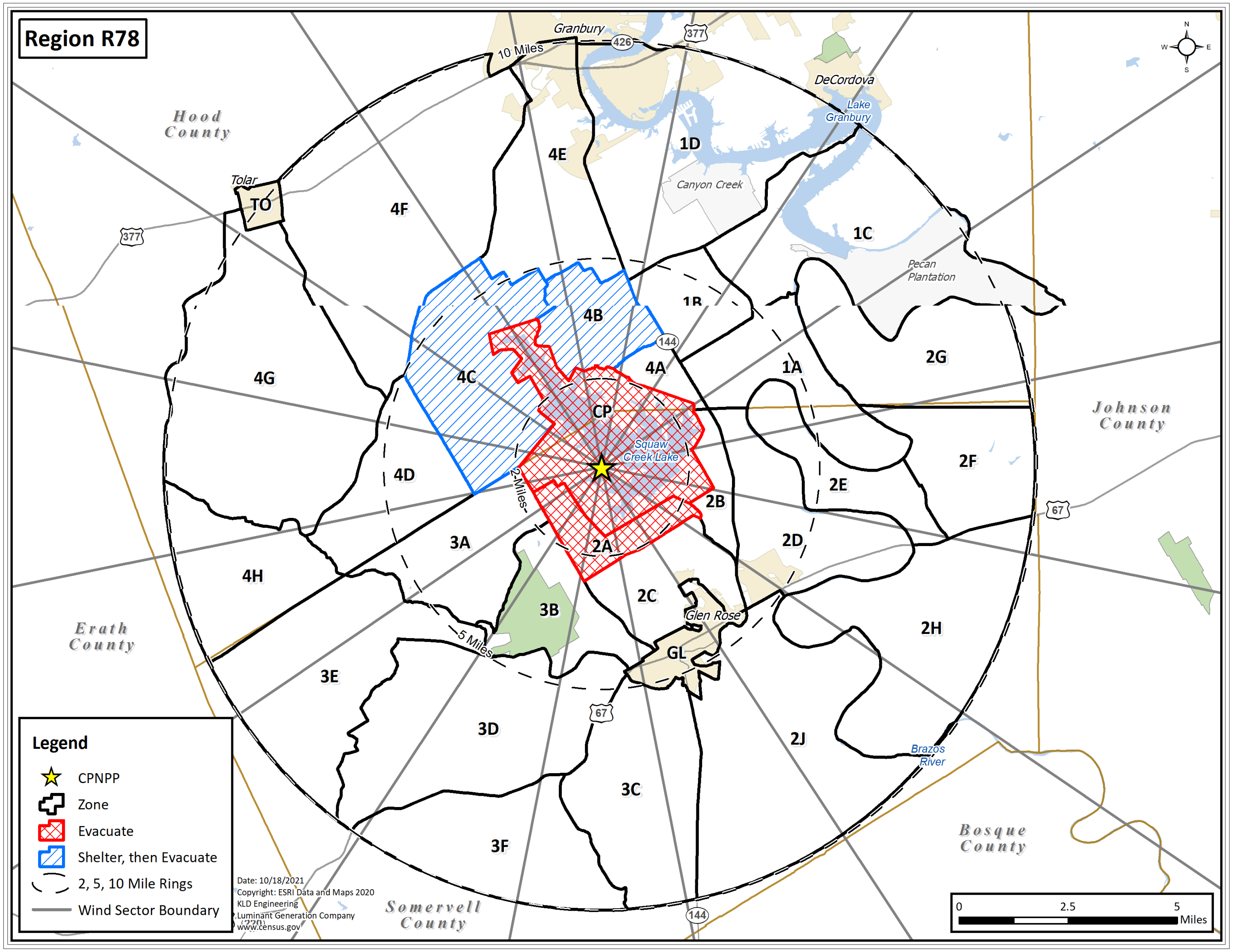


Figure H-78. Region R78

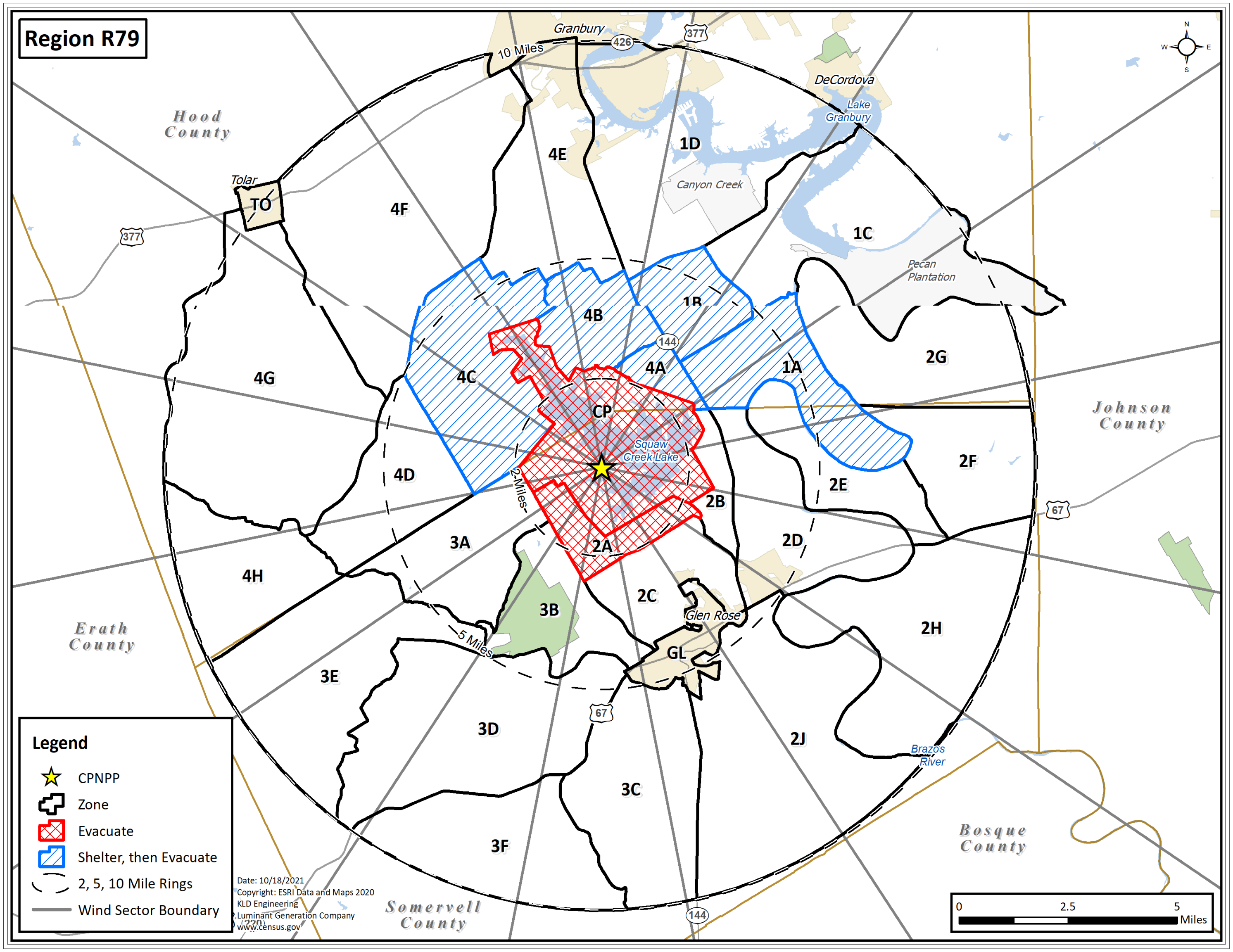


Figure H-79. Region R79

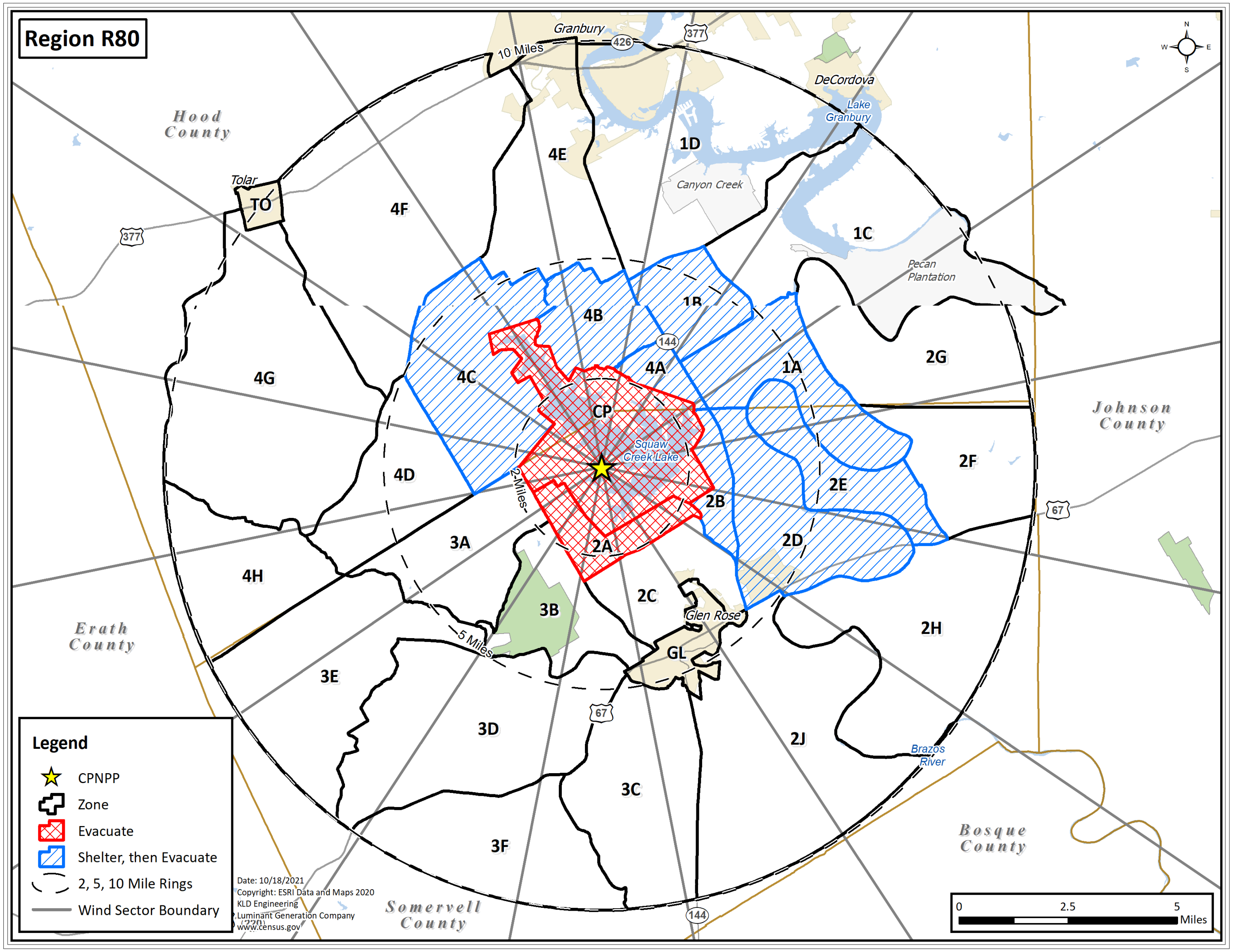


Figure H-80. Region R80

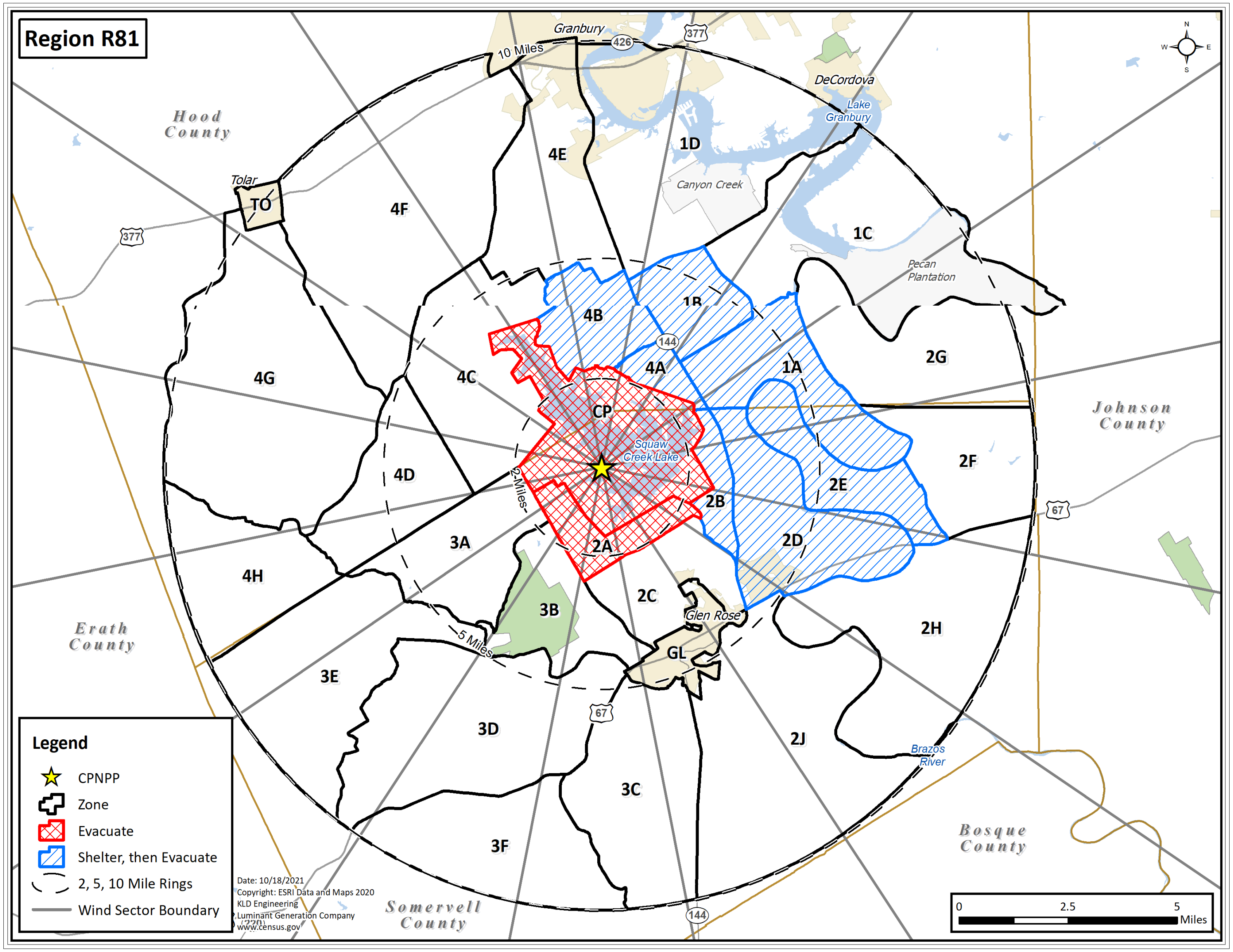


Figure H-81. Region R81

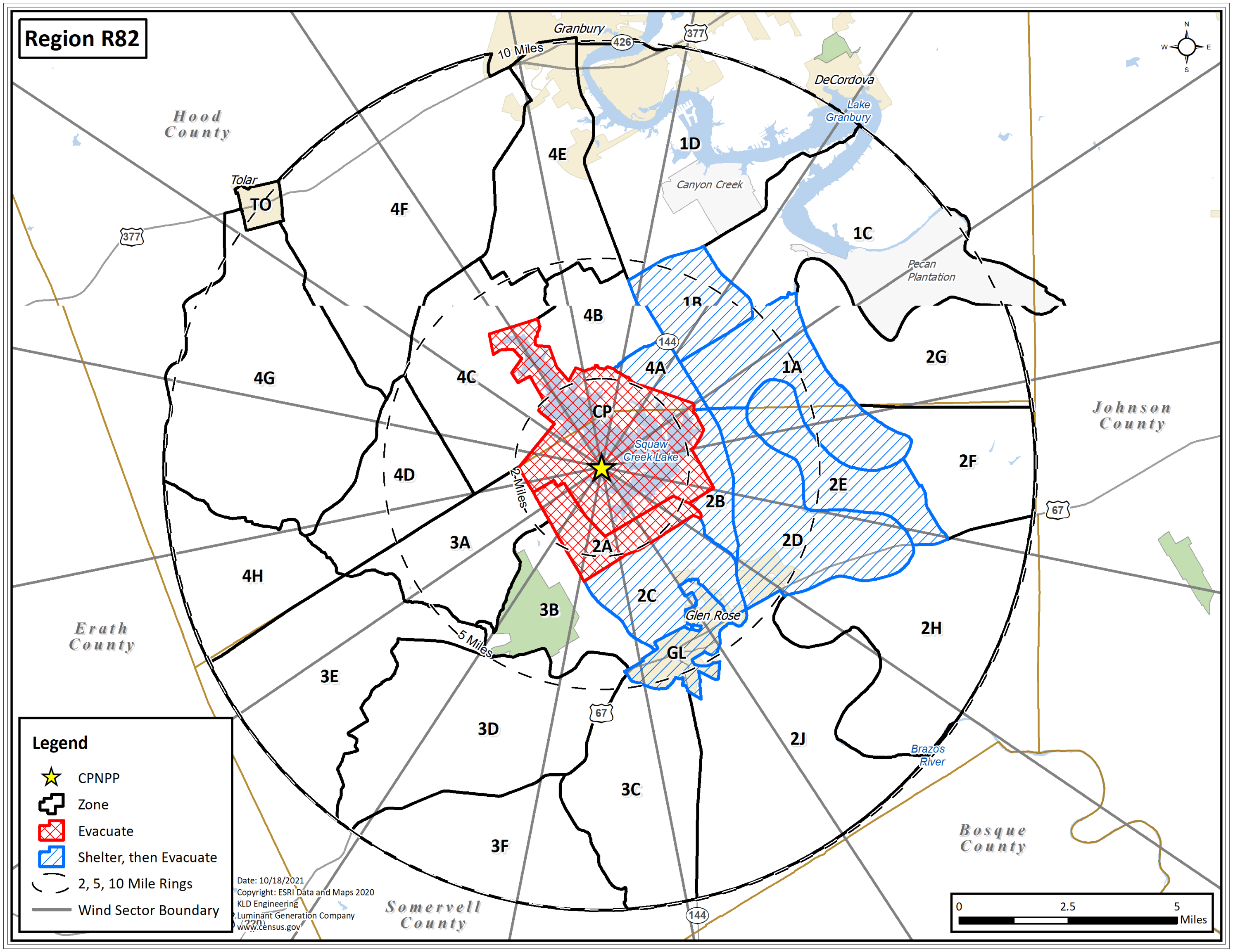


Figure H-82. Region R82

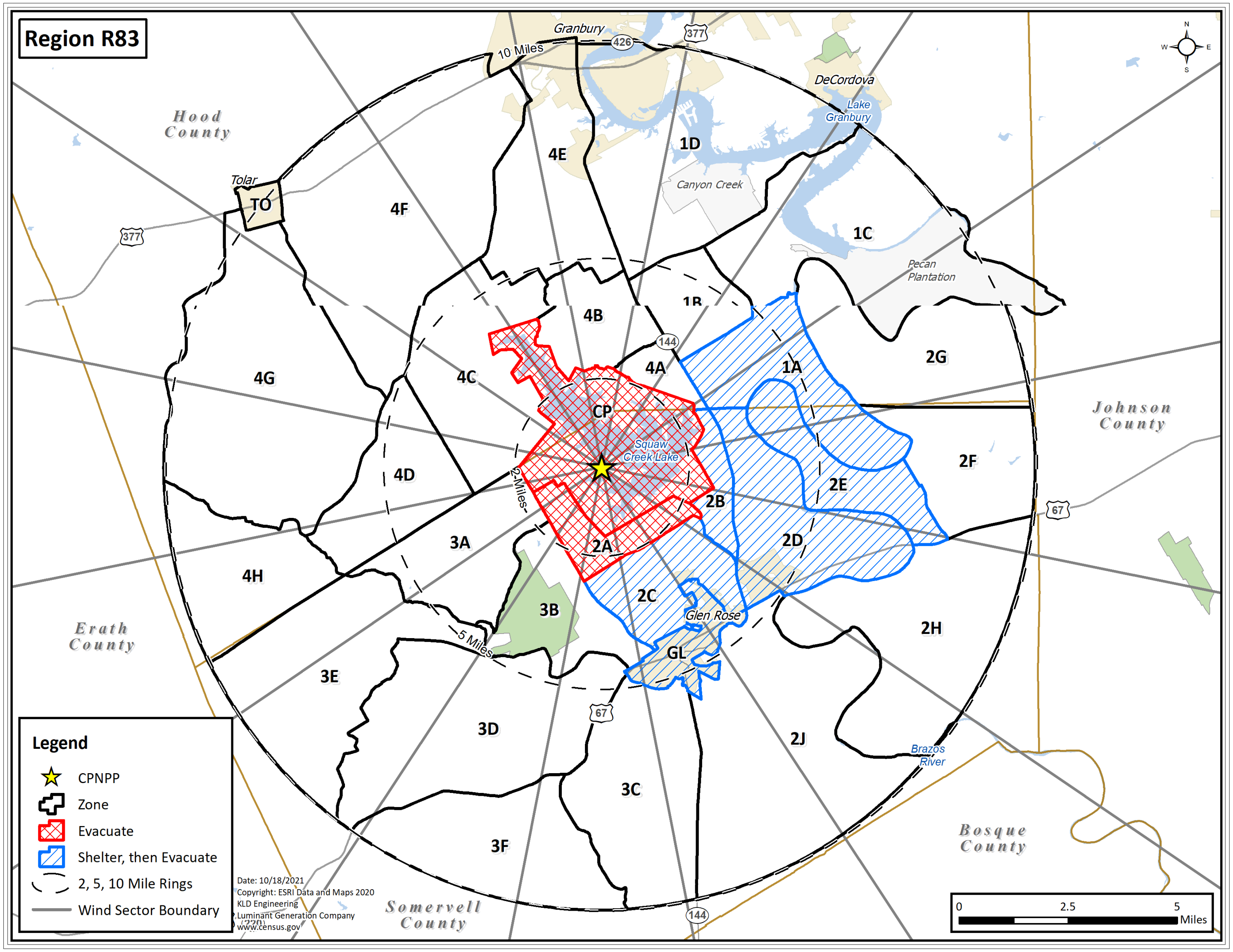


Figure H-83. Region R83

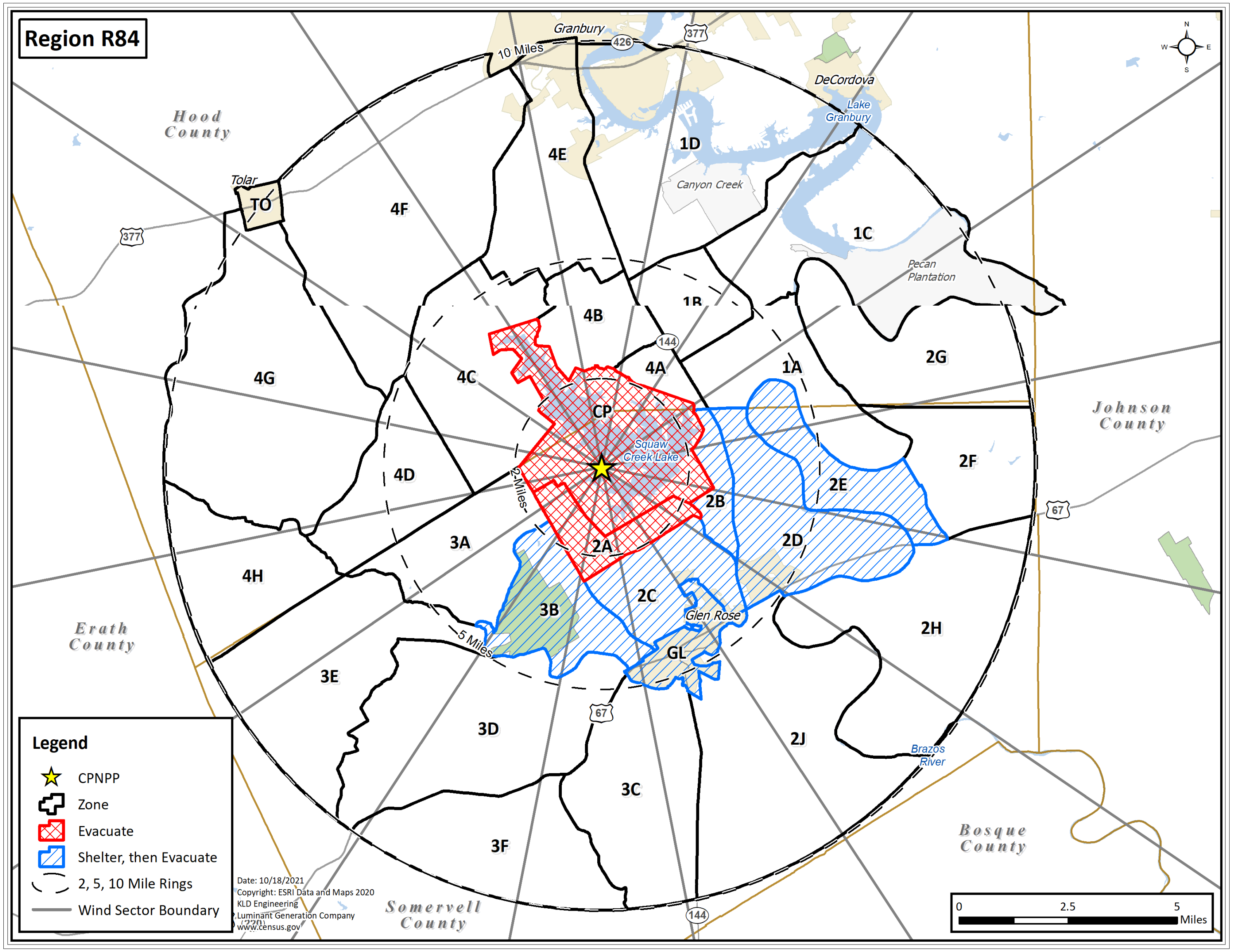


Figure H-84. Region R84

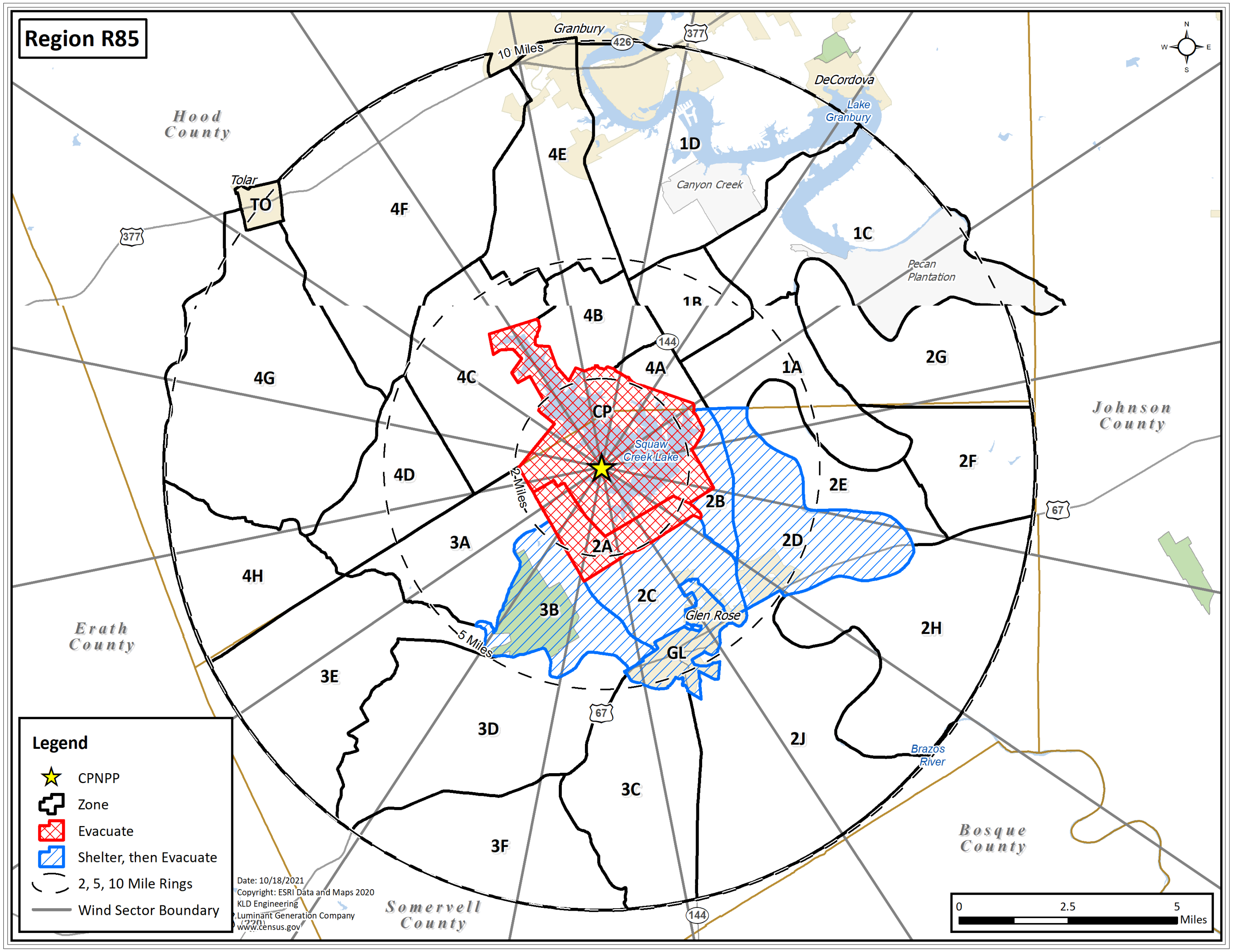


Figure H-85. Region R85

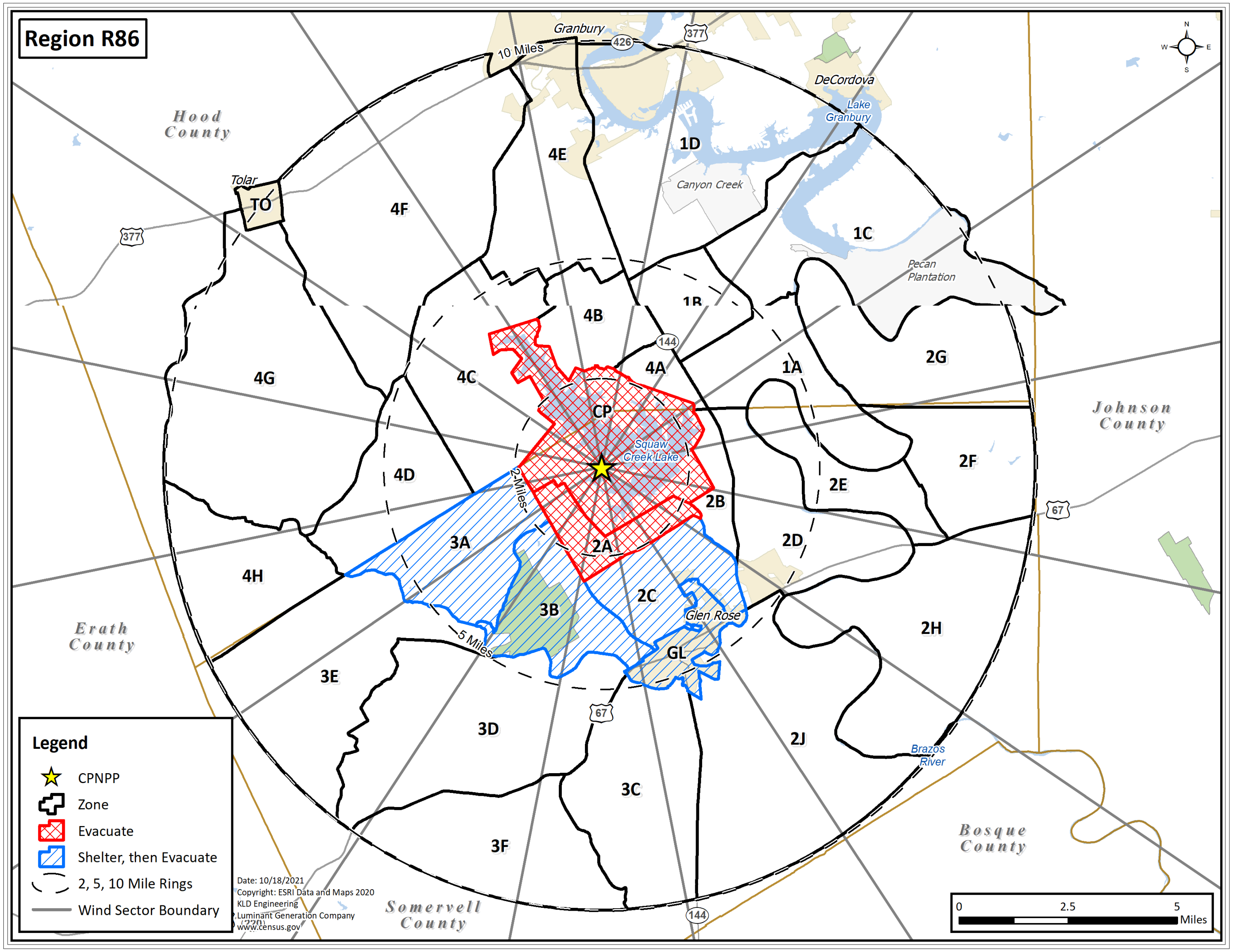


Figure H-86. Region R86

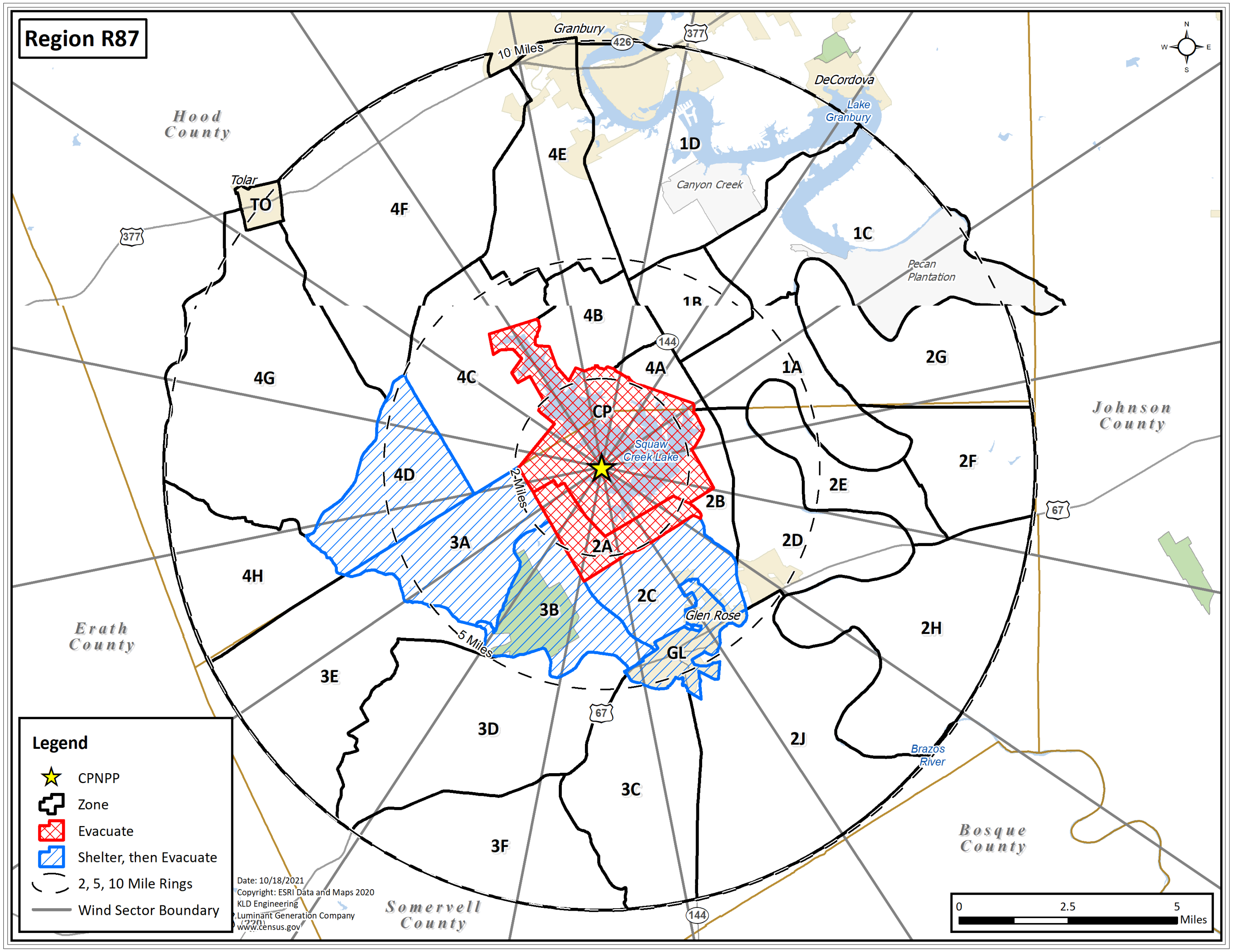


Figure H-87. Region R87

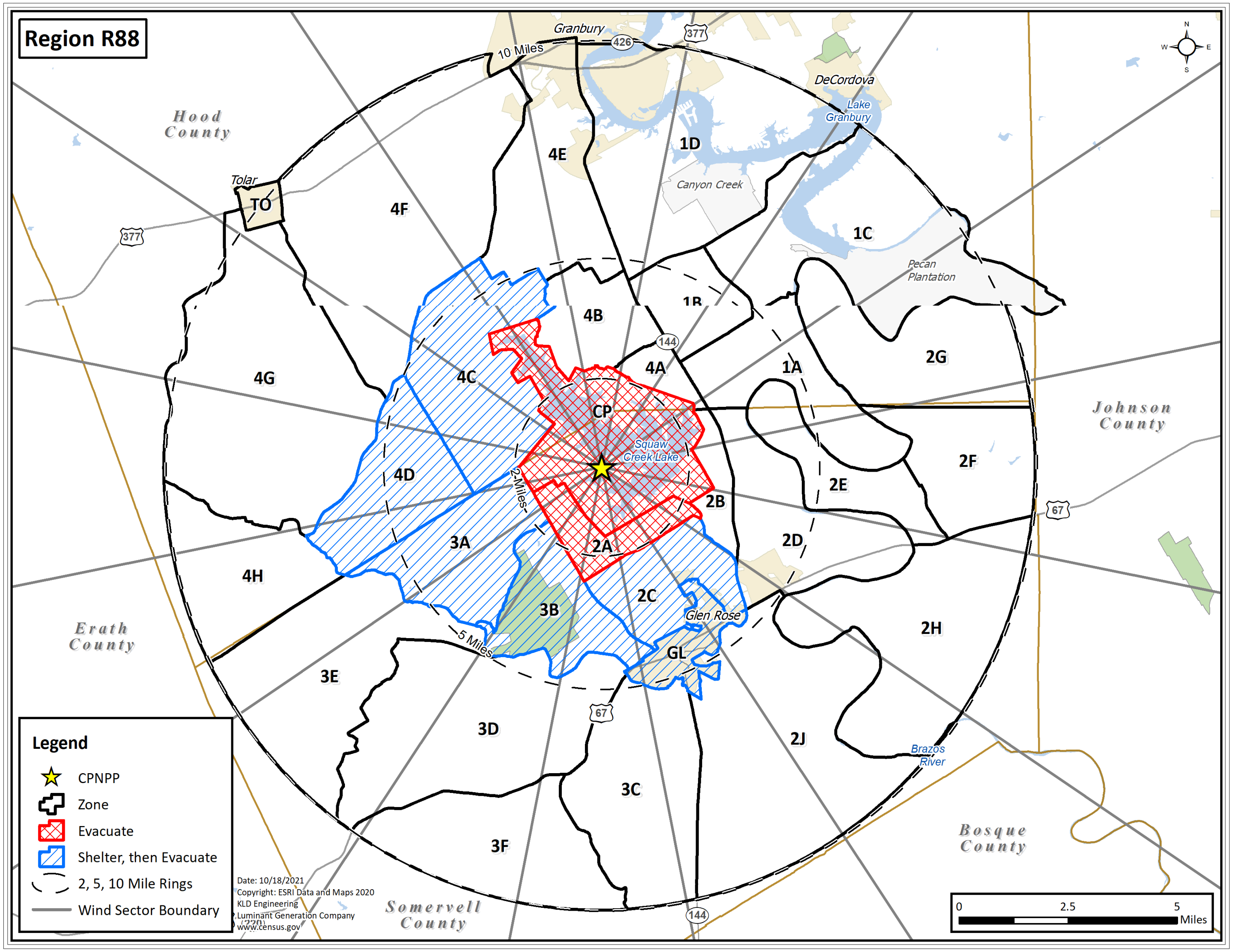


Figure H-88. Region R88

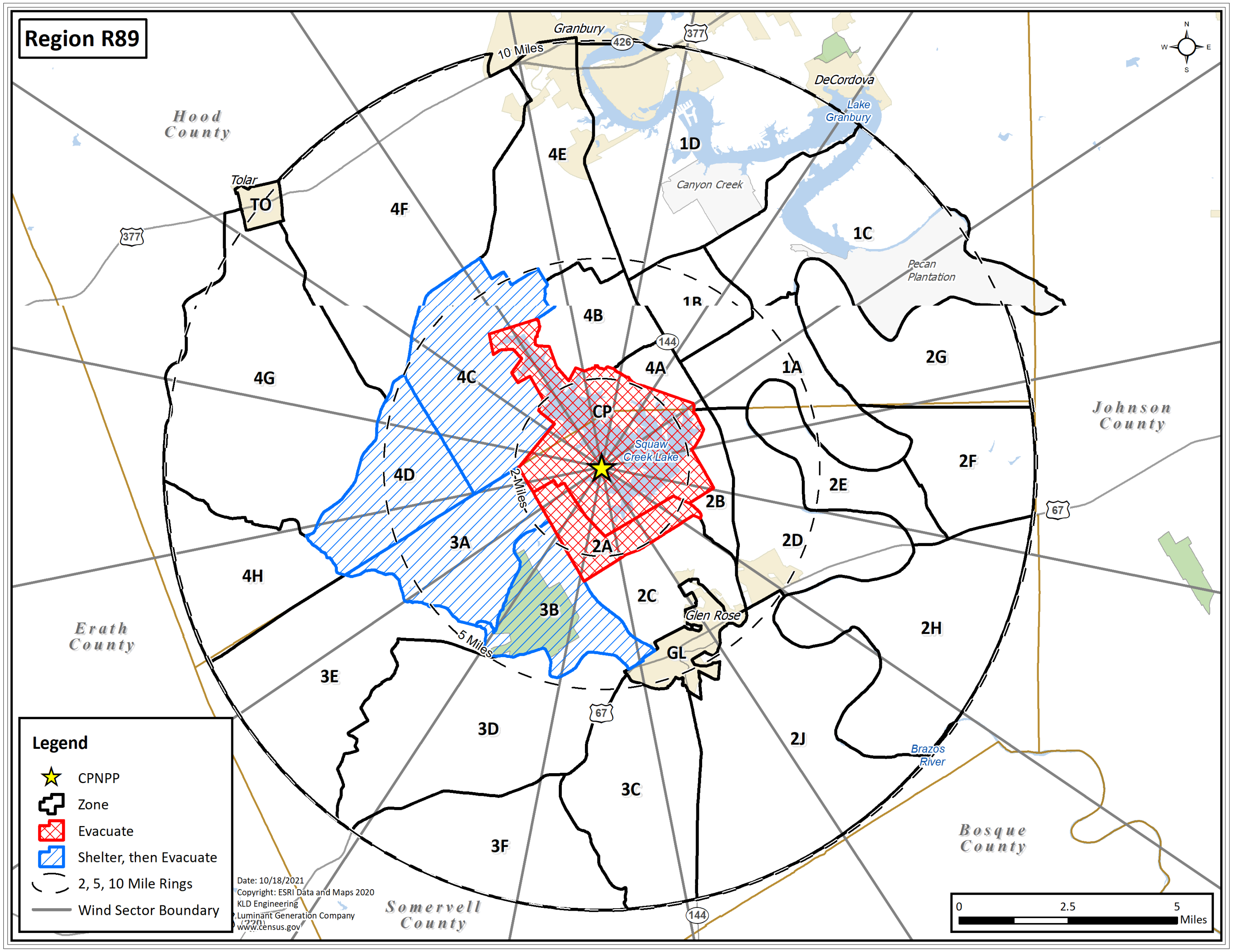


Figure H-89. Region R89

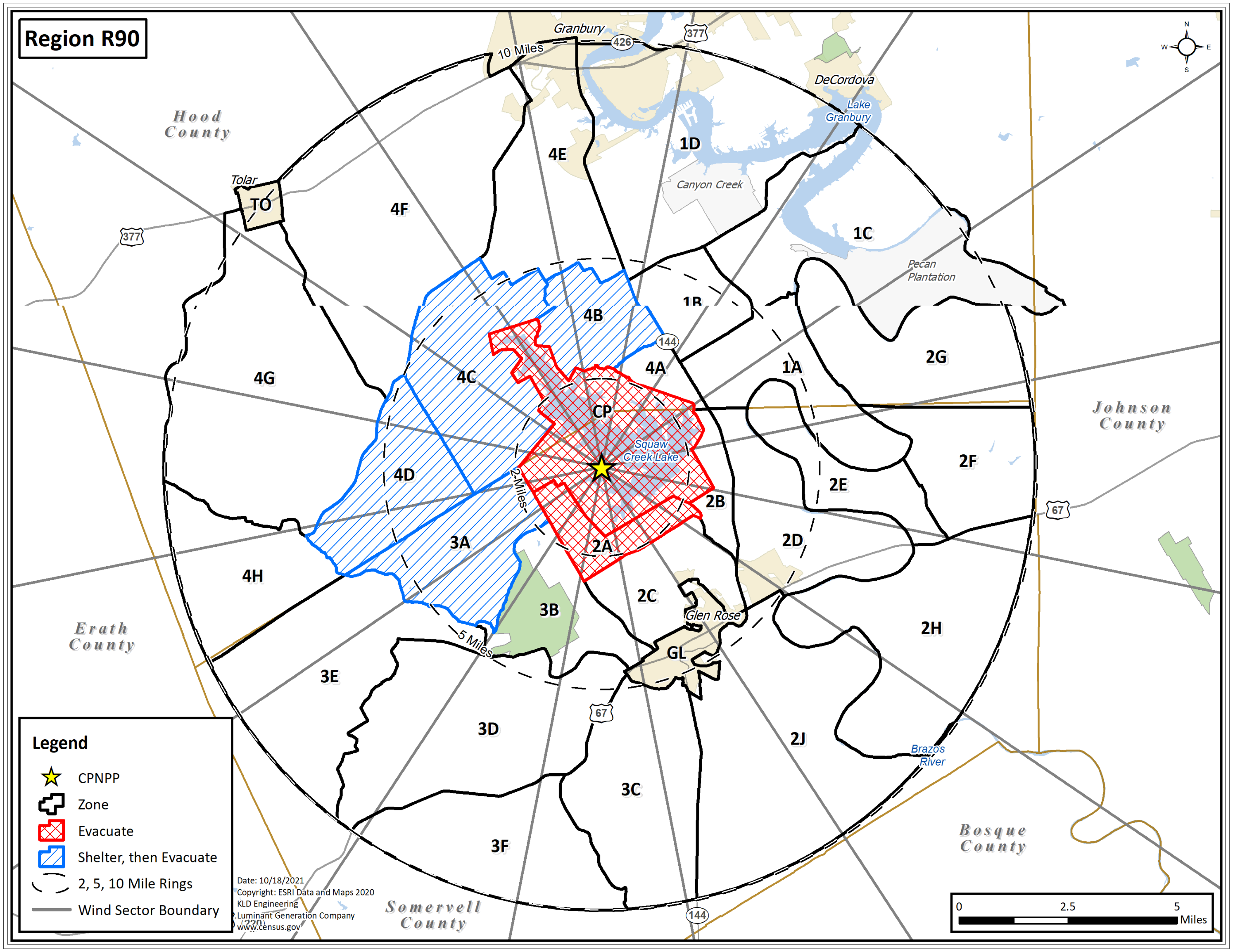


Figure H-90. Region R90

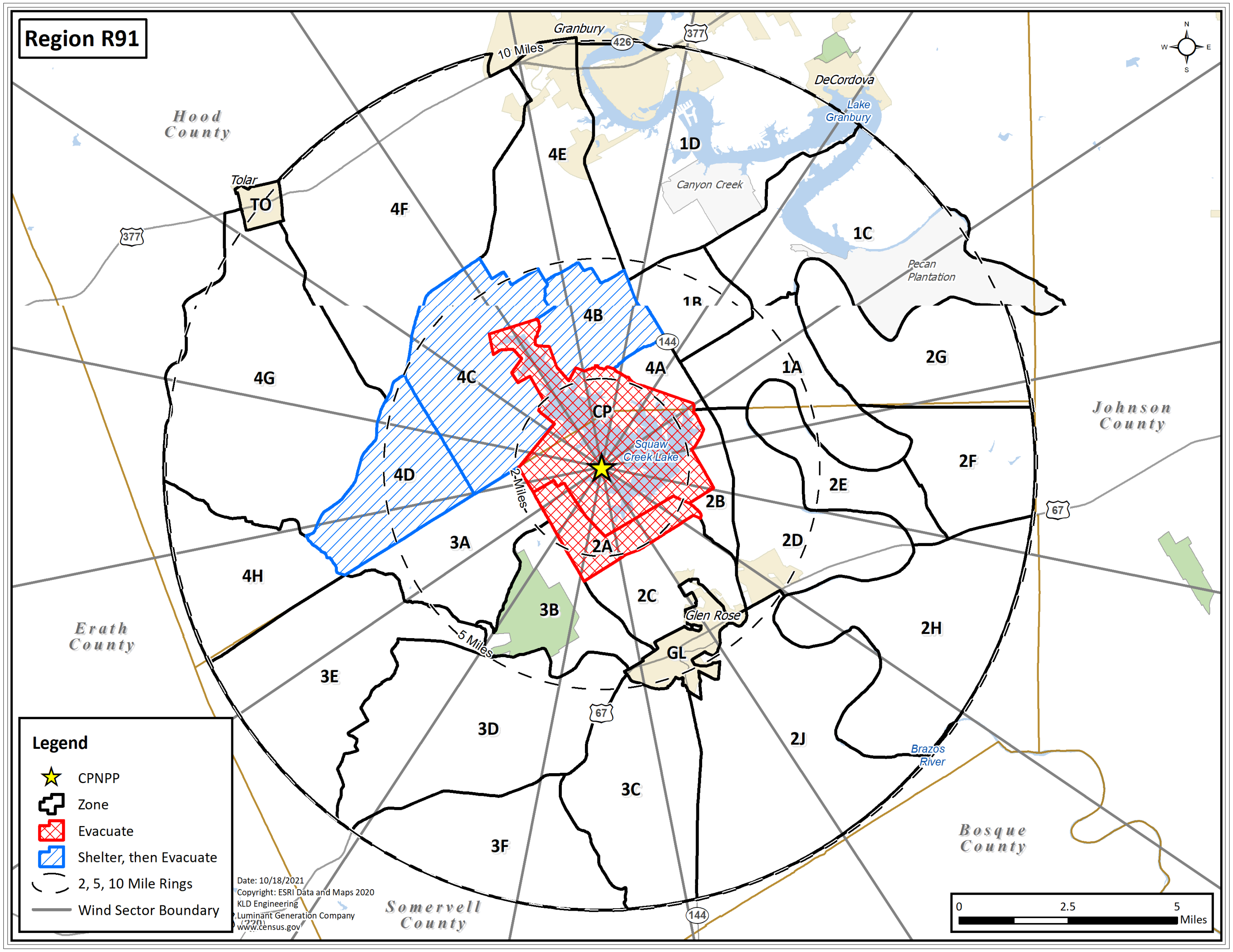


Figure H-91. Region R91

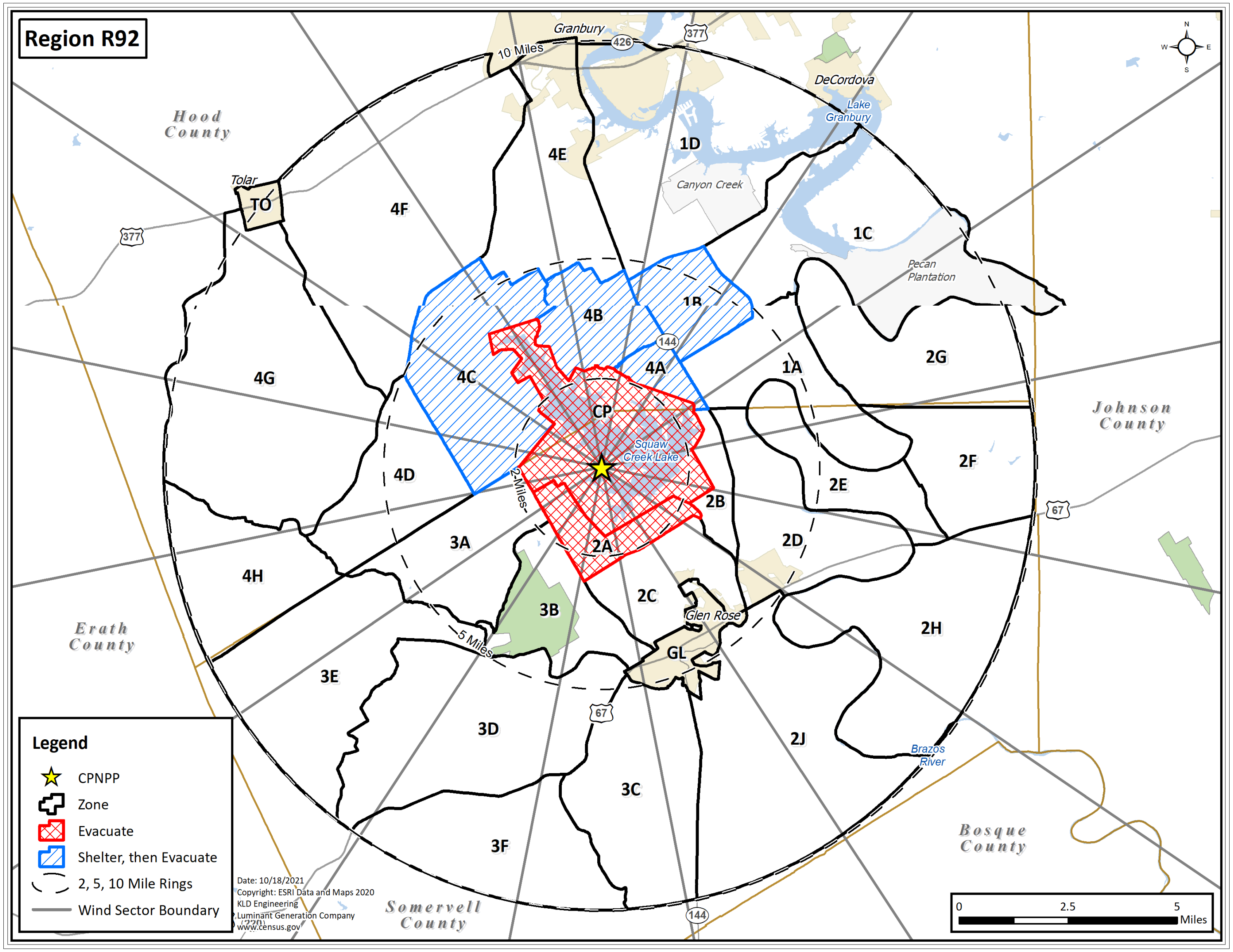


Figure H-92. Region R92

APPENDIX J

Representative Inputs to and Outputs from the DYNEV II System

J. REPRESENTATIVE INPUTS TO AND OUTPUTS FROM THE DYNEV II SYSTEM

This appendix presents data input to and output from the DYNEV II System.

Table J-1 provides source (vehicle loading) and destination information for several roadway segments (links) in the analysis network. In total, there are a total of 312 source links (origins) in the model. The source links are shown as centroid points in Figure J-1. On average, evacuees travel a straight-line distance of 7.26 miles to exit the network.

Table J-2 provides network–wide statistics (average travel time, average delay time[1], average speed and number of vehicles) for an evacuation of the entire EPZ (Region R03) for each scenario. As expected, Scenarios 2, 4, 7 and 9, which are rain scenarios, exhibit the slowest average speed and longest average travel times. Scenario 11 (special event) has a lower network-wide average speed and higher network-wide average travel time when compared with Scenario 3 (summer, weekend, midday, good weather). Scenario 12 (roadway impact) has a lower network-wide average speed and higher network-wide average travel time when compared with Scenario 1 (summer, weekday, midday, good weather).

Table J-3 provides statistics (average speed and travel time) for the major evacuation routes – US 377, US 67, TX 144, FM 4, FM 56, FM 51 and FM 205 – for an evacuation of the entire EPZ (Region R03) under Scenario 1 conditions. As discussed in Section 7.3 and shown in Figures 7-3 through 7-8, congestion persists on US 377 Northbound (NB) within the EPZ for about 4 hours and 30 minutes after the Advisory to Evacuate (ATE). As such, this route has the slowest average speeds of all routes.

Table J-4 provides the number of vehicles discharged and the cumulative percent of total vehicles discharged for each link exiting the analysis network, for an evacuation of the entire EPZ (Region R03) under Scenario 1 conditions. Refer to the figures in Appendix K for a map showing the geographic location of each link.

Figure J-2 through Figure J-13 plot the trip generation time versus the ETE for each of the 12 Scenarios considered. The distance between the trip generation and ETE curves is the travel time. Plots of trip generation versus ETE are indicative of the level of traffic congestion during evacuation. For low population density sites, the curves are close together, indicating short travel times and minimal traffic congestion. For higher population density sites, the curves are farther apart indicating longer travel times and the presence of traffic congestion.

As seen in Figure J-2 through Figure J-13, the curves are spatially separated as a result of the traffic congestion in the EPZ which continues until 4 hours and 30 minutes following the ATE, For Scenarios 1 through Scenario 10 (non-special scenarios, Figure J-2 through Figure J-11, the curves are spatially separated for about 4 hours and 30 minutes and then become close together as a result of the reduced traffic congestion in the EPZ after this time (discussed in detail in Section 7.3). For Scenarios 11 (Special Event) and 12 (Roadway Impact), the curves do not come together as congestion with the EPZ dictates the 100th percentile ETE and not the mobilization time, as discussed in Section 7-5.

[1] Computed as the difference of the average travel time and the average ideal travel time under free flow condition.

