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TALEN ENERGY

September 15, 2022

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

10 CFR 50, Appendix E

SUSQUEHANNA STEAM ELECTRIC STATION
EVACUATION TIME ESTIMATE REPORT
PLA-8030

Docket Nos. 50-387
and 50-388

Susquehanna Nuclear, LLC, hereby submits the 2022 Evacuation Time Estimate (ETE) Report for the Susquehanna Steam Electric Station (SSES). The enclosed report is submitted as required by 10 CFR 50, Appendix E, Section IV, which requires licensees to submit an ETE analysis using decennial census data from the United States Census Bureau.

This letter contains no new or revised regulatory commitments.

If you have any questions or require additional information, please contact Ms. Melisa Krick, Manager of Nuclear Regulatory Affairs, at (570) 542-1818.

K. Cimorelli

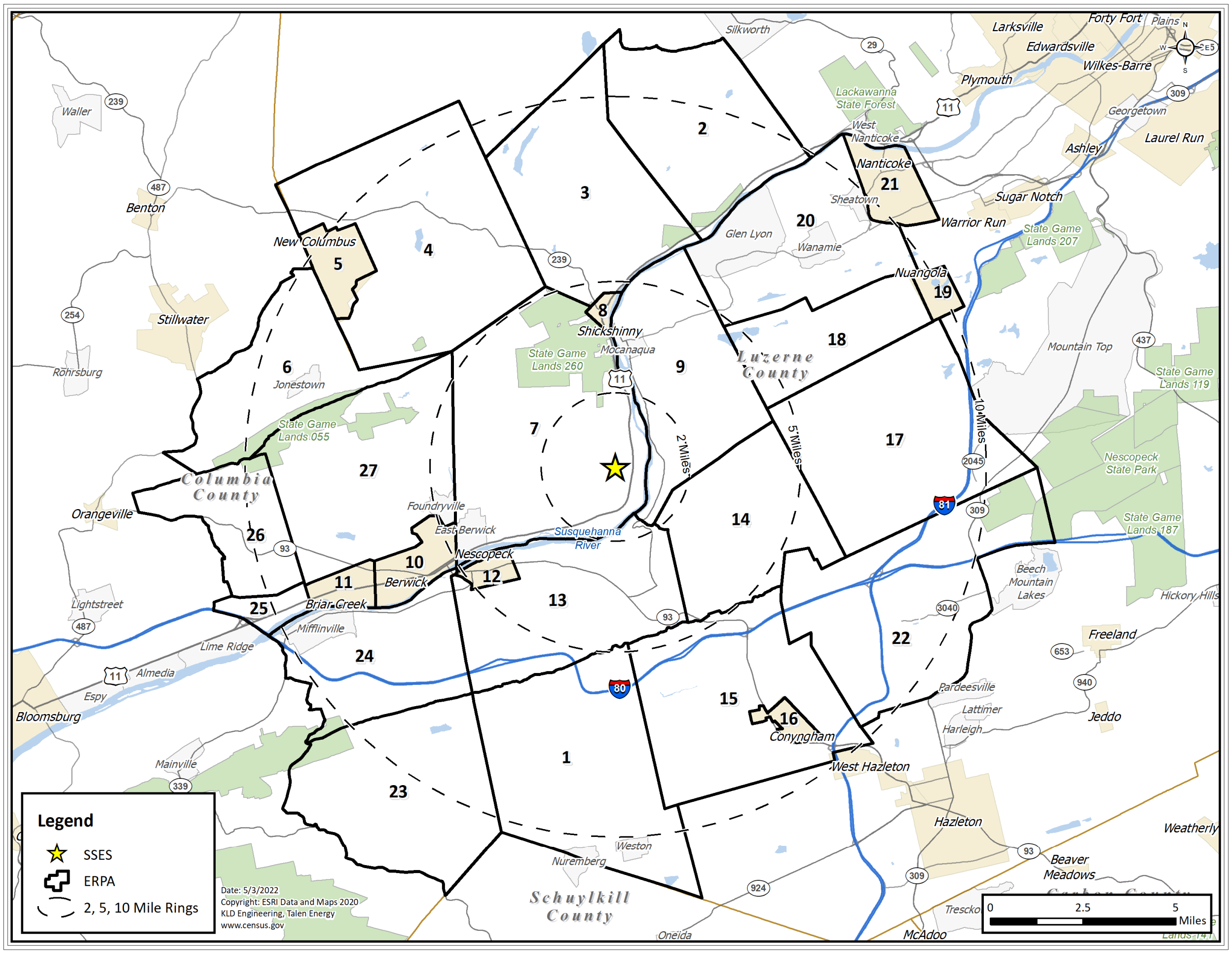
Enclosure: SSES 2022 Evacuation Time Estimate Report

Copy: NRC Region I
Ms. A. Klett, NRC Project Manager
Mr. C. Highley, NRC Senior Resident Inspector
Mr. M. Shields, PA DEP/BRP

Enclosure to PLA-8030
SSES 2022 Evacuation Time Estimate Report

Susquehanna Steam Electric Station

Development of Evacuation Time Estimates



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July 26, 2022 **Final Report, Rev. 0** **KLD TR – 1242**

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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Susquehanna Steam Electric Station (SSES) located in Luzerne County, Pennsylvania. ETE provide Talen Energy and 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.

<u>Project Activities</u>

This project began in September 2020 and extended over twenty months. The major activities performed are briefly described in chronological sequence:

- Attended "kick-off" meetings with Talen Energy personnel and emergency management personnel representing county and state governments.
- Accessed the 2020 U.S. Census Bureau data files.
- Employee data obtained from the previous ETE study and provided by Talen Energy and Luzerne County. Data from the previous study was obtained from a variety of sources including internet searches and direct phone calls to major employers
- Studied Geographic Information Systems (GIS) maps of the area in the vicinity of the SSES, 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 entire Emergency Planning Zone (EPZ), plus a Shadow Region covering the region between the EPZ boundary and approximately 15 miles radially from the plant.
- Conducted an online demographic survey of residents within the study area, to gather focused data needed for this ETE study that were not contained within the census database.
- Special facility data was requested from the counties at the kickoff meeting. If updated information was not provided and data could not be obtained from online sources, the data gathered in the 2012 ETE study was utilized, supplemented by internet searches and aerial imagery.

- The traffic demand and trip-generation rates of evacuating vehicles were estimated from the gathered data. The trip generation rates reflected the estimated mobilization time (i.e., the time required by evacuees to prepare for the evacuation trip) computed using the results of the demographic survey.
- Following federal guidelines, the EPZ is subdivided into 27 Emergency Response Planning Areas (ERPA). These ERPA are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define a total of 33 Evacuation Regions.
- The time-varying external circumstances are represented as Evacuation Scenarios, each described in terms of the following factors: (1) Season (Summer, Winter); (2) Day of Week (Midweek, Weekend); (3) Time of Day (Midday, Evening); and (4) Weather (Good, Rain/Light Snow, Heavy Snow). One special event scenario – a refueling outage at the plant – was considered. One roadway impact scenario was considered wherein a single lane was closed on Interstate 80 westbound for the duration of the evacuation.
- Staged evacuation was considered for those regions wherein the 2-mile radius 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 accident at the SSES that quickly assumes the status of General Emergency such that the Advisory to Evacuate (ATE) is virtually coincident with the siren alert, and no early protective actions have been implemented.
  - While an unlikely accident 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 are in session, the ETE study assumes that the children will be evacuated by bus directly to host schools located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at school prior to the arrival of the buses dispatched for that purpose. The ETE for schoolchildren are calculated separately.
- Evacuees who do not have access to a private vehicle will be evacuated by buses provided as specified in the county evacuation plans. Those in medical facilities will likewise be evacuated with public transit, as needed: bus, van, wheelchair van or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees, for homebound population with access and/or functional needs, and for those evacuated from medical facilities.
- Attended "final" meeting with Talen Energy personnel and county and state representatives to present results from the study.

Computation of ETE

A total of 462 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 33 Evacuation Regions to evacuate from that Region, under the circumstances defined for one of the 14 Evacuation Scenarios (33 x 14 = 462). 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 and shadow evacuees could impede those who are evacuating from within the impacted region. The impedance that could be caused by voluntary and shadow 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 plant), and then simulates 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, of the population within the impacted region, 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. The 100th percentile ETE is when the last vehicle to evacuate crosses the boundary of the area being evacuated.

Traffic Management

This study references the comprehensive traffic management plans provided in the Luzerne and Columbia County Radiological Emergency Response Plans. Due to the detailed plans already in place and the limited traffic congestion within the EPZ, no additional traffic or access control measures have been identified as a result of this study.

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 ERPA based on the 2020 Census data.
- Table 6-1 defines each of the 33 Evacuation Regions in terms of their respective groups of ERPA.
- Table 6-2 lists the Evacuation Scenarios.
- Tables 7-1 and 7-2 are compilations of 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 ETE for the 2 Mile Region when evacuating additional ERPAs downwind to 5 miles for un-staged and staged evacuations for the 90th and 100th percentiles, respectively.
- Table 8-2 presents ETE for the children at schools in good weather.
- Table 8-5 presents ETE for the transit-dependent population in good weather.
- Table 8-8 presents ETE for medical facilities in good weather.
- Figure 6-1 displays a map of the SSES EPZ showing the layout of the 27 ERPA 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. Maps of all regions are provided in Appendix H.

Conclusions

- General population ETE were computed for 462 unique cases – a combination of 33 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document these ETE for the 90th and 100th percentiles. These ETE range from 2:20 (hr:min) to 5:15 at the 90th percentile and 4:45 to 6:25 at the 100th percentile.
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100th percentile are

significantly longer than those for the 90th percentile. This is the result of the relatively long mobilization time of a small proportion of the resident population and some isolated traffic congestion within the EPZ. 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 evacuees (those with the longest mobilization times) travel freely out of the EPZ. See Figures 7-9 through 7-22.

- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation provides no benefit to evacuees from within the 2 Mile Region and adversely impacts evacuees located beyond 2 miles from the plant (compare Regions R26 through R33 and Regions R02 and R04 through R10, respectively, in Tables 7-1 and 7-2). See Section 7.6 for additional discussion.
- Comparison of Scenarios 6 and 13 in Table 7-1 indicates that the Special Event – a refueling outage at the plant – does not have a significant impact on the ETE for the 90th percentile. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that the roadway closure – one lane westbound on I-80 from the interchange with Pennsylvania State Route 93 (PA-93) (Exit 256) to the interchange with PA-487 (Exit 236B) – does not significantly change the ETE, indicating that there is excess capacity on the highway. See Section 7.5.
- Nanticoke City and Briar Creek Borough and Township are the most congested areas during an evacuation. The last roadway in the EPZ to exhibit traffic congestion is PA-93. All links within the EPZ are at LOS A (free-flowing traffic conditions) at 3 hours and 20 minutes after the ATE. See Section 7.3 and Figures 7-3 through 7-8.
- Separate ETE were computed for schools, medical facilities, transit-dependent persons, and access and/or functional needs persons. The average single-wave ETE for this population is comparable to the general population ETE at the 90th percentile for an evacuation for the entire EPZ (Region R03). See Section 8.
- Table 8-1 indicates that there are enough buses available to evacuate the transit-dependent population within the EPZ in a single wave; however, aid agreements with other counties will need to be activated in order to provide enough wheelchair vans and ambulances to evacuate wheelchair bound patients and the bedridden population in a single wave, respectively. See Section 8.1 and 8.2.
- Compressing the mobilization time of evacuees by one hour reduces the general population ETE at the 90th percentile by 20 minutes. An increase in mobilization time by one hour increases the ETE by 20 minutes at the 90th. Neither of these are significant changes. See Table M-1.
- The 90th and 100th percentile ETE for the general population is sensitive to increases in the number of voluntary evacuees in the Shadow Region. When the shadow percent is increased to 100%, the ETE increases by 45 minutes. See Table M-2.
- An increase in permanent resident population (EPZ plus Shadow Region) of 26% or greater results in an increase in the longest 90th percentile ETE of 30 minutes, which

meets the federal criterion for performing a fully updated ETE study between decennial censuses. See Section M.3.

- An increase in the average household size from 2.37 people per household to 3.00 people per household will result in 21% less evacuating vehicles and minimally impacts ETE with a reduction of at most 15 minutes at the 90th percentile and no impact to the 100th percentile ETE. See Section M.4.

Table 3-1. EPZ Permanent Resident Population

ERPA	2010 Population[1]	2020 Population
1	2,024	1,924
2	2,107	1,868
3	2,041	2,040
4	2,241	2,043
5	225	214
6	714	805
7	4,287	4,079
8	838	604
9	1,453	1,313
10	10,387	10,259
11	646	586
12	1,569	1,481
13	1,166	1,083
14	1,196	1,139
15	4,213	3,968
16	1,912	1,772
17	2,188	2,083
18	1,115	1,029
19	679	635
20	5,377	4,467
21	10,462	10,628
22	5,826	5,930
23	652	606
24	2,053	1,977
25	403	397
26	1,010	954
27	3,088	3,040
EPZ TOTAL:	**69,872**	**66,924**
EPZ Population Growth (2010-2020):		**-4.22%**

[1] The boundaries of ERPAs 6, 24, 25 and 26 have changed since the previous ETE study. The 2010 population for those ERPAs have been adjusted to reflect this change and will therefore not align with the numbers documented in the previous ETE study.

Table 6-1. Description of Evacuation Regions

Region	Description		ERPA																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2-Mile Ring								X		X																		
R02	5-Mile Ring								X	X	X	X		X	X	X													
R03	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
Evacuate 2-Mile Radius and Downwind to 5 Miles																													
Region	**Wind Direction From:**		**ERPA**																										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R04	N, NNE	350°-034°							X		X	X		X	X	X													
R05	NE, ENE, E	035°-101°							X		X	X		X	X														
R06	ESE	102°-124°							X	X	X	X		X	X														
R07	SE	125°-146°							X	X	X	X																	
R08	SSE, S	147°-191°							X	X	X																		
R09	SSW, SW, WSW	192°-259°							X	X	X					X													
R10	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													
Key																													
ERPA(s) Shelter-in-Place													ERPA(s) Evacuate																

Evacuate 2-Mile Radius and Downwind to the EPZ Boundary																													
Region	**Wind Direction From:**		**ERPA**																										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R11	N	350°-011°	X						X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R12	NNE	012°-034°	X					X	X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R13	NE	035°-056°	X			X	X	X	X		X	X	X	X	X		X	X							X	X	X	X	X
R14	ENE	057°-079°	X			X	X	X	X		X	X	X	X	X										X	X	X	X	X
R15	E	080°-101°	X		X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R16	ESE	102°-124°		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R17	SE	125°-146°		X	X	X	X	X	X	X	X	X	X									X				X	X	X	X
R18	SSE	147°-169°		X	X	X	X	X	X	X	X									X		X	X					X	X
R19	S	170°-191°		X	X	X	X	X	X	X	X								X	X	X	X	X						X
R20	SSW, SW	192°-237°		X	X	X	X		X	X	X					X			X	X	X	X	X	X					
R21	WSW	238°-259°		X	X				X	X	X					X	X	X	X	X	X	X	X	X					
R22	W	260°-281°		X					X		X			X	X	X	X	X	X	X	X	X	X	X					
R23	WNW	282°-304°	X						X		X			X	X	X	X	X	X	X	X	X	X	X					
R24	NW	305°-326°	X						X		X			X	X	X	X	X	X	X	X			X	X				
R25	NNW	327°-349°	X						X		X			X	X	X	X	X	X					X	X	X			

Key

ERPA(s) not within Plume, but Evacuates because it is surrounded by other ERPA(s) which are Evacuating	ERPA(s) Shelter-in-Place	ERPA(s) Evacuate

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles																													
Region	**Wind Direction From:**		**ERPA**																										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R26	5-Mile Ring								X	X	X	X		X	X	X													
R27	N, NNE	350°-034°							X		X	X		X	X	X													
R28	NE, ENE, E	035°-101°							X		X	X		X	X														
R29	ESE	102°-124°							X	X	X	X		X	X														
R30	SE	125°-146°							X	X	X	X																	
R31	SSE, S	147°-191°							X	X	X																		
R32	SSW, SW, WSW	192°-259°							X	X	X					X													
R33	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													

Key

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

Table 6-2. 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/Light Snow	None
8	Winter	Midweek	Midday	Heavy Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain/Light Snow	None
11	Winter	Weekend	Midday	Heavy Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Winter	Midweek	Midday	Good	SSES Refueling
14	Summer	Midweek	Midday	Good	Roadway Impact – Lane Closure on I-80 Westbound

[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	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R02	2:55	3:05	2:40	2:50	2:45	2:55	3:00	3:55	2:45	2:50	3:40	2:45	2:55	2:55
R03	3:10	3:15	2:55	3:00	3:00	3:10	3:15	4:20	2:55	3:00	3:55	3:00	3:10	3:10
2-Mile Ring and Keyhole to 5 Miles														
R04	2:50	3:00	2:40	2:45	2:50	2:55	3:05	3:55	2:40	2:45	3:40	2:45	2:55	2:50
R05	2:50	3:00	2:40	2:50	2:45	2:55	3:00	3:55	2:40	2:45	3:40	2:50	2:55	2:50
R06	2:50	3:00	2:40	2:50	2:45	2:55	3:00	3:55	2:40	2:45	3:40	2:50	2:55	2:50
R07	3:00	3:05	2:45	2:45	2:50	3:00	3:05	4:05	2:50	2:50	3:45	2:45	3:00	3:00
R08	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R09	2:55	3:00	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R10	2:30	2:30	2:20	2:20	2:30	2:30	2:30	3:25	2:20	2:20	3:10	2:30	2:30	2:35
2-Mile Ring and Keyhole to EPZ Boundary														
R11	3:10	3:15	2:55	3:05	3:05	3:00	3:15	4:05	2:55	3:05	3:55	3:05	3:10	3:20
R12	3:10	3:15	2:55	3:05	3:05	3:10	3:15	4:10	2:55	3:05	3:55	3:00	3:10	3:15
R13	3:10	3:10	3:00	3:00	3:05	3:05	3:15	4:05	3:00	3:05	3:55	3:05	3:10	3:15
R14	3:10	3:30	3:05	3:05	3:10	3:15	3:30	4:20	3:05	3:15	4:05	3:10	3:15	3:25
R15	3:15	3:25	3:05	3:05	3:10	3:15	3:30	4:20	3:05	3:15	4:05	3:10	3:20	3:25
R16	3:15	3:25	3:05	3:05	3:15	3:15	3:30	4:20	3:05	3:10	4:05	3:10	3:20	3:20
R17	3:15	3:20	3:00	3:10	3:00	3:10	3:25	4:25	3:00	3:00	4:10	3:05	3:10	3:20
R18	3:05	3:10	2:50	3:00	2:50	3:05	3:20	4:15	2:50	3:00	3:50	2:50	3:10	3:05
R19	2:55	3:05	2:40	2:50	2:45	3:00	3:15	4:05	2:40	2:50	3:40	2:45	3:00	2:55
R20	2:50	3:00	2:40	2:50	2:45	2:55	3:05	3:55	2:40	2:50	3:35	2:45	2:55	2:50
R21	2:50	3:00	2:40	2:45	2:45	2:55	3:05	3:55	2:40	2:45	3:40	2:45	2:55	2:50
R22	2:50	3:00	2:35	2:45	2:45	2:55	3:05	3:55	2:35	2:45	3:35	2:45	2:55	2:50
R23	2:50	2:55	2:35	2:45	2:45	2:50	3:00	3:50	2:35	2:40	3:35	2:45	2:50	2:50

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
R24	2:45	2:45	2:35	2:35	2:40	2:45	2:45	3:40	2:30	2:35	3:25	2:40	2:45	2:45
R25	2:45	2:45	2:30	2:35	2:45	2:45	2:45	3:40	2:30	2:35	3:25	2:45	2:45	2:55
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R26	3:40	3:45	3:40	3:45	3:45	3:40	3:45	5:15	3:40	3:45	5:10	3:40	3:40	3:40
R27	3:40	3:45	3:35	3:45	3:40	3:40	3:50	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R28	3:40	3:45	3:45	3:45	3:40	3:40	3:50	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R29	3:40	3:45	3:35	3:45	3:40	3:40	3:45	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R30	3:40	3:45	3:40	3:45	3:40	3:40	3:45	5:15	3:40	3:45	5:10	3:40	3:40	3:40
R31	3:00	3:00	2:50	2:50	2:50	3:00	3:00	4:15	2:50	2:50	4:10	2:50	3:00	3:00
R32	3:00	3:00	2:55	2:55	2:55	3:00	3:00	4:30	2:55	2:55	4:25	2:55	3:00	3:00
R33	2:55	2:55	2:50	2:55	2:55	2:55	2:55	4:20	2:50	2:55	4:20	2:55	2:55	2:55

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R03	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
2-Mile Ring and Keyhole to 5 Miles														
R04	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R05	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R06	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R07	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
2-Mile Ring and Keyhole to EPZ Boundary														
R11	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R12	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R13	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R14	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R15	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R16	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R17	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R18	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R19	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R20	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R21	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R22	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	**Midday**		**Midday**		**Evening**	**Midday**			**Midday**			**Evening**	**Midday**	**Midday**
	Good Weather	**Rain**	**Good Weather**	**Rain**	**Good Weather**	**Good Weather**	**Rain/Light Snow**	**Heavy Snow**	**Good Weather**	**Rain/Light Snow**	**Heavy Snow**	**Good Weather**	**Special Event**	**Roadway Impact**
R23	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R24	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R25	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R27	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R28	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R29	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R30	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Unstaged Evacuation - 2-Mile Region and 5-Mile Region														
R01	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R02	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R05	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R06	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R07	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R08	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R09	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R10	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R26	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R27	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R28	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R29	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R30	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R31	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R32	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R33	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Unstaged Evacuation - 2-Mile Region and 5-Mile Region														
R01	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R02	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R05	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R06	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R07	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R08	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R09	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R10	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R26	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R27	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R28	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R29	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R30	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R31	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R32	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R33	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50

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

School	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 H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETA to H.S. (hr:min)
COLUMBIA COUNTY SCHOOLS									
Berwick High School	90	15	7.7	14.2	33	**2:20**	15.1	23	**2:45**
Columbia Day Care	90	15	7.2	14.1	31	**2:20**	19.0	29	**2:50**
New Story Berwick School	90	15	6.7	13.4	31	**2:20**	19.0	29	**2:50**
West Berwick Elementary	90	15	6.1	18.1	21	**2:10**	16.5	25	**2:35**
Beaver-Main Elementary	90	15	0.6	40.0	1	**1:50**	9.1	14	**2:05**
LUZERNE COUNTY SCHOOLS									
Northwest Area Intermediate School	90	15	4.7	40.0	8	**1:55**	13.0	20	**2:15**
Northwest Area Middle/High School	90	15	5.7	40.0	9	**1:55**	19.7	30	**2:25**
Muhlenburg Christian Academy	90	15	2.4	12.7	12	**2:00**	13.9	21	**2:25**
Northwest Area Primary School	90	15	2.9	40.0	5	**1:50**	19.7	30	**2:20**
Salem Elementary School	90	15	7.7	14.2	33	**2:20**	18.8	29	**2:50**
Berwick Area Middle School	90	15	7.7	14.2	33	**2:20**	17.8	27	**2:50**
Nescopeck Elementary School	90	15	8.2	24.3	21	**2:10**	16.5	25	**2:35**
Valley Elementary/Middle School	90	15	2.7	29.7	6	**1:55**	8.2	13	**2:10**
GNA Elementary Center	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
GNA Educational Center	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
GNA High School	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
Drums Elementary/Middle School	90	15	1.8	40.0	3	**1:50**	8.3	13	**2:05**
Hazleton Area Academy of Sciences	90	15	2.7	40.0	5	**1:50**	5.4	9	**2:00**
Keystone Job Corporation High School	90	15	1.7	40.0	3	**1:50**	8.3	13	**2:05**
Rice Elementary School	90	15	Inside Shadow Region			**N/A**	4.5	7	**1:55**
					Maximum for EPZ:	**2:20**		**Maximum:**	**2:50**
					Average for EPZ:	**2:05**		**Average:**	**2:20**

Table 8-5. Transit-Dependent Evacuation Time Estimates – Good Weather

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	2	150	7.4	40.0	11	52	**3:35**	18.9	28	5	10	50	52	**6:00**
2	3	150	4.3	39.3	7	36	**3:15**	28.1	42	5	10	55	36	**5:45**
3	3	150	7.0	40.0	11	34	**3:15**	29.7	45	5	10	66	34	**5:55**
4	3	150	4.0	40.0	6	42	**3:20**	34.2	51	5	10	63	42	**6:15**
5	1	150	4.2	39.9	6	36	**3:15**	34.3	51	5	10	64	36	**6:05**
6	3	150	8.0	20.4	24	43	**3:40**	34.4	52	5	10	76	43	**6:50**
	2	180	8.0	29.6	16	43	**4:00**	34.4	52	5	10	76	43	**7:10**
7	1	150	7.1	40.0	11	44	**3:25**	34.8	52	5	10	73	44	**6:30**
8	2	150	10.3	40.0	15	37	**3:25**	29.7	45	5	10	76	37	**6:20**
9	3	150	7.4	18.0	25	40	**3:35**	45.4	68	5	10	90	40	**7:10**
	3	180	7.4	28.5	16	40	**4:00**	45.4	68	5	10	90	40	**7:35**
	1	210	7.4	35.7	12	40	**4:25**	45.4	68	5	10	90	40	**8:00**
10	3	150	4.2	29.9	8	40	**3:20**	45.4	68	5	10	81	40	**6:45**
	3	180	4.2	32.6	8	40	**3:50**	45.4	68	5	10	81	40	**7:15**
	1	210	4.2	40.0	6	40	**4:20**	45.4	68	5	10	81	40	**7:45**
11	3	150	8.1	22.6	22	49	**3:45**	34.4	52	5	10	76	49	**7:00**
12	1	150	17.0	30.2	34	50	**3:55**	34.4	52	5	10	103	50	**7:35**
13	3	150	6.0	40.0	9	42	**3:25**	18.9	28	5	10	46	42	**5:40**
	2	180	6.0	40.0	9	42	**3:55**	18.9	28	5	10	46	42	**6:10**
14	2	150	2.5	31.7	5	48	**3:25**	18.9	28	5	10	36	48	**5:35**
	2	180	2.5	33.2	5	48	**3:55**	18.9	28	5	10	36	48	**6:05**
15	3	150	4.7	38.0	7	36	**3:15**	29.7	45	5	10	59	36	**5:50**
16	1	150	6.1	40.0	9	50	**3:30**	30.1	45	5	10	63	50	**6:25**
17	1	150	1.0	34.8	2	34	**3:10**	29.8	45	5	10	48	34	**5:35**

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
18	3	150	4.4	18.1	15	38	**3:25**	28.4	43	5	10	56	38	**6:00**
	3	180	4.4	32.9	8	38	**3:50**	28.4	43	5	10	56	38	**6:25**
	1	210	4.4	37.8	7	38	**4:15**	28.4	43	5	10	56	38	**6:50**
19	4	150	0.9	11.7	5	37	**3:15**	28.9	43	5	10	46	37	**5:40**
	4	180	0.9	28.3	2	37	**3:40**	28.9	43	5	10	46	37	**6:05**
	3	210	0.9	32.0	2	37	**4:10**	28.9	43	5	10	46	37	**6:35**
	3	240	0.9	31.1	2	37	**4:40**	28.9	43	5	10	46	37	**7:05**
20	2	150	4.6	40.0	7	48	**3:25**	22.4	34	5	10	48	48	**5:50**
	2	180	4.6	40.0	7	48	**3:55**	22.4	34	5	10	48	48	**6:20**
21	1	150	4.4	40.0	7	34	**3:15**	12.0	18	5	10	31	34	**4:55**
22	3	150	5.5	23.0	14	40	**3:25**	34.4	52	5	10	69	40	**6:25**
23	1	150	2.7	40.0	4	49	**3:25**	34.4	52	5	10	60	49	**6:25**
24	2	150	2.0	32.3	4	38	**3:15**	30.3	45	5	10	51	38	**5:45**
25	2	150	10.1	22.7	27	38	**3:35**	31.7	48	5	10	78	38	**6:35**
	2	180	10.1	31.2	19	38	**4:00**	31.7	48	5	10	78	38	**7:00**
						Maximum ETE:	**4:40**						**Maximum ETE:**	**8:00**
						Average ETE:	**3:40**						**Average ETE:**	**6:30**

Table 8-8. Medical Facilities 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)
Berwick Retirement Villages I & II	Ambulatory	90	1	179	30	8.1	33	**2:35**
	Wheelchair bound	90	5	16	20	8.1	34	**2:25**
	Bedridden	90	15	45	30	8.1	33	**2:35**
Berwick Hospital Center	Ambulatory	90	1	250	30	8.1	33	**2:35**
	Wheelchair bound	90	5	10	20	8.1	34	**2:25**
	Bedridden	90	15	8	30	8.1	33	**2:35**
Elmcroft of Berwick	Ambulatory	90	1	57	30	4.6	12	**2:15**
	Wheelchair bound	90	5	5	20	4.6	12	**2:05**
	Bedridden	90	15	14	30	4.6	12	**2:15**
Bonham Nursing Home	Ambulatory	90	1	44	30	2.8	4	**2:05**
	Bedridden	90	15	30	30	2.8	4	**2:05**
Paradise Manor	Ambulatory	90	1	4	4	9.1	36	**2:10**
	Wheelchair bound	90	5	1	5	9.1	36	**2:15**
	Bedridden	90	15	1	15	9.1	37	**2:25**
ALC Family Care	Ambulatory	90	1	20	20	11.8	18	**2:10**
Guardian Healthcare and Rehabilitation Center	Ambulatory	90	1	15	15	2.0	32	**2:20**
	Wheelchair bound	90	5	49	20	2.0	31	**2:25**
	Bedridden	90	15	12	30	2.0	30	**2:30**
Northeast Counseling Nanticoke Services	Ambulatory	90	1	10	10	1.2	12	**1:55**
	Wheelchair bound	90	5	2	10	1.2	12	**1:55**
Birchwood Nursing Home	Ambulatory	90	1	26	26	0.5	2	**2:00**
	Wheelchair bound	90	5	10	20	0.5	2	**1:55**
	Bedridden	90	15	20	30	0.5	2	**2:05**
Fritzingertown Senior Living Community	Ambulatory	90	1	25	25	1.5	2	**2:00**
	Wheelchair bound	90	5	50	20	1.5	2	**1:55**
	Bedridden	90	15	26	30	1.5	2	**2:05**
Kadima Rehabilitation and Nursing	Ambulatory	90	1	5	5	3.0	5	**1:40**
	Wheelchair bound	90	5	10	20	3.0	5	**1:55**
	Bedridden	90	15	17	30	3.0	5	**2:05**
Conyngham Care Center	Ambulatory	90	1	14	14	2.0	3	**1:50**
	Wheelchair bound	90	5	1	5	2.0	3	**1:40**
	Bedridden	90	15	3	30	2.0	3	**2:05**
							Maximum ETE:	**2:35**
							Average ETE:	**2:10**

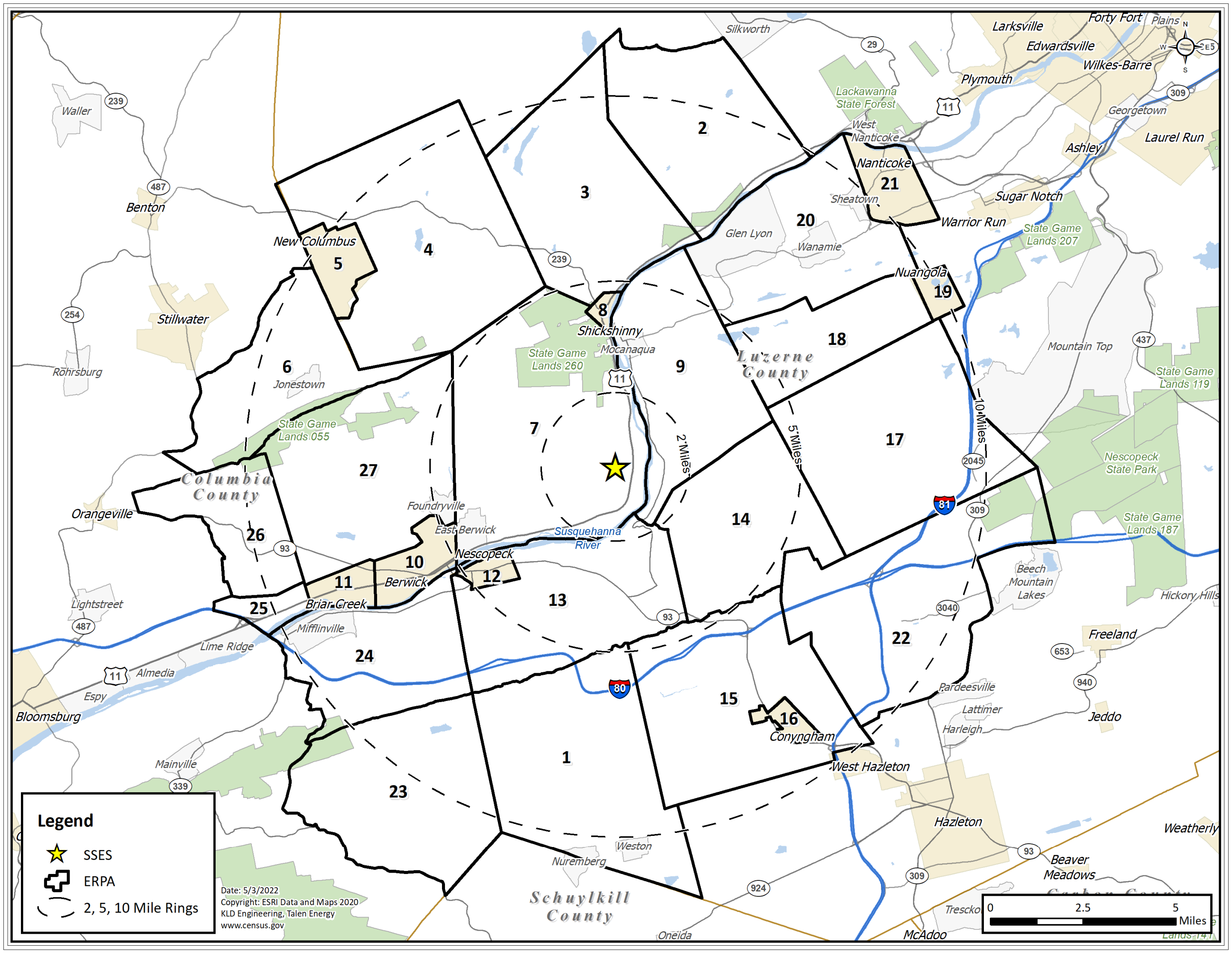


Figure 6-1. ERPAs Comprising the SSES EPZ

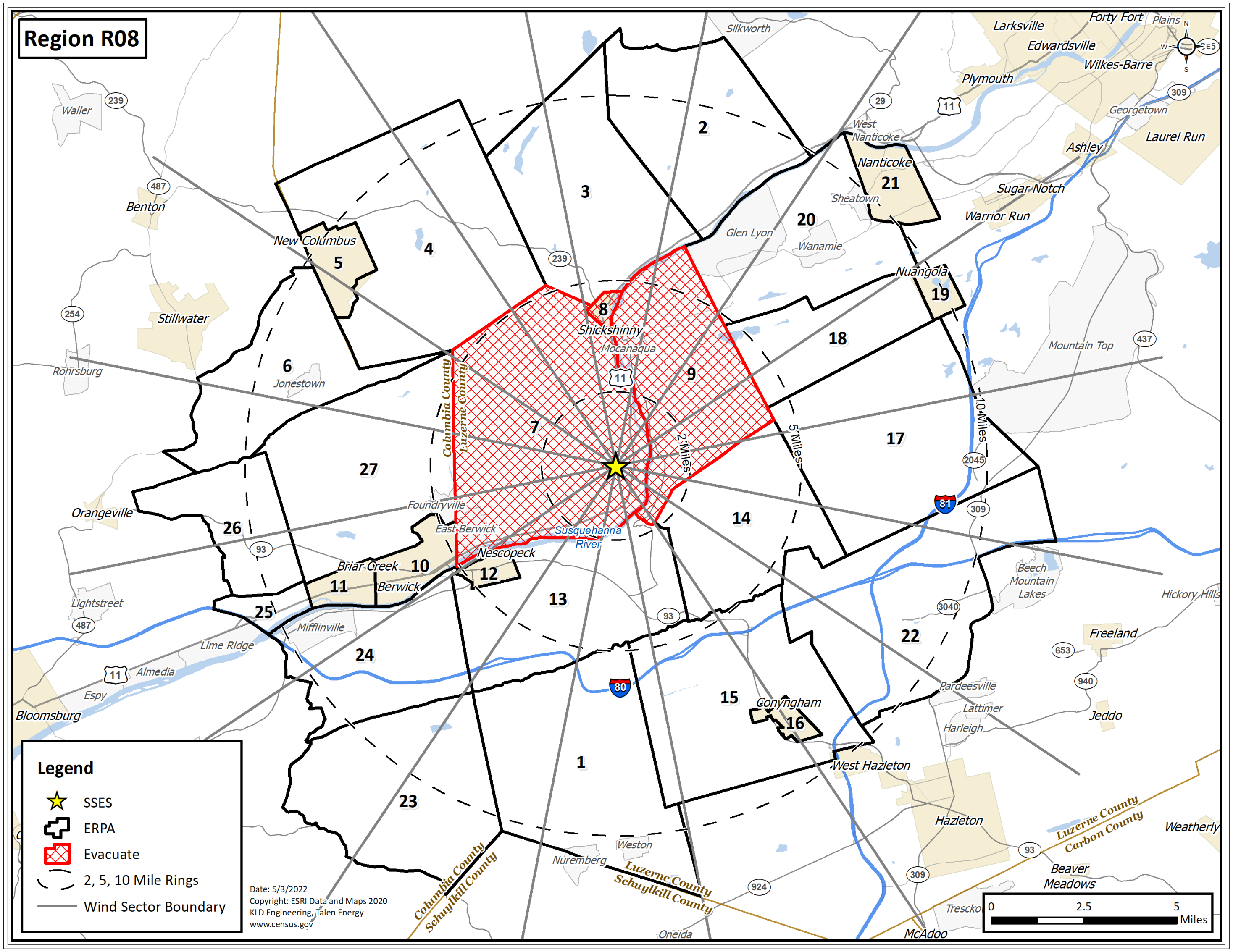


Figure H-8. Region R08

1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Susquehanna Steam Electric Station (SSES), located in Luzerne County, Pennsylvania. ETE provide 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.

- The work effort reported herein was supported and guided by local stakeholders who contributed suggestions, critiques, and the local knowledge base required. Although the permanent resident population decreased by 6%, the number of evacuating vehicles for the permanent resident population increased by 23% (approximately 8,500 vehicles). This significant increase in permanent resident evacuating vehicles is caused by the decreased household size and increased number of evacuating vehicles per household as per the demographic survey, resulting in a significant decrease in permanent resident vehicle occupancy.
- The permanent resident population and number of evacuating vehicles within the shadow region increased by 8% and 43% (largely the result of the significant decrease in permanent resident vehicle occupancy discussed above), respectively, compared to the previous ETE. The significant increase in evacuating vehicles in the shadow region prolongs congestion in Berwick, Briar Creek, Hazleton and Nanticoke, thereby increasing ETE.
- Residents with commuters and residents without commuters take an additional 45 minutes to mobilize. This delay in trip generation directly impact the 100th percentile ETE as traffic congestion clears prior to the completion of mobilization time (see Section 7.3). Thus, trip generation times dictate ETE.
- Access Control Points (ACP) were established at 60 minutes in the 2012 study versus 120 minutes in this study. External traffic flowing on the main thoroughfares of the interstates passing through the EPZ reduces the capacity of entrance ramps to the interstates which can delay the egress of EPZ residents and increase ETE.

The combination of these various factors explain why the 90th and 100th percentile ETE for the entire EPZ (Region R03) are longer in this study relative to the 2012 ETE study.

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 Talen Energy.
    b. Attended meetings/held conference calls with emergency planners from Talen Energy, Columbia County, Luzerne County, and the Commonwealth of Pennsylvania to identify issues to be addressed and resources available.
    c. Conducted a detailed field survey of the highway system and of 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, 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 online 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) located within the EPZ.
5. Used existing ERPA to define evacuation regions. The EPZ is partitioned into 27 ERPA along jurisdictional and geographic boundaries. "Regions" are groups of contiguous ERPA 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 "key-hole section" within the EPZ as recommended by NUREG/CR-7002 Rev.1.
6. Estimated demand for transit services for persons at special facilities and for transit-dependent persons at home.
7. Prepared the input streams for the DYNEV II system, which computes ETE (see Appendices B and C).
    a. Estimated the evacuation traffic demand, based on the available information

derived from Census data, and from data provided by local and state agencies, Talen Energy and from the demographic survey.

b. Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.

c. Applied the procedures specified in the 2016 Highway Capacity Manual (HCM[1]) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.

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 SSES.

8. Executed the DYNEV II model 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.

10. Calculated the ETE for all transit activities including those for special facilities (i.e., schools and medical facilities), for the transit-dependent population and for access and/or functional needs population.

1.2 The SSES Location

The SSES is located along the western shore of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania. The site is approximately 30 miles southwest of Scranton, PA and 45 miles northwest of Allentown, PA. The EPZ consists of parts of Luzerne and Columbia Counties. Figure 1-1 displays the area surrounding the SSES. This map identifies the communities in the area and the major roads.

1.3 Preliminary Activities

These activities are described below.

<u>Field Surveys of the Highway Network</u>

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

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

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.

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 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 Exhibit 15-46. These links may be identified by reviewing Appendix K. 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 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.

Demographic Survey

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

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.

Computing the Evacuation Time Estimates

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data. 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 the DYNEV II System 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 previous ETE study (KLD TR-527, dated November 2012). The 90th percentile ETE for the entire EPZ increased by 50 minutes for a winter midweek midday scenario and by 45 minutes for a summer weekend midday scenario when compared with the 2012 study. The 100th percentile ETE increased by 45 minutes for both a winter midweek midday scenario and for a summer weekend midday scenario. The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study can be summarized as follows:

- Although the permanent resident population decreased by 6%, the number of evacuating vehicles for the permanent resident population increased by 23% (approximately 8,500 vehicles). This significant increase in permanent resident evacuating vehicles is caused by the decreased household size and increased number of evacuating vehicles per household as per the demographic survey, resulting in a significant decrease in permanent resident vehicle occupancy.
- The permanent resident population and number of evacuating vehicles within the shadow region increased by 8% and 43% (largely the result of the significant decrease in permanent resident vehicle occupancy discussed above), respectively, compared to the previous ETE. The significant increase in evacuating vehicles in the shadow region prolongs congestion in Berwick, Briar Creek, Hazleton and Nanticoke, thereby increasing ETE.
- Residents with commuters and residents without commuters take an additional 45 minutes to mobilize. This delay in trip generation directly impact the 100th percentile ETE as traffic congestion clears prior to the completion of mobilization time (see Section

7.3). Thus, trip generation times dictate ETE.

- Access Control Points (ACP) were established at 60 minutes in the 2012 study versus 120 minutes in this study. External traffic flowing on the main thoroughfares of the interstates passing through the EPZ reduces the capacity of entrance ramps to the interstates which can delay the egress of EPZ residents and increase ETE.

The combination of these various factors explain why the 90th and 100th percentile ETE for the entire EPZ (Region R03) are longer in this study relative to the 2012 ETE study.

Table 1-1. Stakeholder Interaction

Stakeholder	Nature of Stakeholder Interaction
Talen Energy	Meetings to define data requirements and set up contacts with local government agencies. Review and approval of demographic survey instrument and of key project assumptions.
Columbia and Luzerne County Emergency Management Offices, Pennsylvania Emergency Management Agency	Meetings and conference calls to define data requirements. Provided state and local emergency plans, special facility data. Review and approval of demographic survey instrument and of key project assumptions.

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	ArcGIS Software using 2010 US Census blocks; area ratio method used. Population = 71,275 in 36,865 vehicles	ArcGIS Software using 2020 US Census blocks; area ratio method used. Population = 66,924 in 45,375 vehicles
Resident Population Vehicle Occupancy	2.52 persons/household, 1.30 evacuating vehicles/household yielding: 1.94 persons/vehicle	2.37 persons/household, 1.63 evacuating vehicles/household yielding: 1.45 persons/vehicle
Shadow Population	ArcGIS Software using 2010 US Census blocks; area ratio method used. 20% Population = 19,206 20% Vehicles = 9,708	ArcGIS Software using 2020 US Census blocks; area ratio method used. 20% Population = 20,755 20% Vehicles = 13,837
Employee Population	Employee estimates based on information provided by the counties, by internet searches, and by direct phone calls to major employers. Using the Journey to Work census data, estimated the percentage of employees residing outside the EPZ. 1.02 employees/vehicle based on phone survey results. Employees = 1,583 in 1,555 vehicles	The estimate of employees commuting into the EPZ is based on data from the previous ETE study and on data provided by Luzerne County. Data from the previous study was obtained from a variety of sources including internet searches and direct phone calls to major employers. 1.06 employees/vehicle based on demographic survey results. Employees = 1,792 in 1,692 vehicles
Transient Population	Transient estimates based on information from each county, colleges considered separately Transients = 2,952 in 1,163 vehicles	Data collected for the previous ETE study was reviewed and updated by Columbia County and Luzerne County Emergency Management Agencies, indicating the data for most facilities remains the same. Transients = 3,006 in 1,222 vehicles

Topic	Previous ETE Study	Current ETE Study
Transit-Dependent Population	Estimates based upon U.S. Census data, the results of the telephone survey, and data provided in the Luzerne County RERP. A total of 6,010 people who do not have access to a vehicle, requiring 108 buses to evacuate. An additional 105 access and/or functional needs persons need special transportation to evacuate in 53 ambulances.	Estimates based upon County RERP Plans. A total of 3,584 people who do not have access to a personal vehicle, require 88 buses to evacuate. An additional 169 access and/or functional needs persons need special transportation to evacuate in 85 ambulances.
Medical Facility Population	Special facility population based on information provided by each county within the EPZ. Current census = 836 Buses Required = 27 Wheelchair Vans Required = 15 Ambulances Required = 85	Data for medical facilities identified within the EPZ were provided by the county emergency management agencies, supplemented by internet searches where no data was provided. Current census = 979 Buses Required = 27 Wheelchair Vans Required = 44 Ambulances Required = 90
School Population	School population based on information provided by each county within the EPZ. Includes colleges. School enrollment = 13,193 Buses required = 189	School population based on information provided by the counties supplemented by internet searches where no data was provided. School enrollment = 14,604 Buses required = 186
Voluntary evacuation from within EPZ in areas outside region to be evacuated	20 percent of the population within the EPZ, but not within the Evacuation Region (see Figure 2-1)	20 percent of the population within the EPZ, but not within the Evacuation Region (see Figure 2-1)
Shadow Evacuation	20% of people outside of the EPZ within the Shadow Region (see Figure 7-2)	20% of people outside of the EPZ within the Shadow Region (see Figure 7-2)
Network Size	1,675 links; 1,136 nodes	2,455 links; 1,867 nodes

Topic	Previous ETE Study	Current ETE Study
Roadway Geometric Data	Field surveys conducted in February 2010. Roads and intersections were video archived. Road capacities based on 2010 HCM.	Field surveys conducted in September 2020. Roads and intersections were video archived. Road capacities based on 2016 HCM.
School Evacuation	Direct evacuation to designated Host School.	Direct evacuation to designated Host School.
Ridesharing	50 percent of transit-dependent persons will evacuate with a neighbor or friend.	Ridesharing is not considered as counties provided all transit dependent population and number of buses needed.
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 135 minutes. All times measured from the ATE.	Based on residential demographic survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 60 and 285 minutes. Residents without commuters returning leave between 30 and 225 minutes. Employees and transients leave between 30 and 105 minutes. All times measured from the ATE.
Weather	Normal, Rain, or Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain and 20% for snow.	Normal, Rain/Light Snow, or Heavy Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain/light snow and 15% and 25% for snow, respectively.
Modeling	DYNEV II System – Version 4.0.10.0	DYNEV II System – Version 4.0.20.0
Special Events	SSES Refueling Special Event Population = 784 additional non-EPZ employee vehicles	SSES Refueling Special Event Population = 755 additional non-EPZ employee vehicles

Topic	Previous ETE Study	Current ETE Study
Evacuation Cases	30 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 420 unique cases.	33 Regions (central sector wind direction and three adjacent sectors on each side used) and 14 Scenarios producing 462 unique cases.
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 (Region R03), 90th percentile	Winter Weekday Midday, Good Weather (Scenario 6): 2:20 Summer Weekend, Midday, Good Weather (Scenario 3): 2:10	Winter Weekday Midday, Good Weather (Scenario 6): 3:10 Summer Weekend, Midday, Good Weather (Scenario 3): 2:55
Evacuation Time Estimates for the entire EPZ (Region R03), 100th percentile	Winter Weekday Midday, Good Weather (Scenario 6): 4:10 Summer Weekend, Midday, Good Weather (Scenario 3): 4:10	Winter Weekday Midday, Good Weather (Scenario 6): 4:55 Summer Weekend, Midday, Good Weather (Scenario 3): 4:55

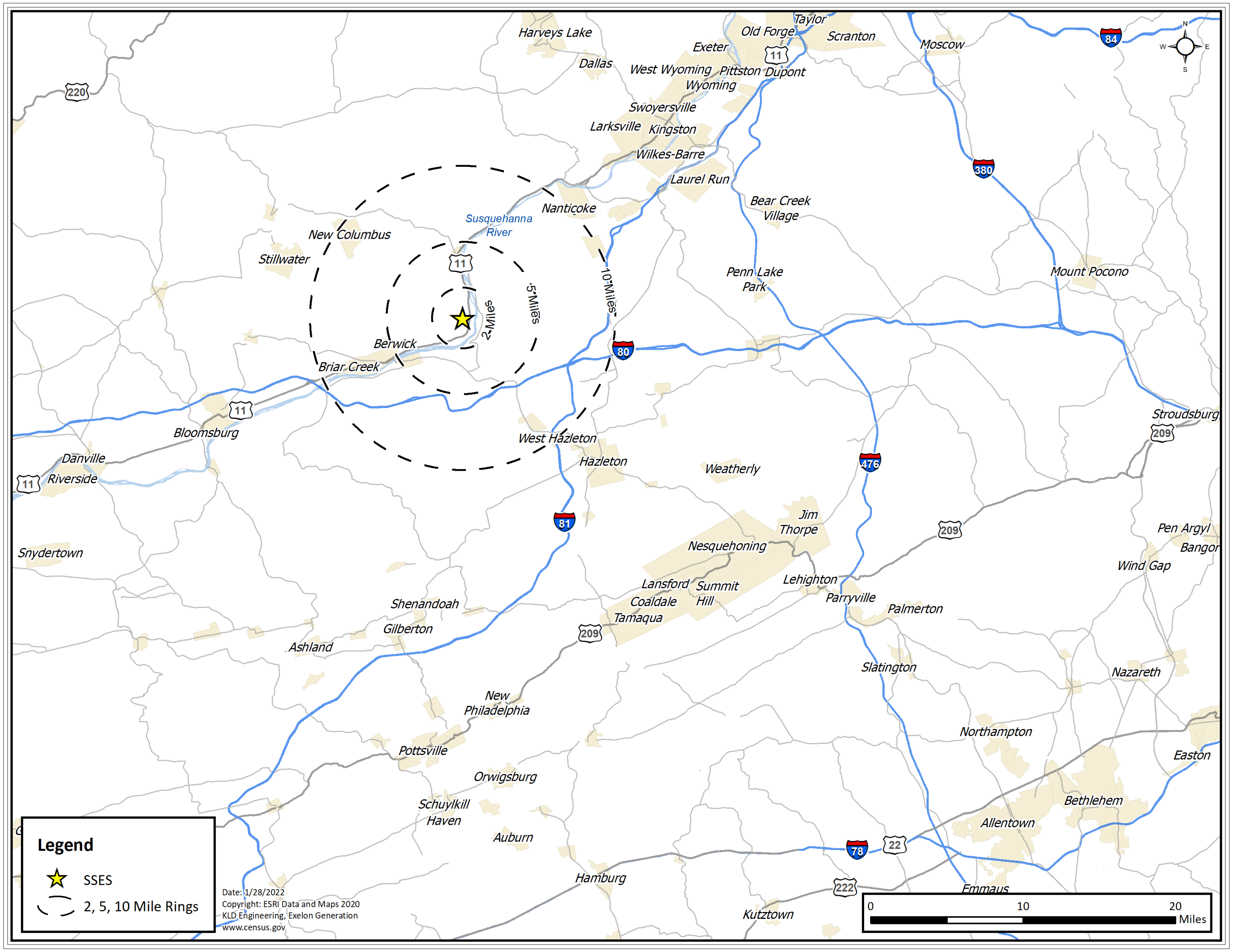


Figure 1-1. SSES Location

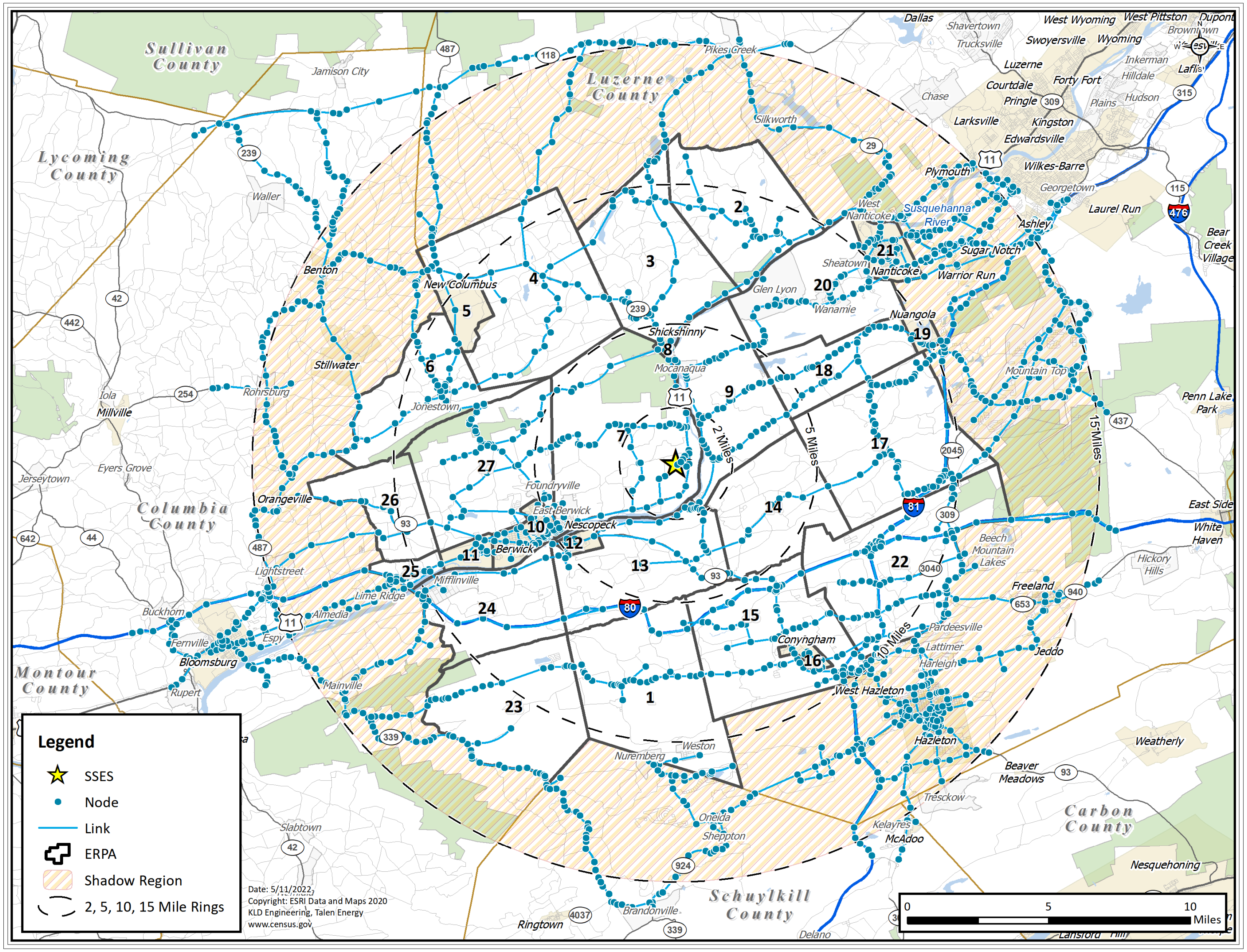


Figure 1-2. SSES Link-Node Analysis Network

2 STUDY ESTIMATES AND ASSUMPTIONS

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

2.1 Data Estimate Assumptions

1. The permanent resident population is based on the 2020 U.S. Census population from the Census Bureau website[1]. (See Section 3.1).
2. Estimates of employees who reside outside the EPZ and commute to work within the EPZ are based upon data provided by each county. (See Section 3.4).
3. Population estimates at transient and special facilities are based on the data received from the counties within the EPZ, the National Center for Education Statistics website[2], and the previous ETE study, supplemented by internet searches where data was missing.
4. The average household size (2.37 people per household) is based on the 2020 U.S. Census.
5. Evacuating vehicles per household (1.63 evacuating vehicles per household) are based on the recent online demographic survey.
6. Where data was not provided, the average household size is assumed to be the vehicle occupancy rate for transient facilities and for the special event.
7. Employee vehicle occupancies are based on the results of the demographic survey; 1.06 employees per vehicle are used in the study. (See Appendix F, sub-section F.3.1 and Figure F-8). In addition, it is assumed there are two people per carpool, on average.
8. The maximum bus speed assumed within the EPZ is 40 mph based on Pennsylvania state laws for buses and average posted speed limits on major roadways within the EPZ.
9. Roadway capacity estimates are based on field surveys performed in 2020 (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 siren notification.
   b. Mobilization of the general population will commence within 15 minutes after

[1] www.census.gov
[2] https://nces.ed.gov/ccd/schoolsearch/index.asp

[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.

siren notification.

c. ETE are measured relative to the ATE.

2. The center-point of the plant is located at the geometric center of the containment building for Units 1 and 2 at 41°05'31.0"N and 76°08'46.3"W.
3. The DYNEV II[4] system 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 traffic control devices and traffic guides. All major evacuation routes are used in the analysis.
5. The existing EPZ and ERPA 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 ERPA 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) are assumed to be the same as that of the permanent resident population within the EPZ.
9. ETE are presented at the 90th and 100th percentiles in graphical and tabular format, as per NRC guidance. The percentile ETE is defined as the elapsed time from the Advisory to Evacuate issued to a specific Region of the EPZ, to the time that Region is clear of the indicated percentile of evacuees.
10. This study does not assume that roadways are empty at the start of the evacuation. Rather, there is an initialization period (often referred to as “fill time” in traffic simulation) wherein the anticipated traffic volumes from the start of the evacuation 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 evacuation depends on the scenario and the region being evacuated. See Section 3.11.
11. To account for boundary conditions beyond the study area, this study assumes a 25% 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 (“main street”) volume will be more significant than the competing traffic (“side street”) volume at any downstream signalized intersections, thereby warranting a more significant

[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.

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.
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, 76% of the households in the EPZ have at least 1 commuter (see Appendix F, sub-section F.3.1 and Figure F-6); 51% of those households with commuters will await the return of a commuter before beginning their evacuation trip (see Appendix F, sub-section F.3.2). Therefore, 39% (76% x 51% = 39%) 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 are based on the results of the demographic survey. According to the survey results, approximately 71% of the transit-dependent population will rideshare (see Appendix F, sub-section F.3.1 and Figure F-5).
2. Transit vehicles are used to transport those without access to private vehicles:
    a. Schools and day care facilities
        i. If schools (and day care facilities affiliated with school districts) are in session, buses will evacuate students directly to the host schools.
        ii. It is assumed that parents will pick up children at privately owned and operated day care facilities prior to evacuation and the time needed to perform this activity is included in the responses to the demographic survey.
        iii. For the schools and day care facilities that are evacuated via buses, it is assumed no school 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, 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 (68%), wheelchair bound (9%) and bedridden patients (23%) from the 2012 ETE study was used to determine

the number of ambulatory, wheelchair bound and bedridden patients at the medical facilities wherein new data was not provided.

c. Transit-dependent permanent residents:
   i. Transit-dependent general population are evacuated to reception centers.
   ii. 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.

d. Analysis of the number of required roundtrips ("waves") of evacuating transit vehicles is presented.

e. 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 = 70 students per bus for elementary schools and 50 students per bus for middle/high schools.
   b. Ambulatory transit-dependent persons = 41 persons per bus (on average) based on data provided by the counties.
   c. Ambulatory medical facility patients = 30 persons per bus.
   d. Ambulances = 2 bedridden persons (includes advanced and basic life support).
   e. Wheelchair vans = 4 wheelchair bound persons.
4. Transit vehicles mobilization times:
   a. Vehicles will arrive at schools, hospitals, medical facilities and senior living facilities, to be evacuated within 90 minutes of the ATE.
   b. Transit dependent buses are mobilized when approximately 90% of residents with no commuters have completed their mobilization at 150 minutes of the ATE (see Figure 5-4).
   c. Vehicles will arrive at hospitals, medical facilities, and senior living facilities to be evacuated within 90 minutes of the ATE.
5. Transit Vehicle loading times:
   a. Buses for schools are loaded in 15 minutes.
   b. Transit Dependent buses require 1 minute of loading time per passenger.
   c. Buses for hospitals and medical 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.

6. Drivers for all transit vehicles are available.

2.5 Traffic and Access Control Assumptions

1. Traffic Control Points (TCP) and Access Control Points (ACP) as defined in the approved county and state emergency plans are considered in the ETE analysis, as per NRC guidance. See Appendix G.

2. TCP and ACP are assumed to be staffed approximately 120 minutes after the ATE, as per NRC guidance. Earlier activation of ACP locations could delay returning commuters. It is assumed that no through traffic will enter the EPZ after this 120-minute time period.

3. All transit vehicles and other responders entering the EPZ to support the evacuation are unhindered by personnel manning TCPs and ACPs.

2.6 Scenarios and Regions

1. A total of 14 "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. A refueling outage at SSES is considered as the special event (single or multi-day event that attracts a significant number of employees/transients into the EPZ; recommended by NRC guidance) for Scenario 13.
    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 one lane on I-80 westbound from Pennsylvania State Route 93 (PA-93) (Exit 256) to the interchange with PA-487 (Exit 236B) for the roadway impact scenario – Scenario 14.

2. Two types of adverse weather scenarios are considered. Rain may occur for either winter or summer scenarios; snow occurs in winter scenarios only. It is assumed that the rain or snow begins at about the same time the evacuation advisory is issued. Thus, 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 and that the appropriate agencies are clearing/treating the roads as they would normally with snow and the roads are passable albeit at lower speeds and capacities.

3. Adverse weather scenarios affect roadway capacity and free flow highway speeds. In accordance with Table 3-1 of Revision 1 to NUREG/CR-7002, this study assumes a 10% reduction in speed and capacity for rain and light snow and a speed and capacity reduction of 15% and 25%, respectively, for heavy snow. The factors are shown in Table 2-2.

4. Some evacuees will need additional time for heavy snow scenarios to clear their driveways and access the public roadway system. The distribution of time for this activity was gathered through a demographic survey of the public and takes up to 150 minutes (see Figure 5-2). It is assumed that the time needed by evacuees to remove snow from their driveways is sufficient time for snow removal crews to mobilize and clear/treat the public roadway system.

5. Employment is reduced slightly in the summer for vacations.
6. Mobilization and loading times for transit vehicles are slightly longer in adverse weather. It is assumed that mobilization times are 10 minutes and 20 minutes longer in rain/light snow and heavy snow, respectively. It is assumed that loading times are 5 minutes and 10 minutes longer for school buses and 10 minutes to 20 minutes longer for transit buses in rain/light snow and heavy snow, respectively. Refer to Table 2-2.
7. Regions are defined by the underlying "keyhole" or circular configurations as discussed in Talen Energy's NEP 15-001 Technical Basis Rev. 2, local Protective Action Recommendation (PAR) plan and in E2014-10-29-01, Rev. 4 evaluation. These Regions, as defined, display irregular boundaries reflecting the geography of the ERPA included within these underlying configurations. All 16 cardinal and intercardinal wind direction keyhole configurations are considered. The keyhole includes the downwind sector and three adjoining sectors on each side (a 7-sector keyhole). The use of a 7-sector keyhole is above and beyond (based on wind persistence studies at the site) the federal guidance of a 3-sector keyhole in Section 1.4 of NUREG/CR-7002, Rev 1. It is assumed that everyone within the group of ERPA forming a Region that is issued an ATE will, in fact, respond and evacuate in general accord with the planned routes.
8. Due to the irregular shapes of the ERPA, there are instances where a small portion of a ERPA (a "sliver") is within the keyhole and the population within that small portion is low (less than 500 people or 10% of the ERPA population, whichever is less). Under those circumstances, the ERPA is not included in the Region so as to not evacuate large numbers of people outside of the keyhole for a small number of people that are actually in the keyhole, unless otherwise stated in the PAR document.
9. Staged evacuation is considered as defined in NUREG/CR-7002, Rev. 1 – 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 R26 through R33 in Table 6-1.

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/Light Snow	None
8	Winter	Midweek	Midday	Heavy Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain/Light Snow	None
11	Winter	Weekend	Midday	Heavy Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Winter	Midweek	Midday	Good	SSES Refueling
14	Summer	Midweek	Midday	Good	Roadway Impact – Lane Closure on I-80 Westbound

[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).