Table J-1. Sample Simulation Model Input

Link Number	Up node	Down node	Vehicles Entering Network on this Link	Directional Preference	Destination Nodes	Destination Capacity
373	322	321	84	S	8285	1,275
					8293	1,700
					8933	1,275
401	334	333	145	SE	8637	1,700
					8630	1,275
					8607	1,700
604	442	443	142	NE	8706	1,275
					8359	1,700
					8103	2,850
790	583	633	180	SE	8637	1,700
936	703	704	14	NE	8706	1,275
1080	922	311	28	S	8933	1,275
1260	1035	657	28	SW	8285	1,275
					8293	1,700
1451	1189	334	187	SE	8637	1,700
					8630	1,275
					8607	1,700

Table J-2. Selected Model Outputs for the Evacuation of the Entire EPZ (Region R03)

Scenario	1	2	3	4	5	6	7	8	9	10	11	12
Network-Wide Average Travel Time (Min/Veh-Mi)	2.8	3.3	3.3	3.9	3.1	2.7	3.3	3.2	3.7	3.1	4.0	3.6
Network-Wide Average Delay Time (Min/Veh-Mi)	1.7	2.2	2.2	2.8	1.9	1.5	2.1	2.1	2.6	1.9	2.9	2.5
Network-Wide Average Speed (mph)	21.6	18.1	18.0	15.5	19.7	22.7	18.4	18.5	16.1	19.6	15.0	16.7
Total Vehicles Exiting Network	38,635	38,731	40,192	40,295	35,451	37,085	37,195	40,246	40,387	36,711	43,414	38,648

Table J-3. Average Speed (mph) and Travel Time (min) for Major Evacuation Routes (Region R03, Scenario 1)

		Elapsed Time (hours)											
		1		2		3		4		5		6	
Evacuation Route	Length (miles)	Speed (mph)	Travel Time (min)	Speed	Travel Time	Speed	Travel Time	Speed	Travel Time	Speed	Travel Time	Speed	Travel Time
US 377 NB	8.6	28.8	18.0	12.3	42.2	12.9	40.2	24.2	21.5	57.9	9.0	46.8	11.1
US 377 SB	15.2	54.7	16.7	41.7	21.8	25.8	35.3	41.2	22.1	61.4	14.8	61.5	14.8
US 67 NB	16.9	34.2	29.7	47.8	21.2	60.4	16.8	60.3	16.8	66.8	15.2	66.8	15.2
US 67 SB	10.4	57.8	10.8	58.5	10.7	58.8	10.6	60.2	10.4	62.3	10.0	62.3	10.0
TX 144 SB	9.3	62.4	9.0	60.1	9.3	61.6	9.1	61.8	9.0	64.9	8.6	64.9	8.6
FM 56 NB	8.7	63.1	8.3	65.3	8.0	66.1	7.9	66.9	7.8	68.2	7.6	68.2	7.6
FM 51 SB	7.9	67.2	7.1	67.2	7.1	69.5	6.8	69.5	6.8	69.5	6.8	69.5	6.8
FM 4 SB	7.5	60.5	7.5	59.9	7.5	61.1	7.4	62.0	7.3	63.5	7.1	63.5	7.1
FM 205 WB	7.3	53.5	8.1	54.2	8.0	54.2	8.0	55.4	7.8	55.4	7.8	55.4	7.8

Table J-4. Simulation Model Outputs at Network Exit Links for Region R03, Scenario 1

Network Exit Link	Up Node	Down Node	Elapsed Time (hours)					
			1	2	3	4	5	6
			Cumulative Vehicles Discharged by the Indicated Time					
			Cumulative Percent of Vehicles Discharged by the Indicated Time					
202	213	214	315	1,009	1,575	1,960	2,124	2,125
			5%	6%	6%	6%	6%	5%
286	264	1007	803	2,067	3,539	4,988	5,407	5,407
			12%	11%	13%	14%	14%	12%
294	268	276	185	470	626	714	764	764
			3%	3%	2%	2%	2%	3%
314	282	283	44	215	334	393	417	417
			1%	1%	1%	1%	1%	1%
315	284	285	396	1,040	1,421	1,504	1,512	1,513
			6%	6%	5%	4%	4%	6%
853	629	630	122	356	447	458	461	461
			2%	2%	2%	1%	1%	2%
860	637	638	381	1,192	1,482	1,541	1,550	1,550
			6%	7%	5%	4%	4%	6%
898	673	674	1	15	34	41	42	42
			0%	0%	0%	0%	0%	0%
1090	932	933	288	959	1,269	1,357	1,372	1,372
			4%	5%	5%	4%	4%	4%
1236	1016	253	186	622	909	1,028	1,060	1,060
			3%	3%	3%	3%	3%	3%
1344	1093	293	129	403	493	504	507	507
			2%	2%	2%	1%	1%	2%
1369	1111	1108	983	2,587	3,535	3,698	3,718	3,718
			15%	14%	13%	11%	10%	15%
1385	1126	1140	508	1,315	2,079	2,843	3,443	3,445
			8%	7%	7%	8%	9%	8%
1554	1279	1280	199	848	1,458	1,864	1,907	1,908
			3%	5%	5%	5%	5%	3%
1646	1352	1356	1,161	2,937	4,781	6,704	7,744	7,749
			18%	16%	17%	19%	20%	18%
1649	1353	1359	0	0	0	188	485	485
			0%	0%	0%	1%	1%	0%
1653	1357	1358	757	2,309	3,843	5,261	6,107	6,113
			12%	13%	14%	15%	16%	12%

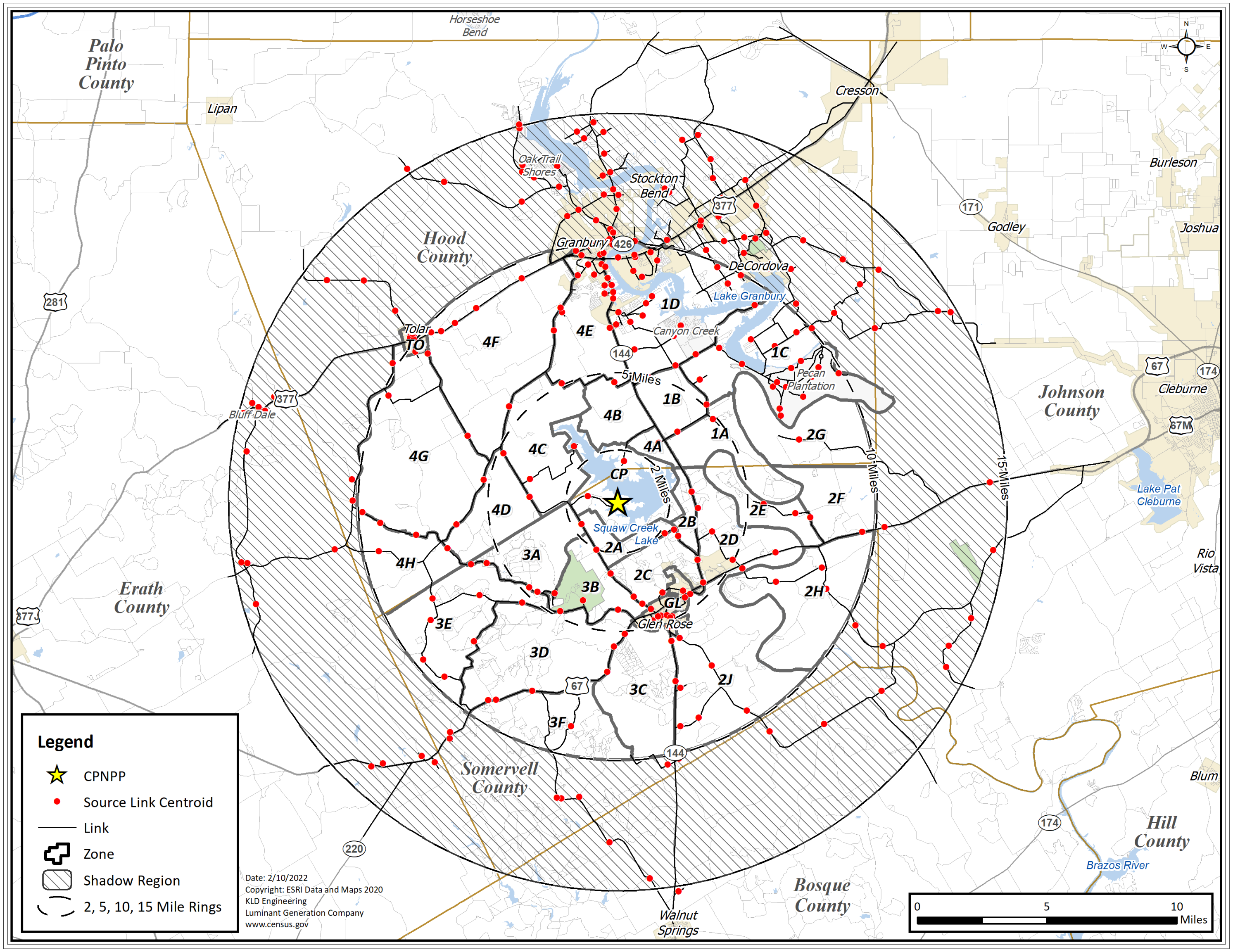


Figure J-1. Network Sources/Origins

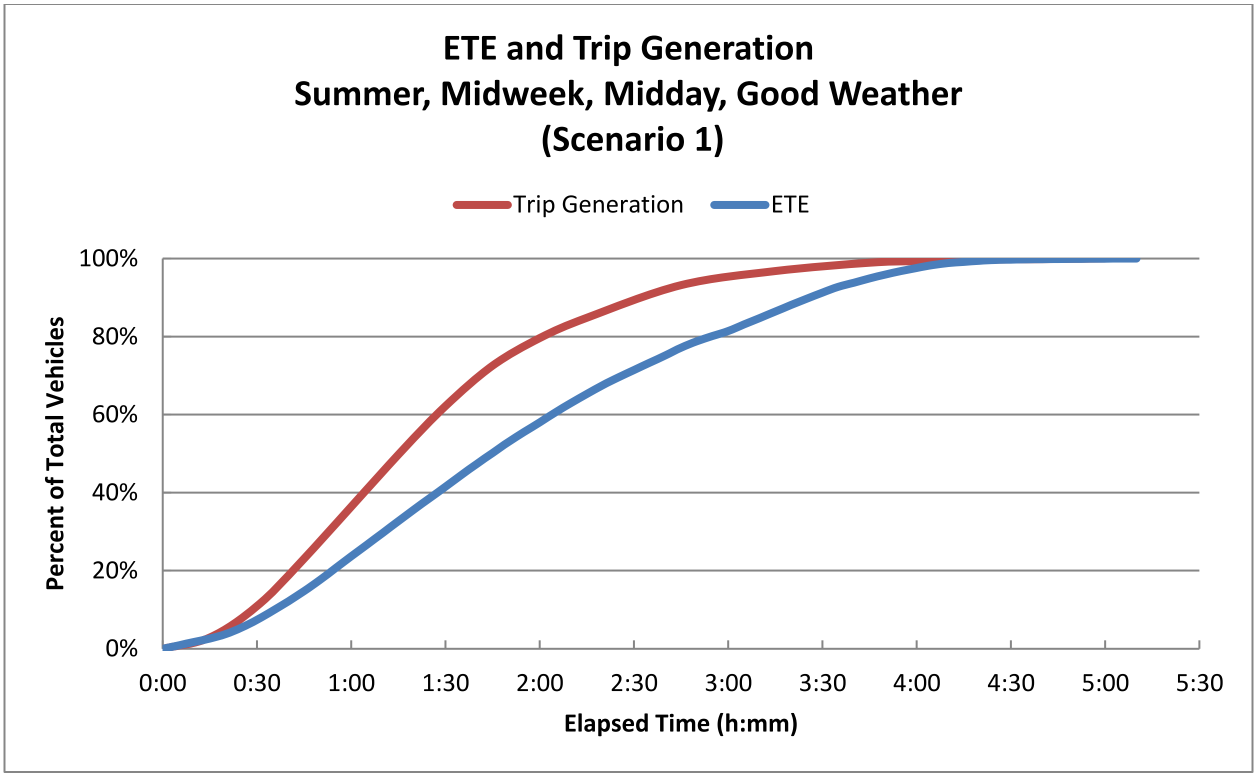


Figure J-2. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather (Scenario 1)

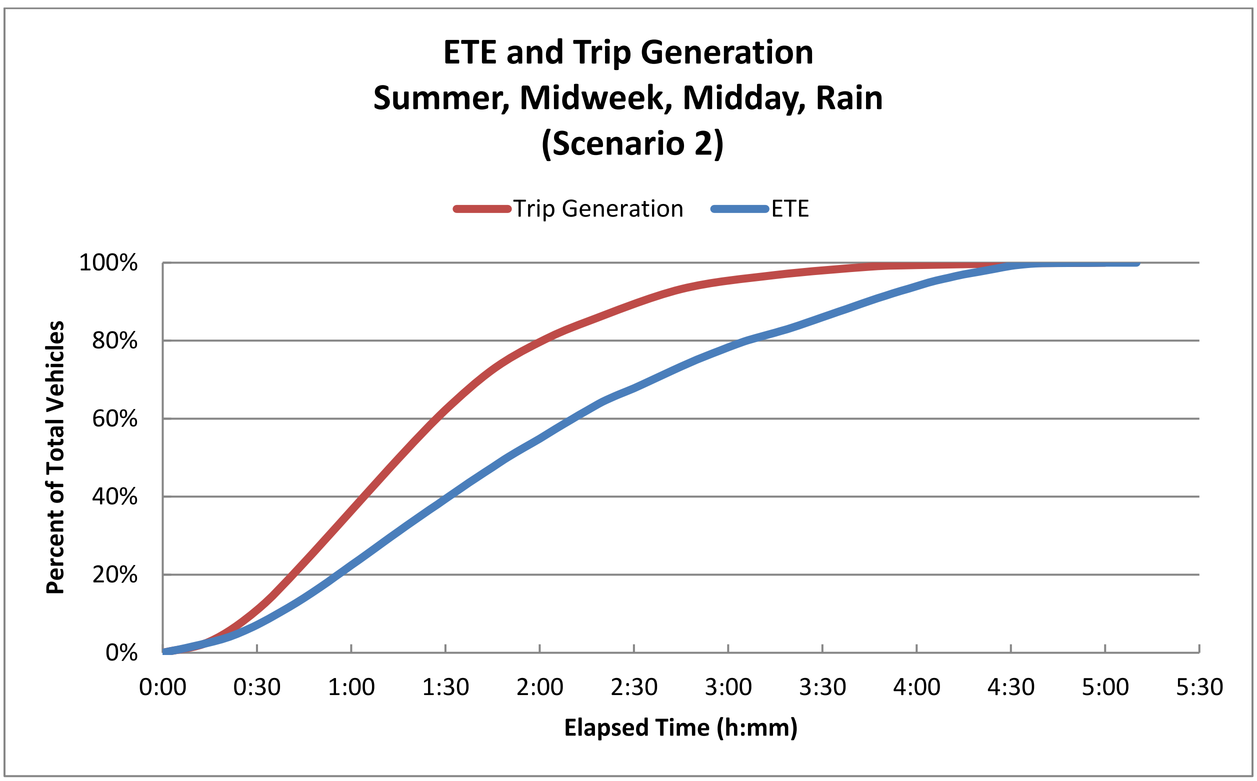


Figure J-3. ETE and Trip Generation: Summer, Midweek, Midday, Rain (Scenario 2)

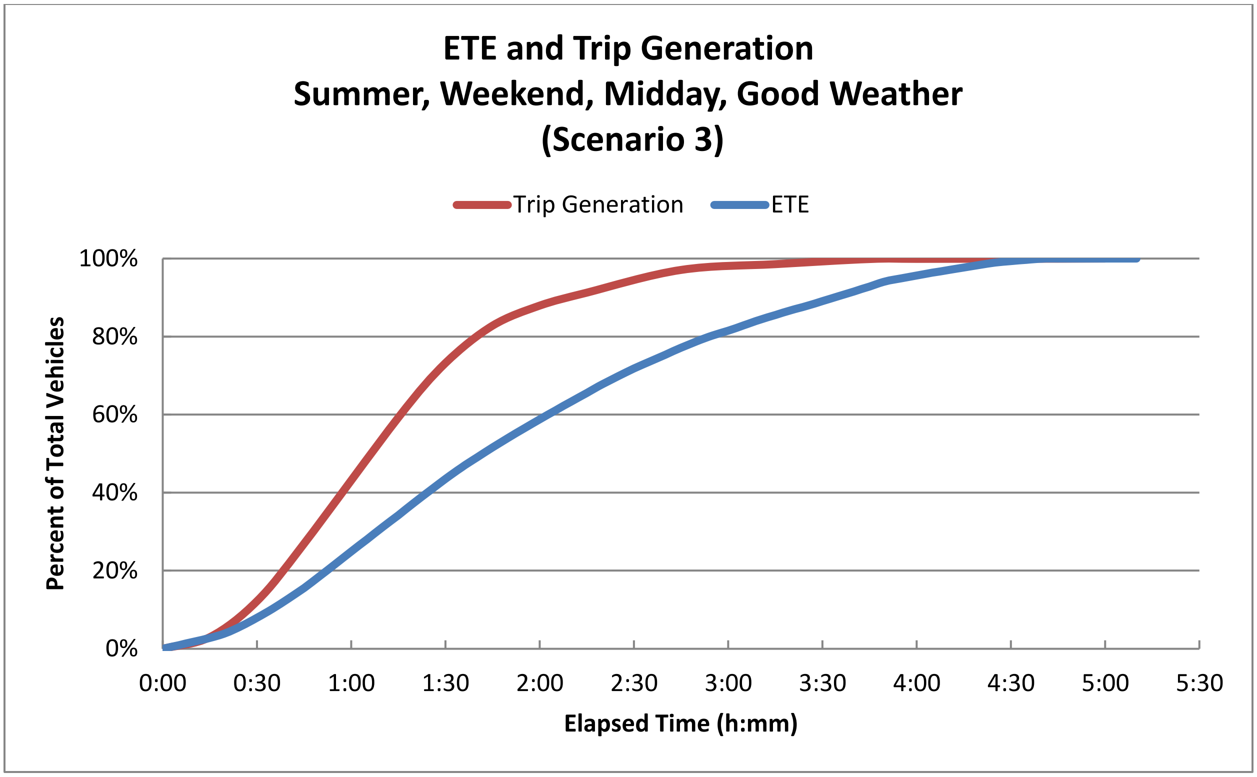


Figure J-4. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather (Scenario 3)

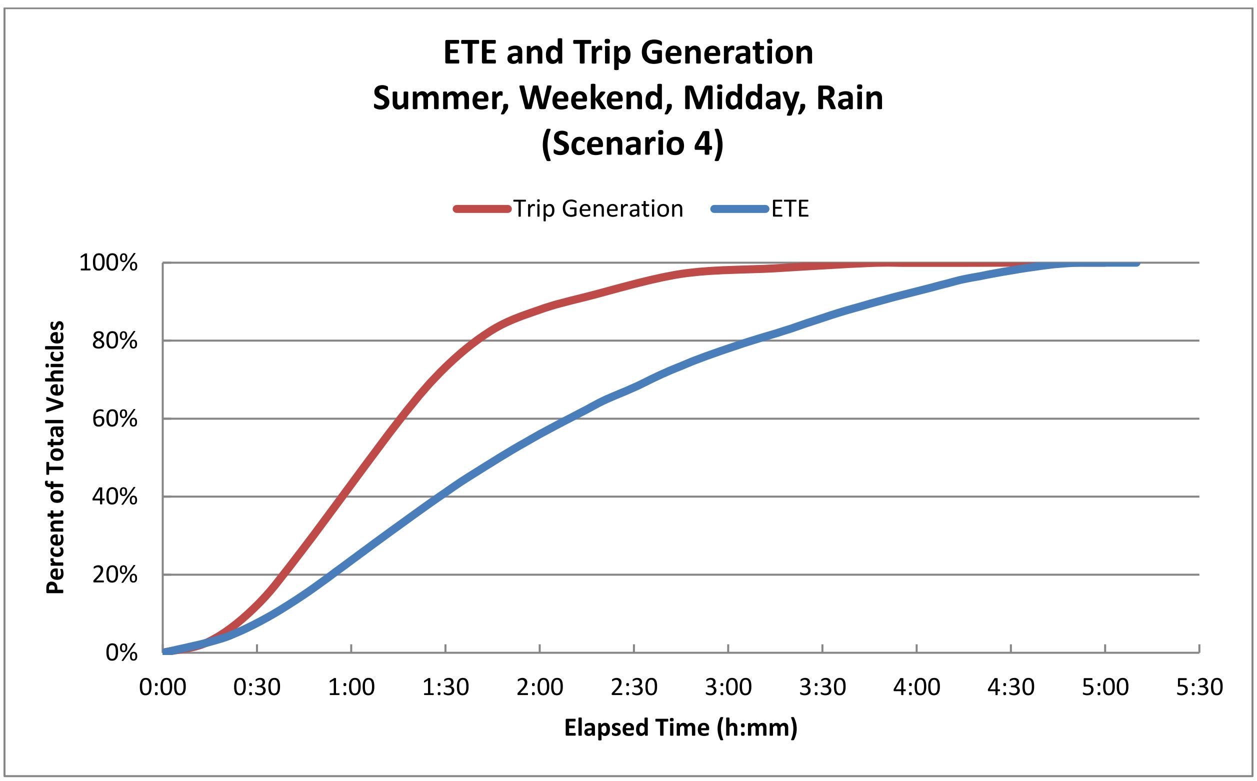


Figure J-5. ETE and Trip Generation: Summer, Weekend, Midday, Rain (Scenario 4)

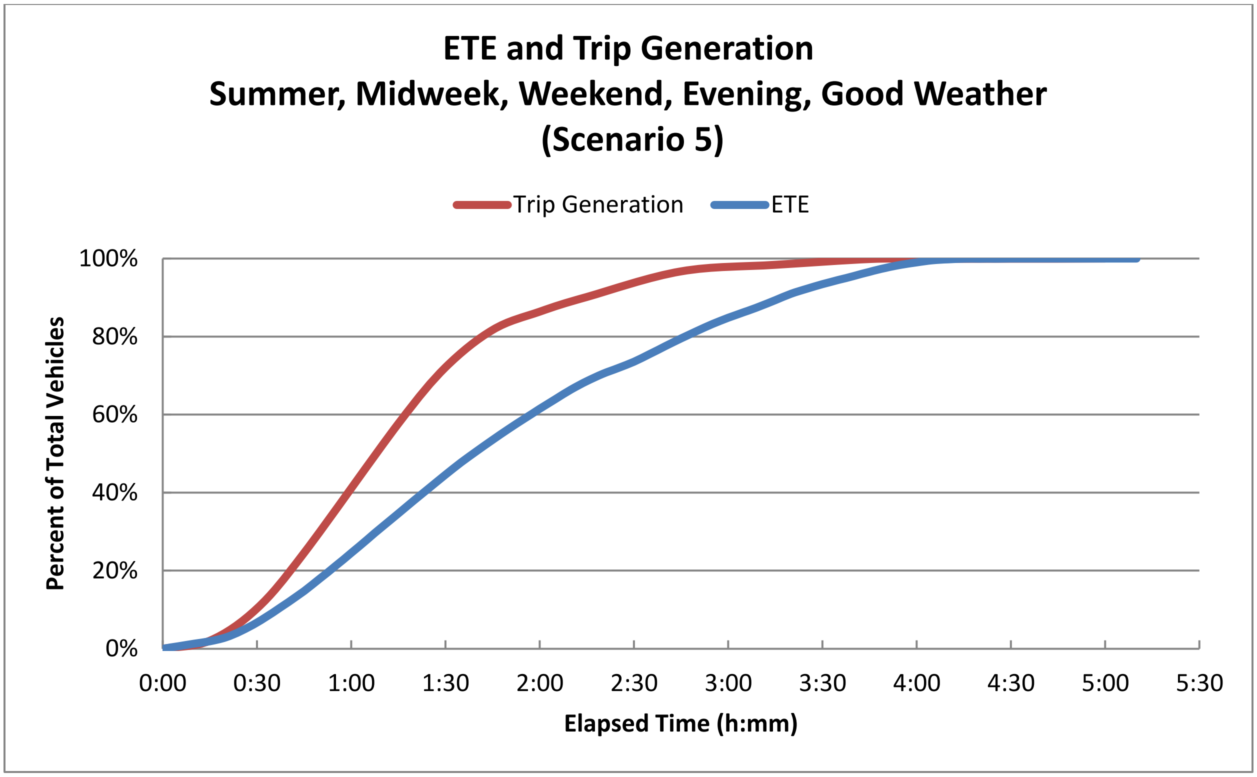


Figure J-6. ETE and Trip Generation: Summer, Midweek, Weekend, Evening, Good Weather (Scenario 5)

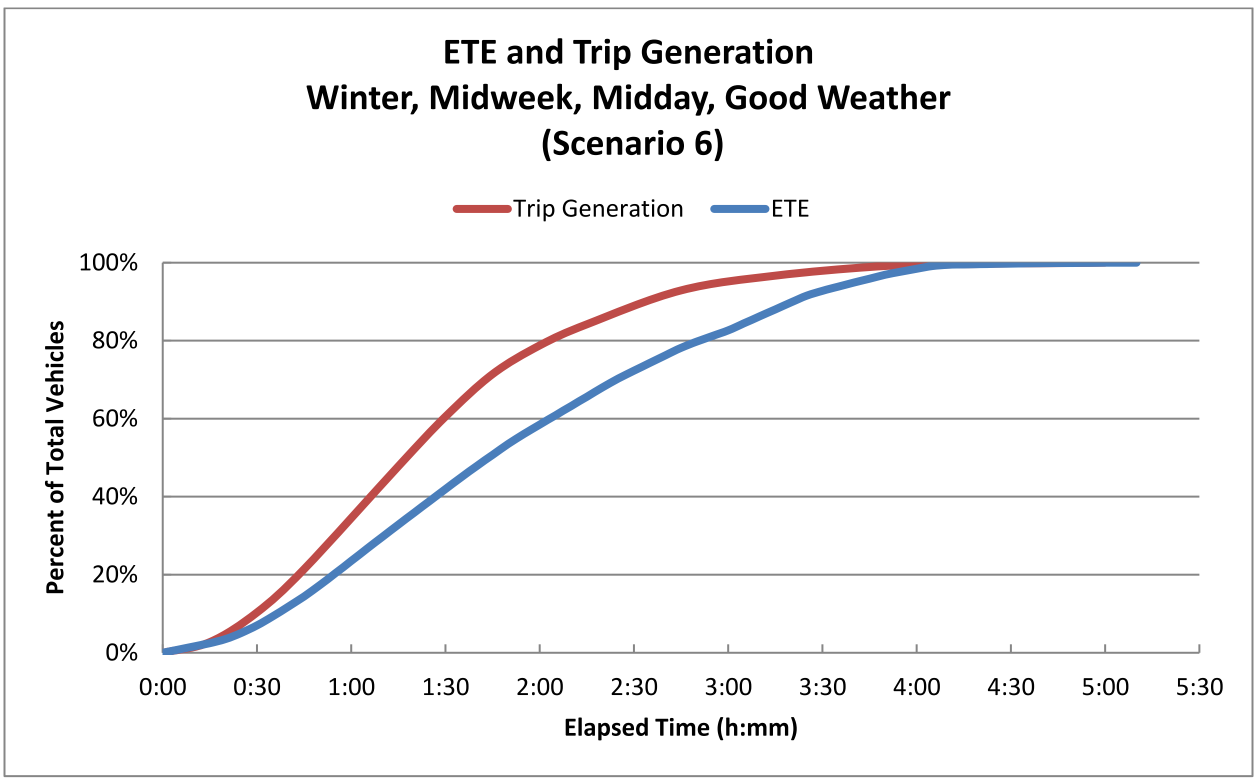


Figure J-7. ETE and Trip Generation: Winter, Midweek, Midday, Good Weather (Scenario 6)

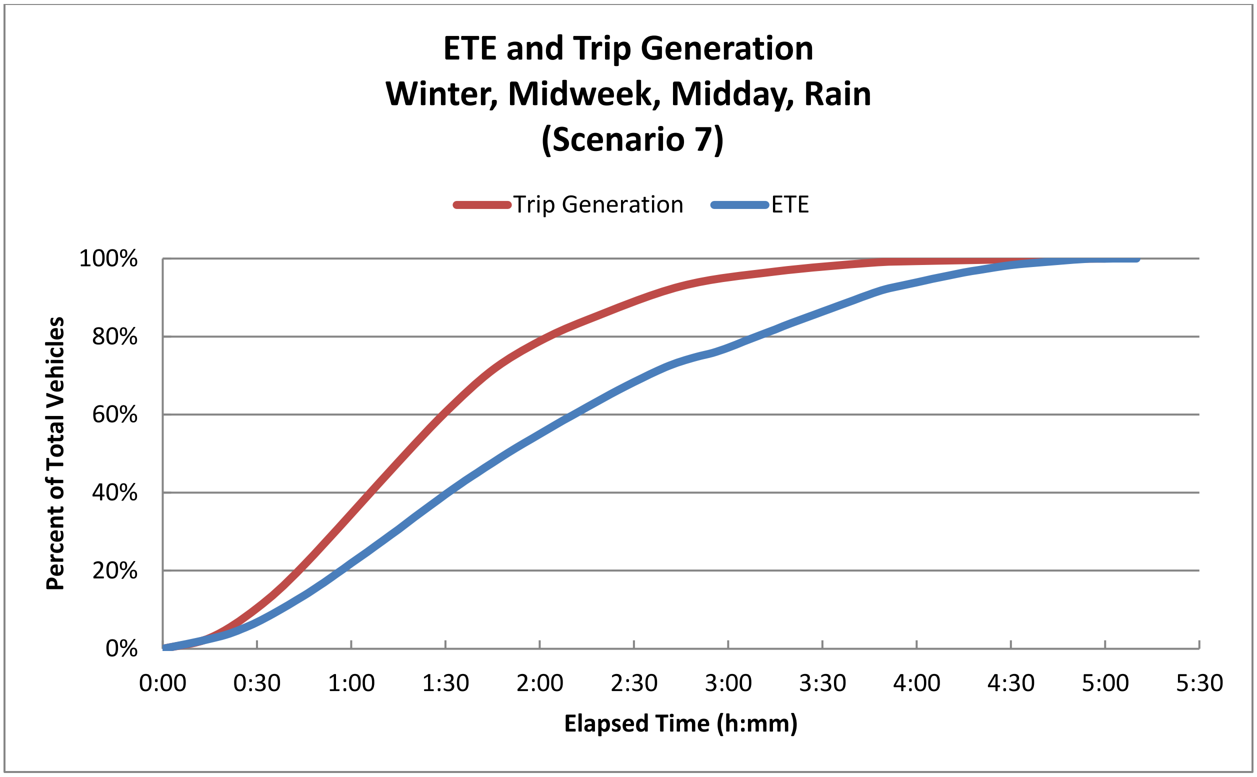


Figure J-8. ETE and Trip Generation: Winter, Midweek, Midday, Rain (Scenario 7)

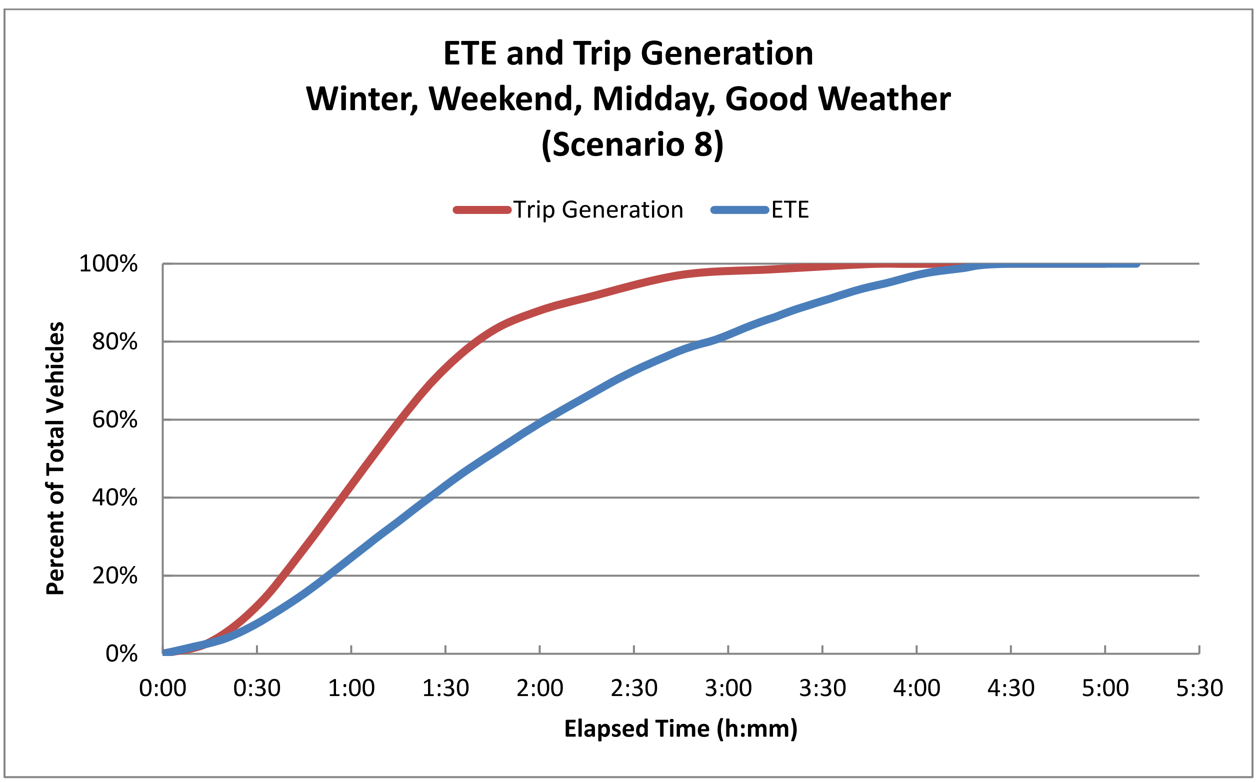


Figure J-9. ETE and Trip Generation: Winter, Weekend, Midday, Good Weather (Scenario 8)

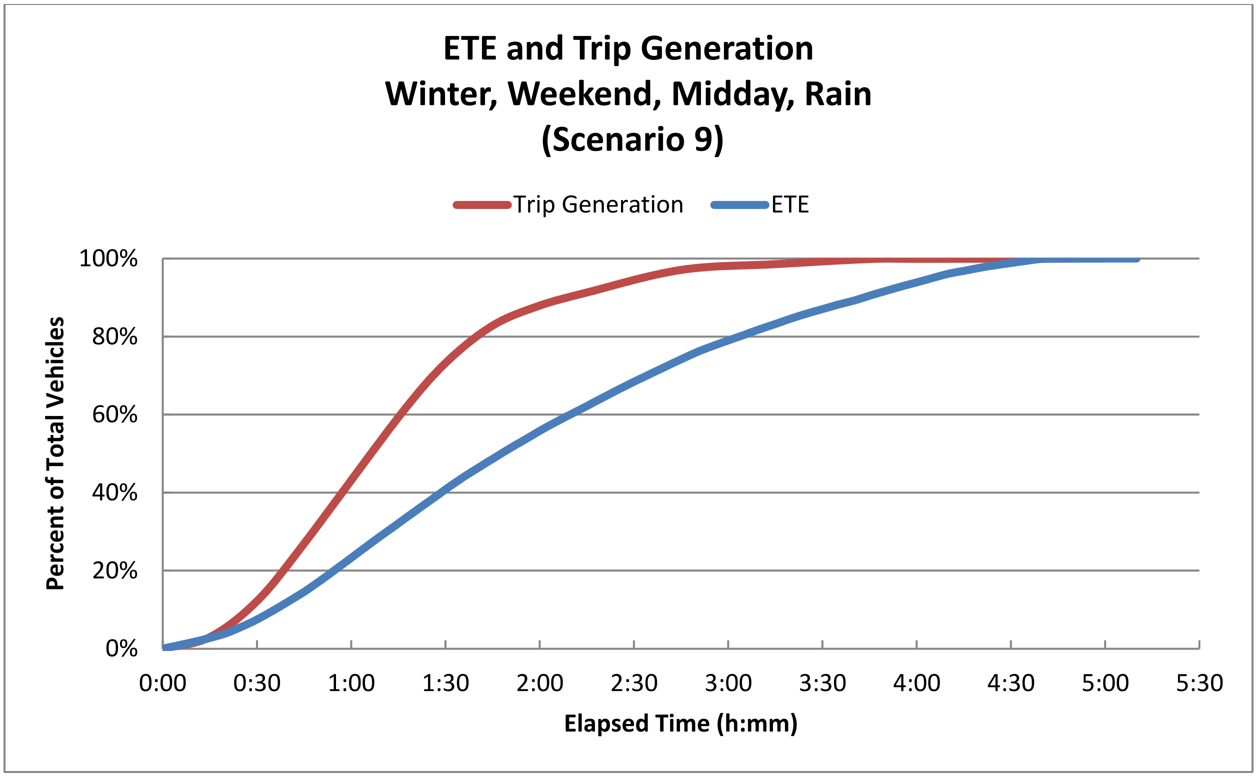


Figure J-10. ETE and Trip Generation: Winter, Weekend, Midday, Rain (Scenario 9)

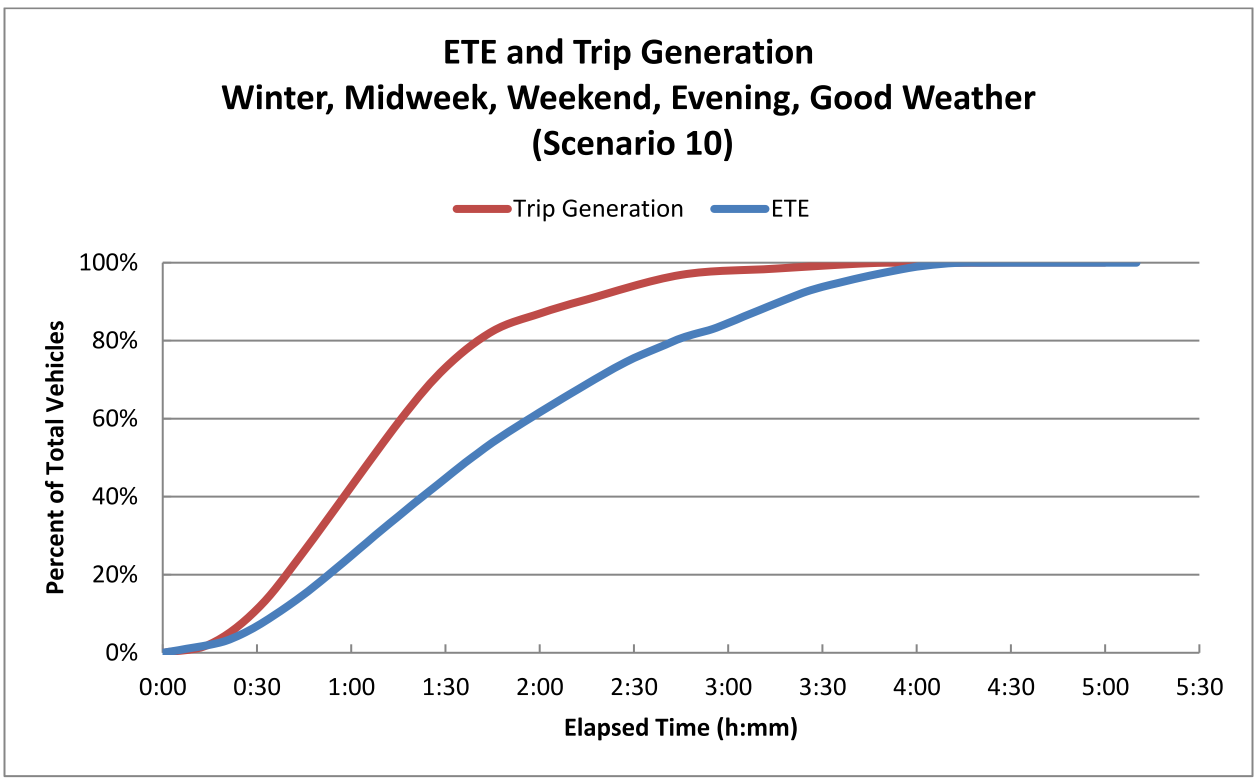


Figure J-11. ETE and Trip Generation: Winter, Midweek, Weekend, Evening, Good Weather (Scenario 10)

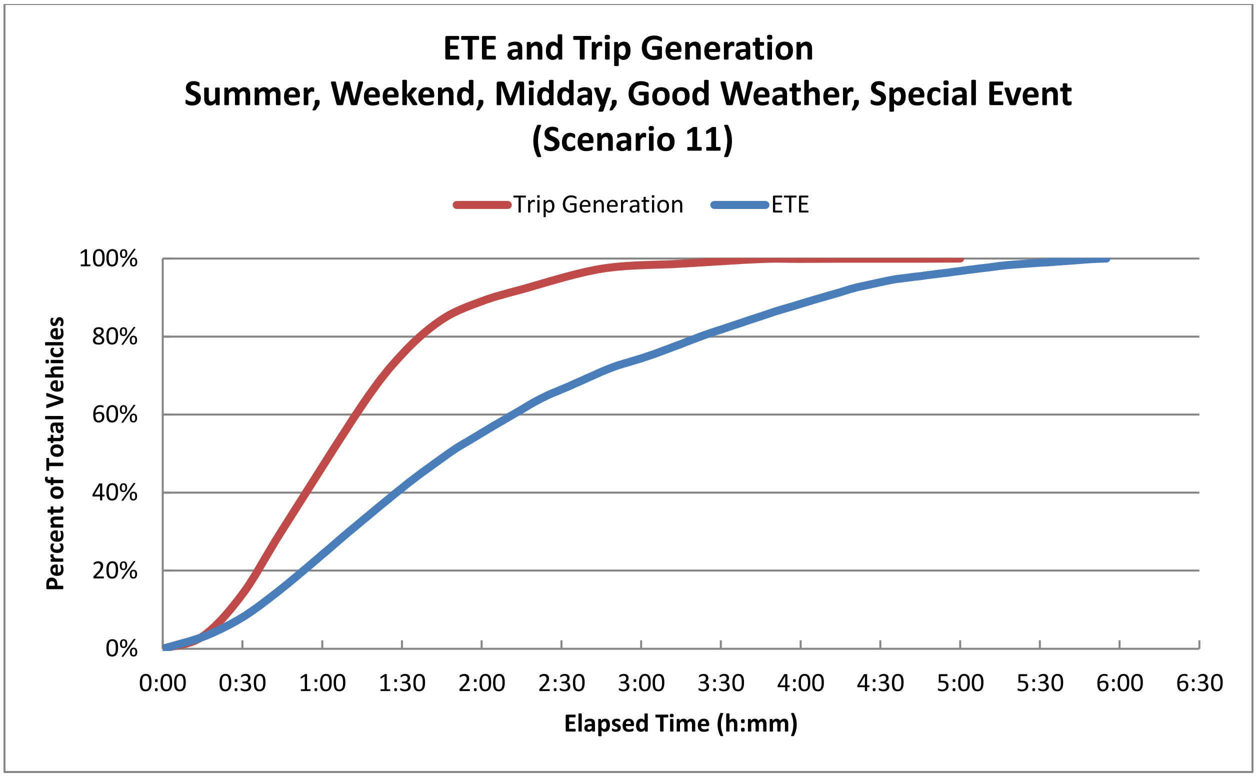


Figure J-12. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather, Special Event (Scenario 11)

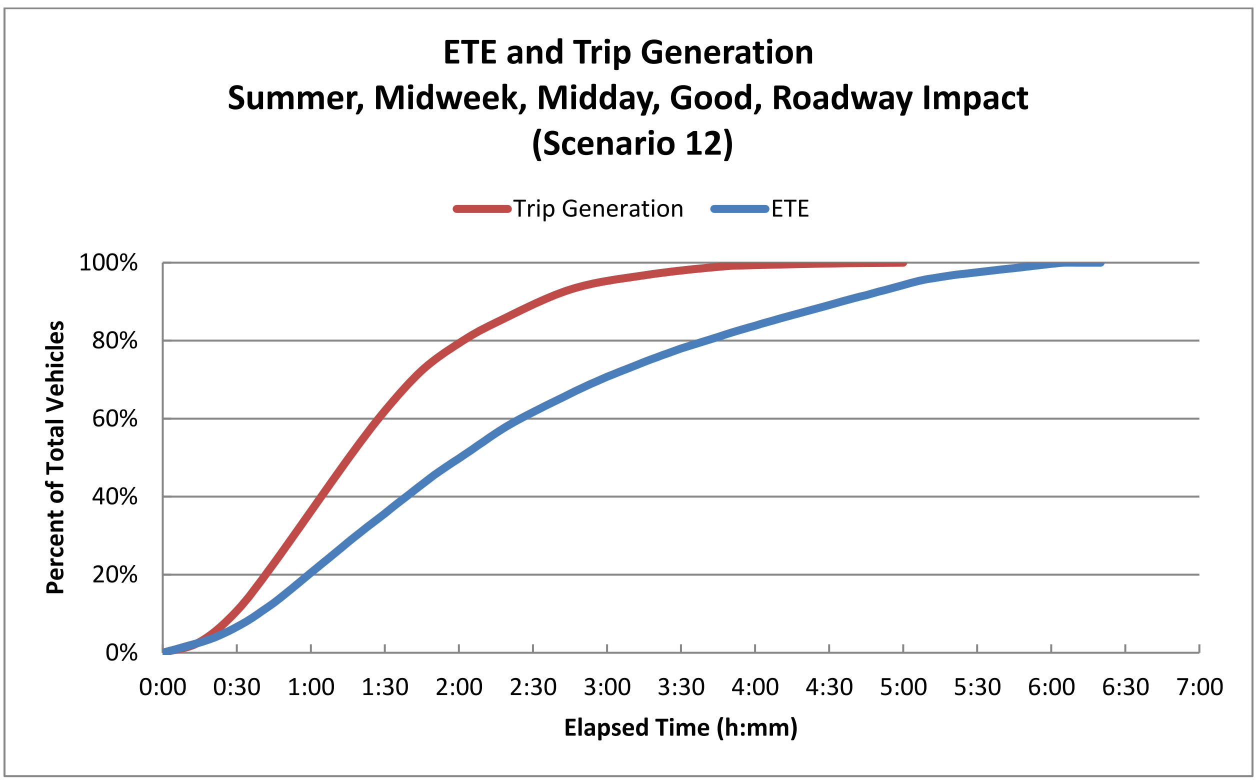


Figure J-13. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather, Roadway Impact (Scenario 12)

APPENDIX K

Evacuation Roadway Network

K. EVACUATION ROADWAY NETWORK

As discussed in Section 1.3, a link-node analysis network was constructed to model the roadway network within the study area. Figure K-1 provides an overview of the link-node analysis network. The figure has been divided up into 58 more detailed figures (Figure K-2 through Figure K-59) which show each of the links and nodes in the network.

The analysis network was calibrated using the observations made during the field surveys conducted in March 2021.

Table K-1 summarizes the number of nodes by the type of control (stop sign, yield sign, pre-timed signal, actuated signal, traffic and access control point [TCP/ACP], uncontrolled).

Table K-1. Summary of Nodes by the Type of Control

Control Type	Number of Nodes
Uncontrolled	922
Pretimed	0
Actuated	25
Stop	148
TCP/ACP	38
Yield	37
Total:	**1,170**