Table 2-2. Model Adjustment for Adverse Weather

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time for General Population	Mobilization Time for Transit Vehicles	Loading Time for School Buses	Loading Time for Transit Buses[6]
Rain/Light Snow	90%	90%	No Effect	10-minute increase	5-minute increase	10-minute increase
Heavy Snow	75%	85%	See Section 5.3	20-minute increase	10-minute increase	20-minute increase
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.						

[6] Does not apply to medical facilities and those with access and/or functional needs as loading times for these people are already conservative.

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, visitors 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 on a weekend in the summer, 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 SSES 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 ERPA and by polar coordinate representation (population rose). The SSES EPZ is subdivided into 27 ERPAs. The ERPAs comprising the EPZ are 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 (2.37 persons/household) was estimated using the 2020 U.S. Census data – See Appendix F, Sub-section F.3.1. The number of evacuating vehicles per household (1.63 vehicles/household – See Appendix F, Sub-section F.3.2) was computed from the demographic survey results.

The permanent resident population is estimated by cutting the census block polygons by the ERPA 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. This methodology (referred to as the "area ratio method") assumes that the population is evenly distributed across a census block. Table 3-1 summarizes the permanent resident population within the EPZ, by ERPA, for 2010 and for 2020 (based on the methodology above). As indicated, the permanent resident population within the EPZ has decreased by 4.22% since the 2010 Census.

To estimate the number of vehicles, the 2020 Census permanent resident population is divided by the average household size and multiplied by the average number of evacuating vehicles per 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 SSES. 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, college/university student housing, 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.

3.1.1 Colleges/Universities

There are three university/college campuses within the EPZ: Luzerne County Community College at Berwick and Nanticoke Campuses, and Pennsylvania State University at Hazleton (Penn State Hazleton). Each facility has commuter students who live outside of the EPZ and drive to campuses. The enrollment data were provided by Luzerne County, supplemented by facility websites, aerial imagery, and the previous ETE study where data is missing. The data/information is summarized as follows:

Luzerne County Community College – Berwick Campus:

- Located in Columbia County, ERPA 10, 5.3 miles west-southwest of SSES.
- The enrollment data (100 students) from the previous study was reviewed by Columbia County and confirmed to be accurate.
- Since this campus does not provide student housing, all the students are considered commuter students. It is conservatively assumed that all the students live outside the EPZ and evacuate in private vehicles. Applying the average commuter vehicle occupancy rate

(1.06 – see Appendix F, Sub-section F.3.1) from the demographic survey, there are 94 (100 ÷ 1.06) commuter vehicles.

Luzerne County Community College - Nanticoke Campus:

- Located in Luzerne County, ERPA 21, 10.7 miles northeast of SSES.
- According to Lucerne County, this campus has an enrollment of 3,587 students.
- Similar to Berwick Campus, Nanticoke Campus has no student housing, and all the students drive to school. It is conservatively assumed that all the students live outside of the EPZ. Based on the aerial imagery, the total number of parking spaces on Nanticoke Campus is 1,650. As such, the maximum number of private vehicles evacuating the campus is 1,650.

Penn State Hazleton:

- Located in Luzerne County, EPRA 15, 9.6 miles southeast of SSES.
- According to Luzerne County, Penn State Hazleton has an enrollment of 1,190 students. The university website[1] shows there are 490 students living on campus. Thus, the remaining 700 off-campus students are considered commuter students.
- The campus map shows there are 260 parking spaces for students living on campus. Thus, the maximum number of evacuating vehicles for on-campus students is 260. It is reasonable to assume that the 490 on-campus students can be evacuated by 260 private vehicles (an average of 1.88 students per vehicle). As such, no bus is needed for this campus.
- It is conservatively assumed that all the 700 commuter students live outside of the EPZ and evacuate in private vehicles. Applying the same commuter vehicle occupancy rate discussed above results in 660 (700 ÷ 1.06) commuter vehicles for these students.

3.2 Shadow Population

A portion of the population living outside the EPZ extending to 15 miles radially from the SSES 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 in Figure 3-5 to avoid double counting.

[1] https://hazleton.psu.edu/fast-facts

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 (shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels.

Data collected for the previous ETE study was reviewed and updated by Columbia County and Luzerne County Emergency Management Agencies, indicating the data for most facilities remains the same. Luzerne County identified a new facility – Bodnarosa Motel and Campground and provided the number of transients and vehicles at this facility. The transient facilities within the SSES EPZ are summarized as follows:

- Campgrounds – 1,059 transients and 256 vehicles; an average of 4.14 transients per vehicle (Note, Camp Louise is a children's camp and categorized as a campground in this study. Refer to Section 8.1 for detailed information)
- Golf courses – 214 transients and 127 vehicles; an average of 1.69 transients per vehicle
- Hunting/Fishing Areas – 375 transients and 190 vehicles; an average of 1.97 transients per vehicle
- Parks – 286 transients and 113 vehicles; an average of 2.53 transients per vehicle
- Lodging facilities – 1,072 transients and 536 vehicles; an average of 2.00 transients per vehicle

Appendix E summarizes the transient data that was estimated for the EPZ. Table E-5 presents the number of transients visiting recreational areas and Table E-6 shows the number at lodging facilities within the EPZ.

In total, there are 3,006 transients in 1,222 vehicles (an average of 2.46 transients per vehicle) in the EPZ. Table 3-4 summarizes the transient population and vehicles by ERPA. Figure 3-6 and Figure 3-7 present these data by sector and distance from the SSES.

3.4 Employees

The estimate of employees commuting into the EPZ is based on data from the previous ETE study and on data provided by Luzerne County. Data from the previous study was obtained from a variety of sources including internet searches and direct phone calls to major employers. It included the maximum shift employment and percentage of employees commuting into the EPZ for each facility. This data was reviewed by Columbia County and Luzerne County Emergency Management Agencies and confirmed as still being valid. Note, the employment data for SSES was provided directly by Talen Energy. There is one new major employer within the Columbia County portion of the EPZ – the Family Dollar Distribution Center. Data for this facility was estimated using the latest data (as of 2019) from the U.S. Census Bureau's OnTheMap Census analysis tool[2].

As per NUREG/CR-7002, Rev. 1, employers with 200 or more employees working in a single shift are considered to be major employers. As such, employers with less than 200 employees (during

[2] http://onthemap.ces.census.gov/ OnTheMap is an interactive map displaying workplace and residential distributions by user-defined geographies at census block level detail. It also reports the work characteristics detail on age, and earnings industry groups.

the maximum shift) are not considered in this study.

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 percentage of employees commuting into the EPZ is included in the data for each facility.

There are a total of 1,792 employees commuting into the EPZ on a daily basis. To estimate the evacuating employee vehicles, a vehicle occupancy of 1.06 employees per vehicle obtained from the demographic survey (see Appendix F, Sub-section F.3.1) was used for the major employers. Detailed information for each major employer can be found in Appendix E, Table E-4. Table 3-5 presents employee and vehicle estimates commuting into the EPZ by ERPA. Figure 3-8 and Figure 3-9 present these data by sector.

3.5 Medical Facilities

Data for medical facilities identified within the EPZ were provided by the county emergency management agencies, supplemented by internet searches where no data was provided. Table E-3 in Appendix E summarizes the data gathered for medical facilities. Table 3-6 presents the census of medical facilities in the EPZ. As shown in these tables, 979 people have been identified as living in, or being treated in, these facilities. This data includes the number of ambulatory, wheelchair-bound and bedridden patients at each facility. The average breakdown of ambulatory (68%), wheelchair bound (9%) and bedridden patients (23%) from the 2012 ETE study was used to determine the number of ambulatory, wheelchair bound, and bedridden patients at the medical facilities wherein updated data was not provided.

The transportation requirements for the special facility population are also presented in Table 3-6. The number of ambulance runs is determined by assuming that 2 patients can be accommodated per ambulance trip; the number of wheelchair van runs assumes 4 wheelchairs per trip, and the number of bus runs estimated assumes 30 ambulatory patients per trip.

3.6 Transit Dependent Population

Transit dependent estimates for the two counties were listed in the county Radiological Emergency Response Plans (RERPs). The plan also lists the number of buses required for the evacuation of the transit dependent population. Table 3-7 indicates that transportation must be provided for 1,028 residents in Columbia County and 2,556 residents in Luzerne County (3,584 people total). A total of 88 buses (average occupancy of 41 passengers per bus) are required to transport this population to reception centers as per the county RERPs.

3.7 School Population Demand

Table 3-8 presents the school population and transportation requirements for the direct evacuation of all schools within the EPZ for the 2020-2021 school year. This information was provided by the counties supplemented by internet searches where no data was provided. The column in Table 3-8 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, since the intent of schools is to evacuate all students by bus.
- Bus capacity, expressed in students per bus, is set to 70 for primary schools and 50 for middle and high schools.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism, which is typically 3 percent daily.

It is recommended that the counties in the EPZ 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. The need for buses would be reduced by any high school students who have evacuated using private automobiles (if permitted by school authorities). Those buses originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing.

Table 10-3 presents a list of the host schools for each school in the EPZ. Students will be transported to these host schools where they will be subsequently retrieved by their respective families or guardians.

3.8 Special Event

A special event can attract large numbers of transients to the EPZ for short periods of time, creating a temporary surge in demand as per Section 2.5.1 of NUREG/CR-7002, Rev. 1. The county and state emergency management agencies were polled regarding potential special events in the EPZ. The only potential special event identified by the county and state agencies that attracts transients from outside the EPZ is a refueling outage of SSES.

Thus, one special event (Scenario 13) is considered for the ETE study – a refueling outage of SSES. Data was provided by Talen Energy on the approximate number of additional workers on site during a refueling outage. The refueling outages normally occur between March 1st and May 1st of every spring and last for approximately 35 to 45 days. There are approximately 1,200 supplemental workers, split between 2 shifts (2/3-day shift vs. 1/3-night shift). Considering the maximum shift, up to 800 supplemental workers could be on site evacuating in 755 additional vehicles (800 employees ÷ 1.06 employees per vehicle). None (0%) of the supplemental workers are EPZ residents.

3.9 Access and/or Functional Needs Population

The county emergency management agencies have an annual registration for homebound (non-institutionalized) people with access and/or functional needs. Based on data provided by Columbia County and on the 2020 Luzerne County RERP, there are an estimated 100 homebound people with access and/or functional needs within the Columbia County portion of the EPZ and 69 people within the Luzerne County portion of the EPZ who require transportation assistance to evacuate. Each of these residents (169 total) requires an ambulance to evacuate. (See Table 3-9).

3.10 External Traffic

Vehicles will be traveling through the EPZ (external-external trips which have their origins and destinations outside of the EPZ) at the time of an accident. After the Advisory to Evacuate is announced, these through-travelers will also evacuate. These through vehicles are assumed to travel on the major routes traversing the EPZ – Interstate 80 (I-80) and I-81. It is assumed that this traffic will continue to enter the EPZ during the first 120 minutes following the Advisory to Evacuate.

Average Annual Daily Traffic (AADT) data was obtained from Pennsylvania Department of Transportation Bureau of Planning and Research Transportation Planning Division 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 3-10, for the routes considered. The DDHV is then multiplied by 2 hours (access control points – ACP – are assumed to be activated at 120 minutes after the advisory to evacuate) to estimate the total number of external vehicles loaded on the analysis network. As indicated, there are 12,628 vehicles entering the EPZ as external-external trips prior to the activation of the ACP and the diversion of this traffic (see Table 3-10). This number is reduced by 60% for evening scenarios (Scenarios 5 and 12) 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 5-9, 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 the evacuation (Time Period 1). Rather, there is an initialization period (often referred to as “fill time” in traffic simulation) wherein the anticipated traffic volumes from the start of the evacuation 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 evacuation depends on the scenario and the region being evacuated (see Section 6). There are 3,915 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 6 (winter, midweek, midday, good weather) conditions.

3.12 Summary of Demand

A summary of population and vehicle demand is provided in Table 3-11 and Table 3-12, respectively. This summary includes all population groups described in this section. A total of 112,366 people and 78,905 vehicles are considered in this study.

Table 3-1. EPZ Permanent Resident Population

ERPA	2010 Population[3]	2020 Population
1	2,024	1,924
2	2,107	1,868
3	2,041	2,040
4	2,241	2,043
5	225	214
6	714	805
7	4,287	4,079
8	838	604
9	1,453	1,313
10	10,387	10,259
11	646	586
12	1,569	1,481
13	1,166	1,083
14	1,196	1,139
15	4,213	3,968
16	1,912	1,772
17	2,188	2,083
18	1,115	1,029
19	679	635
20	5,377	4,467
21	10,462	10,628
22	5,826	5,930
23	652	606
24	2,053	1,977
25	403	397
26	1,010	954
27	3,088	3,040
EPZ TOTAL:	**69,872**	**66,924**
EPZ Population Growth (2010-2020):		**-4.22%**

[3] The boundaries of ERPAs 6, 24, 25 and 26 have changed since the previous ETE study. The 2010 population for those ERPAs have been adjusted to reflect this change and will therefore not align with the numbers documented in the previous ETE study.

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

ERPA	2020 Population	2020 Resident Vehicles
1	1,924	1,329
2	1,868	1,287
3	2,040	1,399
4	2,043	1,359
5	214	147
6	805	551
7	4,079	2,780
8	604	418
9	1,313	903
10	10,259	7,010
11	586	397
12	1,481	1,022
13	1,083	747
14	1,139	786
15	3,968	2,616
16	1,772	1,220
17	2,083	1,431
18	1,029	707
19	635	434
20	4,467	2,815
21	10,628	7,229
22	5,930	4,009
23	606	417
24	1,977	1,358
25	397	274
26	954	658
27	3,040	2,072
EPZ TOTAL:	**66,924**	**45,375**

Table 3-3. Shadow Population and Vehicles by Sector

Sector	2020 Population	Evacuating Vehicles
N	2,416	1,667
NNE	3,860	1,175
NE	14,431	9,818
ENE	10,394	7,017
E	3,292	2,260
ESE	10,151	6,953
SE	42,925	29,200
SSE	926	638
S	2,285	1,573
SSW	431	296
SW	574	395
WSW	6,108	4,151
W	1,739	1,118
WNW	2,211	1,524
NW	959	658
NNW	1,074	742
TOTAL:	**103,776**	**69,185**

Table 3-4. Summary of Transients and Transient Vehicles

ERPA	Transients	Transient Vehicles
1	0	0
2	0	0
3	58	19
4	0	0
5	0	0
6	237	83
7	309	155
8	0	0
9	350	90
10	33	17
11	52	26
12	0	0
13	0	0
14	316	79
15	600	300
16	0	0
17	100	70
18	55	28
19	0	0
20	0	0
21	0	0
22	464	219
23	0	0
24	110	55
25	70	35
26	0	0
27	252	46
EPZ TOTAL:	**3,006**	**1,222**

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

ERPA	Employees	Employee Vehicles
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	537	507
8	0	0
9	0	0
10	377	356
11	293	277
12	0	0
13	0	0
14	0	0
15	210	198
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	375	354
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
EPZ TOTAL:	**1,792**	**1,692**

Table 3-6. Medical Facility Transit Demand

ERPA	Facility Name	Capacity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Bus Runs	Wheel-chair Van Runs	Ambulance Runs
COLUMBIA COUNTY, PA									
10	Berwick Retirement Villages I & II	240	240	179	16	45	6	4	23
10	Berwick Hospital Center	268	268	250	10	8	9	3	4
11	Elmcroft of Berwick	76	76	57	5	14	2	2	7
	Columbia County Subtotal:	*584*	*584*	*486*	*31*	*67*	*17*	*9*	*34*
LUZERNE COUNTY, PA									
4	Bonham Nursing Home	109	74	44	0	30	2	0	15
7	Paradise Manor	6	6	4	1	1	1	1	1
14	ALC Family Care	20	20	20	0	0	1	0	0
20	Guardian Healthcare and Rehabilitation Center	110	76	15	49	12	1	13	6
21	Northeast Counseling Nanticoke Services	17	12	10	2	0	1	1	0
21	Birchwood Nursing Home	120	56	26	10	20	1	3	10
22	Fritzingertown Senior Living Community	168	101	25	50	26	1	13	13
22	Kadima Rehabilitation and Nursing	37	32	5	10	17	1	3	9
22	Conyngham Care Center	20	18	14	1	3	1	1	2
	Luzerne County Subtotal:	*607*	*395*	*163*	*123*	*109*	*10*	*35*	*56*
TOTAL:		**1,191**	**979**	**649**	**154**	**176**	**27**	**44**	**90**

Table 3-7. County Transit-Dependent Population Estimates

Municipality	Transit-Dependent Population	Buses Required
COLUMBIA COUNTY, PA		
Beaver Township	34	1
Berwick Borough / Briar Creek Borough	560	14
Briar Creek Township	153	4
Fishing Creek Township	36	1
Mifflin Township	120	3
North Centre Township	76	2
South Centre Township	49	1
Columbia County Subtotal:	*1,028*	*26*
LUZERNE COUNTY, PA		
Black Creek Township	104	2
Butler Township / Conyngham Borough	386	8
Conyngham Township	75	2
Dorrance Township	110	3
Hollenback Township	50	1
Hunlock Township	108	3
Huntington Twp / New Columbus Borough	128	3
Nanticoke City	530	14
Nescopeck Borough	80	2
Nescopeck Township	58	1
Newport Township	272	7
Nuangola Borough	34	1
Salem Township	215	5
Shickshinny Borough	44	1
Slocum Township	50	1
Sugarloaf Township	210	5
Union Township	102	3
Luzerne County Subtotal:	*2,556*	*62*
TOTAL:	**3,584**	**88**

Table 3-8. School Population Demand Estimates

ERPA	School Name	Enrollment	Buses Required
COLUMBIA COUNTY, PA			
10	Berwick High School	955	20
10	Columbia Day Care	102	2
10	New Story Berwick School	46	1
10	West Berwick Elementary	512	8
23	Beaver-Main Elementary	107	2
	Columbia Schools Subtotals:	1,722	33
LUZERNE COUNTY, PA			
2	Northwest Area Intermediate School	292	5
3	Northwest Area Middle/High School	668	14
3	Muhlenburg Christian Academy	75	2
4	Northwest Area Primary School	233	4
7	Salem Elementary School	410	6
7	Berwick Area Middle School	724	15
12	Nescopeck Elementary School	180	3
15	Valley Elementary/Middle School	890	18
21	GNA Elementary Center	600	9
21	GNA Educational Center	600	12
21	GNA High School	720	15
22	Drums Elementary/Middle School	734	15
22	Hazleton Area Academy of Sciences	530	11
22	Keystone Job Corporation High School	471	10
S.R.	Rice Elementary School	800	12
	Luzerne Schools Subtotals:	7,927	151
	SCHOOLS TOTAL:	**9,649**	**184**
COLLEGES			
10	Luzerne County Community College - Berwick	100	-
15	Penn State Hazleton	1,190	-
21	Luzerne County Community College - Nanticoke	3,587	-
	Colleges Subtotals:	**4,877**	**0**
	GRAND TOTAL:	**14,526**	**184**

Table 3-9. Demand Estimates for Homebound Population with Access and/or Functional Needs

Population Group	Transportation Needed	Population	Vehicles deployed
COLUMBIA COUNTY, PA			
Ambulatory	Bus	0	0
Wheelchair bound	Wheelchair Van	0	0
Bedridden	Ambulance	69	35
	Columbia County Subtotal:	*69*	*35*
LUZERNE COUNTY, PA			
Ambulatory	Bus	0	0
Wheelchair bound	Wheelchair Van	0	0
Bedridden	Ambulance	100	50
	Luzerne County Subtotal:	*100*	*50*
	Total:	**169**	**85**

Table 3-10. External Traffic Traversing the SSES EPZ

Up Node	Down Node	Road Name	Direction	AADT[4]	K-Factor[5]	D-Factor[5]	Hourly Volume	External Traffic
8642	765	I-80	Eastbound	28,000	0.107	0.5	1,498	2,996
8682	682	I-80	Westbound	28,000	0.107	0.5	1,498	2,996
8395	395	I-81	Northbound	31,000	0.107	0.5	1,659	3,318
8755	755	I-81	Southbound	31,000	0.107	0.5	1,659	3,318
							TOTAL:	**12,628**

[4] Pennsylvania Department of Transportation Bureau of Planning and Research Transportation Planning Division, 2020

[5] HCM 2016

Table 3-11. Summary of Population Demand

ERPA	Residents	Transit-Dependent	Transients	Employees	Medical Facilities	Colleges/ Universities	Schools	Special Event	Shadow Population	External Traffic	Total
1	1,924	104	0	0	0	0	0	0	0	0	2,028
2	1,868	108	0	0	0	0	292	0	0	0	2,268
3	2,040	102	58	0	0	0	743	0	0	0	2,943
4	2,043	128	0	0	74	0	233	0	0	0	2,478
5	214	0	0	0	0	0	0	0	0	0	214
6	805	36	237	0	0	0	0	0	0	0	1,078
7	4,079	215	309	537	6	0	1,134	800	0	0	7,080
8	604	44	0	0	0	0	0	0	0	0	648
9	1,313	75	350	0	0	0	0	0	0	0	1,738
10	10,259	560	33	377	508	100	1,615	0	0	0	13,452
11	586	0	52	293	76	0	0	0	0	0	1,007
12	1,481	80	0	0	0	0	180	0	0	0	1,741
13	1,083	58	0	0	0	0	0	0	0	0	1,141
14	1,139	50	316	0	20	0	0	0	0	0	1,525
15	3,968	210	600	210	0	1,190	890	0	0	0	7,068
16	1,772	0	0	0	0	0	0	0	0	0	1,772
17	2,083	110	100	0	0	0	0	0	0	0	2,293
18	1,029	50	55	0	0	0	0	0	0	0	1,134
19	635	34	0	0	0	0	0	0	0	0	669
20	4,467	272	0	0	76	0	0	0	0	0	4,815
21	10,628	530	0	375	68	3,587	1,920	0	0	0	17,108
22	5,930	386	464	0	151	0	1,735	0	0	0	8,666
23	606	34	0	0	0	0	107	0	0	0	747
24	1,977	120	110	0	0	0	0	0	0	0	2,207
25	397	49	70	0	0	0	0	0	0	0	516
26	954	76	0	0	0	0	0	0	0	0	1,030
27	3,040	153	252	0	0	0	0	0	0	0	3,445
Shadow Region	0	0	0	0	0	0	800	0	20,755	0	21,555
TOTAL:	**66,924**	**3,584**	**3,006**	**1,792**	**979**	**4,877**	**9,649**	**800**	**20,755**	**0**	**112,366**

NOTE: Shadow Population has been reduced to 20% (see Figure 2-1).

Table 3-12. Summary of Vehicle Demand

ERPA	Residents	Transit-Dependent	Transients	Employees	Medical Facilities	Colleges/ Universities	Schools	Special Event	Shadow Population	External Traffic	Total
1	1,329	4	0	0	0	0	0	0	0	0	1,333
2	1,287	6	0	0	0	0	10	0	0	0	1,303
3	1,399	6	19	0	0	0	32	0	0	0	1,456
4	1,359	6	0	0	19	0	8	0	0	0	1,392
5	147	0	0	0	0	0	0	0	0	0	147
6	551	2	83	0	0	0	0	0	0	0	636
7	2,780	10	155	507	4	0	42	755	0	0	4,253
8	418	2	0	0	0	0	0	0	0	0	420
9	903	4	90	0	0	0	0	0	0	0	997
10	7,010	28	17	356	64	94	62	0	0	0	7,631
11	397	0	26	277	13	0	0	0	0	0	713
12	1,022	4	0	0	0	0	6	0	0	0	1,032
13	747	2	0	0	0	0	0	0	0	0	749
14	786	2	79	0	2	0	0	0	0	0	869
15	2,616	10	300	198	0	920	36	0	0	0	4,080
16	1,220	0	0	0	0	0	0	0	0	0	1,220
17	1,431	6	70	0	0	0	0	0	0	0	1,507
18	707	2	28	0	0	0	0	0	0	0	737
19	434	2	0	0	0	0	0	0	0	0	436
20	2,815	14	0	0	21	0	0	0	0	0	2,850
21	7,229	28	0	354	18	1,650	72	0	0	0	9,351
22	4,009	16	219	0	47	0	72	0	0	0	4,363
23	417	2	0	0	0	0	4	0	0	0	423
24	1,358	6	55	0	0	0	0	0	0	0	1,419
25	274	2	35	0	0	0	0	0	0	0	311
26	658	4	0	0	0	0	0	0	0	0	662
27	2,072	8	46	0	0	0	0	0	0	0	2,126
Shadow Region	0	0	0	0	0	0	24	0	13,837	12,628	26,489
TOTAL:	**45,375**	**176**	**1,222**	**1,692**	**188**	**2,664**	**368**	**755**	**13,837**	**12,628**	**78,905**

NOTE: Buses represented as two passenger vehicles.

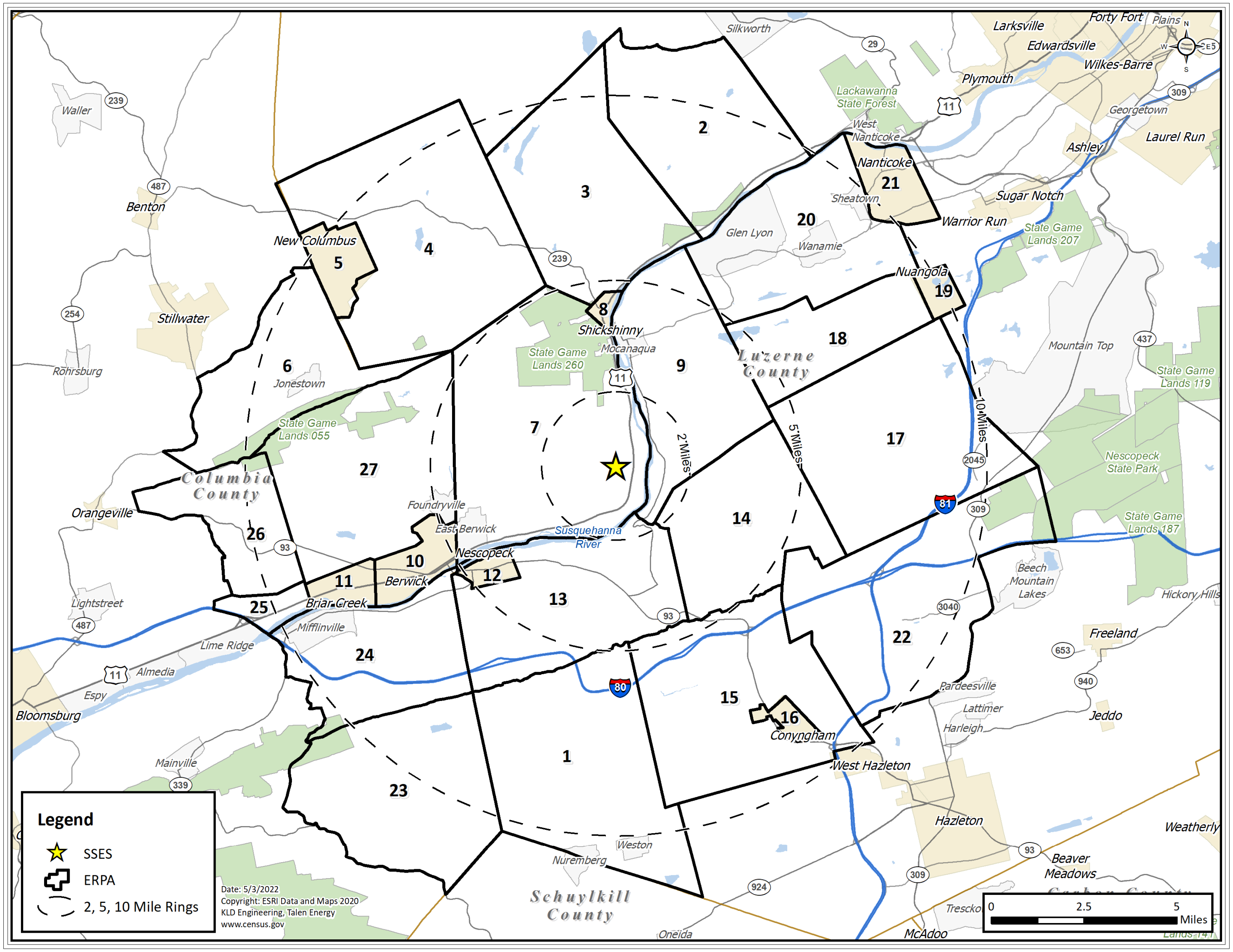
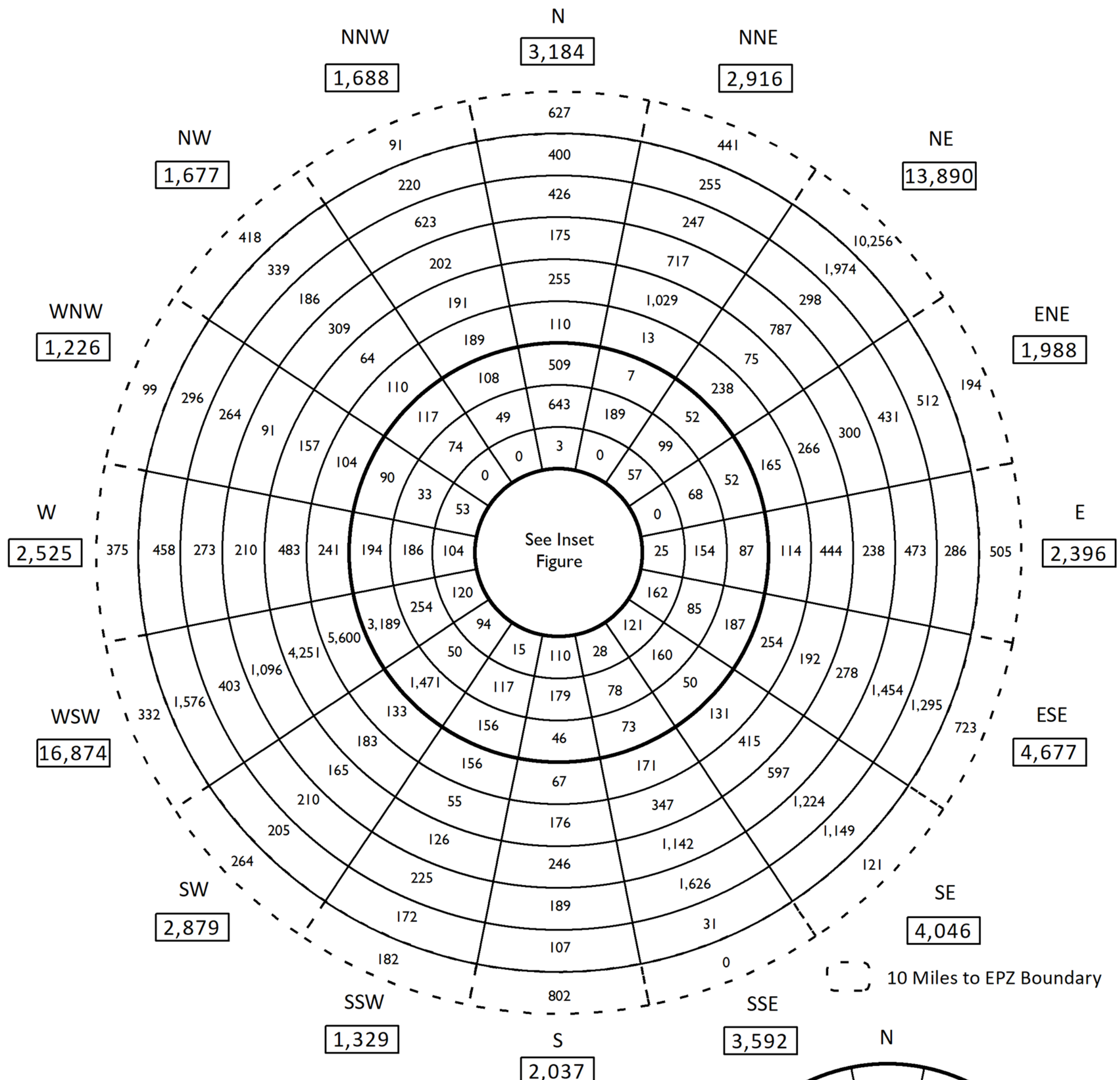


Figure 3-1. ERPAs Comprising the SSES EPZ



2020 Permanent Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	152	152
1 - 2	759	911
2 - 3	892	1,803
3 - 4	2,418	4,221
4 - 5	6,388	10,609
5 - 6	7,796	18,405
6 - 7	8,583	26,988
7 - 8	6,679	33,667
8 - 9	8,552	42,219
9 - 10	9,275	51,494
10 - EPZ	15,430	66,924
	Total:	66,924

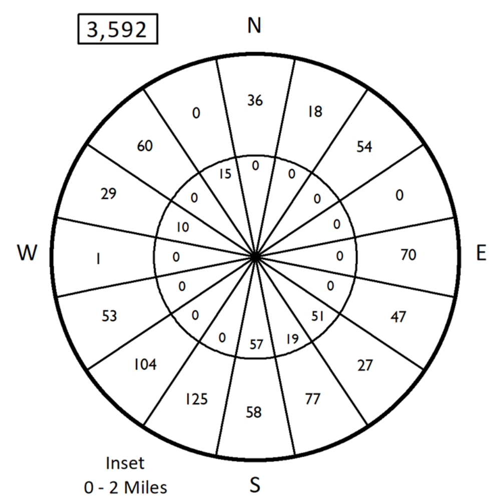
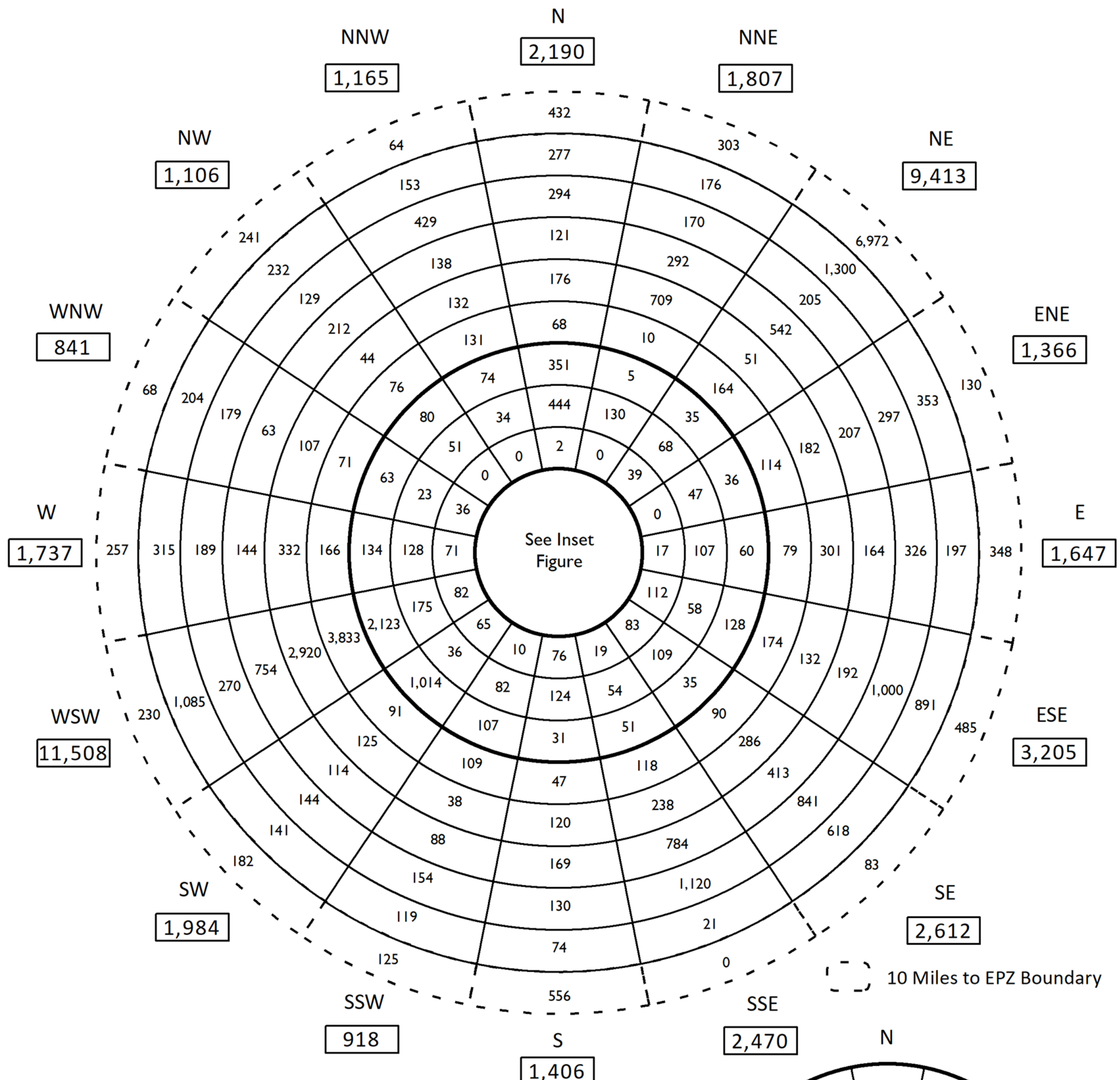


Figure 3-2. Permanent Resident Population by Sector



Resident Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	104	104
1 - 2	522	626
2 - 3	612	1,238
3 - 4	1,670	2,908
4 - 5	4,327	7,235
5 - 6	5,341	12,576
6 - 7	5,893	18,469
7 - 8	4,397	22,866
8 - 9	5,877	28,743
9 - 10	6,156	34,899
10 - EPZ	10,476	45,375
	Total:	45,375

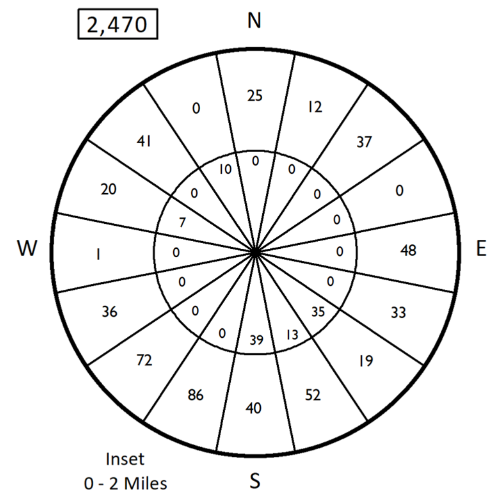
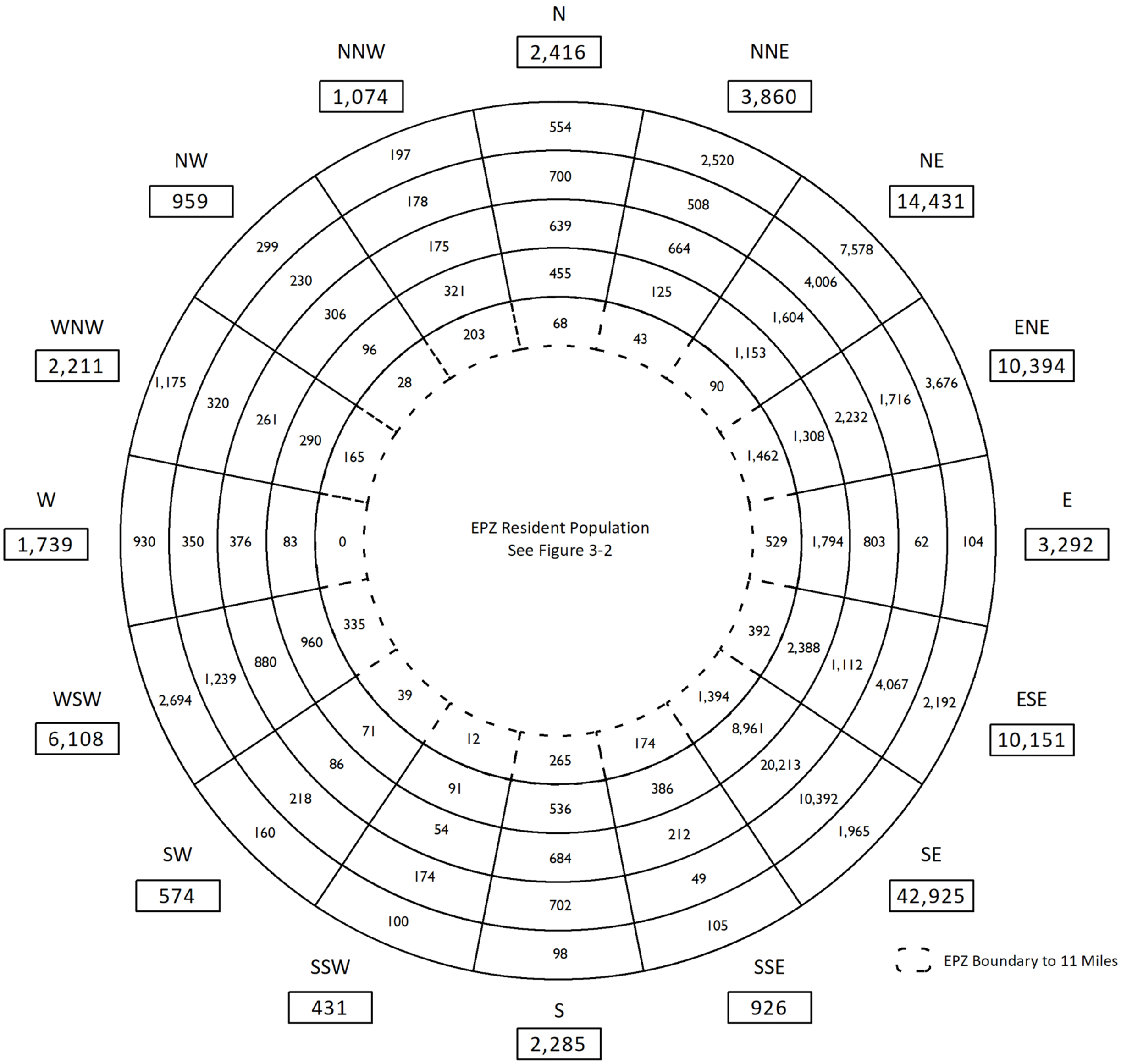


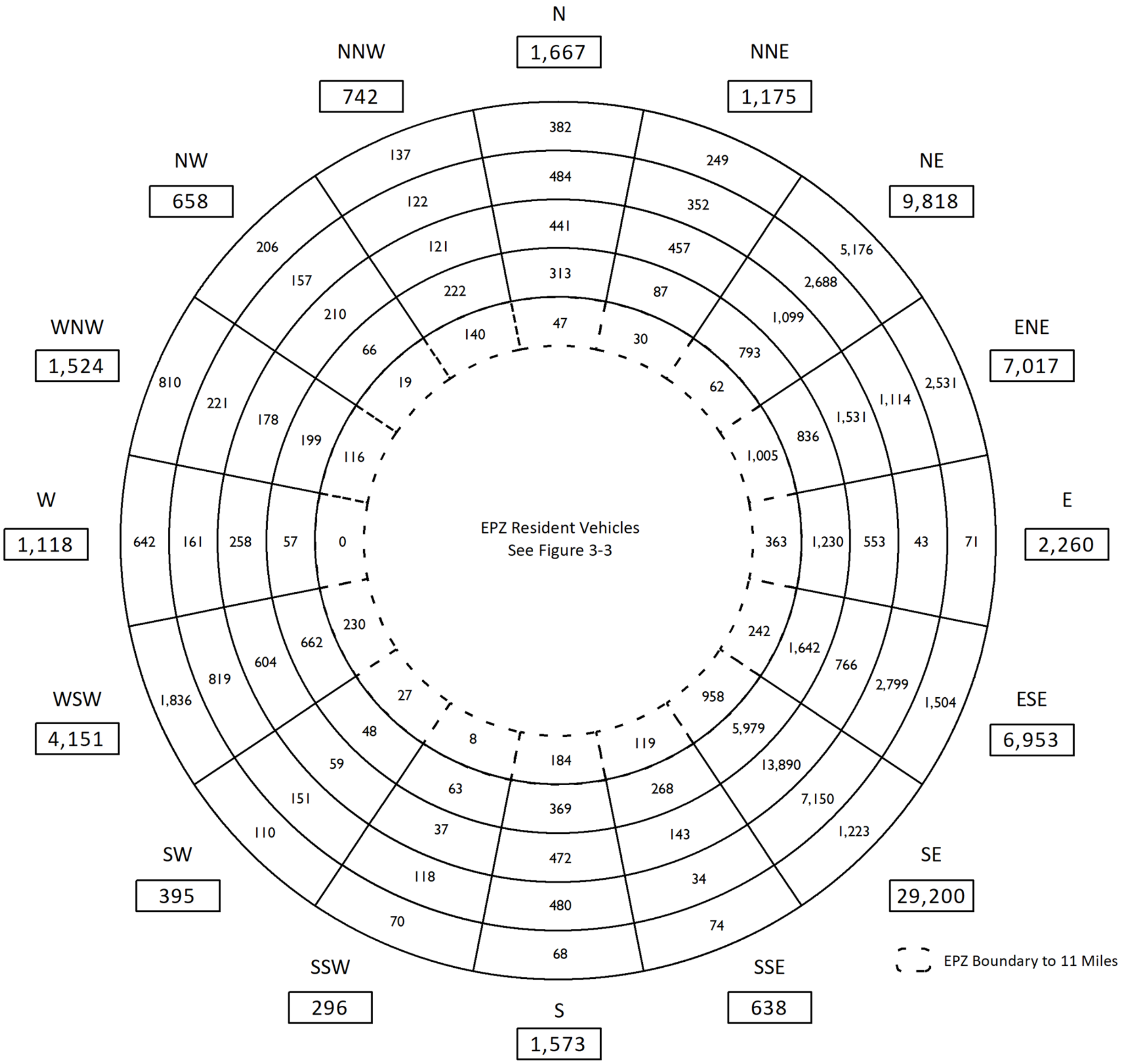
Figure 3-3. Permanent Resident Vehicles by Sector



2020 Shadow Population

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	5,199	5,199
11 - 12	19,018	24,217
12 - 13	30,301	54,518
13 - 14	24,911	79,429
14 - 15	24,347	103,776
	Total:	103,776

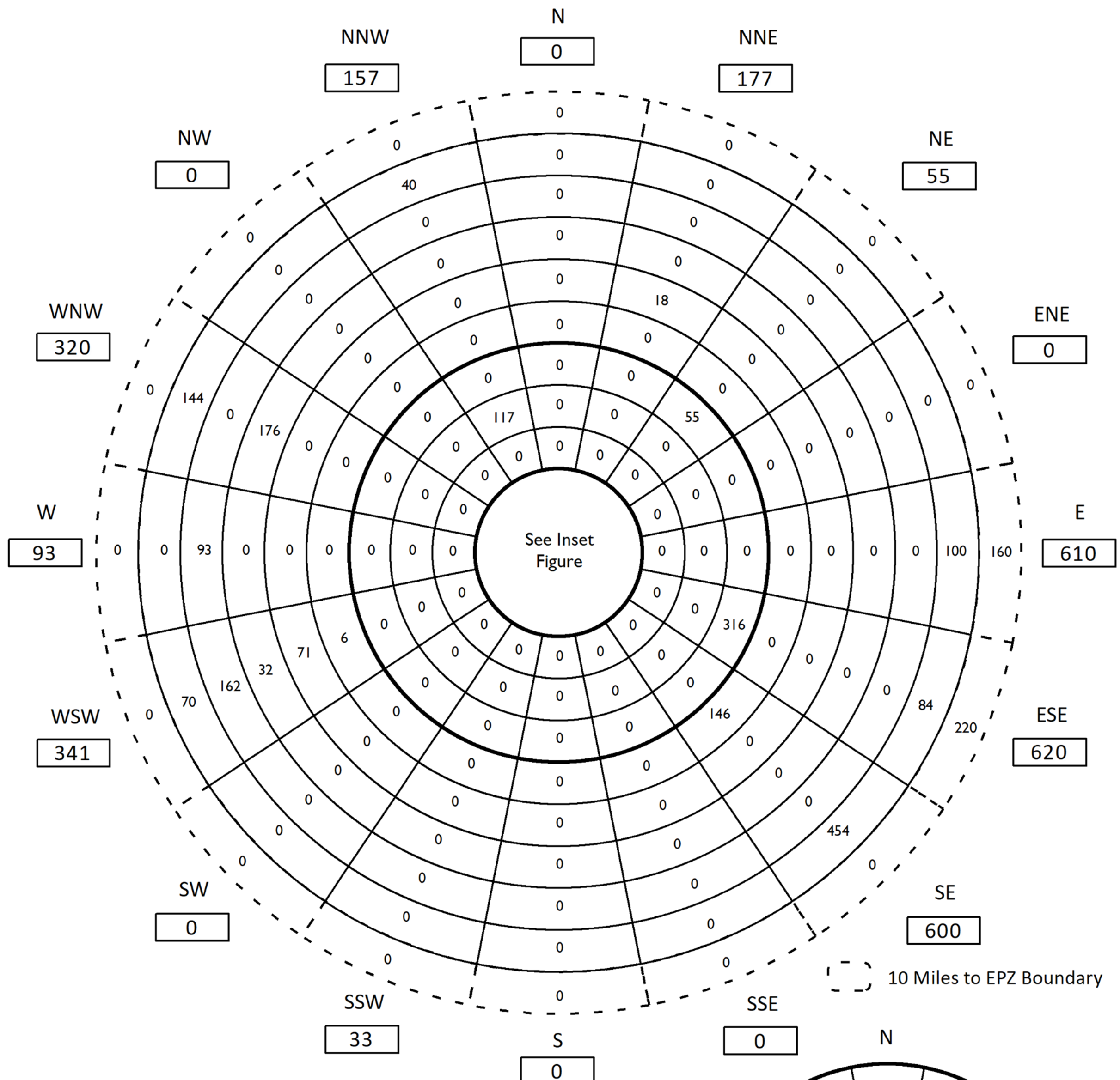
Figure 3-4. Shadow Population by Sector



Shadow Vehicles

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	3,550	3,550
11 - 12	12,834	16,384
12 - 13	20,819	37,203
13 - 14	16,893	54,096
14 - 15	15,089	69,185
	Total:	69,185

Figure 3-5. Shadow Vehicles by Sector



Transients

Miles	Subtotal by Ring	Cumulative Total
0 - 1	159	159
1 - 2	383	542
2 - 3	0	542
3 - 4	117	659
4 - 5	371	1,030
5 - 6	152	1,182
6 - 7	89	1,271
7 - 8	208	1,479
8 - 9	255	1,734
9 - 10	892	2,626
10 - EPZ	380	3,006
	Total:	3,006

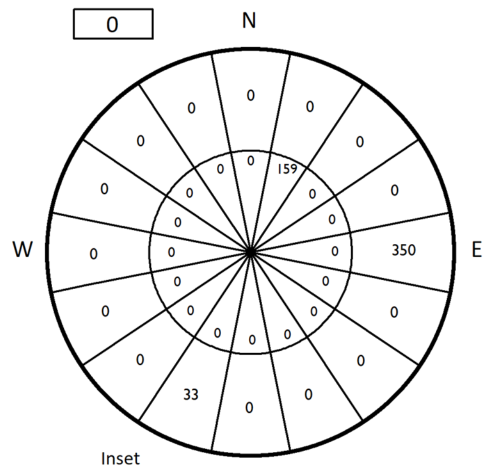
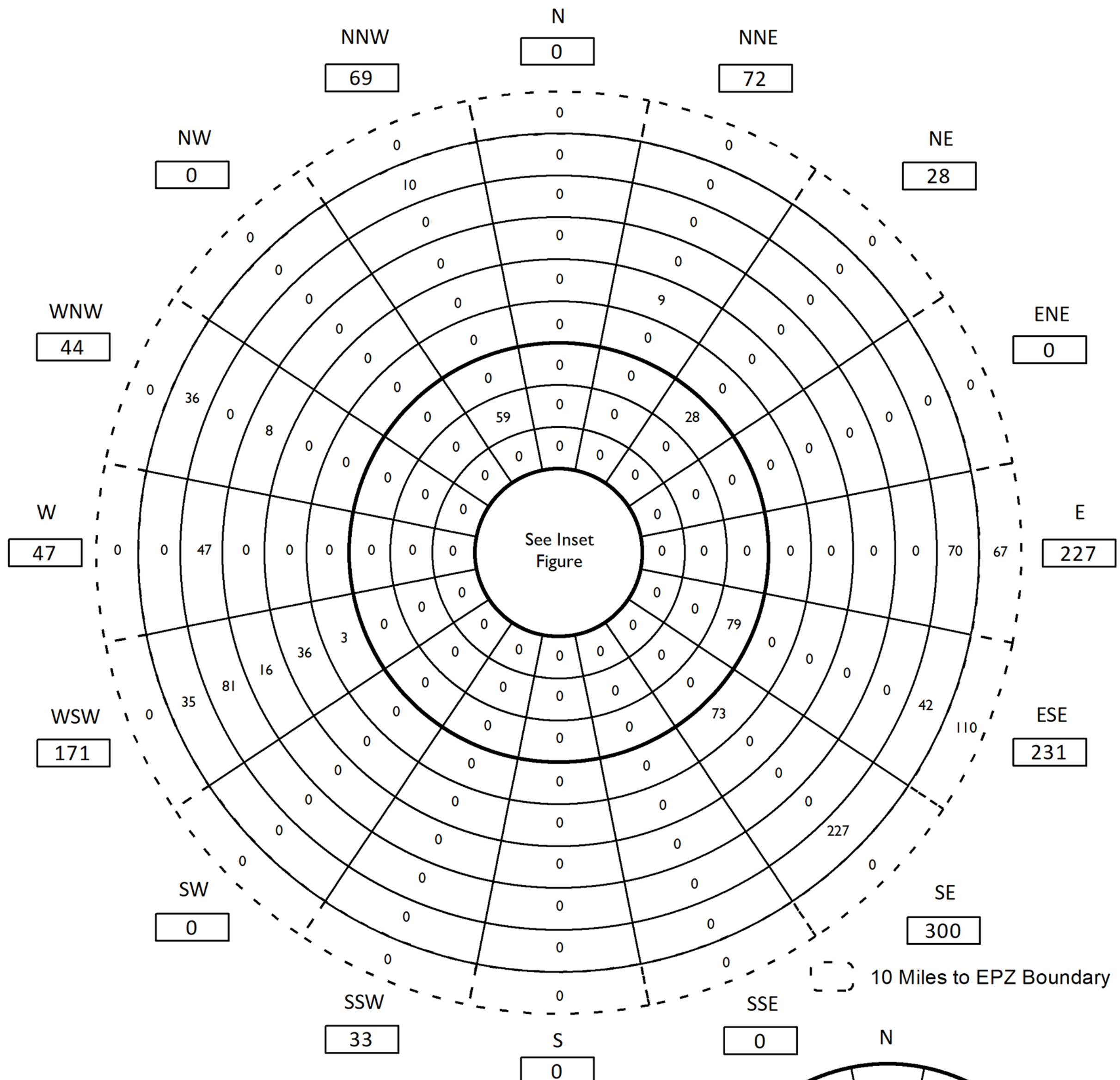


Figure 3-6. Transient Population by Sector



Transient Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	63	63
1 - 2	123	186
2 - 3	0	186
3 - 4	59	245
4 - 5	107	352
5 - 6	76	428
6 - 7	45	473
7 - 8	24	497
8 - 9	128	625
9 - 10	420	1,045
10 - EPZ	177	1,222
	Total:	1,222

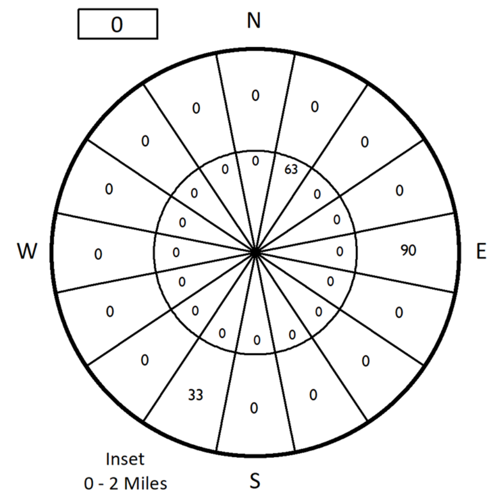
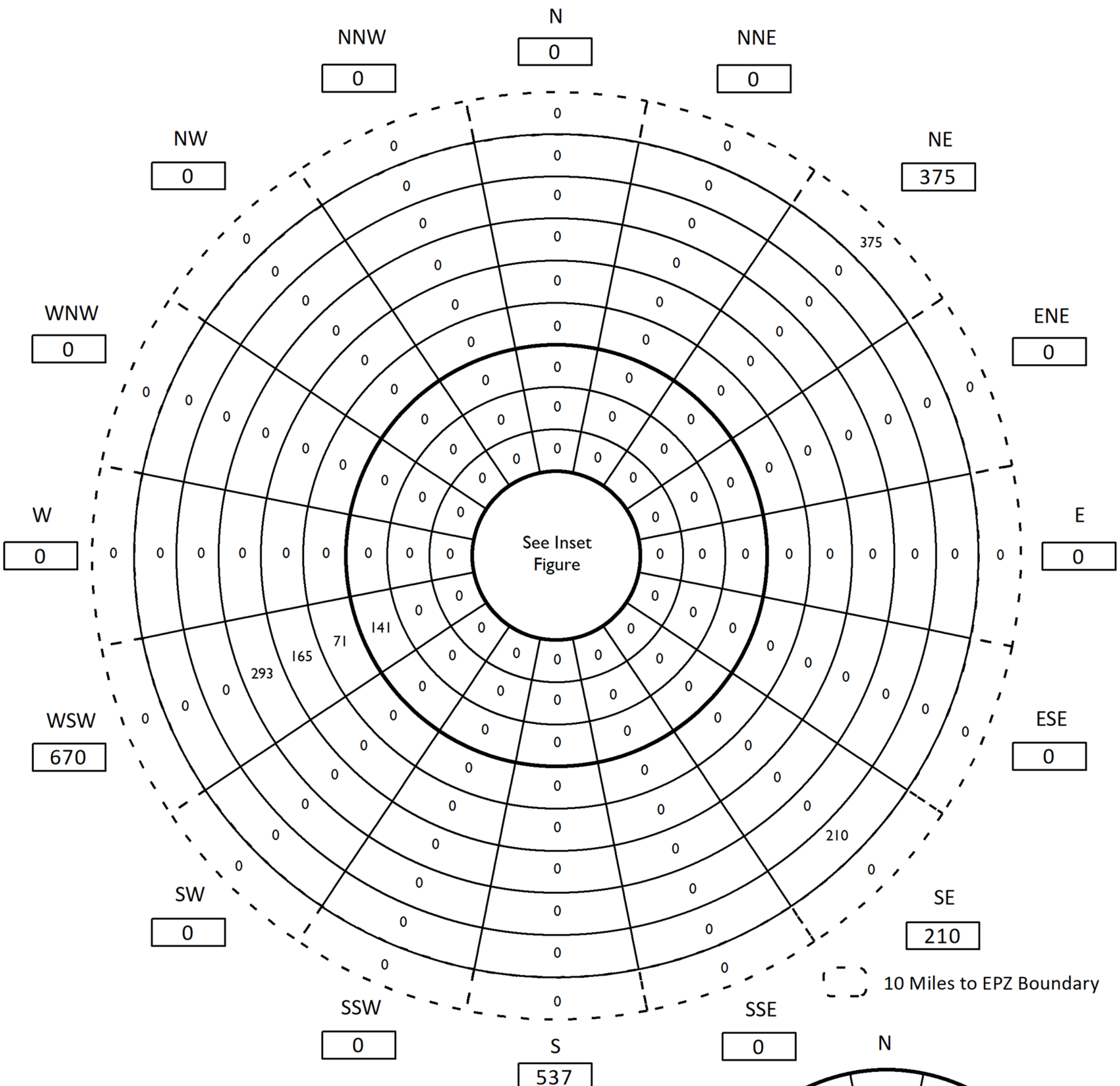


Figure 3-7. Transient Vehicles by Sector



Employees

Miles	Subtotal by Ring	Cumulative Total
0 - 1	537	537
1 - 2	0	537
2 - 3	0	537
3 - 4	0	537
4 - 5	141	678
5 - 6	71	749
6 - 7	165	914
7 - 8	293	1,207
8 - 9	0	1,207
9 - 10	210	1,417
10 - EPZ	375	1,792
	Total:	1,792

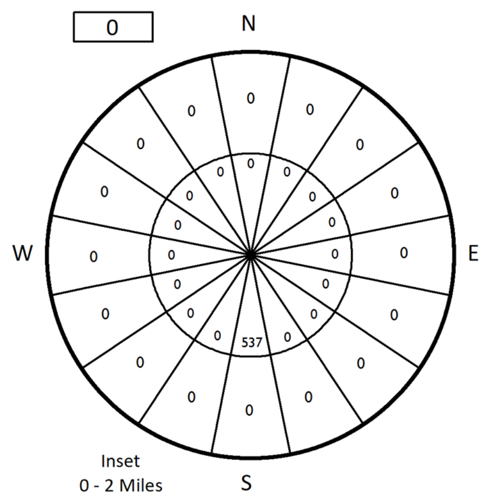
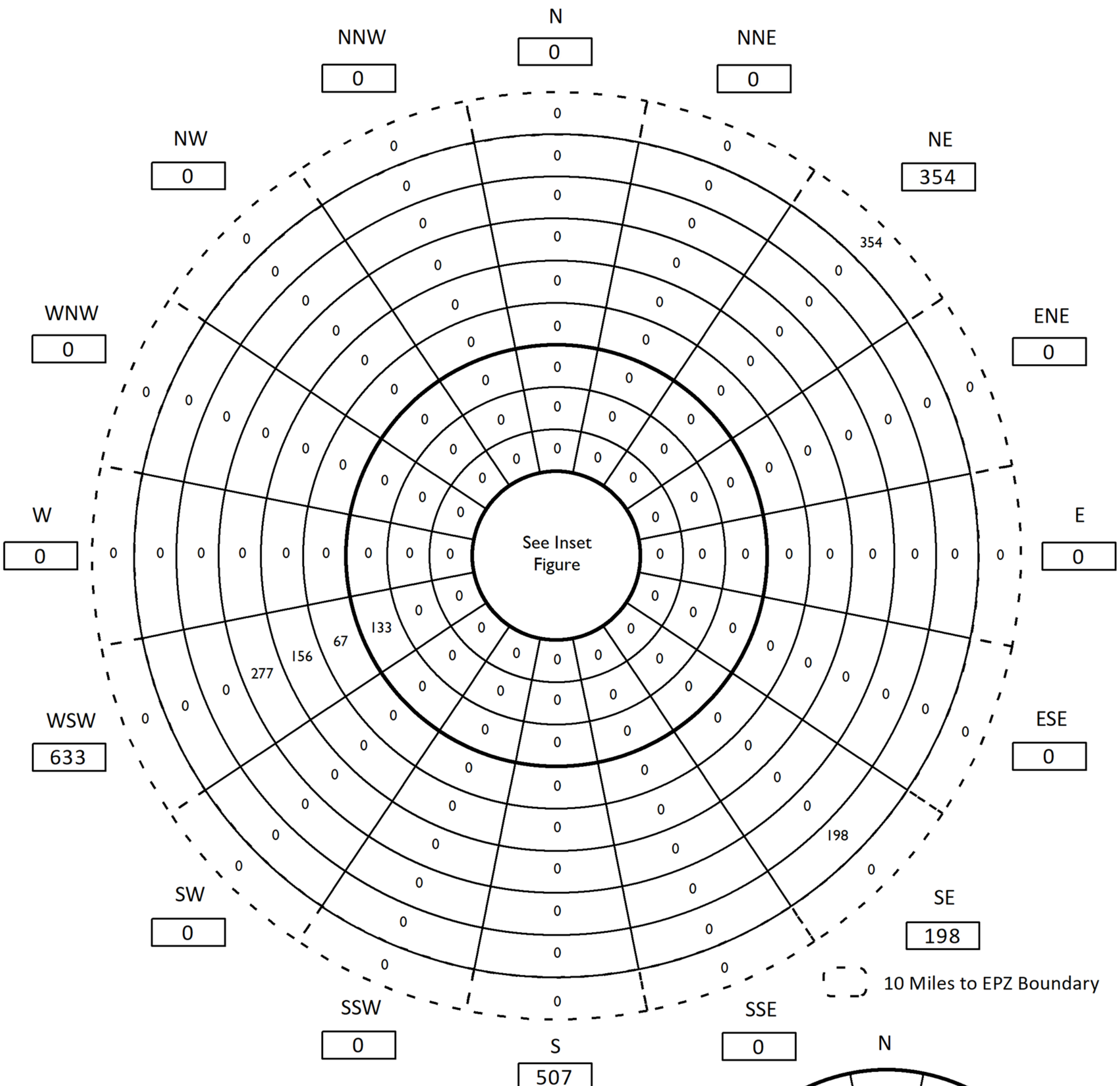


Figure 3-8. Employee Population by Sector



Employee Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	507	507
1 - 2	0	507
2 - 3	0	507
3 - 4	0	507
4 - 5	133	640
5 - 6	67	707
6 - 7	156	863
7 - 8	277	1,140
8 - 9	0	1,140
9 - 10	198	1,338
10 - EPZ	354	1,692
	Total:	1,692

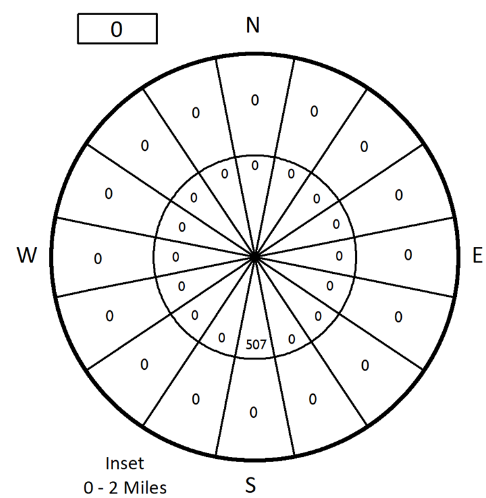


Figure 3-9. Employee Vehicles by Sector

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).