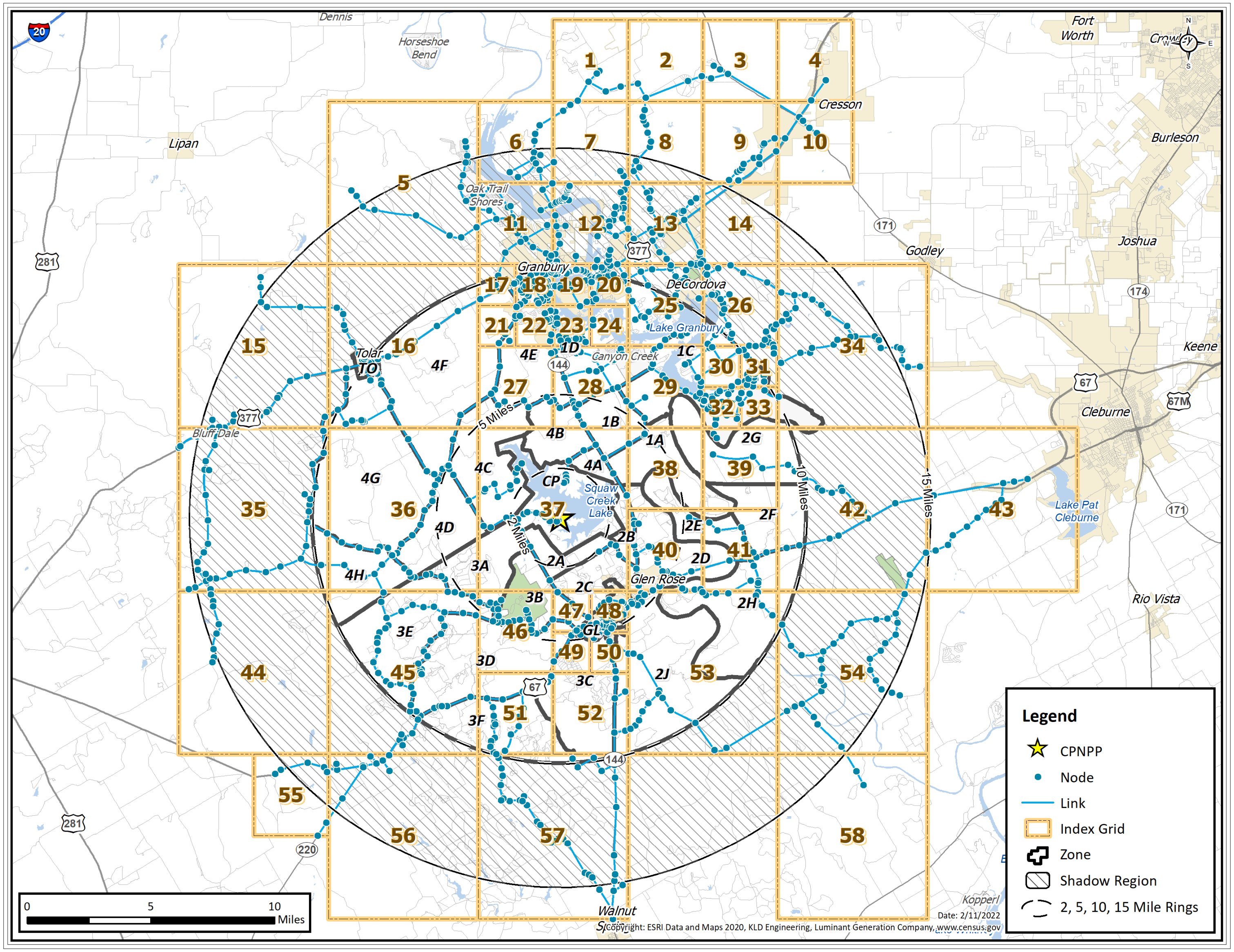


Figure K-1. CPNPP Link-Node Analysis Network

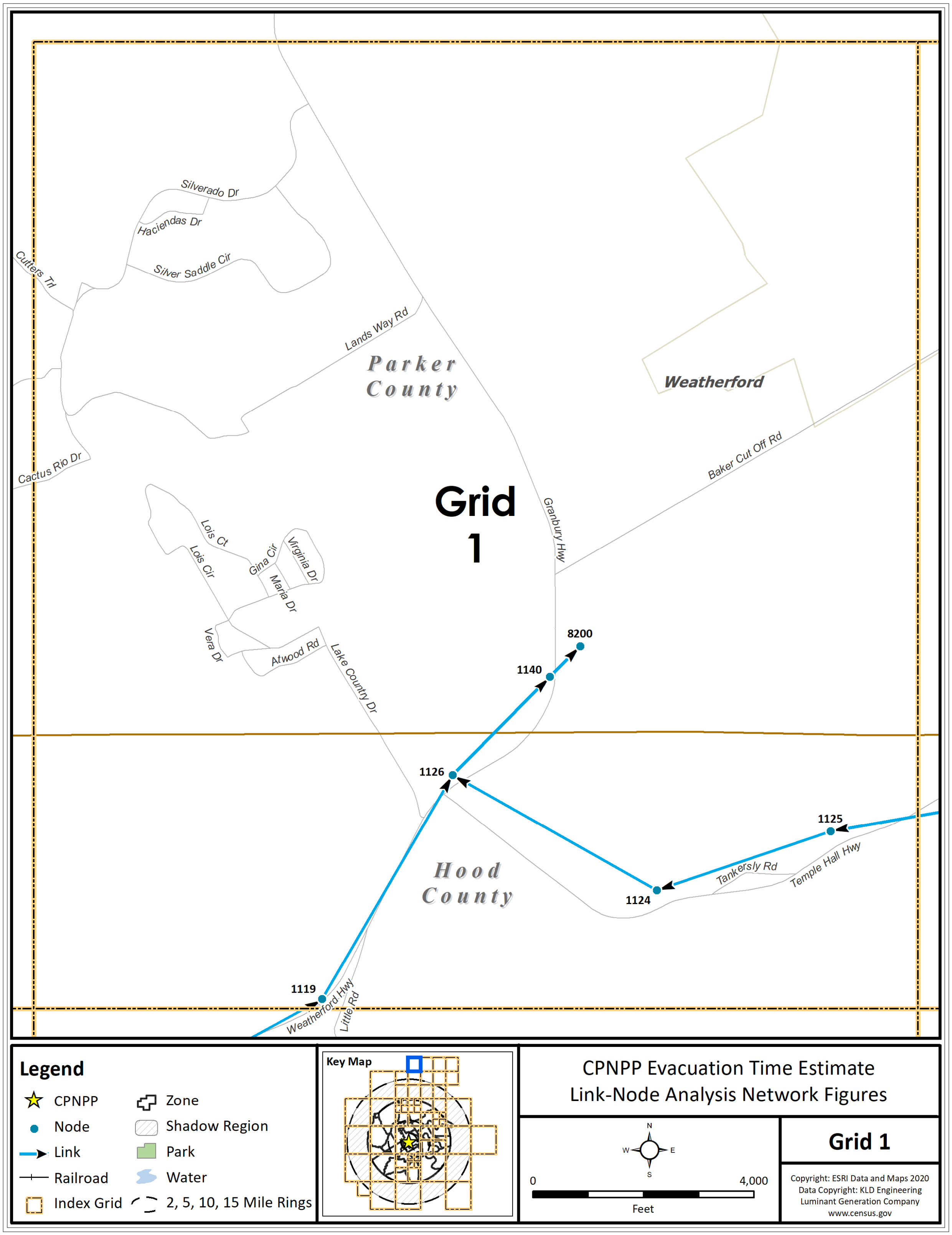


Figure K-2. Link-Node Analysis Network – Grid 1

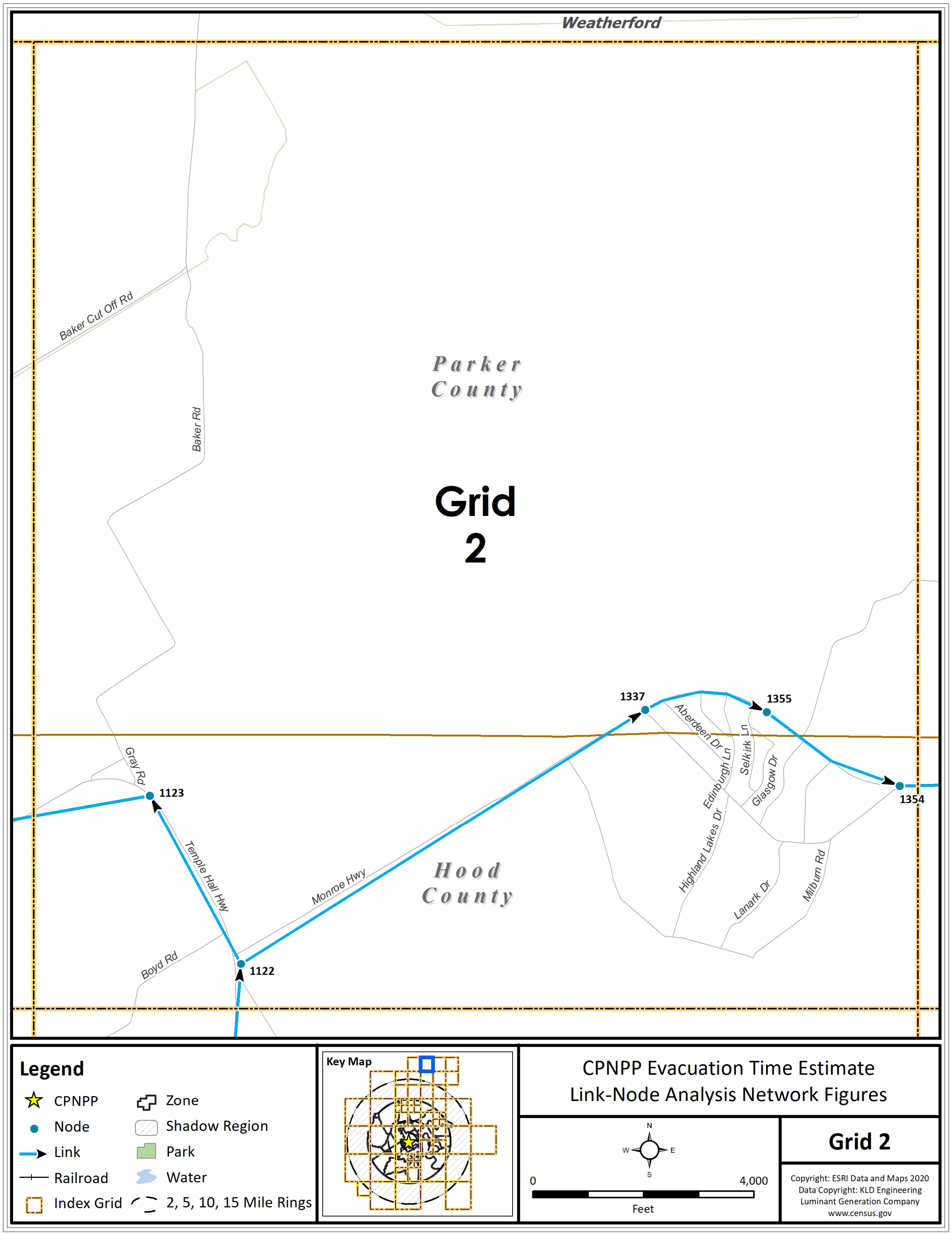


Figure K-3. Link-Node Analysis Network – Grid 2

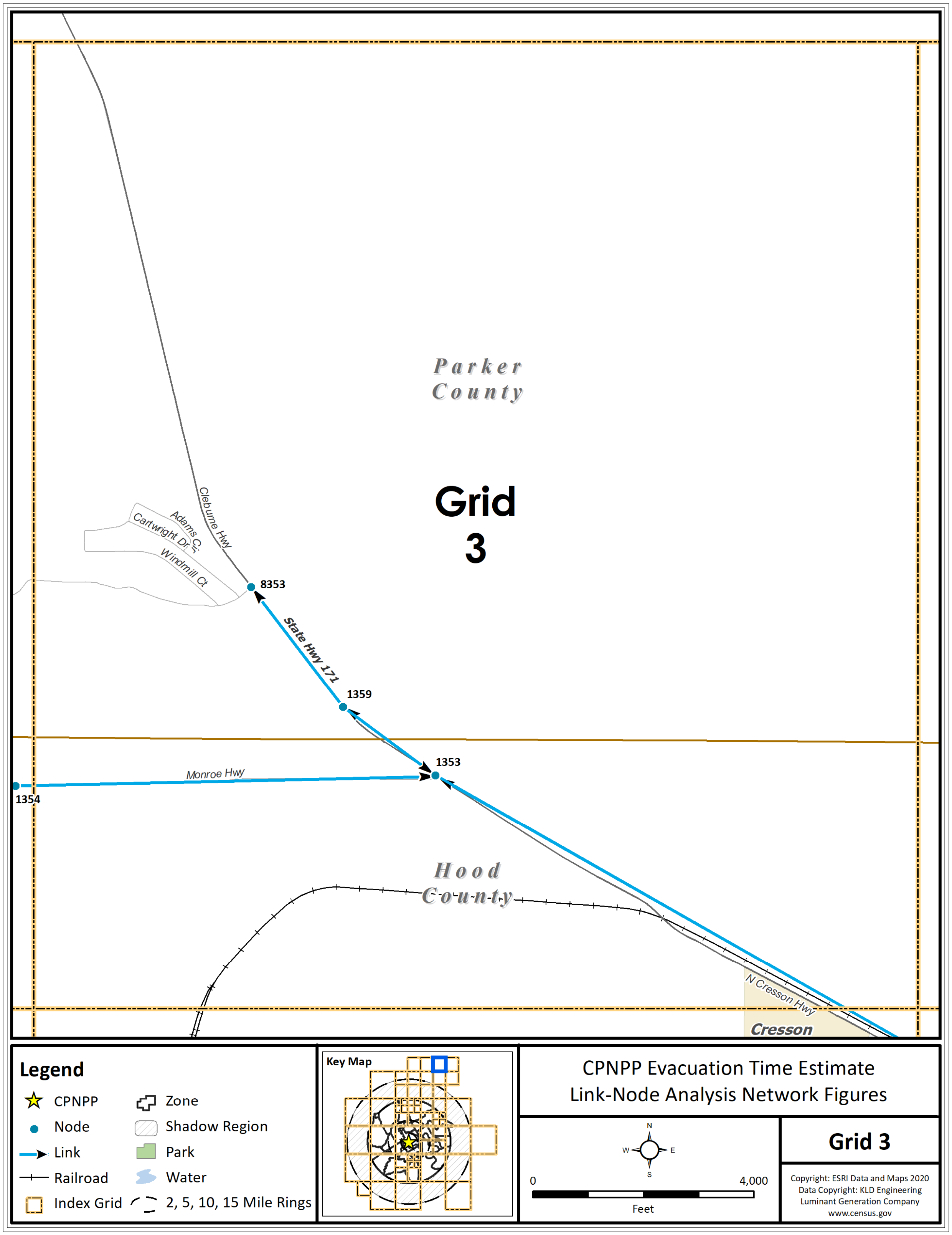


Figure K-4. Link-Node Analysis Network – Grid 3

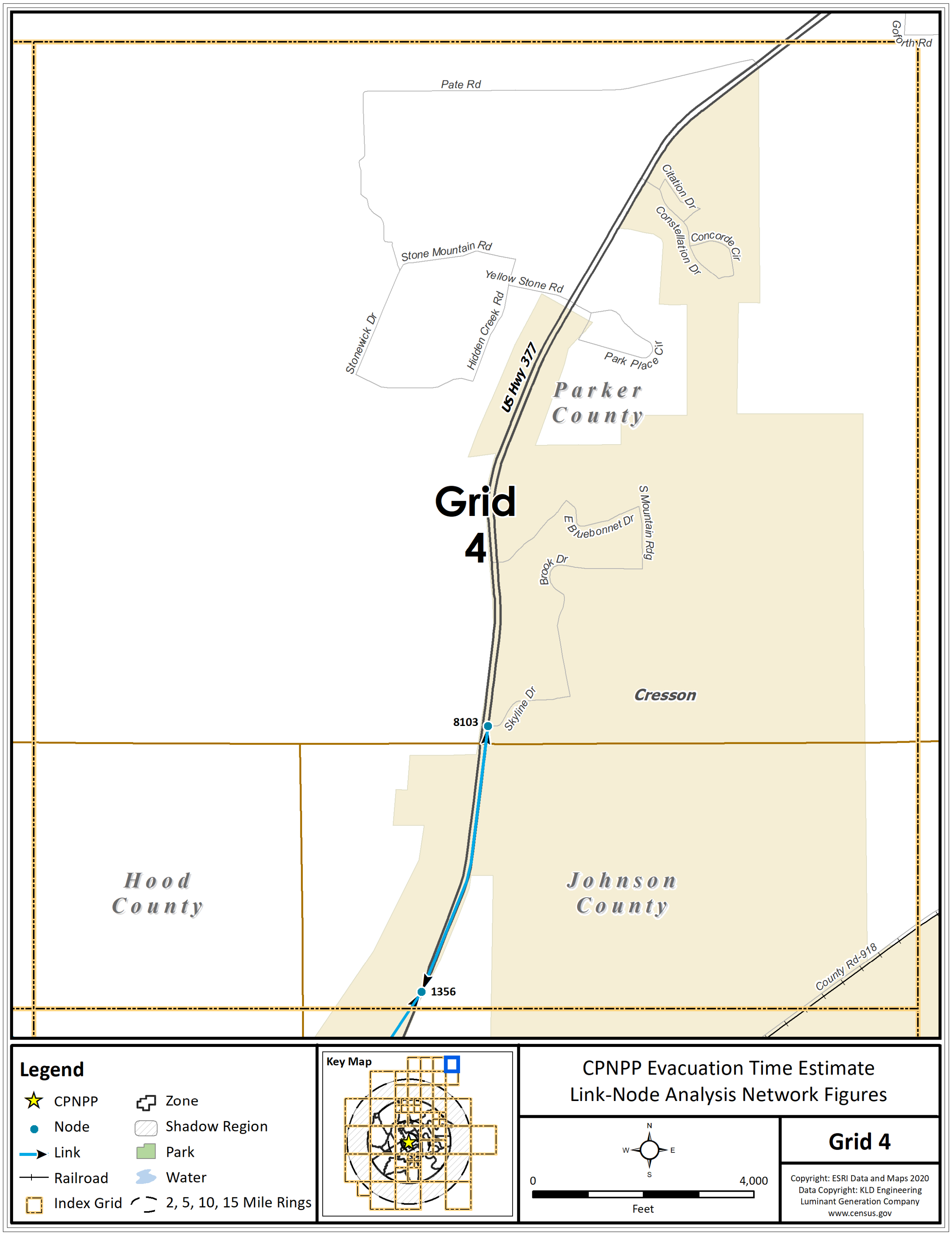


Figure K-5. Link-Node Analysis Network – Grid 4

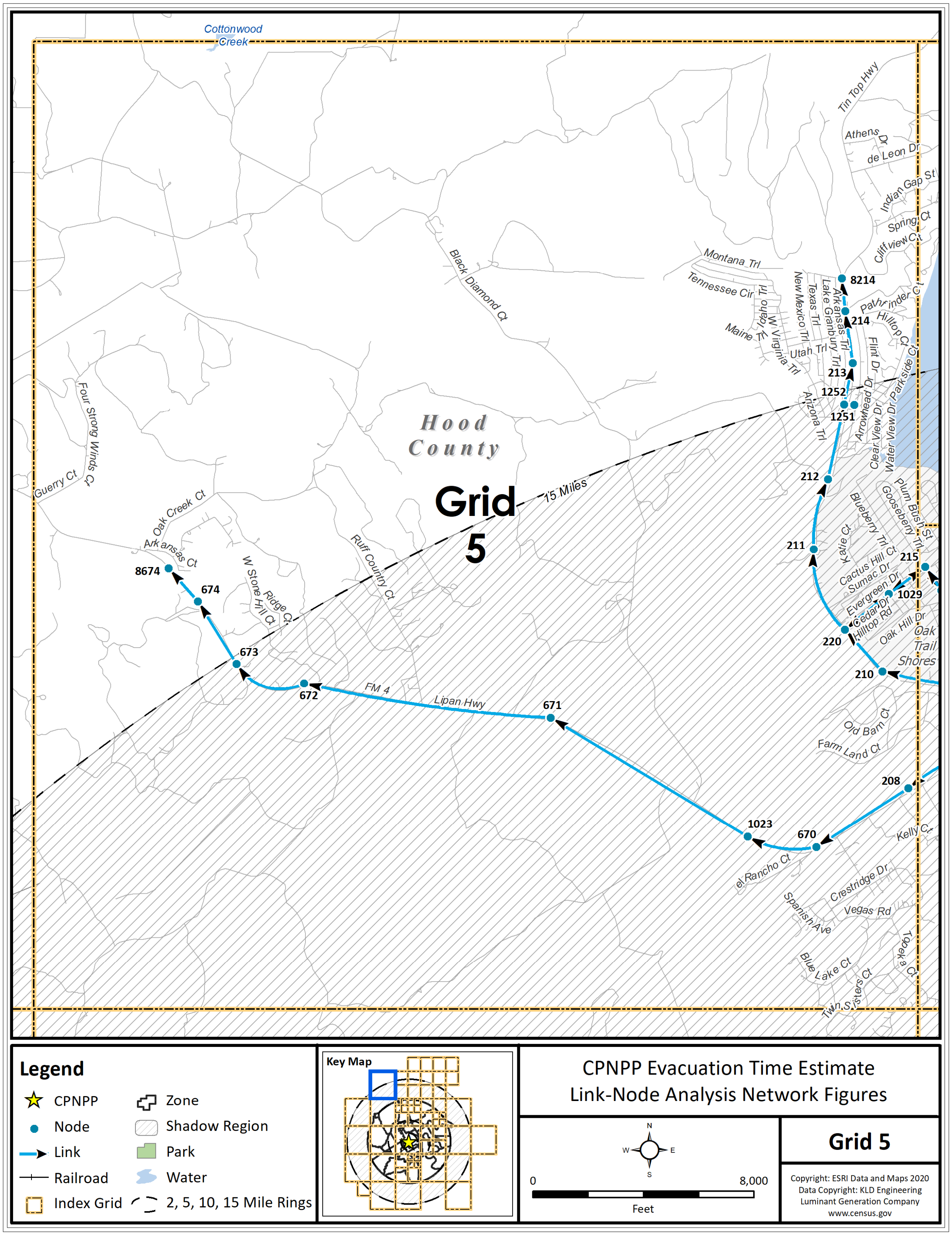


Figure K-6. Link-Node Analysis Network – Grid 5

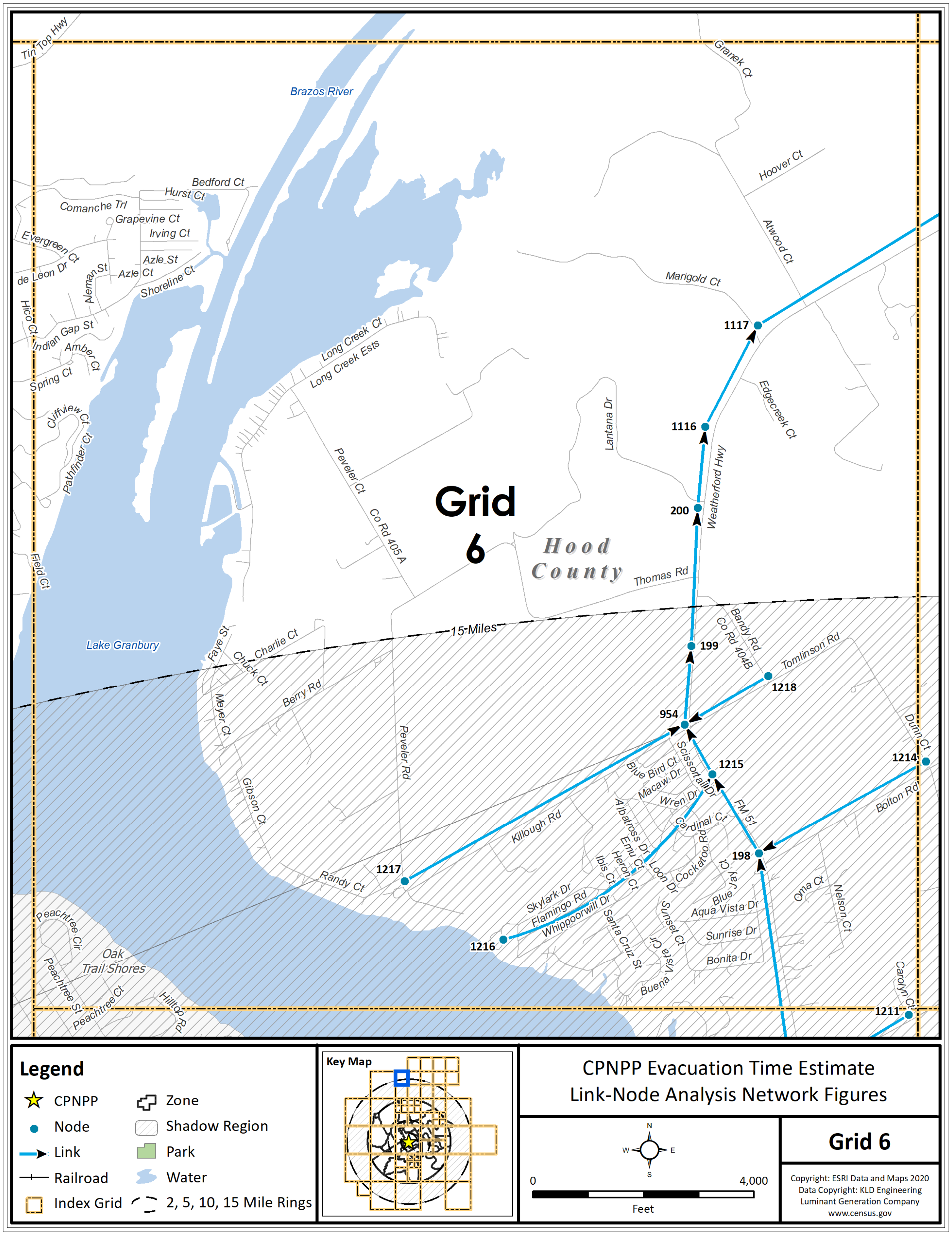


Figure K-7. Link-Node Analysis Network – Grid 6

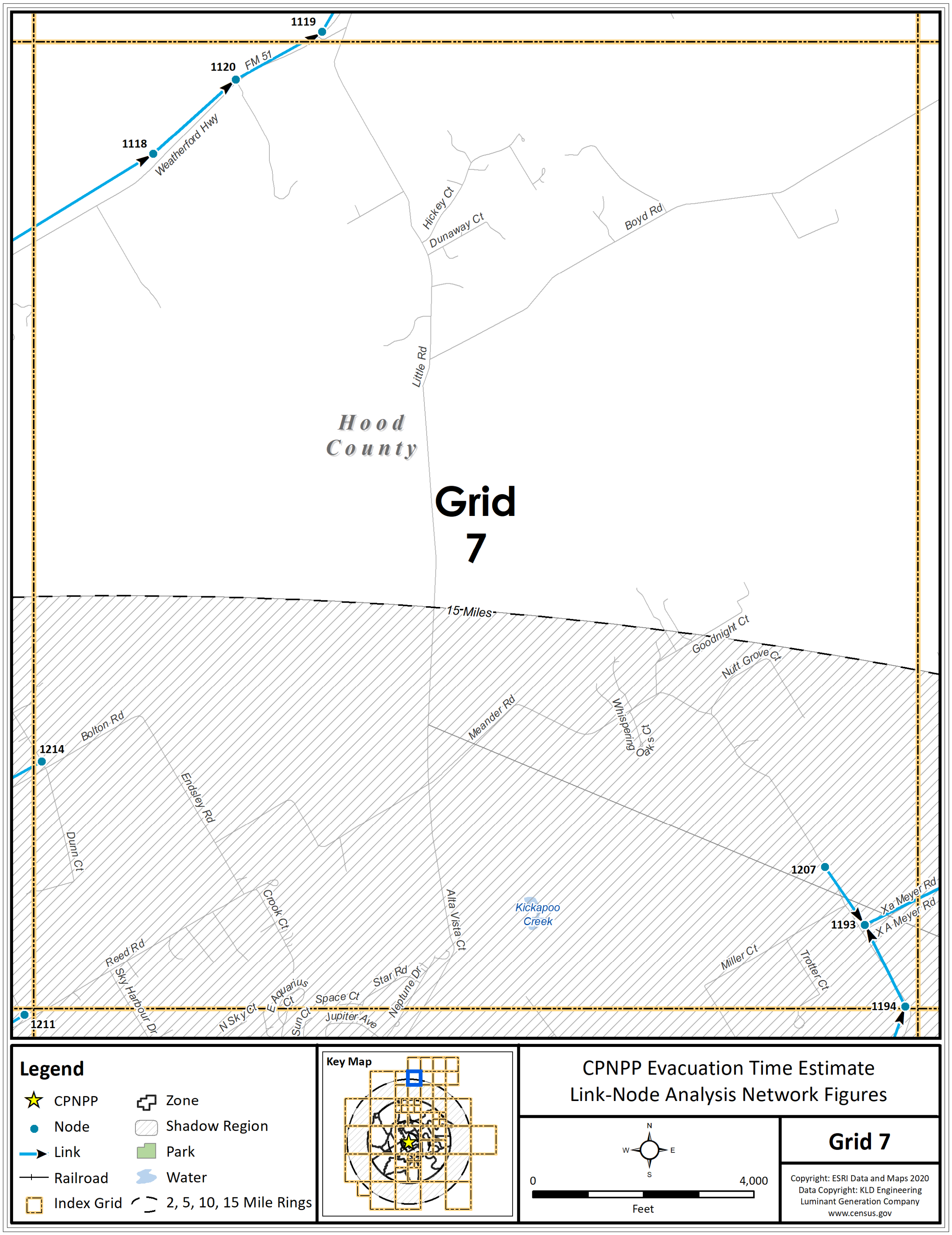


Figure K-8. Link-Node Analysis Network – Grid 7

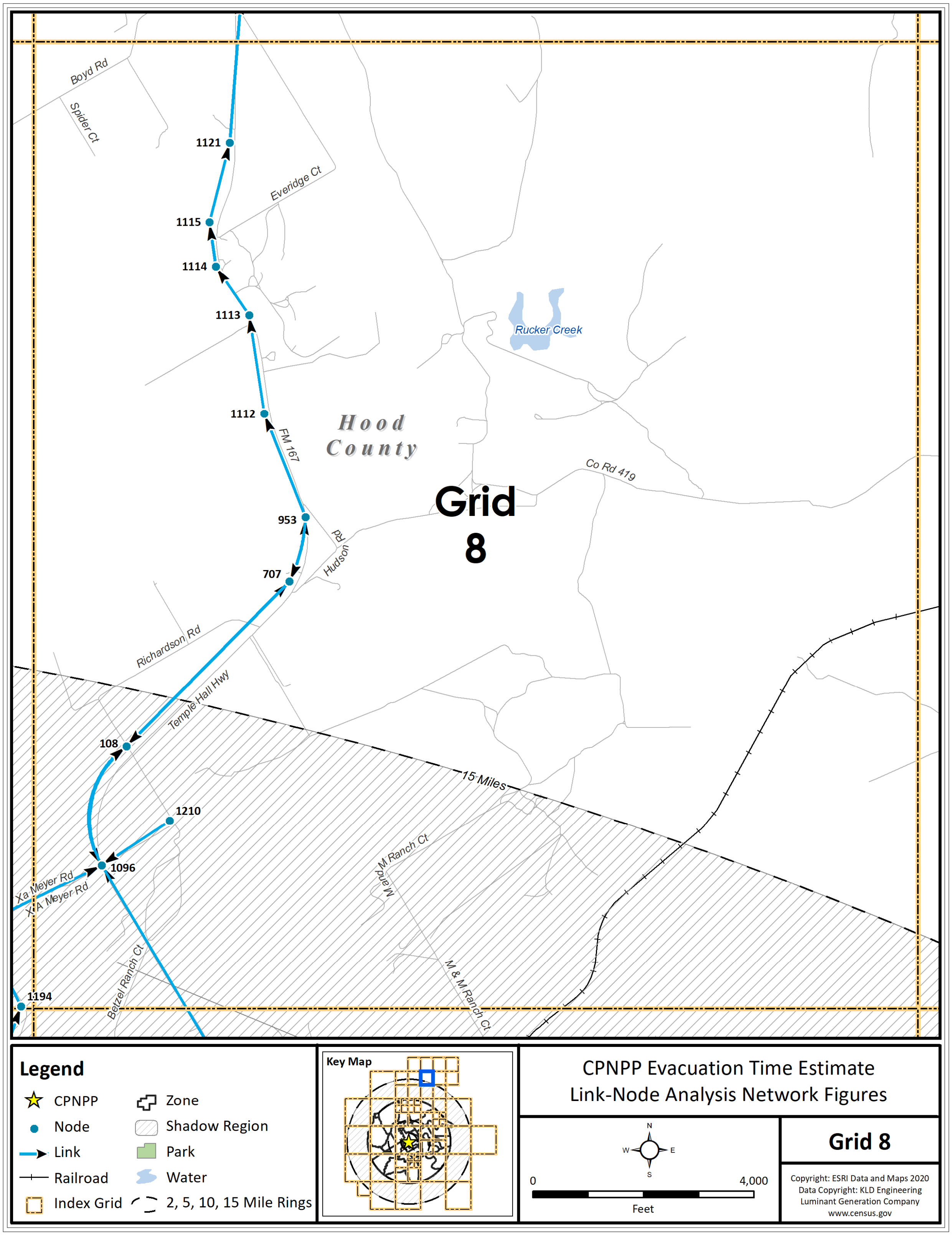


Figure K-9. Link-Node Analysis Network – Grid 8

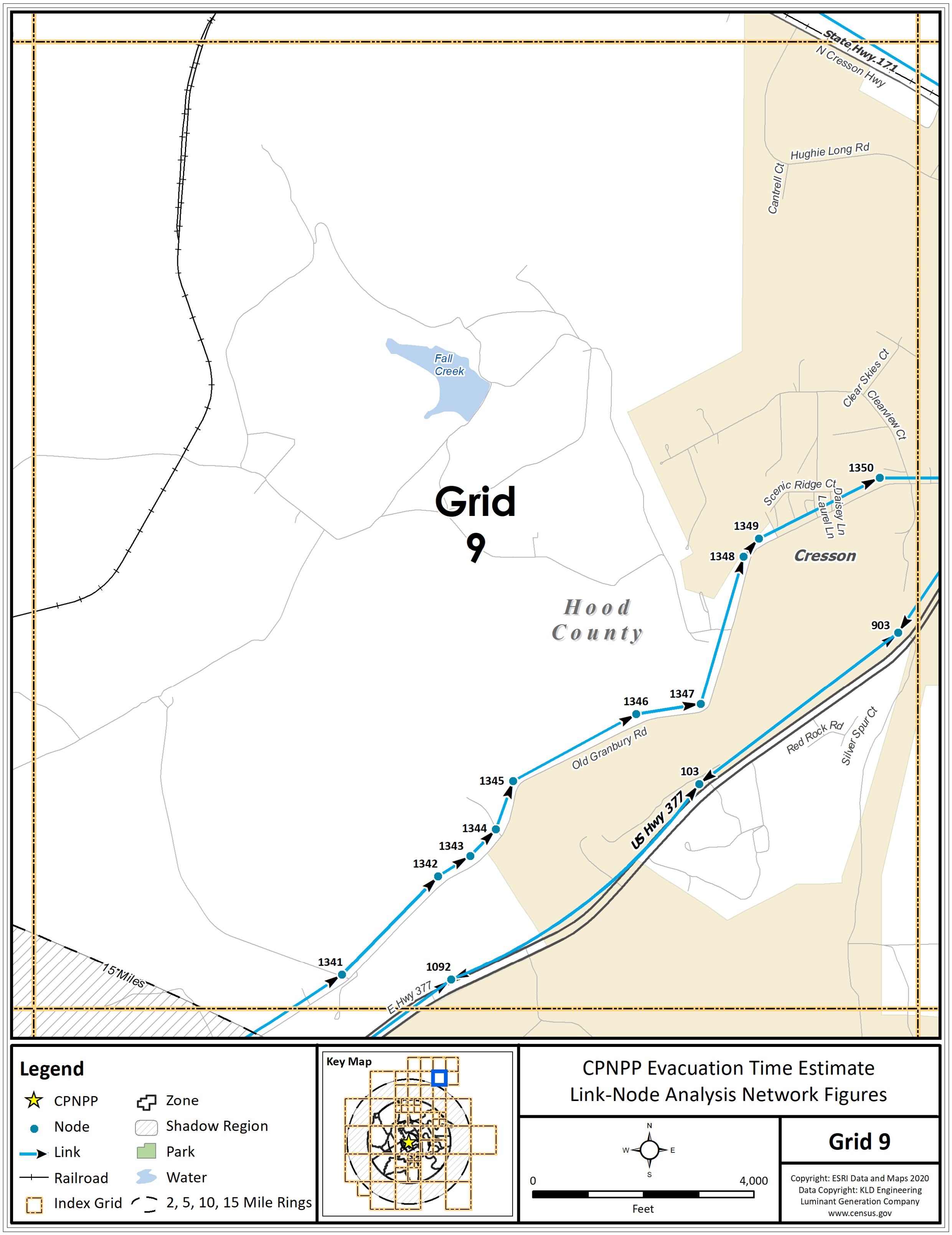


Figure K-10. Link-Node Analysis Network – Grid 9

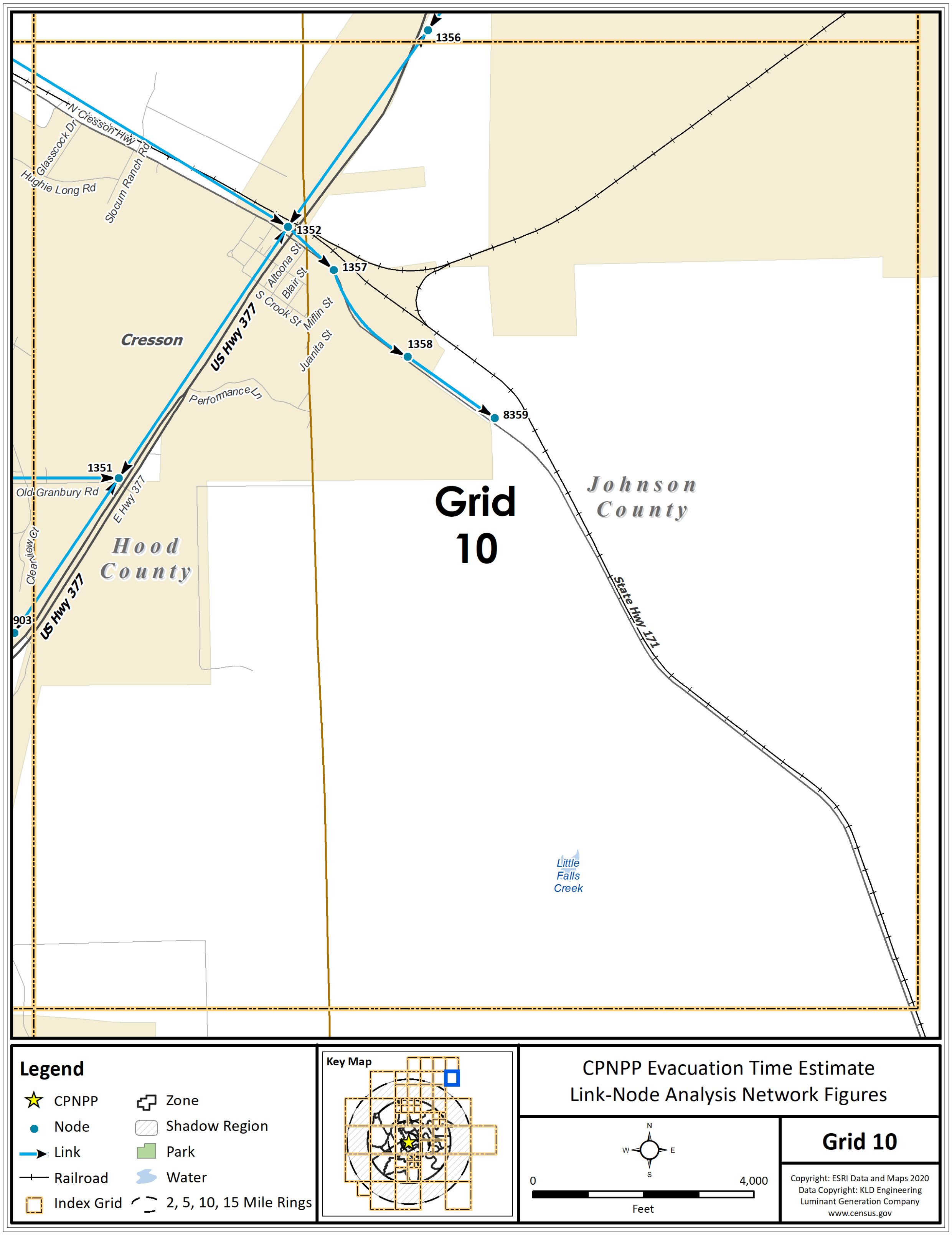


Figure K-11. Link-Node Analysis Network – Grid 10

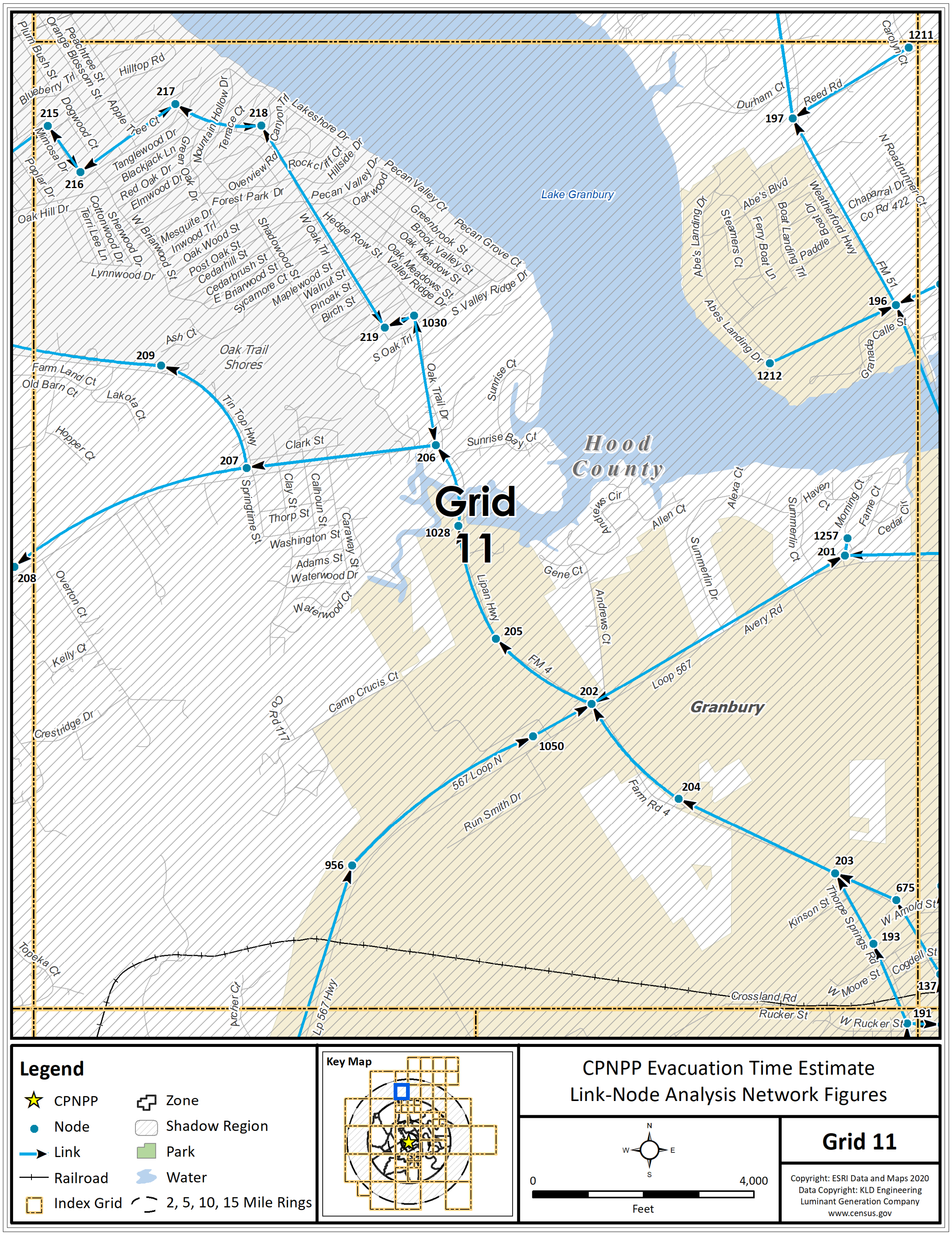


Figure K-12. Link-Node Analysis Network – Grid 11

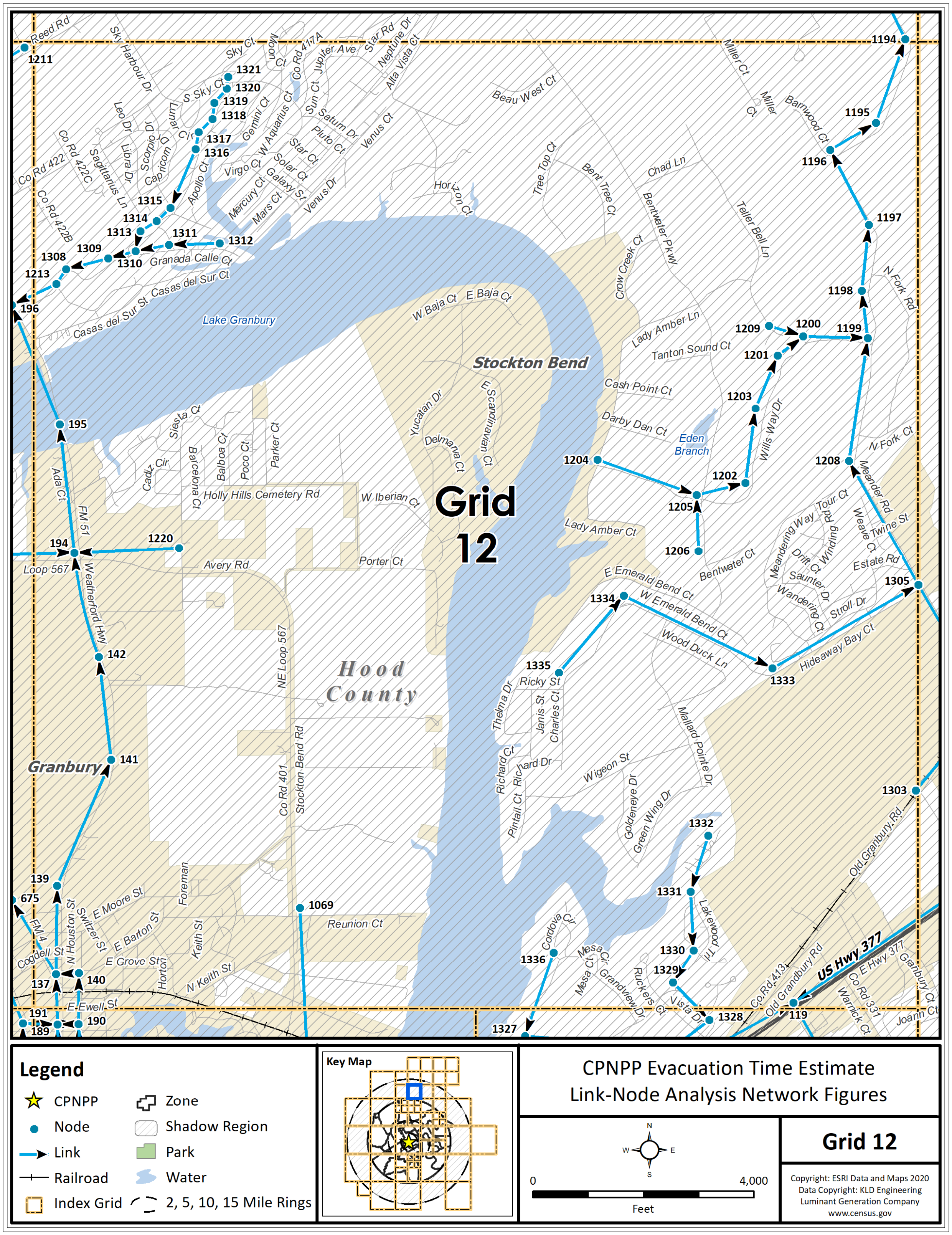


Figure K-13. Link-Node Analysis Network – Grid 12

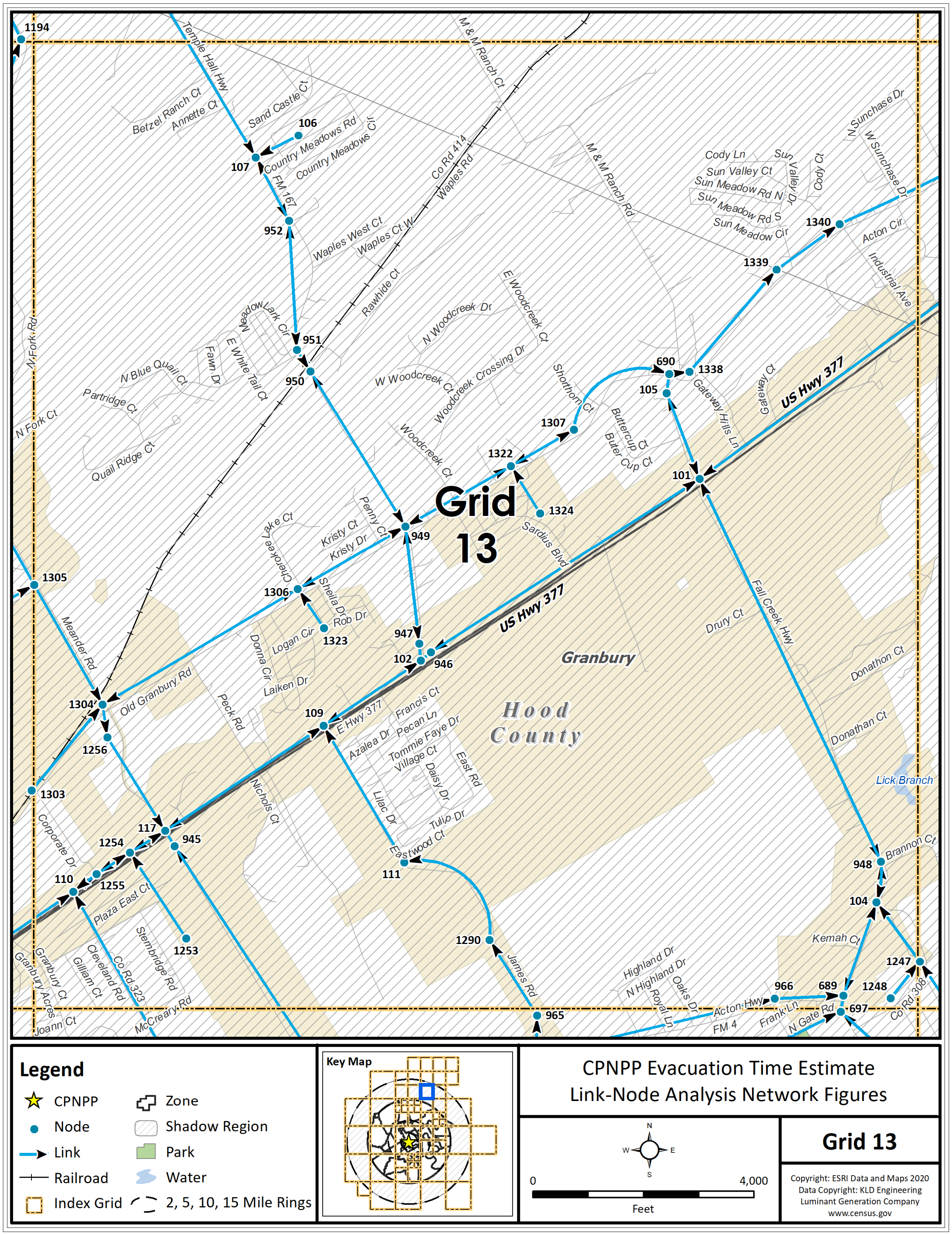


Figure K-14. Link-Node Analysis Network – Grid 13

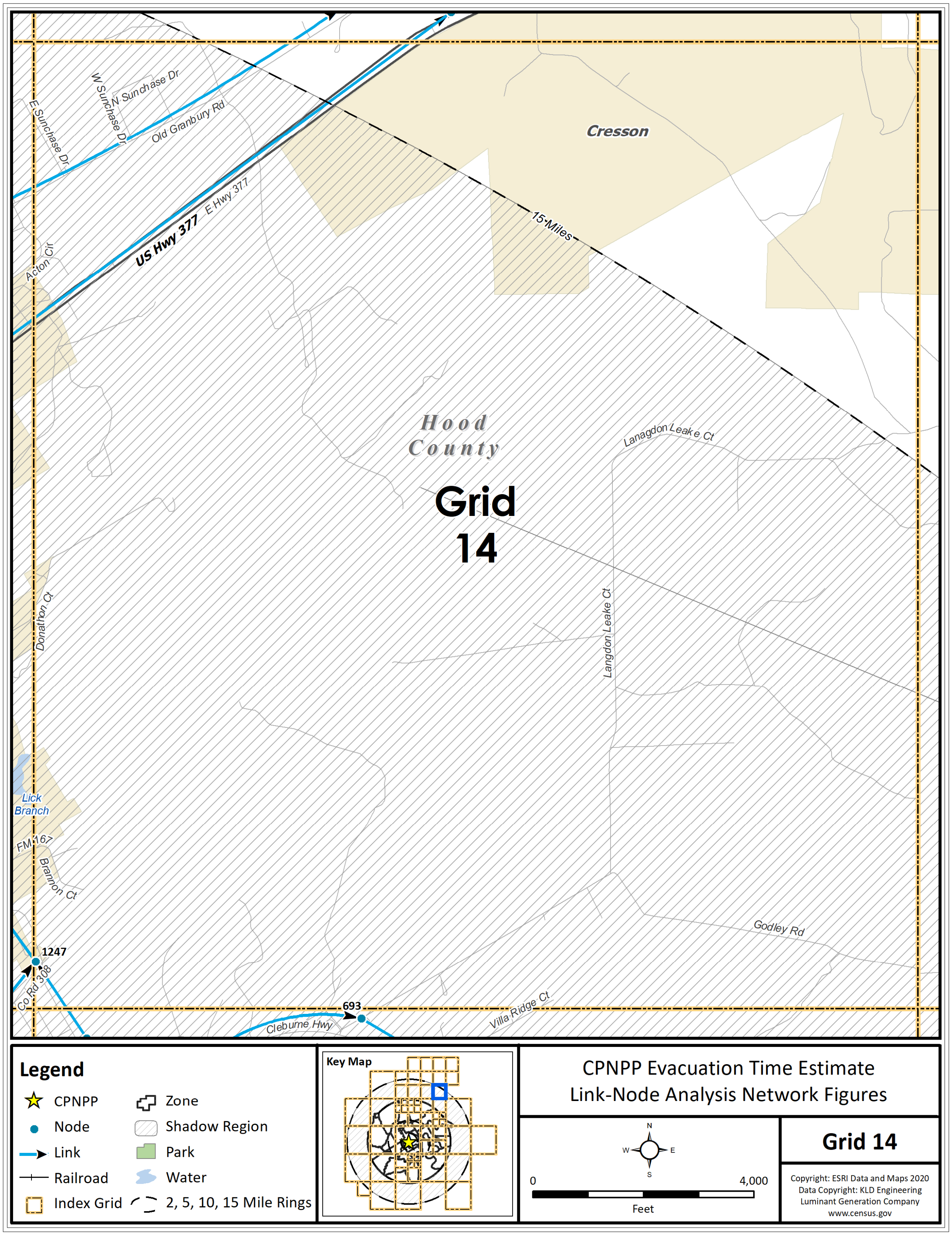


Figure K-15. Link-Node Analysis Network – Grid 14

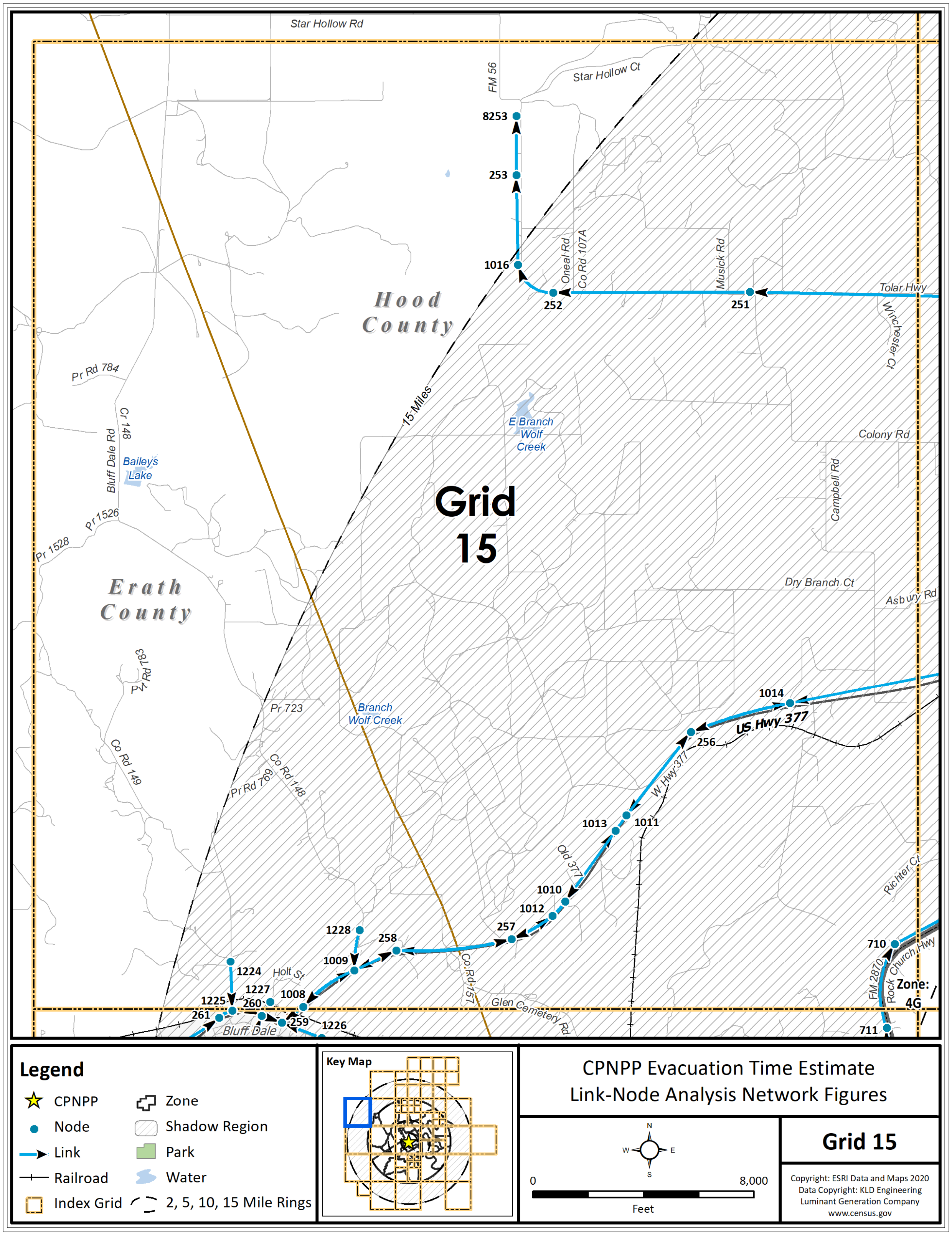


Figure K-16. Link-Node Analysis Network – Grid 15

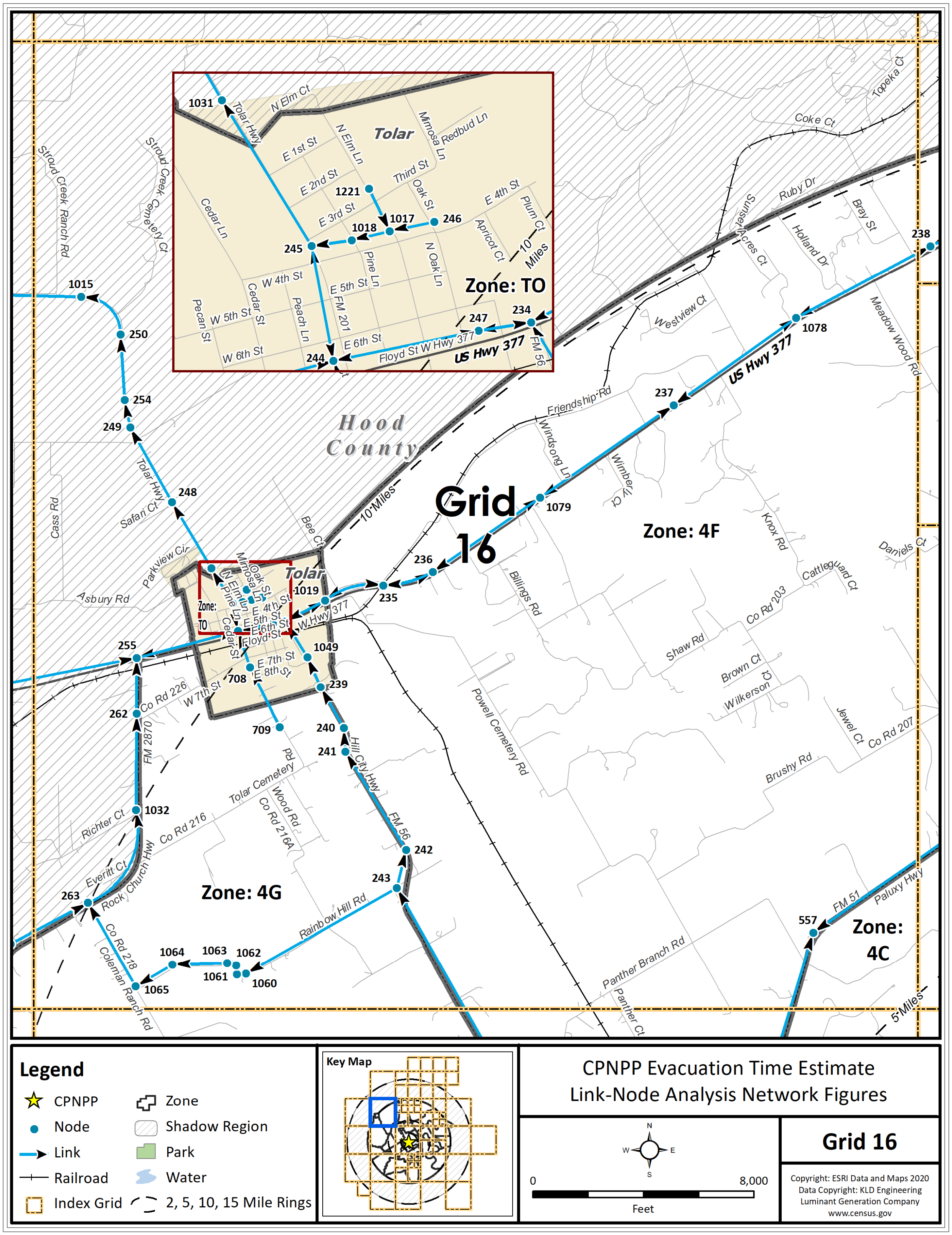


Figure K-17. Link-Node Analysis Network – Grid 16

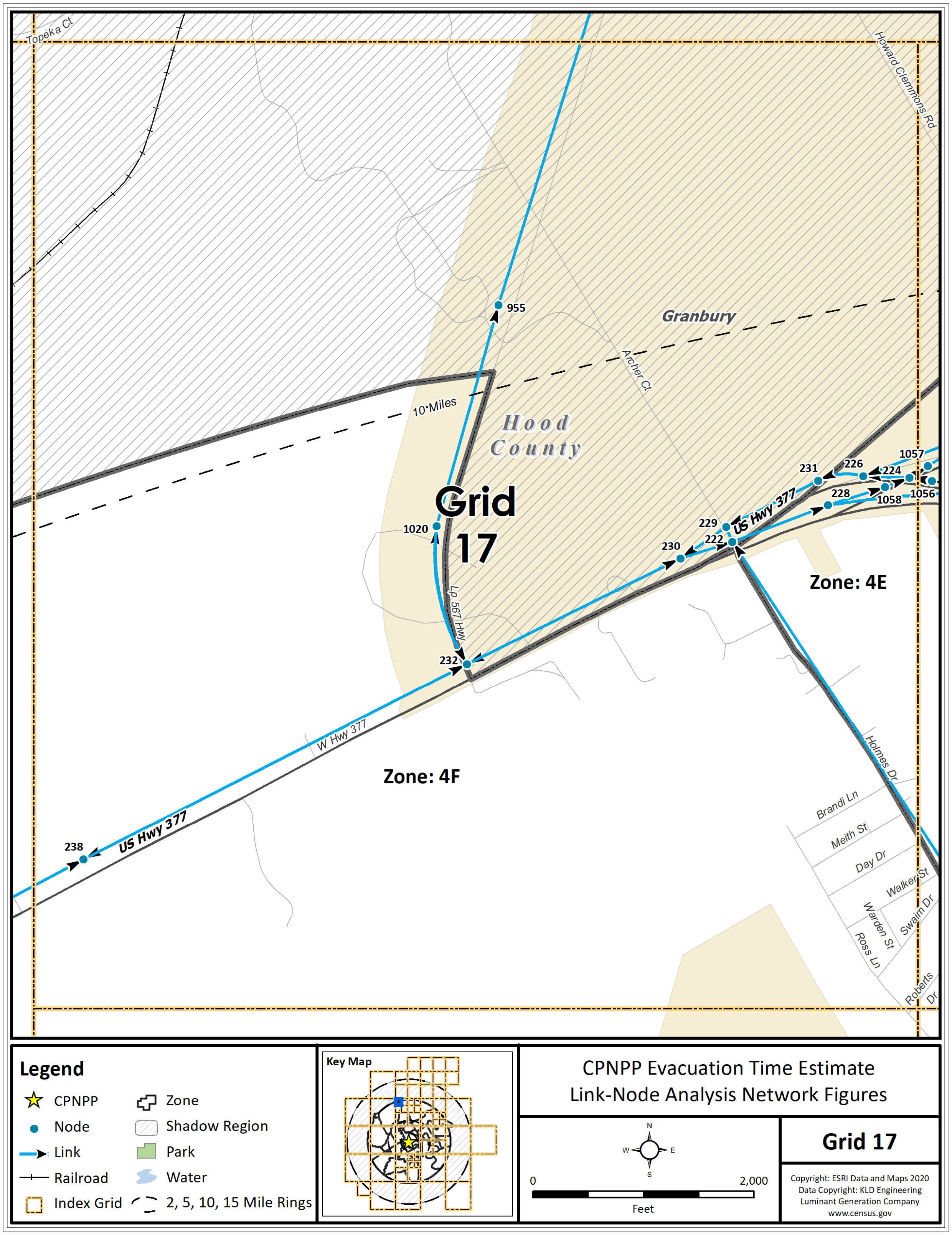


Figure K-18. Link-Node Analysis Network – Grid 17

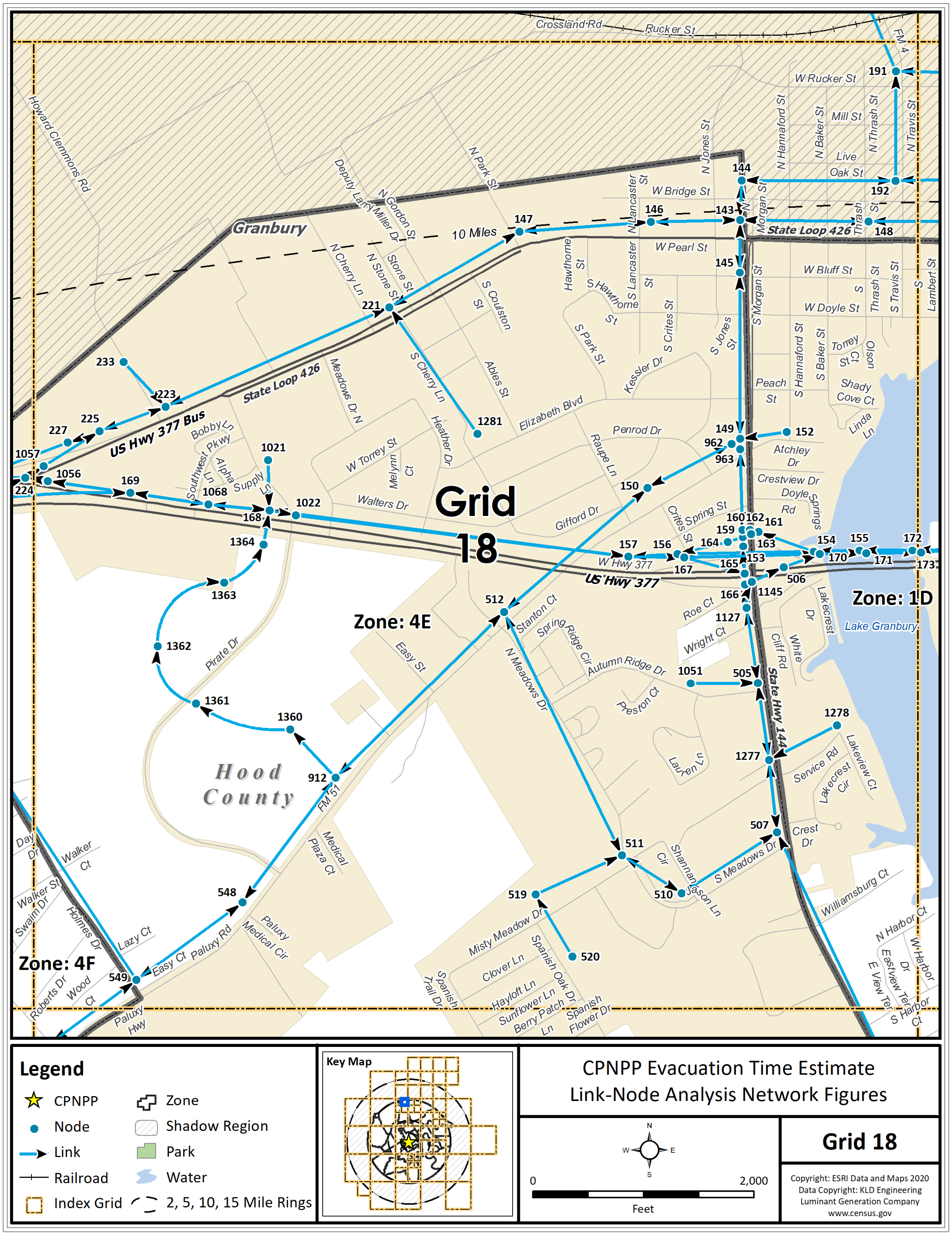


Figure K-19. Link-Node Analysis Network – Grid 18

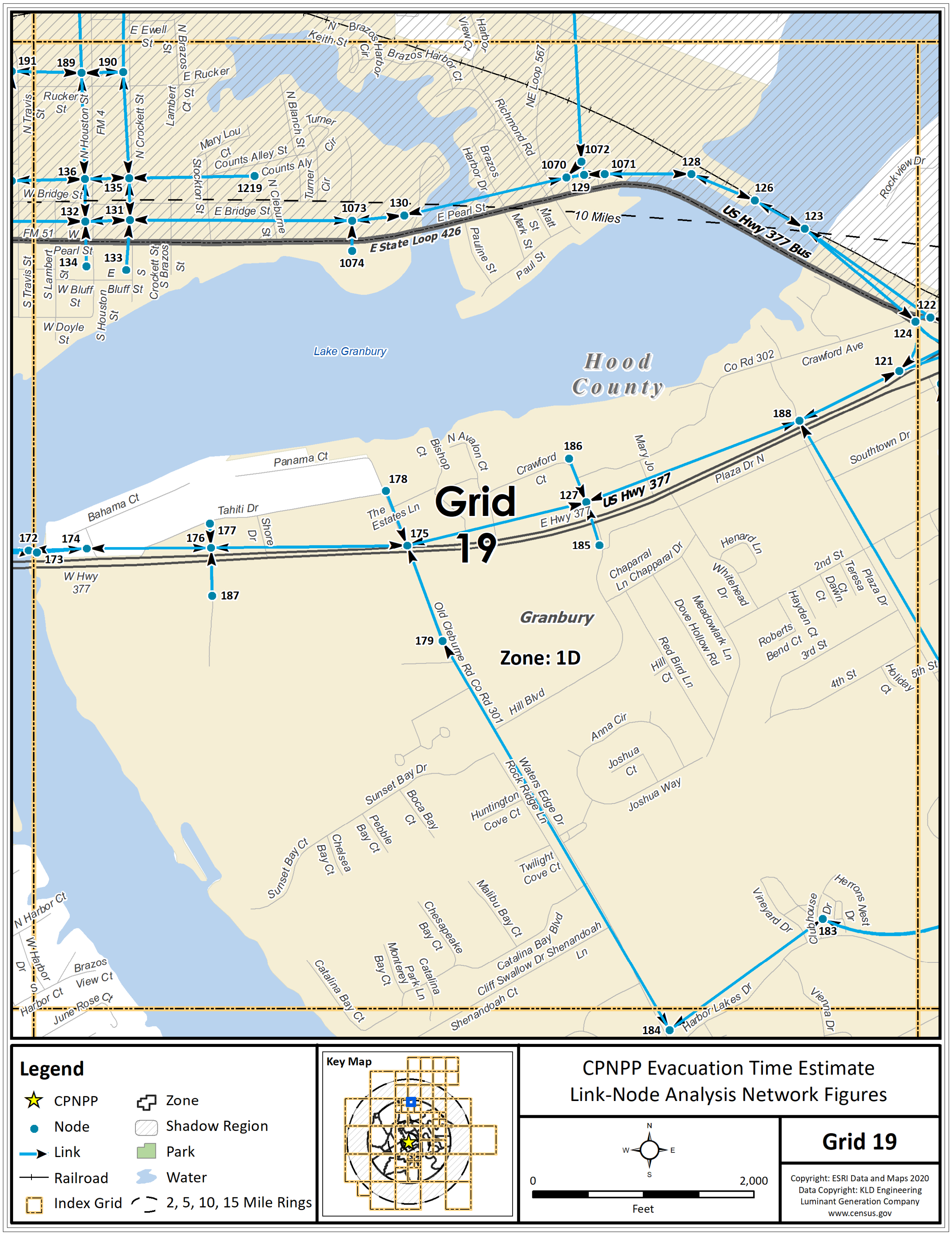


Figure K-20. Link-Node Analysis Network – Grid 19

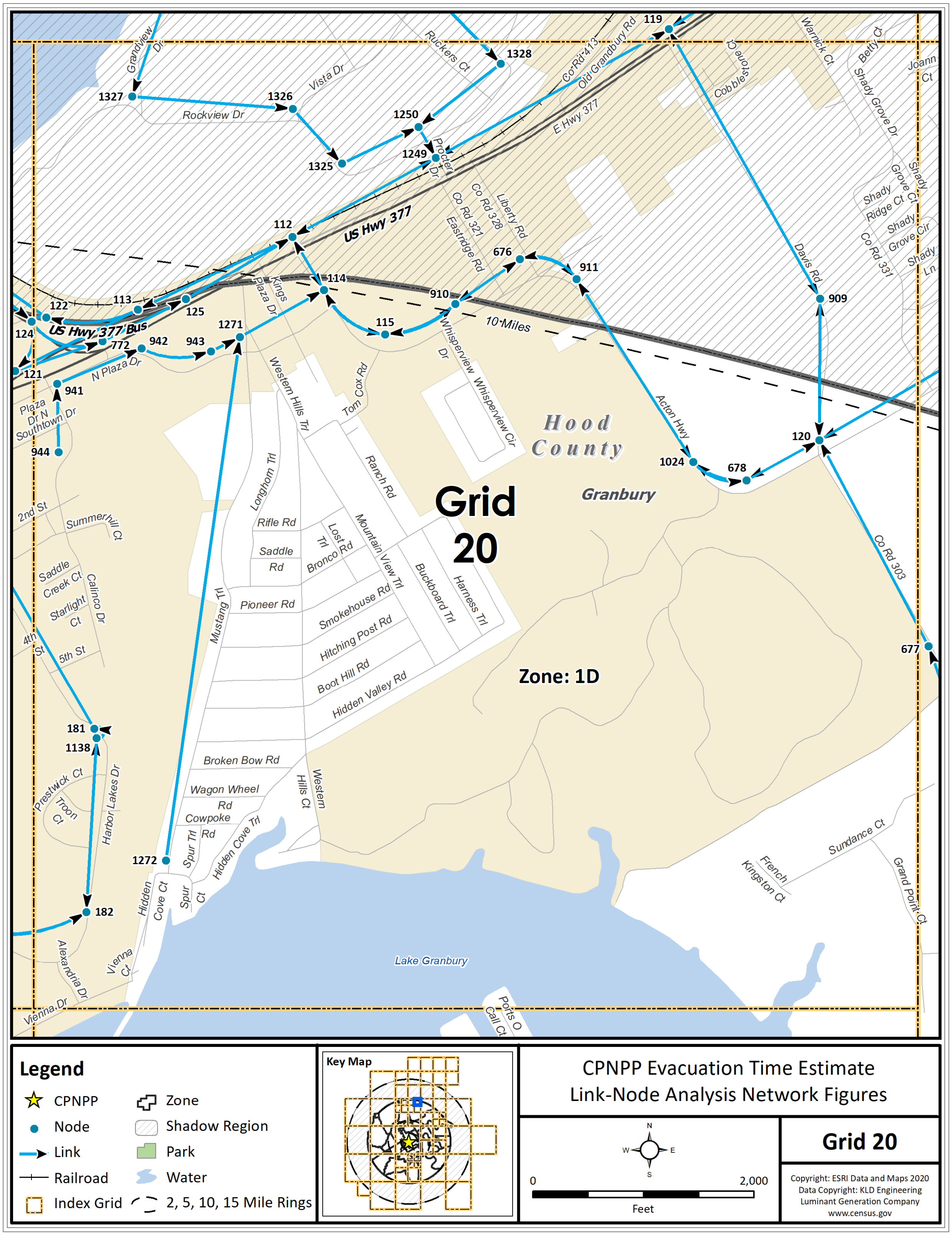


Figure K-21. Link-Node Analysis Network – Grid 20

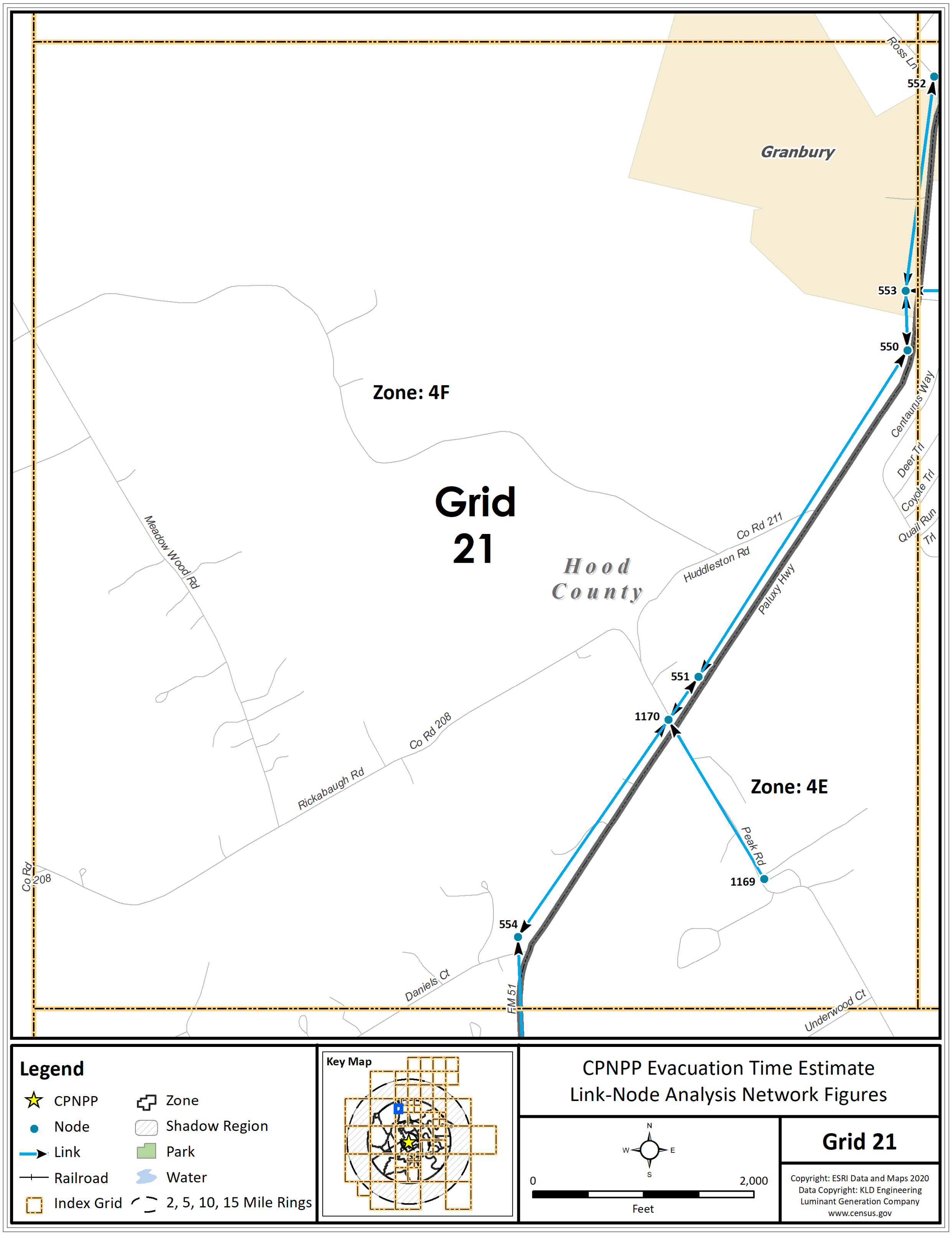


Figure K-22. Link-Node Analysis Network – Grid 21

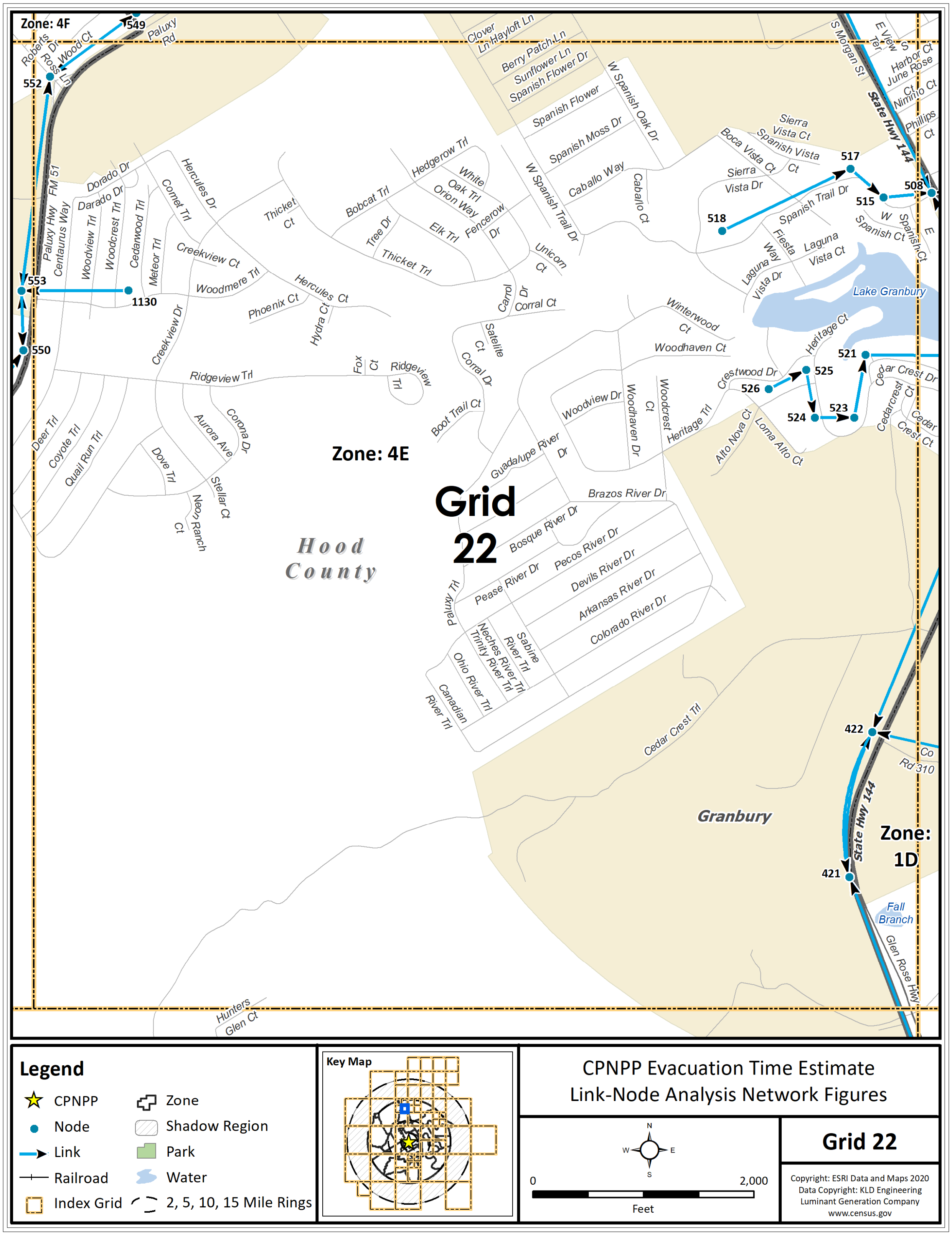


Figure K-23. Link-Node Analysis Network – Grid 22

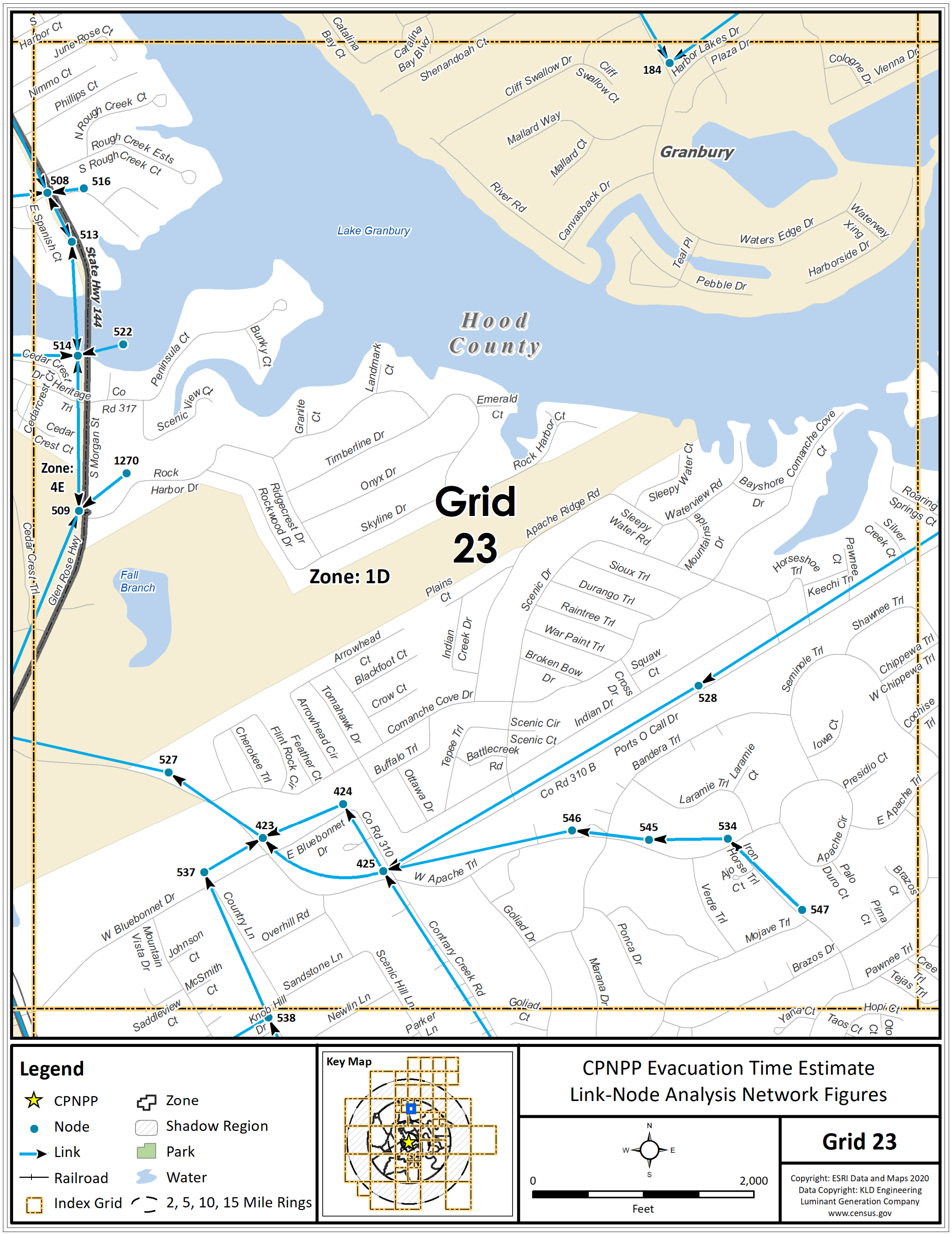


Figure K-24. Link-Node Analysis Network – Grid 23

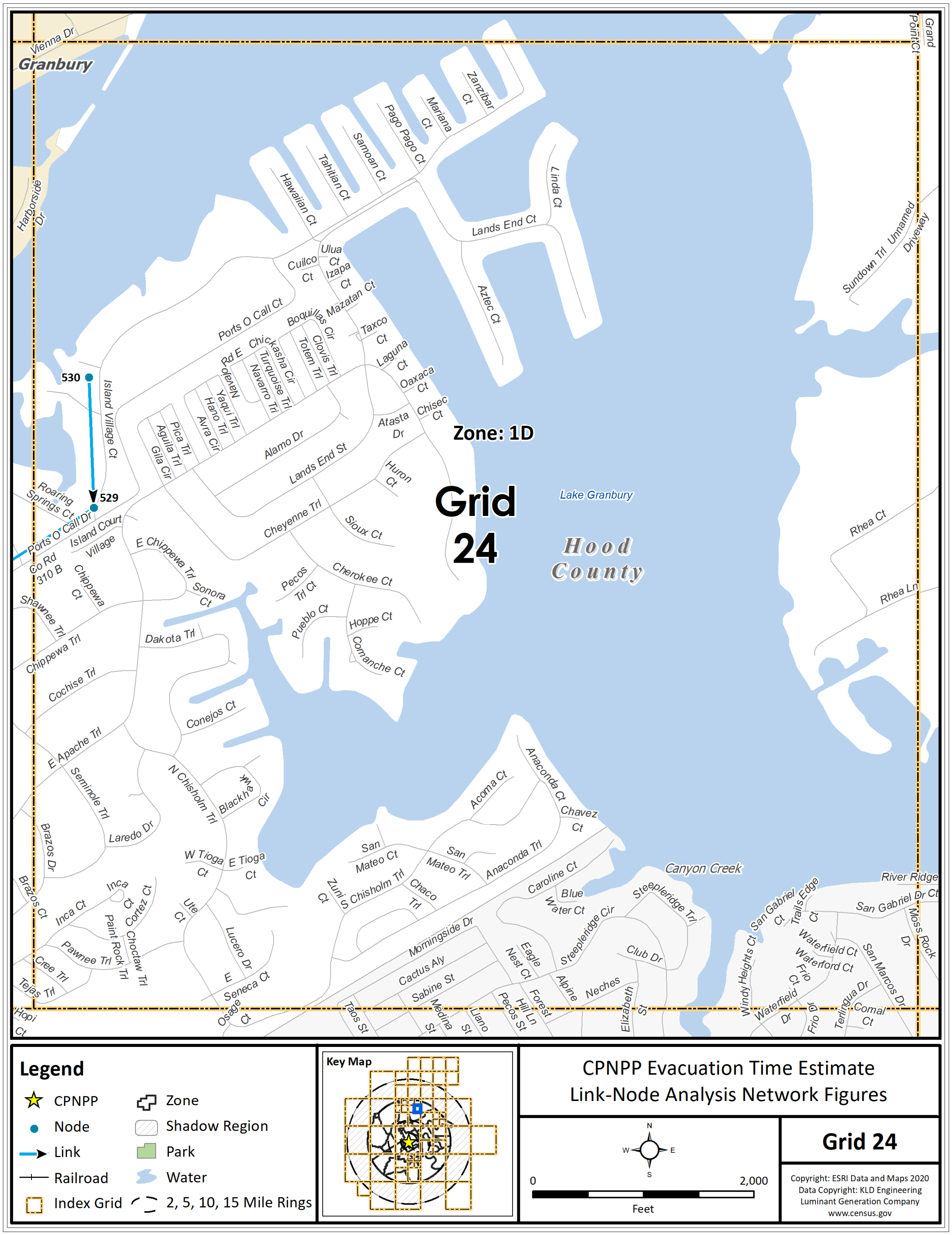


Figure K-25. Link-Node Analysis Network – Grid 24

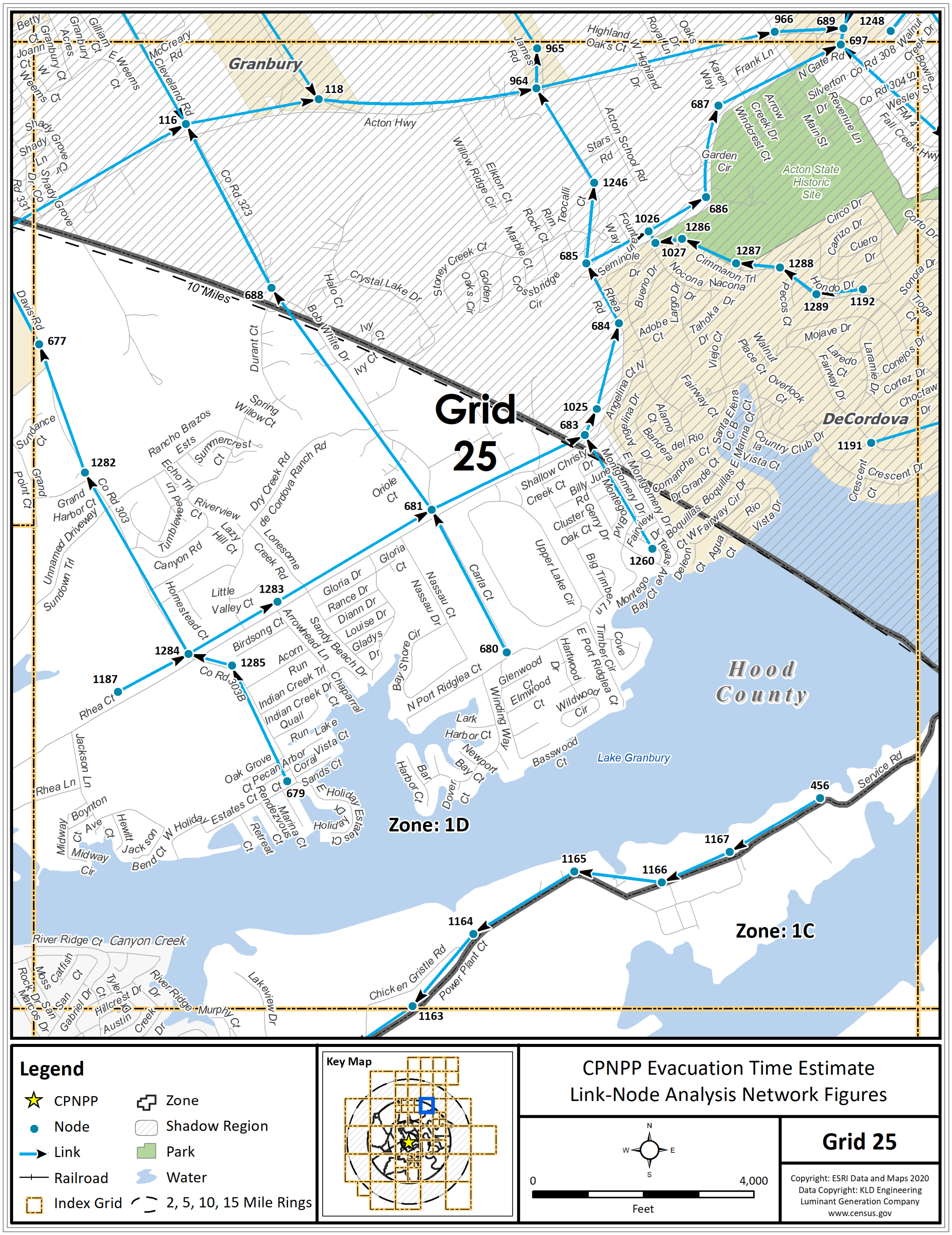


Figure K-26. Link-Node Analysis Network – Grid 25

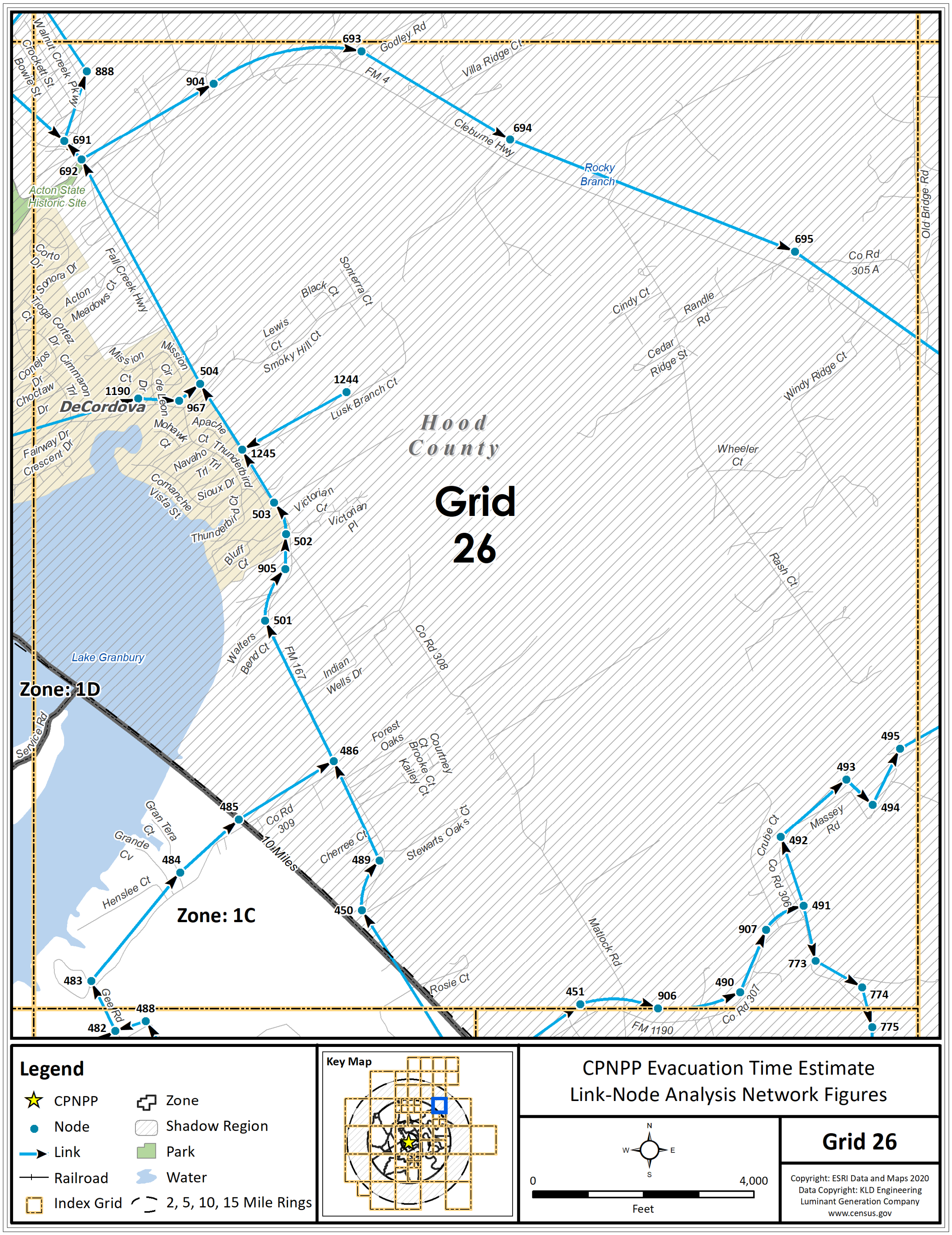


Figure K-27. Link-Node Analysis Network – Grid 26

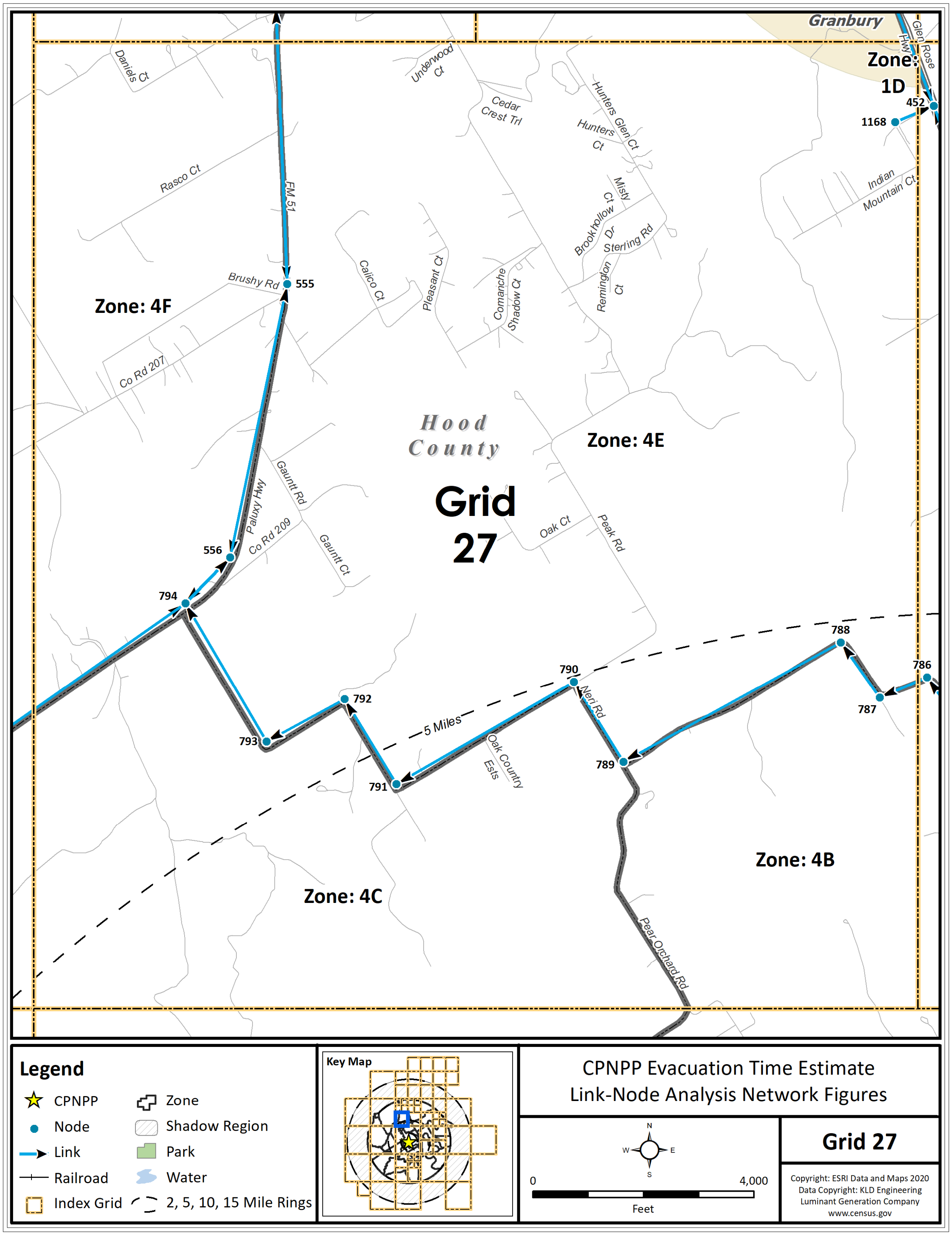


Figure K-28. Link-Node Analysis Network – Grid 27

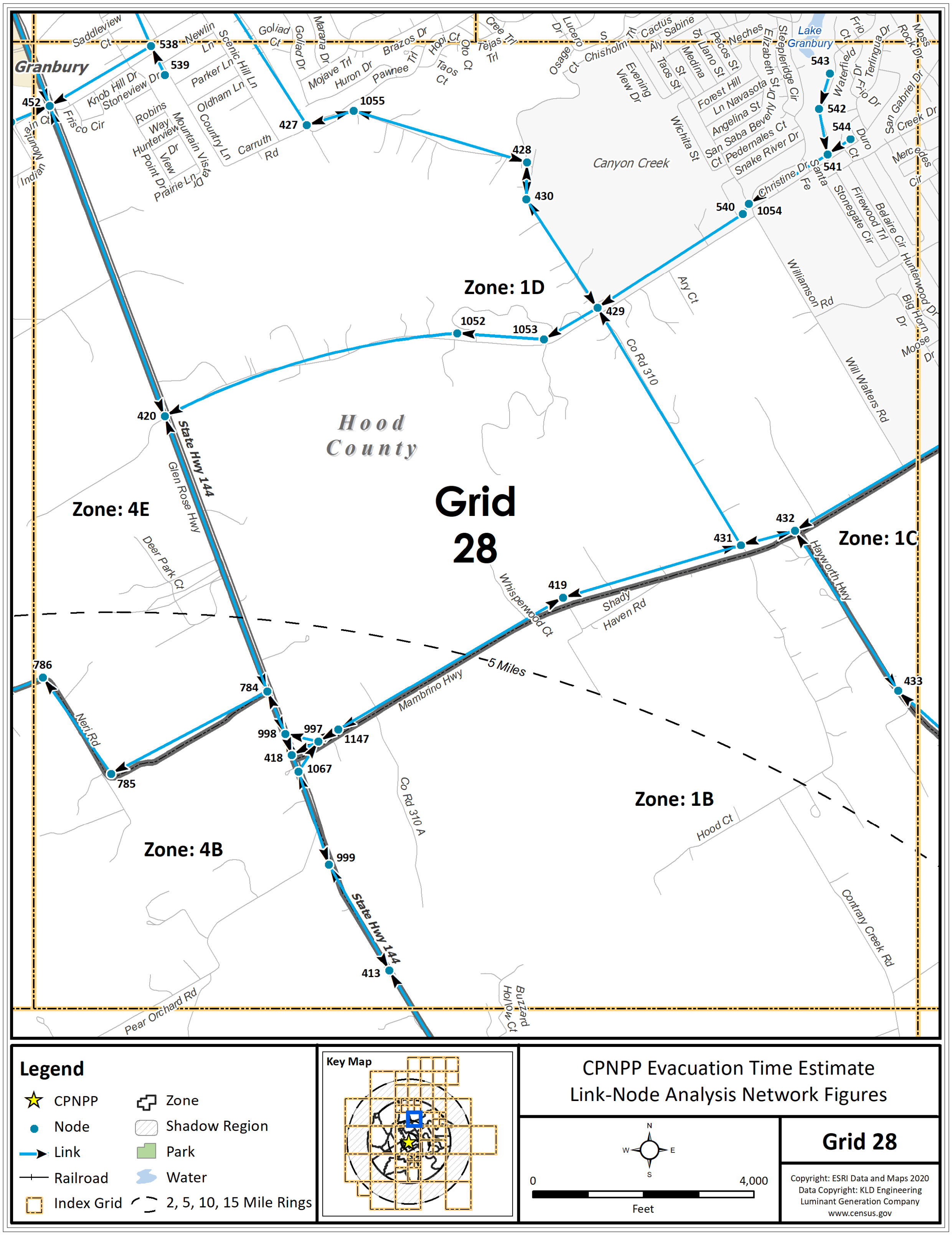


Figure K-29. Link-Node Analysis Network – Grid 28

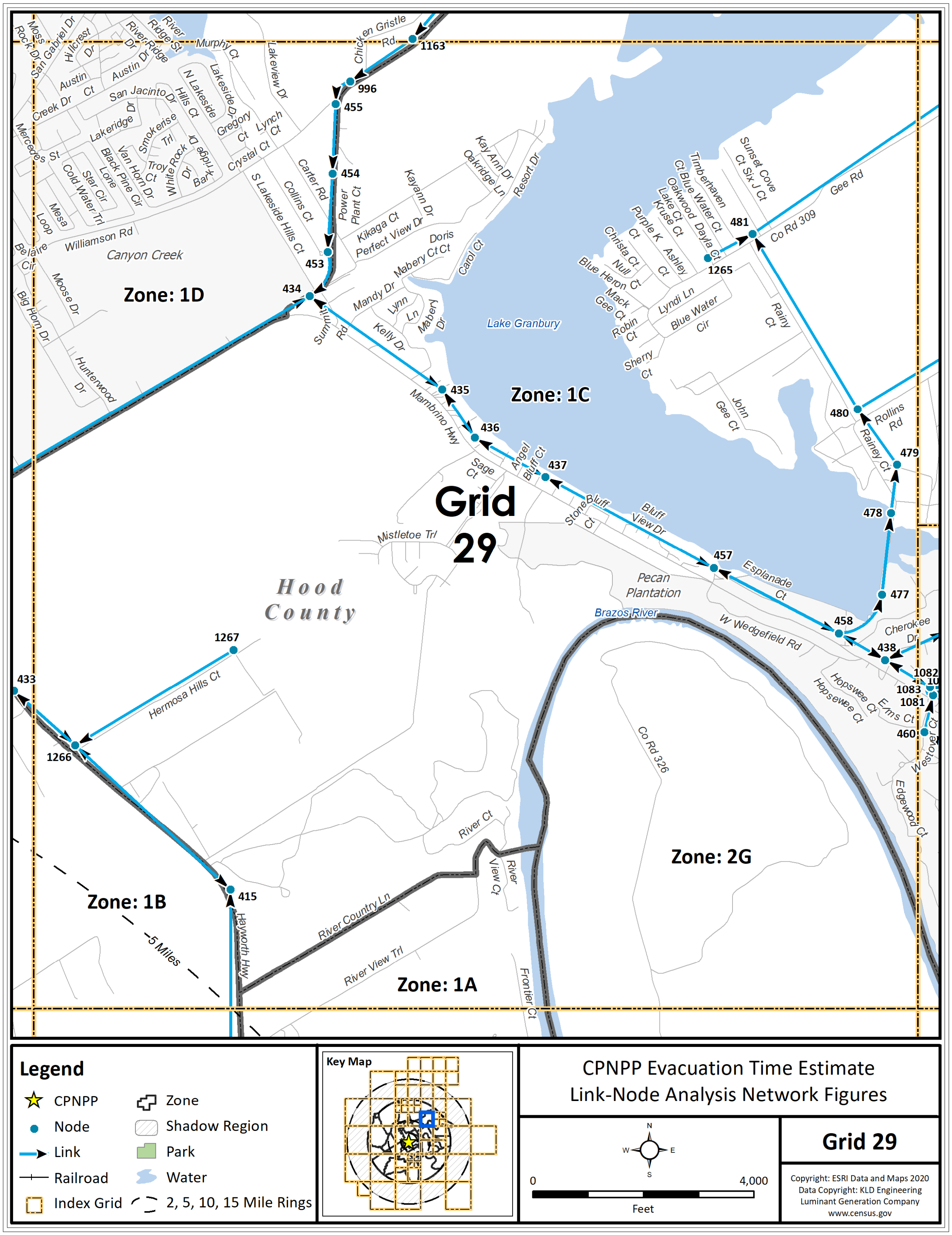


Figure K-30. Link-Node Analysis Network – Grid 29

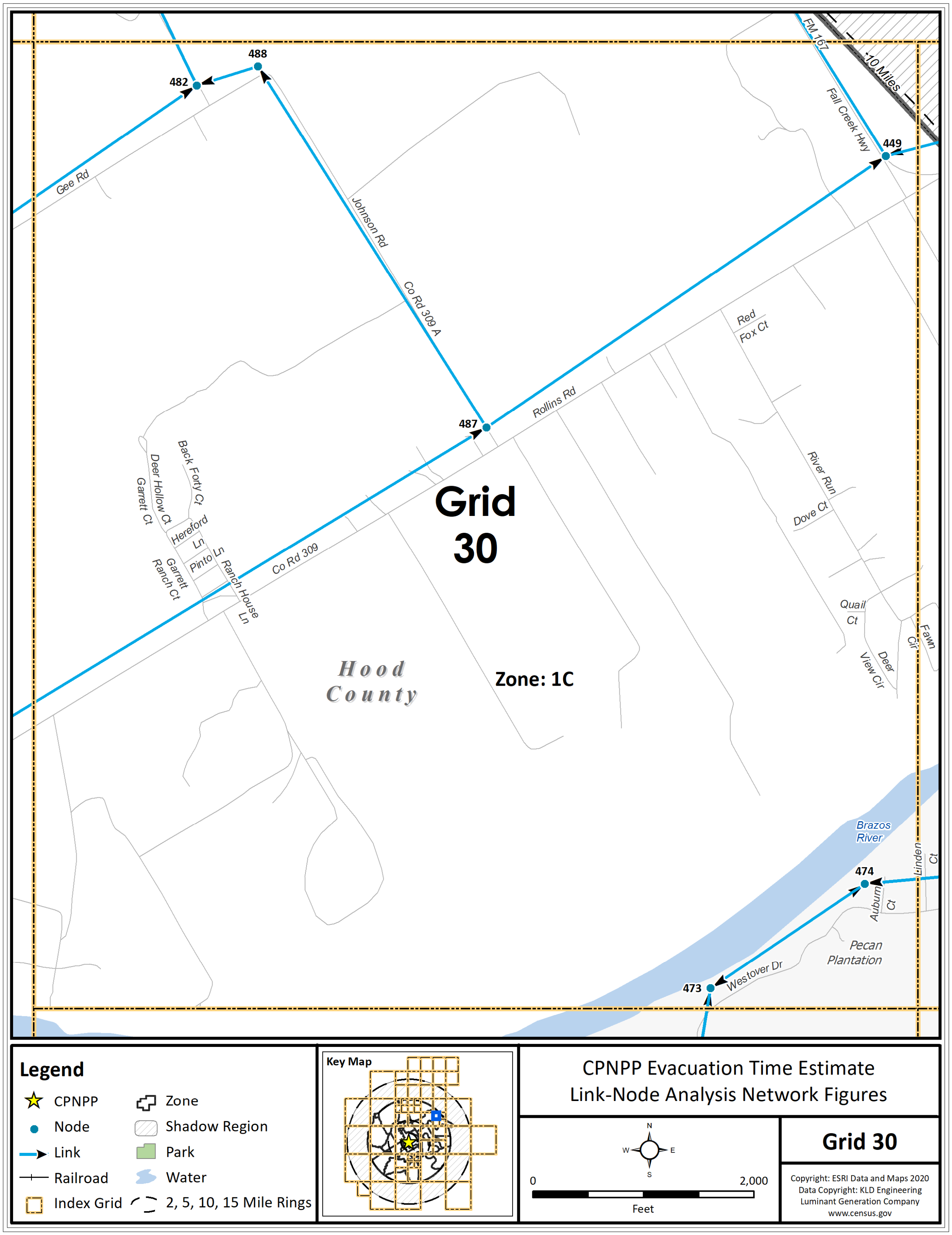
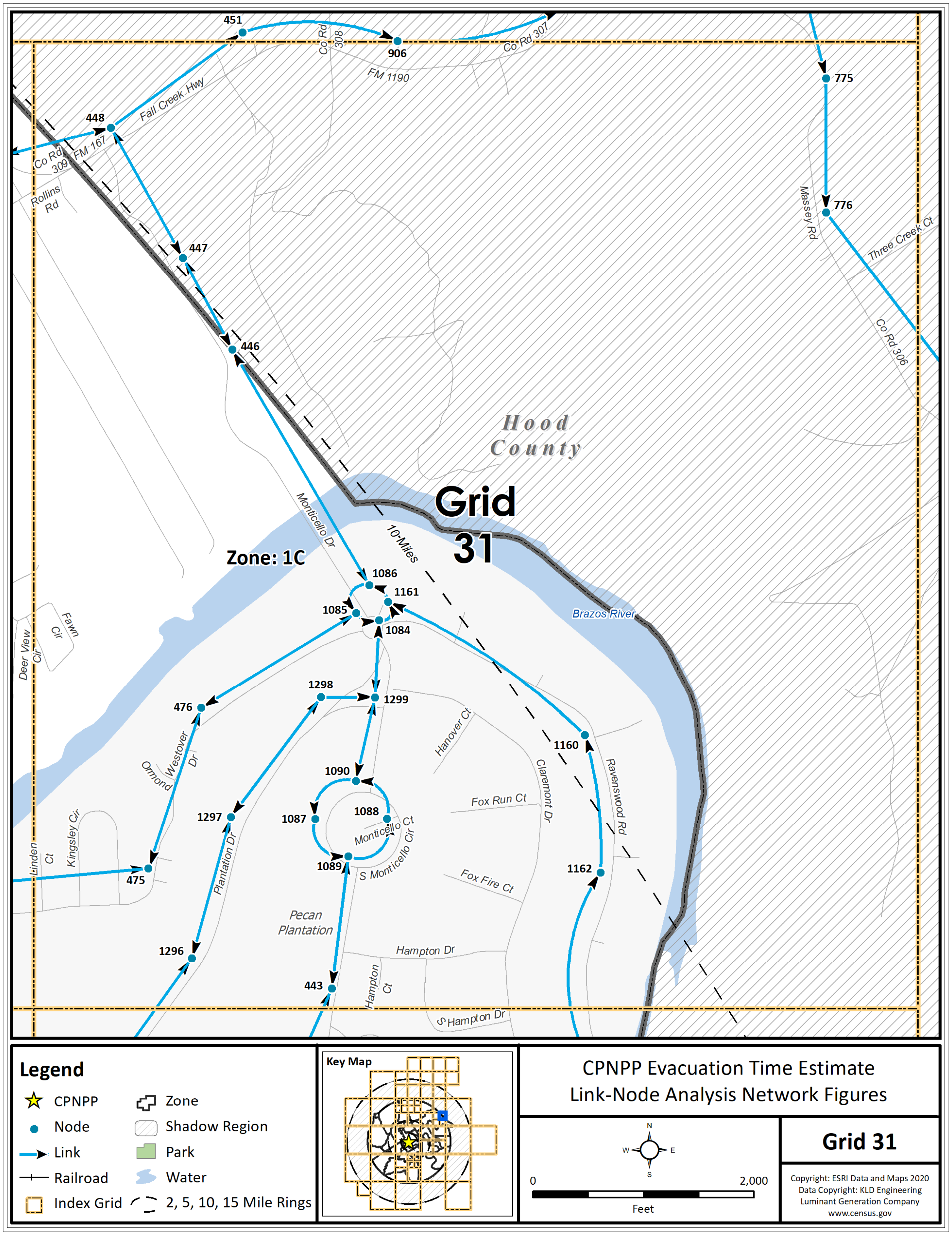