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" (SV). 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 LOS." 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, snow, fog, wind speed, ice)

These factors are considered during the road survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on Base Free Flow Speed (BFFS[1]) according to Exhibit 15-7 of the HCM 2016. Consequently, lane and shoulder widths at the narrowest points were observed during the road survey and these observations were recorded, but no detailed measurements of lane or shoulder width were taken. Horizontal and vertical alignment can

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

influence both FFS and capacity. The estimated FFS were measured using the survey vehicle's speedometer and observing local traffic, under free flow conditions. Capacity is estimated from the procedures of the HCM 2016. 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 SV at the upper bound of LOS E).

As discussed in Section 2.6, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as rain reduce the values of FFS and of highway capacity by approximately 10%. 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 25% 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% for rain\light snow. During heavy snow conditions, the free speed and highway capacity reductions are 15% and 25%, respectively.

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. 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,

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

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

[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

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 Emergency Planning Zone (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.

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 also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE and indicated in Appendix K for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90.

Since the principal objective of evacuation time estimate 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 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.

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" SV, V_E, or by the intersection-specific capacity. For each link, the model selects the lower value of capacity.

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

4.3 Application to the SSES 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)
> 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 Chapter 15

Two lane roads comprise the majority of highways within the EPZ. 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 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 EPZ 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 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 60 mph, respectively. Based on observation, the multilane highways outside of urban areas within the EPZ service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand: capacity relationship and the impact of control at intersections. 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 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 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.

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 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 – 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 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 represents 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 Conditions

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.

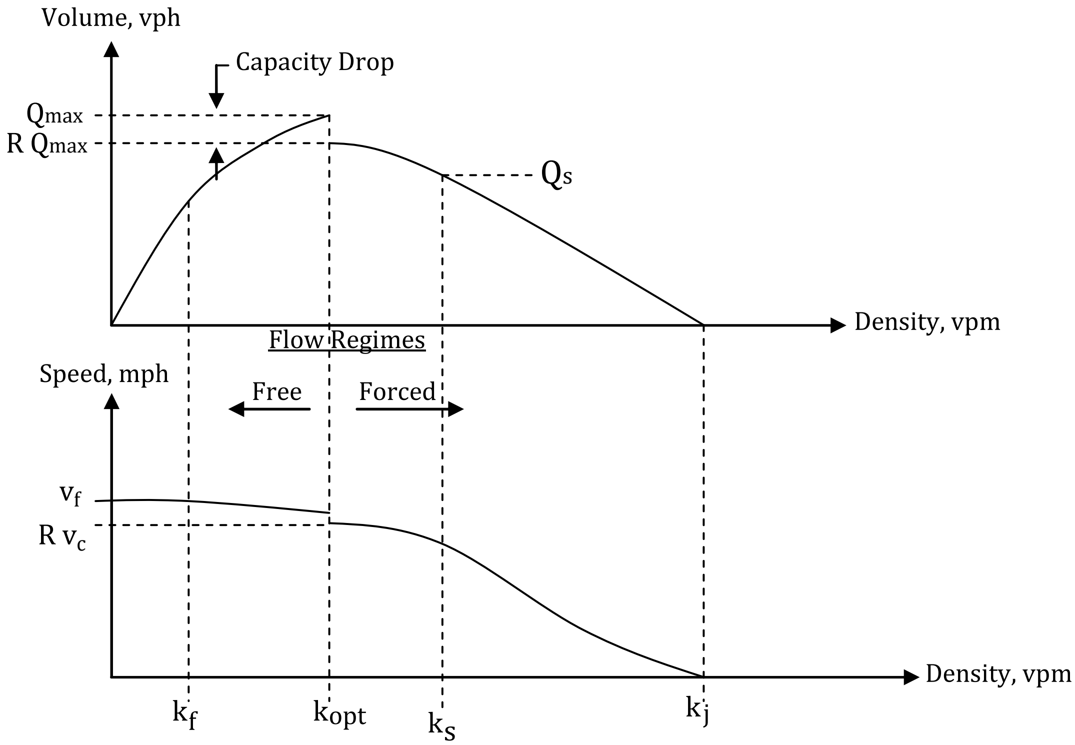


Figure 4-1. Fundamental Diagrams

5 ESTIMATION OF TRIP GENERATION TIME

Federal guidance (see NUREG/CR-7002, Rev. 1) recommends that the 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 <u>sum</u> 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 <u>Actions</u> to be undertaken by the licensee, and by the state and local offsite agencies. As a <u>Planning Basis</u>, 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 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. ETE are measured relative to the ATE.

We emphasize that the adoption of this planning basis is <u>not</u> 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 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 likely to be 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 (e.g. sirens, tone alerts, EAS broadcasts, loudspeakers).
2. Receiving and correctly interpreting the information that is transmitted.

The population within the EPZ is dispersed over an area of approximately 367 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 event.

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 4.1 of NUREG/CR-7002, Rev. 1, the information required to compute trip generation times is typically obtained from a demographic survey of EPZ residents. Such a survey was conducted in support of this ETE study. 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 evacuation time estimate to extend in time well beyond the trip generation 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 (e.g., depart work, arrive home)
- An Activity is a 'process' that takes place over some elapsed time (e.g., prepare to leave work, travel home)

As such, 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, or removing snow only after the 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, Part V, Section B.1, item 3 of the 2019 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness Program Manual states that "Notification methods will be established to ensure coverage within 45 minutes of essentially 100% of the population…"

Given the federal regulations and guidance, and the presence of sirens within the EPZ, it is assumed that 100% of the population in the EPZ can be notified within 45 minutes. The notification distribution 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. 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.

Distribution No. 5, Snow Clearance Time Distribution

Inclement weather scenarios involving snowfall must address the time lags associated with snow clearance. It is assumed that snow equipment is mobilized and deployed during the snowfall to maintain passable roads. The general consensus is that the snow-plowing efforts are generally successful for all but the most extreme blizzards when the rate of snow accumulation exceeds that of snow clearance over a period of many hours.

Consequently, it is reasonable to assume that the highway system will remain passable – albeit at a lower capacity – under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared to the extent needed to permit vehicles to gain access to the roadways. These clearance activities take time; this time must be incorporated into the trip generation time distributions. These data are provided by those households which responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-6.

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 as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-7 presents the summing procedure to arrive at each designated distribution.

Table 5-8 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

5.4.1 Statistical Outliers

As discussed in the footnote to Table 5-3, some portion of the survey respondents answer "Decline to State" 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 three people say "four hours" and four people 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 alternates 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 special 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, clear snow) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-7, and Table 5-8);

3) Outliers can be eliminated either because the response reflects a special population (e.g. those with 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 3.0 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 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 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:

   - 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;
   - 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, <u>not</u> 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, no snow or snow in each). In general, these are additive, using weighting based upon the probability distributions of each element; Figure 5-4 presents the combined trip generation distributions designated A, C, D, E and F. 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 <u>sequential</u> – preparation for departure follows the return of the commuter; snow clearance follows the preparation for departure, 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 distributions that result 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, D, E and F, properly displaced with respect to one another, are tabulated in Table 5-9 (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. ERPAs comprising the 2-Mile Region are advised to evacuate immediately
2. ERPAs 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. The population in the 5 to 10 mile region (to the EPZ boundary) shelters in place
6. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%

Assumptions

1. The EPZ population in ERPAs beyond 5 miles will shelter-in-place, 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.

Procedure

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 ERPAs 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. NUREG/CR-7002, Rev. 1 uses the statement "approximately 90 percent" as the time to end staging and begin evacuating. The value of T_{Scen}^* is 2:45 for non-snow scenarios and 3:45 for snow scenarios.

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

Figure 5-5 presents the staged trip generation distributions for both residents with and without returning commuters; the 90th percentile two-mile evacuation time is approximately 165 minutes for good weather/rain and approximately 225 minutes for snow scenarios. (Note that 165 minutes occurs at the midpoint of Time Period 7. Traffic volumes are distributed throughout the time period. As such, the staged loading for good weather/rain is shown in Time Period 7.) At the approximate 90th percentile evacuation time for the 2-Mile Region, approximately 20% of the population (who have completed their mobilization activities) 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.

Table 5-10 provides the trip generation histograms for staged evacuation.

5.4.3 Trip Generation for Waterways and Recreational Areas

Township emergency plans describe the notification procedures for the Susquehanna River as follows:

1. “Boaters will be afforded the same mode of notification (siren) as the rest of the EPZ population.”
2. “Since public access to the Susquehanna River is restricted throughout the 10 mile EPZ, boaters are not considered as a transient population and therefore will be familiar with actions required upon hearing an emergency siren.”

As indicated in Table 5-2, this study assumes 100% notification in 45 minutes. It is assumed that this timeframe is sufficient for the notification of boaters and that resident boaters will be able to start their evacuation trip within the 4 hour and 45 minute mobilization timeframe for residents (Table 5-9).

Table 5-9 indicates that all transients will have mobilized within 1 hour and 45 minutes; it is assumed that this allows sufficient time for campers and other transients to return to their vehicles 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
N/A	Snow Clearance	5

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Percent of Population Notified
0	0%
5	7%
10	13%
15	27%
20	47%
25	66%
30	87%
35	92%
40	97%
45	100%

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%	35	89%
5	32%	40	92%
10	53%	45	94%
15	69%	50	95%
20	77%	55	96%
25	79%	60	100%
30	87%		

NOTE: The survey data was normalized to distribute the "Decline to State" 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 "Decline to State" 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%	35	81%
5	8%	40	88%
10	18%	45	92%
15	34%	50	97%
20	50%	55	97%
25	63%	60	100%
30	72%		

NOTE: The survey data was normalized to distribute the "Decline to State" response

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

Elapsed Time (Minutes)	Cumulative Percent Leaving Home	Elapsed Time (Minutes)	Cumulative Percent Leaving Home
0	0%	105	79%
15	2%	120	83%
30	16%	135	93%
45	36%	150	95%
60	58%	165	95%
75	72%	180	97%
90	76%	195	100%

NOTE: The survey data was normalized to distribute the "Decline to State" response

Table 5-6. Time Distribution for Population to Clear 6"-8" of Snow

Elapsed Time (Minutes)	Cumulative Percent Completing Snow Removal
0	11%
15	33%
30	51%
45	63%
60	72%
75	83%
90	86%
105	89%
120	93%
135	99%
150	100%

NOTE: The survey data was normalized to distribute the "Decline to State" response

Table 5-7. 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
Distributions C and 5	Distribution E	Event 5
Distributions D and 5	Distribution F	Event 5

Table 5-8. 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).
E	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip, after snow clearance activities (Event 5).
F	Time distribution of residents with no commuters returning home, leaving to begin the evacuation trip, after snow clearance activities (Event 5).

Table 5-9. 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)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	30	37%	37%	0%	2%	0%	0%
2	30	52%	52%	2%	24%	0%	7%
3	30	10%	10%	16%	37%	5%	19%
4	15	1%	1%	15%	10%	6%	12%
5	15	0%	0%	15%	4%	9%	10%
6	30	0%	0%	22%	11%	19%	16%
7	30	0%	0%	13%	7%	18%	14%
8	15	0%	0%	5%	1%	8%	6%
9	30	0%	0%	7%	4%	14%	8%
10	60	0%	0%	5%	0%	15%	7%
11	30	0%	0%	0%	0%	4%	0%
12	15	0%	0%	0%	0%	0%	1%
13	15	0%	0%	0%	0%	1%	0%
14	30	0%	0%	0%	0%	1%	0%
15	600	0%	0%	0%	0%	0%	0%

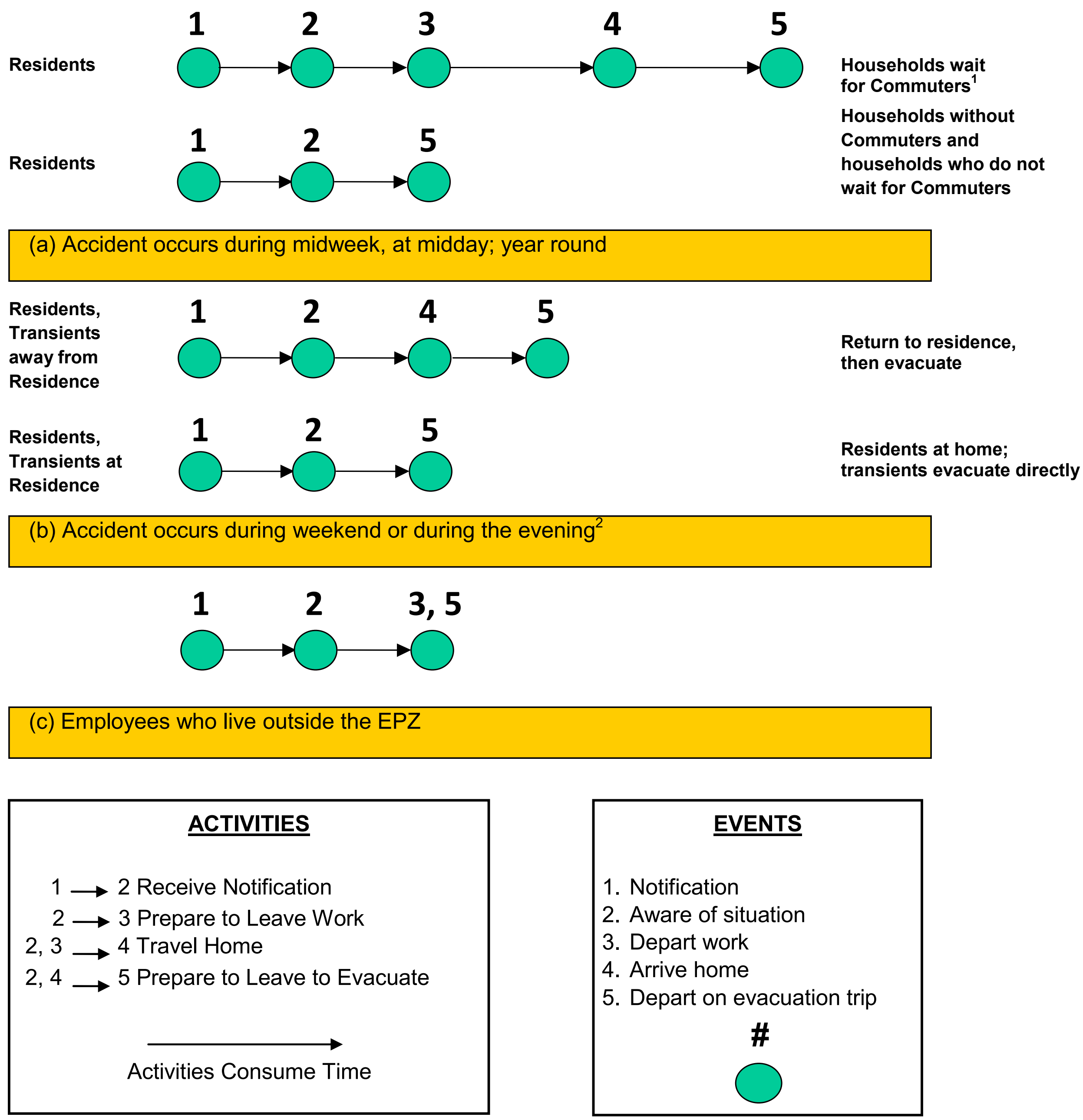
NOTE:

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

Table 5-10. Trip Generation Histograms for the EPZ Population for Staged Evacuation

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period*			
		Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	30	0%	0%	0%	0%
2	30	0%	5%	0%	1%
3	30	4%	8%	1%	4%
4	15	3%	2%	1%	3%
5	15	3%	0%	2%	2%
6	30	4%	3%	4%	3%
7	30	69%	77%	3%	3%
8	15	5%	1%	2%	1%
9	30	7%	4%	3%	1%
10	60	5%	0%	78%	81%
11	30	0%	0%	4%	0%
12	15	0%	0%	0%	1%
13	15	0%	0%	1%	0%
14	30	0%	0%	1%	0%
15	600	0%	0%	0%	0%

*Trip Generation for Employees and Transients (see Table 5-9) 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

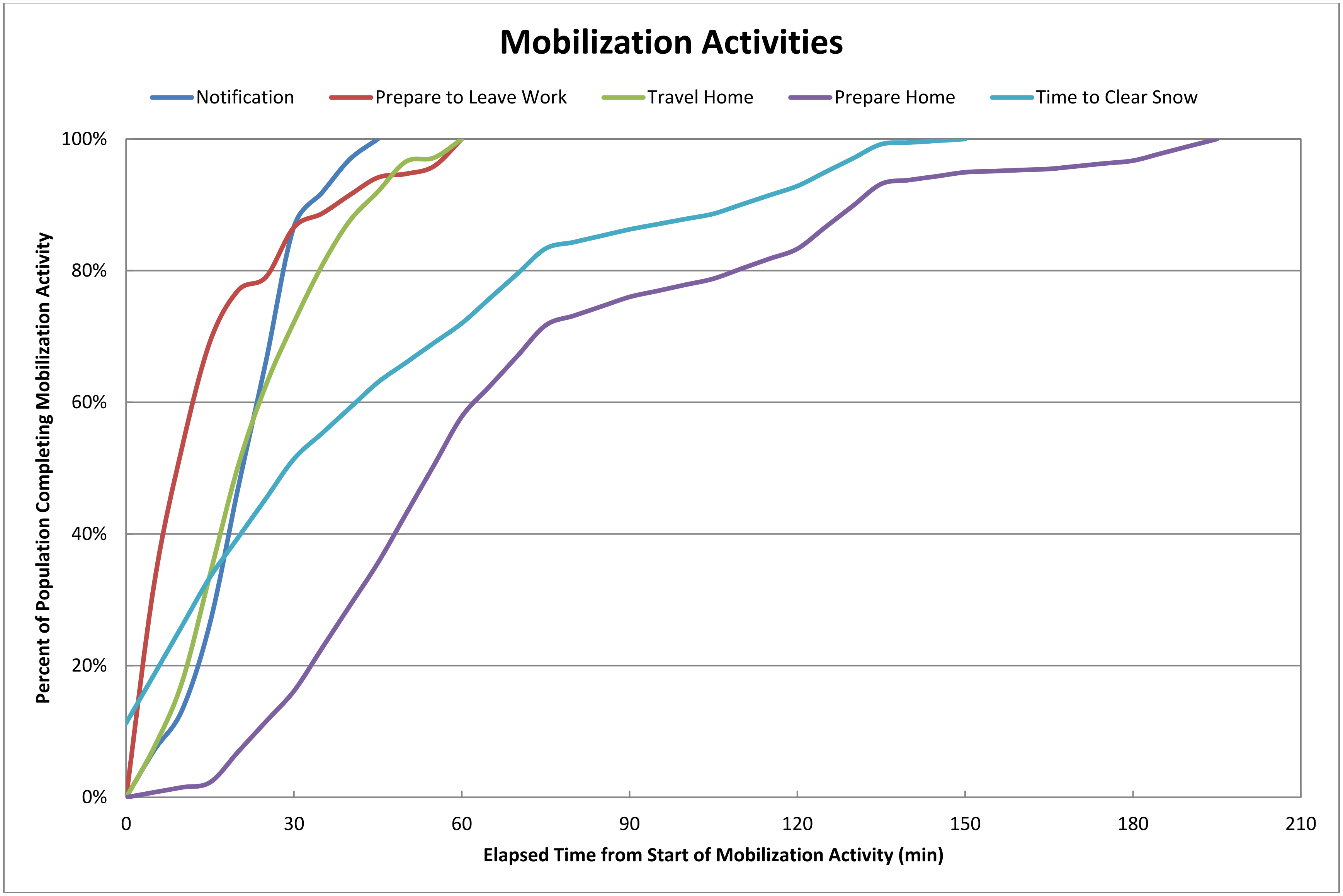


Figure 5-2. Time Distributions for Evacuation Mobilization Activities

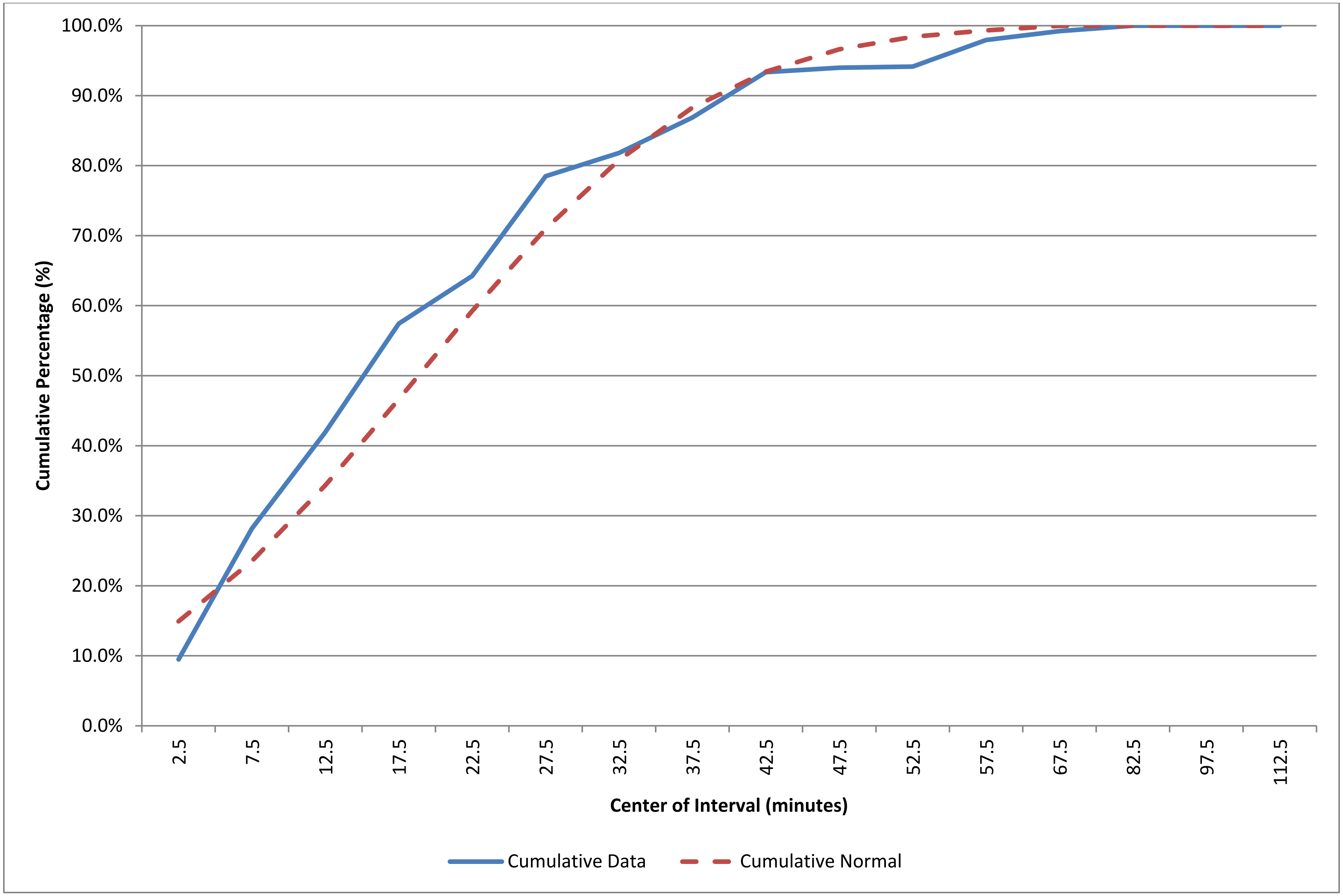


Figure 5-3. Comparison of Data Distribution and Normal Distribution

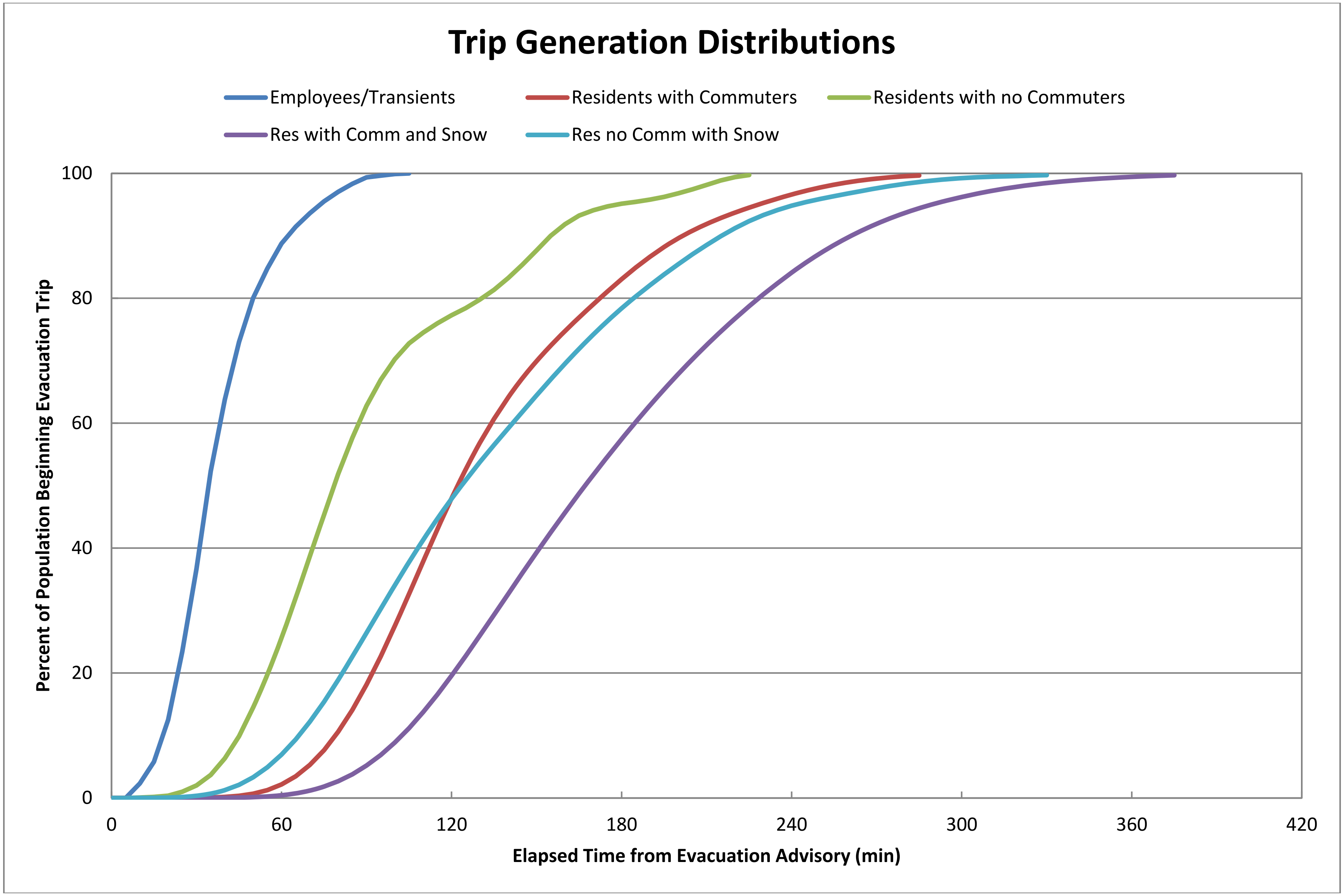


Figure 5-4. Comparison of Trip Generation Distributions

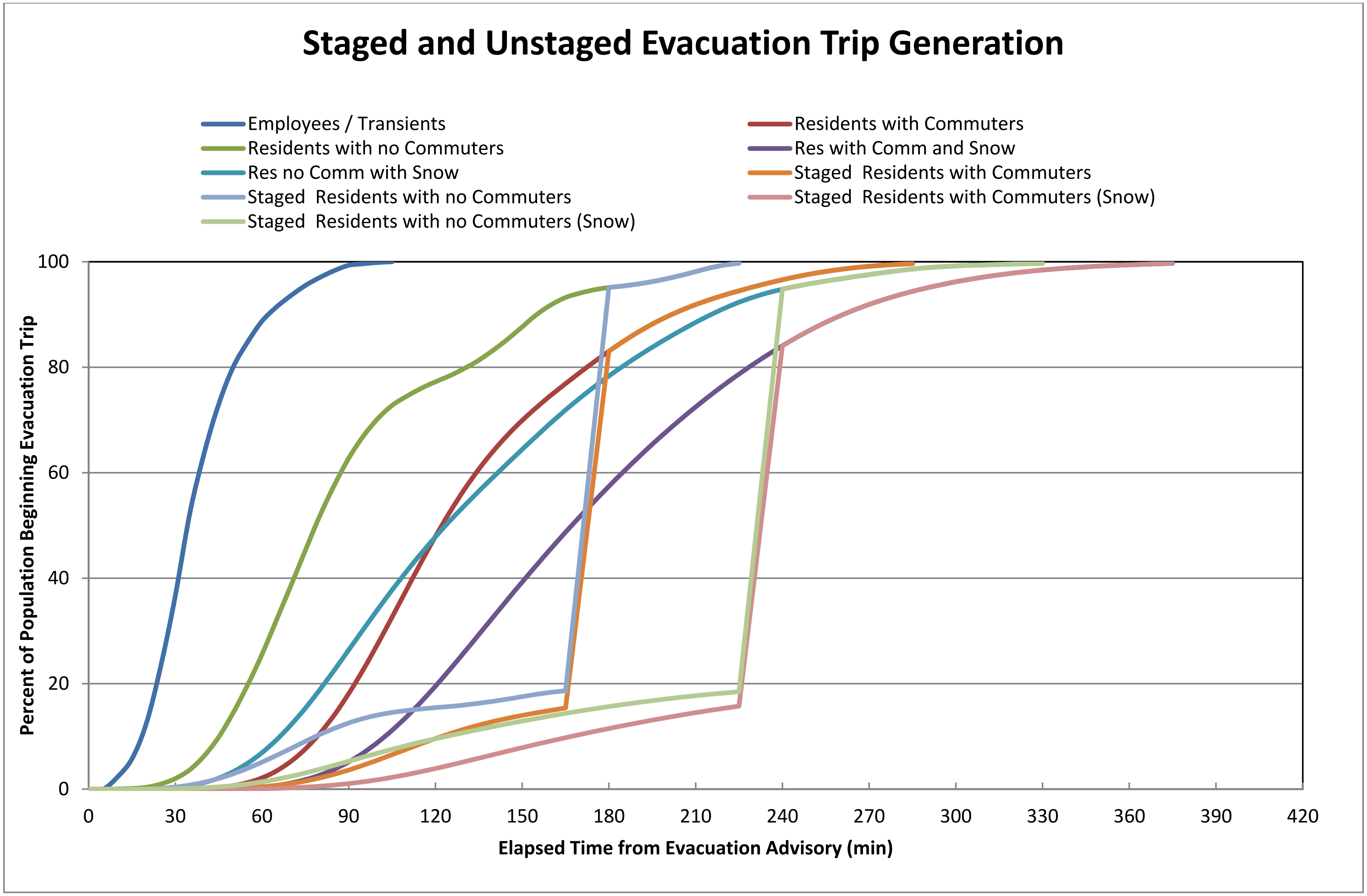


Figure 5-5. Comparison of Staged and Un-staged Trip Generation Distributions in the 2 to 5-Mile Region

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 ERPA 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 33 Regions were identified which encompass all the groupings of ERPA considered. These Regions are defined in Table 6-1. The ERPA configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the power plant, and three adjoining sectors on each side (a 7-sector keyhole), each with a central angle of 22.5 degrees, as per Talen Energy's Protective Action Recommendation (PAR) plan. The central sector coincides with the wind direction. These sectors extend to 5 miles from the plant (Regions R04 through R10) or to the EPZ boundary (Regions R11 through R25).

Regions R01, R02 and R03 represent evacuations of circular areas with radii of 2, 5 and 10 miles, respectively. Regions R26 through R33 are identical to Regions R02 and R04 through R10, respectively; however, those ERPA between 2 miles and 5 miles are staged until 90% of the 2-Mile Region (Region R01) has evacuated.

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 33 x 14 = 462 evacuation cases. Table 6-2 is 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 in 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 6-3, while the Region percentages are provided in Table H-1. Table 6-4 presents the vehicle counts for each scenario for an evacuation of Region R03 – the entire EPZ, based on the scenario percentages in Table 6-3. The percentages presented in Table 6-3 were determined as follows:

The percentage of residents with commuters (39%) during the week (when workforce is at its peak) is equal to the product of 76% (the number of households with at least one commuter) and 51% (the number of households with a commuter that would await the return of the commuter prior to evacuating). See assumption 3 in Section 2.3. It is estimated for weekend and evening scenarios that 10% of those households with returning commuters during the week will have a commuter at work during those times.

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 further estimated that only 10% of the employees are working in the evenings and during the weekends.

Transient activity is estimated to be at its peak during summer weekends (70%) and less (45%) during the week. As shown in Appendix E, there are many lodging facilities and campgrounds offering overnight accommodations in the EPZ, offset by other transient facilities in which evening use is minimal; thus, transient activity is estimated to still occur during evening hours – 70% for summer and 50% for winter. Transient activity in the winter is estimated to be 45% on weekends and 30% during the week.

As noted in the shadow footnote to Table 6-3, 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 6-4 for Scenario 1, the shadow percentage is computed as follows:

$$20\% \times \left(1 + \frac{1{,}624}{17{,}815 + 27{,}560}\right) = 21\%$$

One special event – a refueling outage at SSES – was considered as Scenario 13. Thus, the special event traffic is 100% evacuated for Scenario 13, and 0% for all other scenarios.

As discussed in the footnote to Table 2-1, schools are in session during the winter season, midweek, midday and 100% of buses will be needed under those circumstances. 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.

Transit buses for the transit-dependent and medical facility population are set to 100% for all scenarios as it is assumed that these population groups are present in the EPZ at all times.

External traffic is estimated to be 100% for all midday scenarios, while it is significantly less (40%) during evening scenarios.

Table 6-1. Description of Evacuation Regions

Region	Description		ERPA																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2-Mile Ring								X		X																		
R02	5-Mile Ring								X	X	X	X		X	X	X													
R03	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
Evacuate 2-Mile Radius and Downwind to 5 Miles																													
Region	**Wind Direction From:**		**ERPA**																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R04	N, NNE	350°-034°							X		X	X		X	X	X													
R05	NE, ENE, E	035°-101°							X		X	X		X	X														
R06	ESE	102°-124°							X	X	X	X		X	X														
R07	SE	125°-146°							X	X	X	X																	
R08	SSE, S	147°-191°							X	X	X																		
R09	SSW, SW, WSW	192°-259°							X	X	X					X													
R10	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													

Key	
ERPA(s) Shelter-in-Place	ERPA(s) Evacuate

Evacuate 2-Mile Radius and Downwind to the EPZ Boundary																													
Region	Wind Direction From:		ERPA																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R11	N	350°-011°	X						X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R12	NNE	012°-034°	X					X	X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R13	NE	035°-056°	X			X	X	X	X		X	X	X	X	X		X	X							X	X	X	X	X
R14	ENE	057°-079°	X			X	X	X	X		X	X	X	X	X										X	X	X	X	X
R15	E	080°-101°	X		X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R16	ESE	102°-124°		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R17	SE	125°-146°		X	X	X	X	X	X	X	X	X	X									X				X	X	X	X
R18	SSE	147°-169°		X	X	X	X	X	X	X	X									X		X	X					X	X
R19	S	170°-191°		X	X	X	X	X	X	X	X								X	X	X	X	X						X
R20	SSW, SW	192°-237°		X	X	X	X		X	X	X					X			X	X	X	X	X	X					
R21	WSW	238°-259°		X	X				X	X	X					X	X	X	X	X	X	X	X	X					
R22	W	260°-281°		X					X		X			X	X	X	X	X	X	X	X	X	X	X					
R23	WNW	282°-304°	X						X		X			X	X	X	X	X	X	X	X	X	X	X					
R24	NW	305°-326°	X						X		X			X	X	X	X	X	X	X	X			X	X				
R25	NNW	327°-349°	X						X		X			X	X	X	X	X	X					X	X	X			

Key

ERPA(s) not within Plume, but Evacuates because it is surrounded by other ERPA(s) which are Evacuating	ERPA(s) Shelter-in-Place	ERPA(s) Evacuate

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles

Region	Wind Direction From:		ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R26	5-Mile Ring								X	X	X	X		X	X	X													
R27	N, NNE	350°-034°							X		X	X		X	X	X													
R28	NE, ENE, E	035°-101°							X		X	X		X	X														
R29	ESE	102°-124°							X	X	X	X		X	X														
R30	SE	125°-146°							X	X	X	X																	
R31	SSE, S	147°-191°							X	X	X																		
R32	SSW, SW, WSW	192°-259°							X	X	X					X													
R33	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													

Key

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

Table 6-2. 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/Light Snow	None
8	Winter	Midweek	Midday	Heavy Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain/Light Snow	None
11	Winter	Weekend	Midday	Heavy Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Winter	Midweek	Midday	Good	SSES Refueling
14	Summer	Midweek	Midday	Good	Roadway Impact – Lane Closure on I-80 Westbound

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

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Event	Commuter Students	School Buses	Transit/ Medical Vehicles	External Through Traffic
1	39%	61%	96%	45%	21%	0%	10%	10%	100%	100%
2	39%	61%	96%	45%	21%	0%	10%	10%	100%	100%
3	4%	96%	10%	70%	20%	0%	0%	0%	100%	100%
4	4%	96%	10%	70%	20%	0%	0%	0%	100%	100%
5	4%	96%	10%	70%	20%	0%	0%	0%	100%	40%
6	39%	61%	100%	30%	21%	0%	100%	100%	100%	100%
7	39%	61%	100%	30%	21%	0%	100%	100%	100%	100%
8	39%	61%	100%	30%	21%	0%	100%	100%	100%	100%
9	4%	96%	10%	45%	20%	0%	0%	0%	100%	100%
10	4%	96%	10%	45%	20%	0%	0%	0%	100%	100%
11	4%	96%	10%	45%	20%	0%	0%	0%	100%	100%
12	4%	96%	10%	50%	20%	0%	0%	0%	100%	40%
13	39%	61%	100%	30%	21%	100%	100%	100%	100%	100%
14	39%	61%	96%	45%	21%	0%	10%	10%	100%	100%

Households with Returning Commuters........Households of EPZ residents who await the return of commuters prior to beginning the evacuation trip.
Households without Returning 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 event 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.
School, Transit and Medical Buses ....Vehicle-equivalents present on the road during evacuation servicing schools, medical facility patients and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).
Commuter Students...................................... College Students who live outside the EPZ and commute to colleges within the EPZ.
External Through Traffic ....Traffic on interstates/freeways and major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately 120 minutes after the evacuation begins.

Table 6-4. Vehicle Estimates by Scenario

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Event	Medical Vehicles	Commuter Students	School Buses	Transit Buses	External Through Traffic	Total Scenario Vehicles
1	17,815	27,560	1,624	550	14,332	-	188	266	37	176	12,628	75,176
2	17,815	27,560	1,624	550	14,332	-	188	266	37	176	12,628	75,176
3	1,782	43,594	169	855	13,889	-	188	-	-	176	12,628	73,281
4	1,782	43,594	169	855	13,889	-	188	-	-	176	12,628	73,281
5	1,782	43,594	169	855	13,889	-	188	-	-	176	5,051	65,704
6	17,815	27,560	1,692	367	14,353	-	188	2,664	368	176	12,628	77,811
7	17,815	27,560	1,692	367	14,353	-	188	2,664	368	176	12,628	77,811
8	17,815	27,560	1,692	367	14,353	-	188	2,664	368	176	12,628	77,811
9	1,782	43,594	169	550	13,889	-	188	-	-	176	12,628	72,976
10	1,782	43,594	169	550	13,889	-	188	-	-	176	12,628	72,976
11	1,782	43,594	169	550	13,889	-	188	-	-	176	12,628	72,976
12	1,782	43,594	169	611	13,889	-	188	-	-	176	5,051	65,460
13	17,815	27,560	1,692	367	14,353	755	188	2,664	368	176	12,628	78,566
14	17,815	27,560	1,624	550	14,332	-	188	266	37	176	12,628	75,176

Note: Vehicle estimates are for an evacuation of the entire EPZ (Region R03).

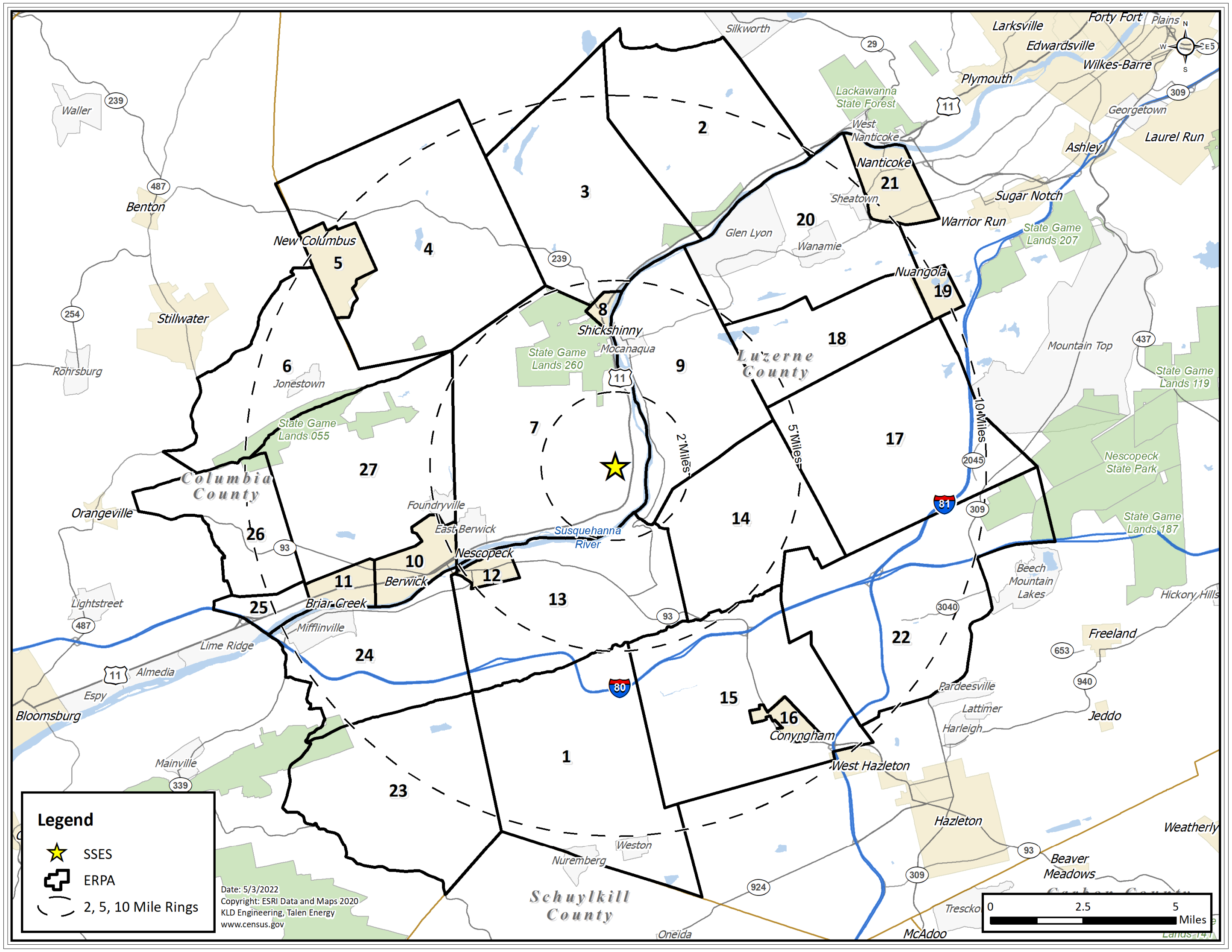


Figure 6-1. ERPAs Comprising the SSES EPZ

7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results for the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 33 regions within the Susquehanna Steam Electric Station (SSES) Emergency Planning Zone (EPZ) and the 14 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 defines the Evacuation Regions considered. The tabulated values of ETE are obtained from the DYNEV II System outputs which are generated at 5-minute intervals.

7.1 Voluntary Evacuation and Shadow Evacuation

"Voluntary evacuees" are people within the EPZ in ERPA 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 people 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 SSES EPZ addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the EPZ, 20% of permanent residents located in ERPAs outside of the Evacuation Region who are not advised to evacuate, are assumed to elect to evacuate. Similarly, it is assumed that 20 percent 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 103,776 people reside in the Shadow Region; 20% of them would evacuate. See Table 6-4 for the number of evacuating vehicles from the Shadow Region.

Traffic generated within this Shadow Region, including external-external traffic, 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. ERPA comprising the 2-Mile Region are advised to evacuate immediately.
2. ERPA 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-Mile Region is advised to evacuate when approximately 90% of the 2-Mile Region evacuating traffic crosses the 2-Mile Region boundary.
5. The population in the 5 to 10-Mile Region (to the EPZ boundary) shelters in place.
6. 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 winter, midweek, midday period under good weather conditions (Scenario 6).

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 to describe 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. These 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, most noticeably on the local roadways in Nanticoke City and Berwick Borough.

Figure 7-3 displays the developing congestion just 30 minutes after the ATE. Throughout the evacuation, there is never significant congestion within 2-miles of the plant. Interstate 80 (I-80) and I-81 are operating at LOS B or better which services the external traffic at this time. There is some localized congestion in Nanticoke, but for the most part most of the EPZ is not congested at this time as few vehicles have mobilized.

At one hour after the ATE, Figure 7-4 shows pronounced congestion in ERPA 21 (Nanticoke) along major evacuation routes (US 11 and PA 29 (Cross Valley Expressway)) leaving the EPZ. There are also significant delays at the on-ramp to I-81 east of Nanticoke. Traffic congestion is building on US 11 westbound through Berwick and Briar Creek Boroughs and along PA 93 as some vehicles try to avoid the congestion on US 11. PA 93 is also congested in the southeastern portion of the EPZ through Conyngham Borough and Hazleton. At this time, approximately 50% of evacuees have mobilized, and approximately 22% of vehicles have evacuated the EPZ.

By two hours after the ATE (Figure 7-5), congestion in Conyngham Borough and Hazelton has intensified. Evacuation routes in Berwick, Briar Creek, Nescopeck, and Nanticoke are all operating under LOS F conditions. The congestion within East Berwick (ERPA 10) spills into the 2-mile region (ERPA 7) along US 11, though this congestion is nearly 5 miles from the plant. Evacuees from Berwick are choosing to use the bridge towards Nescopeck to get on Mifflin Rd, which travels westbound to I-80 in Mifflinville. At this time, 69% of evacuees have mobilized, and approximately 60% of vehicles have evacuated the EPZ.

Over the next hour, congestion in Conyngham Borough and Hazelton dissipates and the only congestion within the EPZ is in the Berwick/Briar Creek/Nescopeck and Nanticoke areas as displayed in Figure 7-6. In Berwick, US 11 and PA 93 are still operating at LOS F conditions. In Nanticoke, despite congestion dissipating in the last hour, W Main St is still operating at LOS F conditions. The traffic congestion in Nanticoke clears at 3:30 after the ATE. Congestion within East Berwick is almost clear which helps clear out the 2-mile region. By 3:05, the 2-mile region is fully clear of congestion. At 3 hours after the ATE, approximately 91% of evacuees have mobilized, and approximately 88% of vehicles have evacuated the EPZ.

At 4:00 after the ATE (Figure 7-7), the only congestion that remains within the EPZ is in ERPA 26 along PA 93 westbound. This congestion is the result of evacuees from Berwick bypassing US 11 into Orangeville outside of the EPZ. PA 93 is controlled by a stop sign at the intersection with Main St (PA 487). Most of these evacuees then travel south along PA 487 towards I-80 where the ramps are operating at LOS F conditions. At this time, approximately 99% of evacuees have mobilized, and approximately 99% of vehicles have evacuated the EPZ.

Figure 7-8 shows the network at 4:20 after the ATE, where the EPZ is fully clear of traffic congestion and only those who were slow to mobilize remain within the EPZ. All evacuees are fully mobilized at 4:45 after the ATE. Congestion persists in the Shadow Region at this time in Bloomsburg at the intersection of US 11 and PA 487. Traffic congestion in the study area fully clears at 4:50 after the ATE.

7.4 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-9 through Figure 7-22. 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, there is typically a long "tail" to these distributions. 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 evacuees (those with the longest mobilization times) travel freely out of the EPZ.

This decline in aggregate flow rate, towards the end of the process, is characterized by these curves flattening and gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes equally so that all will service traffic near capacity levels and all will clear at the same time. For this ideal situation, all curves would retain the same slope until the end – thus minimizing evacuation time. In 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 33 Evacuation Regions and all 14 Evacuation Scenarios. Table 7-3 and Table 7-4 present the ETE values for the 2-Mile region for both staged and un-staged regions downwind to 5 miles. The tables are organized as follows:

Table	Contents
7-1	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	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	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.
7-4	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.

The animation snapshots described above reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in Figure 7-3 through Figure 7-8. Most of the congestion is located in ERPAs 10, 11 and 21 which are beyond the 2-mile area; this is reflected in the ETE statistics:

- The 90th percentile ETE for Region R02 are 5 to 10 minutes longer than the ETE for R01. Similarly, the 90th percentile ETE for Region R03 are 10 to 25 minutes longer than the ETE for R02.
- At the 90th percentile, rain increases the ETE by up to 20 minutes; snow by 45 to 90 minutes (most of this increase is due to longer mobilization times associated with clearing snow from driveways prior to evacuating).
- The 90th percentile ETE for the 5-mile keyhole regions that do not include ERPAs 8 and 10 (i.e., Region R10) are significantly less (30 minutes on average) across all scenarios than the other 5-mile keyhole ETE. ERPAs 8 and 10 make up more than 50 percent of the population of the 5-mile region. (See Table 3-2).
- The 90th percentile ETE for the keyhole regions downwind to the EPZ boundary that do not include ERPAs 10 and 11 (i.e., Regions R18 through R25) are less (25 minutes on average) across all scenarios than the ETE for other keyholes extending to the EPZ boundary. As shown in Figure 7-3 through Figure 7-8, ERPAs 10 and 11 are highly congested throughout the evacuation.
- The 100th percentile ETE for all regions and scenarios reflects the mobilization time (plus 10 minutes travel time to the EPZ boundary) of residents with commuters, due to the fact that the congestion within the EPZ clears nearly an hour before the last residents have left their homes.

Comparison of Scenarios 6 and 13 in Table 7-1 indicates that the special event – a refueling outage at the plant – does not have an impact on the ETE for the 90th percentile for the 2-mile region. The ETE at the 90th percentile increases slightly (at most 10 minutes) for keyhole regions extending downwind to the EPZ boundary. The 100th percentile ETE is dictated by the permanent resident mobilization time ; 100% of the plant employees are mobilized and evacuated before 100% of the residents have completed their mobilization activities. Thus, the 100th percentile ETE is not impacted by the special event.

Comparison of Scenarios 1 and 14 in Table 7-1 and Table 7-2 indicates that the roadway closure – one lane westbound on I-80 from PA-93 (Exit 256) to the interchange with PA-487 (Exit 236B) – does not significantly impact the 90th percentile ETE (increase by at most 15 minutes) and does not impact the 100th percentile ETE. The ramps to access the interstate are the bottleneck, not the main thoroughfare of the interstate. Thus, a reduction in capacity along the main thoroughfare does not significantly impact ETE.

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 R26 through R33 are the same geographic areas as Regions R02 and R04 through R10, respectively.

To determine whether the staged evacuation strategy is worthy of consideration, one must show that the ETE for the 2-mile region can be reduced without significantly affecting the region between 2 miles and 5 miles. In all cases, as shown in these tables, the ETE for the 2-mile region is unchanged when a staged evacuation is implemented. The impedance due to the traffic congestion within the 5-mile area to evacuees from within the 2-mile area is not sufficient to materially influence the 90th percentile ETE for the 2-mile area. Therefore, staging the evacuation to sharply reduce congestion within the 5-mile area provides no benefits to evacuees from within the 2-mile region and unnecessarily delays the evacuation of those beyond 2 miles.

While failing to provide assistance to evacuees from within 2 miles of the SSES, staging produces a negative impact on the ETE for those evacuating from within the 5-mile area. A comparison of ETE between Regions R26 through R33 with R02 and R04 through R10 respectively, reveals that staging retards the 90th percentile ETE for those in the 2 to 5-mile area by up to 1 hour and 35 minutes (see Table 7-1). This extending of ETE is due to the delay in beginning the evacuation trip, experienced by those who shelter, plus the effect of the trip-generation “spike” (significant volume of traffic beginning the evacuation trip at the same time) that follows their eventual ATE, in creating congestion within the EPZ area beyond 2 miles. The 100th percentile ETE is unaffected by staging (see Table 7-2).

In summary, the staged evacuation protective action strategy provides no benefits to evacuees within 2 miles of the SSES and adversely impacts many evacuees located beyond 2 miles from the SSES.

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:

1. 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/Light Snow
        - Heavy Snow
    - Special Event

        - Refueling outage at SSES
        - Road Closure (one lane on I-80 WB is closed)
    - 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/light snow are not explicitly identified in the tables. For these conditions, Scenarios (7) and (10) for rain/light snow apply.
    - The conditions of a winter evening (either midweek or weekend) and heavy snow are not explicitly identified in the tables. For these conditions, Scenarios (8) and (11) for heavy snow apply.
    - The seasons are defined as follows:
        - Summer assumes public school is in session, at summer enrollment levels (lower than normal enrollment).
        - Winter (includes Spring and Autumn) considers that public 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.

2. With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region** (Step 2):
    - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: from N, NNE, NE, …
    - 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 (Region R02, R04 through R10 and staged regions R26 through R33)
        - To EPZ Boundary (Regions R03, R11 through R25)
    - Enter Table 7-5 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.
3. Determine the **ETE Table** based on the **percentile** selected. Then, for the **Scenario** identified in Step 1 and the **Region** 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.

Example

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

- Monday, May 23rd at 1:00 PM.
- It is raining.
- Wind direction is from the northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be a 2-mile radius and downwind to 10 miles (to EPZ boundary).
- 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 90^{th} percentile ETE is desired. Proceed as follows:

1. Identify the Scenario as summer, midweek, midday and raining. Entering Table 7-1, it is seen that Scenario 2 matches the description.
2. Enter Table 7-5 and locate the Region described as “Evacuate 2-Mile Radius and Downwind to the EPZ Boundary” for wind direction from the NE and read Region R13 in the first column of that row.
3. Enter Table 7-1 to locate the data cell containing the value of ETE for Scenario 2 and Region R13. This data cell is in the Scenario (2) column and in the row for Region R13; it contains the ETE value of 3:10.

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R02	2:55	3:05	2:40	2:50	2:45	2:55	3:00	3:55	2:45	2:50	3:40	2:45	2:55	2:55
R03	3:10	3:15	2:55	3:00	3:00	3:10	3:15	4:20	2:55	3:00	3:55	3:00	3:10	3:10
2-Mile Ring and Keyhole to 5 Miles														
R04	2:50	3:00	2:40	2:45	2:50	2:55	3:05	3:55	2:40	2:45	3:40	2:45	2:55	2:50
R05	2:50	3:00	2:40	2:50	2:45	2:55	3:00	3:55	2:40	2:45	3:40	2:50	2:55	2:50
R06	2:50	3:00	2:40	2:50	2:45	2:55	3:00	3:55	2:40	2:45	3:40	2:50	2:55	2:50
R07	3:00	3:05	2:45	2:45	2:50	3:00	3:05	4:05	2:50	2:50	3:45	2:45	3:00	3:00
R08	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R09	2:55	3:00	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:55	2:55
R10	2:30	2:30	2:20	2:20	2:30	2:30	2:30	3:25	2:20	2:20	3:10	2:30	2:30	2:35
2-Mile Ring and Keyhole to EPZ Boundary														
R11	3:10	3:15	2:55	3:05	3:05	3:00	3:15	4:05	2:55	3:05	3:55	3:05	3:10	3:20
R12	3:10	3:15	2:55	3:05	3:05	3:10	3:15	4:10	2:55	3:05	3:55	3:00	3:10	3:15
R13	3:10	3:10	3:00	3:00	3:05	3:05	3:15	4:05	3:00	3:05	3:55	3:05	3:10	3:15
R14	3:10	3:30	3:05	3:05	3:10	3:15	3:30	4:20	3:05	3:15	4:05	3:10	3:15	3:25
R15	3:15	3:25	3:05	3:05	3:10	3:15	3:30	4:20	3:05	3:15	4:05	3:10	3:20	3:25
R16	3:15	3:25	3:05	3:05	3:15	3:15	3:30	4:20	3:05	3:10	4:05	3:10	3:20	3:20
R17	3:15	3:20	3:00	3:10	3:00	3:10	3:25	4:25	3:00	3:00	4:10	3:05	3:10	3:20
R18	3:05	3:10	2:50	3:00	2:50	3:05	3:20	4:15	2:50	3:00	3:50	2:50	3:10	3:05
R19	2:55	3:05	2:40	2:50	2:45	3:00	3:15	4:05	2:40	2:50	3:40	2:45	3:00	2:55
R20	2:50	3:00	2:40	2:50	2:45	2:55	3:05	3:55	2:40	2:50	3:35	2:45	2:55	2:50
R21	2:50	3:00	2:40	2:45	2:45	2:55	3:05	3:55	2:40	2:45	3:40	2:45	2:55	2:50
R22	2:50	3:00	2:35	2:45	2:45	2:55	3:05	3:55	2:35	2:45	3:35	2:45	2:55	2:50
R23	2:50	2:55	2:35	2:45	2:45	2:50	3:00	3:50	2:35	2:40	3:35	2:45	2:50	2:50

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
R24	2:45	2:45	2:35	2:35	2:40	2:45	2:45	3:40	2:30	2:35	3:25	2:40	2:45	2:45
R25	2:45	2:45	2:30	2:35	2:45	2:45	2:45	3:40	2:30	2:35	3:25	2:45	2:45	2:55
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R26	3:40	3:45	3:40	3:45	3:45	3:40	3:45	5:15	3:40	3:45	5:10	3:40	3:40	3:40
R27	3:40	3:45	3:35	3:45	3:40	3:40	3:50	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R28	3:40	3:45	3:45	3:45	3:40	3:40	3:50	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R29	3:40	3:45	3:35	3:45	3:40	3:40	3:45	5:15	3:40	3:45	5:15	3:45	3:40	3:40
R30	3:40	3:45	3:40	3:45	3:40	3:40	3:45	5:15	3:40	3:45	5:10	3:40	3:40	3:40
R31	3:00	3:00	2:50	2:50	2:50	3:00	3:00	4:15	2:50	2:50	4:10	2:50	3:00	3:00
R32	3:00	3:00	2:55	2:55	2:55	3:00	3:00	4:30	2:55	2:55	4:25	2:55	3:00	3:00
R33	2:55	2:55	2:50	2:55	2:55	2:55	2:55	4:20	2:50	2:55	4:20	2:55	2:55	2:55

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R03	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
2-Mile Ring and Keyhole to 5 Miles														
R04	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R05	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R06	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R07	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
2-Mile Ring and Keyhole to EPZ Boundary														
R11	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R12	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R13	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R14	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R15	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R16	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R17	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R18	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R19	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R20	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R21	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R22	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
R23	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R24	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
R25	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:25	4:55	4:55	6:25	4:55	4:55	4:55
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R27	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R28	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R29	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R30	4:50	4:55	4:50	4:50	4:50	4:50	4:55	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Region	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Unstaged Evacuation - 2-Mile Region and 5-Mile Region														
R01	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R02	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R05	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R06	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R07	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R08	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R09	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R10	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R26	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R27	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R28	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R29	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R30	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R31	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R32	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55
R33	2:55	2:55	2:40	2:40	2:40	2:55	2:55	3:55	2:45	2:45	3:40	2:45	2:50	2:55

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Midweek	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Rain/Light Snow	Heavy Snow	Good Weather	Special Event	Roadway Impact
Unstaged Evacuation - 2-Mile Region and 5-Mile Region														
R01	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R02	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R05	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R06	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R07	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R08	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R09	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R10	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R26	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R27	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R28	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R29	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R30	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R31	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R32	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50
R33	4:50	4:50	4:45	4:45	4:45	4:50	4:50	6:15	4:45	4:45	6:15	4:45	4:50	4:50

Table 7-5. Description of Evacuation Regions

Region	Description	ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2-Mile Ring							X		X																		
R02	5-Mile Ring							X	X	X	X		X	X	X													
R03	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

Evacuate 2-Mile Radius and Downwind to 5 Miles

Region	Wind Direction From:		ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R04	N, NNE	350°-034°							X		X	X		X	X	X													
R05	NE, ENE, E	035°-101°							X		X	X		X	X														
R06	ESE	102°-124°							X	X	X	X		X	X														
R07	SE	125°-146°							X	X	X	X																	
R08	SSE, S	147°-191°							X	X	X																		
R09	SSW, SW, WSW	192°-259°							X	X	X					X													
R10	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													

Key

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

Evacuate 2-Mile Radius and Downwind to the EPZ Boundary

Region	Wind Direction From:		ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R11	N	350°-011°	X						X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R12	NNE	012°-034°	X					X	X		X	X	X	X	X	X	X	X						X	X	X	X	X	X
R13	NE	035°-056°	X			X	X	X	X		X	X	X	X	X		X	X							X	X	X	X	X
R14	ENE	057°-079°	X			X	X	X	X		X	X	X	X	X										X	X	X	X	X
R15	E	080°-101°	X		X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R16	ESE	102°-124°		X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	X	X
R17	SE	125°-146°		X	X	X	X	X	X	X	X	X	X									X				X	X	X	X
R18	SSE	147°-169°		X	X	X	X	X	X	X	X									X		X	X					X	X
R19	S	170°-191°		X	X	X	X	X	X	X	X								X	X	X	X	X						X
R20	SSW, SW	192°-237°		X	X	X	X		X	X	X					X			X	X	X	X	X	X					
R21	WSW	238°-259°		X	X				X	X	X					X	X	X	X	X	X	X	X	X					
R22	W	260°-281°		X					X		X			X	X	X	X	X	X	X	X	X	X	X					
R23	WNW	282°-304°	X						X		X			X	X	X	X	X	X	X	X	X	X	X					
R24	NW	305°-326°	X						X		X			X	X	X	X	X	X	X	X			X	X				
R25	NNW	327°-349°	X						X		X			X	X	X	X	X	X					X	X	X			

Key

ERPA(s) not within Plume, but Evacuates because it is surrounded by other ERPA(s) which are Evacuating | ERPA(s) Shelter-in-Place | ERPA(s) Evacuate

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles																													
Region	**Wind Direction From:**		**ERPA**																										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R26	5-Mile Ring								X	X	X	X		X	X	X													
R27	N, NNE	350°-034°							X		X	X		X	X	X													
R28	NE, ENE, E	035°-101°							X		X	X		X	X														
R29	ESE	102°-124°							X	X	X	X		X	X														
R30	SE	125°-146°							X	X	X	X																	
R31	SSE, S	147°-191°							X	X	X																		
R32	SSW, SW, WSW	192°-259°							X	X	X					X													
R33	W, WNW, NW, NNW	260°-349°							X		X			X	X	X													

Key

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

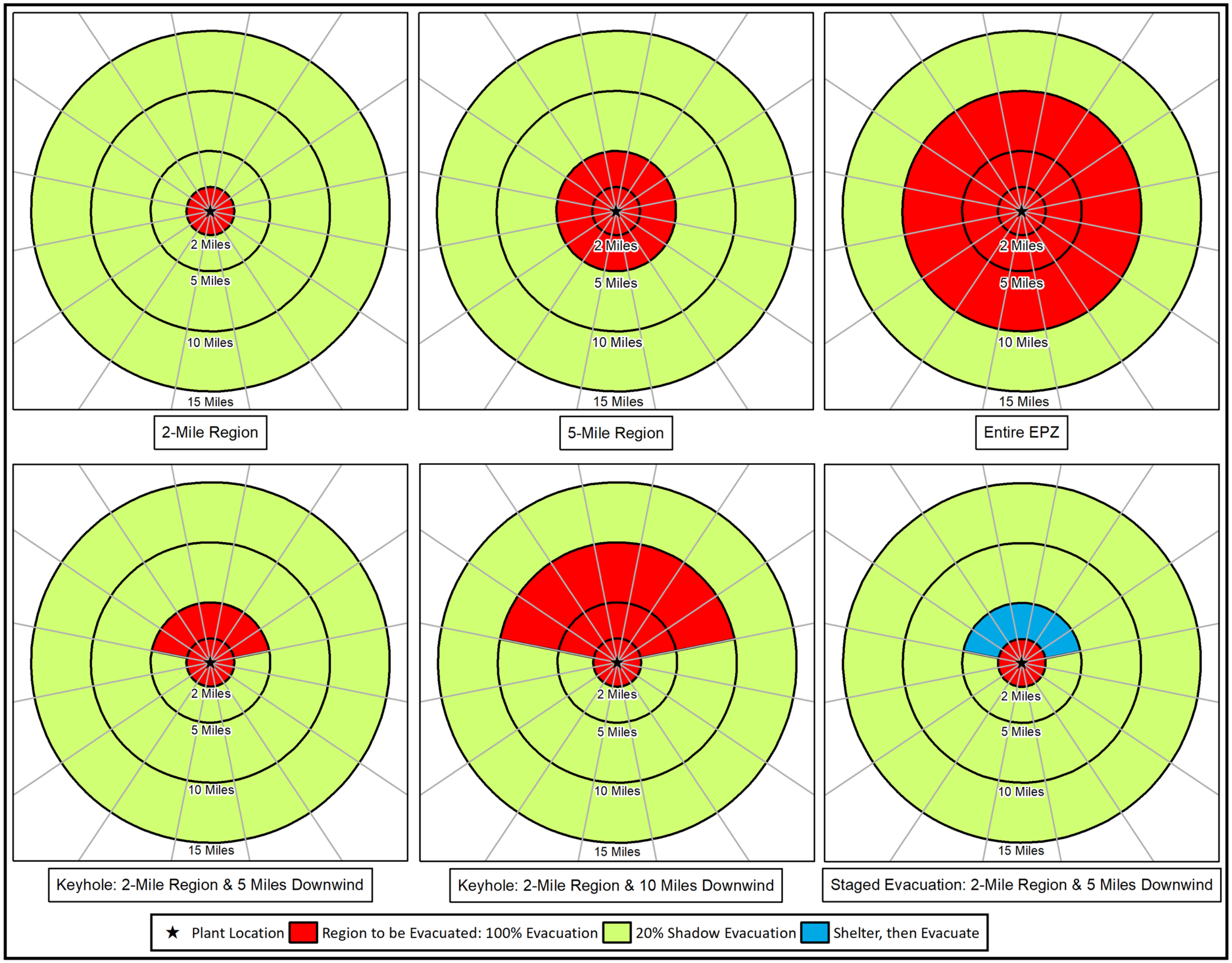


Figure 7-1. Voluntary Evacuation Methodology

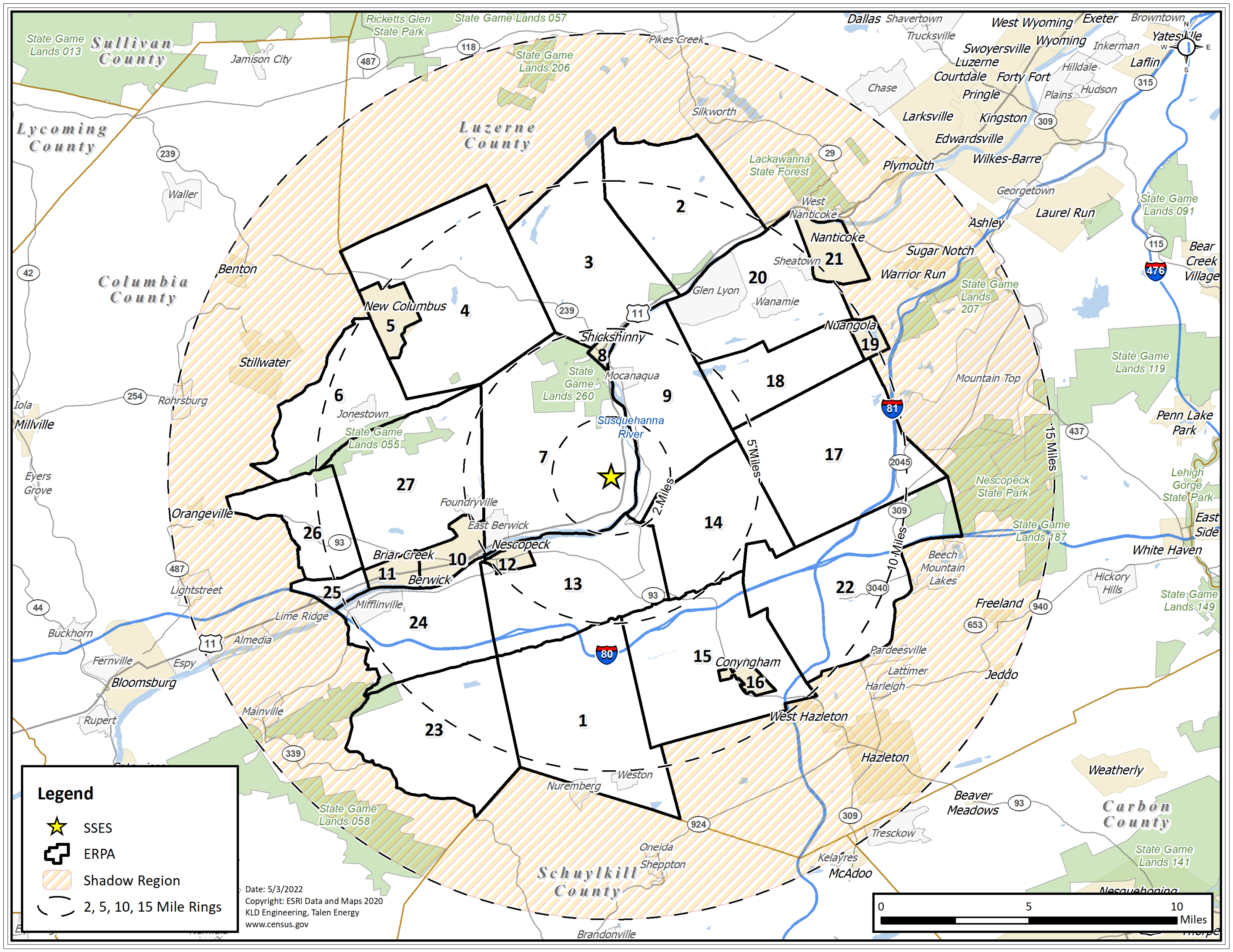


Figure 7-2. SSES Shadow Region

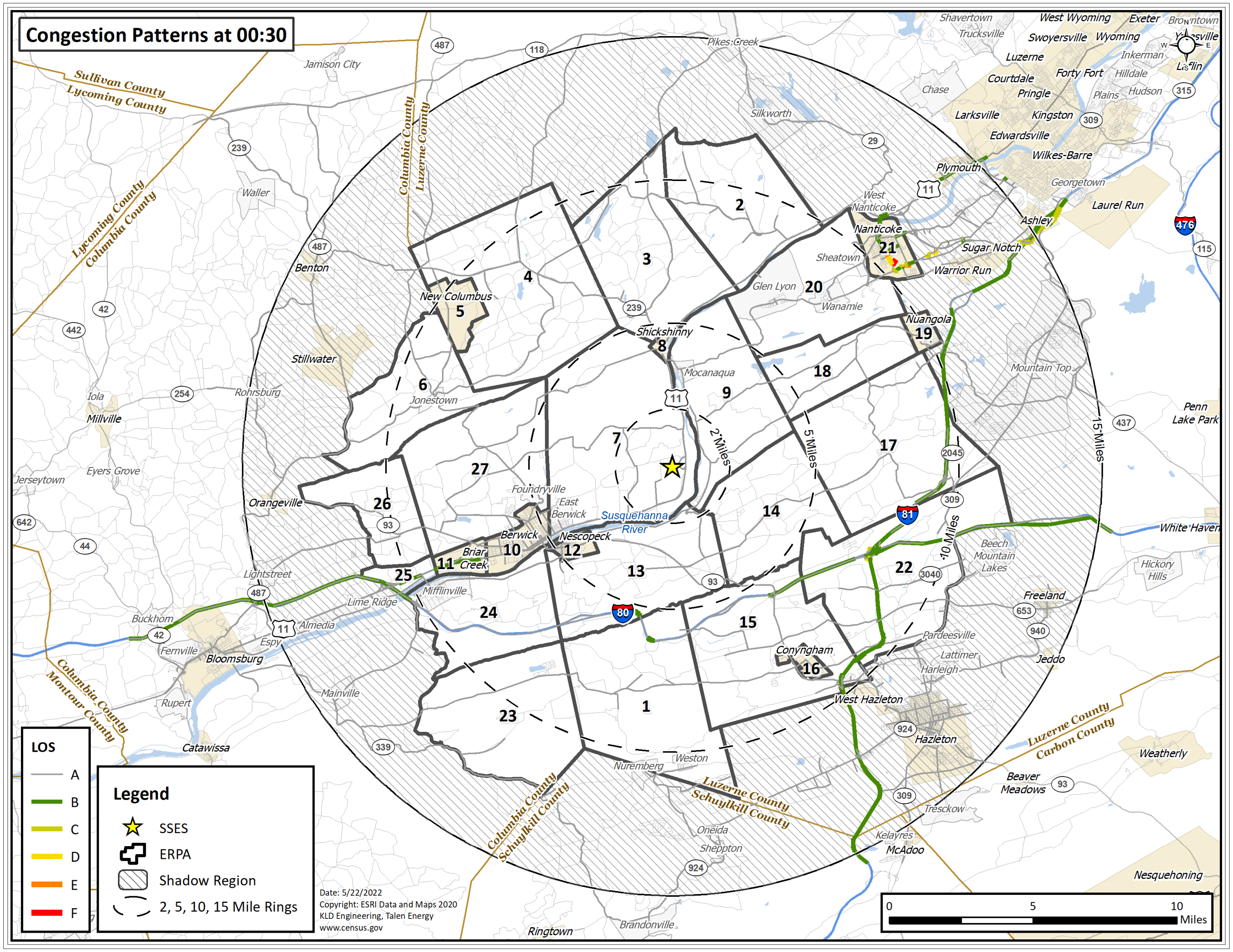


Figure 7-3. Congestion Patterns at 30 Minutes after the ATE

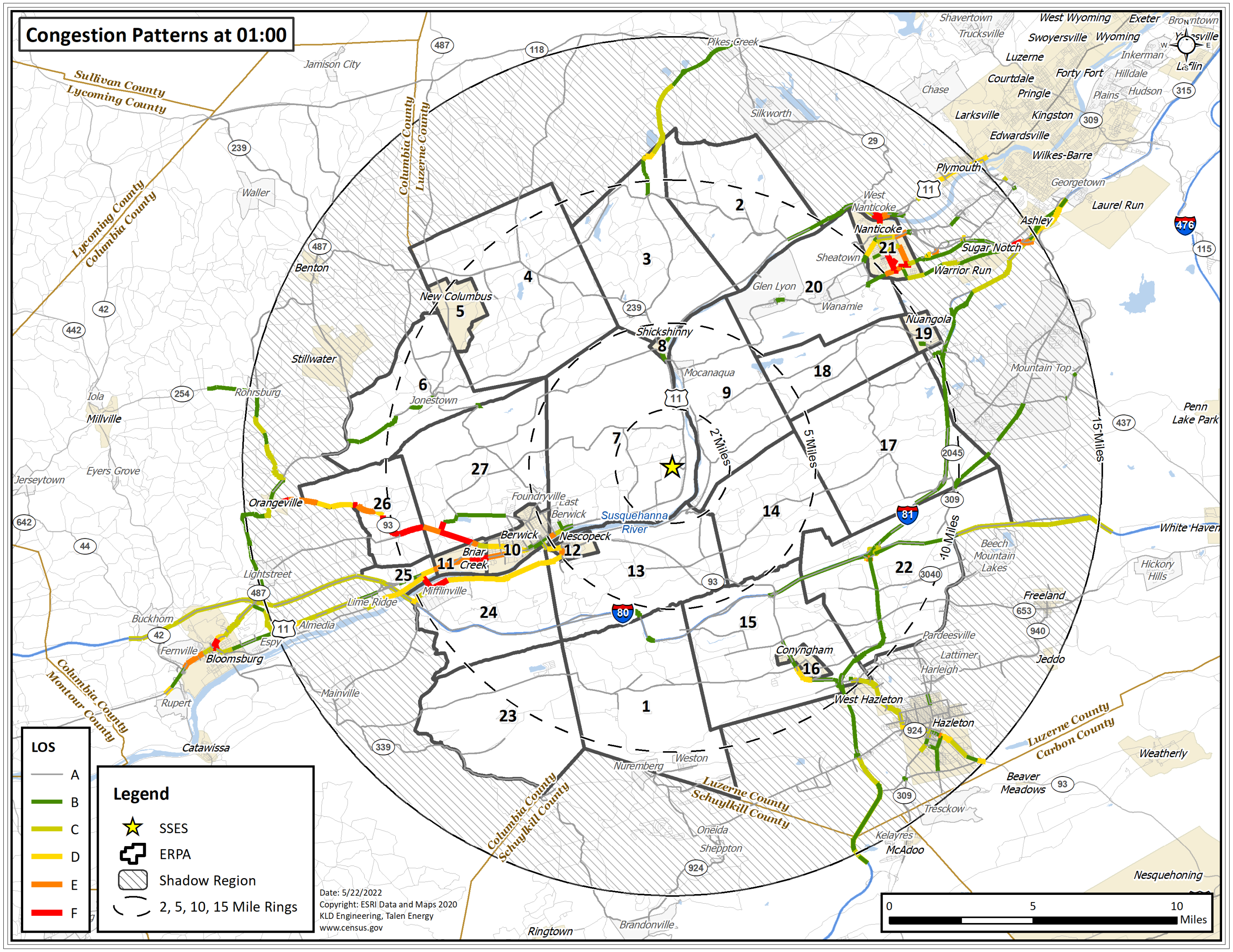


Figure 7-4. Congestion Patterns at 1 Hour after the ATE

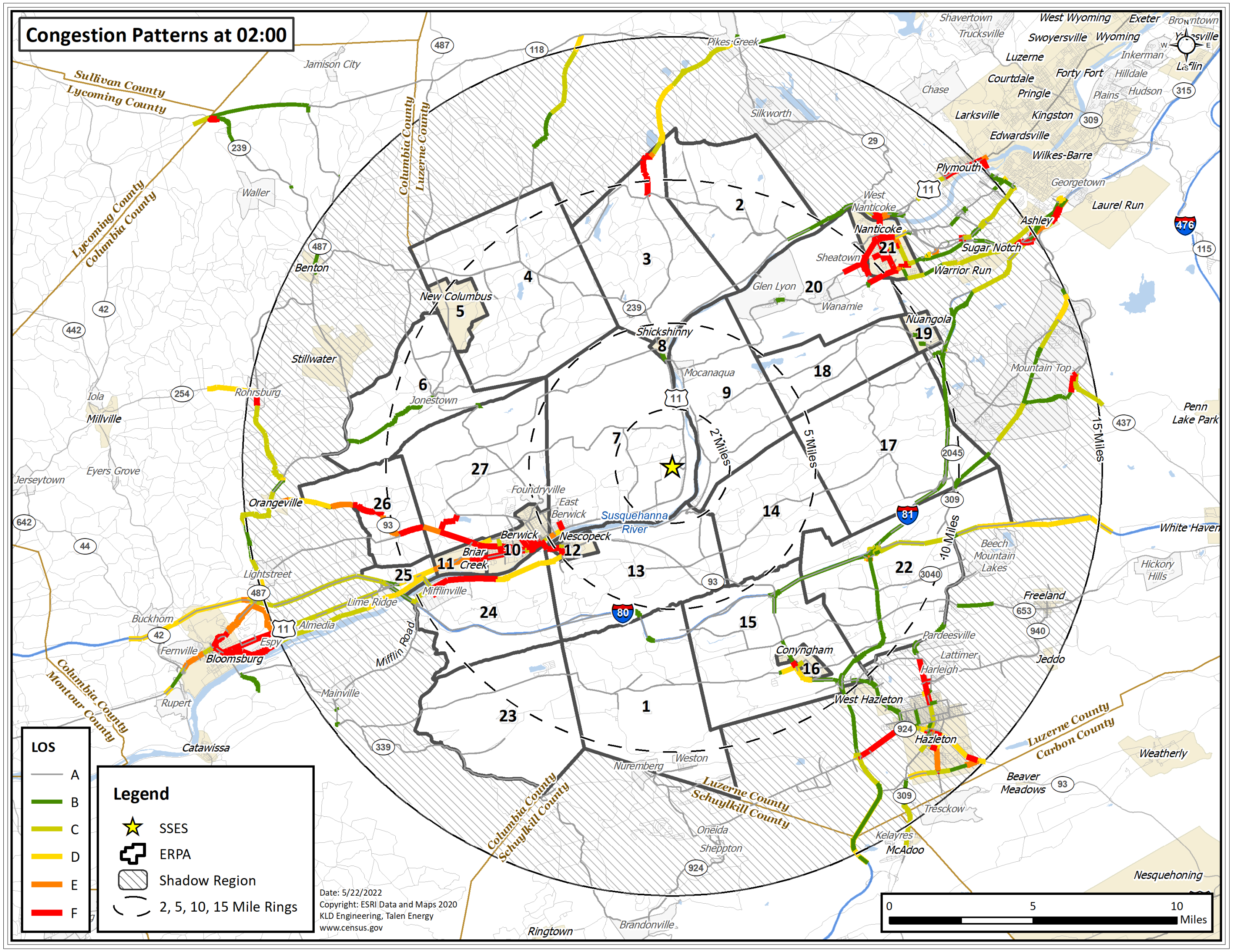


Figure 7-5. Congestion Patterns at 2 Hours after the ATE

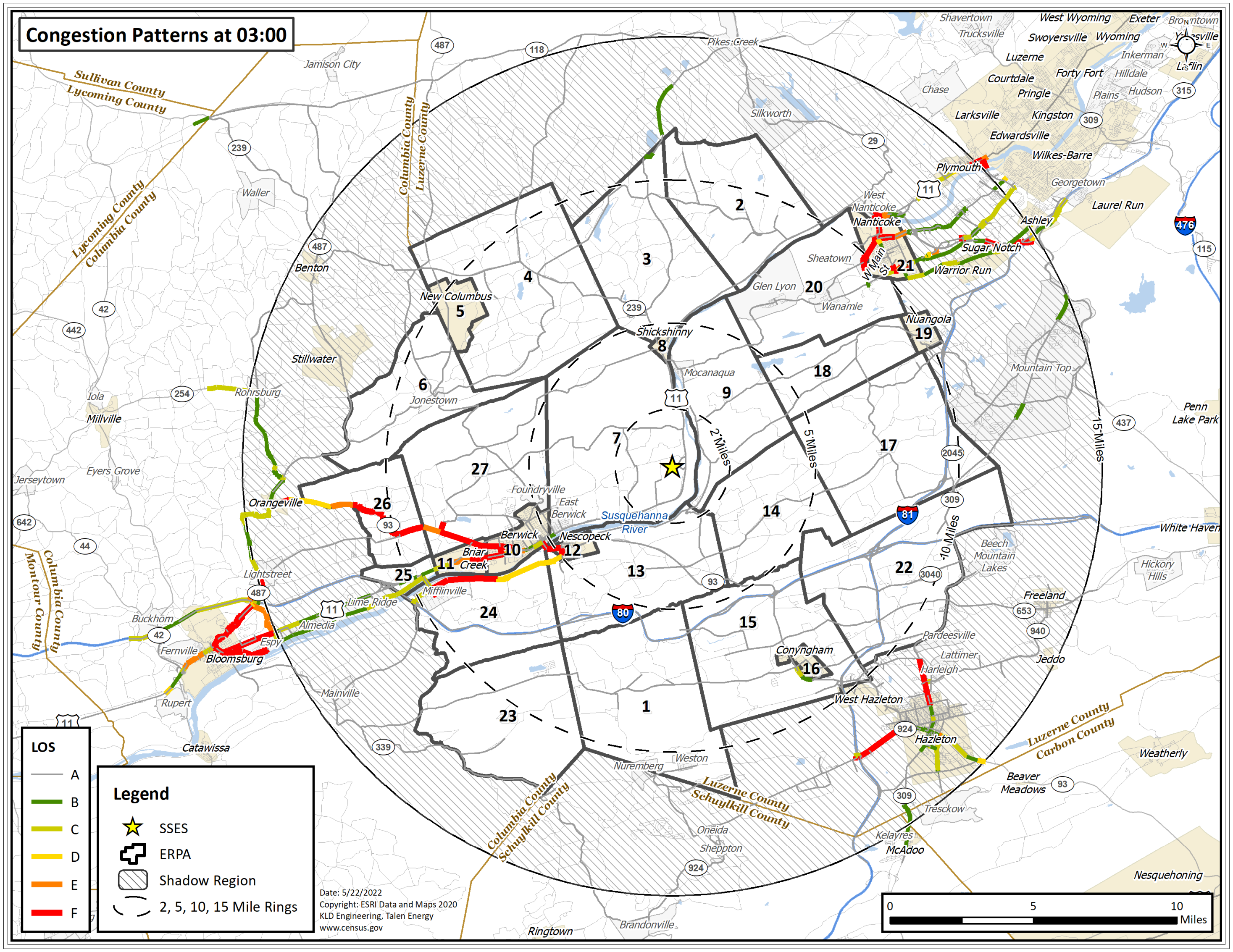


Figure 7-6. Congestion Patterns at 3 Hours after the ATE

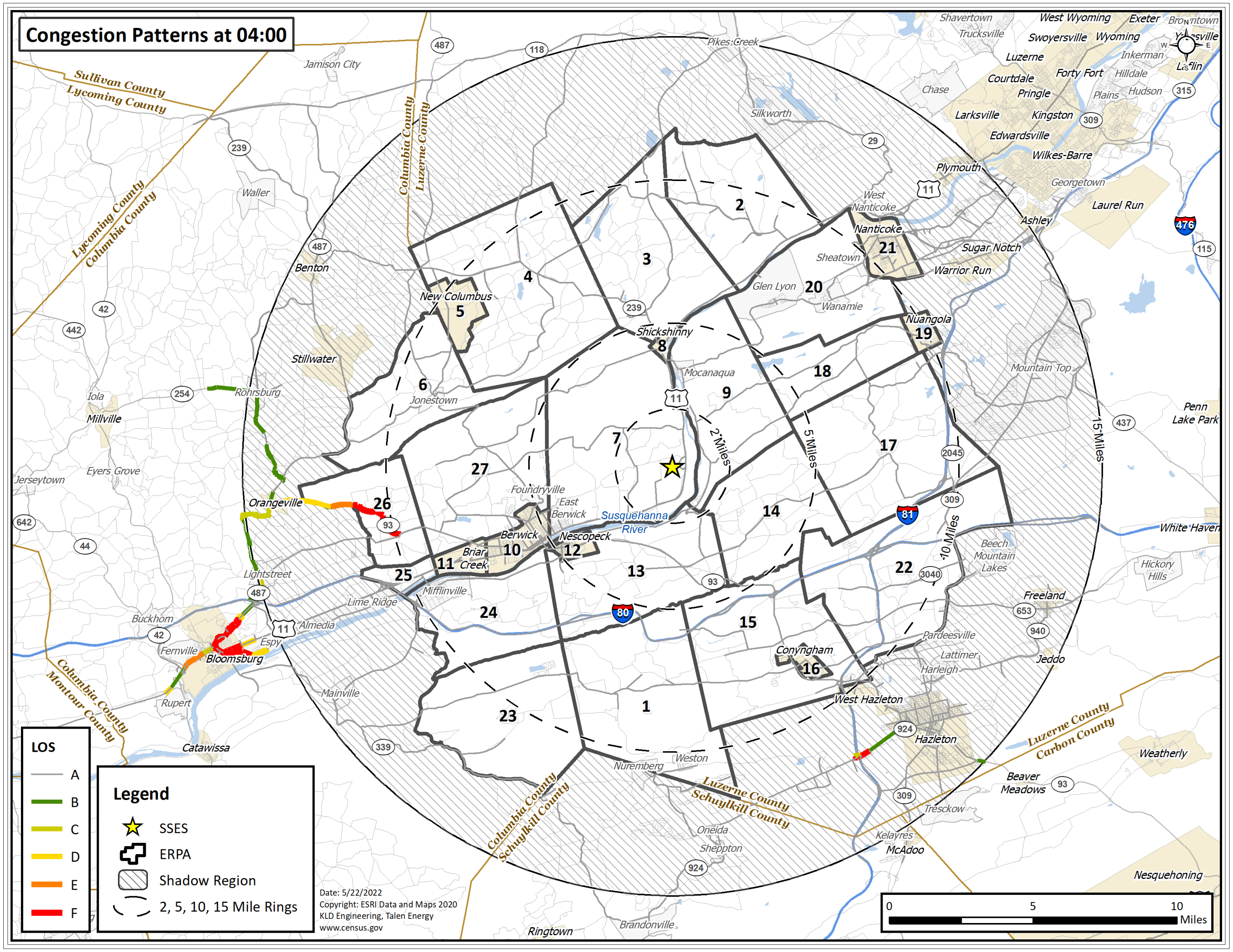


Figure 7-7. Congestion Patterns at 4 Hours after the ATE

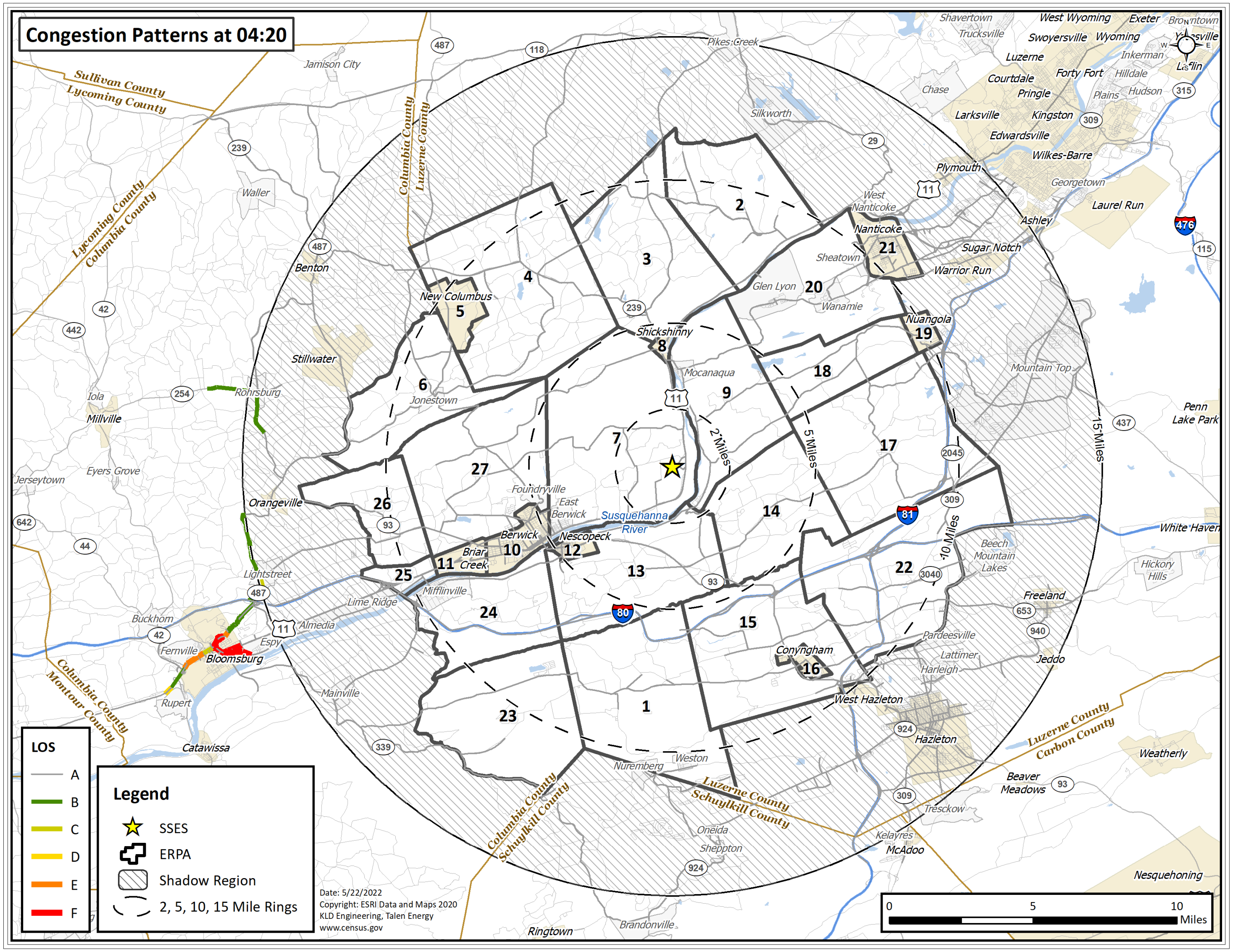


Figure 7-8. Congestion Patterns at 4 Hours, 20 Minutes after the ATE

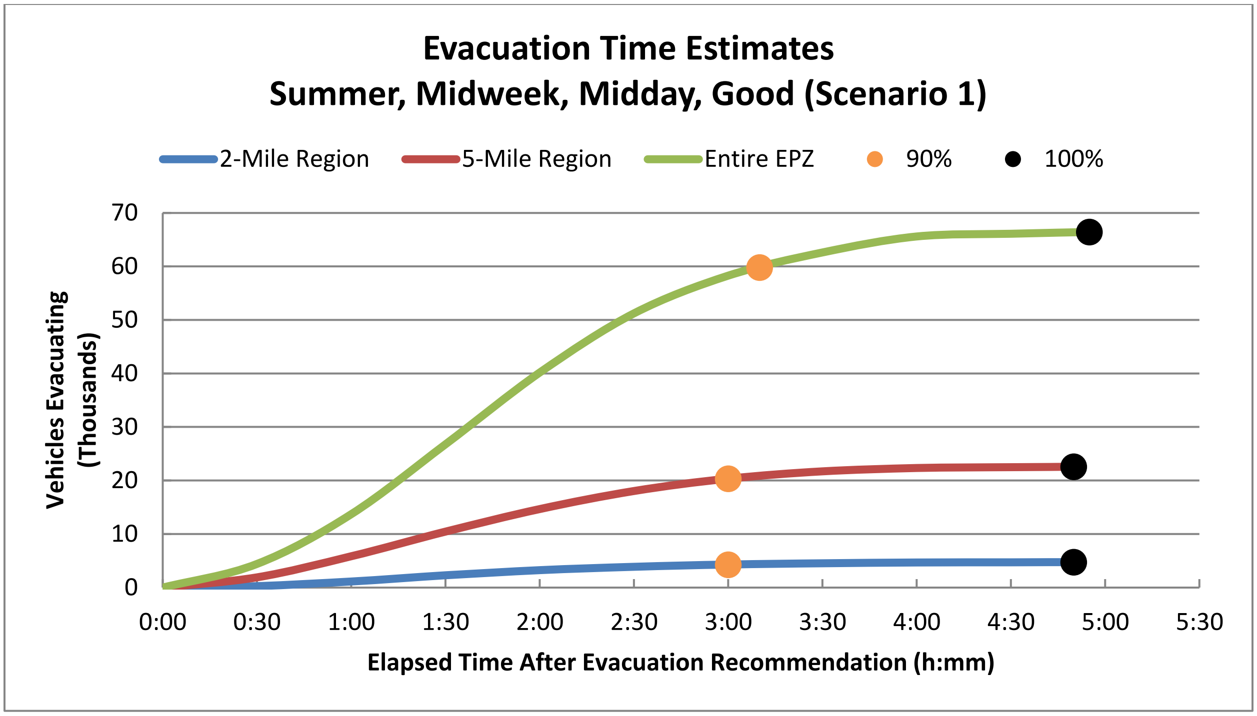


Figure 7-9. Evacuation Time Estimates - Scenario 1 for Region R03

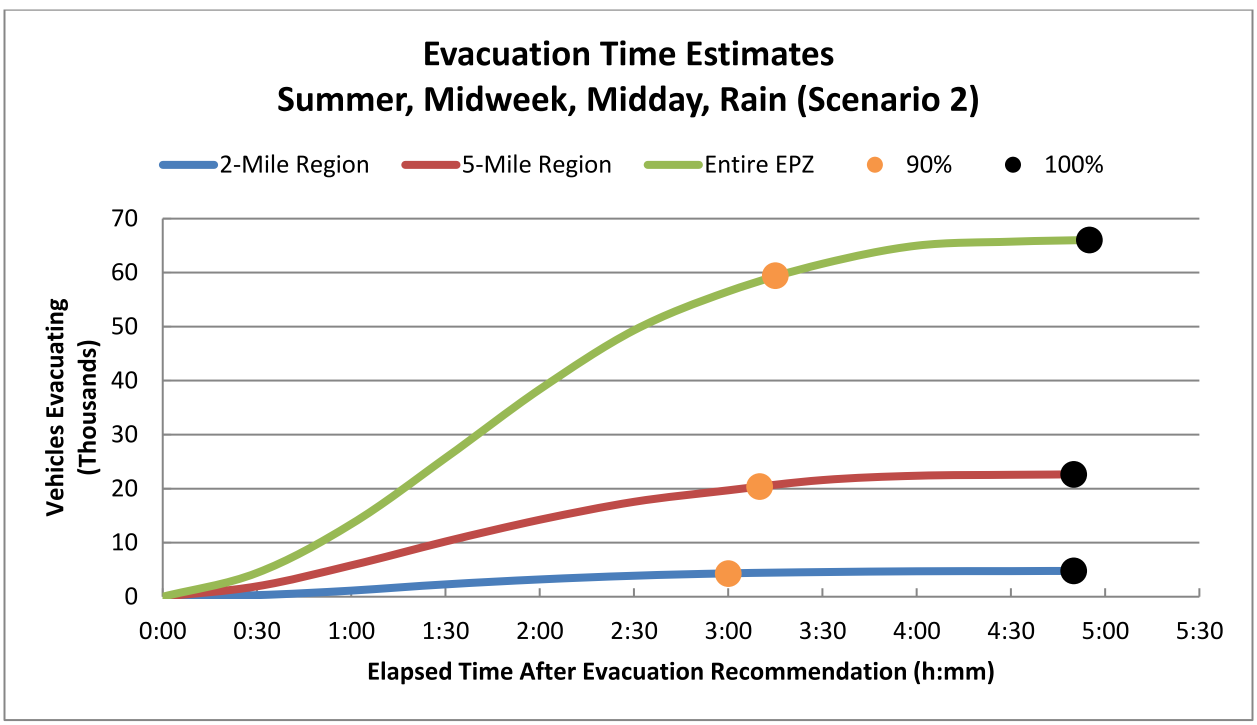


Figure 7-10. Evacuation Time Estimates - Scenario 2 for Region R03

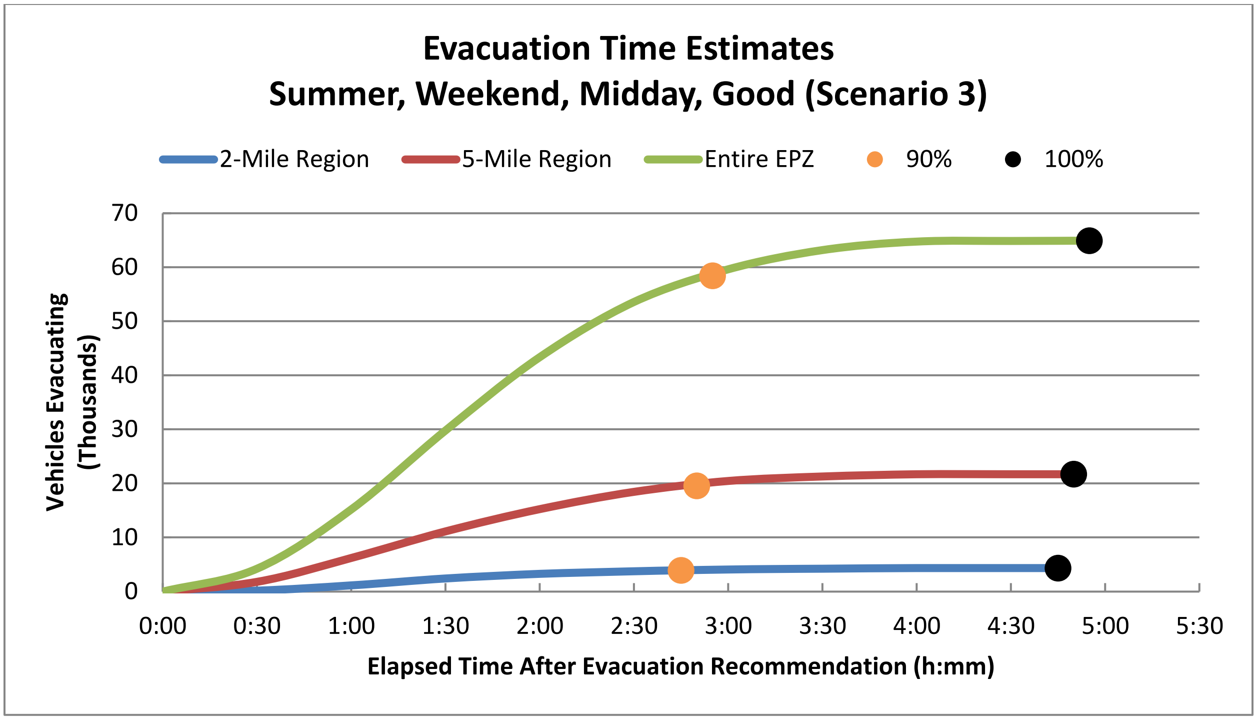


Figure 7-11. Evacuation Time Estimates - Scenario 3 for Region R03

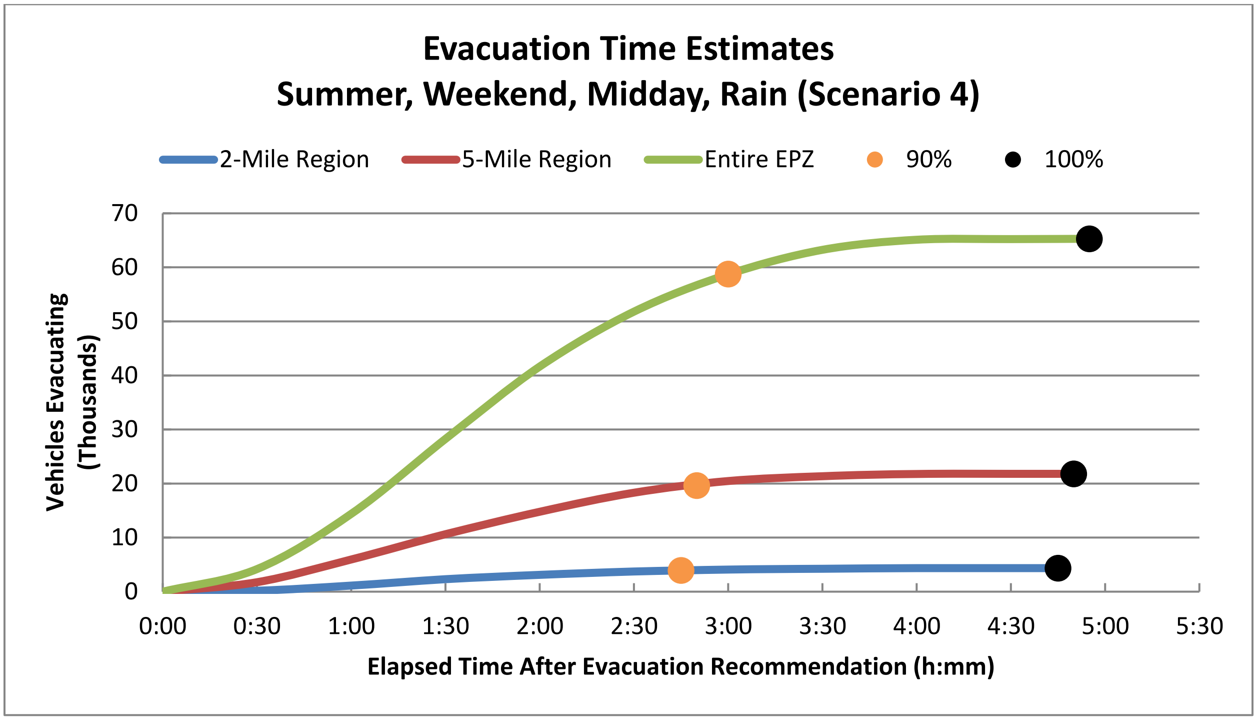


Figure 7-12. Evacuation Time Estimates - Scenario 4 for Region R03

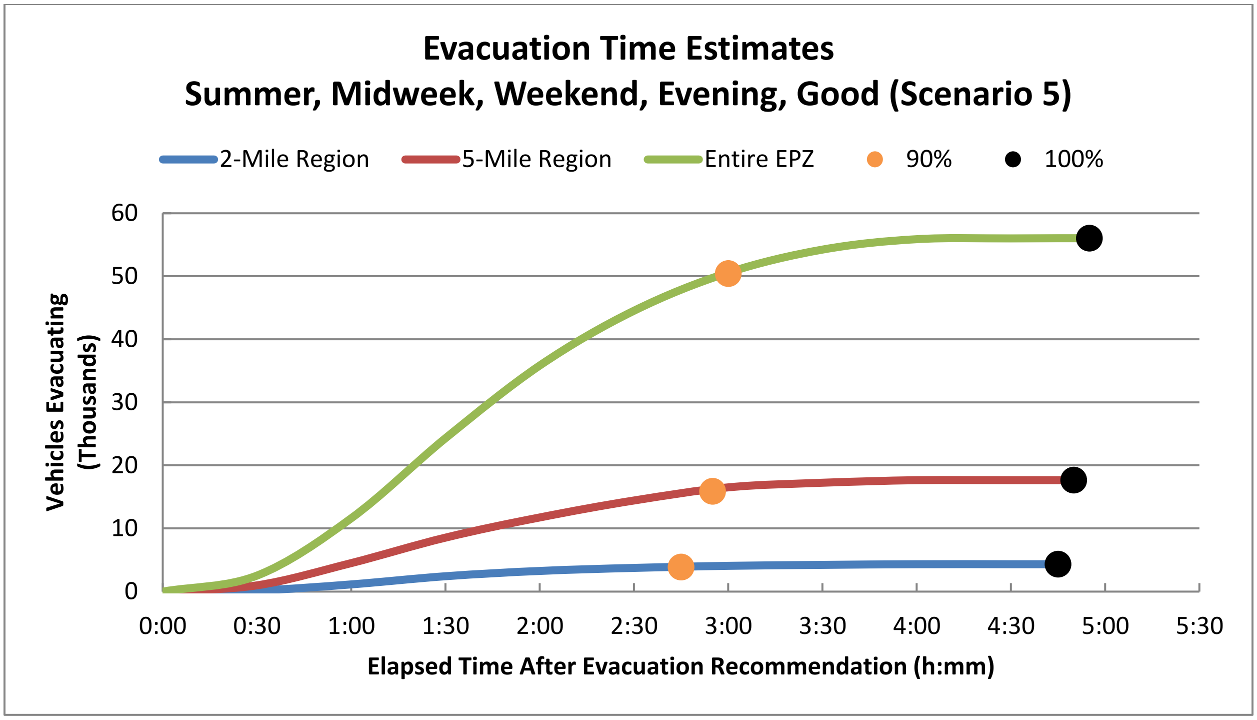


Figure 7-13. Evacuation Time Estimates - Scenario 5 for Region R03

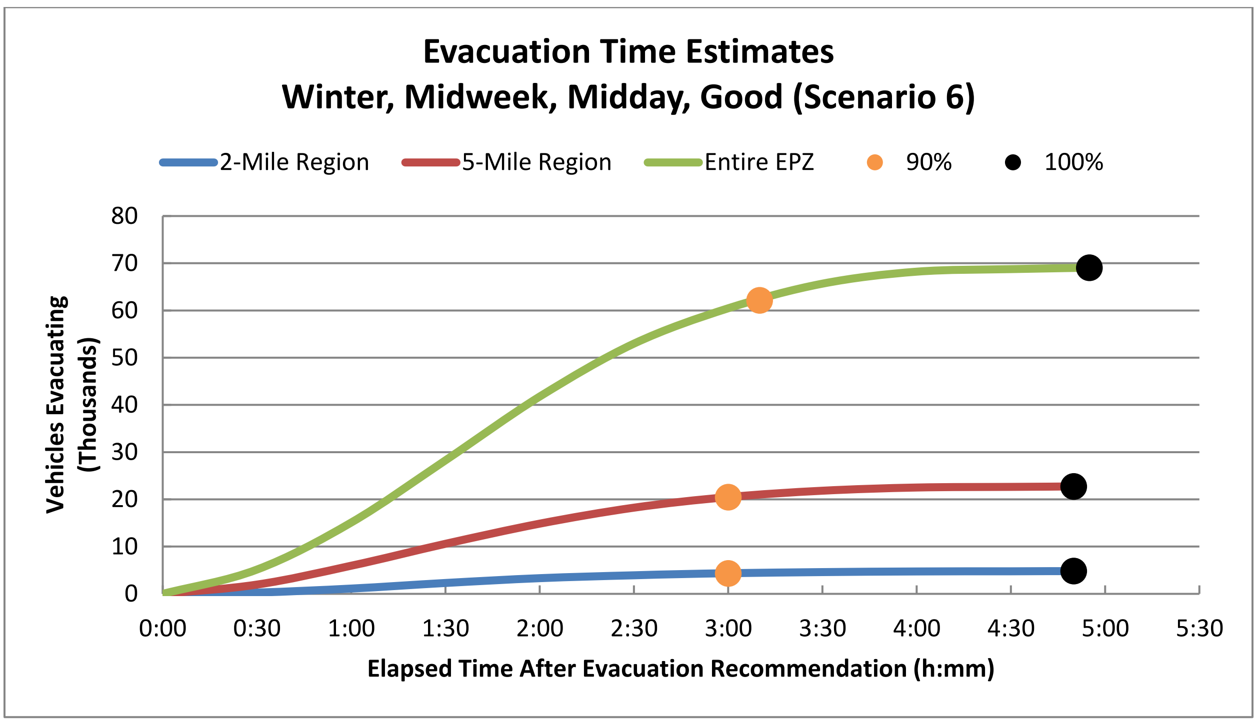


Figure 7-14. Evacuation Time Estimates - Scenario 6 for Region R03

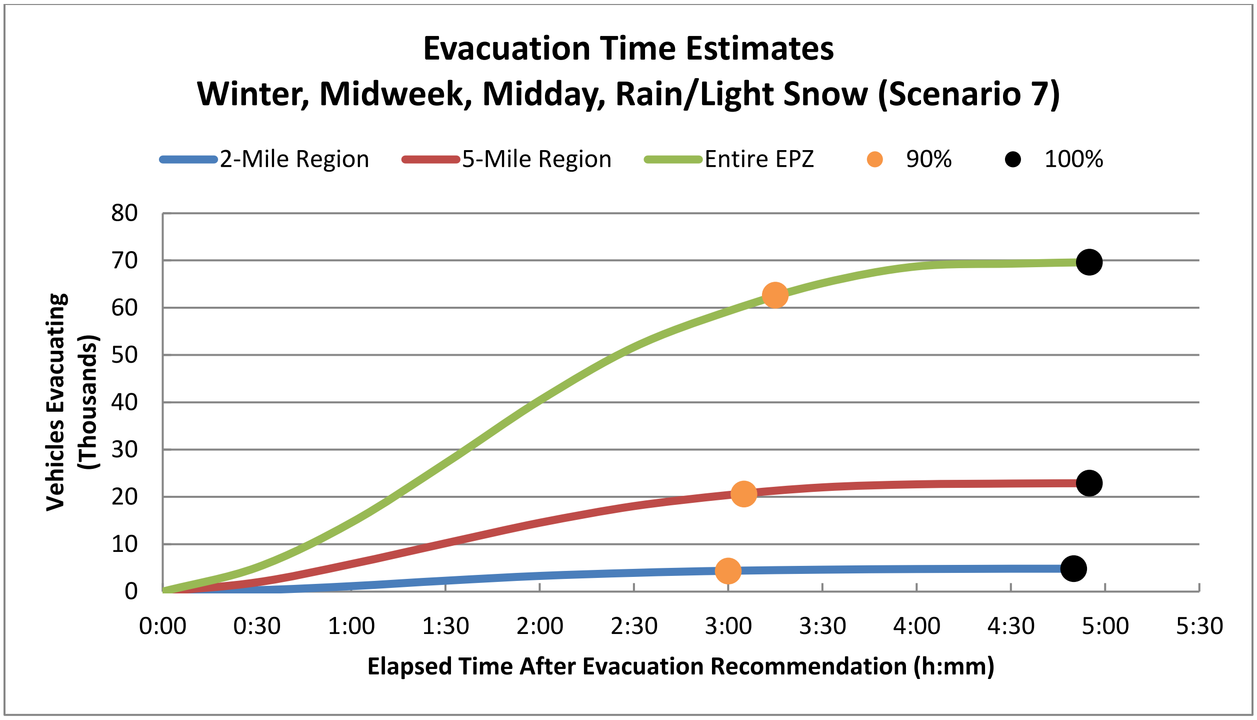


Figure 7-15. Evacuation Time Estimates - Scenario 7 for Region R03

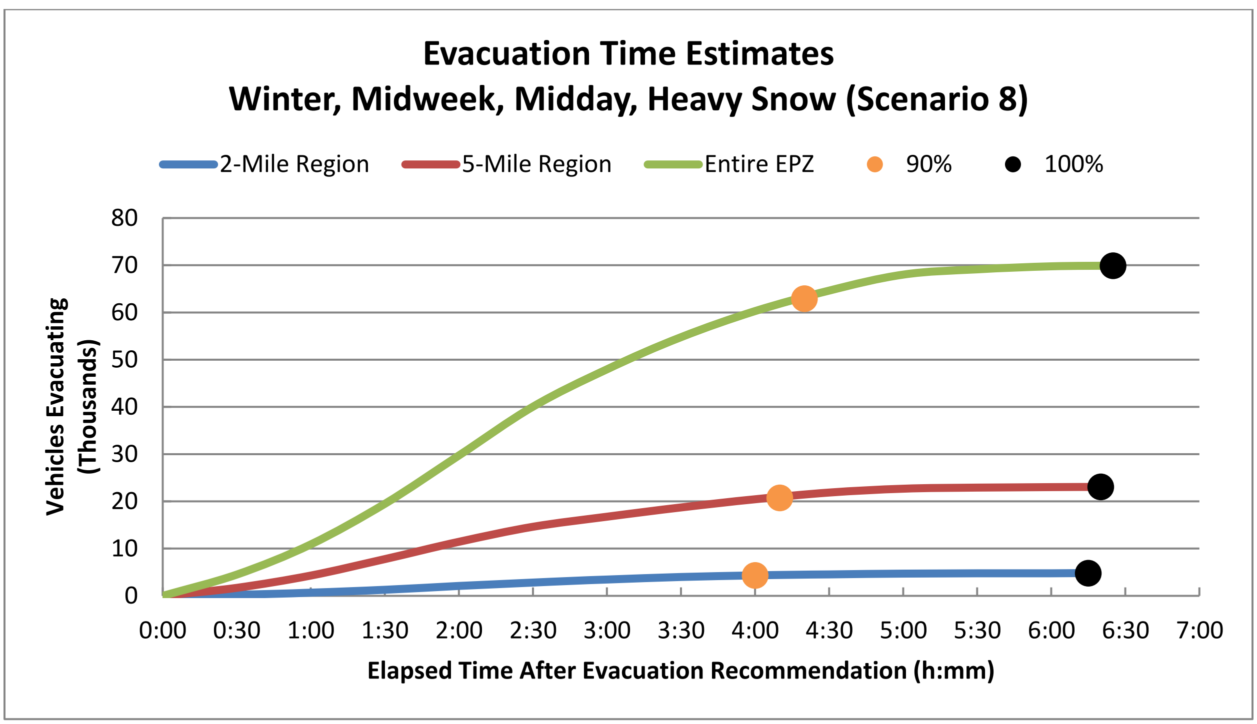


Figure 7-16. Evacuation Time Estimates - Scenario 8 for Region R03

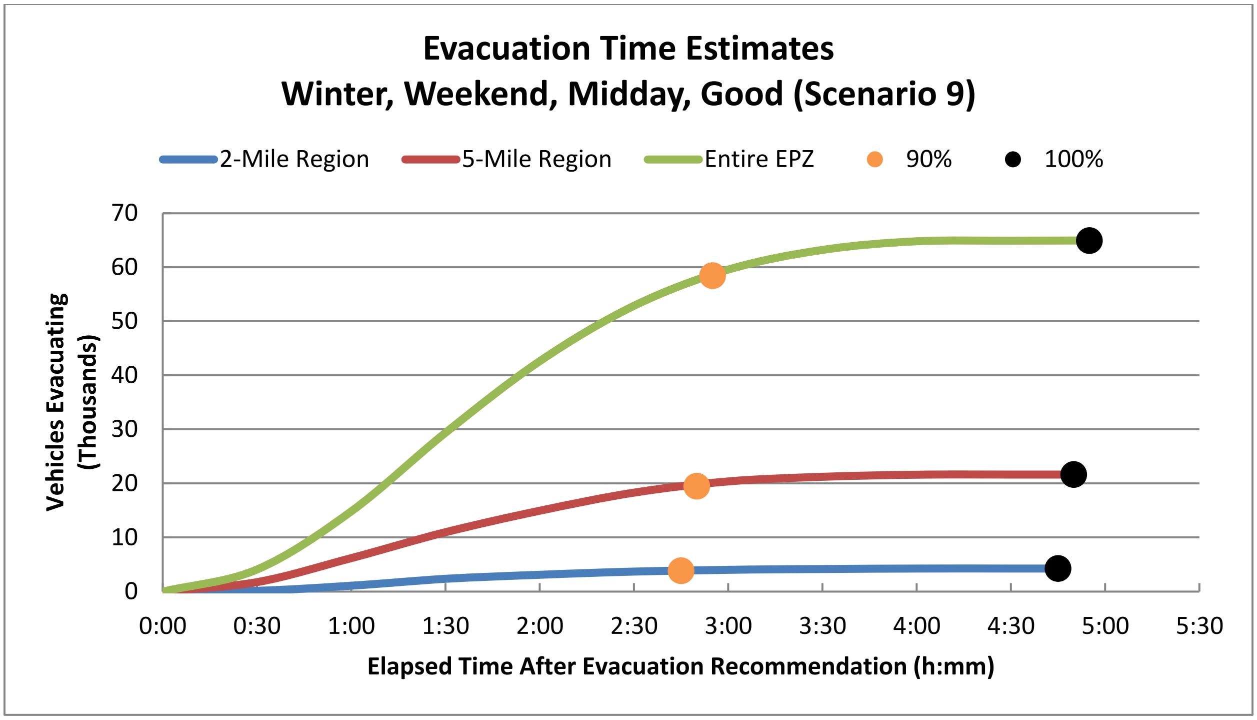


Figure 7-17. Evacuation Time Estimates - Scenario 9 for Region R03

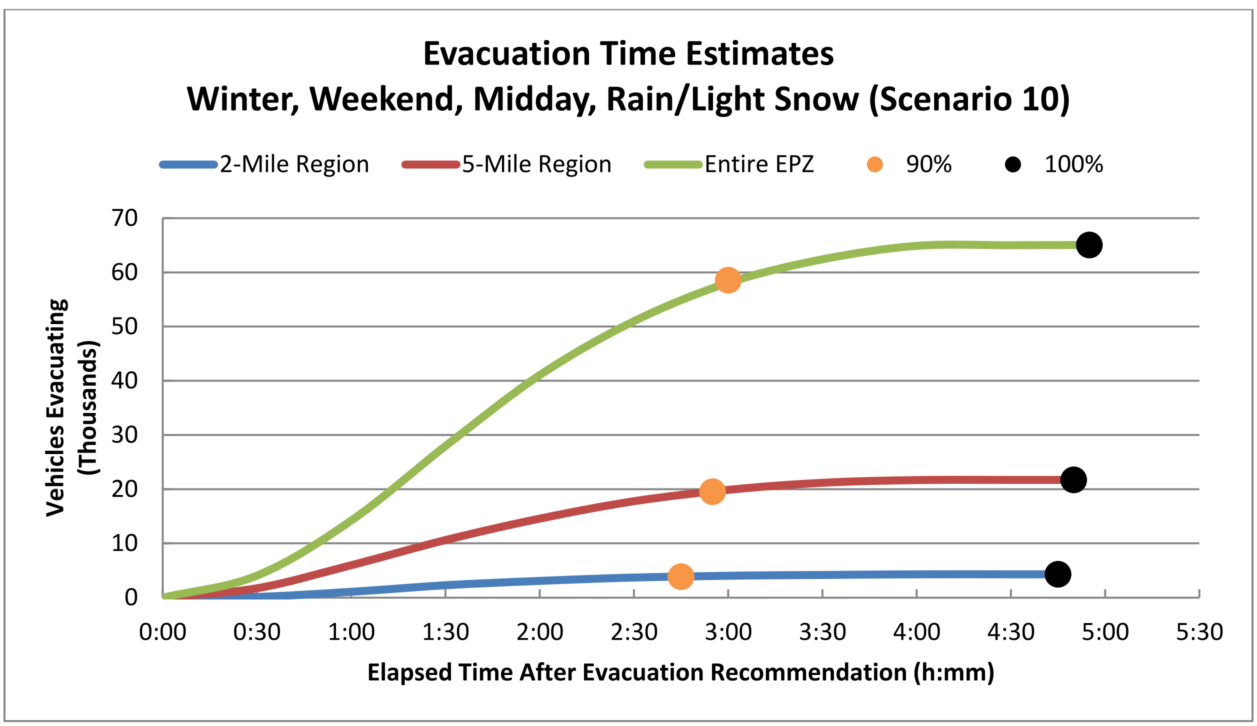


Figure 7-18. Evacuation Time Estimates - Scenario 10 for Region R03

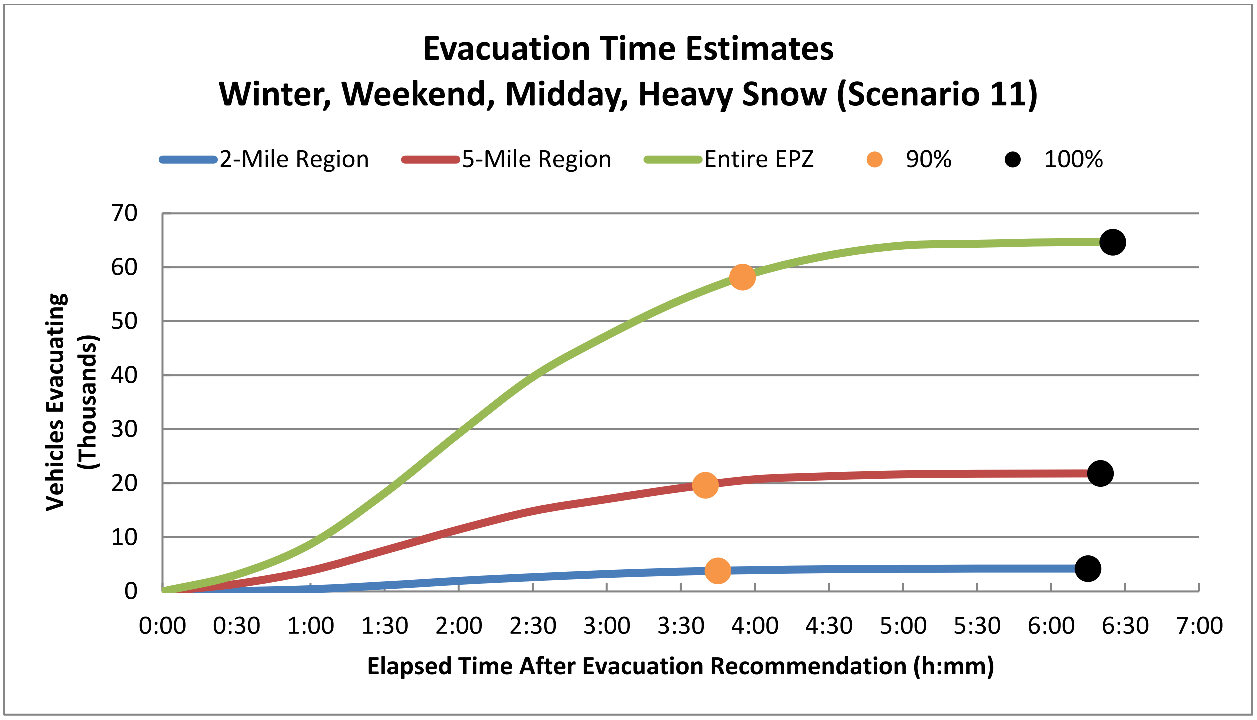


Figure 7-19. Evacuation Time Estimates - Scenario 11 for Region R03

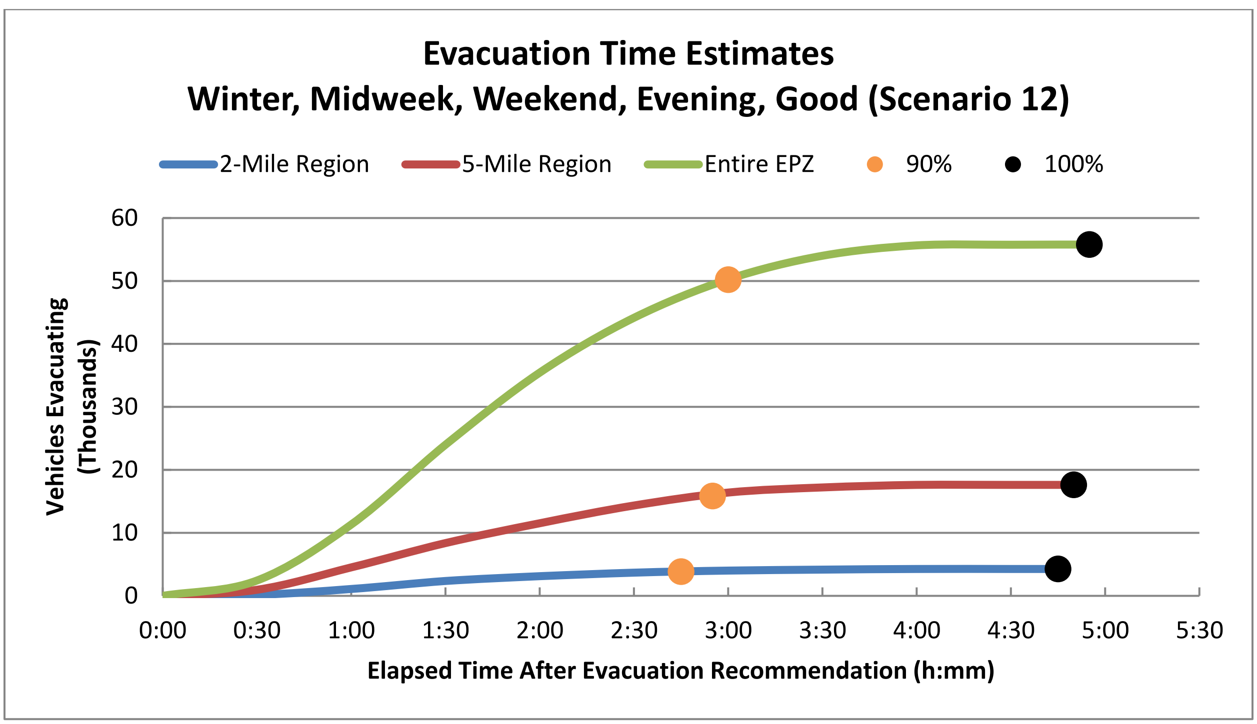


Figure 7-20. Evacuation Time Estimates - Scenario 12 for Region R03

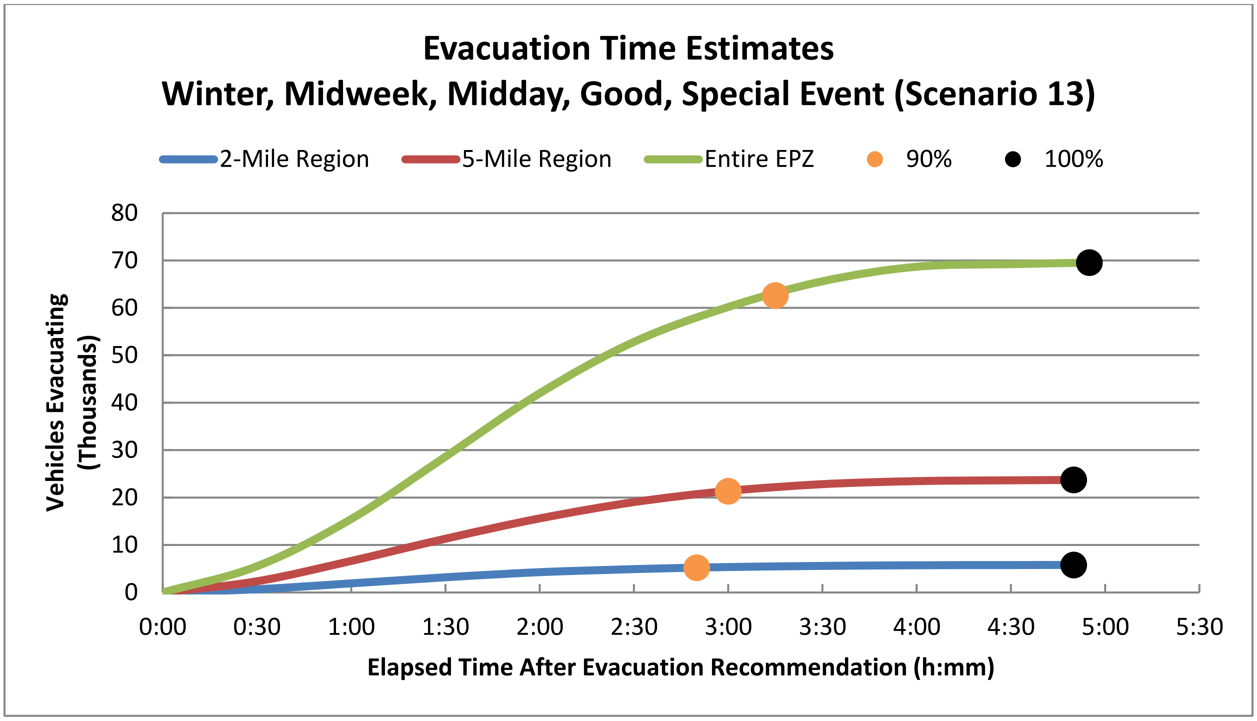


Figure 7-21. Evacuation Time Estimates - Scenario 13 for Region R03

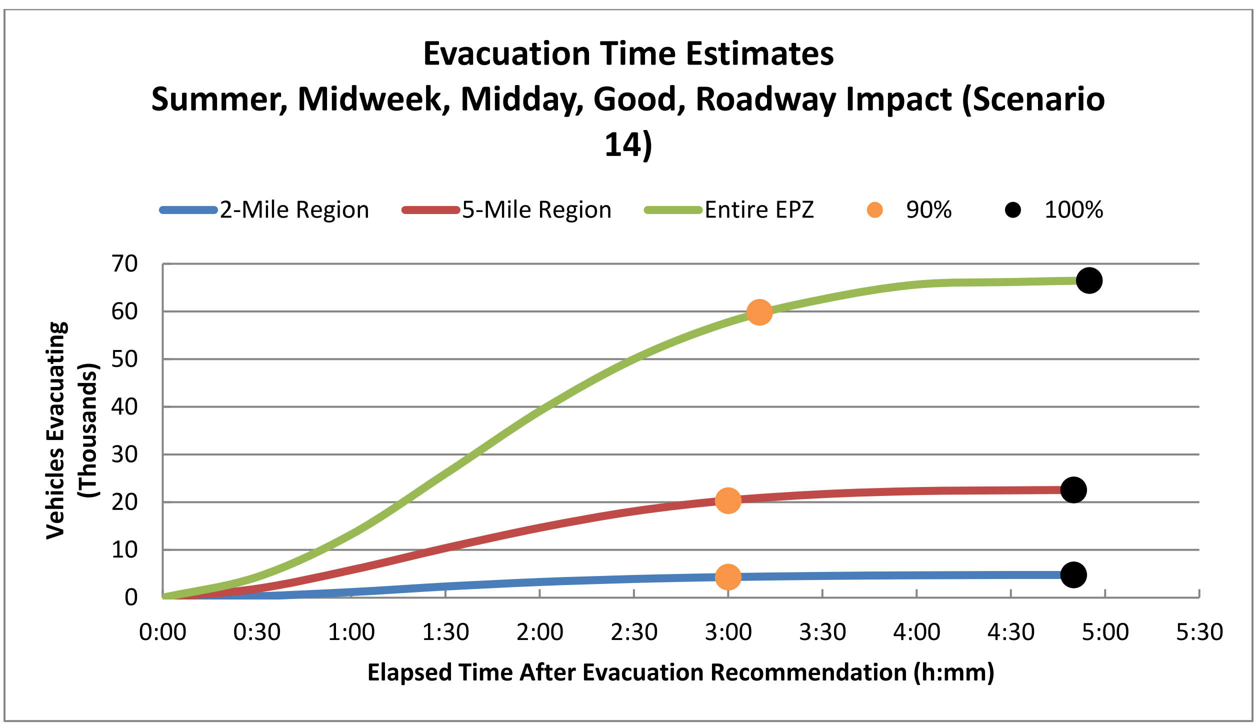


Figure 7-22. Evacuation Time Estimates - Scenario 14 for Region R03

8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES

This section details the analyses applied and the results obtained in the form of ETEs for transit vehicles (i.e., buses, wheelchair transport, 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 and medical facilities; and
- 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. 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 distances 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 SSES EPZ indicates that schoolchildren will be evacuated to host schools at emergency classification levels of Alert or higher, and that parents should pick schoolchildren up at host schools. As discussed in Section 2, this study assumes a fast-breaking general emergency. Therefore, schools and special facilities receive initial notification at the same time as the rest of the EPZ and children are evacuated to host schools. Picking up children at school could add to traffic congestion at the schools, delaying the departure of the buses evacuating schoolchildren, which may have to return in a subsequent "wave" to the EPZ to evacuate the transit-dependent population. This report provides estimates of buses 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.