Figure K-31. Link-Node Analysis Network – Grid 30



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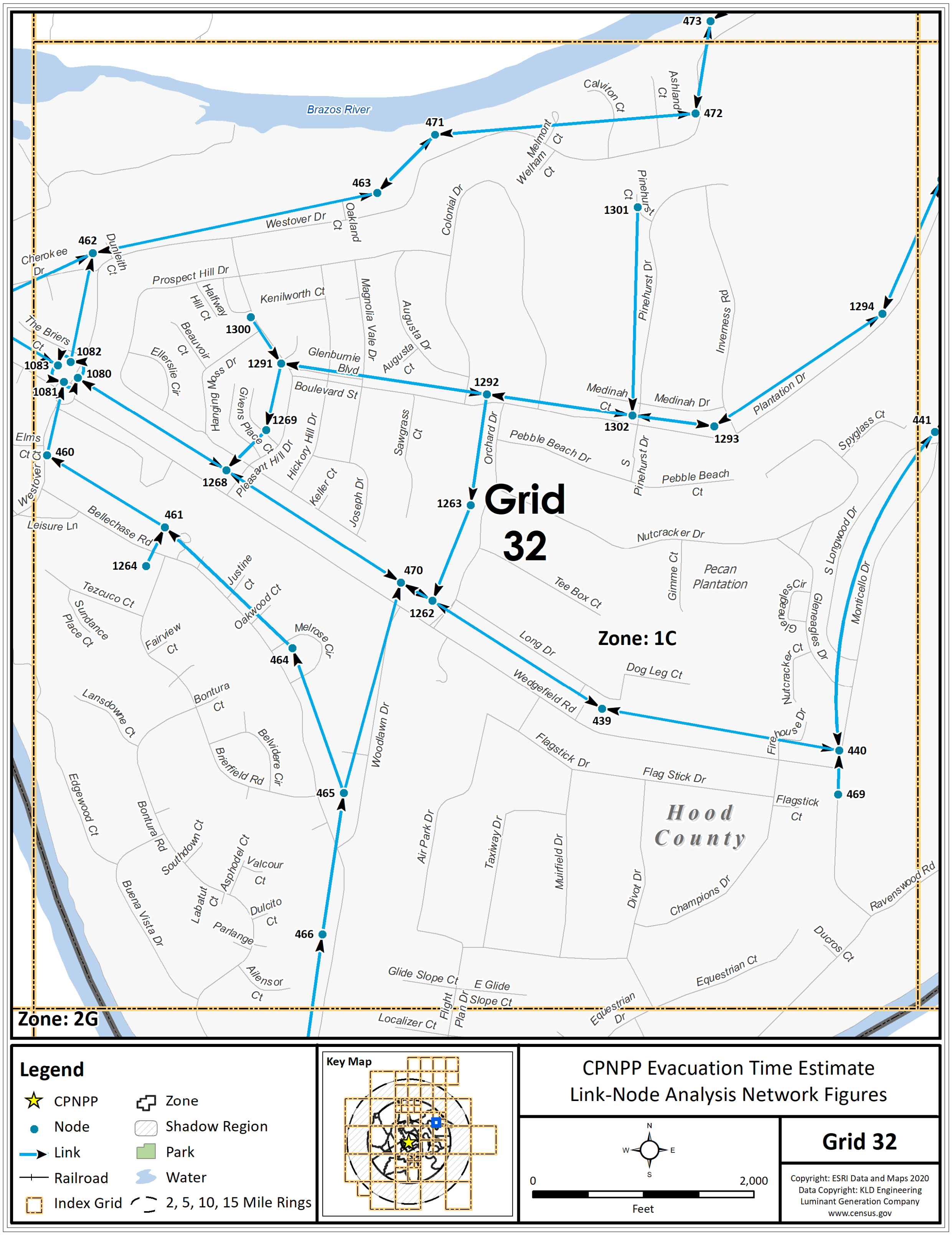

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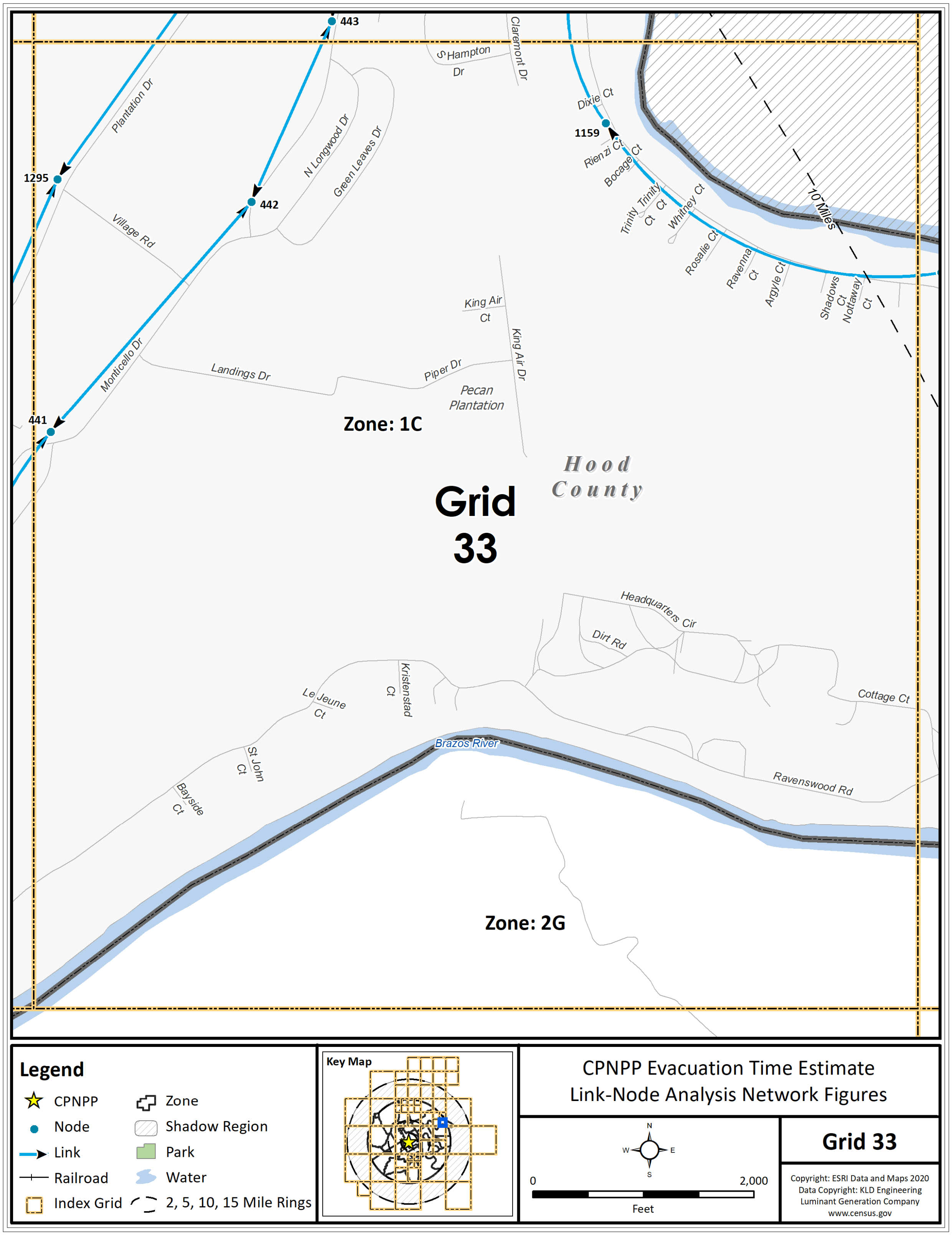

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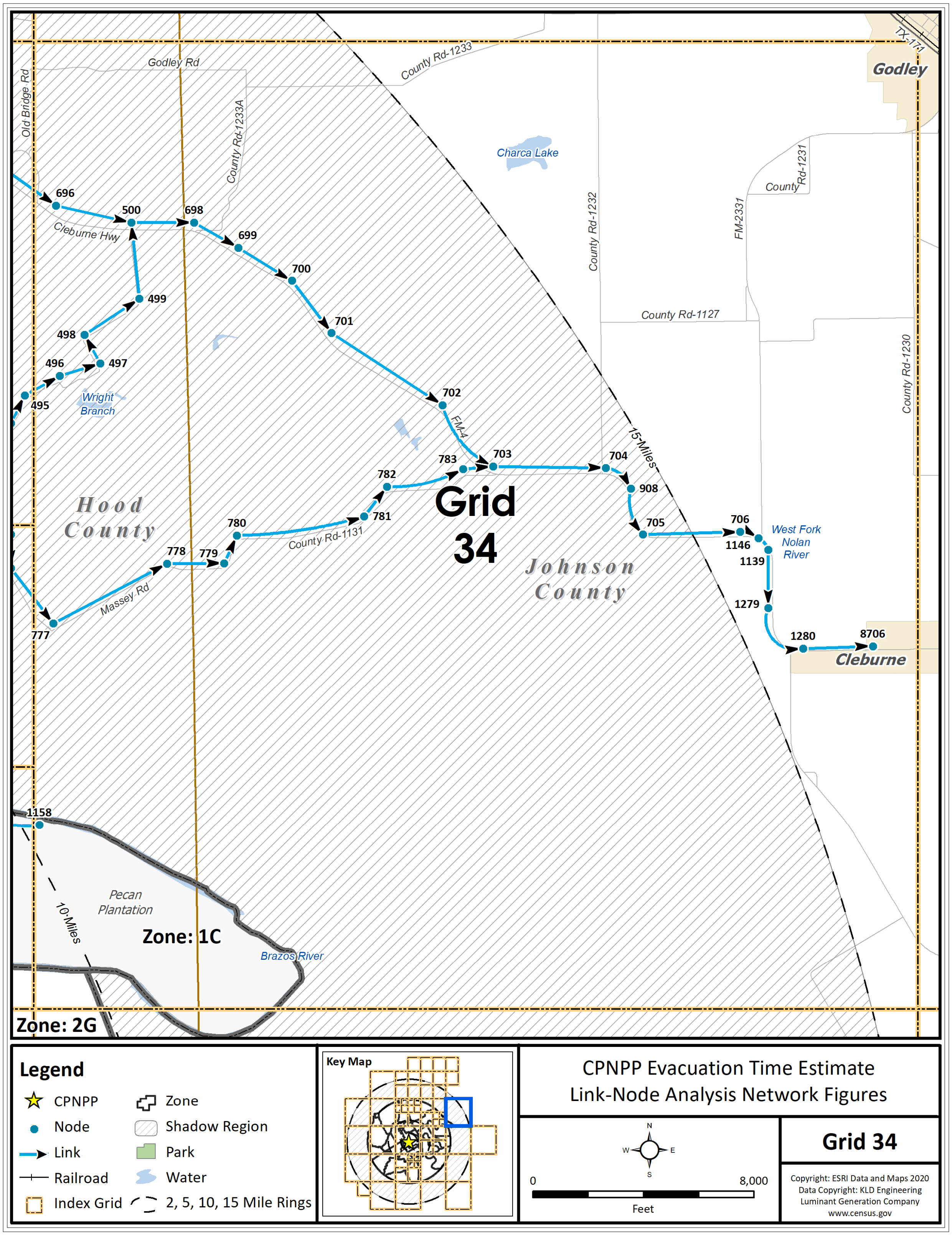

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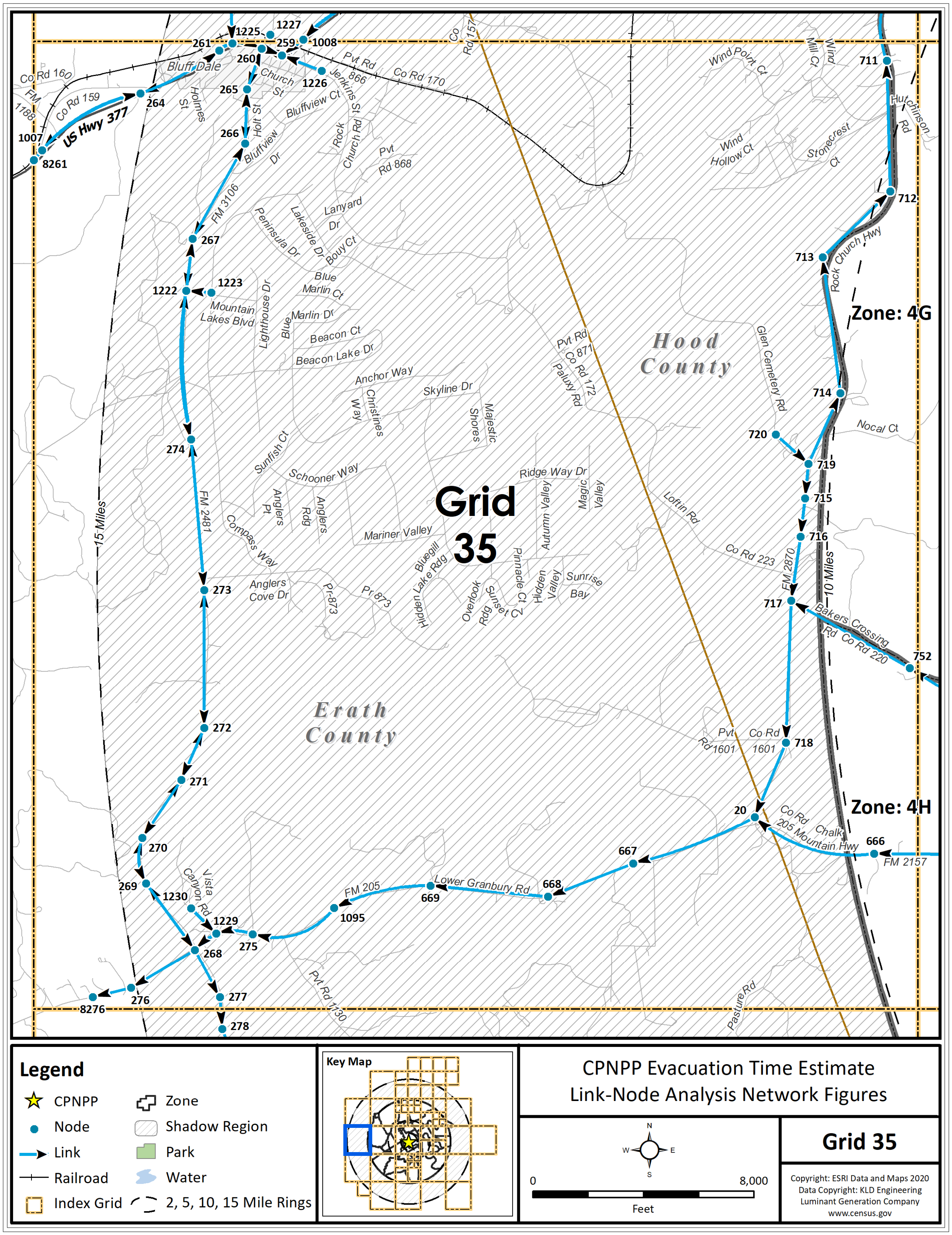

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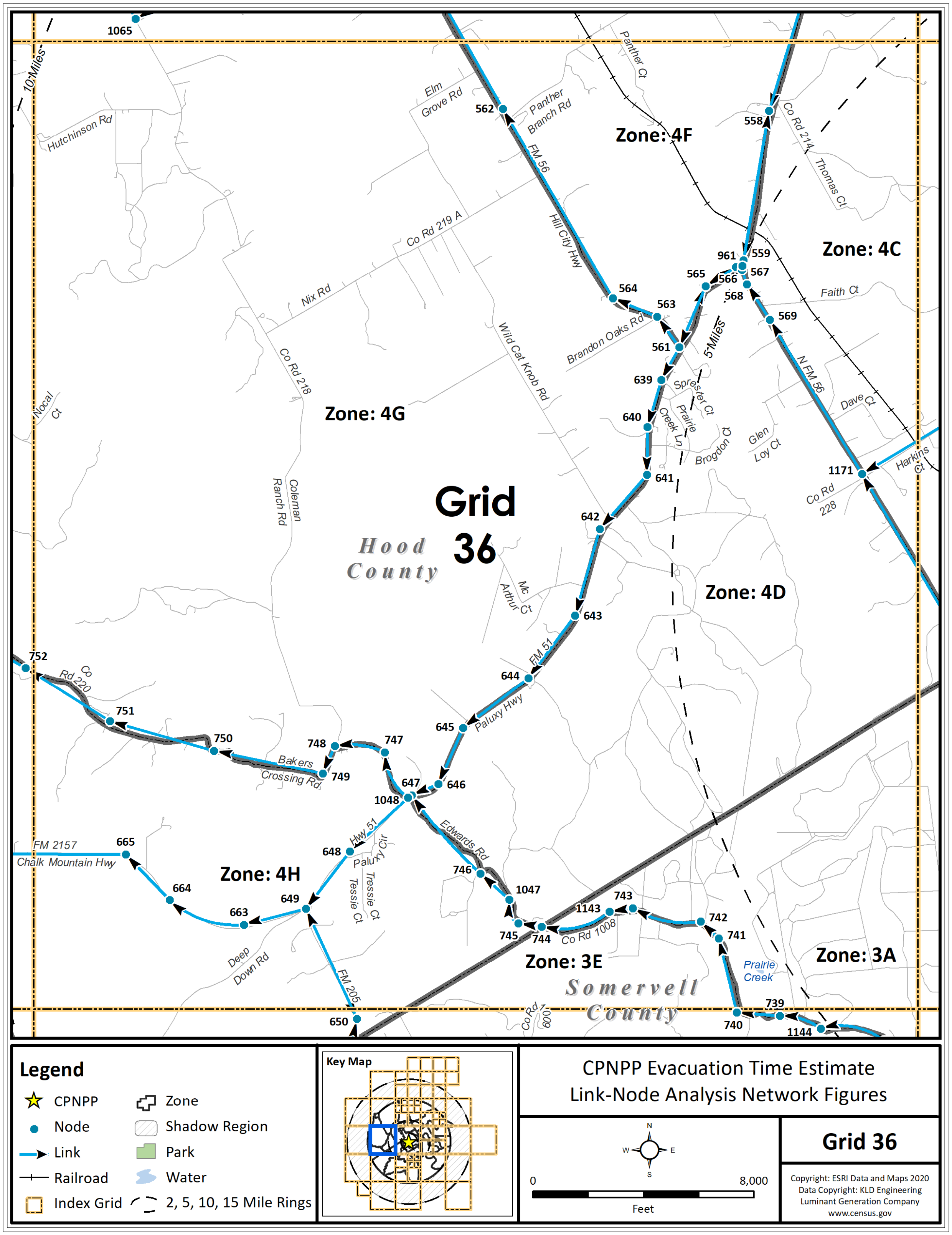

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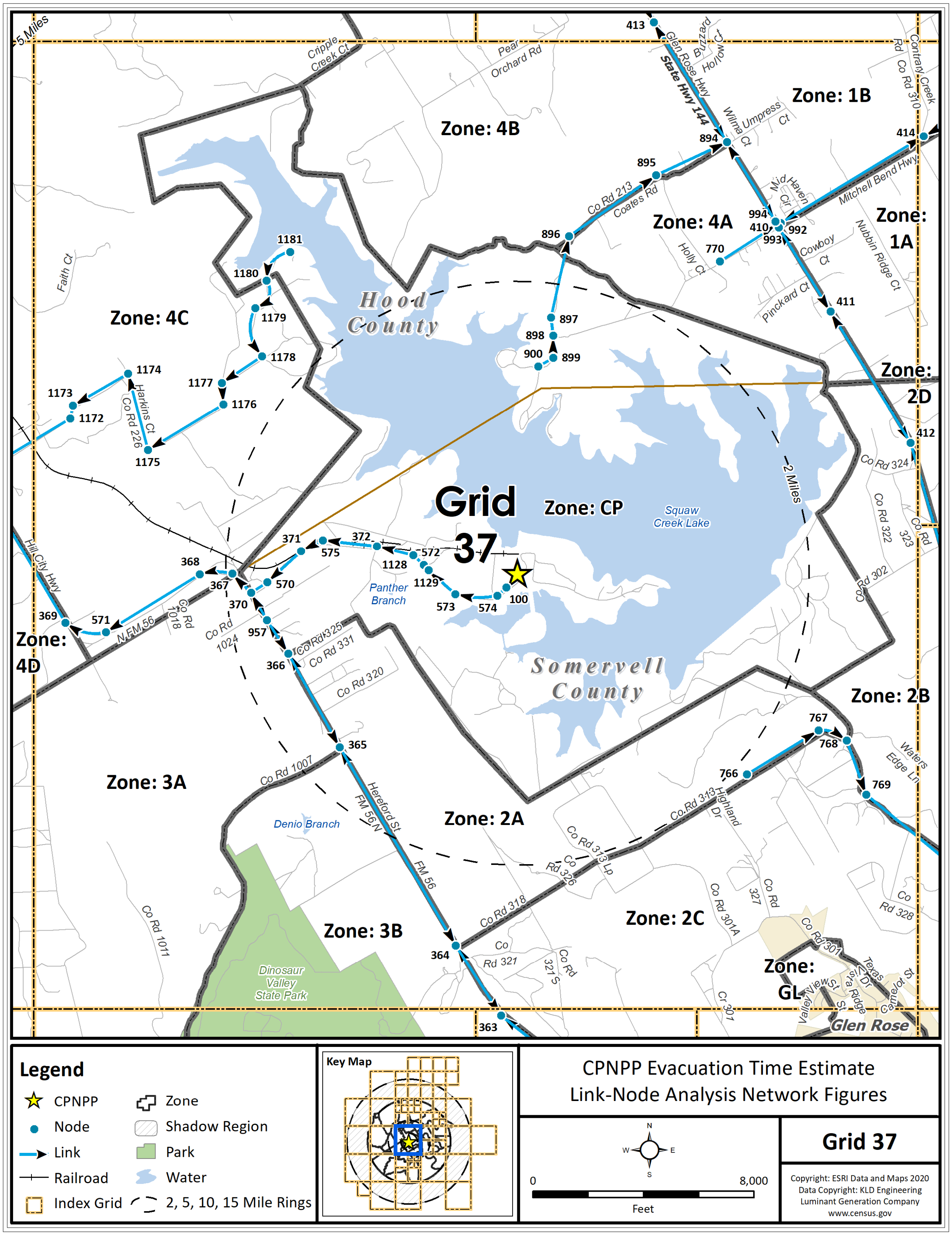

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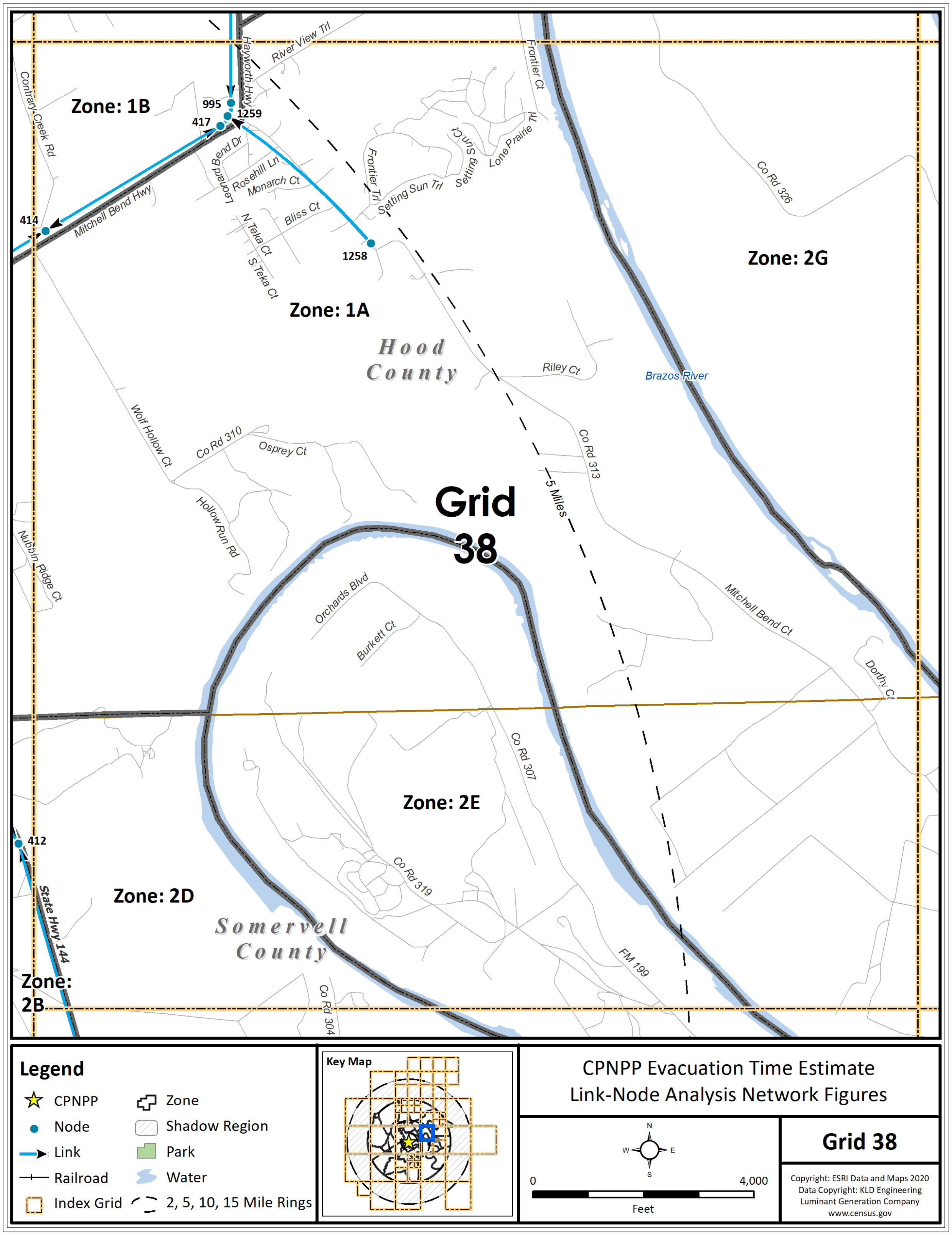

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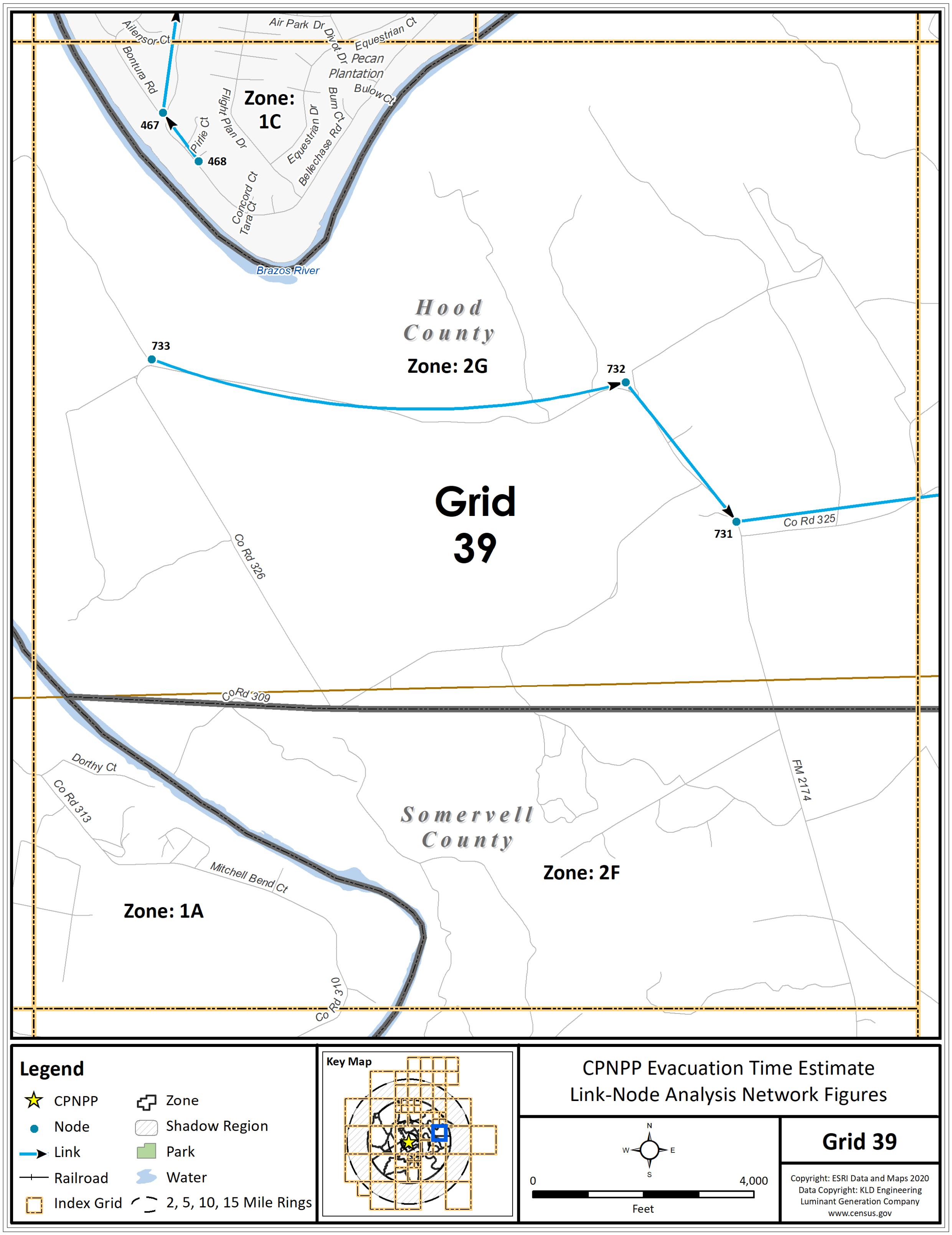

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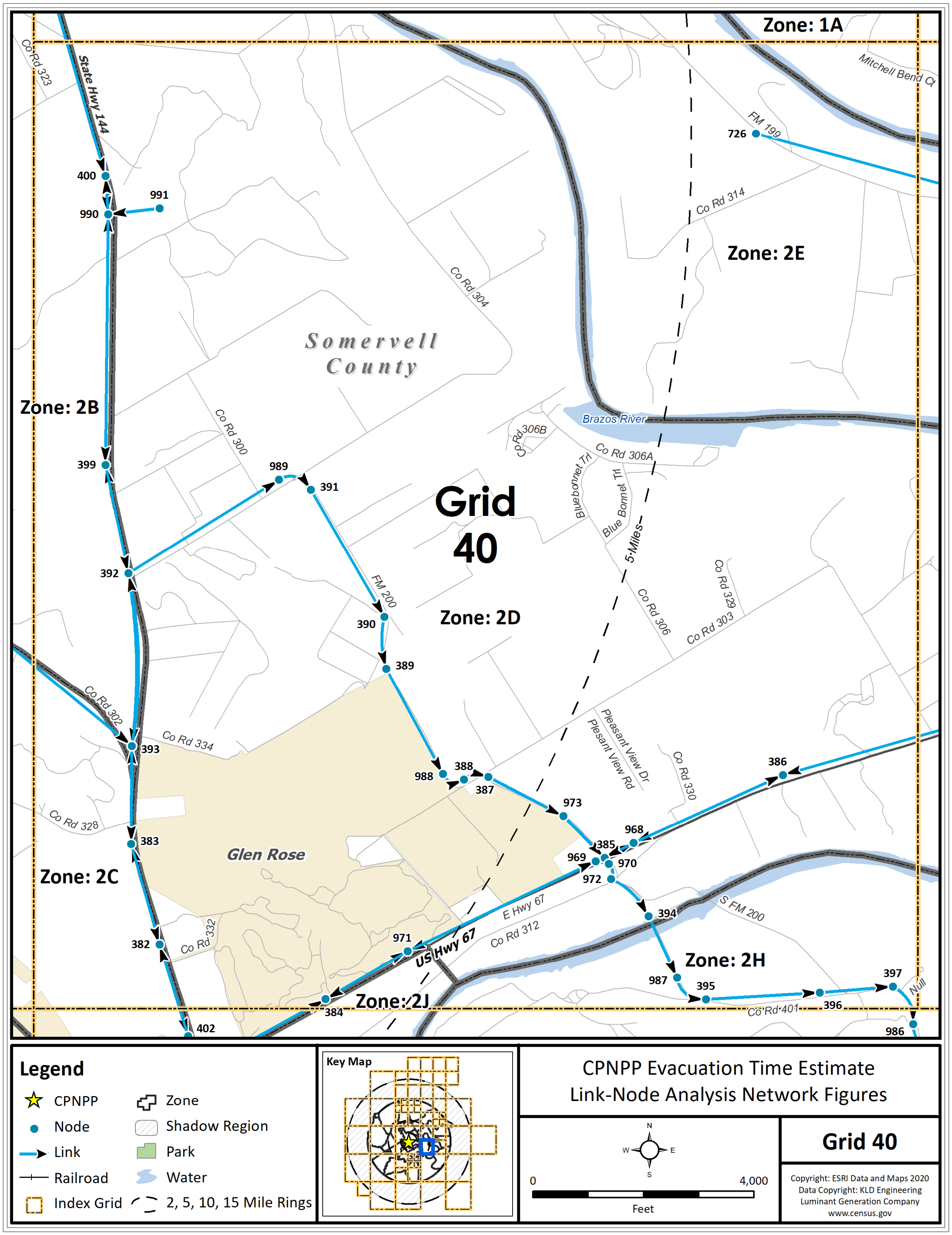

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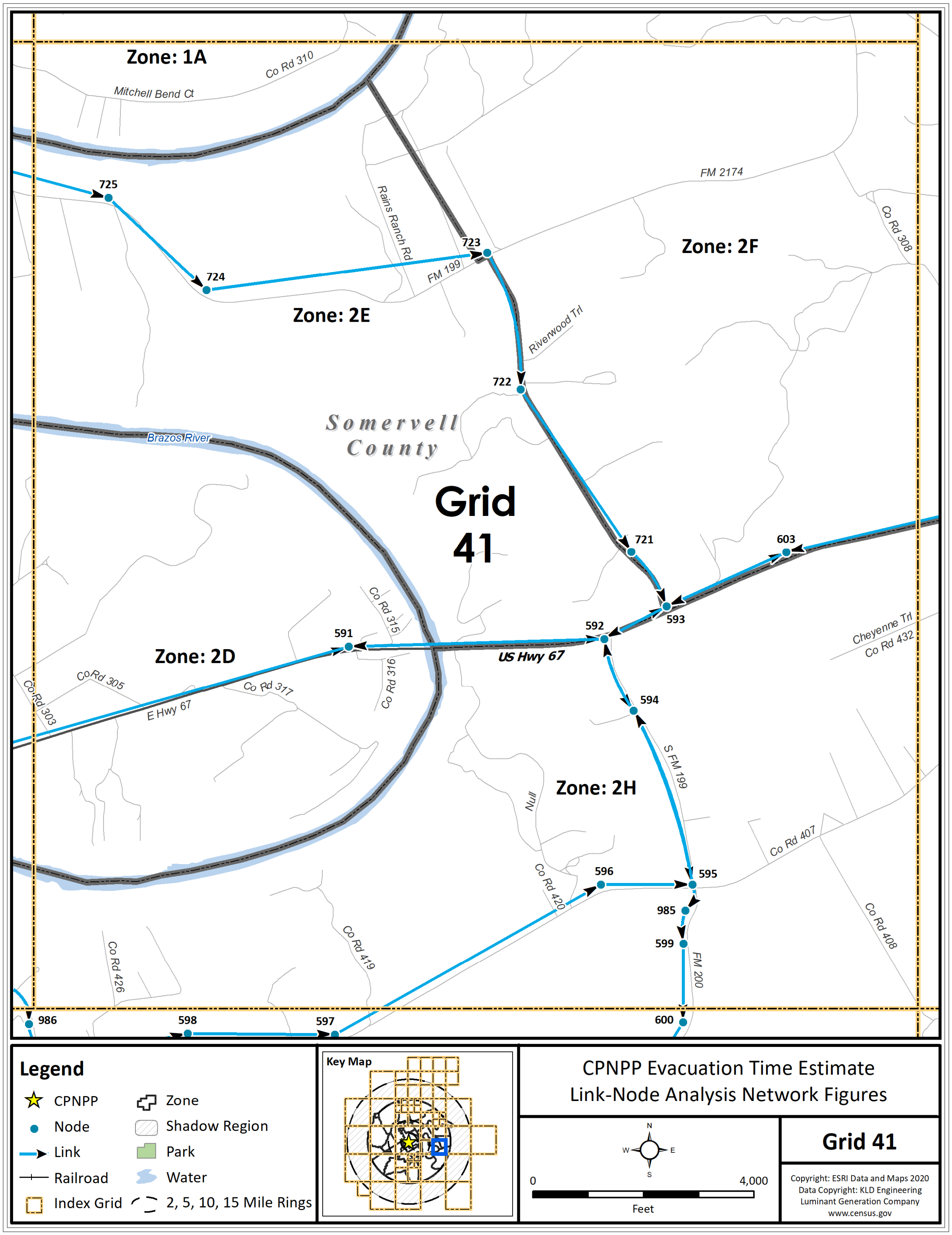

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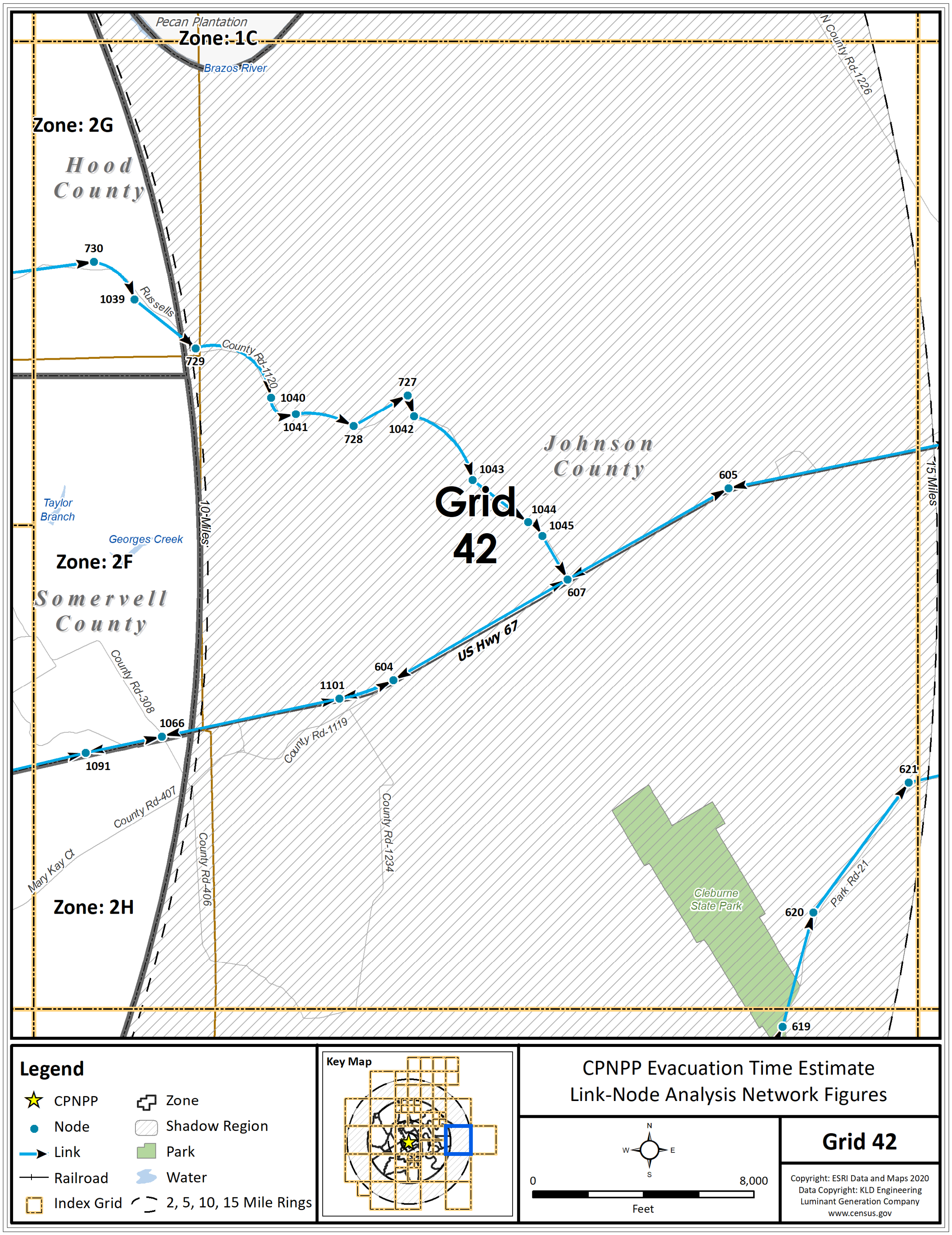

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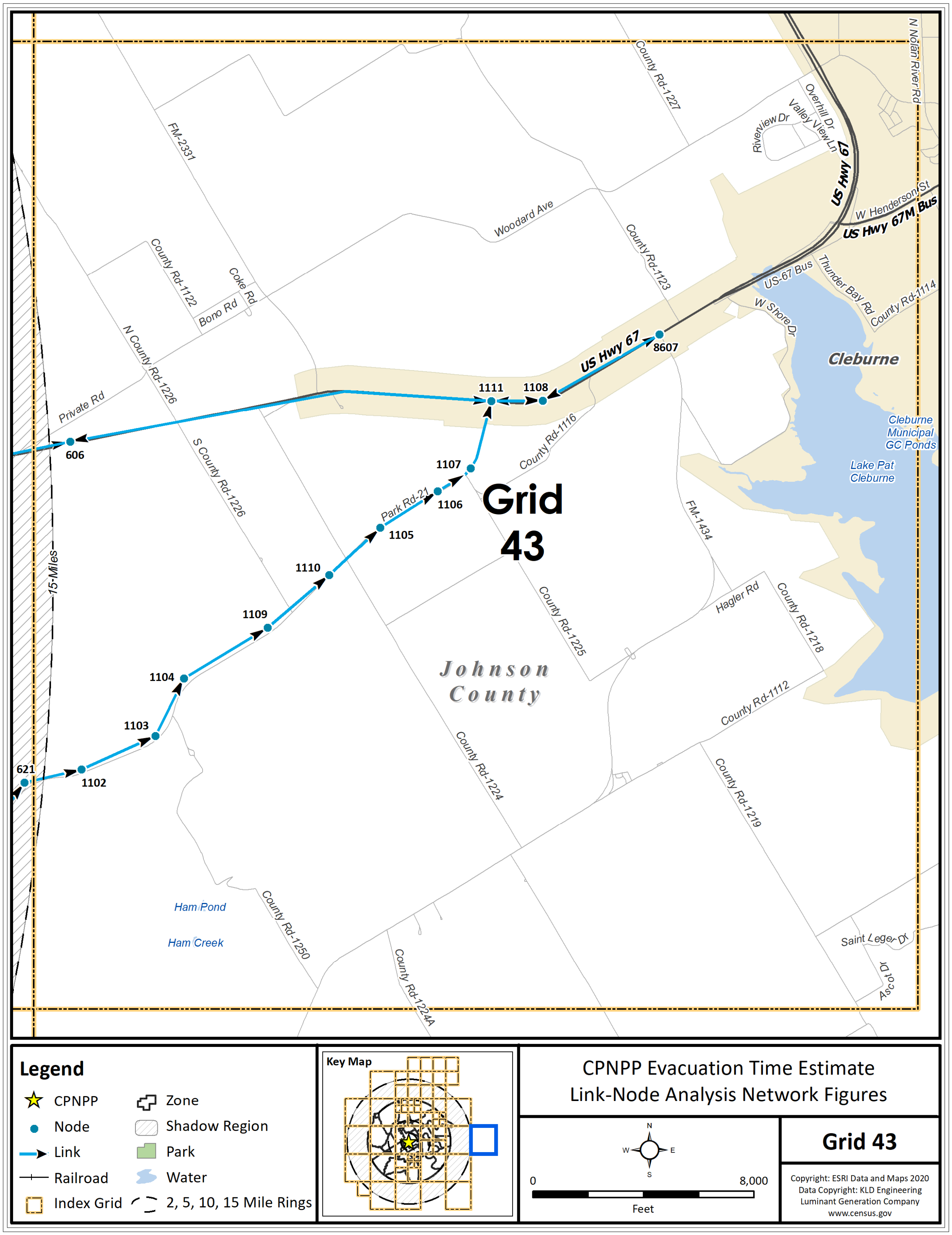