It is assumed that children at day-care centers[1] that do not have a means for transportation are picked up by parents or guardians and that the time to perform this activity is included in the trip generation times discussed in Section 5.

The procedure for computing transit-dependent ETE is to:

- Estimate demand for transit service
- Estimate time to perform all transit functions
- Estimate route travel times to the EPZ boundary and to the host schools/reception centers

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

8.1 ETEs for Schools, Transit-Dependent People, and Special Facilities

Table 8-1 lists the transportation resources and transportation needs to evacuate the transit dependent and special facility population in the EPZ. As shown in the table, there are sufficient bus resources to evacuate the entire school, transit dependent population and ambulatory population at medical facilities. However, there are insufficient wheelchair vans and ambulances to evacuate wheelchair bound and bedridden patient at medical facilities and access and/or functional needs population. EPZ bus resources are assigned to evacuating schoolchildren (if school is in session at the time of the Advisory to Evacuate) 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 or host school after completing their first evacuation trip, to complete a "second wave" of providing transport service to evacuees. For this reason, the ETE for the transit-dependent population will be calculated for both a one wave transit evacuation and for two waves. Of course, if the impacted Evacuation Region is other than R03 (the entire EPZ), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

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

[1] Although Columbia Day Care is a day-care facility, it is evacuated to a host school as mentioned in the 2022 SSES public info brochure.

School Evacuation

Activity: Mobilize Drivers (A→B→C)

Mobilization time is the elapsed time from the ATE until the time the buses arrive at the facility to be evacuated. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the schools. Mobilization time is slightly longer in adverse weather – 100 minutes for rain/light snow, 110 minutes for heavy snow.

Activity: Board Passengers (C→D)

Based on discussions with offsite agencies, a loading time of 15 minutes (20 minutes for rain/light snow and 25 minutes for heavy snow) for school buses is used. See Section 2.4, assumption 5 and Table 2-2.

Activity: Travel to EPZ Boundary (D→E)

The buses servicing the schools are ready to begin their evacuation trips at 105 minutes after the ATE – 90 minutes mobilization time plus a 15-minute loading time – 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 being evacuated to the EPZ boundary, traveling toward the appropriate host school. This is done in UNITES by interactively selecting the series of nodes 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., 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 the EPZ is shown in Table 8-2 through Table 8-4 for school 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 40 mph, 36 mph, and 34 mph for good weather, rain/light snow and heavy snow, respectively. Speeds were reduced in Table 8-2 through Table 8-4 to 40 mph (36 mph for rain/light snow – 10% decrease – and 34 mph for heavy snow – 15% decrease) for those calculated bus speeds which exceed 40 mph.

Table 8-2 (good weather), Table 8-3 (rain/light snow) and Table 8-4 (heavy snow) present the following ETEs (rounded up to the nearest 5 minutes) for schools in the EPZ:

1. The elapsed time from the ATE until the bus exits the EPZ (ETE); and
2. The elapsed time until the bus reaches the host school (ETA to H.S.).

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 + 33 = 2:20 for Berwick High School, with good weather). The average single-wave ETE, for schools, is 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 host school is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

<u>Activity: Travel to Host School (E→F)</u>

The distances from the EPZ boundary to the host schools are measured using GIS software along the most likely route from the EPZ exit point to the host school. The host schools are mapped in Figure 10-4. For a one-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. Assumed bus speeds of 40 mph, 36 mph, and 34 mph for good weather, rain/light snow, and heavy snow, respectively, will be applied for this activity for buses servicing the school population.

<u>Activity: Passengers Leave Bus (F→G)</u>

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

<u>Activity: Bus Returns to Route for Second Wave Evacuation (G→C →D→E)</u>

As shown in Table 8-1, there are sufficient buses for evacuation of children in a single wave, if the entire EPZ is evacuated at once (a highly unlikely event). However, there might be a shortfall of drivers. As such, a two-wave evacuation may be needed for some schools. Due to the large number of schools in the EPZ, second wave ETE were not computed for each school. Rather, the following representative ETE is provided to estimate the additional time needed for a second wave evacuation of schools. The travel time from host school back to the EPZ boundary and then back to the school was computed assuming an average speed of 40 mph (good weather), 36 mph (rain/light snow) and 34 mph (heavy snow) as buses will be traveling counter to the evacuation traffic. Time and distance are based on averages for all schools in the EPZ for good weather:

- School buses arrive at host schools at 2:20.
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.

- Bus returns to EPZ and completes second route: 19 minutes to return to the EPZ (equal to average travel time to host school for good weather) + 6 minutes to return to the start of the route (4.1 miles, average distance to EPZ boundary from Table 8-2 @ 40 mph) + 11 minutes to perform a second wave of service on the route (4.1 miles, average distance to EPZ boundary from Table 8-2 @ 22 mph, average network speed at this time) = 36 minutes.
- Loading Time: 15 minutes.
- Bus exits EPZ at time 2:20 + 0:15 + 0:36 + 0:15 = 3:30 after the ATE, rounded to the nearest 5 minutes.

Given the average single wave ETE for schools is 2:05, a second wave evacuation would require an additional 1 hour and 25 minutes, on average for good weather.

Evacuation of Camp Louise

There is one children's camp – Camp Louise – within the EPZ. Camp Louise is an overnight Girl Scout camp for girls from ages 6 to 17. Based on data received from Columbia County, the peak population at the camp is 176 children. The peak season for the camp is from mid-June to early August. The camp has an agreement with Bowers Bus in Berwick to supply buses in the event of an emergency evacuation. The buses would arrive at the camp within 30 minutes of being contacted. As with the schoolchildren, it is estimated that bus loading time is 15 minutes. The most likely route from Camp Louise out of the EPZ is south on Shickshinny Valley Rd, west on Knob Mountain Rd, south on Yost Hollow Rd and then west on PA-93 out of the EPZ, a 12.4 mile long route. The average speed output by DYNEV at approximately 45 minutes (30-minute mobilization time for the buses plus 15-minute loading time) after the ATE for an evacuation of Region R03 (Entire EPZ) under Scenario 1 conditions (Summer, Midweek, Midday) is 53 mph. However, since bus speed limits are capped at 40 mph, 40 mph will be used in this calculation. Based on the speed, it will take approximately 19 minutes to travel the 12.4 mile route necessary to exit the EPZ.

ETE = 0:30 (mobilization) + 0:15 (loading) + 0:19 (travel time) = 1:05 (rounded to nearest 5 minutes).

Evacuation of Transit Dependent People (Residents without access to a vehicle)

As detailed in Section 3.6, transit dependent population estimates were obtained from the county emergency plans. The county emergency plans also provided the number of buses required for each township/borough. Seat capacities are based on total number of transit-dependent population divided by the number of buses required. Seat capacities range from 34 to 58 passengers per bus. KLD designed 25 bus routes to service the major evacuation routes (as discussed in Section 10). The routes are shown graphically in Figure 10-2 and Figure 10-3 and described in Table 10-1.

Activity: Mobilize Drivers (A→B→C)

Mobilization time is the elapsed time from the ATE until the time the buses arrive at their designated route. The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after a majority of their passengers have completed their mobilization. As shown in Figure 5-4 (Residents with no Commuters), approximately 90% of the evacuees will have completed their mobilization when the buses will begin their routes, approximately 150 minutes after the ATE for good weather. Those routes with multiple buses have been designed such that buses are dispatched using 30-minute headways. The use of bus headways ensures that those people who take longer to mobilize will be picked up.

Activity: Board Passengers (C→D)

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. As mentioned previously, seat bus seat capacities range from 34 to 58 passenger per bus. Thus, bus pick-up times range from 34 to 58 minutes per bus, for good weather. It is assumed that bus acceleration and speed will be less in rain/light snow and heavy snow resulting in 10 and 20-minute delays per bus, respectively.

Activity: Travel to EPZ Boundary (D→E)

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

Table 8-5 through Table 8-7 present the transit-dependent population evacuation time estimates for each bus route calculated using the above procedures for good weather, rain/light snow and heavy snow, respectively.

For example, the ETE for the bus route servicing Black Creek Township (Route 1) is computed as 150 + 11 + 52 = 3:35 for good weather (rounded up to nearest 5 minutes). Here, 11 minutes is the time to travel 7.4 miles at 40.0 mph, the average speed output by the model for this route starting at 150 minutes. As mentioned before, the total pickup time is equal to the seat capacity of the buses for each township/borough. For Black Creek Township, this is 52 minutes for good weather.

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.

The average ETE for a one-wave evacuation of transit-dependent people exceeds the ETE for the general population by 30 minutes 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 protective action decision making.

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 general population 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 40 mph, 36 mph, and 34 mph for good weather, rain/light snow, and heavy snow, respectively, will be applied for this activity for buses servicing schools and the transit-dependent 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→D→E)

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 Black Creek Township (Route 1) is computed as follows for good weather:

- Bus arrives at reception center at 4:03 in good weather (3:35 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 and completes second route: 28 minutes (equal to travel time to reception center) + 11 minutes (7.4 miles @ 40 mph – assumed speed to start of route) + 11 minutes (7.4 miles @ 40.0 mph – network wide speed at time bus starts route for the second time) = 50 minutes.
- Bus completes pick-ups along route: 52 minutes.
- Bus exits EPZ at time 4:03 + 0:15 + 0:50 + 0:52 = 6:00 after the ATE.

The ETE for the completion of the second wave for all transit-dependent bus routes are provided in Table 8-5 through Table 8-7. The average ETE for a two-wave evacuation of transit-dependent people exceeds 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 protective action decision making.

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

Evacuation of Medical Facilities

As discussed in Section 2.4 and in Table 2-2, it is assumed that the mobilization time for medical facilities average 90 minutes in good weather, 100 minutes in rain/light snow and 110 minutes for heavy snow. 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.

Activity: Board Passengers (C→D)

Item 5 of Section 2.4 discusses transit vehicle loading times for medical facilities. Loading times are assumed to be 1 minute per ambulatory passenger, 5 minutes per wheelchair bound passenger, and 15 minutes per bedridden passenger for buses, wheelchair vans, and ambulances, respectively. Item 3 of Section 2.4 discusses transit vehicle capacities to cap loading times per vehicle type.

Activity: Travel to EPZ Boundary (D→E)

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

Table 8-8 through Table 8-10 summarize the ETE for medical facilities within the EPZ for good weather, rain/light snow, and heavy snow. Average speeds output by the model for Scenario 6 (Scenario 7 for rain/light snow and Scenario 8 for heavy snow) Region 3, capped at 40 mph (36 mph for rain/light snow and 34 mph for heavy snow), are used to compute travel time to the 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, wheelchair vans, and ambulances at capacity is assumed such that the maximum loading times for buses, wheelchair vans and ambulances are 30, 20 and 30 minutes, respectively. All ETE are rounded up to the nearest 5 minutes.

For example, the calculation of ETE for the Berwick Retirement Villages I & II with 179 ambulatory residents during good weather is:

ETE: 90 + 30 x 1 + 33 = 153 min or 2:35 (rounded to the nearest 5 minutes)

It is assumed that 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 center before arriving at the host facility are not considered in this analysis.

The average single wave ETE for medical facilities in the EPZ does not exceed the 90th percentile ETE for the general population for a winter, midweek, midday, good weather scenario.

<u>Activity: Vehicles Travel to Host Facilities (E→F), Passengers Leave (F→G), Vehicle Returns to Route for Second Wave Evacuation (G→C→D→E)</u>

As shown in Table 8-1, there are insufficient wheelchair vans and ambulances to evacuate the wheelchair bound and bedridden patients at the medical facilities in the EPZ. In the absence of data on the location and capacity of host medical facilities, it was assumed that these medical facilities are evacuated to medical facilities in Bloomsburg, Hazleton and/or Wilkes-Barre.

Due to the large number of medical facilities in the EPZ, second wave ETE for these vehicle types were not computed for each medical facility. Rather, the following representative ETE is provided to estimate the additional time needed for a second wave evacuation for wheelchair vans..

Times and distances are based on facility-wide averages:

- Wheelchair bound patients:
  - Wheelchair Vans arrive at Host Hospitals at 2:16 (2:05 Average ETE for wheelchair vans to exit the EPZ plus 11 minutes to travel 7-miles, average distance to medical facilities in Bloomsburg, Hazleton and/or Wilkes-Barre at 40 mph).
  - Van discharges passengers (16 minutes – average loading time for vans from Table 8-8) and driver takes a 10-minute rest: 26 minutes.
  - Van returns to facility: 11 minutes to travel back to the EPZ boundary (time needed to travel 7 miles back to the EPZ at 40 mph) + 6 minutes to travel back to the facility (average distance to EPZ = 4 miles for vans from Table 8-8 @ 40 mph) = 24 minutes.
  - Remaining patients loaded on van (maximum): 20 minutes.
  - Van travels to EPZ boundary: 10 minutes (average distance from medical facilities to EPZ boundary (4 miles) at 25 mph (network wide average speed at 3:30).
  - Van exits EPZ at time 2:16 + 0:26 + 0:24 + 0:20 + 0:10 = 3:40 (rounded up to nearest 5 minutes) after the ATE.

Thus, the second wave evacuation requires an additional 1 hour and 35 minutes than the first wave ETE. The average ETE for a two-wave evacuation of medical facilities does exceed the ETE for the general population at the 90th percentile for a winter, midweek, midday, good weather scenario.

Note that only 2 wheelchair vans were identified as being available in the EPZ versus 44 wheelchair vans needed (see Table 8-1). However, there are 126 vans available in the EPZ. It is assumed that some of these vans will be used to assist in the evacuation of wheelchair bound patients wherein patients would be carried on to the van by medical facility staff and wheelchairs would be folded and stacked in the rear of the van.

8.2 ETE for Access and/or Functional Needs Population

The access and/or functional needs population was provided by the offsite agencies and is further discussed in Section 3.9. Table 8-11 summarizes the ETE for access and/or functional needs population. The table is broken down by weather condition. It is assumed that the special needs population will be picked up from their homes. Furthermore, it is conservatively assumed that bedridden households are spaced 3 miles apart. Ambulance speeds approximate 20 mph between households in good weather (10% slower in rain/light snow, 15% slower in heavy snow). Mobilization times of 90 minutes were used (100 minutes for rain/light snow, and 110 minutes for heavy snow). The last household is assumed to be 5 miles from the EPZ boundary, and the network-wide average speed, capped at 40 mph (36 mph for rain/light snow and 34 mph for heavy snow), after the last pickup is used to compute travel time.

ETE is computed by summing mobilization time, loading time at first household, travel to the 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 special needs person per household implies that 169 households need to be serviced. Ambulances are assumed to have a capacity of two persons per ambulance resulting in a total of 85 ambulances needed to complete the evacuation in a single wave. The following outlines the ETE calculations:

1. Assume 85 ambulances are deployed, each with about 2 stops, to service a total of 169 HH.
2. The ETE is calculated as follows:
    a. Ambulances arrive at the first pickup location: 90 minutes
    b. Load passenger at first pickup: 15 minutes
    c. Travel to next pickup location: 9 minutes (assumed 3 miles @ 20 mph)
    d. Load passenger at subsequent pickup location: 15 minutes
    e. Travel to EPZ boundary: 13 minutes (5 miles @ 22.2 mph).

ETE: 90 + 15 + 9 + 15 + 13 = 2:25 rounded to the nearest 5 minutes

The ETE of a first-wave evacuation of the bedridden access and/or functional needs population within the EPZ is less than the 90th percentile ETE for evacuation of the general population in the Full EPZ (Region R03) under winter, midweek, midday, good weather (Scenario 6) conditions.

The following outlines the ETE calculations of a second wave needed using ambulances after the medical facilities have been evacuated assuming host medical facilities are located in either Bloomsburg, Hazleton and/or Wilkes-Barre:

a. Ambulances arrive at Host Hospitals: 2:31 (2:20 Average ETE for ambulances to exit the EPZ plus 11 minutes to travel 7-miles, average distance to medical facilities in

Bloomsburg, Hazleton and/or Wilkes-Barre at 40 mph) on average.

b. Unload patient at pick-up point: 15 minutes.
c. Driver takes 10-minute rest: 10 minutes.
d. Travel time back to EPZ: 11 minutes (7-miles at 40mph).
e. Travel to first household: 15 minutes (5 miles x 20 mph).
f. Loading time at first household: 15 minutes.
g. Travel to subsequent pickup location: 1 @ 9 minutes = 9 minutes
h. Loading time at subsequent household: 1 stop @ 15 minutes = 15 minutes
i. Travel time to EPZ boundary: 5 miles @22.7 mph (at 4:00) = 13 minutes

Bus exits EPZ at time: 2:31 + 15 + 10 + 11 + 15 + 15 + 9 + 15 + 13 = 4:15 after the ATE, rounded to the nearest 5-minutes.

The average ETE of a second-wave evacuation of the bedridden access and/or functional needs population within the EPZ is 1 hour and 5 minutes longer than the 90th percentile ETE for evacuation of the general population in the Full EPZ (Region R03) under winter, midweek, midday, good weather (Scenario 6) conditions and could impact protective action decision making.

Table 8-1. Summary of Transportation Resources

Transportation Resource	Buses	Cars	Vans	Wheelchair Vans	Ambulances
Resources Available					
Luzerne County	171	0	123	0	53
Luzerne County (For Non-Ambulatory Persons)	0	0	0	0	18
Luzerne County (School Districts)	110	0	0	0	0
Columbia County (Ambulance Services)	0	0	0	0	14
Columbia County (School Districts & Municipal)	126	0	0	0	0
Columbia County (Persons Without Transportation)	2	0	0	0	0
Area Agency On Aging	0	4	2	0	0
Medic 1 (GCMTS)	0	0	1	2	1
TOTAL:	**409**	**4**	**126**	**2**	**86**
Resources Needed					
Schools (Table 3-8):	184	0	0	0	0
Transit-Dependent Population (Table 3-7):	88	0	0	0	0
Medical Facilities (Table 3-6):	27	0	0	44	90
Access and/or Functional Needs Population (Table 3-9):	0	0	0	0	85
TOTAL TRANSPORTATION NEEDS:	**299**	**0**	**0**	**44**	**175**

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

School	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 H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETA to H.S. (hr:min)
COLUMBIA COUNTY SCHOOLS									
Berwick High School	90	15	7.7	14.2	33	**2:20**	15.1	23	**2:45**
Columbia Day Care	90	15	7.2	14.1	31	**2:20**	19.0	29	**2:50**
New Story Berwick School	90	15	6.7	13.4	31	**2:20**	19.0	29	**2:50**
West Berwick Elementary	90	15	6.1	18.1	21	**2:10**	16.5	25	**2:35**
Beaver-Main Elementary	90	15	0.6	40.0	1	**1:50**	9.1	14	**2:05**
LUZERNE COUNTY SCHOOLS									
Northwest Area Intermediate School	90	15	4.7	40.0	8	**1:55**	13.0	20	**2:15**
Northwest Area Middle/High School	90	15	5.7	40.0	9	**1:55**	19.7	30	**2:25**
Muhlenburg Christian Academy	90	15	2.4	12.7	12	**2:00**	13.9	21	**2:25**
Northwest Area Primary School	90	15	2.9	40.0	5	**1:50**	19.7	30	**2:20**
Salem Elementary School	90	15	7.7	14.2	33	**2:20**	18.8	29	**2:50**
Berwick Area Middle School	90	15	7.7	14.2	33	**2:20**	17.8	27	**2:50**
Nescopeck Elementary School	90	15	8.2	24.3	21	**2:10**	16.5	25	**2:35**
Valley Elementary/Middle School	90	15	2.7	29.7	6	**1:55**	8.2	13	**2:10**
GNA Elementary Center	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
GNA Educational Center	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
GNA High School	90	15	0.5	9.3	4	**1:50**	2.1	4	**1:55**
Drums Elementary/Middle School	90	15	1.8	40.0	3	**1:50**	8.3	13	**2:05**
Hazleton Area Academy of Sciences	90	15	2.7	40.0	5	**1:50**	5.4	9	**2:00**
Keystone Job Corporation High School	90	15	1.7	40.0	3	**1:50**	8.3	13	**2:05**
Rice Elementary School	90	15	Inside Shadow Region			**N/A**	4.5	7	**1:55**
					Maximum for EPZ:	**2:20**		**Maximum:**	**2:50**
					Average for EPZ:	**2:05**		**Average:**	**2:20**

Table 8-3. School Evacuation Time Estimates – Rain/Light Snow

School	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 H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETA to H.S. (hr:min)
COLUMBIA COUNTY SCHOOLS									
Berwick High School	100	20	7.7	11.4	41	**2:45**	15.1	26	**3:15**
Columbia Day Care	100	20	7.2	10.9	40	**2:40**	19.0	32	**3:15**
New Story Berwick School	100	20	6.7	10.2	40	**2:40**	19.0	32	**3:15**
West Berwick Elementary	100	20	6.1	12.9	29	**2:30**	16.5	28	**3:00**
Beaver-Main Elementary	100	20	0.6	36.0	1	**2:05**	9.1	16	**2:25**
LUZERNE COUNTY SCHOOLS									
Northwest Area Intermediate School	100	20	4.7	36.0	8	**2:10**	13.0	22	**2:35**
Northwest Area Middle/High School	100	20	5.7	36.0	10	**2:10**	19.7	33	**2:45**
Muhlenburg Christian Academy	100	20	2.4	10.2	15	**2:15**	13.9	24	**2:40**
Northwest Area Primary School	100	20	2.9	36.0	5	**2:05**	19.7	33	**2:40**
Salem Elementary School	100	20	7.7	11.4	41	**2:45**	18.8	32	**3:20**
Berwick Area Middle School	100	20	7.7	11.4	41	**2:45**	17.8	30	**3:15**
Nescopeck Elementary School	100	20	8.2	19.4	26	**2:30**	16.5	28	**3:00**
Valley Elementary/Middle School	100	20	2.7	22.5	8	**2:10**	8.2	14	**2:25**
GNA Elementary Center	100	20	0.5	22.7	2	**2:05**	2.1	4	**2:10**
GNA Educational Center	100	20	0.5	22.7	2	**2:05**	2.1	4	**2:10**
GNA High School	100	20	0.5	22.7	2	**2:05**	2.1	4	**2:10**
Drums Elementary/Middle School	100	20	1.8	36.0	3	**2:05**	8.3	14	**2:20**
Hazleton Area Academy of Sciences	100	20	2.7	36.0	5	**2:05**	5.4	9	**2:15**
Keystone Job Corporation High School	100	20	1.7	36.0	3	**2:05**	8.3	14	**2:20**
Rice Elementary School	100	20	Inside Shadow Region			**N/A**	4.5	8	**2:10**
					Maximum for EPZ:	**2:45**		**Maximum:**	**3:20**
					Average for EPZ:	**2:20**		**Average:**	**2:40**

Table 8-4. School Evacuation Time Estimates – Heavy Snow

School	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 H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETA to H.S. (hr:min)
COLUMBIA COUNTY SCHOOLS									
Berwick High School	110	25	7.7	12.9	36	**2:55**	15.1	27	**3:25**
Columbia Day Care	110	25	7.2	13.3	33	**2:50**	19.0	34	**3:25**
New Story Berwick School	110	25	6.7	12.4	33	**2:50**	19.0	34	**3:25**
West Berwick Elementary	110	25	6.1	14.2	26	**2:45**	16.5	30	**3:15**
Beaver-Main Elementary	110	25	0.6	34.0	2	**2:20**	9.1	17	**2:40**
LUZERNE COUNTY SCHOOLS									
Northwest Area Intermediate School	110	25	4.7	34.0	9	**2:25**	13.0	23	**2:50**
Northwest Area Middle/High School	110	25	5.7	34.0	11	**2:30**	19.7	35	**3:05**
Muhlenburg Christian Academy	110	25	2.4	15.7	10	**2:25**	13.9	25	**2:50**
Northwest Area Primary School	110	25	2.9	34.0	6	**2:25**	19.7	35	**3:00**
Salem Elementary School	110	25	7.7	12.9	36	**2:55**	18.8	34	**3:30**
Berwick Area Middle School	110	25	7.7	12.9	36	**2:55**	17.8	32	**3:30**
Nescopeck Elementary School	110	25	8.2	23.5	21	**2:40**	16.5	30	**3:10**
Valley Elementary/Middle School	110	25	2.7	17.5	10	**2:25**	8.2	15	**2:40**
GNA Elementary Center	110	25	0.5	16.8	2	**2:20**	2.1	4	**2:25**
GNA Educational Center	110	25	0.5	16.8	2	**2:20**	2.1	4	**2:25**
GNA High School	110	25	0.5	16.8	2	**2:20**	2.1	4	**2:25**
Drums Elementary/Middle School	110	25	1.8	34.0	4	**2:20**	8.3	15	**2:35**
Hazleton Area Academy of Sciences	110	25	2.7	34.0	5	**2:20**	5.4	10	**2:30**
Keystone Job Corporation High School	110	25	1.7	34.0	3	**2:20**	8.3	15	**2:35**
Rice Elementary School	110	25	Inside Shadow Region			**N/A**	4.5	8	**2:25**
					Maximum for EPZ:	**2:55**		**Maximum:**	**3:30**
					Average for EPZ:	**2:35**		**Average:**	**2:55**

Table 8-5. Transit-Dependent Evacuation Time Estimates - Good Weather

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	2	150	7.4	40.0	11	52	**3:35**	18.9	28	5	10	50	52	**6:00**
2	3	150	4.3	39.3	7	36	**3:15**	28.1	42	5	10	55	36	**5:45**
3	3	150	7.0	40.0	11	34	**3:15**	29.7	45	5	10	66	34	**5:55**
4	3	150	4.0	40.0	6	42	**3:20**	34.2	51	5	10	63	42	**6:15**
5	1	150	4.2	39.9	6	36	**3:15**	34.3	51	5	10	64	36	**6:05**
6	3	150	8.0	20.4	24	43	**3:40**	34.4	52	5	10	76	43	**6:50**
	2	180	8.0	29.6	16	43	**4:00**	34.4	52	5	10	76	43	**7:10**
7	1	150	7.1	40.0	11	44	**3:25**	34.8	52	5	10	73	44	**6:30**
8	2	150	10.3	40.0	15	37	**3:25**	29.7	45	5	10	76	37	**6:20**
9	3	150	7.4	18.0	25	40	**3:35**	45.4	68	5	10	90	40	**7:10**
	3	180	7.4	28.5	16	40	**4:00**	45.4	68	5	10	90	40	**7:35**
	1	210	7.4	35.7	12	40	**4:25**	45.4	68	5	10	90	40	**8:00**
10	3	150	4.2	29.9	8	40	**3:20**	45.4	68	5	10	81	40	**6:45**
	3	180	4.2	32.6	8	40	**3:50**	45.4	68	5	10	81	40	**7:15**
	1	210	4.2	40.0	6	40	**4:20**	45.4	68	5	10	81	40	**7:45**
11	3	150	8.1	22.6	22	49	**3:45**	34.4	52	5	10	76	49	**7:00**
12	1	150	17.0	30.2	34	50	**3:55**	34.4	52	5	10	103	50	**7:35**
13	3	150	6.0	40.0	9	42	**3:25**	18.9	28	5	10	46	42	**5:40**
	2	180	6.0	40.0	9	42	**3:55**	18.9	28	5	10	46	42	**6:10**
14	2	150	2.5	31.7	5	48	**3:25**	18.9	28	5	10	36	48	**5:35**
	2	180	2.5	33.2	5	48	**3:55**	18.9	28	5	10	36	48	**6:05**
15	3	150	4.7	38.0	7	36	**3:15**	29.7	45	5	10	59	36	**5:50**
16	1	150	6.1	40.0	9	50	**3:30**	30.1	45	5	10	63	50	**6:25**
17	1	150	1.0	34.8	2	34	**3:10**	29.8	45	5	10	48	34	**5:35**

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
18	3	150	4.4	18.1	15	38	**3:25**	28.4	43	5	10	56	38	**6:00**
	3	180	4.4	32.9	8	38	**3:50**	28.4	43	5	10	56	38	**6:25**
	1	210	4.4	37.8	7	38	**4:15**	28.4	43	5	10	56	38	**6:50**
19	4	150	0.9	11.7	5	37	**3:15**	28.9	43	5	10	46	37	**5:40**
	4	180	0.9	28.3	2	37	**3:40**	28.9	43	5	10	46	37	**6:05**
	3	210	0.9	32.0	2	37	**4:10**	28.9	43	5	10	46	37	**6:35**
	3	240	0.9	31.1	2	37	**4:40**	28.9	43	5	10	46	37	**7:05**
20	2	150	4.6	40.0	7	48	**3:25**	22.4	34	5	10	48	48	**5:50**
	2	180	4.6	40.0	7	48	**3:55**	22.4	34	5	10	48	48	**6:20**
21	1	150	4.4	40.0	7	34	**3:15**	12.0	18	5	10	31	34	**4:55**
22	3	150	5.5	23.0	14	40	**3:25**	34.4	52	5	10	69	40	**6:25**
23	1	150	2.7	40.0	4	49	**3:25**	34.4	52	5	10	60	49	**6:25**
24	2	150	2.0	32.3	4	38	**3:15**	30.3	45	5	10	51	38	**5:45**
25	2	150	10.1	22.7	27	38	**3:35**	31.7	48	5	10	78	38	**6:35**
	2	180	10.1	31.2	19	38	**4:00**	31.7	48	5	10	78	38	**7:00**
Maximum ETE:							**4:40**	**Maximum ETE:**						**8:00**
Average ETE:							**3:40**	**Average ETE:**						**6:30**

Table 8-6. Transit-Dependent Evacuation Time Estimates – Rain/Light Snow

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	2	160	7.4	36.0	12	62	**3:55**	18.9	32	5	10	57	62	**6:45**
2	3	160	4.3	28.2	9	46	**3:40**	28.1	47	5	10	61	46	**6:30**
3	3	160	7.0	35.6	12	44	**3:40**	29.7	50	5	10	73	44	**6:45**
4	3	160	4.0	36.0	7	52	**3:40**	34.2	57	5	10	70	52	**6:55**
5	1	160	4.2	35.6	7	46	**3:35**	34.3	57	5	10	71	46	**6:45**
6	3	160	8.0	16.2	30	53	**4:05**	34.4	57	5	10	84	53	**7:35**
	2	190	8.0	23.0	21	53	**4:25**	34.4	57	5	10	84	53	**7:55**
7	1	160	7.1	36.0	12	54	**3:50**	34.8	58	5	10	82	54	**7:20**
8	2	160	10.3	36.0	17	47	**3:45**	29.7	50	5	10	84	47	**7:05**
9	3	160	7.4	15.1	30	50	**4:00**	45.4	76	5	10	101	50	**8:05**
	3	190	7.4	22.2	20	50	**4:20**	45.4	76	5	10	101	50	**8:25**
	1	220	7.4	30.9	14	50	**4:45**	45.4	76	5	10	101	50	**8:50**
10	3	160	4.2	22.8	11	50	**3:45**	45.4	76	5	10	90	50	**7:40**
	3	190	4.2	22.5	11	50	**4:15**	45.4	76	5	10	90	50	**8:10**
	1	220	4.2	32.9	8	50	**4:40**	45.4	76	5	10	90	50	**8:35**
11	3	160	8.1	19.7	25	59	**4:05**	34.4	57	5	10	84	59	**7:40**
12	1	160	17.0	27.4	37	60	**4:20**	34.4	57	5	10	114	60	**8:30**
13	3	160	6.0	36.0	10	52	**3:45**	18.9	32	5	10	52	52	**6:20**
	2	190	6.0	36.0	10	52	**4:15**	18.9	32	5	10	52	52	**6:50**
14	2	160	2.5	30.0	5	58	**3:45**	18.9	32	5	10	40	58	**6:10**
	2	190	2.5	30.5	5	58	**4:15**	18.9	32	5	10	40	58	**6:40**
15	3	160	4.7	34.4	8	46	**3:35**	29.7	50	5	10	66	46	**6:35**
16	1	160	6.1	36.0	10	60	**3:55**	30.1	50	5	10	70	60	**7:10**
17	1	160	1.0	31.2	2	44	**3:30**	29.8	50	5	10	54	44	**6:15**

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
18	3	160	4.4	10.3	26	48	**3:55**	28.4	47	5	10	62	48	**6:50**
	3	190	4.4	15.8	17	48	**4:15**	28.4	47	5	10	62	48	**7:10**
	1	220	4.4	31.4	8	48	**4:40**	28.4	47	5	10	62	48	**7:35**
19	4	160	0.9	13.6	4	47	**3:35**	28.9	48	5	10	51	47	**6:20**
	4	190	0.9	17.2	3	47	**4:05**	28.9	48	5	10	51	47	**6:50**
	3	220	0.9	28.4	2	47	**4:30**	28.9	48	5	10	51	47	**7:15**
	3	250	0.9	28.2	2	47	**5:00**	28.9	48	5	10	51	47	**7:45**
20	2	160	4.6	36.0	8	58	**3:50**	22.4	37	5	10	52	58	**6:35**
	2	190	4.6	36.0	8	58	**4:20**	22.4	37	5	10	52	58	**7:05**
21	1	160	4.4	36.0	7	44	**3:35**	12.0	20	5	10	35	44	**5:30**
22	3	160	5.5	21.1	16	50	**3:50**	34.4	57	5	10	75	50	**7:10**
23	1	160	2.7	36.0	5	59	**3:45**	34.4	57	5	10	66	59	**7:05**
24	2	160	2.0	32.9	4	48	**3:35**	30.3	51	5	10	58	48	**6:30**
25	2	160	10.1	18.3	33	48	**4:05**	31.7	53	5	10	87	48	**7:30**
	2	190	10.1	24.8	24	48	**4:25**	31.7	53	5	10	87	48	**7:50**
						Maximum ETE:	**5:00**						**Maximum ETE:**	**8:50**
						Average ETE:	**4:05**						**Average ETE:**	**7:15**

Table 8-7. Transit Dependent Evacuation Time Estimates – Heavy Snow

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	2	170	7.4	29.0	15	72	**4:20**	18.9	33	5	10	59	72	**7:20**
2	3	170	4.3	18.8	14	56	**4:00**	28.1	50	5	10	65	56	**7:10**
3	3	170	7.0	34.0	12	54	**4:00**	29.7	52	5	10	77	54	**7:20**
4	3	170	4.0	34.0	7	62	**4:00**	34.2	60	5	10	74	62	**7:35**
5	1	170	4.2	34.0	7	56	**3:55**	34.3	61	5	10	76	56	**7:25**
6	3	170	8.0	11.6	42	63	**4:35**	34.4	61	5	10	89	63	**8:25**
	2	200	8.0	13.2	36	63	**5:00**	34.4	61	5	10	89	63	**8:50**
7	1	170	7.1	34.0	13	64	**4:10**	34.8	61	5	10	86	64	**8:00**
8	2	170	10.3	34.0	18	57	**4:10**	29.7	52	5	10	88	57	**7:45**
9	3	170	7.4	10.9	41	60	**4:35**	45.4	80	5	10	106	60	**9:00**
	3	200	7.4	12.5	35	60	**5:00**	45.4	80	5	10	106	60	**9:25**
	1	230	7.4	18.3	24	60	**5:15**	45.4	80	5	10	106	60	**9:40**
10	3	170	4.2	24.0	11	60	**4:05**	45.4	80	5	10	95	60	**8:15**
	3	200	4.2	24.8	10	60	**4:35**	45.4	80	5	10	95	60	**8:45**
	1	230	4.2	26.0	10	60	**5:00**	45.4	80	5	10	95	60	**9:10**
11	3	170	8.1	18.8	26	69	**4:25**	34.4	61	5	10	90	69	**8:20**
12	1	170	17.0	26.0	39	70	**4:40**	34.4	61	5	10	121	70	**9:10**
13	3	170	6.0	28.7	13	62	**4:05**	18.9	33	5	10	54	62	**6:50**
	2	200	6.0	34.0	11	62	**4:35**	18.9	33	5	10	54	62	**7:20**
14	2	170	2.5	19.3	8	68	**4:10**	18.9	33	5	10	43	68	**6:50**
	2	200	2.5	26.9	6	68	**4:35**	18.9	33	5	10	43	68	**7:15**
15	3	170	4.7	32.6	9	56	**3:55**	29.7	52	5	10	69	56	**7:10**
16	1	170	6.1	34.0	11	70	**4:15**	30.1	53	5	10	75	70	**7:50**
17	1	170	1.0	29.9	2	54	**3:50**	29.8	53	5	10	57	54	**6:50**

Route Number	Number of Buses	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Route Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to Rec. Ctr. (miles)	Travel Time to Rec. Ctr. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
18	3	170	4.4	9.7	27	58	**4:20**	28.4	50	5	10	66	58	**7:30**
	3	200	4.4	9.2	29	58	**4:50**	28.4	50	5	10	66	58	**8:00**
	1	230	4.4	15.1	17	58	**5:10**	28.4	50	5	10	66	58	**8:20**
19	4	170	0.9	8.5	6	57	**3:55**	28.9	51	5	10	55	57	**6:55**
	4	200	0.9	9.4	6	57	**4:25**	28.9	51	5	10	54	57	**7:25**
	3	230	0.9	9.2	6	57	**4:55**	28.9	51	5	10	54	57	**7:55**
	3	260	0.9	25.2	2	57	**5:20**	28.9	51	5	10	54	57	**8:20**
20	2	170	4.6	34.0	8	68	**4:10**	22.4	40	5	10	56	68	**7:10**
	2	200	4.6	34.0	8	68	**4:40**	22.4	40	5	10	56	68	**7:40**
21	1	170	4.4	34.0	8	54	**3:55**	12.0	21	5	10	37	54	**6:05**
22	3	170	5.5	16.5	20	60	**4:10**	34.4	61	5	10	80	60	**7:50**
23	1	170	2.7	34.0	5	69	**4:05**	34.4	61	5	10	71	69	**7:45**
24	2	170	2.0	16.7	7	58	**4:00**	30.3	53	5	10	60	58	**7:10**
25	2	170	10.1	13.6	45	58	**4:35**	31.7	56	5	10	92	58	**8:20**
	2	200	10.1	15.2	40	58	**5:00**	31.7	56	5	10	92	58	**8:45**
						Maximum ETE:	**5:20**						**Maximum ETE:**	**9:40**
						Average ETE:	**4:25**						**Average ETE:**	**7:55**

Table 8-8. Medical Facilities 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)
Berwick Retirement Villages I & II	Ambulatory	90	1	179	30	8.1	33	**2:35**
	Wheelchair bound	90	5	16	20	8.1	34	**2:25**
	Bedridden	90	15	45	30	8.1	33	**2:35**
Berwick Hospital Center	Ambulatory	90	1	250	30	8.1	33	**2:35**
	Wheelchair bound	90	5	10	20	8.1	34	**2:25**
	Bedridden	90	15	8	30	8.1	33	**2:35**
Elmcroft of Berwick	Ambulatory	90	1	57	30	4.6	12	**2:15**
	Wheelchair bound	90	5	5	20	4.6	12	**2:05**
	Bedridden	90	15	14	30	4.6	12	**2:15**
Bonham Nursing Home	Ambulatory	90	1	44	30	2.8	4	**2:05**
	Bedridden	90	15	30	30	2.8	4	**2:05**
Paradise Manor	Ambulatory	90	1	4	4	9.1	36	**2:10**
	Wheelchair bound	90	5	1	5	9.1	36	**2:15**
	Bedridden	90	15	1	15	9.1	37	**2:25**
ALC Family Care	Ambulatory	90	1	20	20	11.8	18	**2:10**
Guardian Healthcare and Rehabilitation Center	Ambulatory	90	1	15	15	2.0	32	**2:20**
	Wheelchair bound	90	5	49	20	2.0	31	**2:25**
	Bedridden	90	15	12	30	2.0	30	**2:30**
Northeast Counseling Nanticoke Services	Ambulatory	90	1	10	10	1.2	12	**1:55**
	Wheelchair bound	90	5	2	10	1.2	12	**1:55**
Birchwood Nursing Home	Ambulatory	90	1	26	26	0.5	2	**2:00**
	Wheelchair bound	90	5	10	20	0.5	2	**1:55**
	Bedridden	90	15	20	30	0.5	2	**2:05**
Fritzingertown Senior Living Community	Ambulatory	90	1	25	25	1.5	2	**2:00**
	Wheelchair bound	90	5	50	20	1.5	2	**1:55**
	Bedridden	90	15	26	30	1.5	2	**2:05**
Kadima Rehabilitation and Nursing	Ambulatory	90	1	5	5	3.0	5	**1:40**
	Wheelchair bound	90	5	10	20	3.0	5	**1:55**
	Bedridden	90	15	17	30	3.0	5	**2:05**
Conyngham Care Center	Ambulatory	90	1	14	14	2.0	3	**1:50**
	Wheelchair bound	90	5	1	5	2.0	3	**1:40**
	Bedridden	90	15	3	30	2.0	3	**2:05**
							Maximum ETE:	**2:35**
							Average ETE:	**2:10**

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

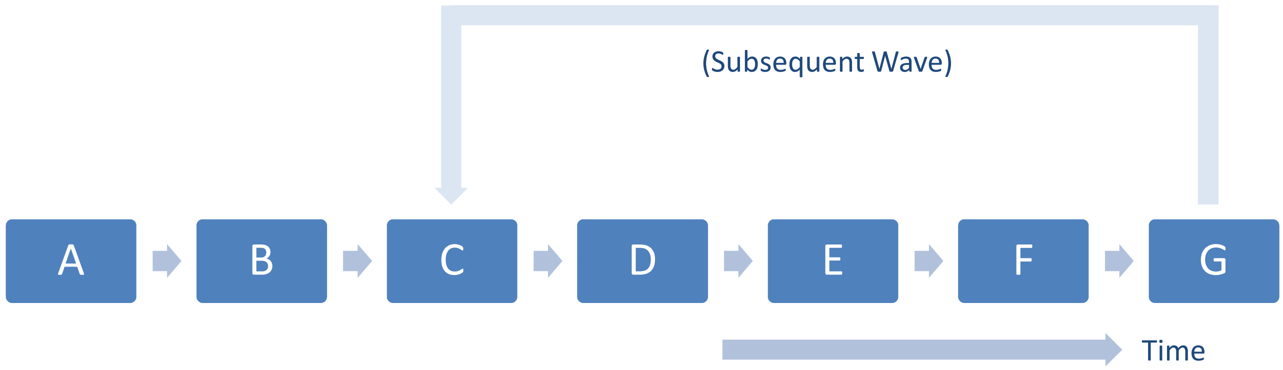
Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Berwick Retirement Villages I & II	Ambulatory	100	1	179	30	8.1	40	**2:50**
	Wheelchair bound	100	5	16	20	8.1	43	**2:45**
	Bedridden	100	15	45	30	8.1	40	**2:50**
Berwick Hospital Center	Ambulatory	100	1	250	30	8.1	40	**2:50**
	Wheelchair bound	100	5	10	20	8.1	43	**2:45**
	Bedridden	100	15	8	30	8.1	40	**2:50**
Elmcroft of Berwick	Ambulatory	100	1	57	30	4.6	17	**2:30**
	Wheelchair bound	100	5	5	20	4.6	18	**2:20**
	Bedridden	100	15	14	30	4.6	17	**2:30**
Bonham Nursing Home	Ambulatory	100	1	44	30	2.8	5	**2:15**
	Bedridden	100	15	30	30	2.8	5	**2:15**
Paradise Manor	Ambulatory	100	1	4	4	9.1	50	**2:35**
	Wheelchair bound	100	5	1	5	9.1	50	**2:35**
	Bedridden	100	15	1	15	9.1	48	**2:45**
ALC Family Care	Ambulatory	100	1	20	20	11.8	20	**2:20**
Guardian Healthcare and Rehabilitation Center	Ambulatory	100	1	15	15	2.0	32	**2:30**
	Wheelchair bound	100	5	49	20	2.0	32	**2:35**
	Bedridden	100	15	12	30	2.0	32	**2:45**
Northeast Counseling Nanticoke Services	Ambulatory	100	1	10	10	1.2	18	**2:10**
	Wheelchair bound	100	5	2	10	1.2	18	**2:10**
Birchwood Nursing Home	Ambulatory	100	1	26	26	0.5	2	**2:10**
	Wheelchair bound	100	5	10	20	0.5	2	**2:05**
	Bedridden	100	15	20	30	0.5	2	**2:15**
Fritzingertown Senior Living Community	Ambulatory	100	1	25	25	1.5	3	**2:10**
	Wheelchair bound	100	5	50	20	1.5	3	**2:05**
	Bedridden	100	15	26	30	1.5	3	**2:15**
Kadima Rehabilitation and Nursing	Ambulatory	100	1	5	5	3.0	5	**1:50**
	Wheelchair bound	100	5	10	20	3.0	5	**2:05**
	Bedridden	100	15	17	30	3.0	5	**2:15**
Conyngham Care Center	Ambulatory	100	1	14	14	2.0	3	**2:00**
	Wheelchair bound	100	5	1	5	2.0	3	**1:50**
	Bedridden	100	15	3	30	2.0	3	**2:15**
							Maximum ETE:	**2:50**
							Average ETE:	**2:25**

Table 8-10. Medical Facility Evacuation Time Estimates – Heavy Snow

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)
Berwick Retirement Villages I & II	Ambulatory	110	1	179	30	8.1	39	**3:00**
	Wheelchair bound	110	5	16	20	8.1	36	**2:50**
	Bedridden	110	15	45	30	8.1	39	**3:00**
Berwick Hospital Center	Ambulatory	110	1	250	30	8.1	39	**3:00**
	Wheelchair bound	110	5	10	20	8.1	36	**2:50**
	Bedridden	110	15	8	30	8.1	39	**3:00**
Elmcroft of Berwick	Ambulatory	110	1	57	30	4.6	16	**2:40**
	Wheelchair bound	110	5	5	20	4.6	16	**2:30**
	Bedridden	110	15	14	30	4.6	16	**2:40**
Bonham Nursing Home	Ambulatory	110	1	44	30	2.8	5	**2:25**
	Bedridden	110	15	30	30	2.8	5	**2:25**
Paradise Manor	Ambulatory	110	1	4	4	9.1	33	**2:30**
	Wheelchair bound	110	5	1	5	9.1	33	**2:30**
	Bedridden	110	15	1	15	9.1	37	**2:45**
ALC Family Care	Ambulatory	110	1	20	20	11.8	21	**2:35**
Guardian Healthcare and Rehabilitation Center	Ambulatory	110	1	15	15	2.0	40	**2:45**
	Wheelchair bound	110	5	49	20	2.0	40	**2:50**
	Bedridden	110	15	12	30	2.0	40	**3:00**
Northeast Counseling Nanticoke Services	Ambulatory	110	1	10	10	1.2	15	**2:15**
	Wheelchair bound	110	5	2	10	1.2	15	**2:15**
Birchwood Nursing Home	Ambulatory	110	1	26	26	0.5	2	**2:20**
	Wheelchair bound	110	5	10	20	0.5	2	**2:15**
	Bedridden	110	15	20	30	0.5	2	**2:25**
Fritzingertown Senior Living Community	Ambulatory	110	1	25	25	1.5	3	**2:20**
	Wheelchair bound	110	5	50	20	1.5	3	**2:15**
	Bedridden	110	15	26	30	1.5	3	**2:25**
Kadima Rehabilitation and Nursing	Ambulatory	110	1	5	5	3.0	5	**2:00**
	Wheelchair bound	110	5	10	20	3.0	5	**2:15**
	Bedridden	110	15	17	30	3.0	5	**2:25**
Conyngham Care Center	Ambulatory	110	1	14	14	2.0	4	**2:10**
	Wheelchair bound	110	5	1	5	2.0	4	**2:00**
	Bedridden	110	15	3	30	2.0	4	**2:25**
							Maximum ETE:	**3:00**
							Average ETE:	**2:35**

Table 8-11. Homebound Special Needs Population Evacuation Time Estimates

Vehicle Type	People Requiring Vehicle	Vehicles deployed	Stops	Weather Conditions	Mobilization Time (min)	Loading Time at 1st Stop (min)	Travel to Subsequent Stop (min)	Total Loading Time at Subsequent Stop (min)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Ambulances	169	85	2	Good	90	15	9	15	13	**2:25**
				Rain/Light Snow	100		10		16	**2:40**
				Heavy Snow	110		11		18	**2:50**
									Maximum ETE:	**2:50**
									Average ETE:	**2:40**



Event	
A	ATE
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 School
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 control and management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy 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. Facilitate evacuating traffic movements that safely expedite travel out of the EPZ.
2. Discourage 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.

We employ the terms "facilitate" and "discourage" 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 enroute to perform an important activity.

The implementation of a plan must also be flexible enough for the application of sound judgment by the traffic guide.

The traffic management plan is the outcome of the following process:

1. The existing TCPs and ACPs identified by each county agency in their existing emergency plans serve as the basis of the traffic management plan, as per NUREG/CR-7002, Rev 1. The ETE analysis treated all controlled intersections that are existing TCP or ACP locations in the county plans as being controlled by actuated signals. Appendix K identifies the number of intersections that were modeled as TCPs.
2. 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 traffic congestion during an evacuation. Any critical intersections that would benefit from

traffic or access control which are not already identified in the existing offsite plans are examined. No additional TCPs or ACPs were identified as part of this study.

3. Prioritization of TCPs and ACPs. 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 far 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 a list of priority TCPs using the process enumerated above.

9.1 Assumptions

- The ETE calculations documented in Section 7 and 8 assume that the traffic management plan 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 personal manning TCPs and ACPs.
- Study assumptions 1 through 3 in Section 2.5 further 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 be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. 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 vehicle's stereo systems. Automated Travel 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 some examples of how ITS technologies can benefit the evacuation process. Consideration should be given that ITS technologies 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 an ERPA being evacuated to the boundary of the Evacuation Region and thence out of the EPZ.
- Routing of transit-dependent evacuees (schools, medical facilities and residents, employees or transients who do not own or have access to a private vehicle) from the EPZ boundary to host schools/reception centers.

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. General population may evacuate to either a reception center or some alternate destination (e.g., lodging facilities, relative's home, campgrounds) 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 25 bus routes, shown graphically in Figure 10-2 and Figure 10-3 and described in Table 10-1. This does not imply that these exact routes would be used in an emergency. It is assumed that residents will walk to and congregate along the routes or walk along major evacuation routes to flag down a bus.

Schools and medical facilities were routed along the most likely path from the facility being evacuated to the EPZ boundary, traveling toward the appropriate host facility.

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

Figure 10-4 presents a map showing the primary reception centers and host schools for evacuees. Table 10-3 identifies the host school for each of the schools in the EPZ. Transit-dependent evacuees are transported to the nearest reception center for each county. It is assumed that all school evacuees will be taken to the appropriate host school and will be subsequently picked up by parents or guardians.

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

Route	No. of Buses	Servicing ERPA	Municipality	Length (mi.)
1	2	1	Black Creek Township	7.4
2	3	2	Hunlock Township	4.3
3	3	3	Union Township	7.0
4	3	4 & 5	Huntington Township & New Columbus	4.0
5	1	6	Fishing Creek Township	4.2
6	5	7	Salem Township	8.0
7	1	8	Shickshinny Borough	7.1
8	2	9	Conyngham Township	10.3
9	7	10	Berwick Borough	7.4
10	7	11	Briar Creek Borough	4.2
11	3	12 & 13	Nescopeck Borough & Township	8.1
12	1	14	Hollenback Township	17.0
13	5	15	Sugarloaf Township	6.0
14	4	16	Conyngham Borough	2.5
15	3	17	Dorrance Township	4.7
16	1	18	Slocum Township	6.1
17	1	19	Nuangola Borough	1.0
18	7	20	Newport Township	4.4
19	14	21	Nanticoke City	0.9
20	4	22	Butler Township	4.6
21	1	23	Beaver Township	4.4
22	3	24	Mifflin Township	5.5
23	1	25	South Centre Township	2.7
24	2	26	North Centre Township	2.0
25	4	27	Briar Creek Township	10.1
Total:	**88**			

Table 10-2. Bus Route Descriptions

Route Type	Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
Transit Dependent	1	Black Creek Township	705, 1319, 1320, 1321, 1322, 1324, 1323, 706, 1325, 707, 511, 1326, 333, 1793, 513, 21, 106, 99, 104, 103
	2	Hunlock Township	1094, 1093, 934, 933, 575, 1046, 1047, 1048, 1092, 1265, 573, 1264, 572
	3	Union Township	928, 1168, 1169, 931, 224, 421, 423, 580, 579, 578, 576, 575, 1046, 1047, 1048
	4	Huntington Twp & New Columbus Borough	439, 609, 610
	5	Fishing Creek Township	948, 582, 581, 453, 229, 567, 226
	6	Salem Township	201, 382, 380, 379, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	7	Shickshinny Borough	208, 1786, 404, 183, 182, 1177, 402, 1042, 247, 209, 1178, 407
	8	Conyngham Township	263, 1430, 1432, 1434, 1433, 1431, 264, 1435, 1436, 1438, 1437, 1439, 1440, 1441, 265, 1445, 1444, 1443, 1442, 266, 1391, 481, 1395, 1393, 1394, 267, 1456, 1457, 1458, 1464, 1459, 1460, 1465, 1463, 1462, 1461, 270, 271, 1467, 1466, 336
	9	Berwick Borough	744, 887, 961, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	10	Briar Creek Borough	350, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	11	Nescopeck Borough & Township	722, 240, 468, 747, 748, 1498, 249, 250, 251, 185, 20, 14, 64, 62, 61, 168
	12	Hollenback Township	716, 717, 714, 475, 474, 1366, 254, 472, 253, 470, 469, 240, 468, 747, 748, 1498, 249, 250, 251, 185, 20, 14, 64, 62, 61, 168
	13	Sugarloaf Township	257, 186, 25, 1359, 26, 27, 1356, 187, 1354, 1355, 514, 1353, 1790, 1791, 333, 1793, 513, 21, 106, 99, 104, 103
	14	Conyngham Borough	512, 1349, 333, 1793, 513, 21, 106, 99, 104, 103
	15	Dorrance Township	1070, 273, 1400, 1071, 1399, 272, 1398, 479, 866, 1397, 269, 1396, 865, 267, 1456, 1457, 1458, 1464, 1459, 1460, 1465, 1463, 1462, 1461, 270, 271, 1467, 1466, 336
	16	Slocum Township	265, 1445, 1444, 1443, 1442, 266, 1391, 481, 1395, 1393, 1394, 267, 1456, 1457, 1458, 1464, 1459, 1460, 1465, 1463, 1462, 1461, 270, 271, 1467, 1466, 336
	17	Nuangola Borough	852, 1452, 1453, 853, 484, 1454, 1455, 120
	18	Newport Township	283, 1787, 1480, 1481, 1482, 731, 286, 1485, 1486, 1487, 285, 1053, 1489, 1054, 811, 1763, 287, 1044, 1184, 1185, 1186, 288, 1187, 1195, 1193, 1188, 1765, 335
	19	Nanticoke City	501, 1789, 508, 1072
	20	Butler Township	792, 188, 1555, 1871, 318, 317, 1554, 1553, 793, 571, 796, 545, 316, 491, 549
	21	Beaver Township	295, 296, 1513, 1514, 1512, 981, 297, 1515, 635, 1516, 1517, 1518, 1519, 1520, 298, 299
	22	Mifflin Township	363, 251, 185, 20, 14, 64, 62, 61, 168
	23	South Centre Township	364, 198, 359, 70, 56, 60, 59, 62, 61, 168

Route Type	Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
	24	North Centre Township	246, 245, 966, 965, 964
	25	Briar Creek Township	869, 870, 871, 872, 873, 874, 875, 729, 377, 960, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
Schools	26	Berwick Senior High School	378, 1751, 1756, 959, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	27	Columbia Day Care	377, 960, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	28	New Story Berwick School	887, 961, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	29	West Berwick Elementary	214, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	30	Beaver-Main Elementary	564, 1511, 295, 1510, 1509, 980
	31	Northwest Area Intermediate School	926, 927, 627, 1780, 1779, 1778, 398, 209, 1178, 407
	32	Northwest Area Middle/High School	428, 430, 431, 221, 439, 609, 610
	33	Muhlenburg Christian Academy	929, 924, 932, 575, 1046, 1047, 1048, 1092, 1265, 573, 1264, 572
	34	Northwest Area Primary School	221, 439, 609, 610
	35	Salem Elementary School	378, 1751, 1756, 959, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	36	Berwick Area Middle School	378, 1751, 1756, 959, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	37	Nescopeck Elementary School	469, 240, 468, 747, 748, 1498, 249, 250, 251, 185, 20, 14, 64, 62, 61, 168
	38	Valley Elementary/Middle School	511, 1326, 333, 1793, 513, 21, 106, 99, 104, 103
	39	GNA Elementary Center, GNA Educational Center & GNA High School	506, 508, 1072
	40	Drums Elementary/Middle School & Keystone Job Corporation High School	1037, 1036, 316, 491, 549
	41	Hazleton Area Academy of Sciences	188, 1729, 75, 72, 79, 166
Medical Facilities	42	Berwick Retirement Villages I & II & Berwick Hospital Center	378, 1751, 1756, 959, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	43	Elmcroft of Berwick	199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	44	Bonham Nursing Home	439, 609, 610
	45	Paradise Manor	201, 382, 380, 379, 388, 389, 390, 888, 369, 239, 203, 199, 1165, 1794, 738, 368, 366, 364, 198, 359, 70, 56, 60, 59, 62, 61, 168
	46	ALC Family Care	1069, 713, 712, 719, 720, 721, 1401, 1070, 273, 1402, 1403, 274, 1404, 1405, 867, 275, 1409, 1408, 1407, 1406, 193, 1410, 1411, 868, 113, 112, 192, 1412, 594, 591, 596, 1556, 189, 73, 75, 72, 79, 166

Route Type	Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
	47	Guardian Healthcare and Rehabilitation Center	284, 1788, 504, 501, 1789, 508, 1072
	48	Northeast Counseling Nanticoke Services	1759, 1758, 501, 1789, 508, 1072
	49	Birchwood Nursing Home	1185, 1186, 288, 1187, 1195, 1193
	50	Fritzingertown Senior Living Community	1035, 1037, 1036, 316, 491, 549
	51	Kadima Rehabilitation and Nursing	188, 1729, 75, 72, 79, 166
	52	Conyngham Care Center	571, 796, 545, 316, 491, 549

Table 10-3. Host Schools

School	Host School
Northwest Area Intermediate School	Dallas Middle School
Northwest Area Middle/High School	
Muhlenburg Christian Academy*	
Northwest Area Primary School	
Salem Elementary School	Liberty Valley Elementary
New Story Berwick School	
Columbia Child Development Program (Columbia Day Care)	
Berwick Area Middle School	Danville Middle School
Nescopeck Elementary School	Danville Elementary School
Berwick High School	Danville Senior School
West Berwick Elementary	Danville Primary School
Valley Elementary/Middle School	McAdoo-Kelayres School
GNA Elementary Center	Hanover Area Senior High
GNA Educational Center	
GNA High School	
Drums Elementary/Middle School	Freeland Elem/Middle School
Keystone Job Corporation High School*	
Rice Elementary School	Schools attended until 3:30 p.m., then to Crestwood High School
Beaver-Main Elementary	Bloomsburg High School
Academy of Sciences	Hazleton High School

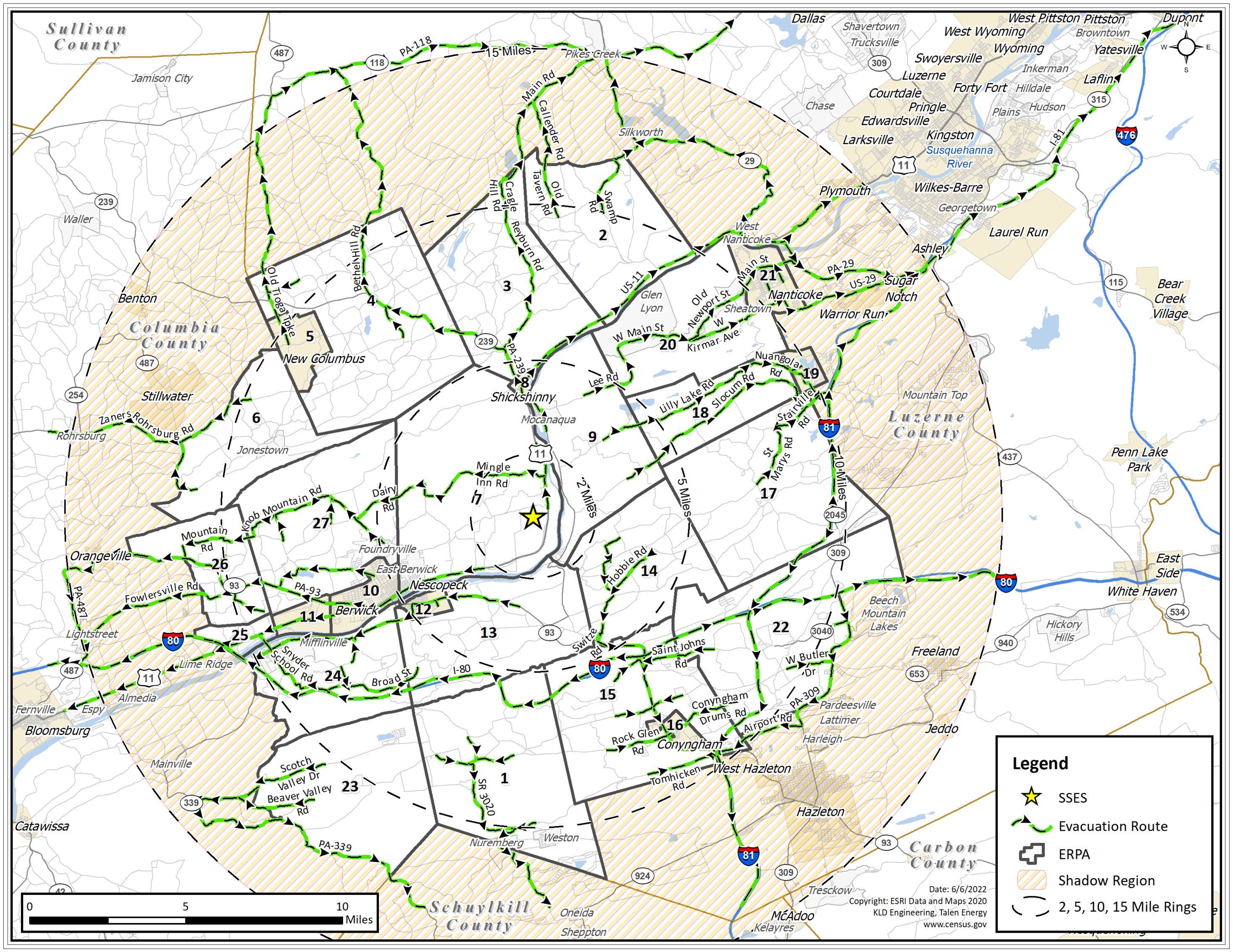


Figure 10-1. Evacuation Route Map

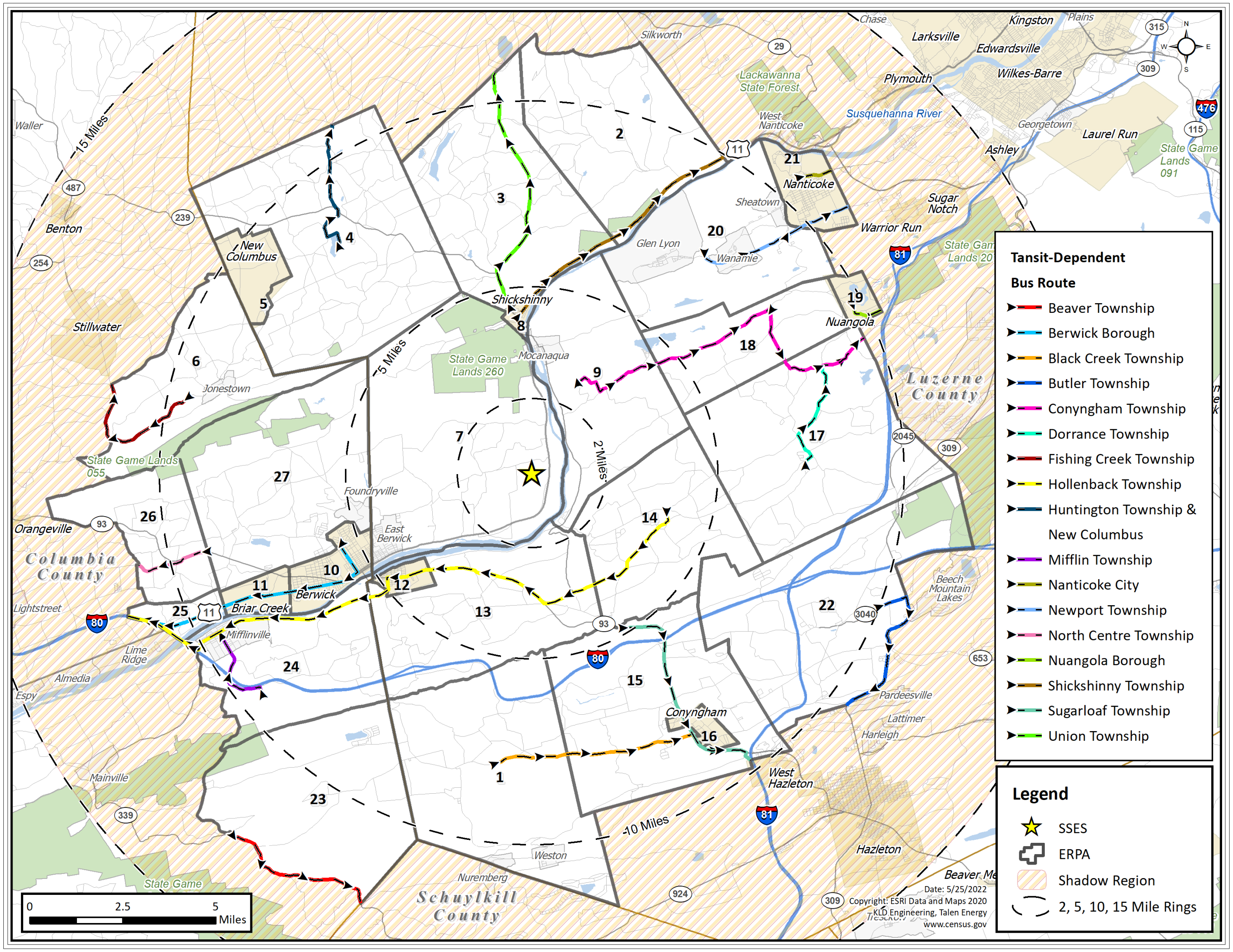


Figure 10-2. Transit-Dependent Bus Routes

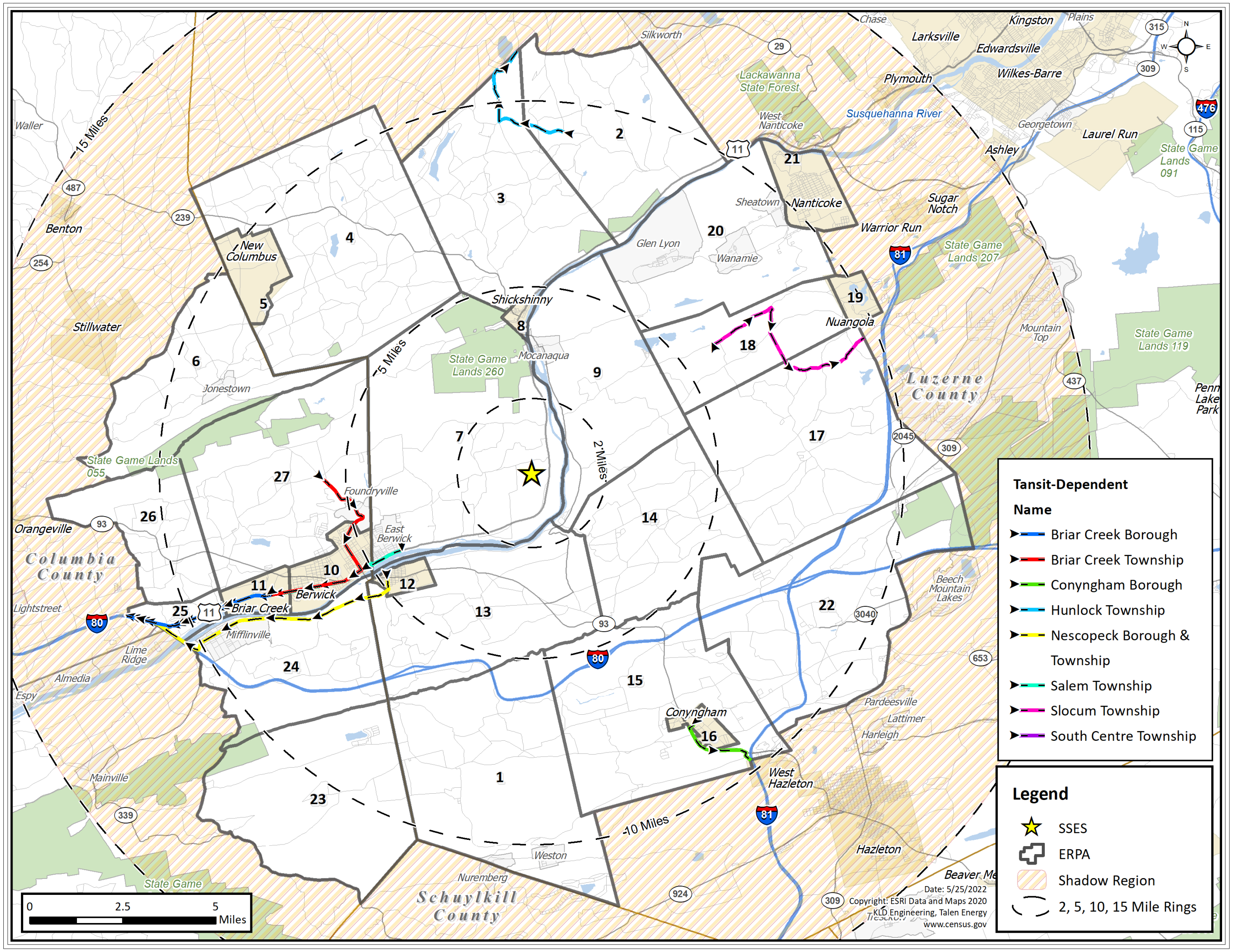


Figure 10-3. Transit-Dependent Bus Routes (Continued)

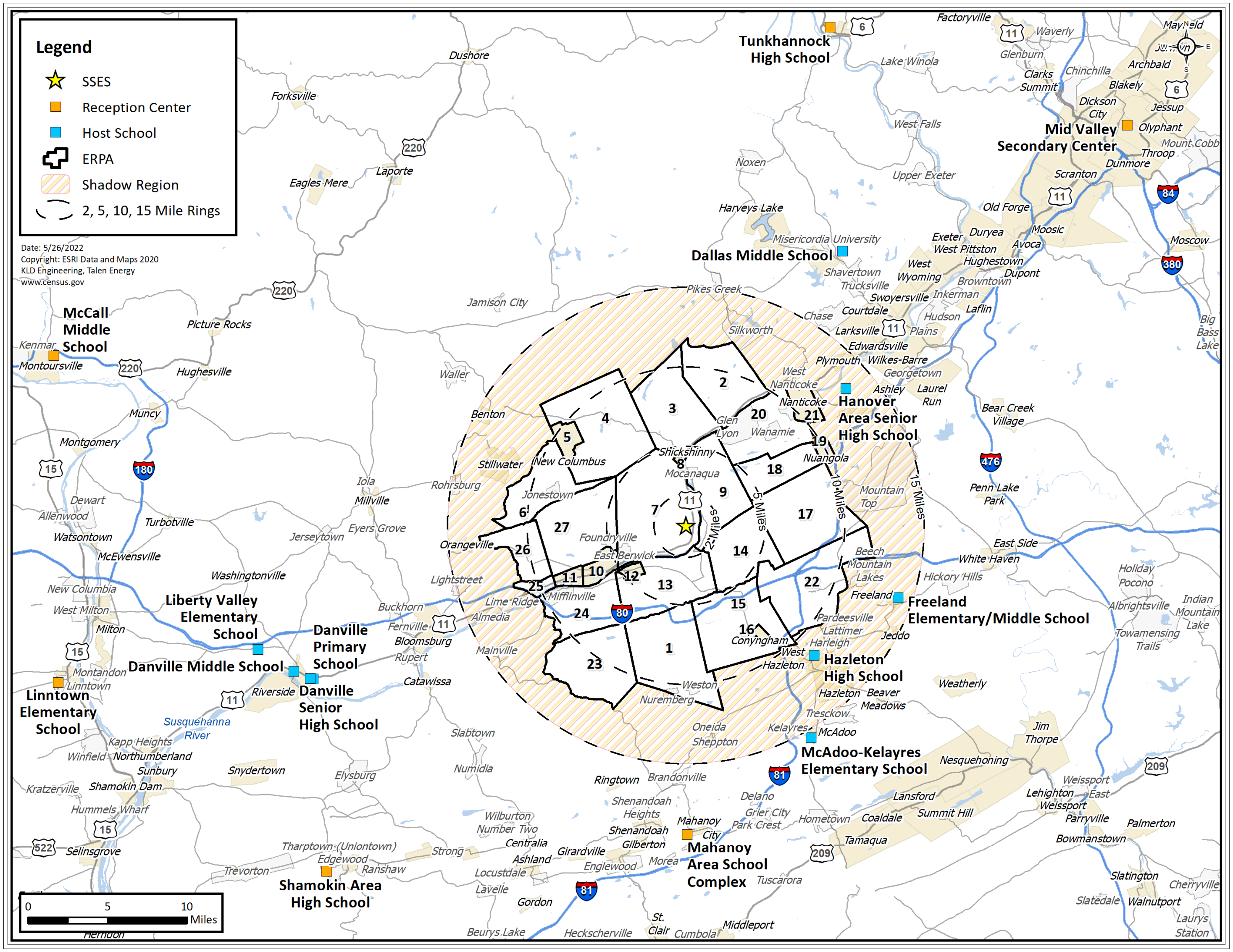


Figure 10-4. General Population Reception Centers and Host Schools

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 vehicles per hour (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 vehicles per hour (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 vehicles per hour (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 vehicles per hour (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 section 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 (OD) 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 traffic assignment 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 = - β ln (p), 0 ≤ p ≤ l ; β >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 = 10 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.

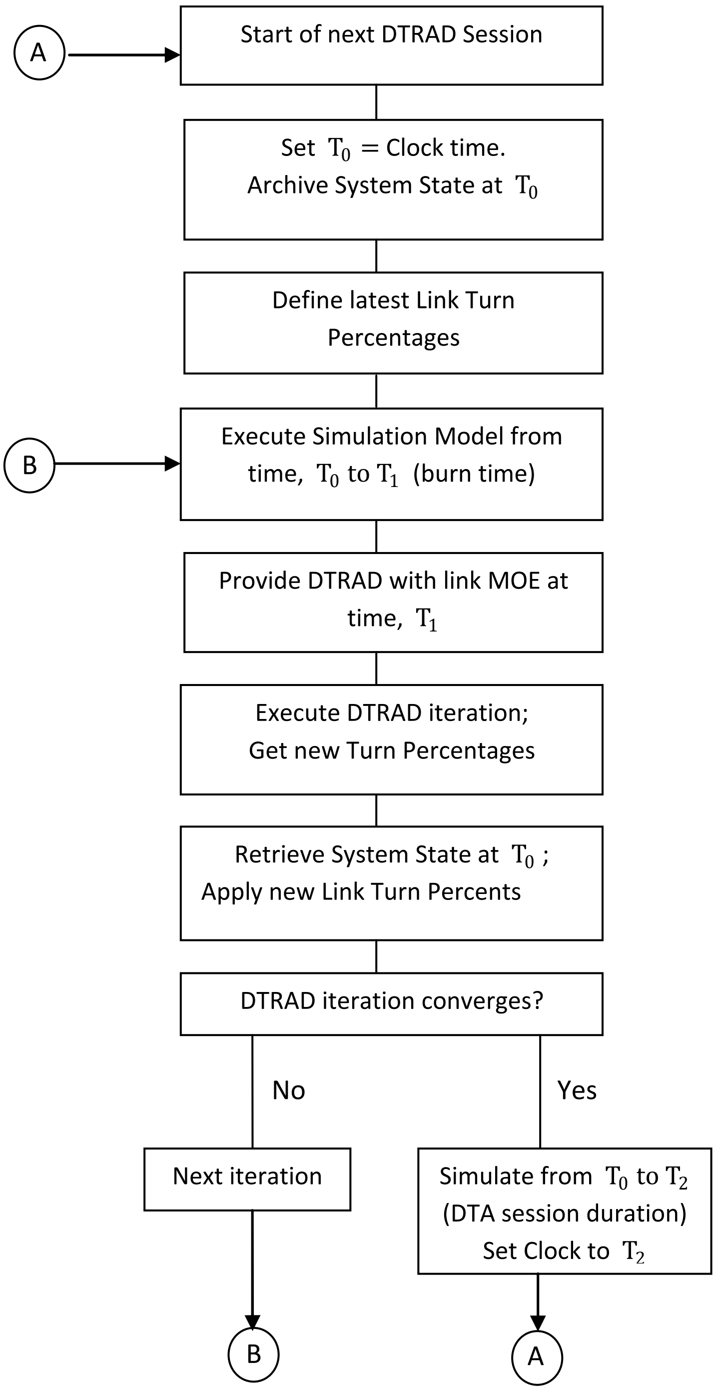


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

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 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, EVAN
- Calculates 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.

$$\text{Given} = Q_b , M_b , L , TI , E_0 , LN , {}^{G}\!/_{C} , h , L_v , R_0 , L_c , E , M$$
$$\text{Compute} = O , Q_e , M_e$$

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 $t_1 < 0$, 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 $(Q_b < \text{Cap})$
   $O_Q = Q_b$, $\text{RCap} = \text{Cap} - O_Q$

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 <u>moving</u> vehicles.

If $|\bar{k}_n - \bar{k}_{n-1}| > \in$ 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

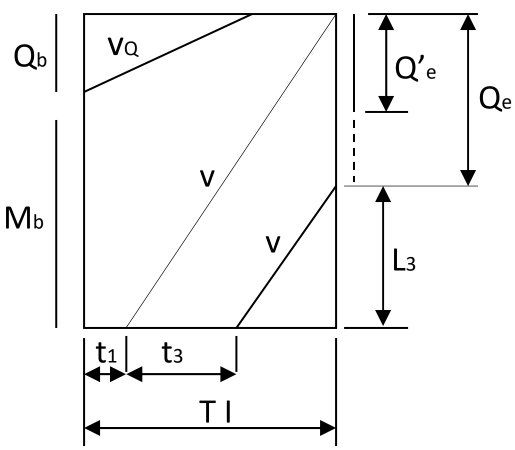
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W)\cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

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

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 $t_3 = TI - t_1$.

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

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, 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: Q_e and 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 measures of effectiveness for each link and turn movement for output purposes. It then prepares for the following time interval by defining the values of Q_b and M_b for the start of the next TI as being those values of Q_e and 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, $[T_0, T_2]$, 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, $T_1 \leq T_2$, which lies within the session duration, $[T_0, T_2]$. This "burn time", $T_1 - T_0$, 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, T_0, and executes until it arrives at the end of the DTRAD session duration at time, 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.

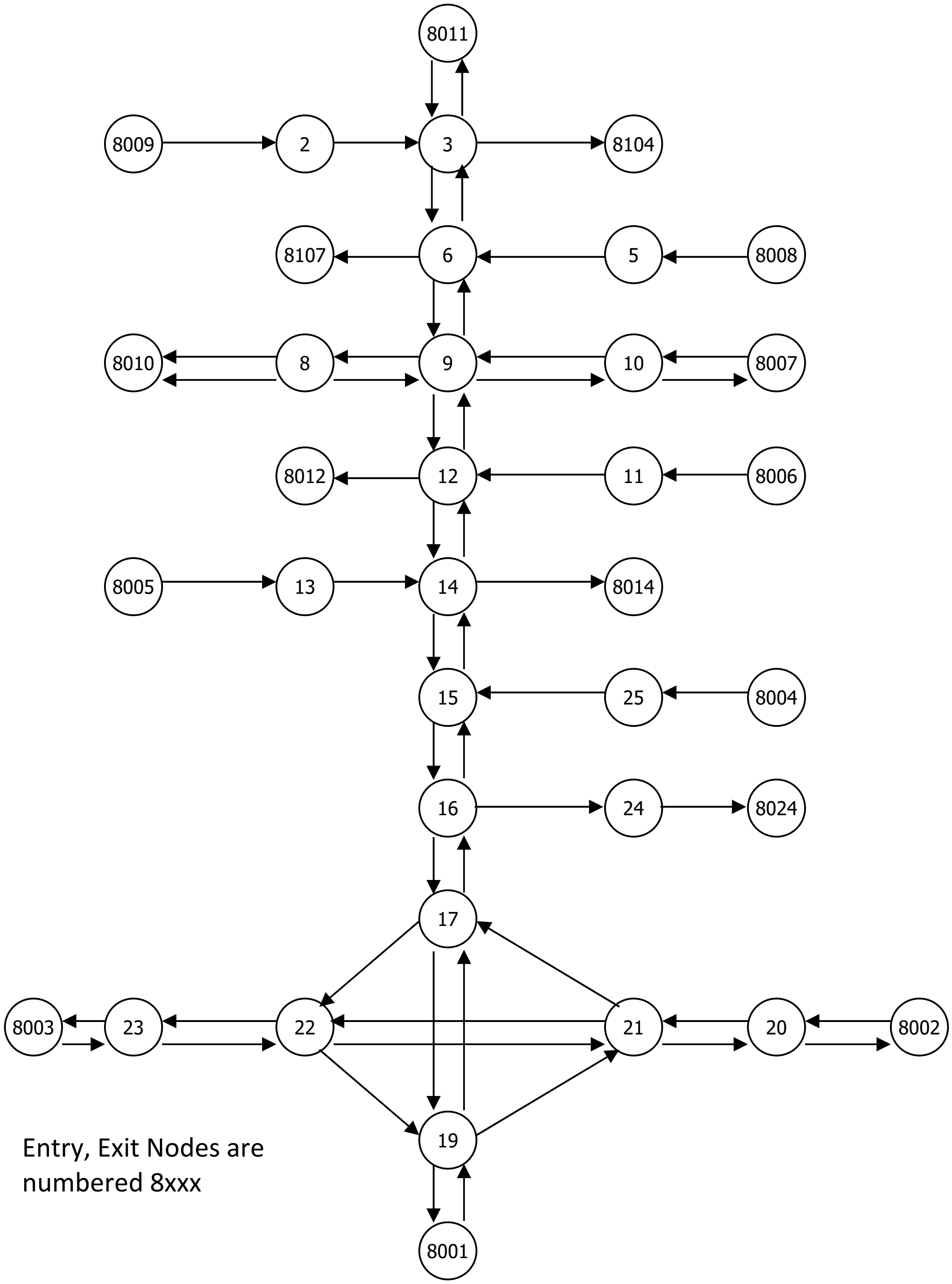


Figure C-1. Representative Analysis Network

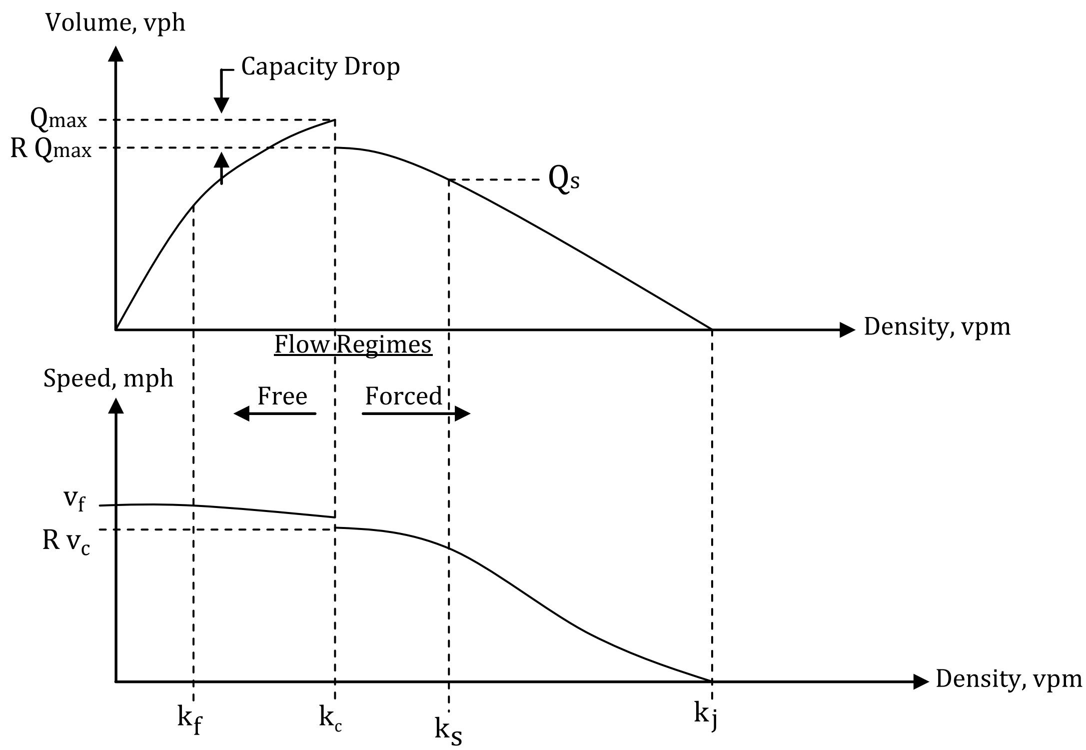


Figure C-2. Fundamental Diagrams

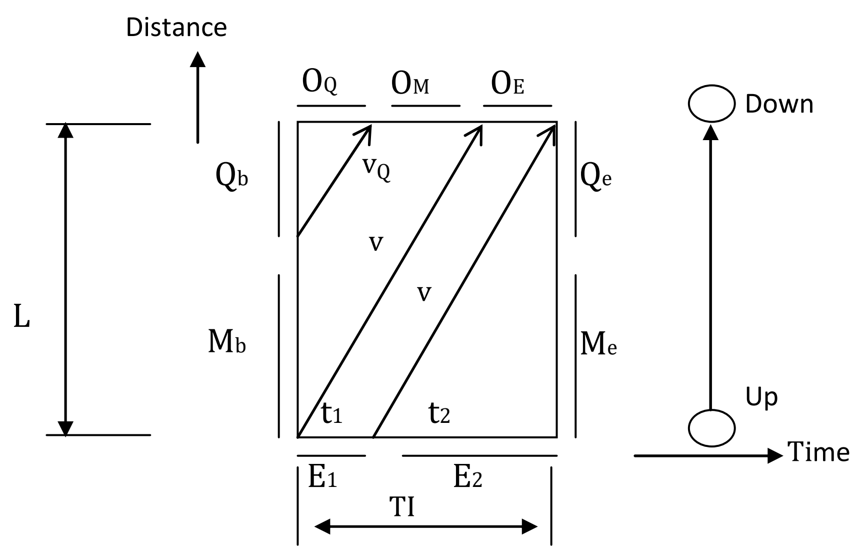


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

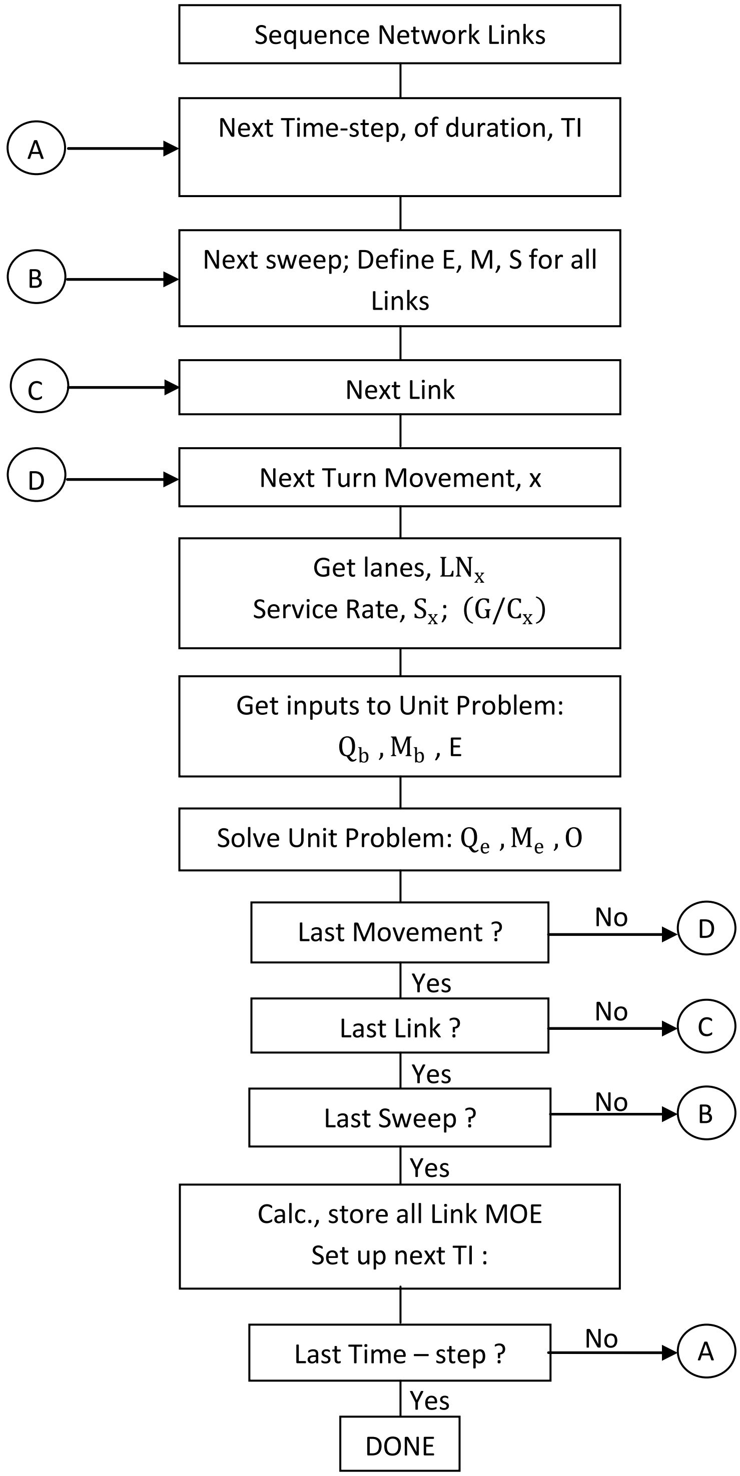


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

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 boundary.

Step 2

2020 Census block information was obtained in GIS format. This information was used to estimate the resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. The employee, transient, school and other special facility data used in the 2012 ETE study was updated by the county emergency management agencies and by Talen Energy.

Step 3

A kickoff meeting was conducted with major stakeholders (state and county emergency planning personnel and on-site and off-site utility emergency planning personnel). 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. 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

An online demographic survey of the households within the EPZ was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the EPZ population. 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 estimates (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 27 ERPAs. Based on wind direction and speed, Regions (groupings of ERPA) 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 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, and other transit vehicles 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 are consistent, dynamic routing is reasonable, and traffic congestion/bottlenecks are addressed properly. Traffic management plans are analyzed, and traffic control points are prioritized, if applicable. Additional analysis is conducted to identify the sensitivity of the ETE to change in some base evacuation conditions and model assumptions.

Step 16

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes are used to compute ETE 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.

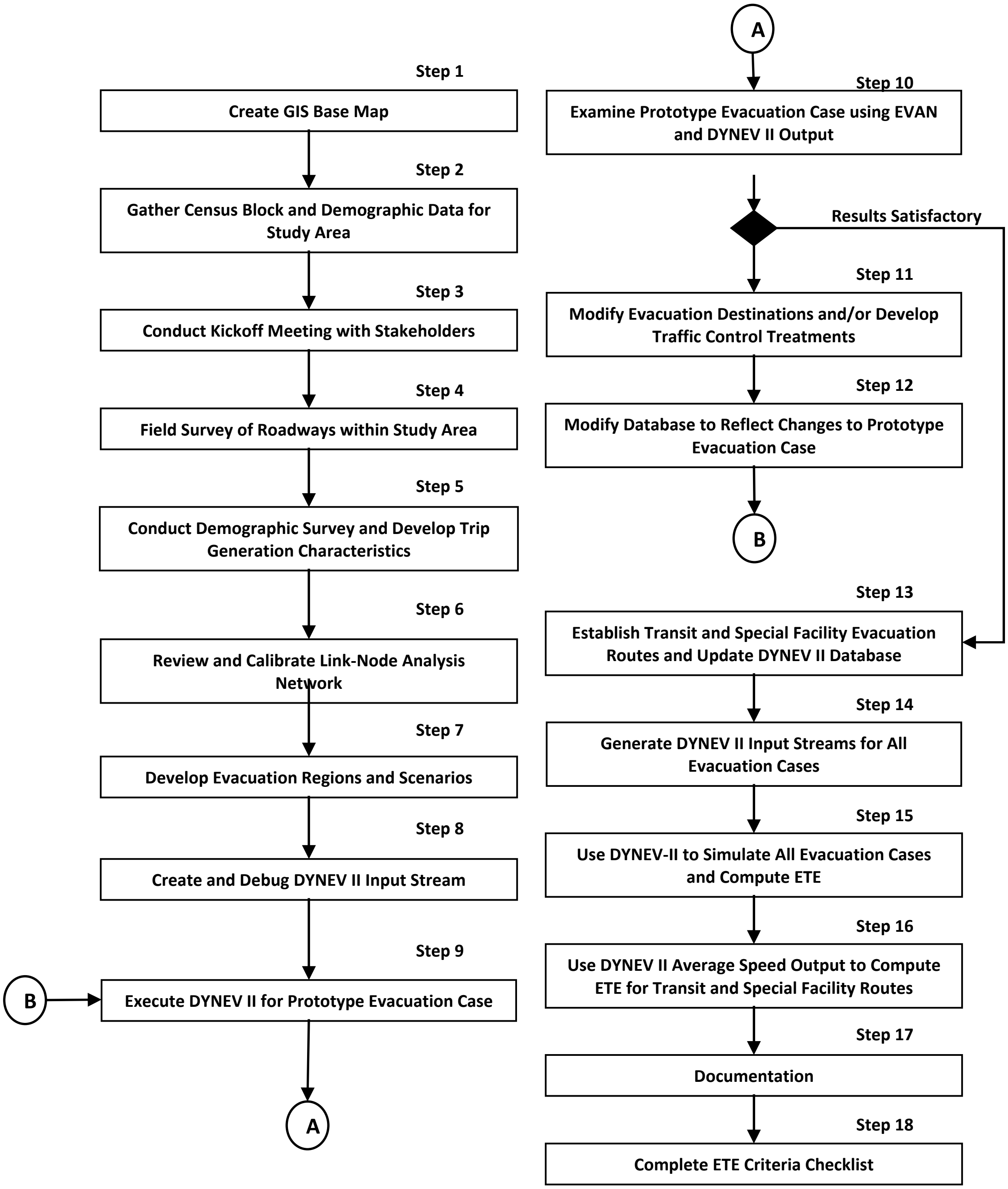


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

E. SPECIAL FACILITY DATA

The following tables list population information, as of February 2022, for special facilities that are located within the SSES EPZ. Special facilities are defined as schools, colleges/universities, and medical facilities. Transient population data is included in the tables for recreational areas (campgrounds, day camps, golf courses, hunting/fishing areas, parks), and lodging 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, college/university, medical facility, recreational area (campground, day camp, golf course, hunting/fishing area, park), lodging facility, and major employer are also provided.

Table E-1. Schools within the EPZ

ERPA	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Enroll-ment
COLUMBIA COUNTY, PA						
10	4.7	WSW	Berwick High School	1100 Fowler Ave	Berwick	955
10	5.4	WSW	Columbia Day Care[1]	116 Columbia Ave	Berwick	102
10	5.5	WSW	New Story Berwick School	218 W 6th St	Berwick	46
10	6.0	WSW	West Berwick Elementary	809 Sycamore St	Berwick	512
23	12.5	SW	Beaver-Main Elementary	245 Beaver Valley Rd	Bloomsburg	107
					Columbia County Subtotal:	*1,722*
LUZERNE COUNTY, PA						
2	9.1	N	Northwest Area Intermediate School	20 Sunset Lake Rd	Shickshinny	292
3	6.7	NNW	Northwest Area Middle/High School	243 Thorne Hill Rd	Shickshinny	668
3	9.9	N	Muhlenburg Christian Academy	362 Hunlock-Harveyville Rd	Hunlock Creek	75
4	8.3	NW	Northwest Area Primary School	417 Shickshinny Lake Rd	Shickshinny	233
7	4.5	WSW	Salem Elementary School	810 E 10th St	Berwick	410
7	4.6	WSW	Berwick Area Middle School	1100 Evergreen Dr	Berwick	724
12	4.6	SW	Nescopeck Elementary School	315 Dewey St	Nescopeck	180
15	8.0	SSE	Valley Elementary/Middle School	79 Rock Glen Rd	Sugarloaf	890
21	11.1	NE	GNA Elementary Center	615 Kosciuszko St	Nanticoke	600
21	11.1	NE	GNA Educational Center	600 E Union St	Nanticoke	600
21	11.2	NE	GNA High School	425 Kosciuszko St	Nanticoke	720
22	9.4	SE	Drums Elementary/Middle School	85 S Old Turnpike Rd	Drums	734
22	10.2	ESE	Hazleton Area Academy of Sciences	40 Azalea Rd	Drums	530
22	10.7	ESE	Keystone Job Corporation High School	235 W Foothills Rd	Drums	471
S.R.	9.8	ENE	Rice Elementary School[2]	3700 Church Rd	Mountain Top	800
					Luzerne County Subtotal:	*7,927*
					EPZ TOTAL:	**9,649**

[1] Based on information provided by Talen Energy, Columbia Day Care is a day care center that is associated with the Berwick School District and will be evacuated to Liberty Valley Elementary School in an emergency.
[2] Rice Elementary School is located in the Shadow Region (S.R.). According to the 2020 Luzerne County Radiological Emergency Response Plan, this school will be evacuated to Crestwood Jr. – Sr. High School in an emergency.

Table E-2. Colleges/Universities within the EPZ

ERPA	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Enroll-ment
COLUMBIA COUNTY, PA						
10	5.3	WSW	Luzerne County Community College - Berwick	107 South Market St	Berwick	100
					Columbia County Subtotal:	*100*
LUZERNE COUNTY, PA						
15	9.6	SE	Penn State University – Hazleton	76 University Dr	Hazleton	1,190
21	10.7	NE	Luzerne County Community College - Nanticoke	1333 S Prospect St	Nanticoke	3,587
					Luzerne County Subtotal:	*4,777*
					EPZ TOTAL:	**4,877**

Table E-3. Medical Facilities within the EPZ

ERPA	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Capa-city	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
COLUMBIA COUNTY, PA										
10	4.6	WSW	Berwick Retirement Villages I & II	801 - 901 E 16th St	Berwick	240	240	179	16	45
10	4.7	WSW	Berwick Hospital Center	701 E 16th St	Berwick	268	268	250	10	8
11	7.3	WSW	Elmcroft of Berwick	2050 W Front St	Berwick	76	76	57	5	14
					Columbia County Subtotal:	*584*	*584*	*486*	*31*	*67*
LUZERNE COUNTY, PA										
4	10.3	NW	Bonham Nursing Home	477 Bonnieville Rd	Stillwater	109	74	44	0	30
7	3.0	WSW	Paradise Manor	48 Bower Rd	Berwick	6	6	4	1	1
14	3.8	ESE	ALC Family Care	897 Hobbie Rd	Wapwallopen	20	20	20	0	0
20	9.6	NE	Guardian Healthcare and Rehabilitation Center	147 Old Newport St	Nanticoke	110	76	15	49	12
21	10.7	NE	Northeast Counseling Nanticoke Services	121 S Prospect St	Nanticoke	17	12	10	2	0
21	10.8	NE	Birchwood Nursing Home	395 Middle Rd	Nanticoke	120	56	26	10	20
22	9.7	SE	Fritzingertown Senior Living Community	159 S Old Turnpike Rd	Drums	168	101	25	50	26
22	10.5	ESE	Kadima Rehabilitation and Nursing	463 N Hunter Hwy	Drums	37	32	5	10	17
22	10.8	ESE	Conyngham Care Center	63 S Hunter Hwy	Drums	20	18	14	1	3
					Luzerne County Subtotal:	*607*	*395*	*163*	*123*	*109*
					EPZ TOTAL:	**1,191**	**979**	**649**	**154**	**176**

Table E-4. Major Employers within the EPZ

ERPA	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Employees (Mas Shift)	% Employees Commuting into the EPZ	Employees Commuting into the EPZ	Employee Vehicles Commuting into the EPZ
COLUMBIA COUNTY, PA									
10	4.7	WSW	Berwick Hospital Center	701 E 16th St	Berwick	600	23.5%	141	133
10	5.7	WSW	Deluxe Building Systems	499 West Third St	Berwick	300	23.5%	71	67
10	6.2	WSW	Wise Foods, Inc	228 Raseley St	Berwick	700	23.5%	165	156
11	7.3	WSW	Berwick Offray	2015 West Front St	Berwick	700	23.5%	165	156
11	7.7	WSW	Family Dollar Distribution Center	1000 Commerce Dr	Berwick	214	59.8%	128	121
					Columbia County Subtotal:	*2,514*	*-*	*670*	*633*
LUZERNE COUNTY, PA									
7	-	-	Susquehanna Steam Electric Station	634 Salem Blvd	Berwick	922	58.2%	537	507
15	9.6	SE	Penn State Hazelton	76 University Dr	Hazleton	210	100.0%	210	198
21	10.7	NE	Luzerne County Community College - Nanticoke	1333 S Prospect St	Nanticoke	375	100.0%	375	354
					Luzerne County Subtotal:	*1,507*	*-*	*1,122*	*1,059*
					EPZ TOTAL:	**4,021**	**-**	**1,792**	**1,692**

Table E-5. Recreational Areas within the EPZ

ERPA	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Facility Type	Transients	Vehicles
COLUMBIA COUNTY, PA								
6	8.6	W	State Game Lands 55	41° 6' 29" N, 76° 19' 0" W	Fishing Creek	Hunting/Fishing	93	47
6	9.5	WNW	Whispering Pines Camping	1557 N Bendertown Rd	Stillwater	Campground	144	36
10	7.0	WSW	Susquehanna River, North Branch	SR-3005	Berwick	Hunting/Fishing	27	14
25	9.1	WSW	Rolling Pines Golf Course	355 Golf Course Rd	Berwick	Golf Course	70	35
27	6.3	WSW	Berwick Golf Club	473 Martzville Rd	Berwick	Golf Course	44	22
27	7.3	WSW	Briar Creek Lake	105 Evansville Rd	Berwick	Hunting/Fishing	32	16
27	7.3	WNW	Camp Louise[3]	195 Hawk Rd	Shickshinny	Day Camp	176	8
Columbia County Subtotal:							*586*	*178*
LUZERNE COUNTY, PA								
3	6.6	NNE	State Game Lands 224	41° 11' 30" N, 76° 6' 29" W	Hunlock	Hunting/Fishing	18	9
3	9.2	NNW	Hidden New Lake Campground	745 Hunlock Harveyville Rd	Shickshinny	Campground	40	10
7	0.8	NNE	Susquehanna Riverlands	634 Salem Blvd	Berwick	Park	159	63
7	1.5	SSW	Bodnarosa Motel and Campground	1175 Salem Blvd	Berwick	Campground	33	33
7	3.3	NNW	State Game Lands 260	41° 7' 59" N, 76° 12' 0" W	Salem	Hunting/Fishing	117	59
9	1.6	E	Council Cup Campground	212 Ruckle Hill Rd	Wapwallopen	Campground	350	90
14	4.3	ESE	Moyers Grove Campground	309 Moyers Grove Rd	Wapwallopen	Campground	316	79
17	9.2	E	Blue Ridge Trail Golf Club	260 Country Club Dr	Mountain Top	Golf Course	100	70
18	4.8	NE	Lily Lake	Lily Lake Rd	Shickshinny	Hunting/Fishing	55	28
22	10.8	E	State Game Lands 187	41° 6' 0" N, 75° 49' 59" W	Butler	Hunting/Fishing	33	17
22	11.7	E	Nescopeck State Park	1137 Honey Hole Rd	Drums	Park	127	50
Luzerne County Subtotal:							*1,348*	*508*
EPZ TOTAL:							**1,934**	**686**

[3] Camp Louise is a children's camp and will be evacuated with 4 buses (8 passenger car equivalents). See section 8 for more details.

Table E-6. Lodging Facilities within the EPZ

ERPA	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
COLUMBIA COUNTY, PA							
10	5.4	WSW	White Birch Inn B & B	1303 N Market St	Berwick	6	3
11	8.3	WSW	Red Maple Inn	7545 Columbia Blvd	Berwick	52	26
24	8.9	WSW	Super 8 by Wyndham Mifflinville Near Bloomsburg	450 W 3rd St	Mifflinville	110	55
					Columbia County Subtotal:	*168*	*84*
LUZERNE COUNTY, PA							
15	5.1	SE	Lookout Motor Lodge	1279 State Rte 93	Drums	34	17
15	5.8	SE	Motel 6 Drums	1064 State Rte 93	Drums	112	56
15	9.5	SE	Hampton Inn	1 Top of the 80s Rd	Hazleton	222	111
15	9.8	SE	Fairfield Inn & Suites	1 Woodbine St	Hazleton	180	90
15	9.8	SE	Forest Hill Inn	3 Forest Hill Rd	Hazleton	52	26
22	9.9	ESE	Econo Lodge Hazleton North	10 Woodmere Dr	Drums	84	42
22	10.1	ESE	Holiday Inn Express & Suites Drums-Hazleton (I-80)	1 Corporate Dr	Drums	220	110
					Luzerne County Subtotal:	*904*	*452*
					EPZ TOTAL:	**1,072**	**536**

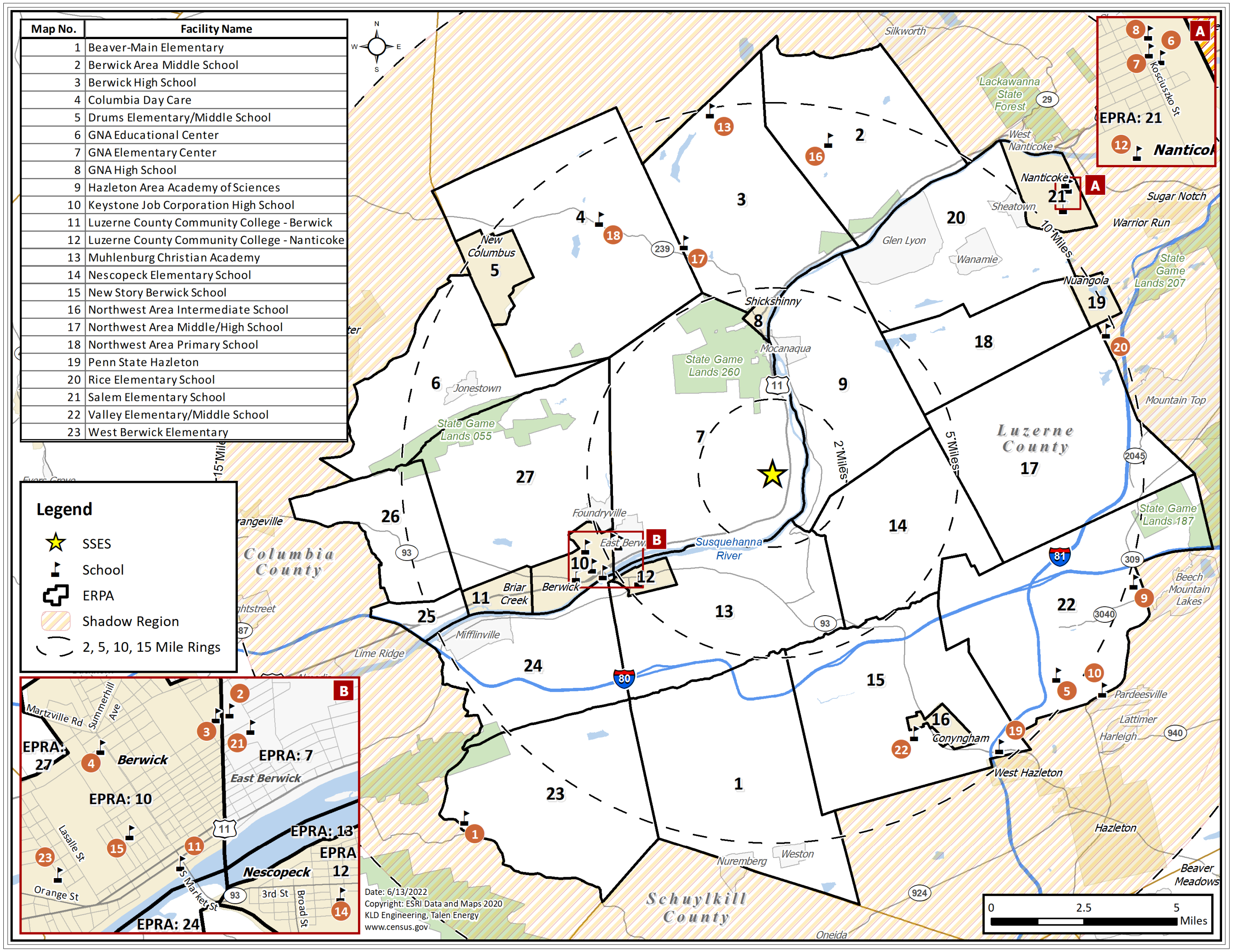


Figure E-1. Schools and Colleges/Universities within the Study Area

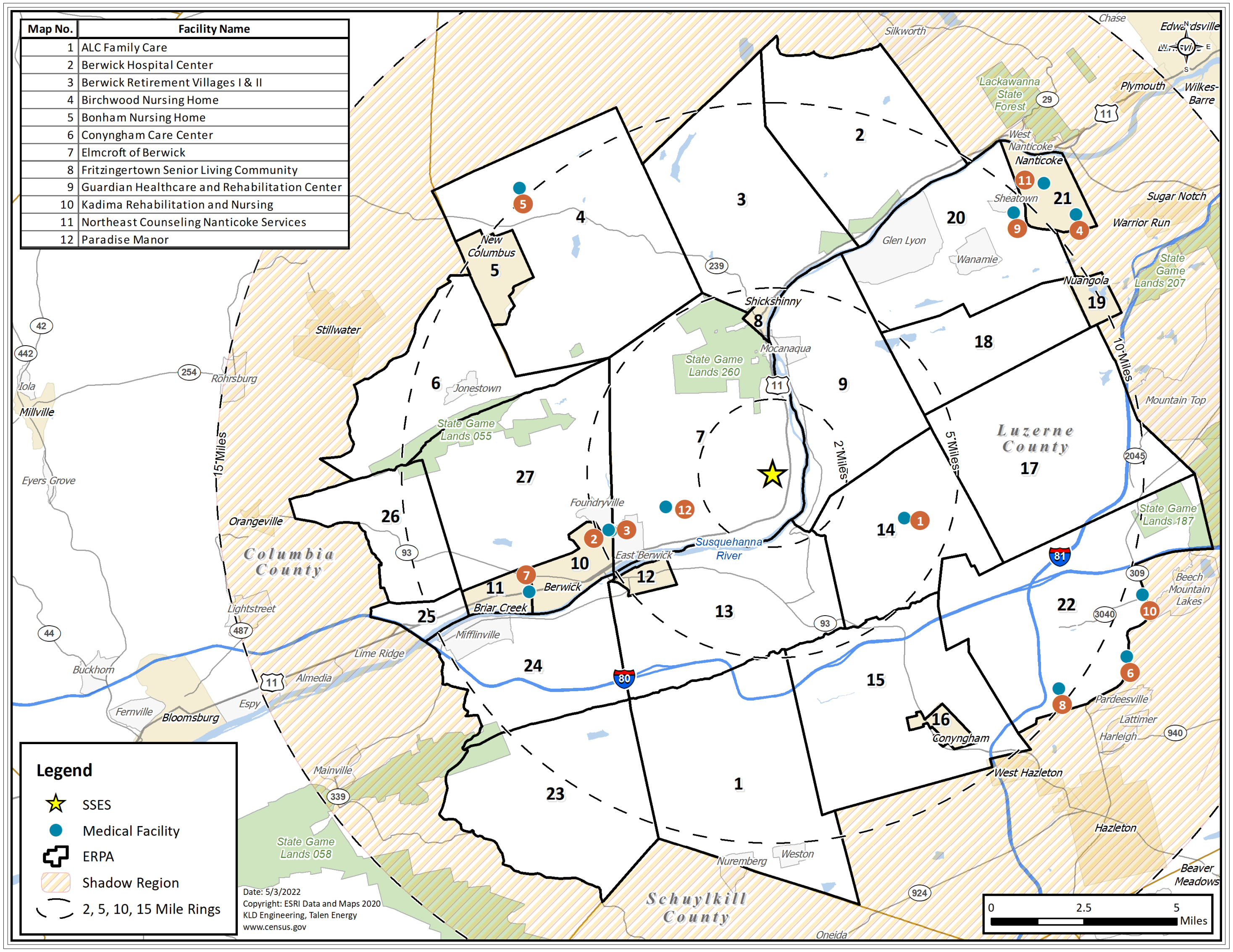


Figure E-2. Medical Facilities within the EPZ

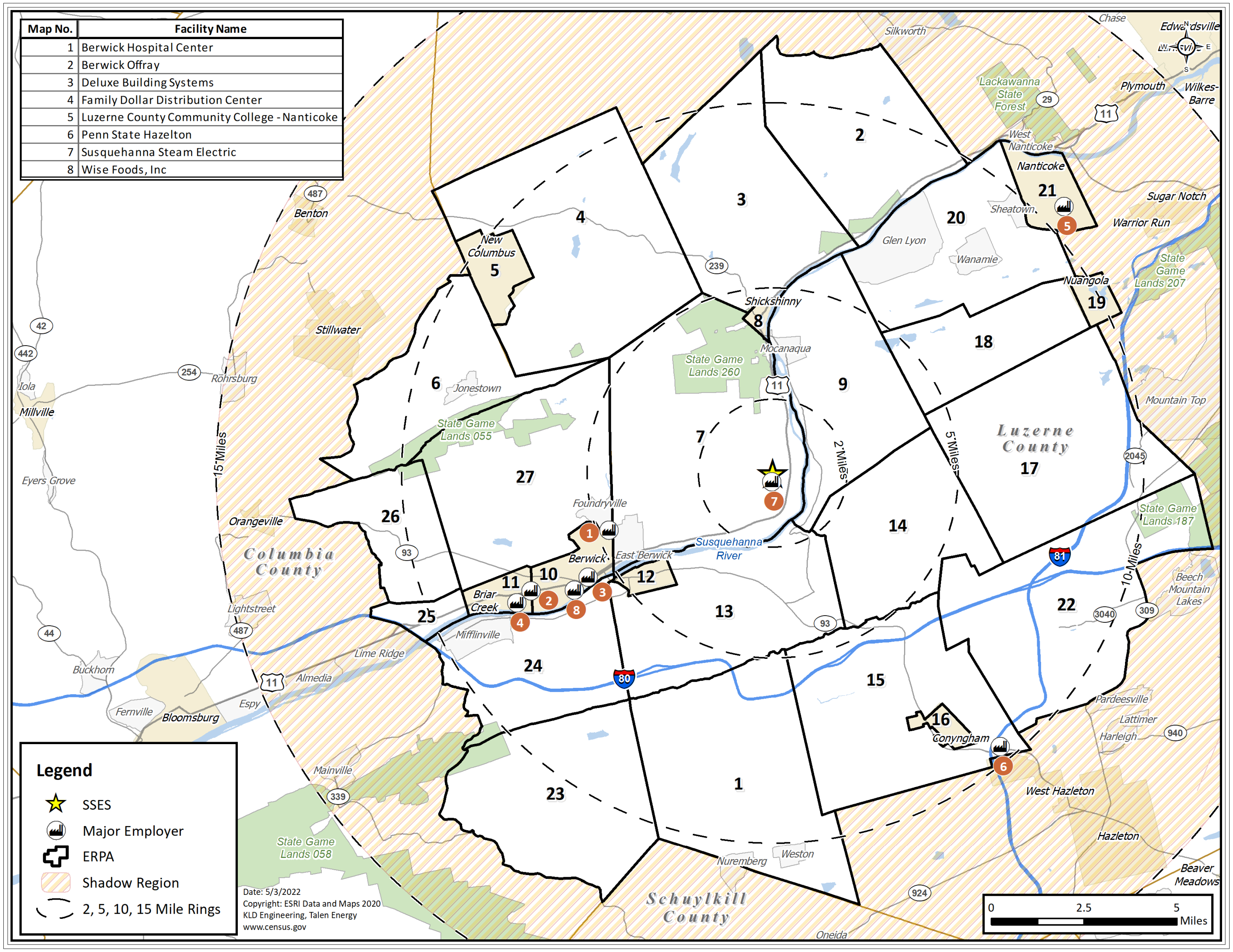


Figure E-3. Major Employers within the EPZ

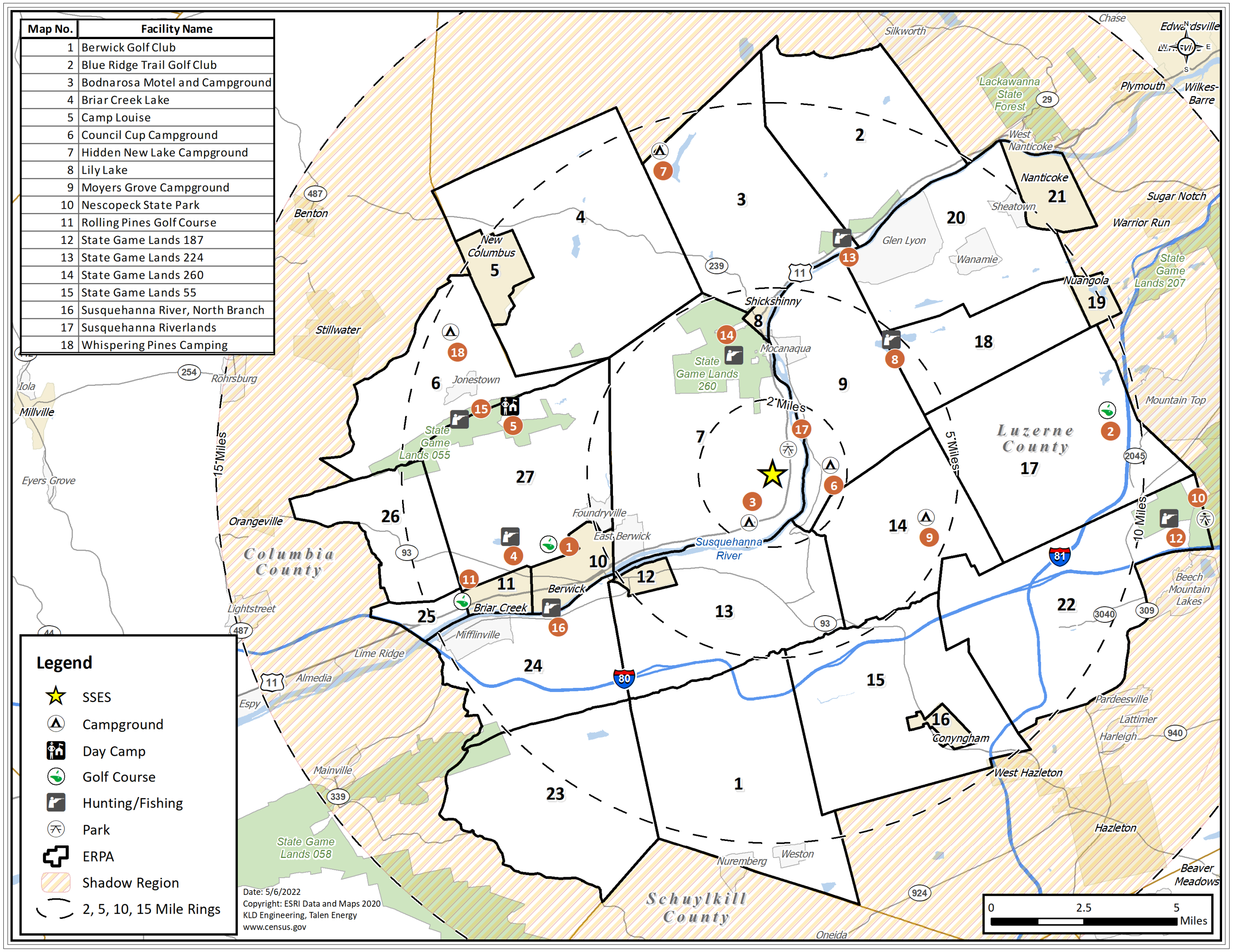


Figure E-4. Recreational Areas within the EPZ

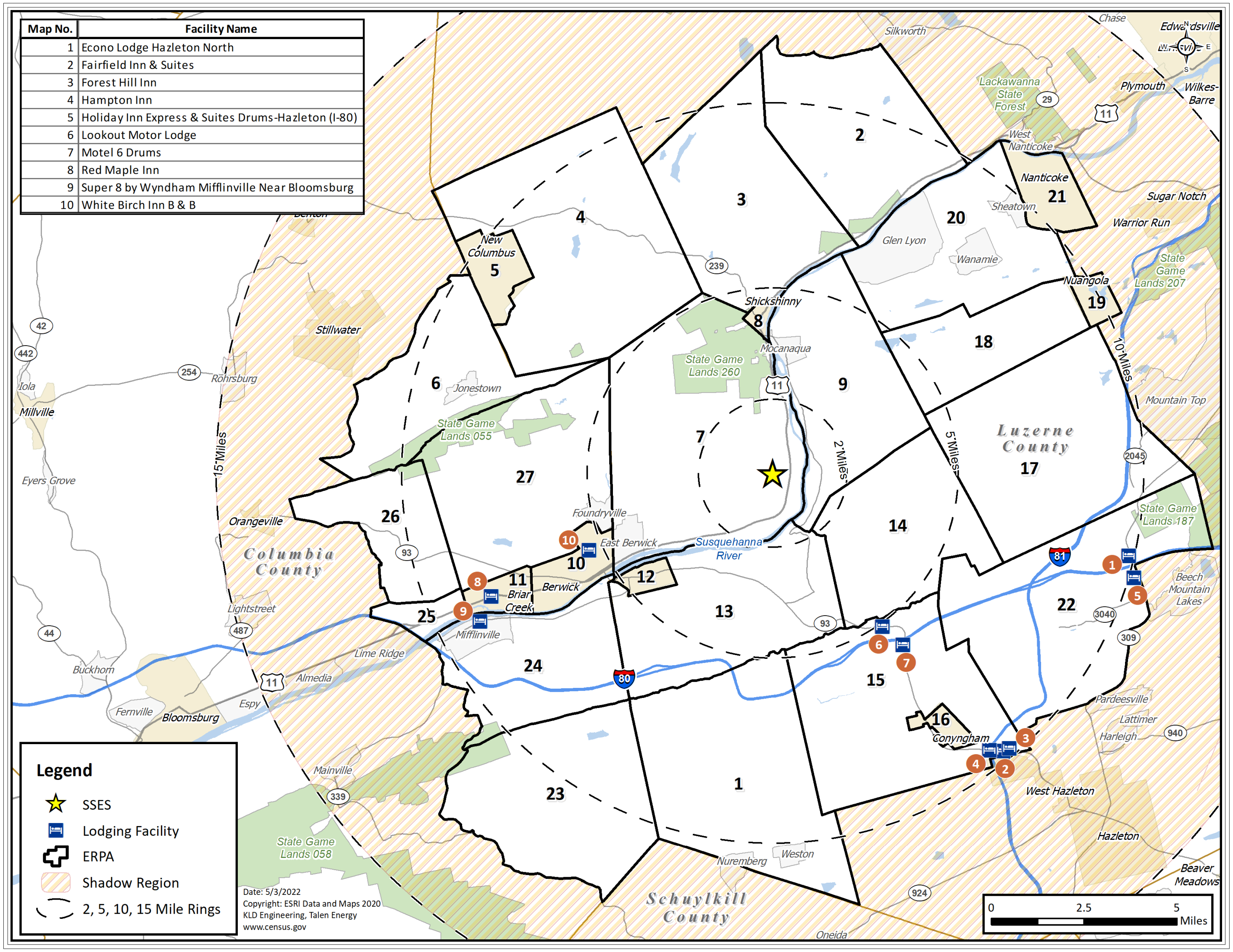


Figure E-5. Lodging Facilities within the EPZ

APPENDIX F

Demographic Survey

F. DEMOGRAPHIC SURVEY

F.1 Introduction

The development of evacuation time estimates for the Susquehanna Steam Electric Station (SSES) 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; however, 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 in this study. 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 2020 and the 2020 Census data had not yet been released, 2010 Census data was used to develop the sampling plan.

A sample size of approximately 380 **completed** survey forms yields results with a sampling error of ±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 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 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 exceeded the sampling plan. A total of 430 completed samples were obtained within the EPZ, which corresponds to a sampling error of ±4.71% at the 95% confidence level based on the 2010 Census data. Table F-1 also shows the number of samples obtained within each zip code.

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 for a few questions 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. The average household contains 3.00 people according to the survey results. The estimated household size (2.46 persons and 2.37 persons) used to determine the survey sampling plan (Table F-1) was taken from 2010 Census data and 2020 Census Data, respectively. The household size obtained from the demographic survey is approximately 21 percent higher than the 2020 Census Data, which exceeds the sampling error of ±4.71%. Discussions with Talen Energy resulted in using the 2020 Census average household size (2.37 persons) as the household size for this study, which will result in more evacuating vehicles and more conservative ETE. Appendix M includes a sensitivity study exploring the effect of average household size on ETE.

Automobile Ownership

The average number of automobiles available per household in the EPZ is 2.39. There are 0.47% of households that do not have access to an automobile. 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. As expected, nearly all households of 2 or more people have access to at least one vehicle.

Ridesharing

Approximately 71% of households responded that they would share a ride with a neighbor, relative, or a friend, if a car was not available to them when advised to evacuate in the event of an emergency. Figure F-5 presents this response.

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 1.30 commuters per household in the EPZ, and approximately 76% of households have at least one commuter.

Vehicle Availability When Commuters are Away

Approximately 68% of households indicated that there is a vehicle available at home to use for an evacuation when commuters are away. The remaining 32% indicated that there are no vehicles available when the commuters are away. Figure F-7 presents this response.

Commuter Travel Modes

Figure F-8 presents the mode of travel that commuters use on a daily basis. The vast majority of commuters use their private automobiles to travel to work. The data shows an average of 1.06 employees per vehicle, assuming 2 people per vehicle – on average – for carpools.

Commuter Work Location

Approximately 35% of households with commuters responded that they work within the EPZ. The remaining 65% travel outside of the EPZ to work. Figure F-9 presents this response.

Impact of COVID-19 on Commuters

Figure F-10 presents the distribution of the number of commuters in each household that were temporarily impacted by the COVID-19 pandemic. Approximately 48% of households indicated someone in their household had a work and/or school commute that was temporarily impacted by the COVID-19 pandemic. The commuter patterns were compared to the telephone survey conducted for the previous ETE study (2012). As discussed below, the commuter travel patterns are very similar between the telephone survey and the demographic survey. The 2020 demographic survey results were used as they are more conservative (slightly longer mobilization times).

Functional or Transportation Needs

Figure F-11 presents the distribution of the number of individuals with functional or transportation needs. Approximately four percent of households (18 households total) responded to the survey as having functional or transportation needs. A total of 28 people were identified as having functional and/or transportation needs in those 18 households: 7 require a bus, 4 require a medical bus/van, 8 require a wheelchair accessible van, and 9 require other types of transportation.