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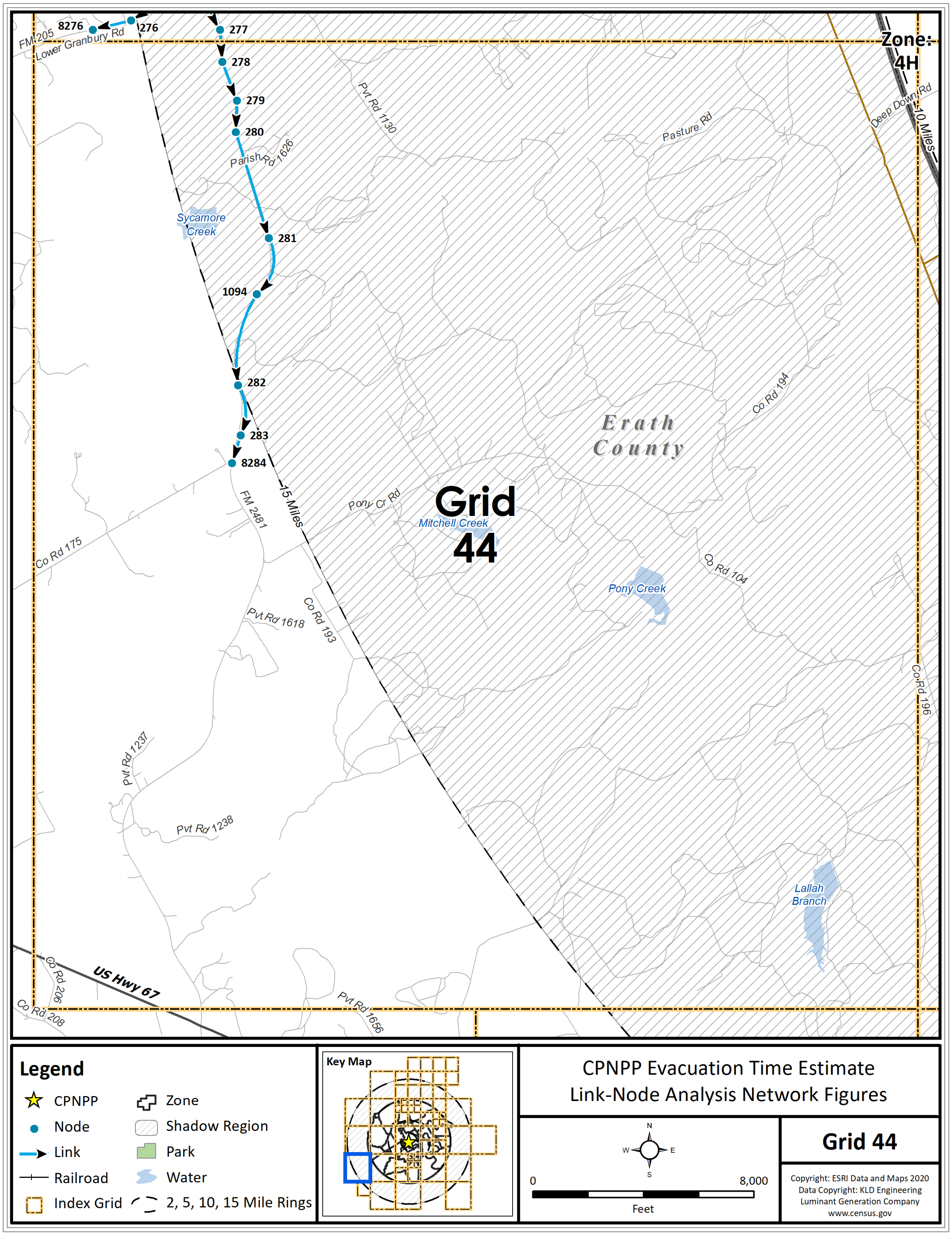

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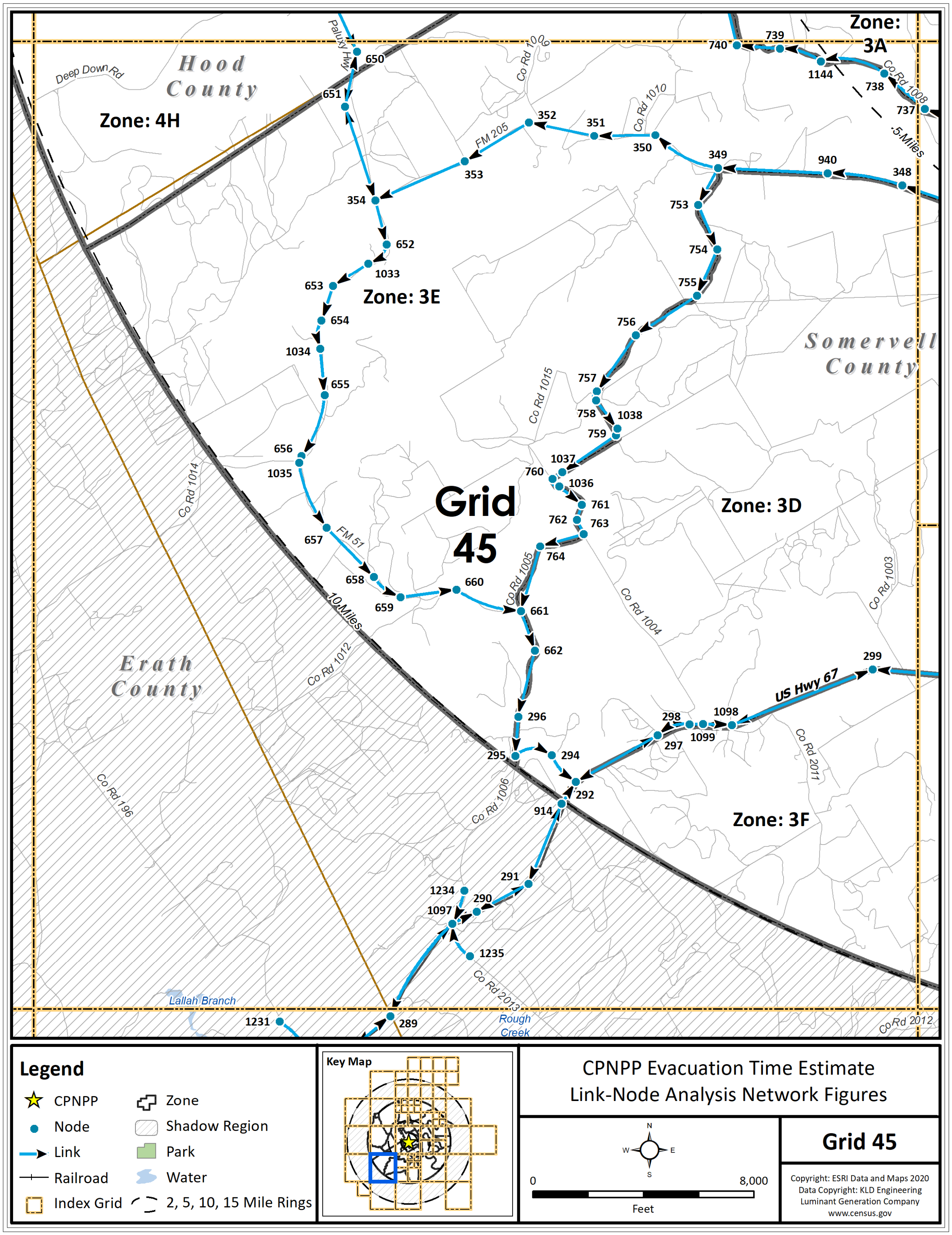

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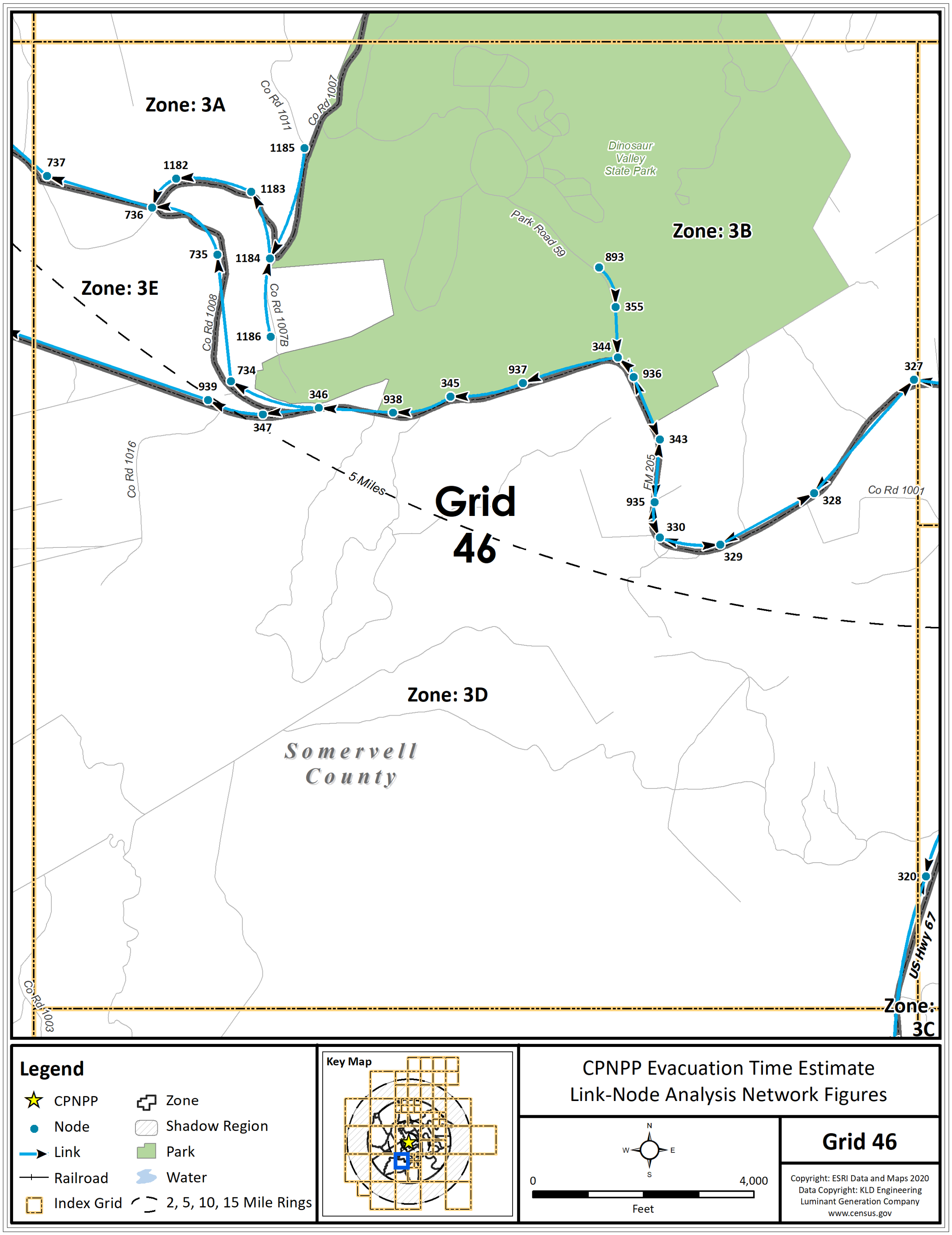

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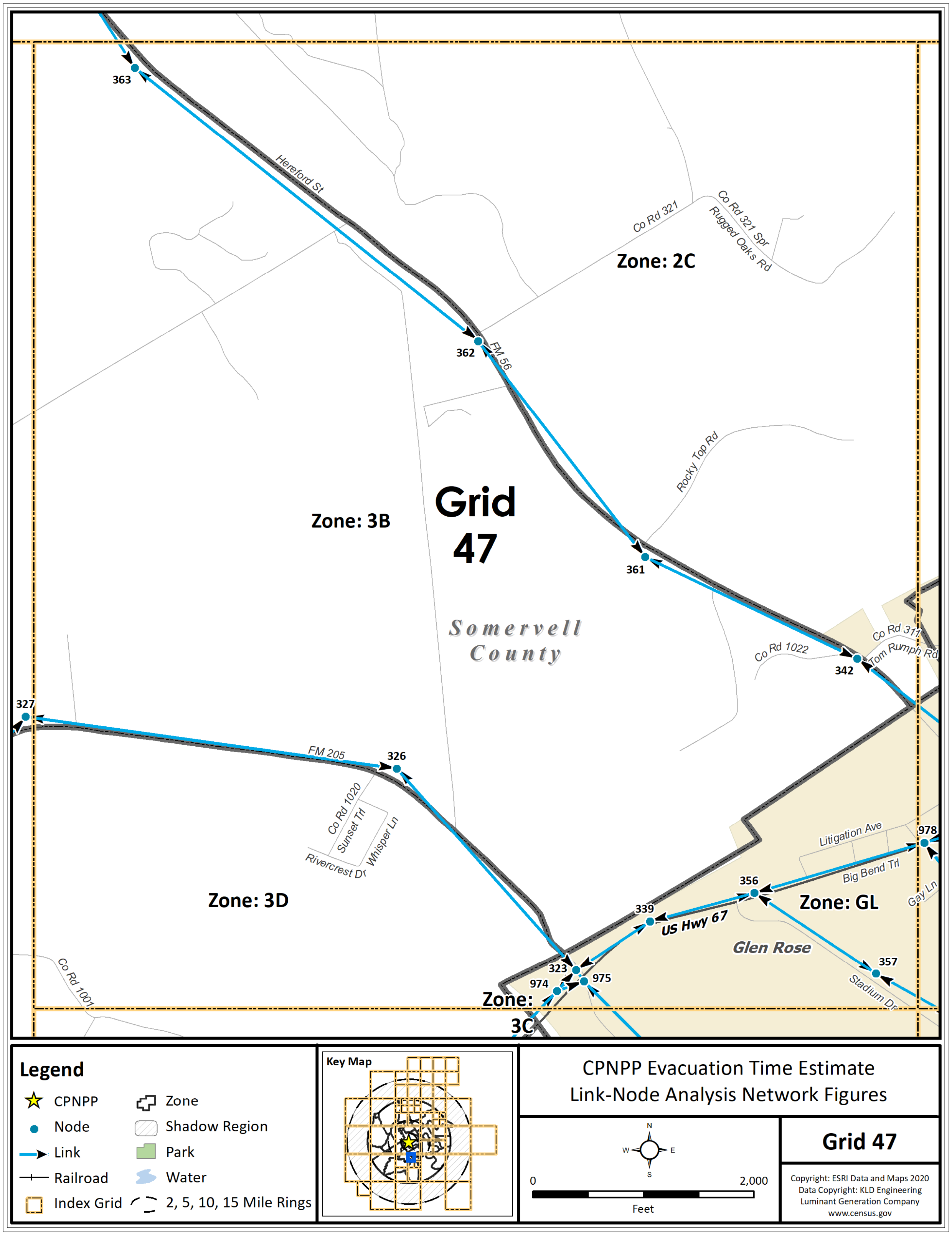

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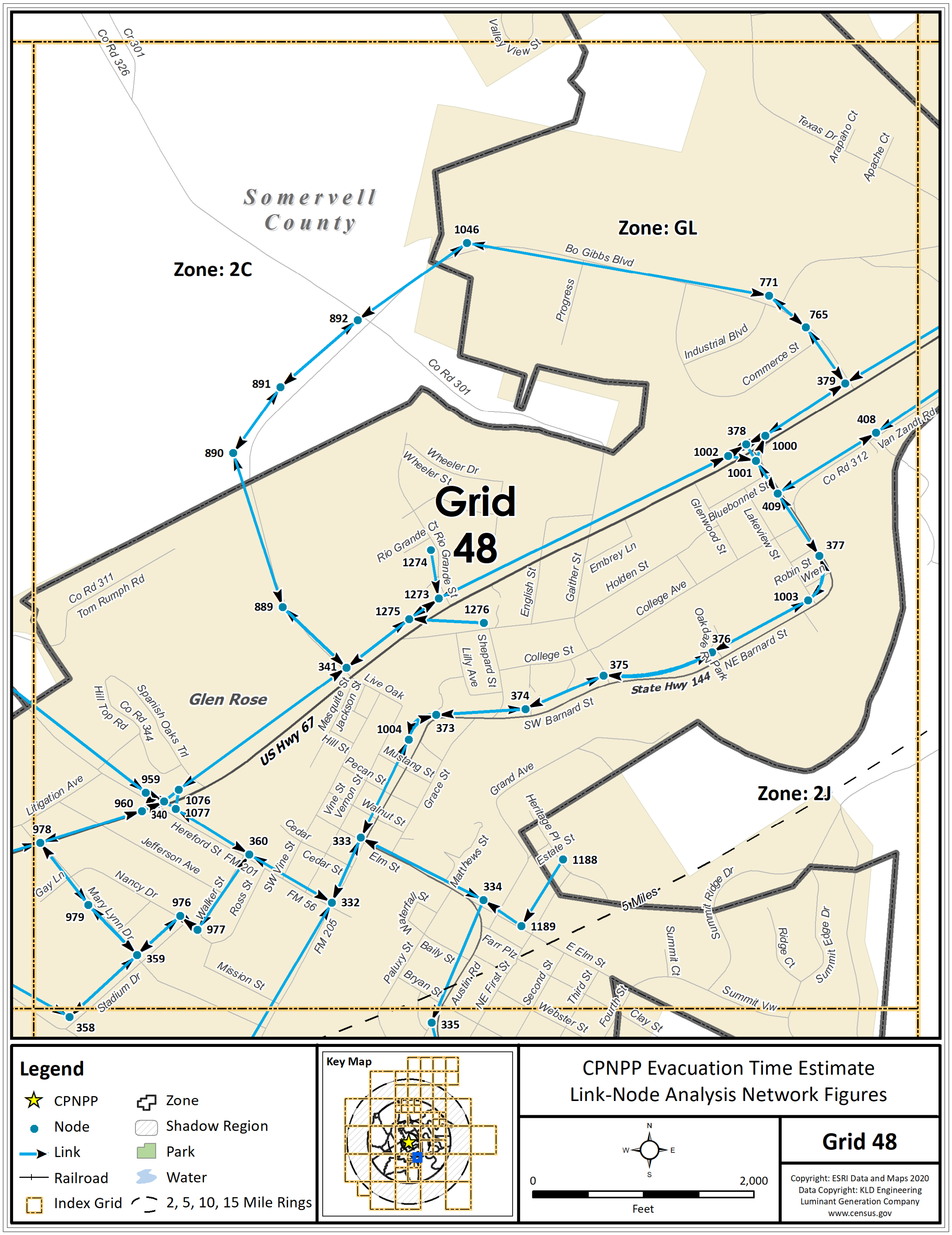
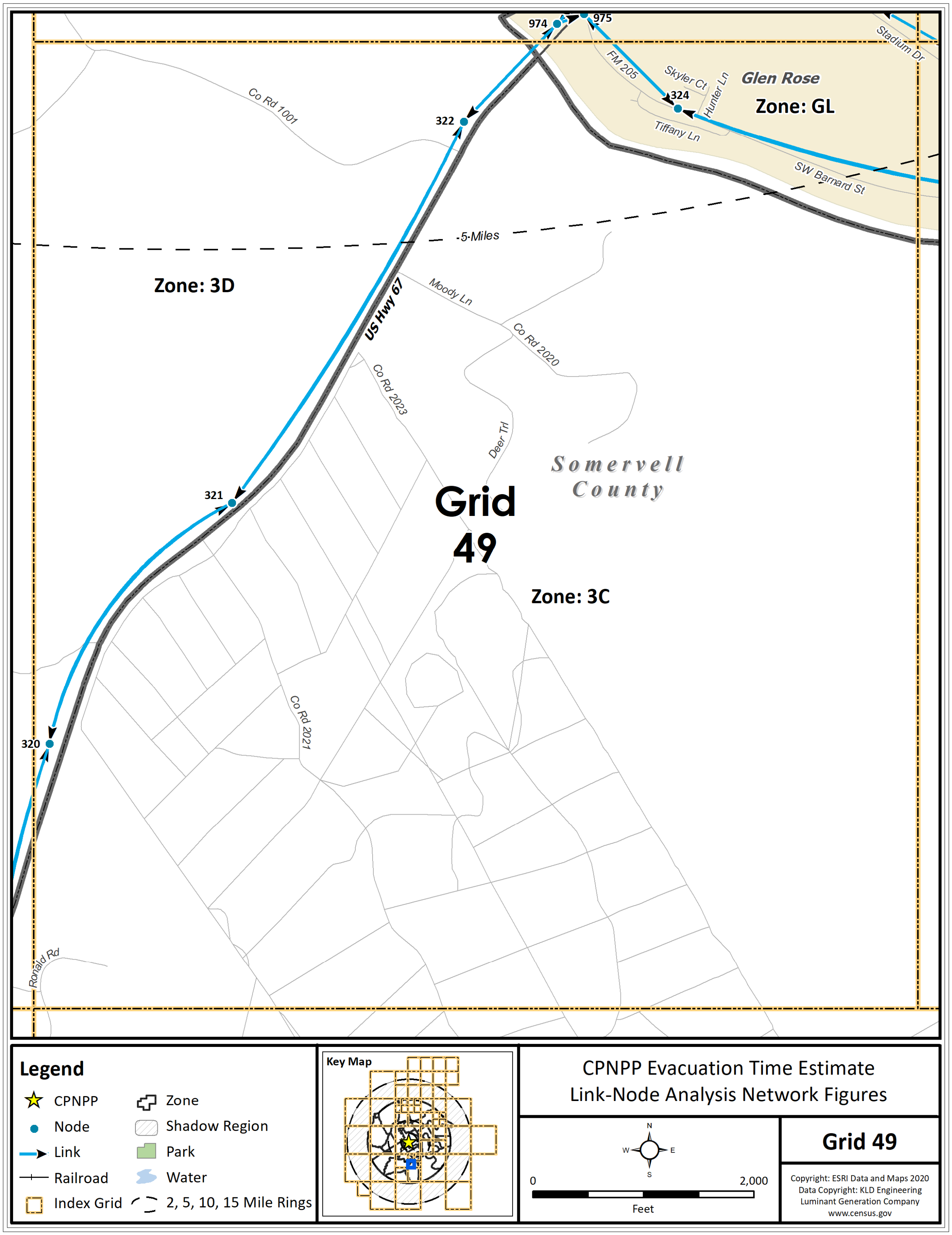


Figure K-49. Link-Node Analysis Network – Grid 48



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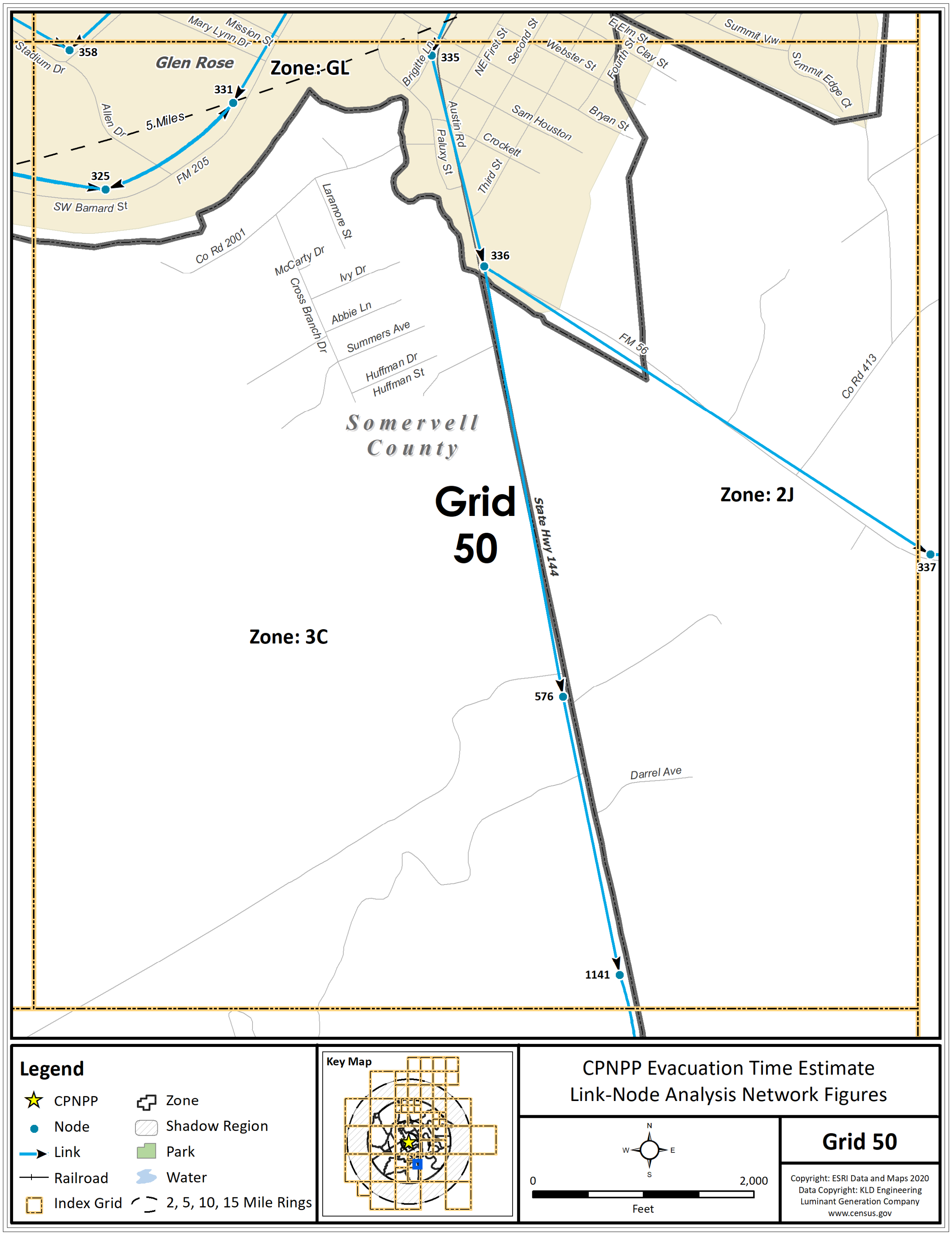

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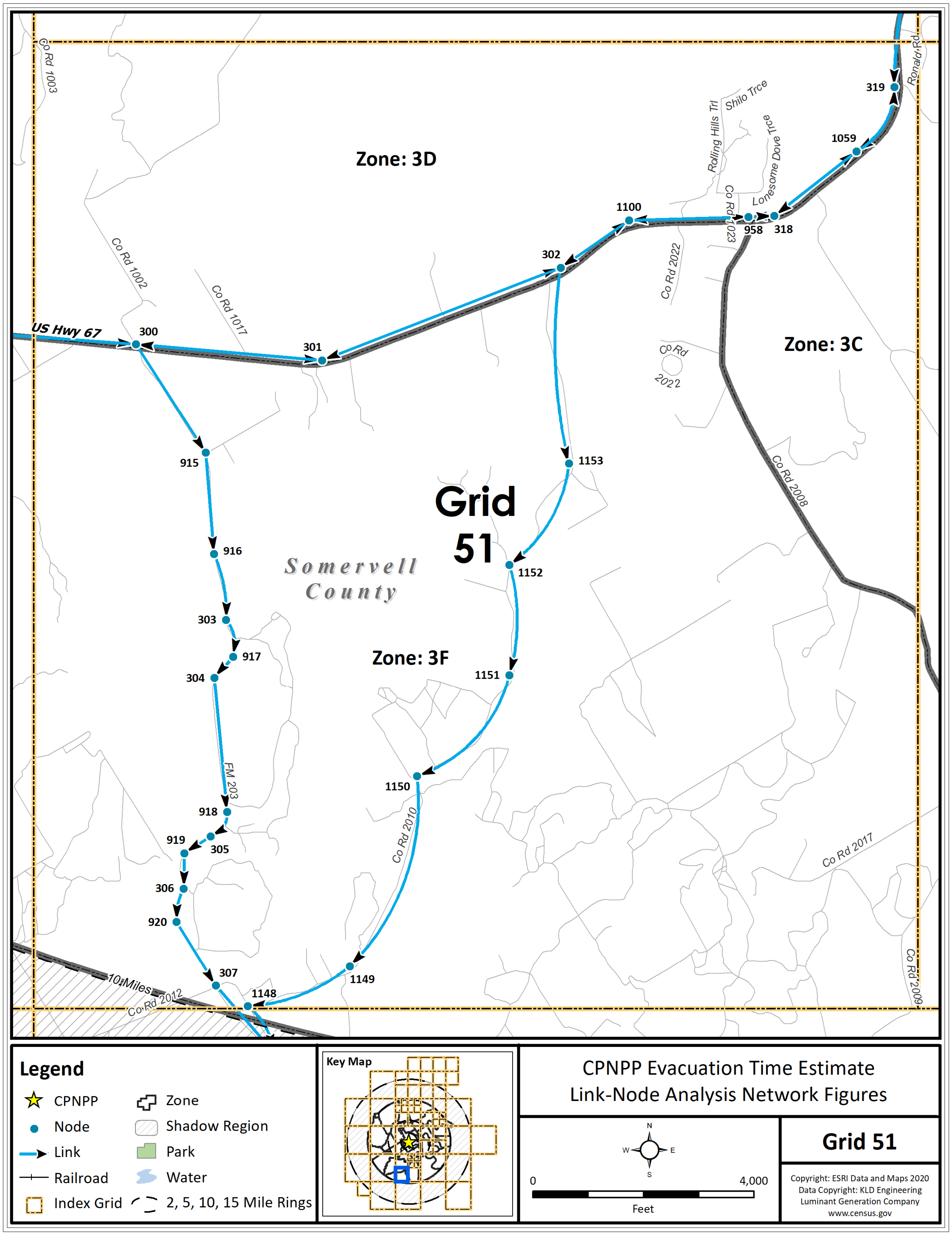


Figure K-52. Link-Node Analysis Network – Grid 51

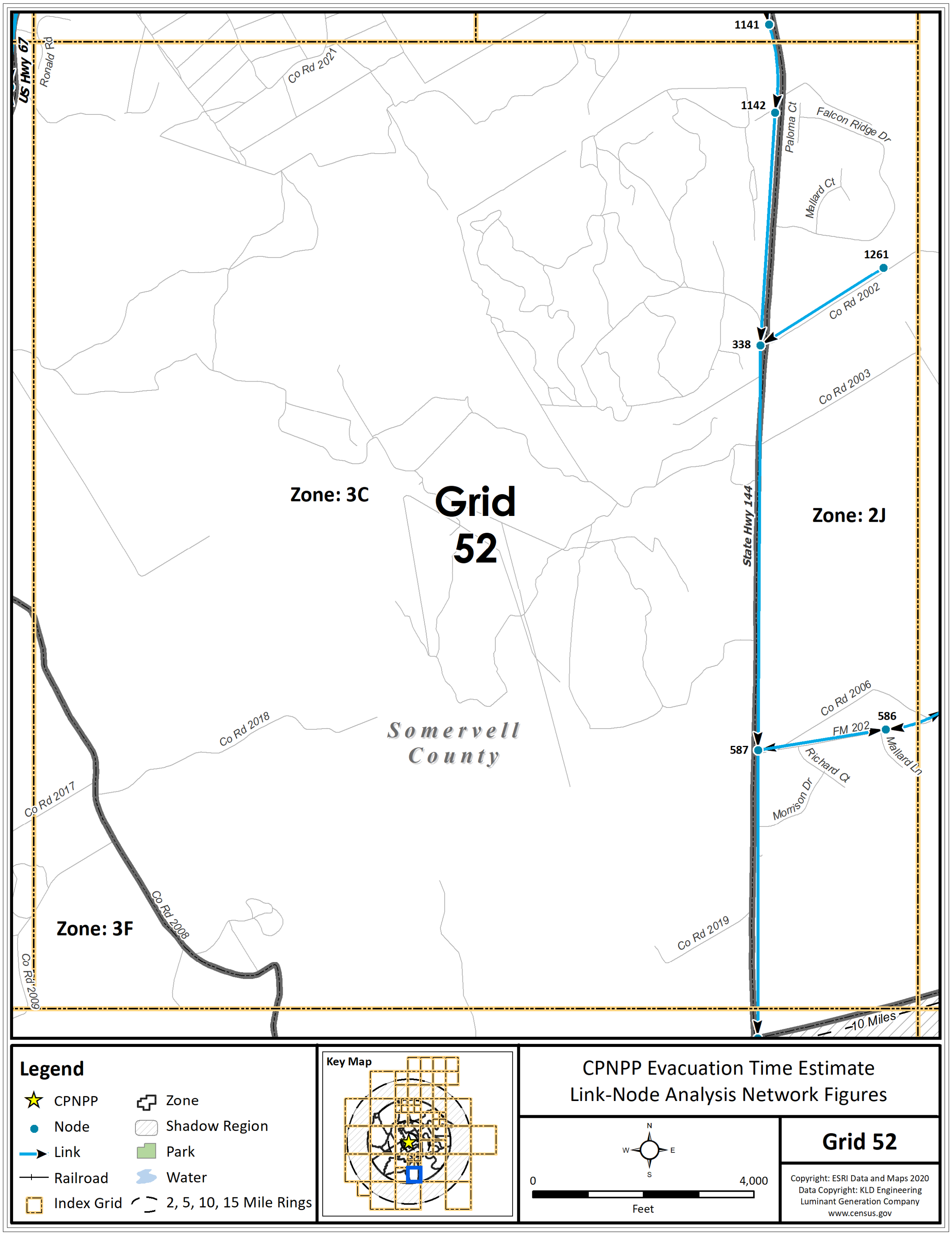
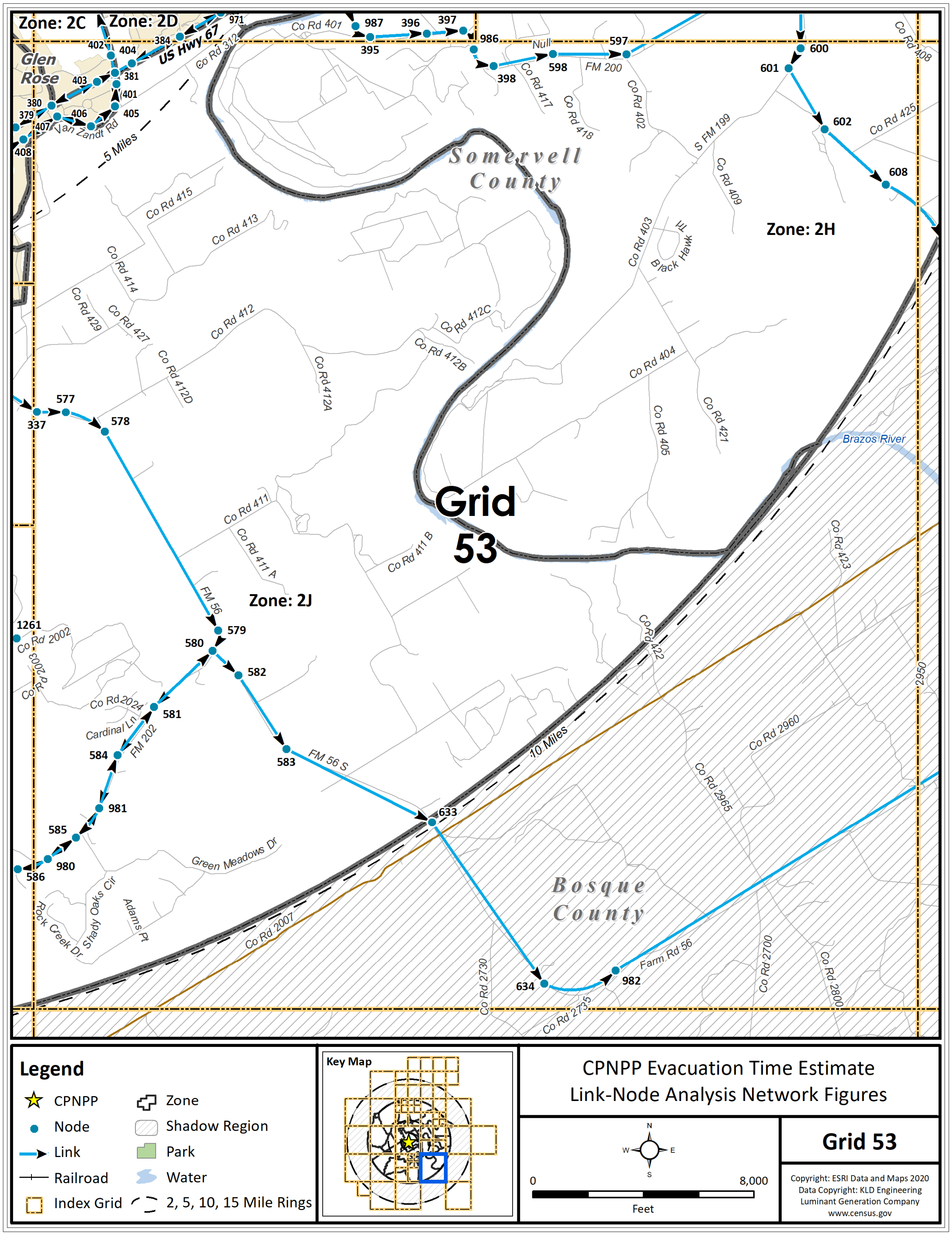


Figure K-53. Link-Node Analysis Network – Grid 52



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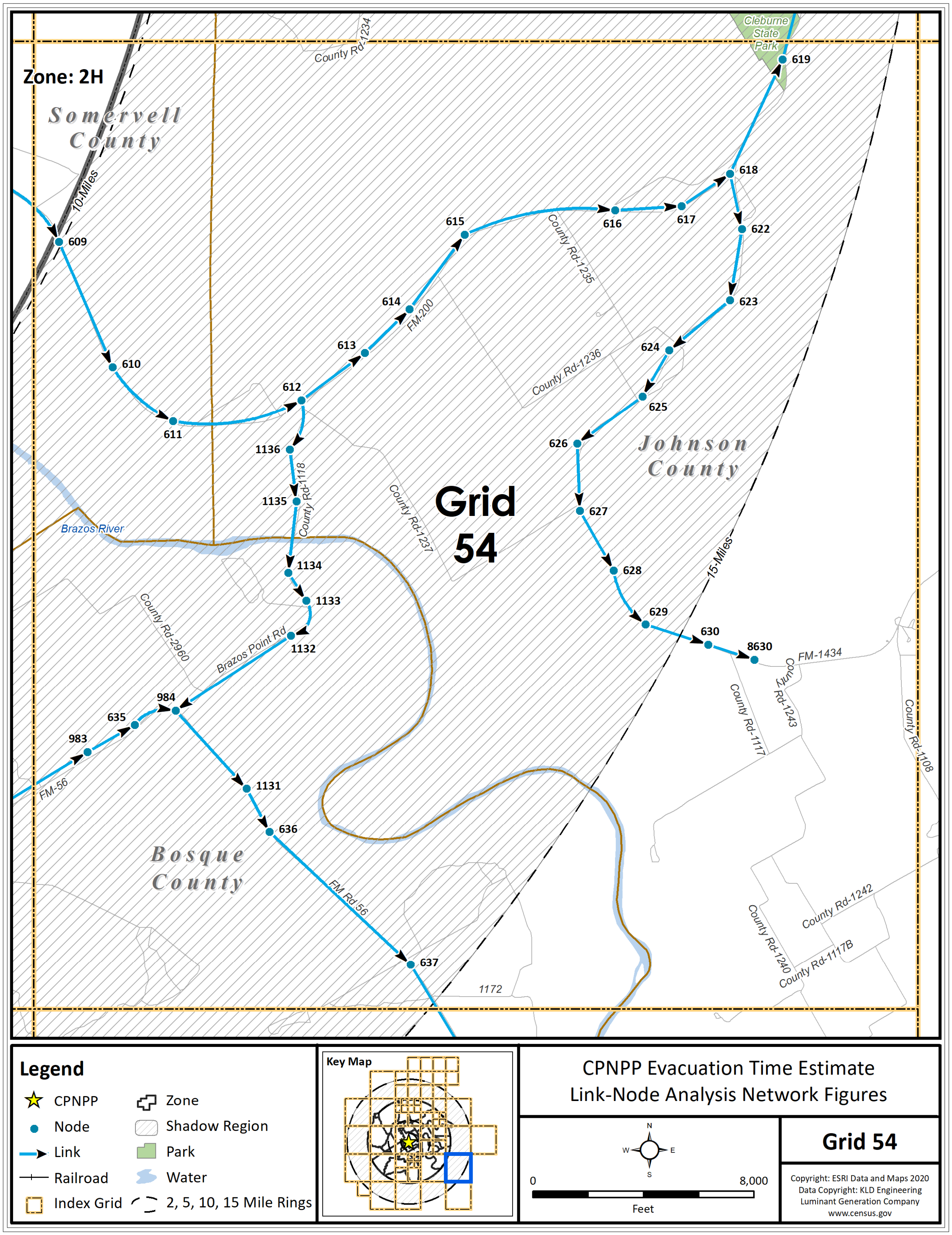
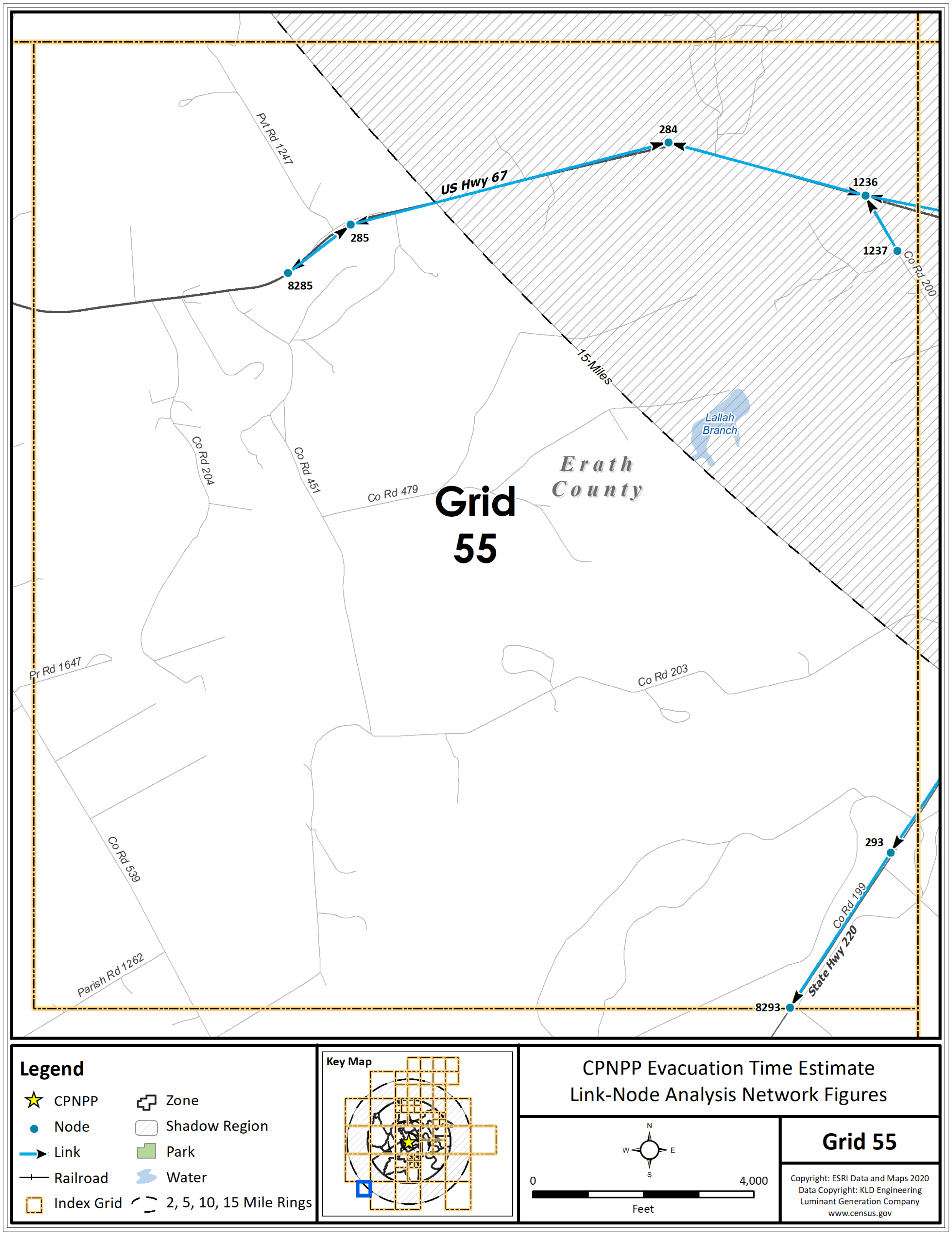