F.3.2 Evacuation Response

Several questions were asked to gauge the population's response to an emergency. These are now discussed:

"How many of the vehicles would your household use during an evacuation?" The response is shown in Figure F-12. On average, evacuating households would use 1.63 vehicles.

"Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, approximately 51% said they would await the return of other family members before evacuating and approximately 49% indicated that they would not await the return of other family members. Figure F-13 presents this response.

"If you had a household pet, would you take your pet with you if you were asked to evacuate the area?" Based on the responses to the survey, 75% of households have a family pet. Of the households with pets, 23% indicated that they would take their pets with them to a shelter, 72% indicated that they would take their pets somewhere else and only 5% would leave their pet at home, as shown Figure F-14. Of the households that would evacuate with their pets, 97% 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 the responses to the survey, 89% of households with a pet have a household pet (dog, cat, bird, reptile, rabbit, guinea pig, hermit crab, rodent, gerbil, turtle or fish) and 11% have farm animals (horse, chicken, goat, pig, etc.).

"Emergency officials advise you to take shelter at home in an emergency. Would you?" This question is designed to elicit information regarding compliance with instructions to shelter in place. The results indicate that 79% of households who are advised to shelter in place would do so; the remaining 21% 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 from the survey is in excellent agreement with the federal guidance. A sensitivity study was conducted to estimate the impact of shadow evacuation non-compliance of shelter advisory on ETE – see Table M-2 in Appendix M.

"Emergency officials advise you to take shelter at home now in an emergency and possibly evacuate later while people in other areas 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. Results indicate that 57% of households would follow instructions and delay the start of evacuation until so advised, while the other 43% 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 54% of households indicated that they would evacuate to a friend or relative's home, 6% to a reception center, 11% to a hotel, motel or campground, 6% to a second or seasonal home, 1% would choose not the evacuate and the remaining 22% answered other/don't know to this question, as shown in Figure F-15.

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-10, the COVID-19 pandemic had a slight impact on the commuting patterns of those who live in the SSES EPZ. To compare both the results obtained from the 2012 telephone survey and the 2020 demographic survey, the figures showing distributions involving commuters (time to prepare to leave work/college and time to travel home from work/college) will present both distributions.

"How long does it take the commuter to complete preparation for leaving work/college?" Figure F-16 presents the cumulative distribution for the 2020 and 2012 survey responses. For the 2020 survey, in all cases, the activity is completed within 60 minutes. Approximately 89% can leave within 35 minutes. For the 2012 survey, in all cases, the activity is completed within 105 minutes. Approximately 91% can leave within 45 minutes. The distributions are very similar for the first 60 minutes, with the 2012 survey having a longer tail.

"How long would it take the commuter to travel home?" Figure F-17 presents the work to home travel time for the EPZ for the 2020 and 2012 survey responses. Approximately 72% of commuters can arrive home within 30 minutes of leaving work; all within 60 minutes, according to the 2020 survey. Approximately 84% of commuters can arrive home within 30 minutes of leaving work; all within 60 minutes, according to the 2012 survey.

"How long would it take the family to pack clothing, secure the house, and load the car?" Figure F-18 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. Approximately 83% of households can be ready to leave home withing 2 hours; the remaining households require up to an additional one hour and 15 minutes.

"How much time, on average, would it take you to clear 6-8 inches of snow to move the car from the driveway or curb to begin the evacuation trip assuming the roads are passable?" Figure F-19 presents the time required to clear 6-8 inches of snow and begin the evacuation trip.

Approximately 83% of households can have their car cleared and the driveway passable within one hour and 15 minutes; the remaining households would require up to an additional 75 minutes to begin their evacuation trip, as shown in Figure F-19.

F.4 Conclusions

The demographic survey provides valuable, relevant data associated with the EPZ population, which have been used to quantify demographics specific to the EPZ, and "mobilization time" which can influence evacuation time estimates.

Table F-1. SSES Demographic Survey Sampling Plan

Zip Code	2010 Population	2010 Households	2020 Population	2020 Households	Desired Sample Size	Achieved Sample Size
17814	14	9	16	8	0	1
17815	2,058	821	1,997	826	11	38
17859	474	194	517	231	3	8
17878	864	303	707	271	4	3
17985	69	24	15	6	0	0
18202	1,146	320	987	360	4	3
18219	1,436	639	1,318	603	8	1
18222	6,110	2,239	6,049	2,576	29	29
18241	307	146	272	135	2	0
18246	143	61	154	61	1	1
18249	4,129	1,642	4,170	1,664	22	14
18251	46	22	20	9	0	0
18256	359	158	355	140	2	0
18603	19,318	8,215	18,754	8,062	109	173
18617	1,924	792	1,672	762	10	9
18621	3,314	826	2,283	795	11	3
18622	244	100	340	85	1	3
18631	1,286	541	1,242	533	7	13
18634	12,788	5,659	13,130	5,674	74	11
18635	3,880	1,573	3,687	1,553	21	36
18655	5,616	2,316	5,138	2,219	30	29
18660	3,702	1,456	3,454	1,426	20	39
18707	2,048	814	2,017	814	11	16
Total EPZ	**71,275**	**28,870**	**68,294**	**28,813**	**380**	**430**
Average 2010 HH Size:		**2.46**				
Average 2020 HH Size:		**2.37**				

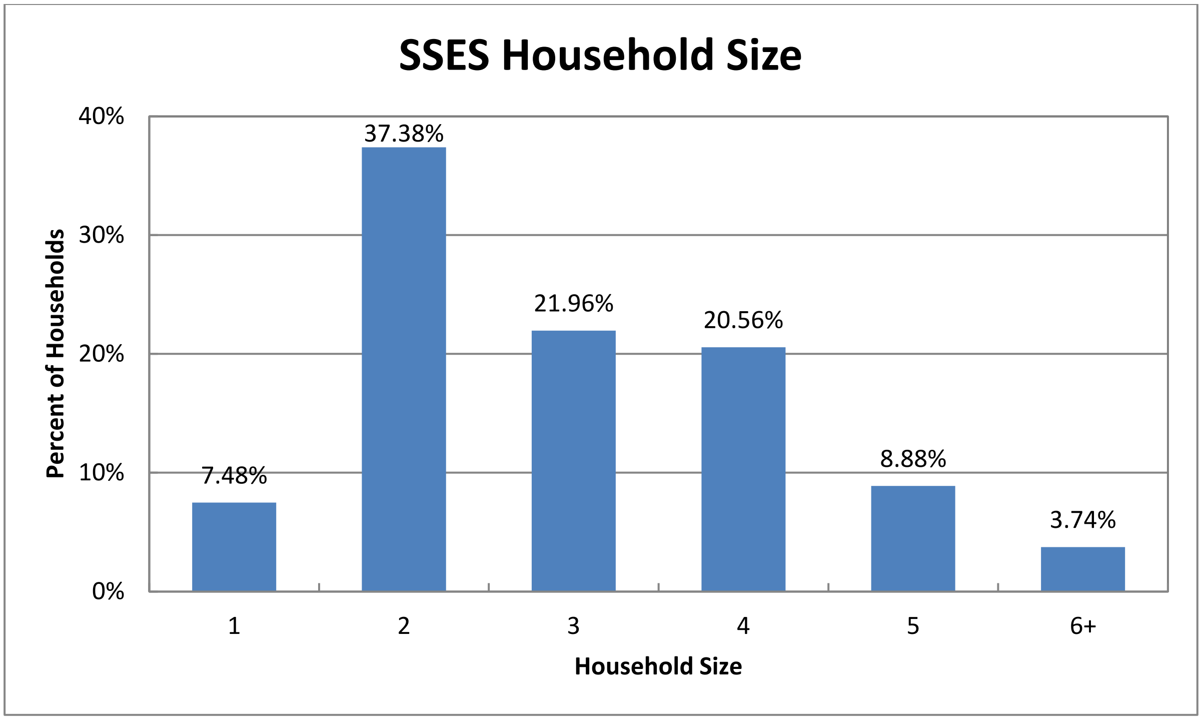


Figure F-1. Household Size in the EPZ

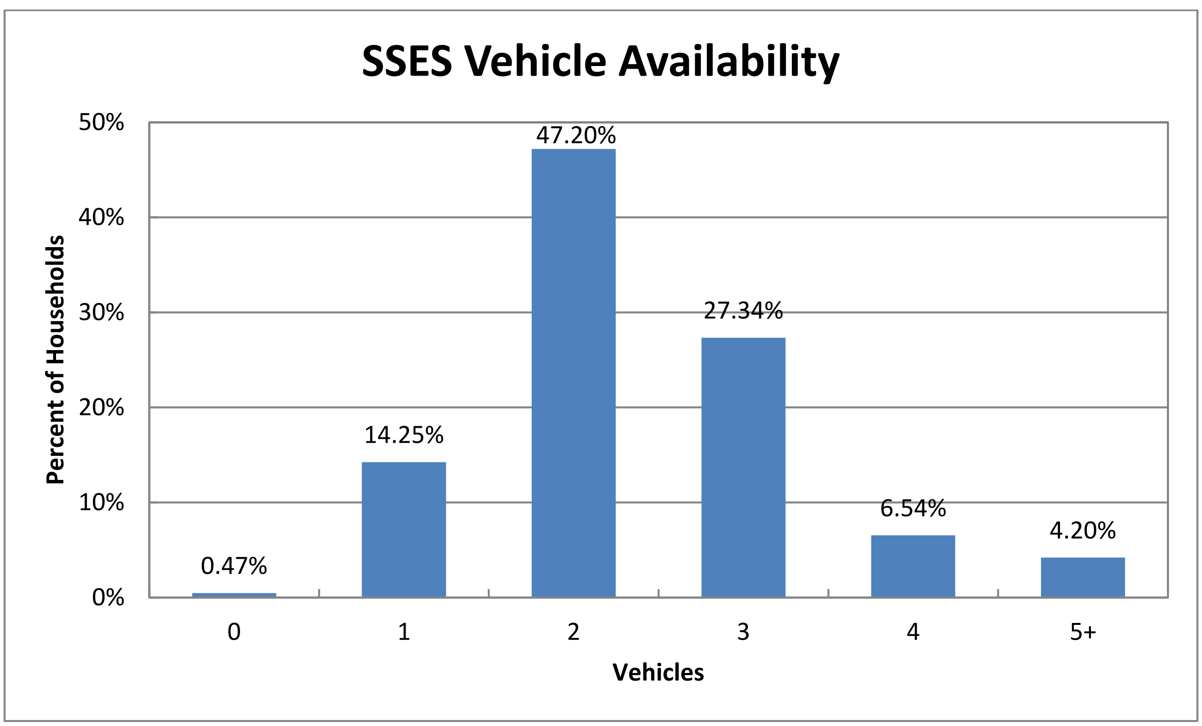


Figure F-2. Household Vehicle Availability

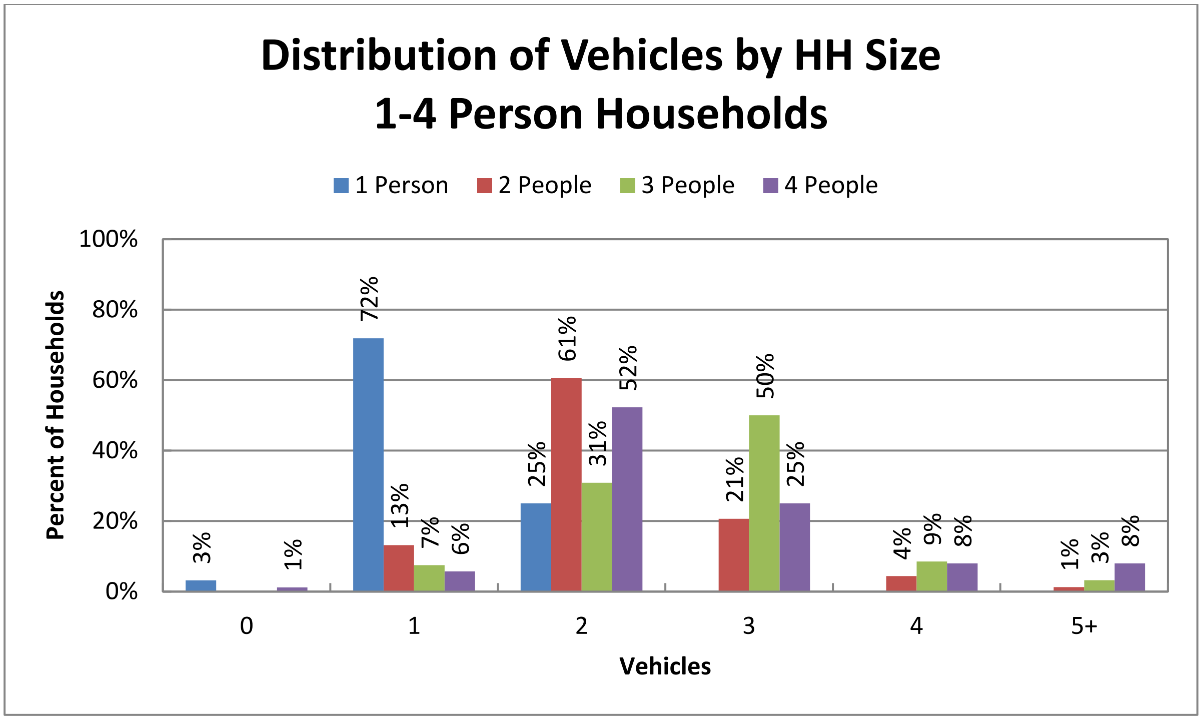


Figure F-3. Vehicle Availability - 1 to 4 Person Households

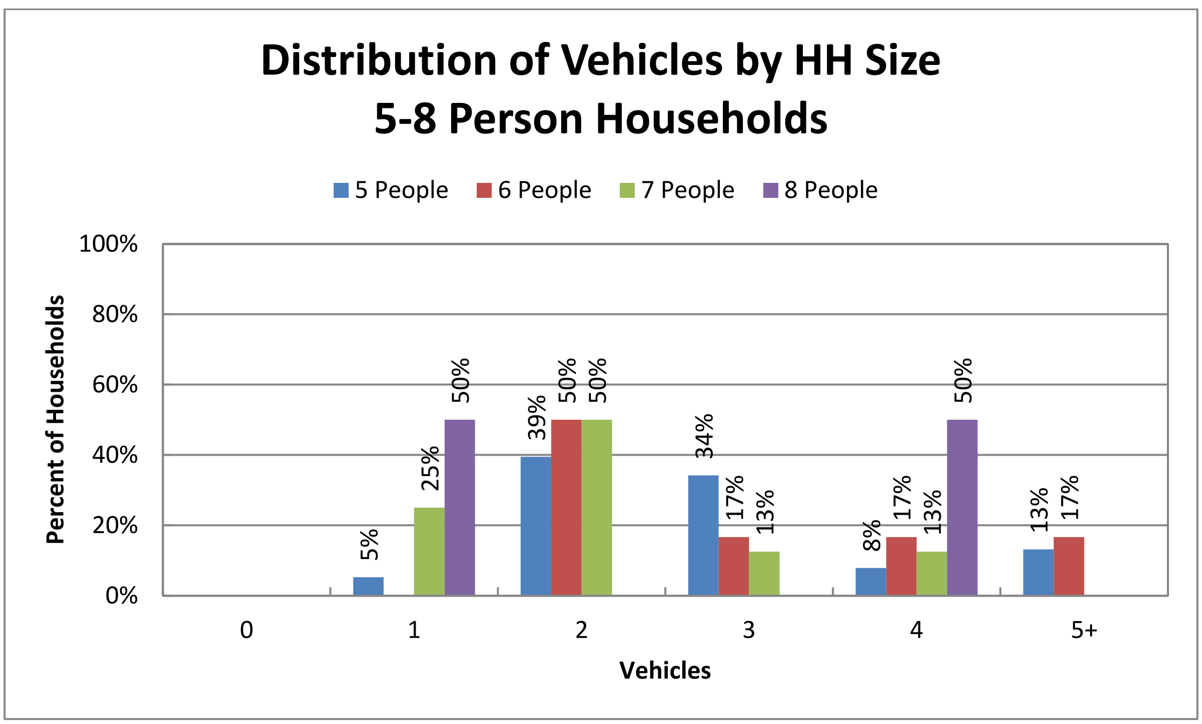


Figure F-4. Vehicle Availability - 5 to 8 Person Households

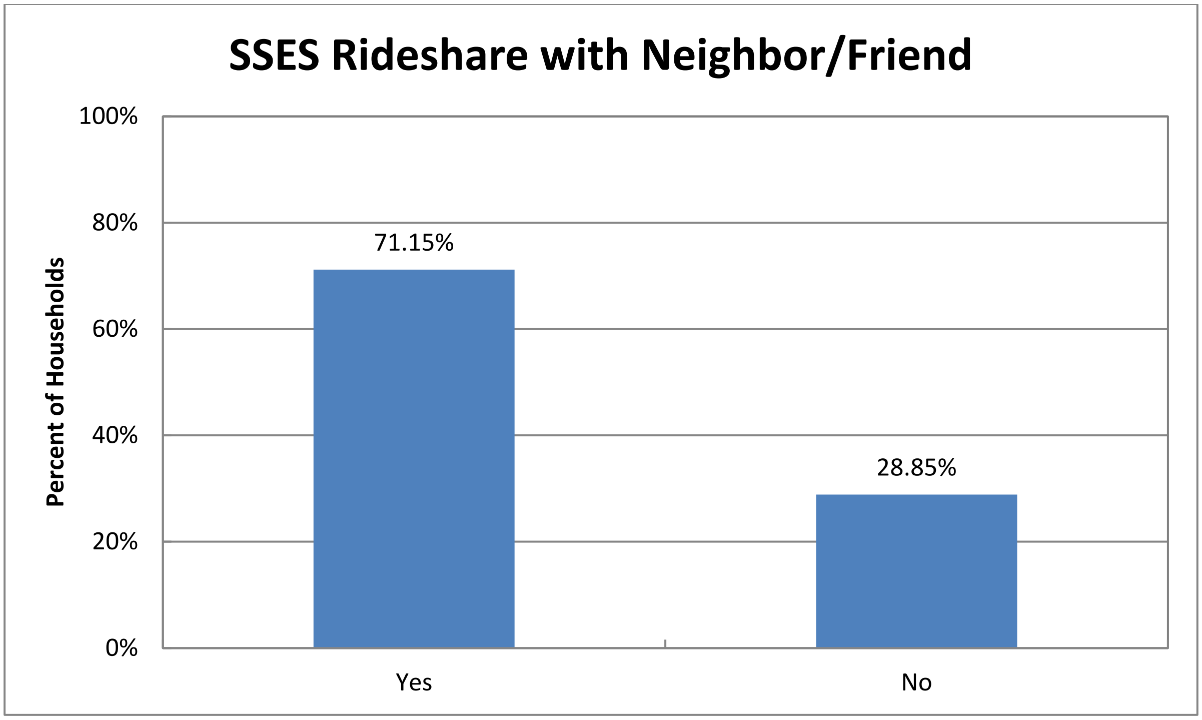


Figure F-5. Household Ridesharing Preference

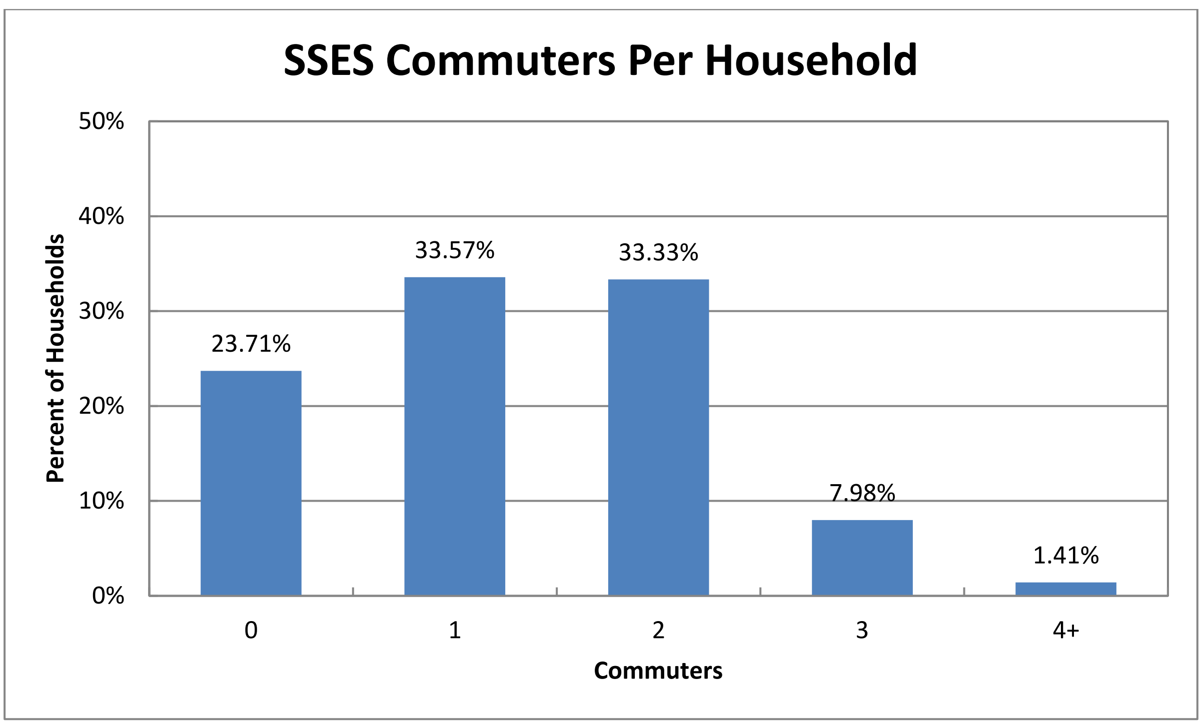


Figure F-6. Commuters in Households in the EPZ

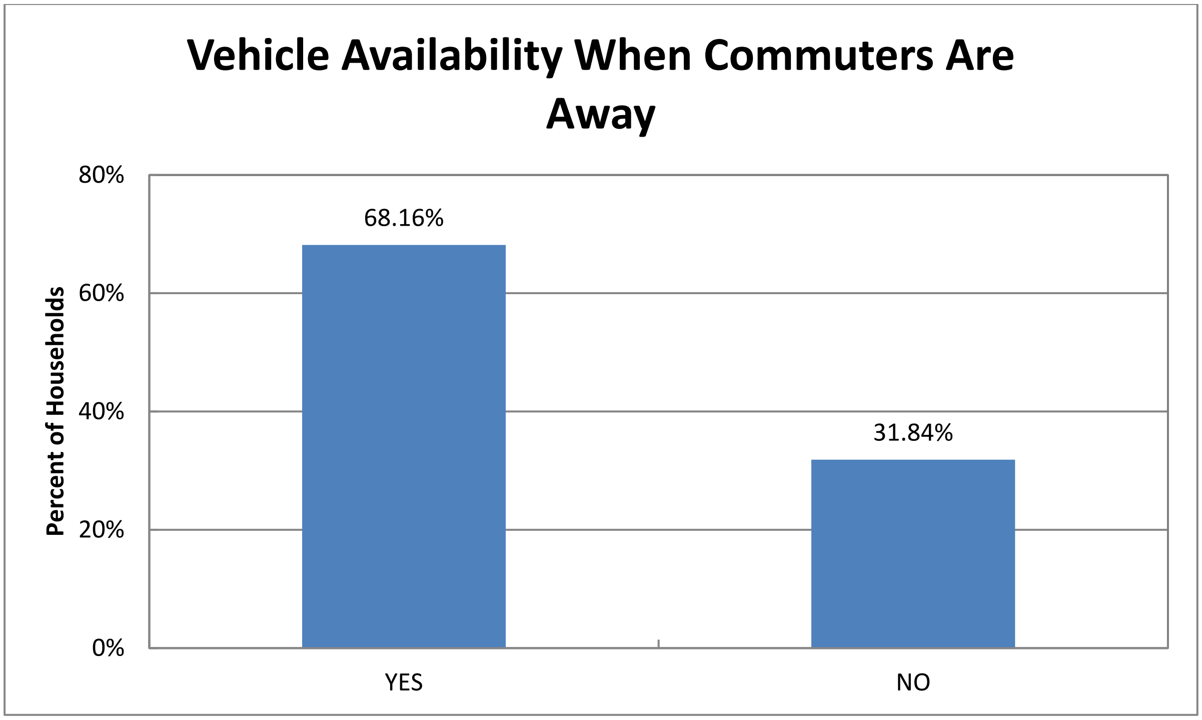


Figure F-7. Vehicle Availability When Commuters Are Away

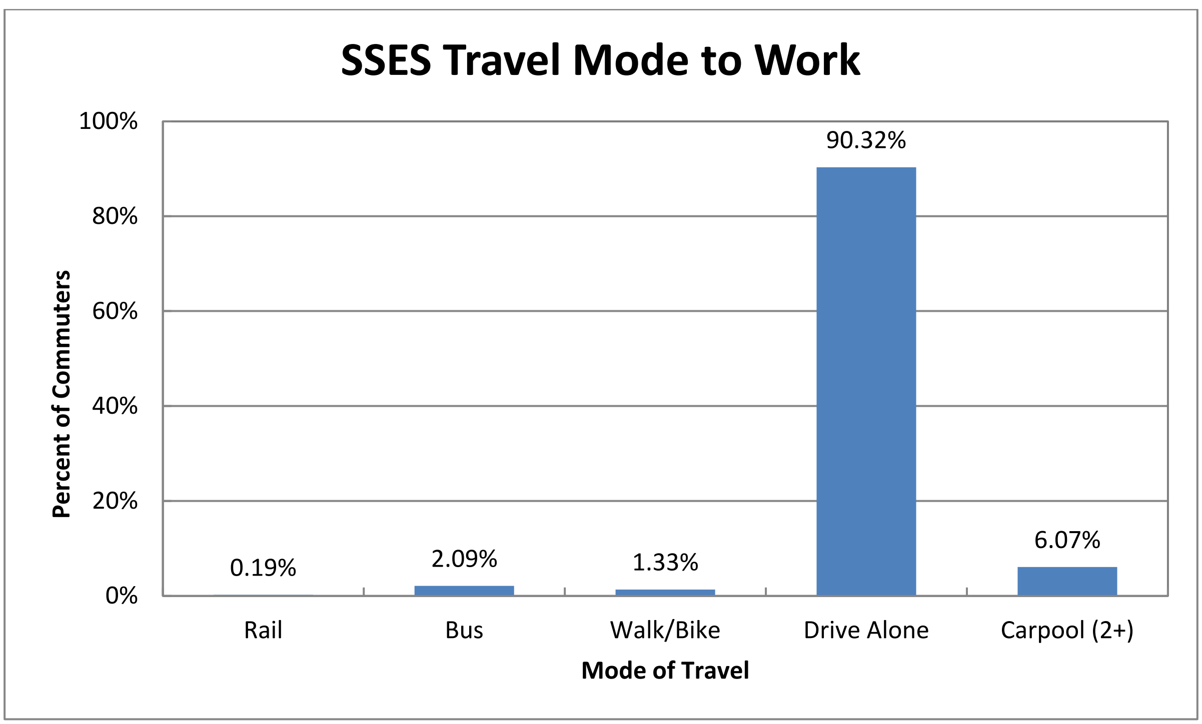


Figure F-8. Modes of Travel in the EPZ

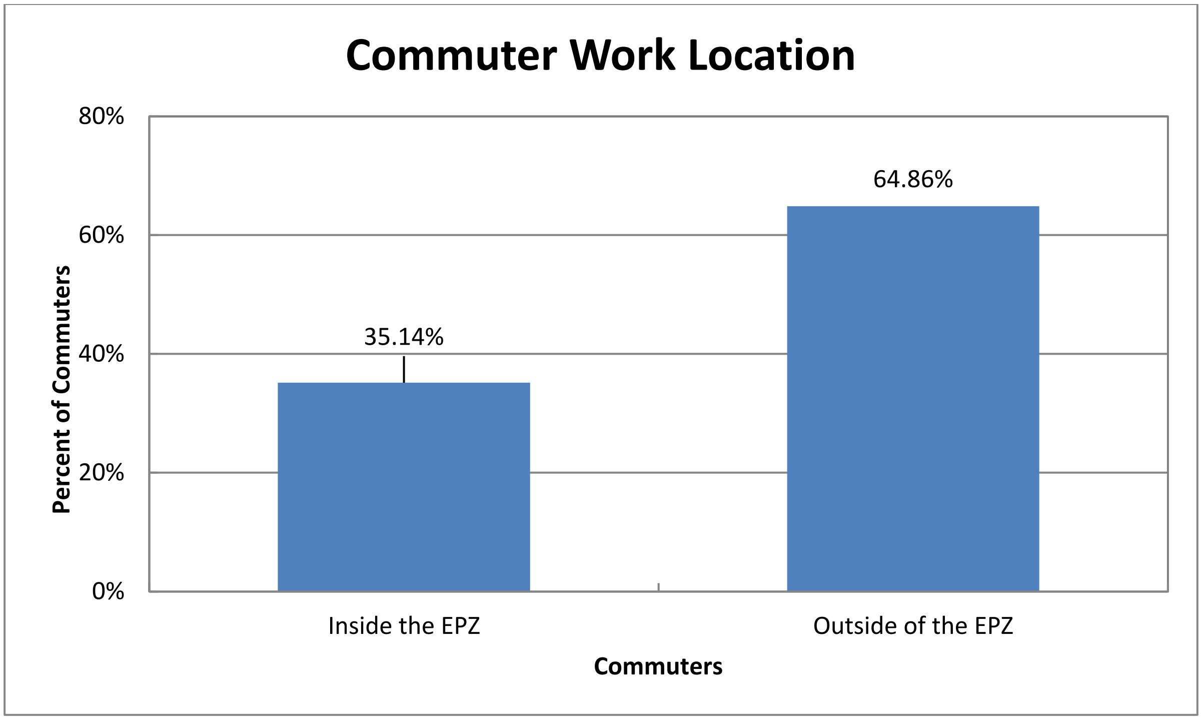


Figure F-9. Commuter Work Location

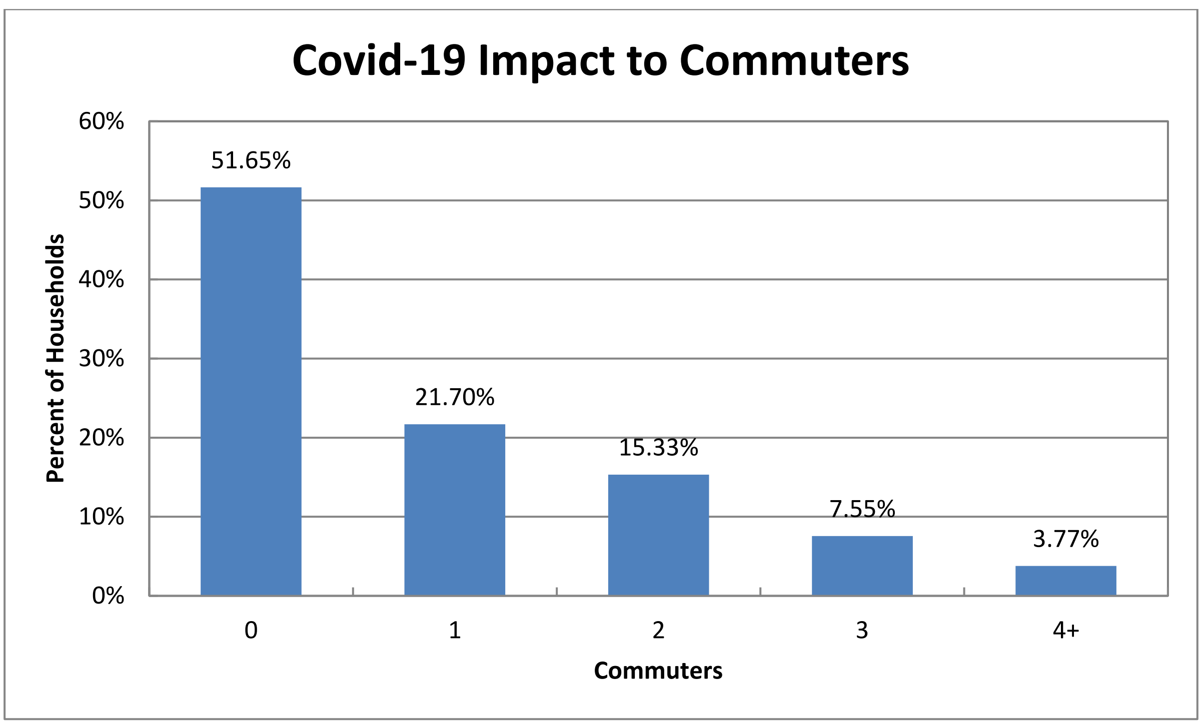


Figure F-10. Impact to Commuters due to the COVID-19 Pandemic

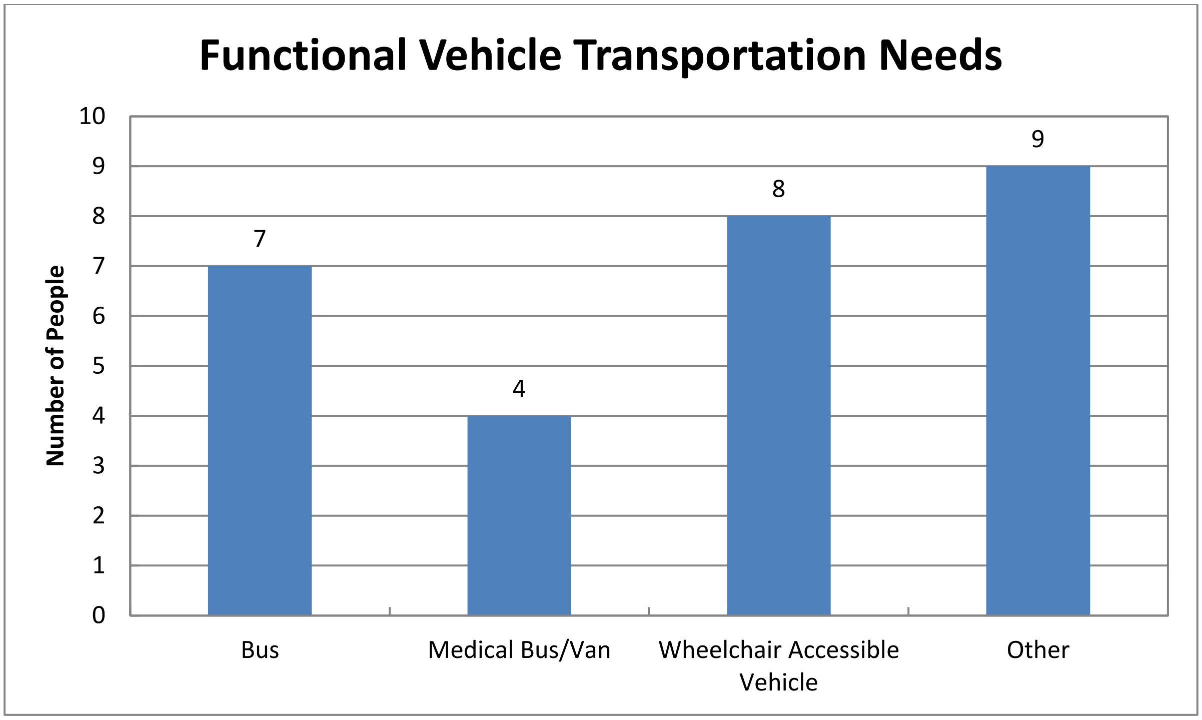


Figure F-11. People with Functional or Transportation Needs

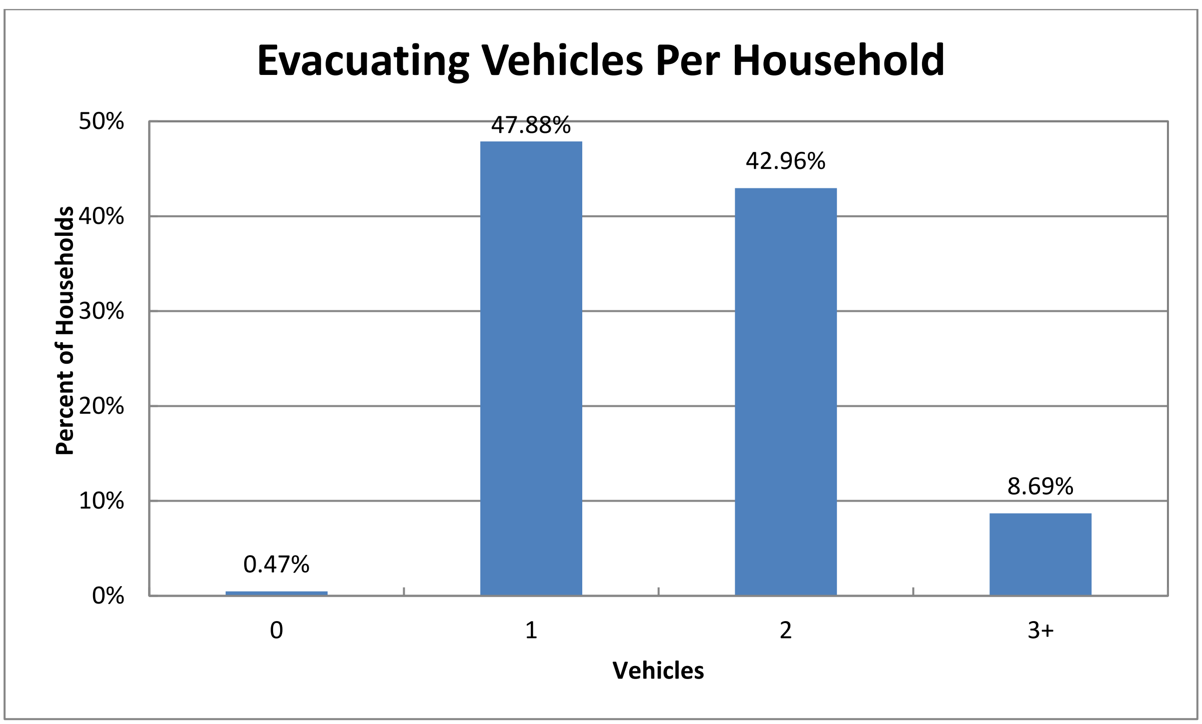


Figure F-12. Number of Vehicles Used for Evacuation

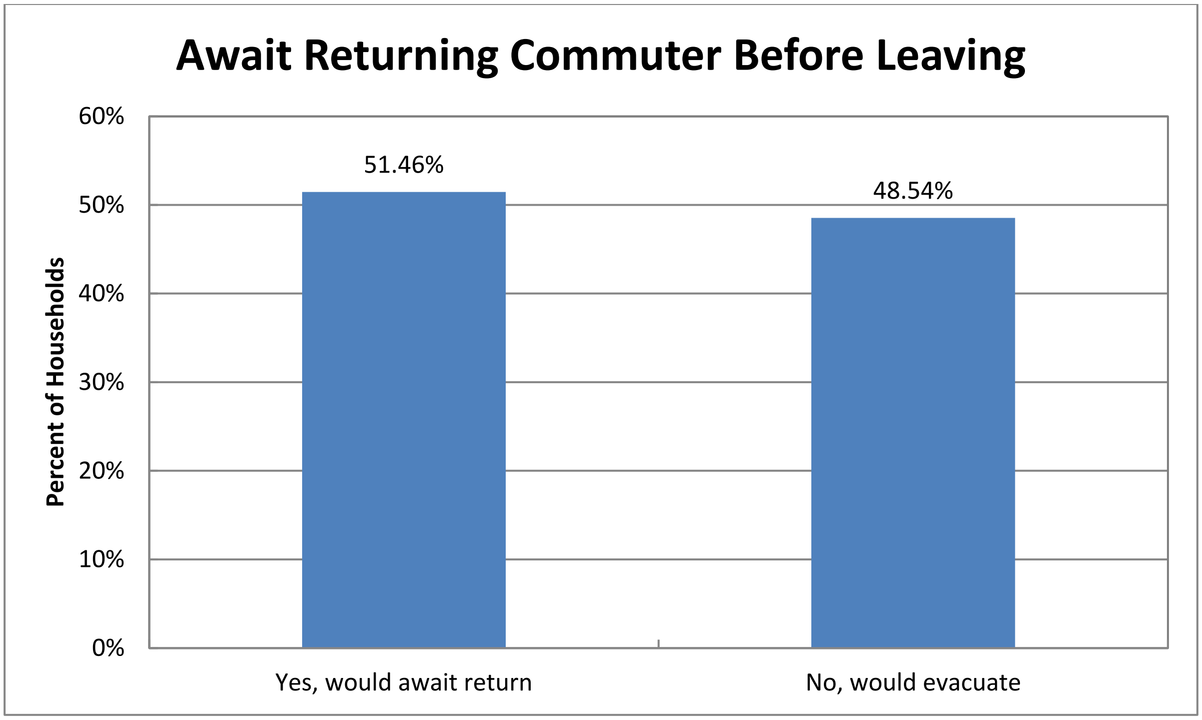


Figure F-13. Percent of Households that Await Returning Commuter Before Leaving

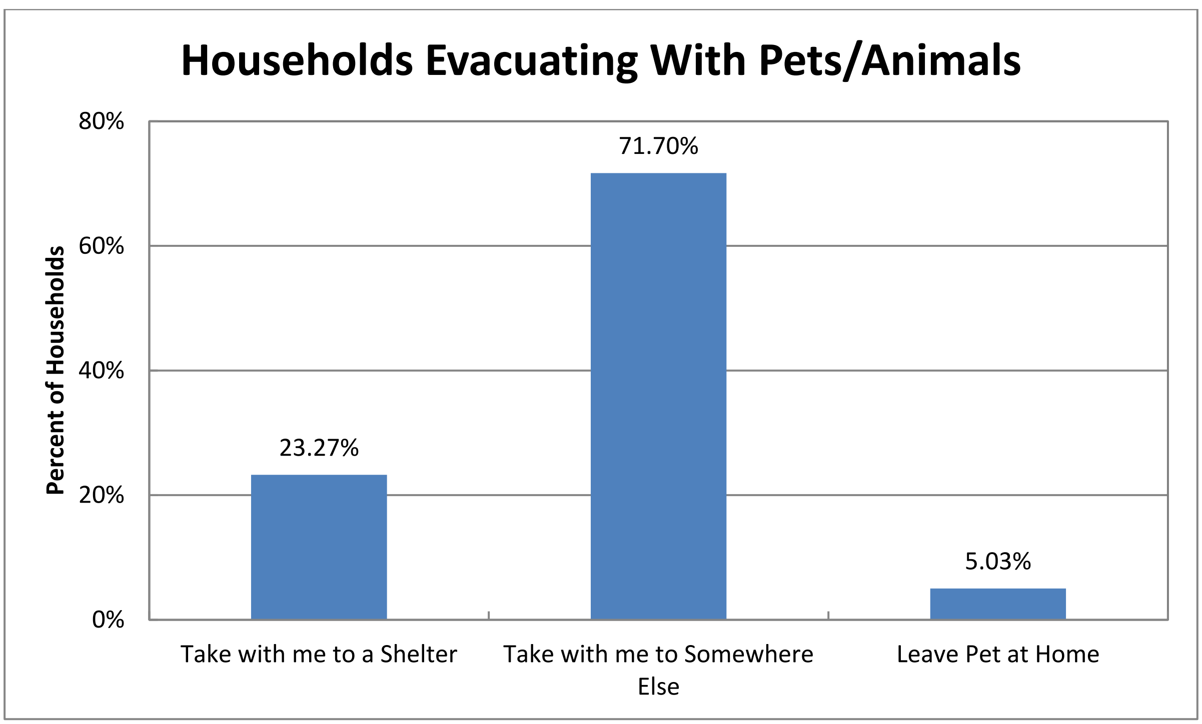


Figure F-14. Households Evacuating with Pets/Animals

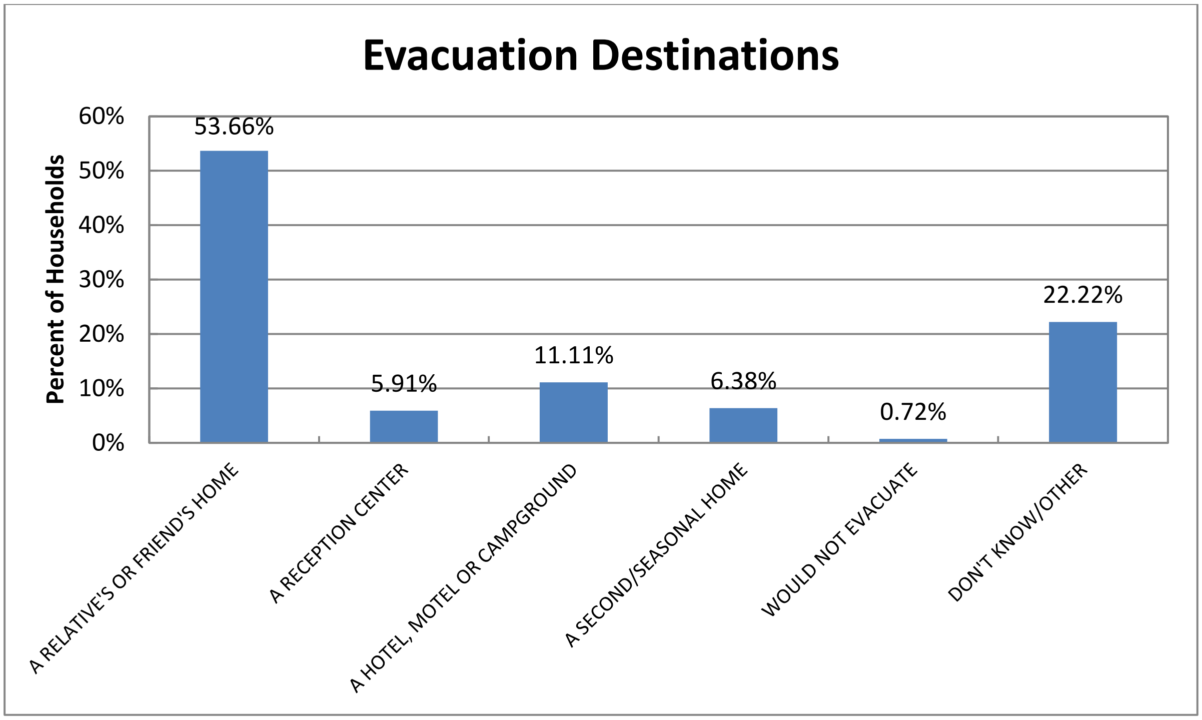


Figure F-15. Study Area Evacuation Destinations

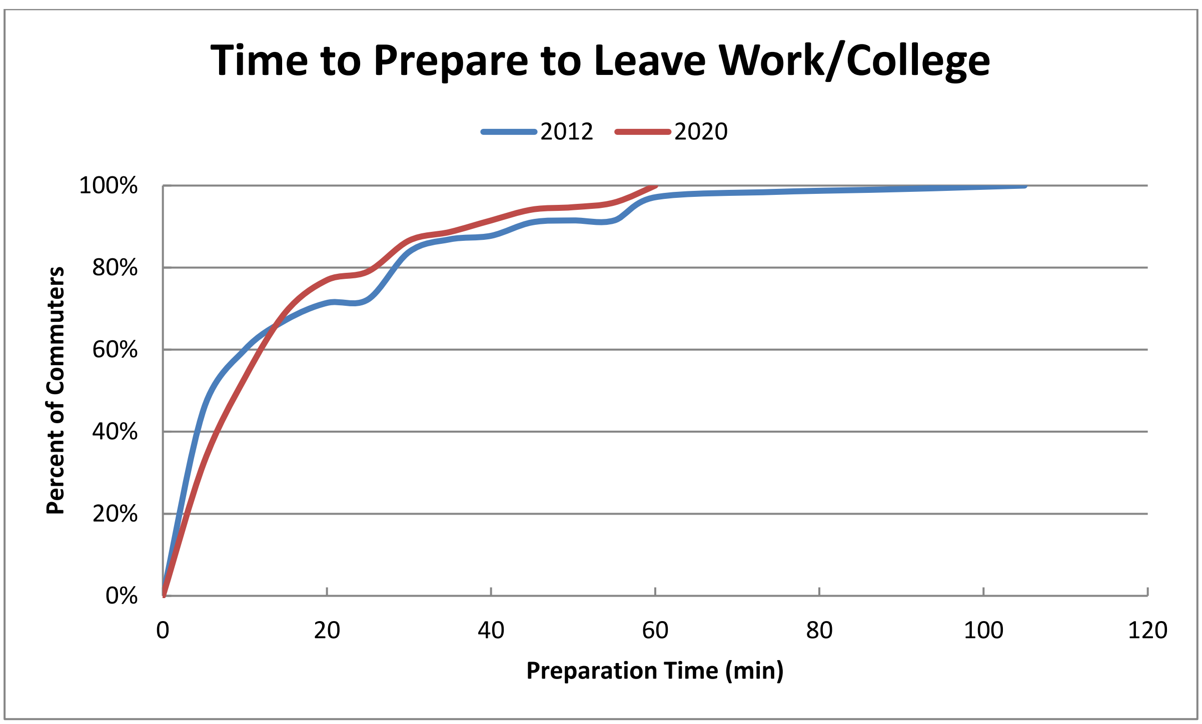


Figure F-16. Time Required to Prepare to Leave Work/School

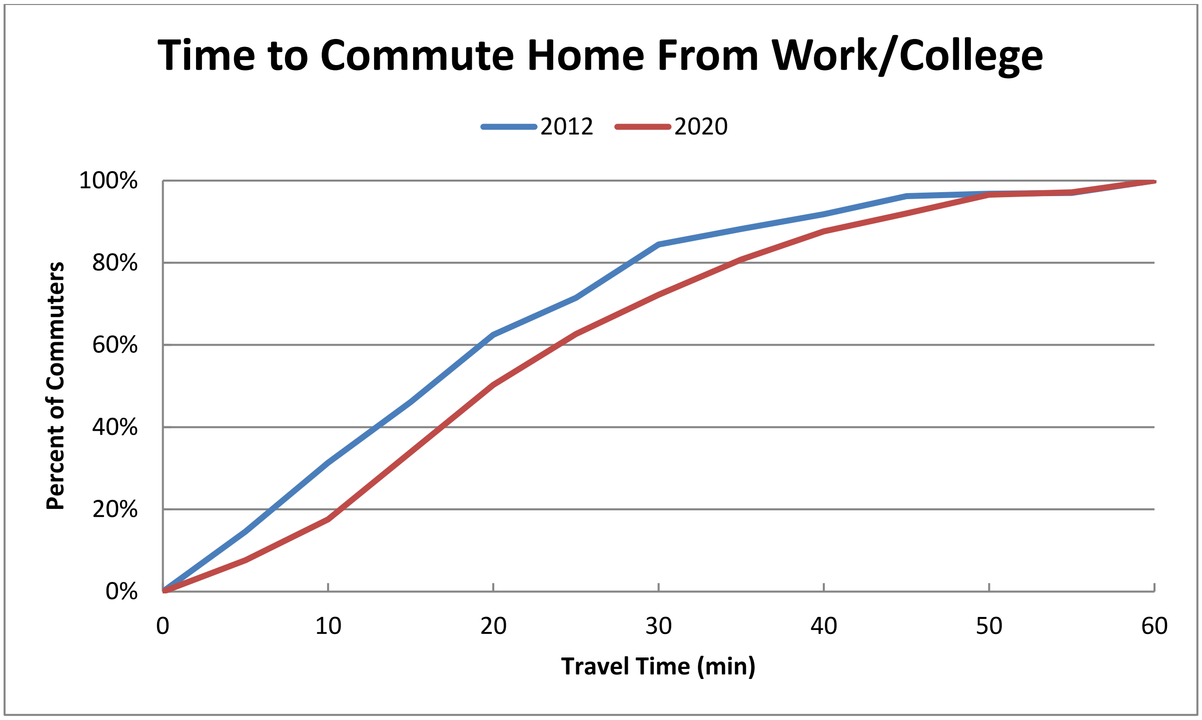


Figure F-17. Work to Home Travel Time

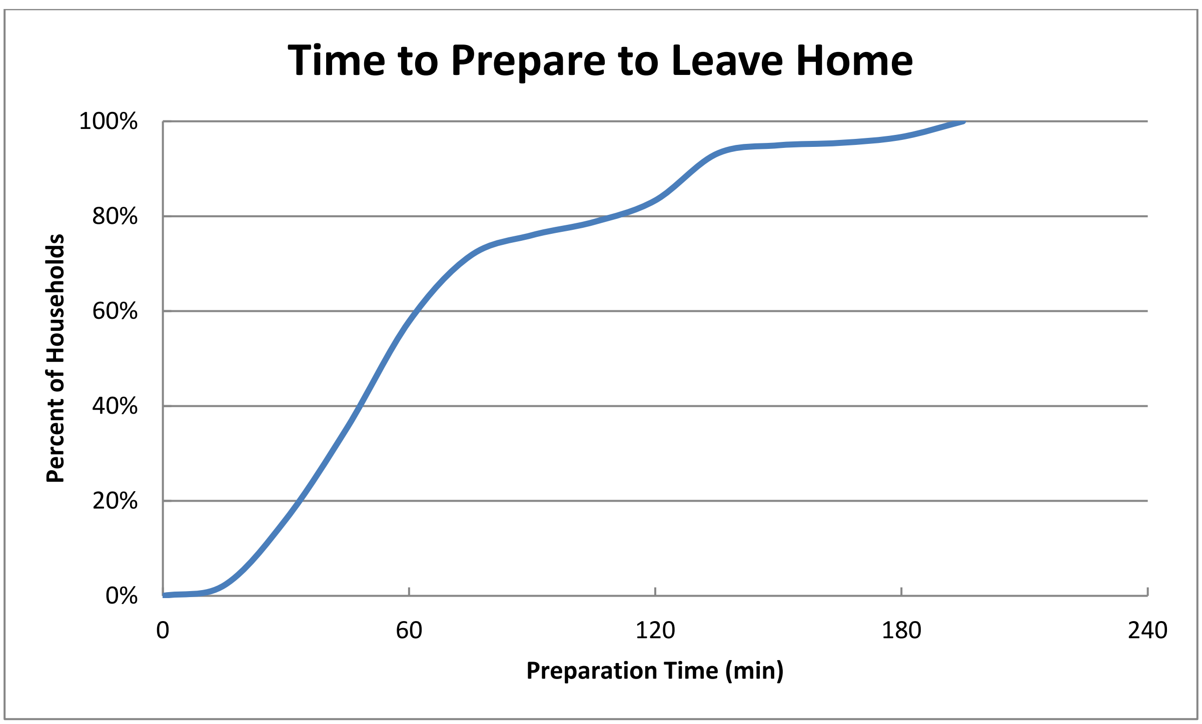


Figure F-18. Time to Prepare Home for Evacuation

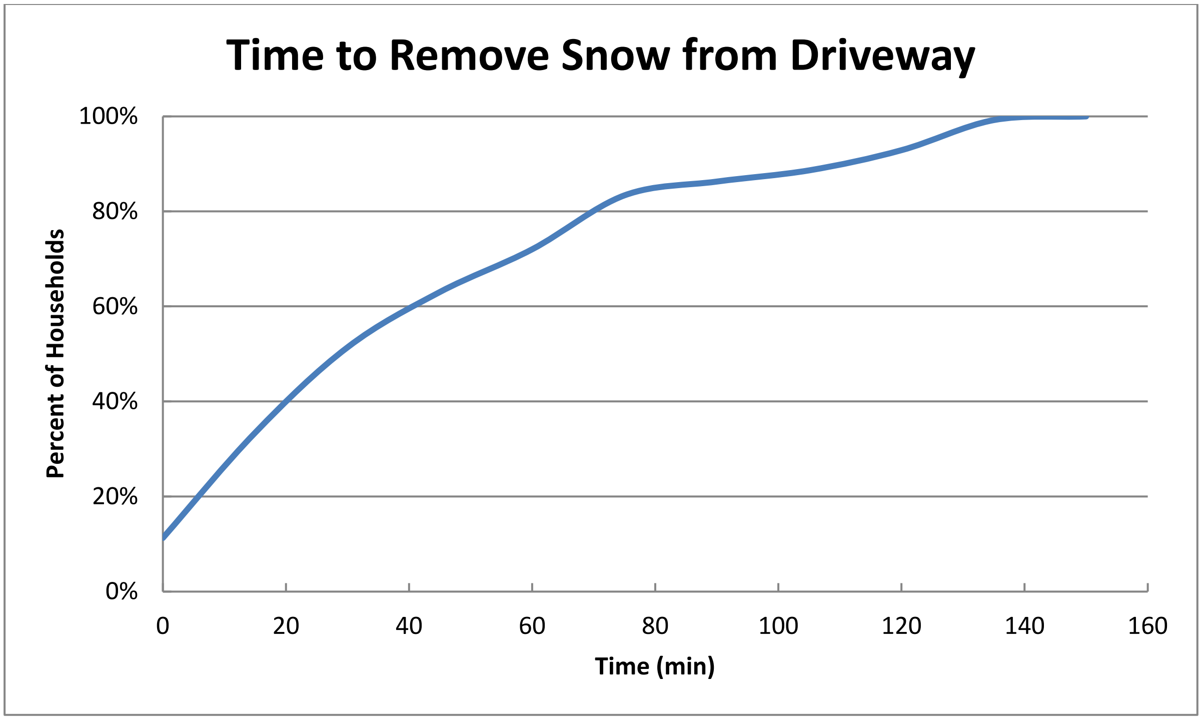


Figure F-19. Time to Clear Driveway of 6"-8" of Snow

ATTACHMENT A

Demographic Survey Instrument

Susquehanna Steam Electric Station 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 local emergency planners 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

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
- ONE
- TWO
- THREE
- FOUR OR MORE
- DECLINE TO STATE

8. 7. How many people in the household commute to a job, or to college on a daily basis? *

Mark only one oval.

- ZERO *Skip to question 63*
- 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 63*

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.

	Rail	Bus	Taxi	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.

	Rail	Bus	Taxi	Walk/Bicycle	Drive Alone	Carpool- 2 or more people	Don’t know
Commuter 1	◯	◯	◯	◯	◯	◯	◯
Commuter 2	◯	◯	◯	◯	◯	◯	◯

Skip to question 14

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.

	Rail	Bus	Taxi	Walk/Bicycle	Drive Alone	Carpool- 2 or more people	Don’t know
Commuter 1	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Commuter 2	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Commuter 3	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Skip to question 16

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.

	Rail	Bus	Taxi	Walk/Bicycle	Drive Alone	Carpool- 2 or more people	Don’t know
Commuter 1	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Commuter 2	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Commuter 3	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Commuter 4	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Skip to question 19

Location of Work/College

13. 9-1. What is the name of the city, town, or community in which Commuter #1 works or attends college?

Skip to question 23

Location of Work/College

14. 9-1. What is the name of the city, town, or community in which Commuter #1 works or attends college?

15. 9-2. What is the name of the city, town, or community in which Commuter #2 works or attends college?

Skip to question 25

Location of Work/College

16. 9-1. What is the name of the city, town, or community in which Commuter #1 works or attends college?

17. 9-2. What is the name of the city, town, or community in which Commuter #2 works or attends college?

18. 9-3. What is the name of the city, town, or community in which Commuter #3 works or attends college?

____

Skip to question 29

Location of Work/College

19. 9-1. What is the name of the city, town, or community in which Commuter #1 works or attends college?

____

20. 9-2. What is the name of the city, town, or community in which Commuter #2 works or attends college?

____

21. 9-3. What is the name of the city, town, or community in which Commuter #3 works or attends college?

____

22. 9-4. What is the name of the city, town, or community in which Commuter #4 works or attends college?

____

Skip to question 35

Travel Home From Work/College

23. 10-1. 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

24. 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 43

Travel Home From Work/College

25. 10-1. 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 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

____

27. 10-2. 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 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

____

Skip to question 45

Travel Home From Work/College

29. 10-1. 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

30. If Over 2 Hours for Question 10-1, Specify Here

leave blank if your answer for Question 10-1, is under 2 hours.

____

31. 10-2. 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

32. If Over 2 Hours for Question 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

____

33. 10-3. 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

34. 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 49

Travel Home From Work/College

35. 10-1. 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

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. 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

38. If Over 2 Hours for Question 10-2, Specify Here

leave blank if your answer for Question 10-2, is under 2 hours.

____

39. 10-3. 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

40. If Over 2 Hours for Question 10-3, Specify Here

leave blank if your answer for Question 10-3, is under 2 hours.

____

41. 10-4. 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

42. 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 55

Preparation to leave Work/College

43. 11-1. 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

44. If Over 2 Hours for Question 11-1, Specify Here

leave blank if your answer for Question 11-1, is under 2 hours.

____

Skip to question 63

Preparation to leave Work/College

45. 11-1. 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 11-1, Specify Here

leave blank if your answer for Question 11-1, is under 2 hours.

____

47. 11-2. 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 11-2, Specify Here

leave blank if your answer for Question 11-2, is under 2 hours.

____

Skip to question 63

Preparation to leave Work/College

49. 11-1. 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

50. If Over 2 Hours for Question 11-1, Specify Here

leave blank if your answer for Question 11-1, is under 2 hours.

____

51. 11-2. 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

52. If Over 2 Hours for Question 11-2, Specify Here

leave blank if your answer for Question 11-2, is under 2 hours.

____

53. 11-3. 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

54. If Over 2 Hours for Question 11-3, Specify Here

leave blank if your answer for Question 11-3, is under 2 hours.

____

Skip to question 63

Preparation to leave Work/College

55. 11-1. 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

56. If Over 2 Hours for Question 11-1, Specify Here

leave blank if your answer for Question 11-1, is under 2 hours.

____

57. 11-2. 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

58. If Over 2 Hours for Question 11-2, Specify Here

leave blank if your answer for Question 11-2, is under 2 hours.

____

59. 11-3. 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

60. If Over 2 Hours for Question 11-3, Specify Here

leave blank if your answer for Question 11-3, is under 2 hours.

____

61. 11-4. 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

62. If Over 2 Hours for Question 11-4, Specify Here

leave blank if your answer for Question 11-4, is under 2 hours.

Skip to question 63

Additional Questions

63. 12. 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

64. If Over 6 Hours for Question 12, Specify Here

leave blank if your answer for Question 12, is under 6 hours.

____

65. 13. If there are 6-8 inches of snow on your driveway or curb, would you need to shovel out to evacuate? If yes, how much time, on average, would it take you to clear the 6-8 inches of snow to move the car from the driveway or curb to begin the evacuation trip? Assume the roads are passable.

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
- NO, WILL NOT SHOVEL OUT
- OVER 3 HOURS
- DECLINE TO STATE

66. If Over 3 Hours for Question 13, Specify Here

leave blank if your answer for Question 13, is under 3 hours.

____

67. 14. 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	⬭	⬭	⬭	⬭	⬭	⬭

68. Specify "Other" Transportation Need Below

____

69. 15. When the commuters are away from home, is there a vehicle at home that is available for evacuation during any emergency?

Mark only one oval.

- ⬭ Yes
- ⬭ No
- ⬭ Decline to State

70. 16. 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

71. 17A. 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

72. 17B. 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

73. 17C. 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

74. Fill in OTHER answers for question 17C

Pet Questions

75. 18A. Do you have any pet(s) and/or animal(s)?

Mark only one oval.

- YES
- NO
- DECLINE TO STATE

Pet Questions

76. 18B. 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)
- [ ] Other: ______________________

77.

Mark only one oval.

- ( ) DECLINE TO STATE

Pet Questions

78. 18C. 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
- ( ) DECLINE TO STATE

Pet Questions

79. 18D. 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
- ⬭ DECLINE TO STATE
- ⬭ Other: ____________________

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 EPZ were provided by each county.

These traffic management plans (TMP) were reviewed, and the TCPs and ACPs were modeled accordingly. Figure G-1 maps the existing TCPs and ACPs.

G.1 Traffic Control Points (TCPs)

As discussed in Section 9, traffic control points 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 traffic control point, 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.

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, the control type is indicated as a TCP in Table K-1. Figure G-1 maps the TCPs identified in the emergency plans of Columbia and Luzerne Counties. State and municipal police will provide law enforcement and traffic control along major evacuation routes. They will also be responsible for coordinating access control points for areas taking shelter or evacuating. The Pennsylvania National Guard will also assist with security and access control in the risk area.

G.2 Access Control Points (ACPs)

The existing ACPs within the study area are mapped as yellow circles in Figure G-1. It is assumed that ACPs will be established within 2 hours of the Advisory to Evacuate to discourage through travelers from using major through routes which traverse the EPZ.

As discussed in Section 3.10, external traffic was only considered on two routes which traverse the EPZ – Interstates 80 and 81 – in this analysis. The generation of these external trips ceased at 120 minutes after the ATE in the simulation. The Pennsylvania Fish & Boat Commission establishes and operates waterway ACPs as required.

G.3 Analysis of Key TCP Locations

TCPs are forms of manual traffic control (MTC). As discussed in Section 5.2 of NUREG/CR-7002, Rev. 1, MTC at intersections could benefit from ETE analysis. The TCP locations contained within the traffic management plan 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.

The majority of the TCPs identified in the TMP were located at intersections with actuated signals or intersections without control. Table G-1 shows a list of the controlled intersections that were identified as TCPs 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 winter, midweek, midday, good weather scenario (Scenario 6) 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. Although localized congestion could worsen without MTC, the ETE did not change at both the 90^{th} and 100^{th} percentile when MTC was not present at these intersections, as shown in Table G-2. The remaining TCPs were left as actuated signals in the model and, therefore, had no impact to ETE.

The majority of the TCPs and ACPs in the study area are located along major evacuation routes near major population centers, as shown in Figure G-1. As discussed in Section 7.3, the main thoroughfare on US-11 is operating at LOS F for several hours, as shown in Figures 7-3 through 7-8. Positioning police officers at intersections to facilitate access to these roadways would have minimal benefit as the main thoroughfare is already heavily congested.