Figure K-55. Link-Node Analysis Network – Grid 54



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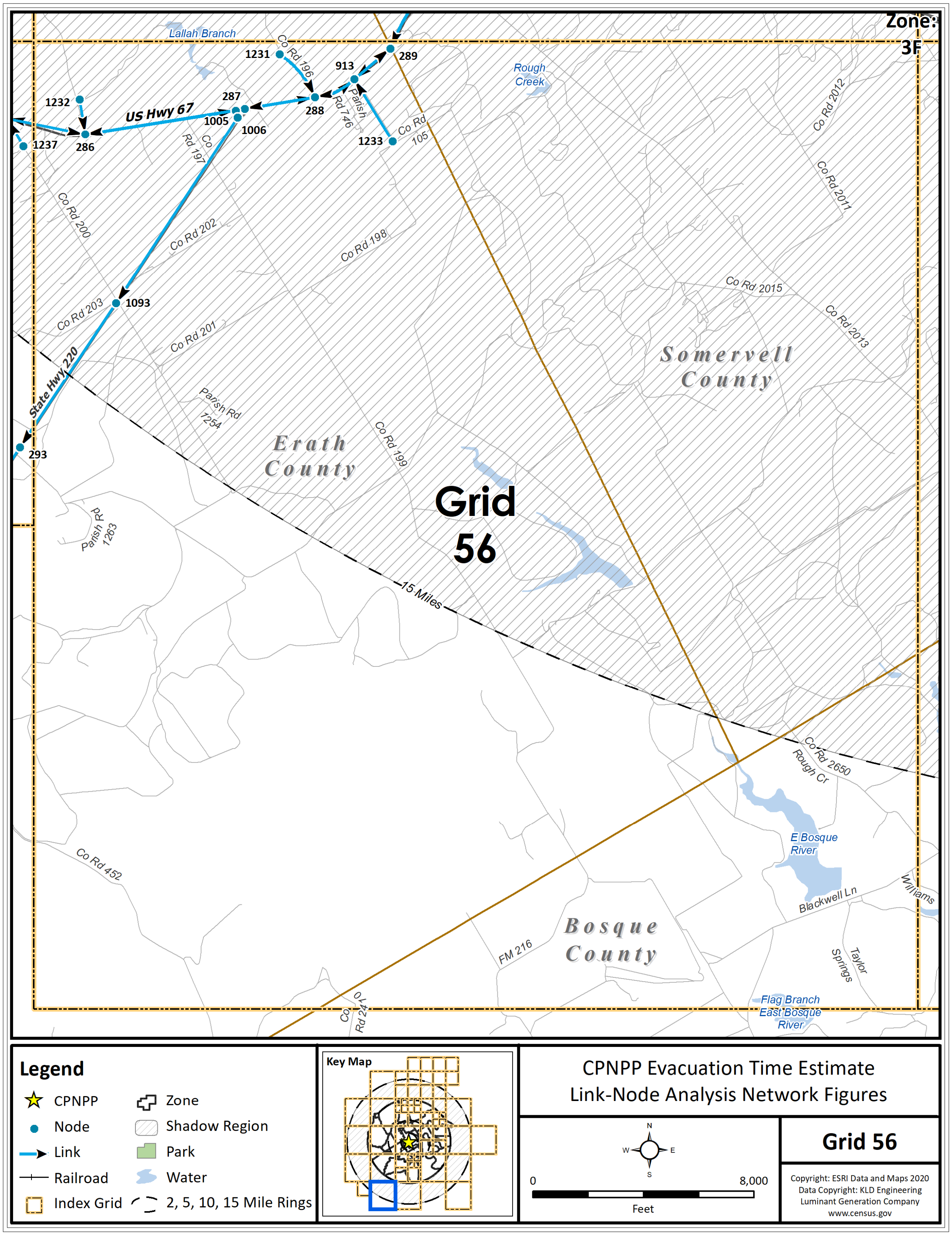
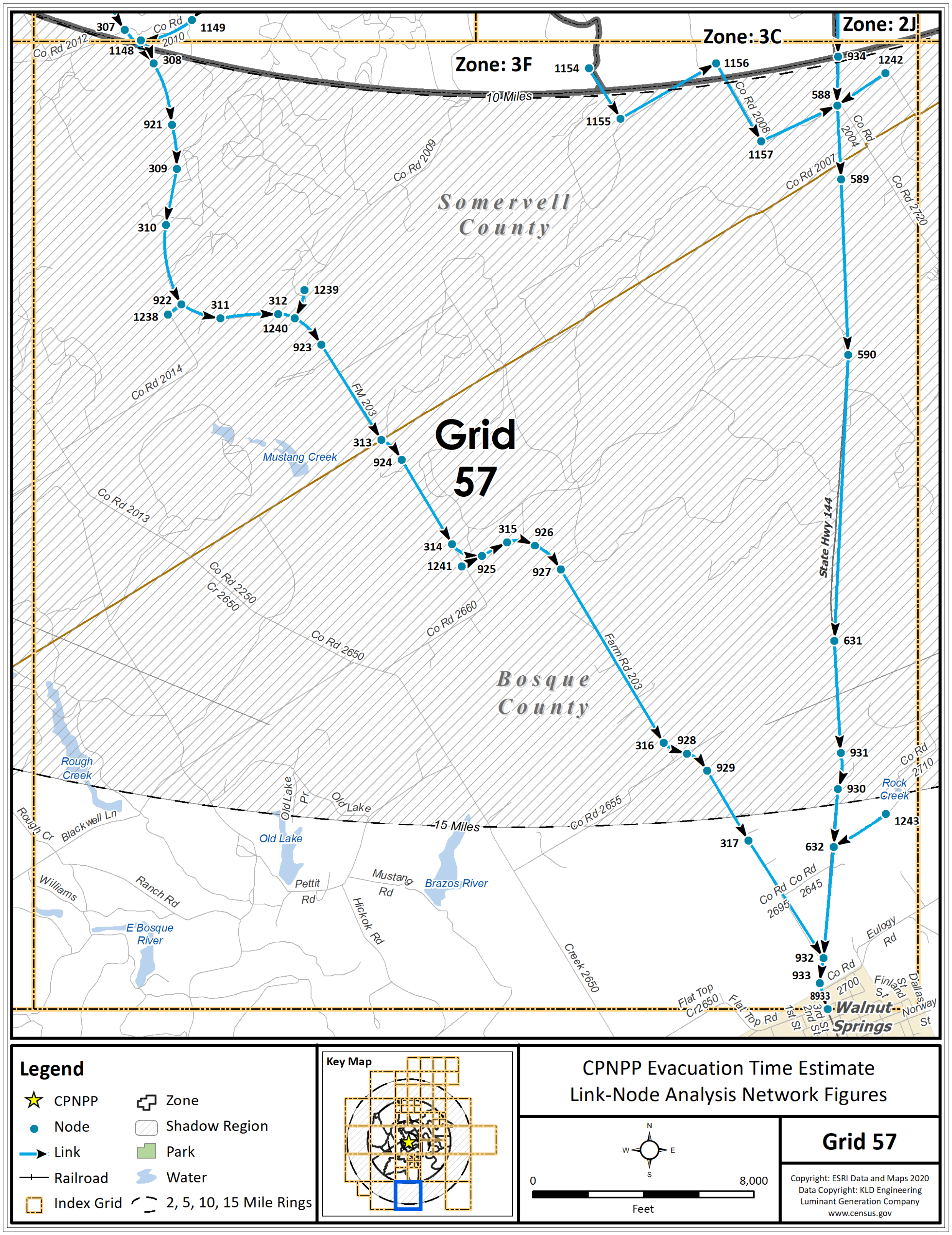


Figure K-57. Link-Node Analysis Network – Grid 56



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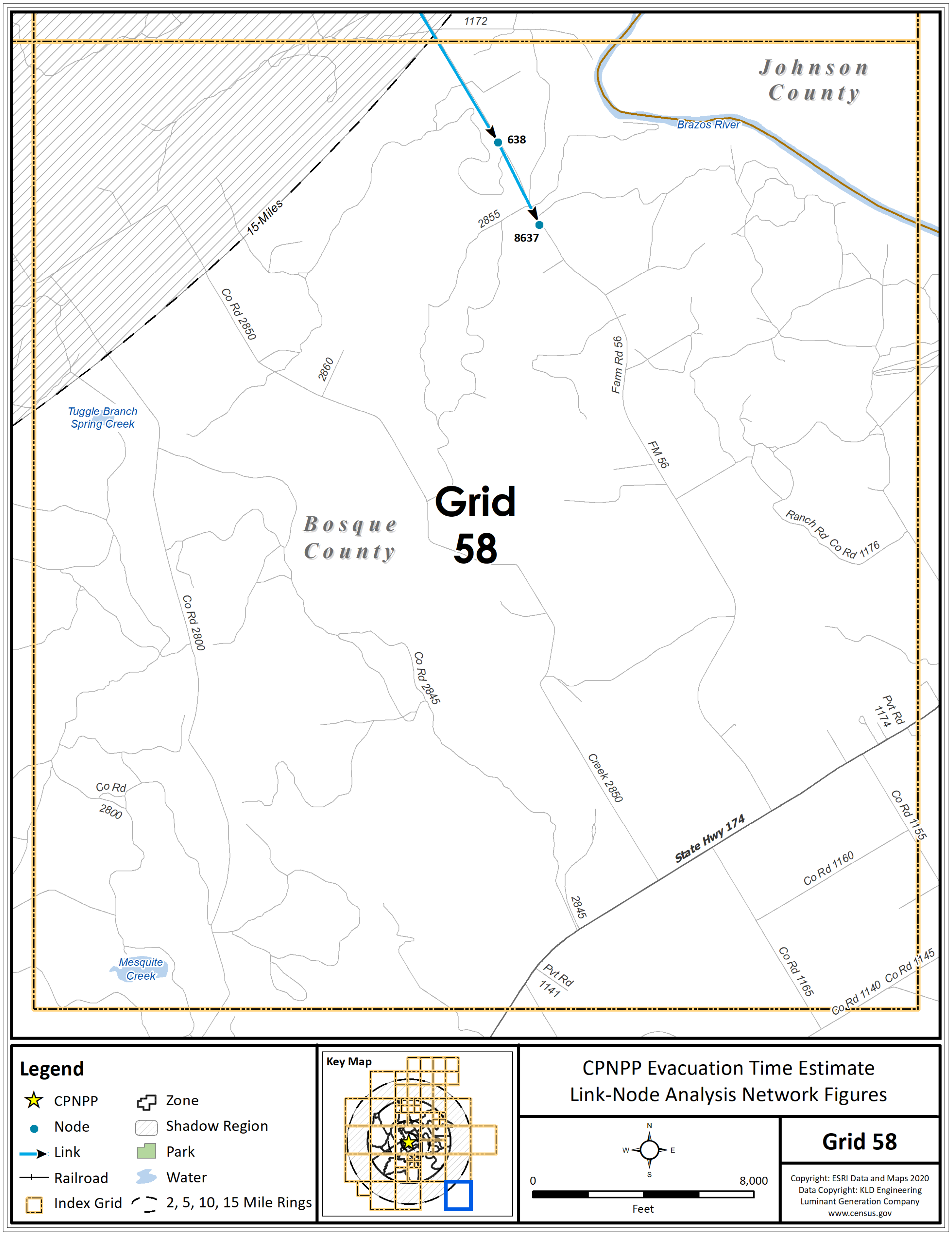

Figure K-59. Link-Node Analysis Network – Grid 58

APPENDIX L

Zone Boundaries

L. ZONE BOUNDARIES EVACUATION ROUTES

Zone CPNPP — Counties: Hood and Somervell

Defined as the area within the following boundary: Comanche Peak Nuclear Power Plant (CPNPP) Boundary

Zone 1A — Counties: Hood and Somervell

Defined as the area within the following boundary:

North: Hayworth Highway (Farm to Market (FM) 2425) and River Country Lane

East: Brazos River

South: Brazos River and Mitchell Bend to River

West: Glen Rose Highway (Highway 144)

Zone 1B — County: Hood

Defined as the area within the following boundary:

North: Mambrino Highway (FM 2425)

East: Hayworth Highway (FM 2425)

South: Mitchell Bend Highway (FM 2425)

West: Glen Rose Highway (Highway 144)

Zone 1C — County: Hood

Defined as the area within the following boundary:

North: Mambrino Highway (FM 3210), Power Plant Court, and Lake Granbury

East: Brazos River and Fall Creek Highway (FM 167)

South: River Country Lane and Brazos River

West: Mambrino Highway (FM 2425) and Brazos River

Zone 1D — County: Hood

Defined as the area within the following boundary:

North: Pearl Street

East: FM 167, 10-mile limit

South: Mambrino Highway (FM 2425/ FM 3210), Power Plant Court and Lake Granbury

West: Glen Rose Highway (Highway 144), Morgan Street

Zone 2A County: Somervell

Defined as the area within the following boundary:

North: CPNPP boundary

East: County Road 302

South: County Road 318 and 313

West: FM 56

Zone 2B County: Somervell

Defined as the area within the following boundary:

North: Somervell/Hood County Line

East: Highway 144

South: County Road 302

West: County Road 302 and CPNPP boundary

Zone 2C County: Somervell

Defined as the area within the following boundary:

North: County Road 318 and 313

East: County Road 302 and Highway 144

South: Glen Rose north city limits

West: FM 56

Zone 2D County: Somervell

Defined as the area within the following boundary:

North: Somervell /Hood County Line

East: Brazos River

South: Brazos River and Highway 67

West: Highway 144

Zone 2E County: Hood and Somervell

Defined as the area within the following boundary:

North: Brazos River

East: FM 199

South: Highway 67

West: Brazos River

Zone 2F County: Somervell

Defined as the area within the following boundary:

North: Somervell/Hood County Line

East: Johnson County Line

South: Highway 67

West: FM 199

Zone 2G County: Hood

Defined as the area within the following boundary:

North: Brazos River

East: Johnson County Line, 10-mile limit

South: Hood County Line

West: Brazos River

Zone 2H County: Somervell

Defined as the area within the following boundary:

North: Highway 67 and Brazos River

East: 10-mile limit

South: Brazos River and 10-mile limit

West: Brazos River

Zone 2J County: Somervell

Defined as the area within the following boundary:

North: Glen Rose south city limits and Highway 67

East: Brazos River

South: 10-mile limit

West: Highway 144

Zone 3A County: Somervell

Defined as the area within the following boundary:

North: Somervell/Hood County Line

East: FM 56

South: County Road 1007

West: County Road 1008

Zone 3B County: Somervell

Defined as the area within the following boundary:

North: County Road 1007

East: FM 56

South: FM 205

West: County Road 1007

Zone 3C County: Somervell

Defined as the area within the following boundary:

North: Glen Rose south city limits

East: Highway 144

South: 10-mile limit

West: County Road 2008 and Highway 67

Zone 3D County: Somervell

Defined as the area within the following boundary:

North: FM 205

East: Highway 67

South: Highway 67

West: County Road 1004

Zone 3E County: Somervell

Defined as the area within the following boundary:

North: Somervell/Hood County Line and County Road 1008

East: County Road 1004 and FM 51

South: County Road 1004 and 10-mile limit

West: Somervell/Hood County Line and 10-mile limit

Zone 3F County: Somervell

Defined as the area within the following boundary:

North: Highway 67

East: County Road 2008

South: 10-mile limit

West: Highway 67 and 10-mile limit

Zone 4A County: Hood

Defined as the area within the following boundary:

North: Coates Road

East: Glen Rose Highway (Highway 144)

South: CPNPP boundary and Hood/Somervell County Line

West: CPNPP boundary

Zone 4B County: Hood

Defined as the area within the following boundary:

North: Cripple Creek Court, Neri Road and Pear Orchard Road

East: Glen Rose Highway (Highway 144)

South: Coates Road

West: CPNPP boundary and Cripple Creek Court Highway 67

Zone 4C County: Hood

Defined as the area within the following boundary:

North: Paluxy Highway (FM 51) and Neri Road

East: Cripple Creek Court, Pear Orchard Rd, Neri Road and CPNPP boundary

South: Hood/Somervell County Line

West: Hill City Highway (FM 56) and Paluxy Highway (FM 51)

Zone 4D County: Hood

Defined as the area within the following boundary:

North: Paluxy Highway (FM 51)

East: Hill City Highway (FM 56)

South: Hood/Somervell County Line

West: Paluxy Highway (FM 51) and Edwards Road

Zone 4E County: Hood

Defined as the area within the following boundary:

North: Pearl Street

East: Glen Rose Highway (Highway 144)

South: Neri Road

West: Paluxy Highway (FM 51), Holmes Drive

Zone 4F	<u>County:</u> Hood	
	<u>Defined as the area within the following boundary:</u>	
	North:	10-mile limit, W. US Highway 377 and Loop 567
	East:	Paluxy Highway (FM 51)
	South:	Paluxy Highway (FM 51)
	West:	Hill City Highway (FM 56)
Zone 4G	<u>County:</u> Hood	
	<u>Defined as the area within the following boundary:</u>	
	North:	Tolar south city limits, W. US Highway 377
	East:	Hill City Highway (FM 56)
	South:	Paluxy Highway (FM 51), Bakers Crossing Road
	West:	10-mile limit and Rock Church Highway
Zone 4H	<u>County:</u> Hood	
	<u>Defined as the area within the following boundary:</u>	
	North:	Bakers Crossing Road
	East: Edwards Road	
	South:	Hood/Somervell County Line
	West:	10-mile limit, FM 51
Glen Rose	<u>County:</u> Somervell	
	<u>Defined as the area within the following boundary:</u> City Limits Highway 67	
Tolar	<u>County:</u> Hood	
	<u>Defined as the area within the following boundary:</u> City Limits	

APPENDIX M

Evacuation Sensitivity Studies

M. EVACUATION SENSITIVITY STUDIES

This appendix presents the results of a series of sensitivity analyses. These analyses are designed to identify the sensitivity of the Evacuation Time Estimates (ETE) to changes in some base evacuation conditions.

M.1 Effect of Changes in Trip Generation Times

A sensitivity study was performed to determine whether changes in the estimated trip generation time have an effect on the ETE for the entire Emergency Planning Zone (EPZ). Specifically, if the tail of the mobilization distribution were truncated (i.e., if those who responded most slowly to the Advisory to Evacuate (ATE), could be persuaded to respond much more rapidly or if the tail were elongated (i.e., spreading out the departure of evacuated to limit the demand during peak times), how would the ETE be affected? The case considered was Scenario 1, Region 3; a summer, midweek, midday, with good weather evacuation of the entire EPZ. Table M-1 presents the results of this study.

If evacuees mobilize in one hour quicker, the 90th percentile ETE remains the same and the 100th percentile ETE is reduced by 35 minutes – a significant change. An increase in mobilization time by 1 hour increases the 90th percentile ETE by 10 minutes and the 100th percentile ETE by 1 hour – a significant change.

As discussed in Section 7.3, traffic congestion within the EPZ clears at about 4 hours and 30 minutes after the ATE. As such, congestion dictates the 100th percentile ETE until 4 hours and 30 minutes after the ATE. After this time, trip generation (plus a 10-minute travel time to the EPZ boundary) dictates the 100th percentile ETE. Therefore, shortening the trip generation below 4 hours and 30 minutes, the 100th percentile ETE is dictated by the congestion, while elongating the trip generation above 4 hours and 30 minutes, the 100th percentile ETE is dictated by the trip generation time (plus a 10-minute travel time to the EPZ boundary). The 90th percentile ETE, however, are relatively insensitive to truncating or elongating the tail of the mobilization time distribution.

M.2 Effect of Changes in the Number of People in the Shadow Region Who Relocate

A sensitivity study was conducted to determine the effect on ETE due to changes in the percentage of people who decide to relocate from the Shadow Region. The case considered was Scenario 1, Region 3; a summer, midweek, midday, with good weather evacuation for the entire EPZ. The movement of people in the Shadow Region has the potential to impede vehicles evacuating from an Evacuation Region within the EPZ. Refer to Sections 3.2 and 7.1 for additional information on population within the Shadow Region.

Table M-2 presents the ETE for each of the cases considered. The results show that eliminating the shadow evacuation (0%) decreases the 90th percentile ETE by 5 minutes – not a significant change – and does not impact the 100th percentile ETE. Tripling (60%) the shadow evacuation increases the 90th percentile ETE by 15 minutes and has no impact to the 100th percentile ETE. A full evacuation

(100%) of the Shadow Region increases the 90th and 100th percentile ETE by 30 minutes (significant impact) and 15 minutes (minimal impact) respectively.

Note that the demographic survey results presented in Appendix F, indicate that approximately 11% of households would elect to evacuate if advised to shelter, which differs from the assumption of 20% non-compliance as suggested in NUREG/CR-7002, Rev. 1. A sensitivity study was considered using a 11% shadow evacuation and the 90th and 100th percentile ETEs were not affected.

The Shadow Region for CPNPP is sparsely populated except for near population centers of Granbury, Bluff Dale, Brazos Bend, and DeCordova. As shown in Figure 7-3 through 7-8, congestion exists within the Shadow Region, such that the EPZ evacuees would be delayed. Therefore, any additional shadow residents that decide to voluntarily evacuate increase this congestion, delay the egress of EPZ evacuees and prolong ETE.

M.3 Effect of Changes in EPZ Resident Population

A sensitivity study was conducted to determine the effect on ETE due to changes in the permanent resident population within the study area (EPZ plus Shadow Region). As population in the study area changes over time, the time required to evacuate the public may increase, decrease, or remain the same. Since the ETE is related to the demand to capacity ratio present within the study area, changes in population will cause the demand side of the equation to change and could impact ETE.

As per the NRC's response to the Emergency Planning Frequently Asked Question (EPFAQ) 2013-001, the ETE population sensitivity study must be conducted to determine what percentage increase in permanent resident population causes an increase in the 90th percentile ETE of 25% or 30 minutes, whichever is less. The sensitivity study must use the scenario with the <u>longest 90th percentile ETE</u> (excluding the roadway impact scenario and the special event scenario if it is a one day per year special event)

Thus, the sensitivity study was conducted using the following planning assumptions:

1. The percent change in population within the study area was increased by up to 18%. Changes in population were applied to the permanent resident population only (as per federal guidance), in both the EPZ area and in the Shadow Region.
2. The transportation infrastructure remained fixed (as presented in Appendix K); the presence of future proposed roadway changes and/or highway capacity improvements were not considered.
3. The study was performed for the 2-Mile Region (R01), the 5-Mile Region (R02) and the entire EPZ (R03).
4. The scenario (excluding roadway impact and special event) which yielded the <u>longest 90th percentile ETE</u> values was selected as the case to be considered in this sensitivity study (Scenario 9 - Winter, Weekend, Midday, with Rain).

Table M-3 presents the results of the sensitivity study. Section IV of Appendix E to 10 CFR Part 50, and NUREG/CR-7002, Rev. 1, Section 5.4, require licensees to provide an updated ETE analysis to the NRC when a population increase within the EPZ causes the longest 90th percentile ETE values (for the 2-Mile Region, 5-Mile Region or entire EPZ) to increase by 25% or 30 minutes, whichever is less. All base ETE values are greater than 2 hours; 25% of these base ETE is always equal or greater than 30 minutes. Therefore, 30 minutes is the lesser and is the criterion for updating the ETE.

Those percent population changes which result in the longest 90th percentile ETE change greater than or equal to 30 minutes are highlighted in red in Table M-3 – an 18% or greater increase in the full EPZ permanent resident population. Vistra OpCo will have to estimate the full EPZ population on an annual basis. If the full EPZ population increases by 18% or more, an updated ETE analysis will be needed.

M.4 Enhancements in Evacuation Time

This appendix documents sensitivity studies on critical variables that could potentially impact ETE. Possible improvements to ETE are further discussed below:

- Reducing the trip generation time an hour does not impact the 90th percentile ETE whereas the 100th percentile ETE is reduced by 35 minutes. Prolonging the trip generation time an hour increases the 90th percentile ETE by 10 minutes and 100th percentile ETE increases by 1 hour respectively, since trip generation within the EPZ dictates ETE (Section M.1).
- Increasing the percent shadow evacuation has material impact on ETE (Section M.2). As such, public outreach could be considered to inform those people within the EPZ (and potentially beyond the EPZ) that if they are not advised to evacuate, they should not.
- Population growth results (Section M.3) in more evacuating vehicles, which could significantly increase ETE. Public outreach to inform people within the EPZ to evacuate as a family in a single vehicle would reduce the number of evacuating vehicles and could reduce ETE or offset the impact of population growth.

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

Trip Generation Time	Evacuation Time Estimate for Entire EPZ	
	90th Percentile	100th Percentile
4 Hours	3:25	4:35
5 Hours (Base)	3:25	5:10
6 Hours	3:35	6:10

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

Percent Shadow Evacuation	Evacuating Shadow Vehicles[1]	Evacuation Time Estimate for Entire EPZ	
		90th Percentile	100th Percentile
0	0	3:20	5:10
11	1,724	3:20	5:10
20 (Base)	3,135	3:25	5:10
40	6,270	3:30	5:10
60	9,405	3:40	5:10
80	12,540	3:50	5:10
100	15,675	3:55	5:25

Table M-3. Evacuation Time Estimates Variation with Population Change

EPZ and 20% Shadow Permanent Resident Population	Base	Population Change		
		16%	17%	18%
	46,402	53,826	54,290	54,754
ETE (hrs:mins) for the 90th Percentile				
Region	Base	Population Change		
		16%	17%	18%
2-MILE	2:30	2:30	2:30	2:30
5-MILE	2:30	2:35	2:35	2:35
FULL EPZ	3:45	4:10	4:10	4:20
ETE (hrs:mins) for the 100th Percentile				
Region	Base	Population Change		
		16%	17%	18%
2-MILE	5:00	5:00	5:00	5:00
5-MILE	5:05	5:05	5:05	5:05
FULL EPZ	5:10	5:35	5:35	5:55

[1] The Evacuating Shadow Vehicles, in Table M-2, represent the residents and employees who will spontaneously decide to relocate during the evacuation. The basis, for the base values shown, is a 20% relocation of shadow residents along with a proportional percentage of shadow employees. See Section 6 for further discussion.

APPENDIX N

ETE Criteria Checklist

N. ETE CRITERIA CHECKLIST

Table N-1. ETE Review Criteria Checklist

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
1.0 Introduction		
a. The emergency planning zone (EPZ) and surrounding area is described.	Yes	Section 1.2
b. A map is included that identifies primary features of the site including major roadways, significant topographical features, boundaries of counties, and population centers within the EPZ.	Yes	Figures 1-1, 3-1, 6-1
c. A comparison of the current and previous ETE is provided including information similar to that identified in Table 1-1, "ETE Comparison."	Yes	Table 1-3
1.1 Approach		
a. The general approach is described in the report as outlined in Section 1.1, "Approach."	Yes	Section 1.1, Section 1.3, Appendix D, Table 1-1
1.2 Assumptions		
a. Assumptions consistent with Table 1-2, "General Assumptions," of NUREG/CR-7002 are provided and include the basis to support use.	Yes	Section 2

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
1.3 Scenario Development		
a. The scenarios in Table 1-3, "Evacuation Scenarios," are developed for the ETE analysis. A reason is provided for use of other scenarios or for not evaluating specific scenarios.	Yes	Table 2-1, Section 6, Table 6-5
1.4 Evacuation Planning Areas		
a. A map of the EPZ with emergency response planning areas (ERPAs) is included.	Yes	Figure 3-1, Figure 6-1
1.4.1 Keyhole Evacuation		
a. A table similar to Table 1-4 "Evacuation Areas for a Keyhole Evacuation", is provided identifying the ERPAs considered for each ETE calculation by downwind direction.	Yes	Table 6-1 through Table 6-3, Table 7-5 through Table 7-7, Table H-1 and Table H-2
1.4.2 Staged Evacuation		
a. The approach used in development of a staged evacuation is discussed.	Yes	Section 7.2
b. A table similar to Table 1-5, "Evacuation Areas for a Staged Evacuation," is provided for staged evacuations identifying the ERPAs considered for each ETE calculation by downwind direction.	Yes	Table 6-4, Table 7-8, Table H-3
2.0 Demand Estimation		
a. Demand estimation is developed for the four population groups (permanent residents of the EPZ, transients, special facilities, and schools).	Yes	Section 3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
2.1 Permanent Residents and Transient Population		
a. The U.S. Census is the source of the population values, or another credible source is provided.	Yes	Section 3.1
b. The availability date of the census data is provided.	Yes	Section 3.1
c. Population values are adjusted as necessary for growth to reflect population estimates to the year of the ETE.	N/A	2020 Census data used as the base year of the analysis
d. A sector diagram, similar to Figure 2-1, "Population by Sector," is included showing the population distribution for permanent residents.	Yes	Figure 3-2
2.1.1 Permanent Residents with Vehicles		
a. The persons per vehicle value is between 1 and 3 or justification is provided for other values.	Yes	Section 3.1, Appendix F
2.1.2 Transient Population		
a. A list of facilities that attract transient populations is included, and peak and average attendance for these facilities is listed. The source of information used to develop attendance values is provided.	Yes	Section 3.3, Table E-6 through Table E-8
b. Major employers are listed.	Yes	Section 3.4, Table E-5

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
c. The average population during the season is used, itemized and totaled for each scenario.	Yes	Table 3-4, Table 3-5 and Appendix E itemize the peak transient population and employee estimates. These estimates are multiplied by the scenario specific percentages provided in Table 6-6 to estimate average transient vehicle by scenario – see Table 6-7.
d. The percentage of permanent residents assumed to be at facilities is estimated.	Yes	Section 3.3 and Section 3.4
e. The number of people per vehicle is provided. Numbers may vary by scenario, and if so, reasons for the variation are discussed.	Yes	Section 3.3 and Section 3.4
f. A sector diagram is included, similar to Figure 2-1, "Population by Sector", is included showing the population distribution for the transient population.	Yes	Figure 3-6 (transients) and Figure 3-8 (employees)
2.2 Transit Dependent Permanent Residents		
a. The methodology (e.g., surveys, registration programs) used to determine the number of transit dependent residents is discussed.	Yes	Section 3.6
b. The State and local evacuation plans for transit dependent residents are used in the analysis.	Yes	Section 3.6, Section 3.7
c. The methodology used to determine the number of people with disabilities and those with access and functional needs who may need assistance and do not reside in special facilities is provided. Data from local/county registration programs are used in the estimate.	Yes	Section 3.8

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
d. Capacities are provided for all types of transportation resources. Bus seating capacity of 50 percent is used or justification is provided for higher values.	Yes	Item 3 of Section 2.4
e. An estimate of the transit dependent population is provided.	Yes	Section 3.6, Table 3-8, Table 3-10
f. A summary table showing the total number of buses, ambulances, or other transport assumed available to support evacuation is provided. The quantification of resources is detailed enough to ensure that double counting has not occurred.	Yes	Table 3-13, Table 8-1
2.3 Special Facility Residents		
a. Special facilities, including the type of facility, location, and average population, are listed. Special facility staff is included in the total special facility population.	Yes	Table E-4 and Table E-9 lists all medical facilities and correctional facilities, respectively, by facility name, location, and average population. Staff estimates were not provided.
b. The method of obtaining special facility data is discussed.	Yes	Section 3.5
c. An estimate of the number and capacity of vehicles assumed available to support the evacuation of the facility is provided.	Yes	Table 3-6
d. The logistics for mobilizing specially trained staff (e.g., medical support or security support for prisons, jails, and other correctional facilities) are discussed when appropriate.	Yes	Section 8.1 – under Evacuation of Medical Facilities and Section 8.3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
2.4 Schools		
a. A list of schools including name, location, student population, and transportation resources required to support the evacuation, is provided. The source of this information should be identified.	Yes	Table 3-9, Table E-1 and Table E-2, Section 3.7
b. Transportation resources for elementary and middle schools are based on 100 percent of the school capacity.	Yes	Section 3.7
c. The estimate of high school students who will use personal vehicle to evacuate is provided and a basis for the values used is given.	Yes	Section 3.7
d. The need for return trips is identified.	Yes	Section 8.1
2.5 Other Demand Estimate Considerations		
2.5.1 Special Events		
a. A complete list of special events is provided including information on the population, estimated duration, and season of the event.	Yes	Section 3.9
b. The special event that encompasses the peak transient population is analyzed in the ETE.	Yes	Section 3.9
c. The percentage of permanent residents attending the event is estimated.	Yes	Section 3.9

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
2.5.2 Shadow Evacuation		
a. A shadow evacuation of 20 percent is included consistent with the approach outlined in Section 2.5.2, "Shadow Evacuation".	Yes	Item 7 of Section 2.2, Figure 2-1 and Figure 7-1, Section 3.2
b. Population estimates for the shadow evacuation in the shadow region beyond the EPZ are provided by sector.	Yes	Section 3.2, Table 3-3, Figure 3-4
c. The loading of the shadow evacuation onto the roadway network is consistent with the trip generation time generated for the permanent resident population.	Yes	Section 5 – Table 5-8 (footnote)
2.5.3 Background and Pass Through Traffic		
a. The volume of background traffic and pass-through traffic is based on the average daytime traffic. Values may be reduced for nighttime scenarios.	Yes	Section 3.10 and Section 3.11
b. The method of reducing background and pass-through traffic is described.	Yes	Section 2.2 – Assumptions 10 and 11 Section 2.5 Section 3.10 and Section 3.11 Table 6-6 – External Through Traffic footnote
c. Pass-through traffic is assumed to have stopped entering the EPZ about two (2) hours after the initial notification.	Yes	Section 2.5

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
2.6 Summary of Demand Estimation		
a. A summary table is provided that identifies the total populations and total vehicles used in the analysis for permanent residents, transients, transit dependent residents, special facilities, schools, shadow population, and pass-through demand in each scenario.	Yes	Table 3-12, Table 3-13, and Table 6-7
3.0 Roadway Capacity		
a. The method(s) used to assess roadway capacity is discussed.	Yes	Section 4
3.1 Roadway Characteristics		
a. The process for gathering roadway characteristic data is described including the types of information gathered and how it is used in the analysis.	Yes	Section 1.3, Appendix D (Step 4)
b. Legible maps are provided that identify nodes and links of the modeled roadway network similar to Figure A-1, “Roadway Network Identifying Nodes and Links,” and Figure A-2, “Grid Map Showing Detailed Nodes and Links.”	Yes	Appendix K

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
3.2 Model Approach		
a. The approach used to calculate the roadway capacity for the transportation network is described in detail, and the description identifies factors that are expressly used in the modeling.	Yes	Section 4
b. Route assignment follows expected evacuation routes and traffic volumes.	Yes	Appendix B and Appendix C
c. A basis is provided for static route choices if used to assign evacuation routes.	N/A	Static route choices are not used to assign evacuation routes. Dynamic traffic assignment is used.
d. Dynamic traffic assignment models are described including calibration of the route assignment.	Yes	Appendix B and Appendix C
3.3 Intersection Control		
a. A list that includes the total numbers of intersections modeled that are unsignalized, signalized, or manned by response personnel is provided.	Yes	Table K-1
b. The use of signal cycle timing, including adjustments for manned traffic control, is discussed.	Yes	Section 4, Appendix G
3.4 Adverse Weather		
a. The adverse weather conditions are identified.	Yes	Assumption 2 and 3 of Section 2.6
b. The speed and capacity reduction factors identified in Table 3-1, "Weather Capacity Factors," are used or a basis is provided for other values, as applicable to the model.	Yes	Table 2-2

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
c. The calibration and adjustment of driver behavior models for adverse weather conditions are described, if applicable.	N/A	Driver behavior is not adjusted for adverse weather conditions.
d. The effect of adverse weather on mobilization is considered and assumptions for snow removal on streets and driveways are identified, when applicable.	Yes	Table 2-2; snow is not considered for this site.
4.0 Development of Evacuation Times		
4.1 Traffic Simulation Models		
a. General information about the traffic simulation model used in the analysis is provided.	Yes	Section 1.3, Table 1-3, Appendix B, Appendix C
b. If a traffic simulation model is not used to perform the ETE calculation, sufficient detail is provided to validate the analytical approach used.	N/A	Not applicable since a traffic simulation model was used.
4.2 Traffic Simulation Model Input		
a. Traffic simulation model assumptions and a representative set of model inputs are provided.	Yes	Section 2, Appendix J
b. The number of origin nodes and method for distributing vehicles among the origin nodes are described.	Yes	Appendix J, Appendix C
c. A glossary of terms is provided for the key performance measures and parameters used in the analysis.	Yes	Appendix A, Table C-1 and Table C-3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
4.3 Trip Generation Time		
a. The process used to develop trip generation times is identified.	Yes	Section 5
b. When surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance are provided.	Yes	Appendix F
c. Data used to develop trip generation times are summarized.	Yes	Appendix F, Section 5
d. The trip generation time for each population group is developed from site-specific information.	Yes	Section 5
e. The methods used to reduce uncertainty when developing trip generation times are discussed, if applicable.	N/A	No uncertainty existed when developing trip generation times.
4.3.1 Permanent Residents and Transient Population		
a. Permanent residents are assumed to evacuate from their homes but are not assumed to be at home at all times. Trip generation time includes the assumption that a percentage of residents will need to return home before evacuating.	Yes	Section 5 discusses trip generation for households with and without returning commuters. Table 6-6 presents the percentage of households with returning commuters and the percentage of households either without returning commuters or with no commuters. Appendix F presents the percent households who will await the return of commuters. Section 2.3, Assumption 3
b. The trip generation time accounts for the time and method to notify transients at various locations.	Yes	Section 5

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
c. The trip generation time accounts for transients potentially returning to hotels before evacuating.	Yes	Section 5, Figure 5-1
d. The effect of public transportation resources used during special events where a large number of transients are expected is considered.	Yes	Section 3.9
4.3.2 Transit Dependent Permanent Residents		
a. If available, existing and approved plans and bus routes are used in the ETE analysis.	N/A	Established bus routes do not exist. Basic bus routes were develop for the ETE analysis. Section 8.1 under Evacuation of Transit-Dependent Population
b. The means of evacuating ambulatory and non-ambulatory residents are discussed.	Yes	Section 8.1 under Evacuation of Transit-Dependent Population, Section 8.2
c. Logistical details, such as the time to obtain buses, brief drivers and initiate the bus route are used in the analysis.	Yes	Section 8.1, Figure 8-1
d. The estimated time for transit dependent residents to prepare and then travel to a bus pickup point, including the expected means of travel to the pickup point, is described.	Yes	Section 8.1 under Evacuation of Transit-Dependent Population
e. The number of bus stops and time needed to load passengers are discussed.	Yes	Section 8.1, Table 8-6 and Table 8-7
f. A map of bus routes is included.	Yes	Figure 10-2, 10-3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
g. The trip generation time for non-ambulatory persons including the time to mobilize ambulances or special vehicles, time to drive to the home of residents, time to load, and time to drive out of the EPZ, is provided.	Yes	Section 8.2
h. Information is provided to support analysis of return trips, if necessary.	Yes	Section 8.1 and 8.2
4.3.3 Special Facilities		
a. Information on evacuation logistics and mobilization times is provided.	Yes	Section 2.4, Section 8.1, Section 8.3, Table 8-8, Table 8-9, and Table 8.12
b. The logistics of evacuating wheelchair and bed bound residents are discussed.	Yes	Section 8.1, Table 8-8 and Table 8-9
c. Time for loading of residents is provided.	Yes	Section 2.4, Section 8.1, Section 8.3, Table 8-8, Table 8-9, and Table 8-12
d. Information is provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed.	Yes	Section 8.1 and Section 8.3
e. Discussion is provided on whether special facility residents are expected to pass through the reception center before being evacuated to their final destination.	Yes	Section 8.1 and Section 8.3
f. Supporting information is provided to quantify the time elements for each trip, including destinations if return trips are needed.	Yes	Section 8.1 and Section 8.3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
4.3.4 Schools		
a. Information on evacuation logistics and mobilization times is provided.	Yes	Section 2.4, Section 8.1, Table 8-2 through Table 8-5
b. Time for loading of students is provided.	Yes	Section 2.4, Section 8.1, Table 8-2 through Table 8-5
c. Information is provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed.	Yes	Section 8.1
d. If used, reception centers should be identified. A discussion is provided on whether students are expected to pass through the reception center before being evacuated to their final destination.	Yes	Section 8.1, Section 10.1, Table 10-4
e. Supporting information is provided to quantify the time elements for each trip, including destinations if return trips are needed.	Yes	Section 8.1, Table 8-2 through Table 8-5
4.4 Stochastic Model Runs		
a. The number of simulation runs needed to produce average results is discussed.	N/A	DYNEV does not rely on simulation averages or random seeds for statistical confidence. For DYNEV/DTRAD, it is a meso-scopic simulation and uses dynamic traffic assignment model to obtain the "average" (stable) network work flow distribution. This is different from microscopic simulation, which is monte-carlo random sampling by nature relying on different seeds to establish statistical confidence. Refer to Appendix B for more details
b. If one run of a single random seed is used to produce each ETE result, the report includes a sensitivity study on the 90 percent and 100 percent ETE using 10 different random seeds for evacuation of the full EPZ under Summer, Midweek, Daytime, Normal Weather conditions.	N/A	

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
4.5 Model Boundaries		
a. The method used to establish the simulation model boundaries is discussed.	Yes	Section 4.5
b. Significant capacity reductions or population centers that may influence the ETE and that are located beyond the evacuation area or shadow region are identified and included in the model, if needed.	Yes	Section 4.5
4.6 Traffic Simulation Model Output		
a. A discussion of whether the traffic simulation model used must be in equilibration prior to calculating the ETE is provided.	Yes	Appendix B
b. The minimum following model outputs for evacuation of the entire EPZ are provided to support review: 1. Evacuee average travel distance and time. 2. Evacuee average delay time. 3. Number of vehicles arriving at each destination node. 4. Total number and percentage of evacuee vehicles not exiting the EPZ. 5. A plot that provides both the mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the EPZ. 6. Average speed for each major evacuation route that exits the EPZ.	Yes	1. Appendix J, Table J-2 2. Table J-2 3. Table J-4 4. None and 0%. The 100% ETE is based on the time the last vehicle exits the evacuation zone 5. Figures J-2 through J-13 (one plot for each scenario considered) 6. Table J-3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
c. Color coded roadway maps are provided for various times (e.g., at 2, 4, 6 hrs.) during a full EPZ evacuation scenario, identifying areas where congestion exists.	Yes	Figure 7-3 through Figure 7-8
4.7 Evacuation Time Estimates for the General Public		
a. The ETE includes the time to evacuate 90 percent and 100 percent of the total permanent resident and transient population.	Yes	Table 7-1 and Table 7-2
b. Termination criteria for the 100 percent ETE are discussed, if not based on the time the last vehicle exits the evacuation zone.	N/A	The 100% ETE is based on the time the last vehicle exits the evacuation zone.
c. The ETE for 100 percent of the general public includes all members of the general public. Any reductions or truncated data is explained.	Yes	Section 5.4.1 – truncating survey data to eliminate statistical outliers Table 7-2 – 100th percentile ETE for general population
d. Tables are provided for the 90 and 100 percent ETEs similar to Table 4-3, "ETEs for a Staged Evacuation," and Table 4-4, "ETEs for a Keyhole Evacuation."	Yes	Table 7-3 and Table 7-4
e. ETEs are provided for the 100 percent evacuation of special facilities, transit dependent, and school populations.	Yes	Section 8

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
5.0 Other Considerations		
5.1 Development of Traffic Control Plans		
a. Information that responsible authorities have approved the traffic control plan used in the analysis are discussed.	Yes	Section 9, Appendix G
b. Adjustments or additions to the traffic control plan that affect the ETE is provided.	Yes	Section 9, Appendix G
5.2 Enhancements in Evacuation Time		
a. The results of assessments for enhancing evacuations are provided.	Yes	Appendix M
5.3 State and Local Review		
a. A list of agencies contacted is provided and the extent of interaction with these agencies is discussed.	Yes	Table 1-1
b. Information is provided on any unresolved issues that may affect the ETE.	Yes	Results of the ETE study were formally presented to state and local agencies at the final project meeting. Comments on the draft report were provided and were addressed in the final report. There are no unresolved issues.
5.4 Reviews and Updates		

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
a. The criteria for when an updated ETE analysis is required to be performed and submitted to the NRC is discussed.	Yes	Appendix M, Section M.3
5.4.1 Extreme Conditions		
a. The updated ETE analysis reflects the impact of EPZ conditions not adequately reflected in the scenario variations.	N/A	This ETE is being updated as a result of the availability of US Census Bureau decennial census data.
5.5 Reception Centers and Congregate Care Center		
a. A map of congregate care centers and reception centers is provided.	Yes	Figure 10-4