Although there is no reduction in ETE when MTC is implemented, traffic control can be beneficial in the reduction of localized congestion and driver confusion and can be extremely helpful for fixed point surveillance, amongst other things. Should there be a shortfall of personnel to staff the TCPs, the list of locations provided in Table G-1 could be considered as priority locations when implementing the TMP as all other TCPs already have actuated traffic signals which would mimic MTC.

Table G-1. List of Key TCP Locations

TCP/ACP #	Node #	Previous Control
Huntington Township POST 1	918	Stop Control
Huntington Township POST 2	221	Stop Control
Fairmont Township POST 3	606	Stop Control
Lake Township POST 7	653	Stop Control
Nuangola Borough POST 11 TCP & Nuangola Borough POST 1 Municipal TCP	485	Stop Control
Rice Township POST 12	336	Stop Control
Rice Township POST 14 TCP & Rice Township POST 225 ACP	116	Stop Control
	115	Stop Control
Dorrance Township POST 3	192	Stop Control
Dorrance Township POST 18	113	Stop Control
	112	Stop Control
Butler Township POST 26 TCP & Butler Township POST 229 ACP	73	Stop Control
	75	Stop Control
Black Creek Township POST 3	705	Stop Control
Butler Township POST 6/B TCP & Butler Township POST 233 ACP	316	Stop Control
Butler Township 4/A	189	Stop Control
Conyngham Borough POST 6	1032	Stop Control
Conyngham Borough POST 7	21	Stop Control
Conyngham Township POST 1	477	Stop Control
Hollenback Township POST 1	713	Stop Control
Hunlock Township POST 1	627	Stop Control
Huntington Township POST 3	220	Stop Control
Newport Township POST 2	494	Stop Control
Newport Township POST 8	284	Stop Control
Salem Township POST 1	77	Stop Control
Slocum Township POST 3	266	Stop Control
Slocum Township POST 4	481	Stop Control
Union Township POST 2	575	Stop Control
Rice Township POST 226	118	Stop Control
Fishing Creek Township POST 50	229	Stop Control
Briar Creek Township POST 52	869	Stop Control
Briar Creek Township POST 53	876	Stop Control
Briar Creek Borough (Berwick Borough) POST 57	368	Stop Control
Orangeville Borough POST 63 TCP & Orangeville Borough POST 112 ACP	455	Stop Control
Mifflin Township POST 68 TCP & Mifflin Township POST 124 ACP	19	Stop Control
	20	Stop Control
Mifflin Township POST 69 TCP & Mifflin Township POST 1 Municipal TCP	251	Stop Control
Main Township POST 71	293	Stop Control

TCP/ACP #	Node #	Previous Control
Benton Township POST 103	217	Stop Control
Beaver Township POST 134	295	Stop Control
Berwick/Briar Creek Borough POST 3	377	Stop Control
Berwick/Briar Creek Borough POST 12	237	Stop Control
Nescopeck Township POST 1	254	Stop Control

Table G-2. ETE with No MTC

Region	Scenario 6					
	90th Percentile ETE			100th Percentile ETE		
	Base	No MTC	Difference	Base	No MTC	Difference
R01 (2-Mile)	2:55	2:55	0:00	4:50	4:50	0:00
R02 (5-Mile)	2:55	2:55	0:00	4:50	4:50	0:00
R03 (Entire EPZ)	3:10	3:10	0:00	4:55	4:55	0:00

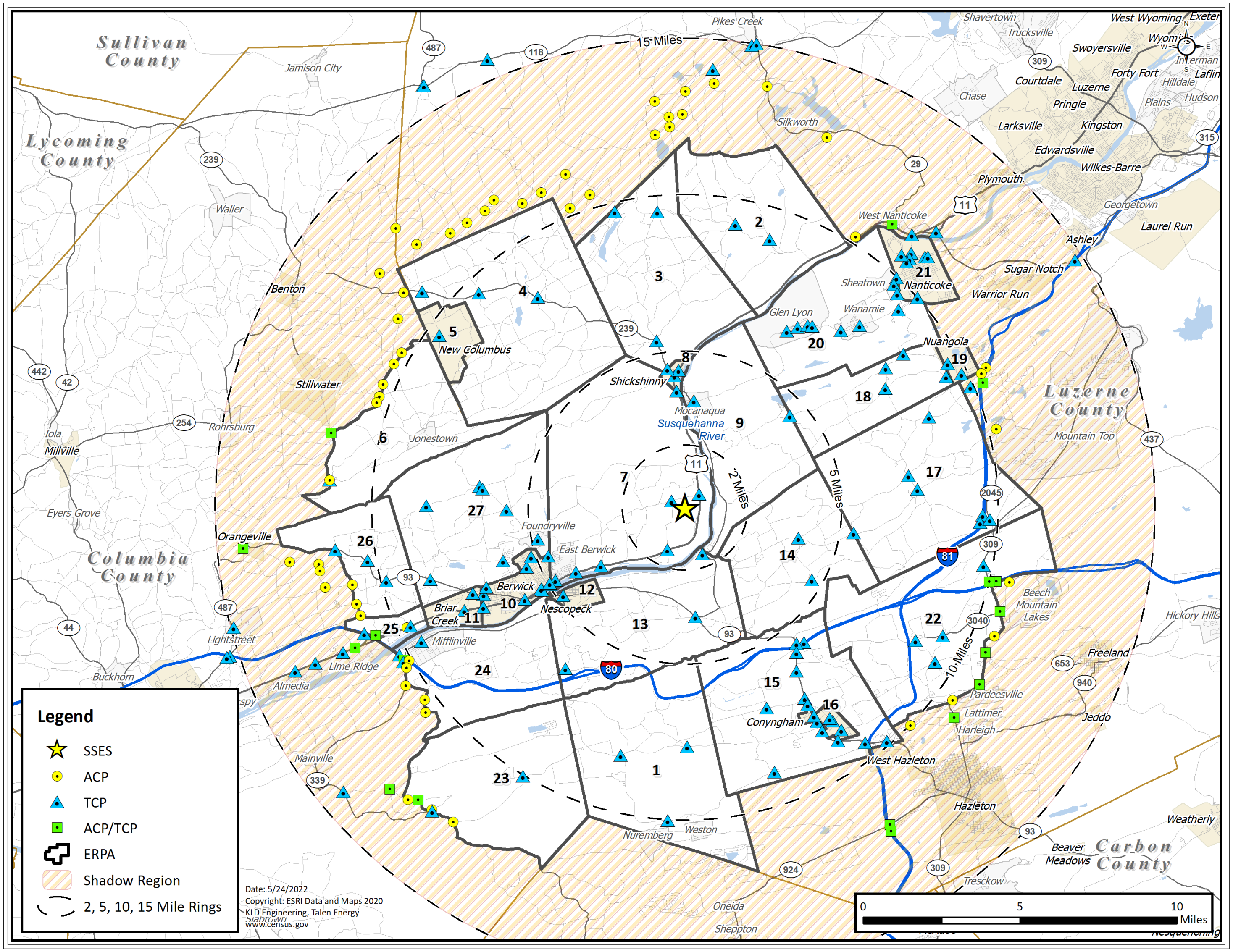


Figure G-1. Traffic and Access Control Points for the SSES EPZ

APPENDIX H

Evacuation Regions

H EVACUATION REGIONS

This appendix presents the evacuation percentages for each Evacuation Region (Table H-1) and maps of all Evacuation Regions (Figure H-1 through Figure H-33). The percentages presented in Table H-1 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 ERPA Population Evacuating for Each Region

Region	Description	ERPA																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2-Mile Ring	20%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R02	5-Mile Ring	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R03	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%
Evacuate 2-Mile Radius and Downwind to 5 Miles																												
Region	**Wind Direction From:**	**ERPA**																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R04	N, NNE	20%	20%	20%	20%	20%	20%	100%	20%	100%	100%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R05	NE, ENE, E	20%	20%	20%	20%	20%	20%	100%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R06	ESE	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R07	SE	20%	20%	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%
R08	SSE, S	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R09	SSW, SW, WSW	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R10	W, WNW, NW, NNW	20%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Key																												
ERPA(s) Shelter-in-Place															ERPA(s) Evacuate													

Evacuate 2-Mile Radius and Downwind to the EPZ Boundary

Region	Wind Direction From:	ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R11	N	100%	20%	20%	20%	20%	20%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%
R12	NNE	100%	20%	20%	20%	20%	100%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%
R13	NE	100%	20%	20%	100%	100%	100%	100%	20%	100%	100%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%
R14	ENE	100%	20%	20%	100%	100%	100%	100%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%
R15	E	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%
R16	ESE	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%
R17	SE	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	100%	100%	100%	100%
R18	SSE	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	100%	100%	20%	20%	20%	20%	100%	100%
R19	S	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%
R20	SSW, SW	20%	100%	100%	100%	100%	20%	100%	100%	100%	20%	20%	20%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%
R21	WSW	20%	100%	100%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%
R22	W	20%	100%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%
R23	WNW	100%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	20%
R24	NW	100%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	100%	100%	20%	20%	100%	100%	20%	20%	20%	20%
R25	NNW	100%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	100%	100%	100%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%

Key

ERPA(s) not within Plume, but Evacuates because it is surrounded by other ERPA(s) which are Evacuating	ERPA(s) Shelter-in-Place	ERPA(s) Evacuate

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles

Region	Wind Direction From:	ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R26	5-Mile Ring	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R27	N, NNE	20%	20%	20%	20%	20%	20%	100%	20%	100%	100%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R28	NE, ENE, E	20%	20%	20%	20%	20%	20%	100%	20%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R29	ESE	20%	20%	20%	20%	20%	20%	100%	100%	100%	100%	20%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R30	SE	20%	20%	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%
R31	SSE, S	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R32	SSW, SW, WSW	20%	20%	20%	20%	20%	20%	100%	100%	100%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
R33	W, WNW, NW, NNW	20%	20%	20%	20%	20%	20%	100%	20%	100%	20%	20%	100%	100%	100%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%

Key

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

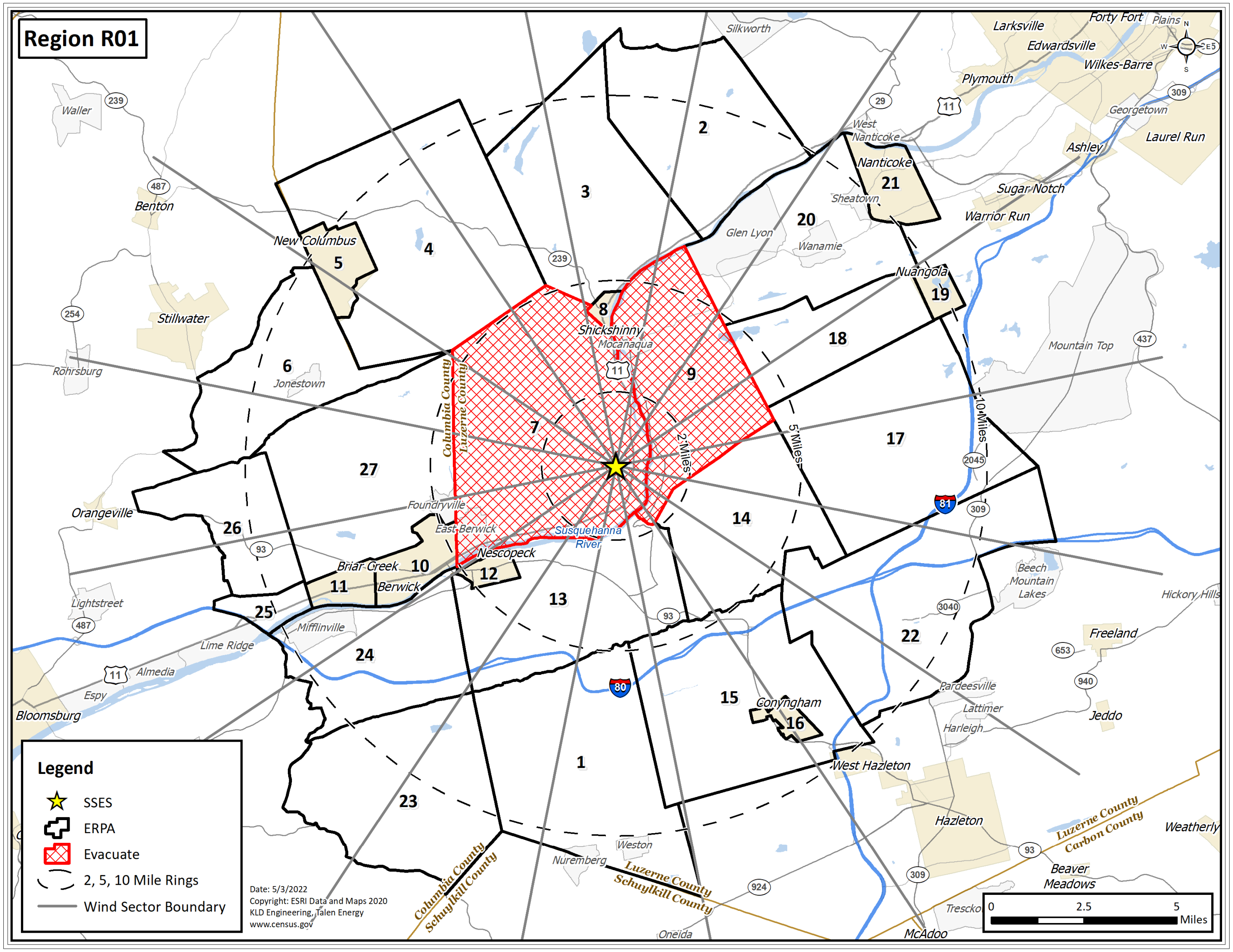


Figure H-1. Region R01

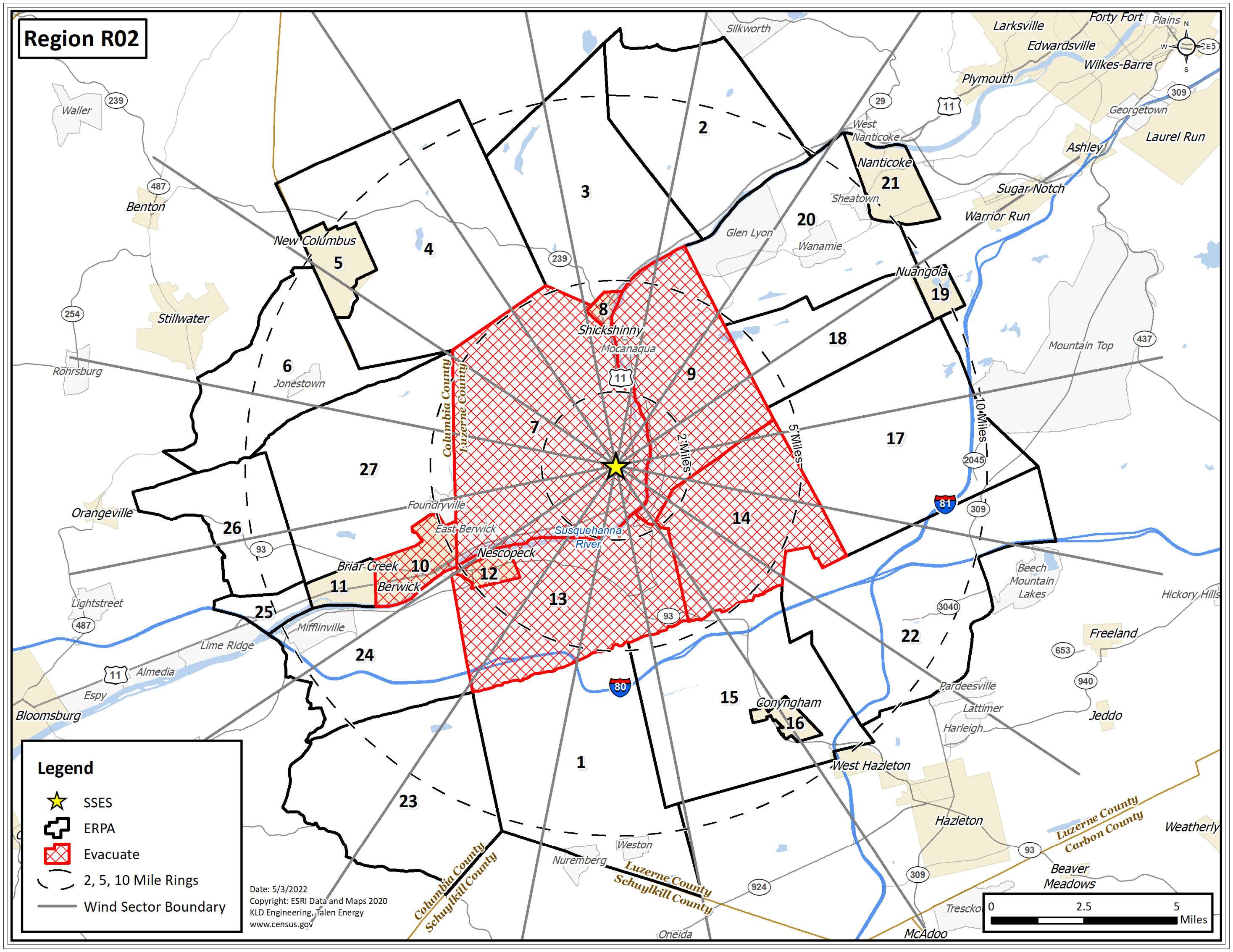


Figure H-2. Region R02

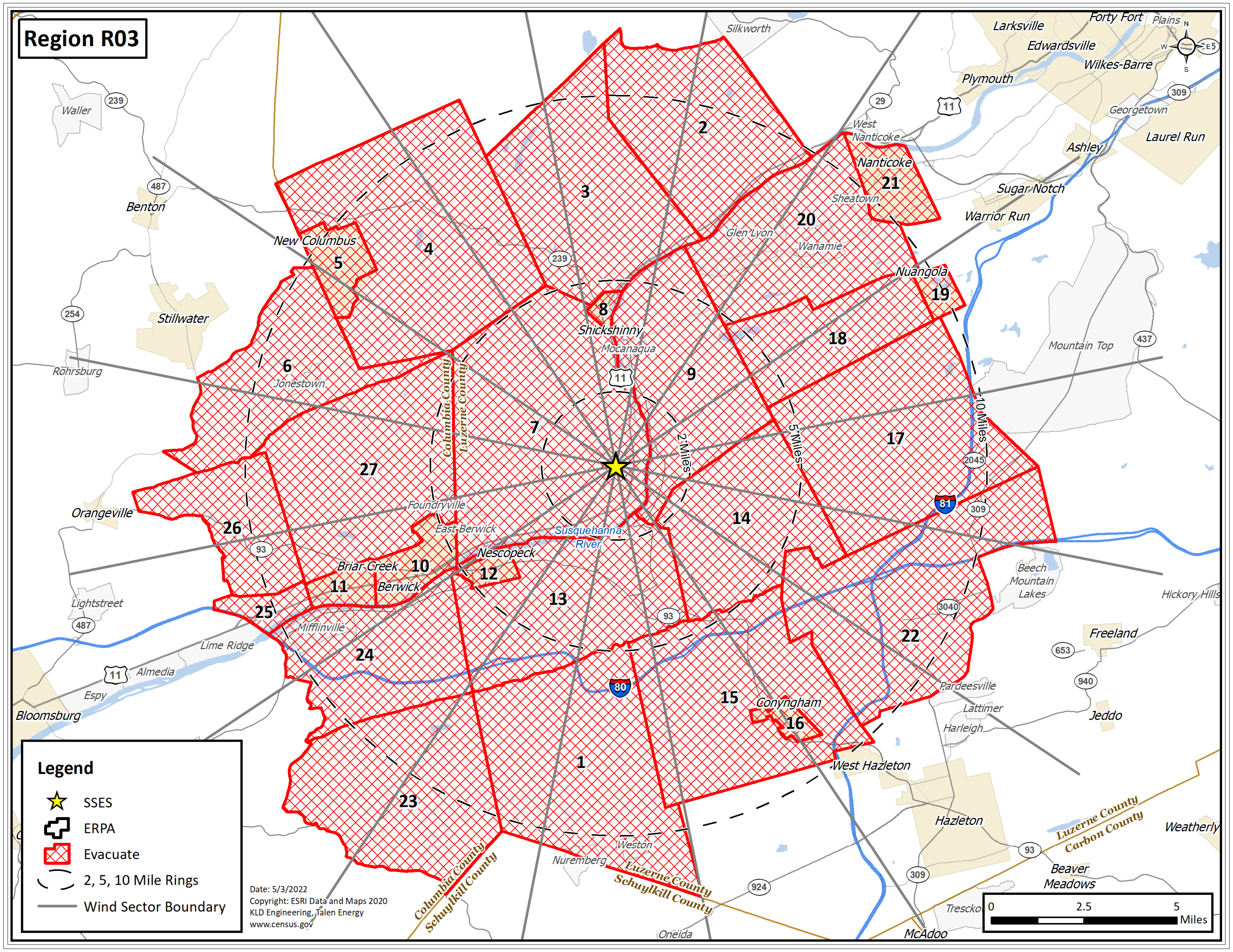


Figure H-3. Region R03

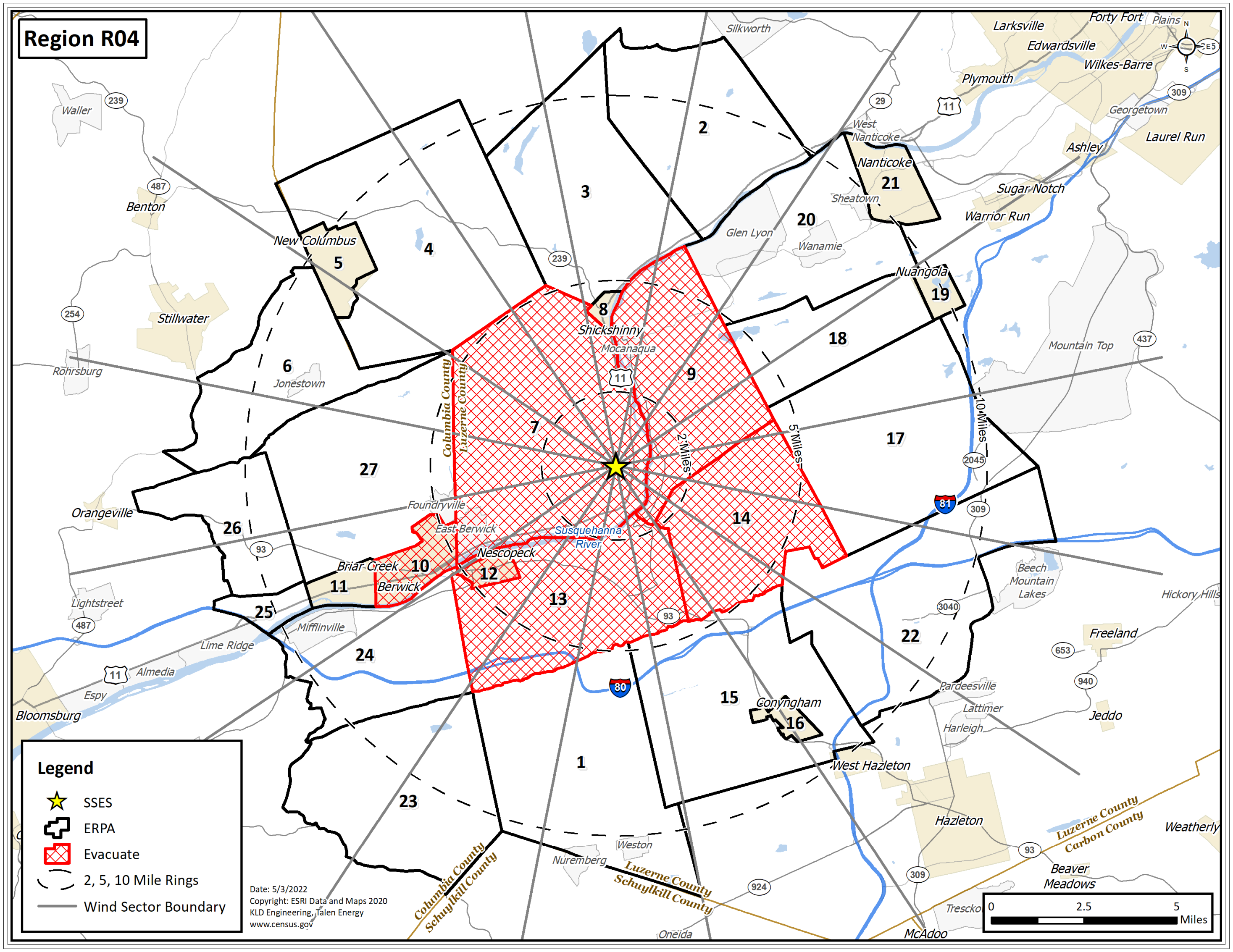


Figure H-4. Region R04

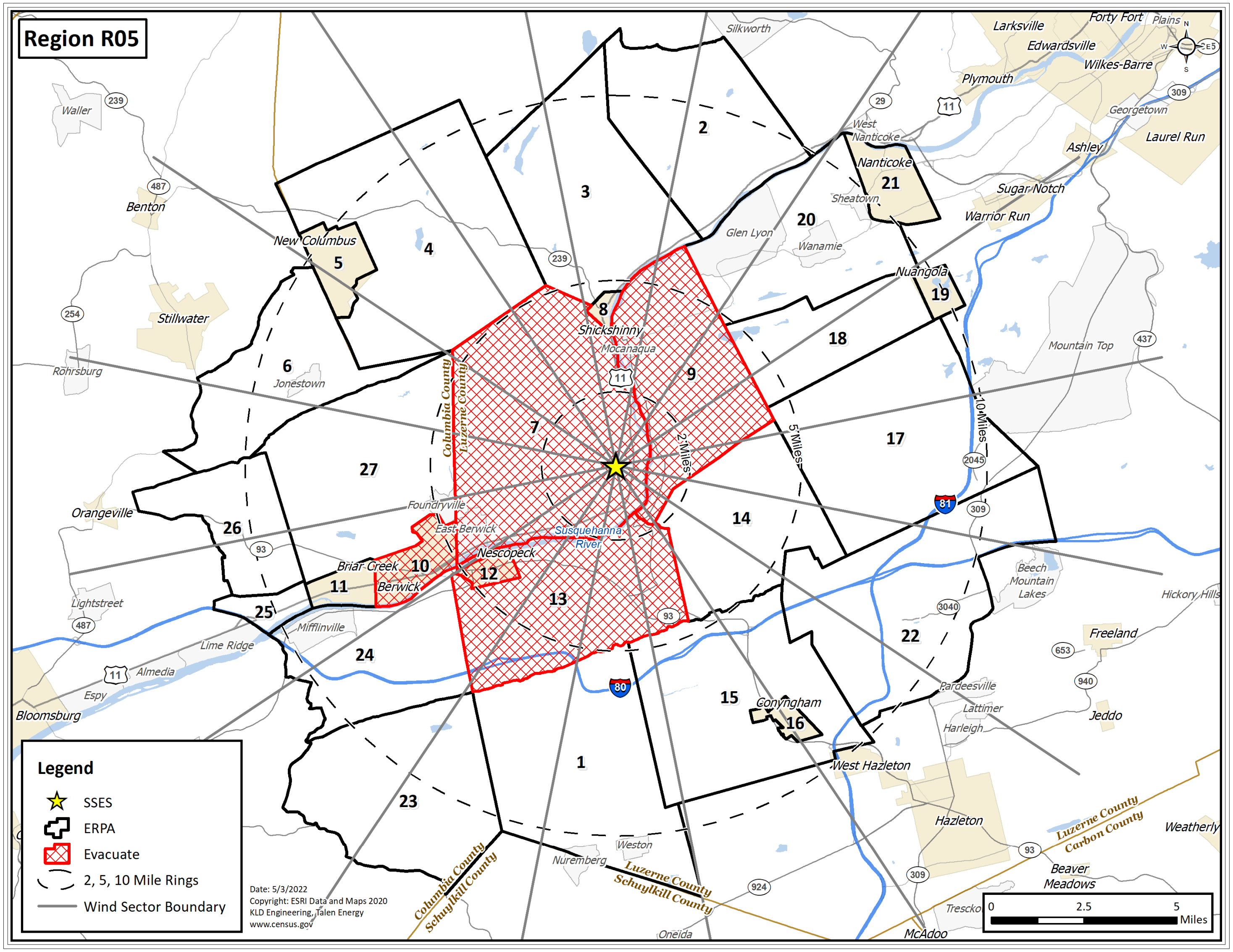


Figure H-5. Region R05

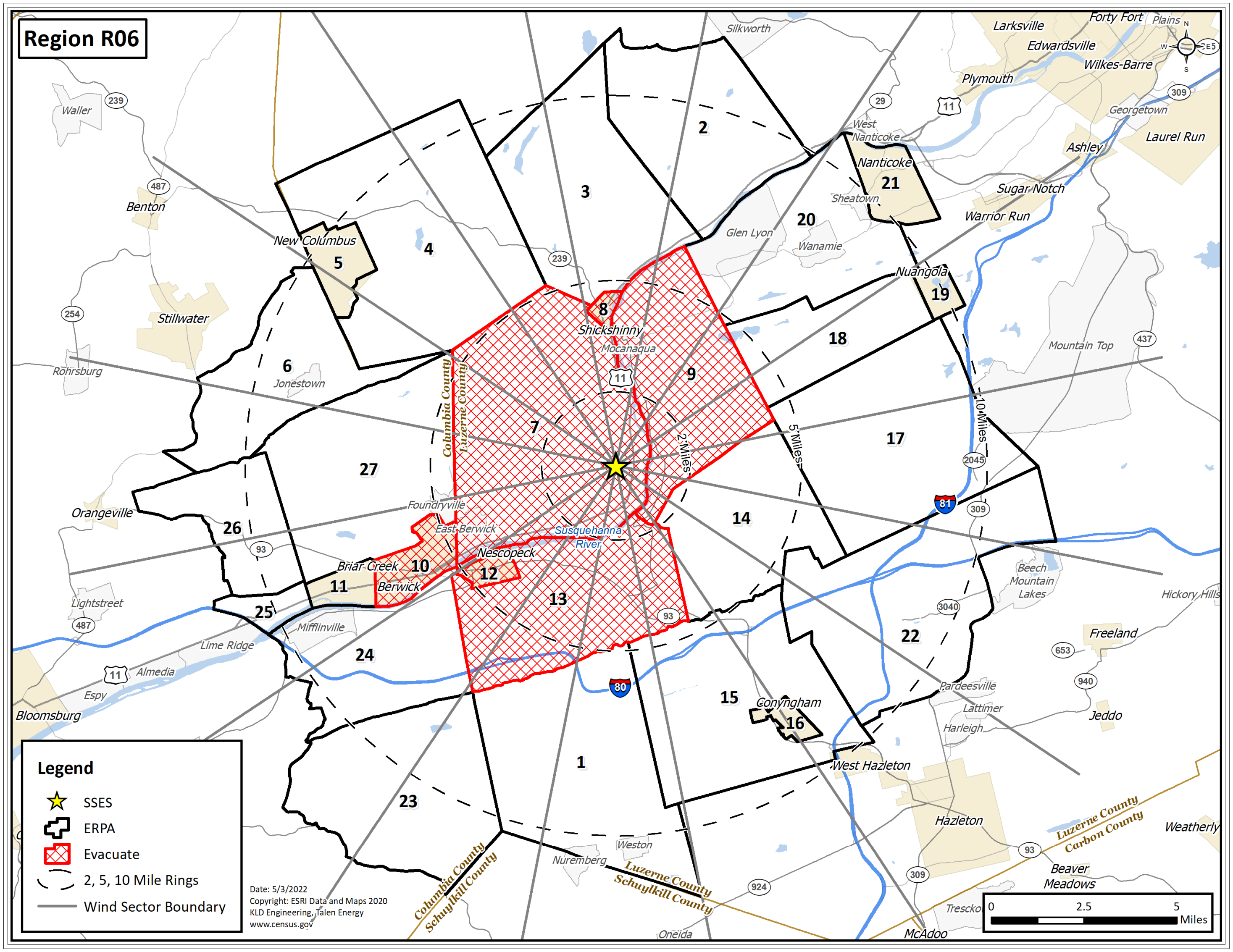


Figure H-6. Region R06

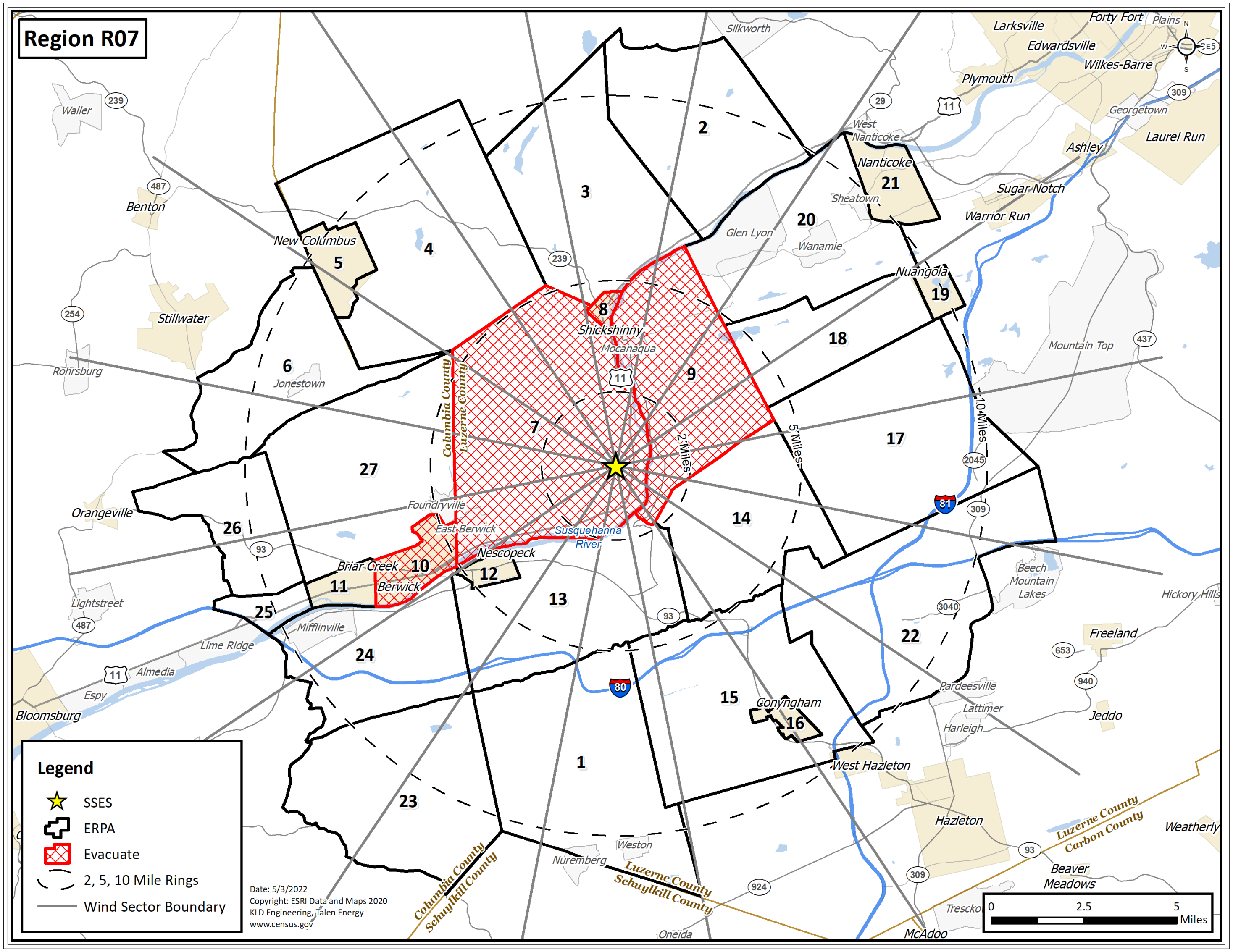


Figure H-7. Region R07

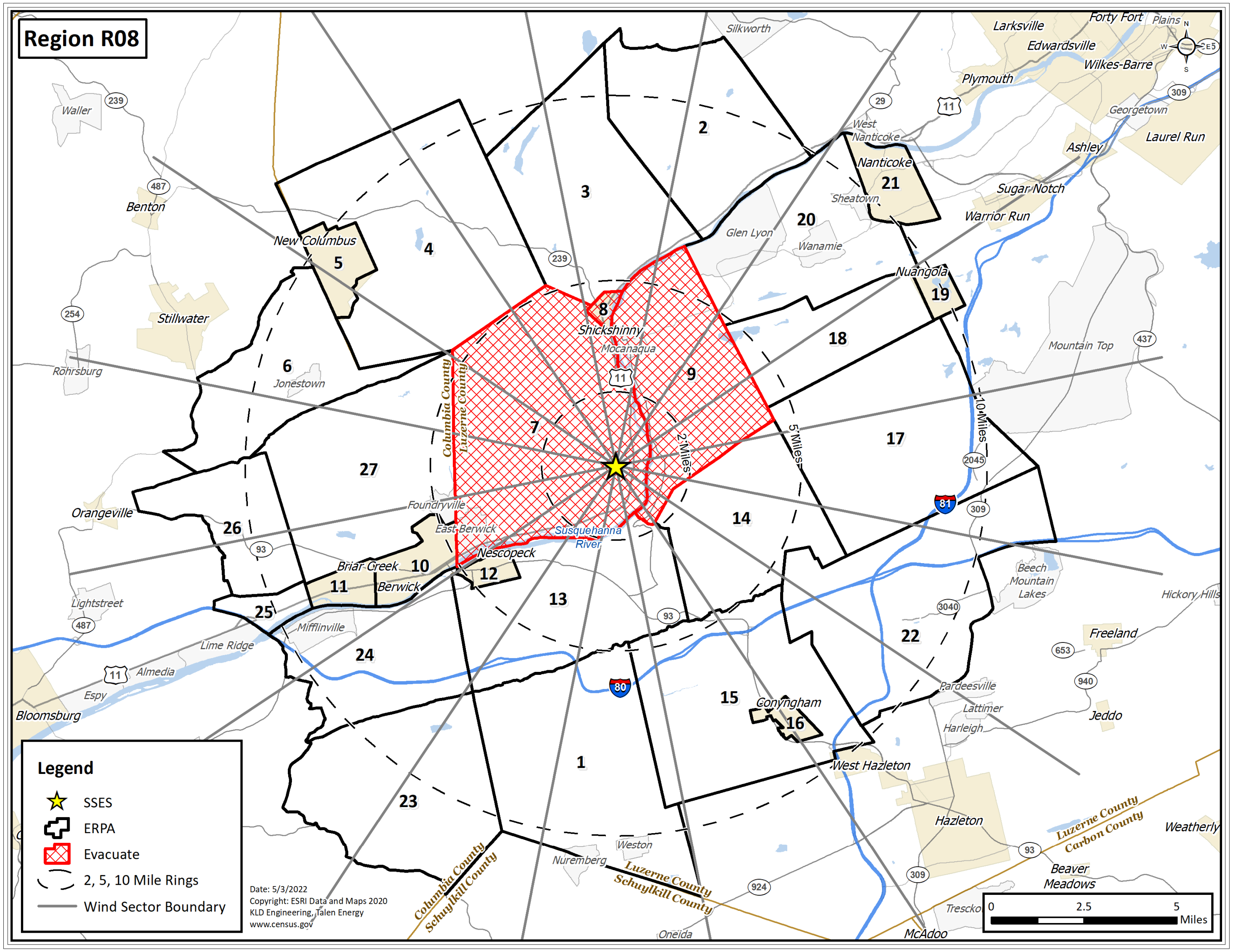


Figure H-8. Region R08

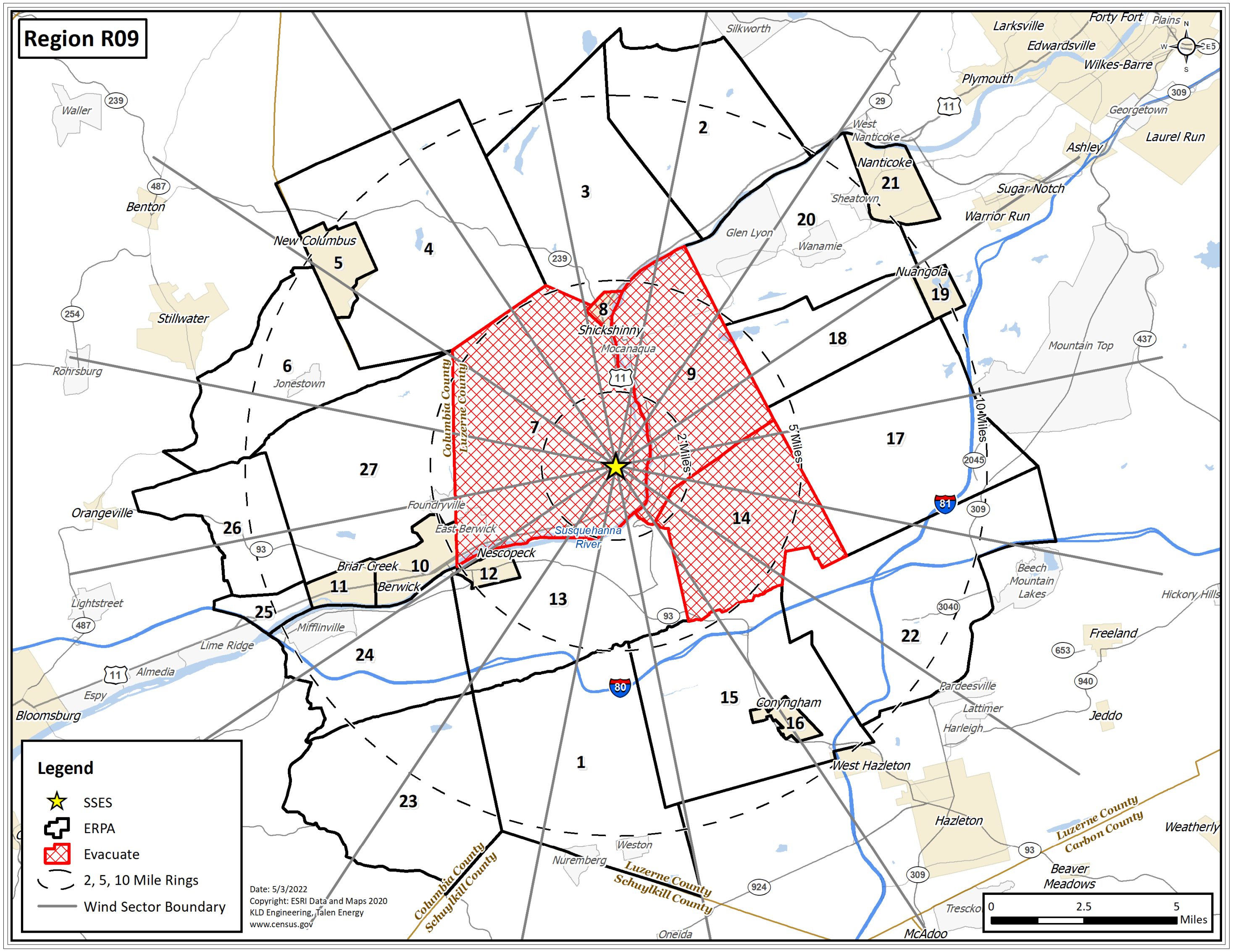


Figure H-9. Region R09

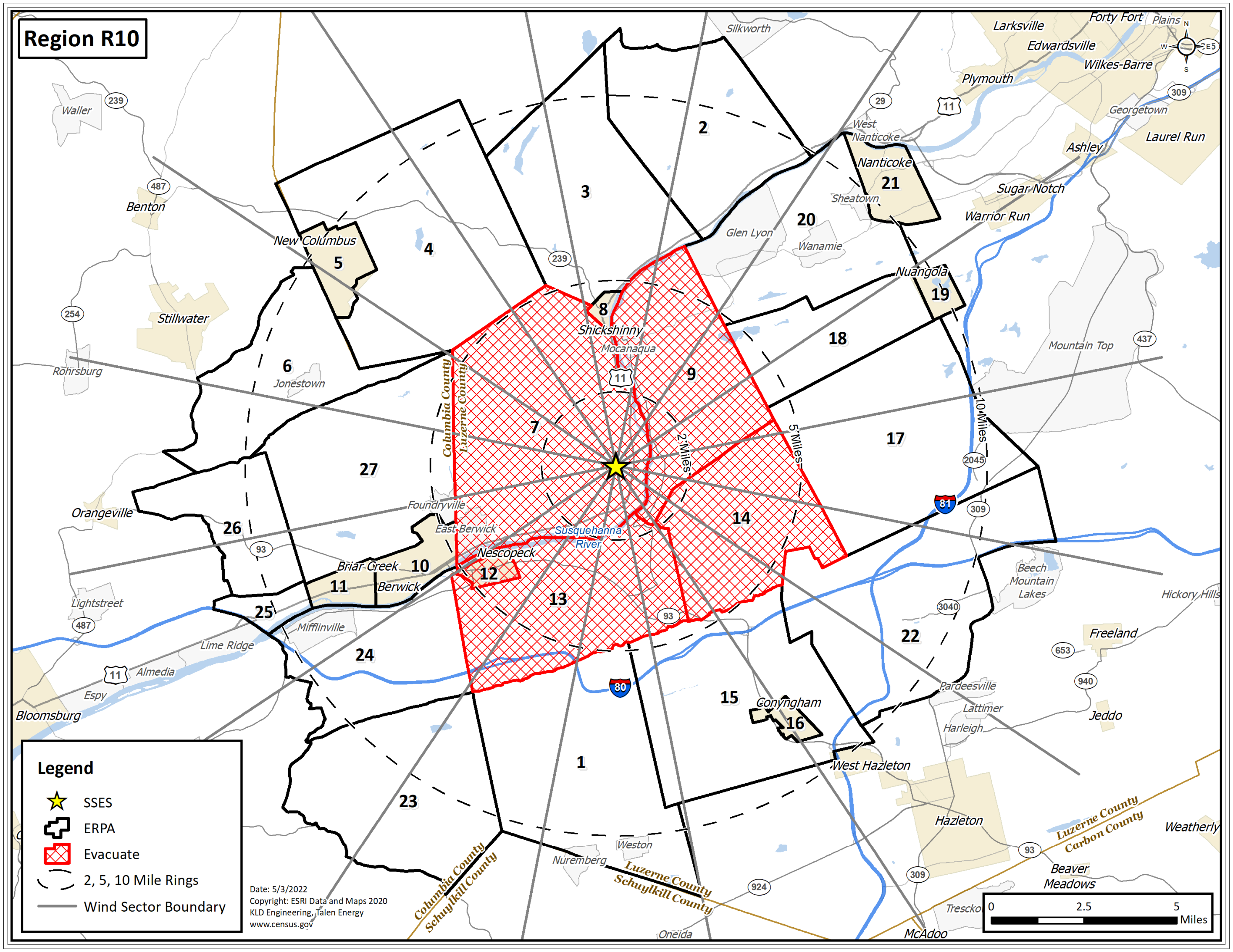


Figure H-10. Region R10

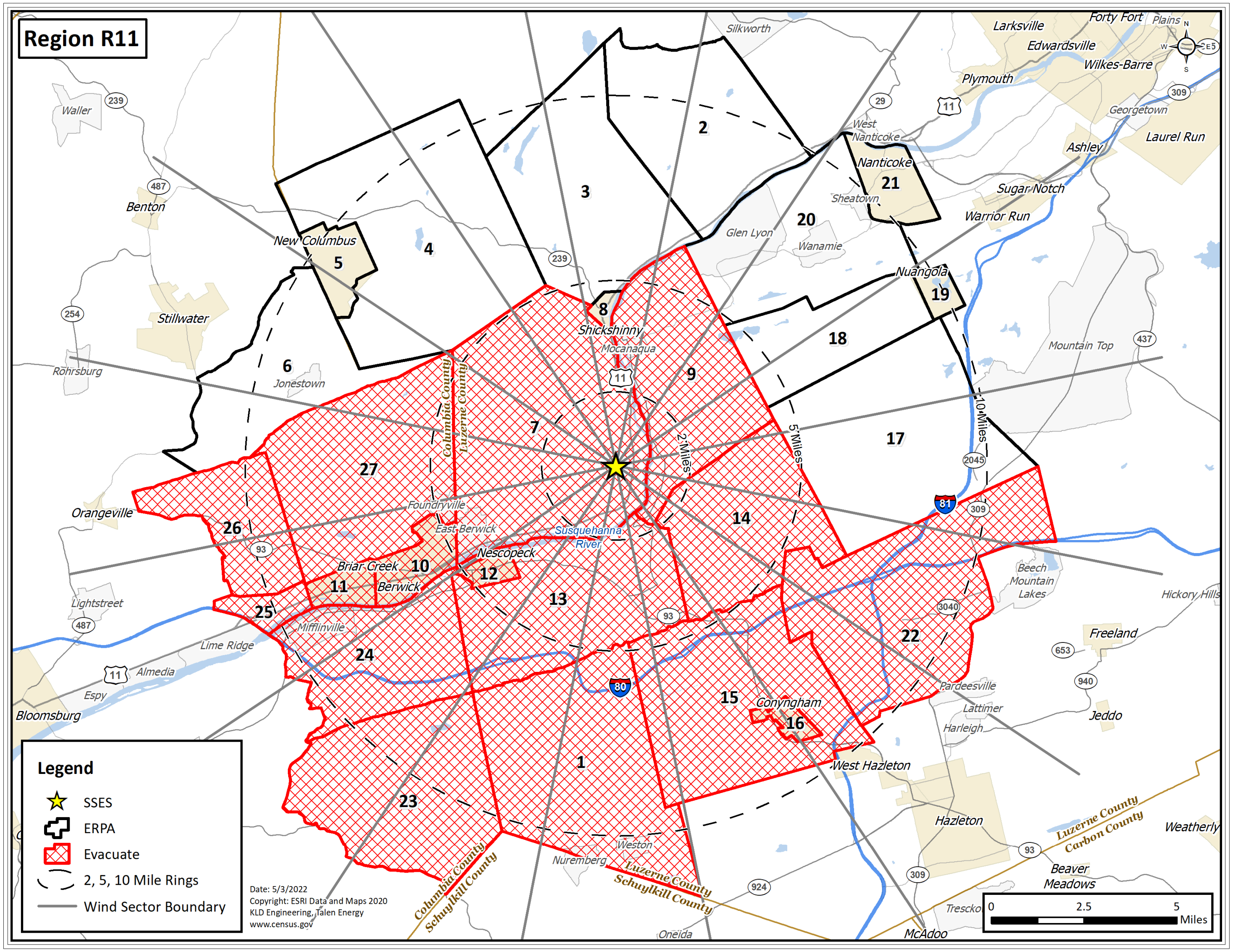


Figure H-11. Region R11

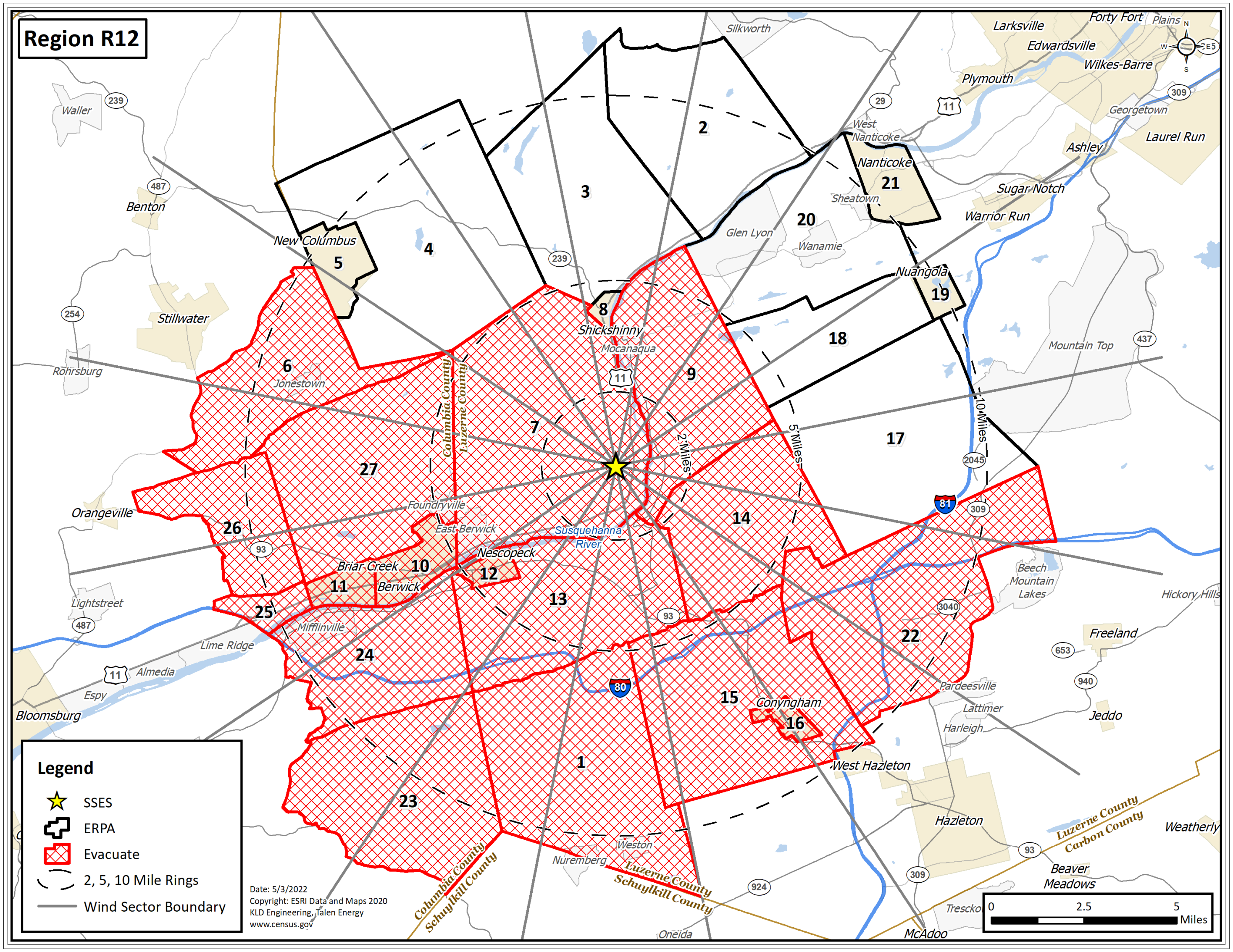


Figure H-12. Region R12

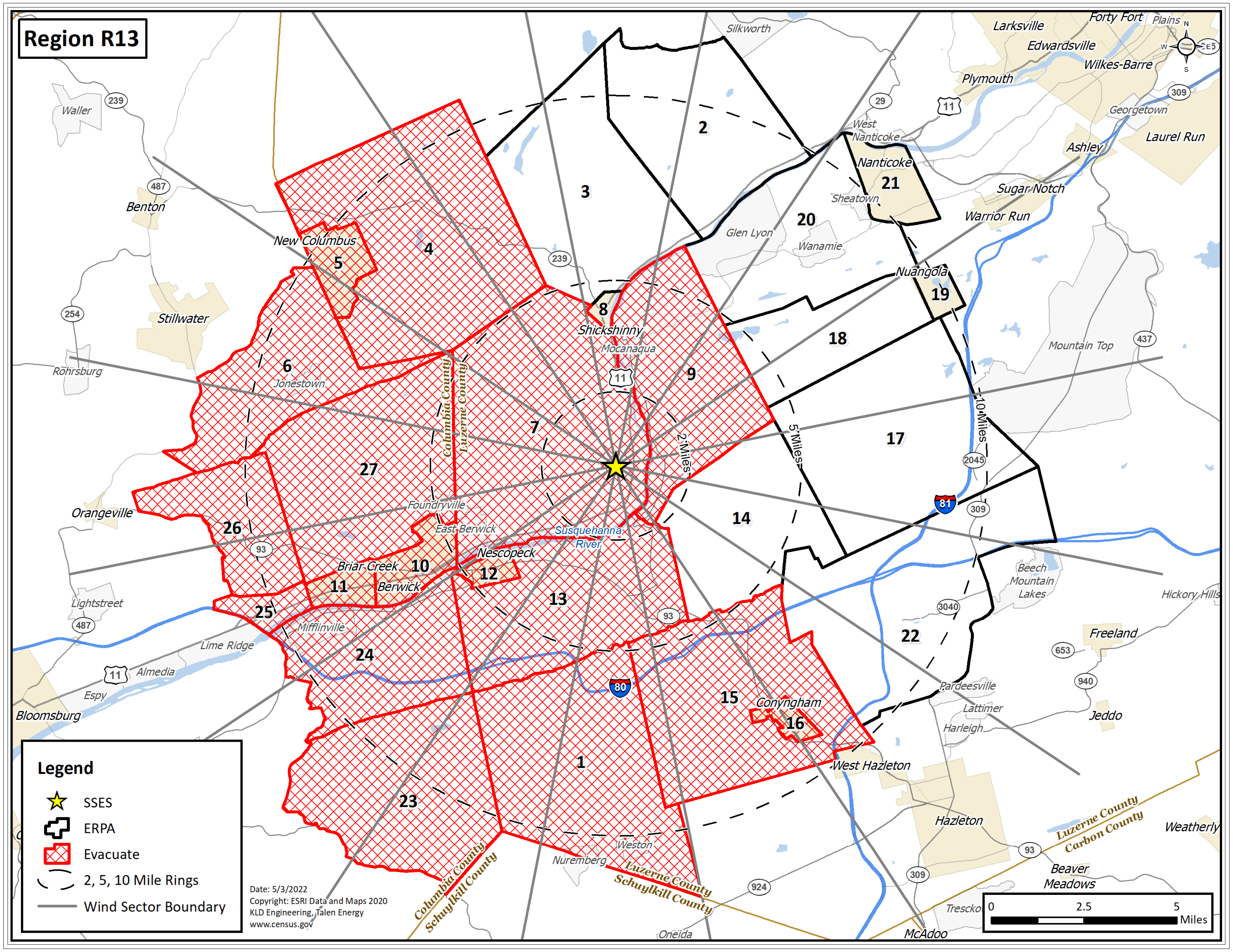


Figure H-13. Region R13

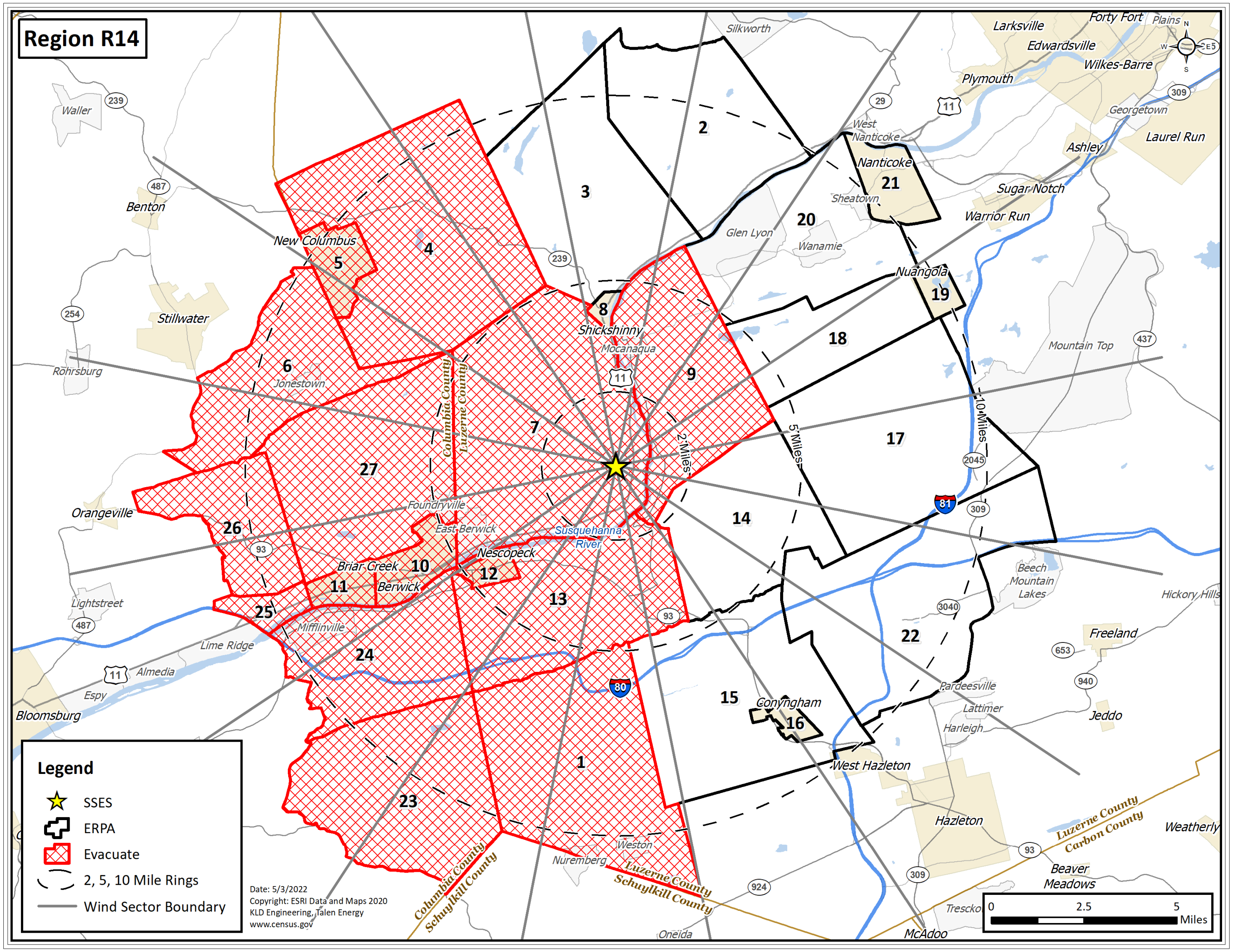


Figure H-14. Region R14

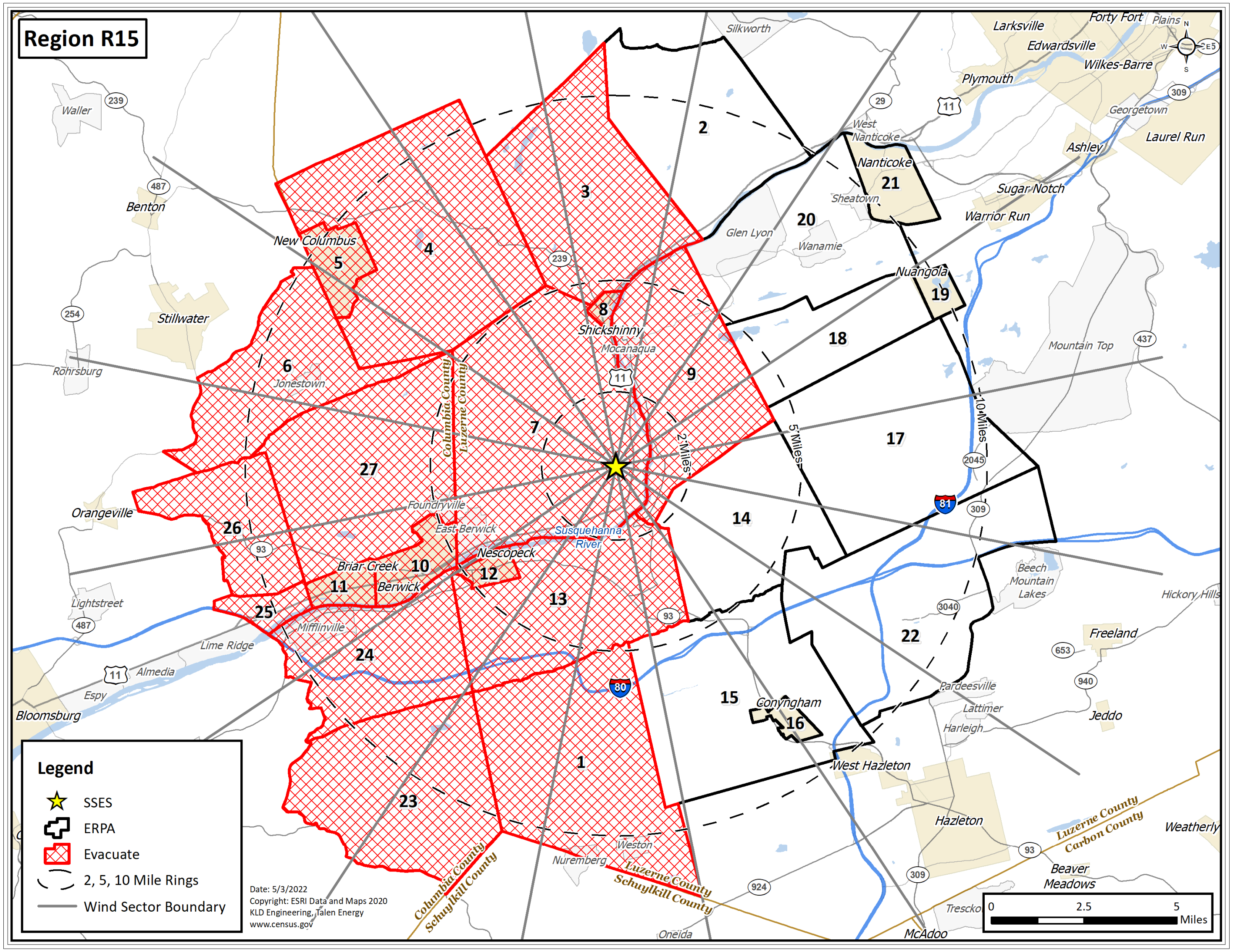


Figure H-15. Region R15

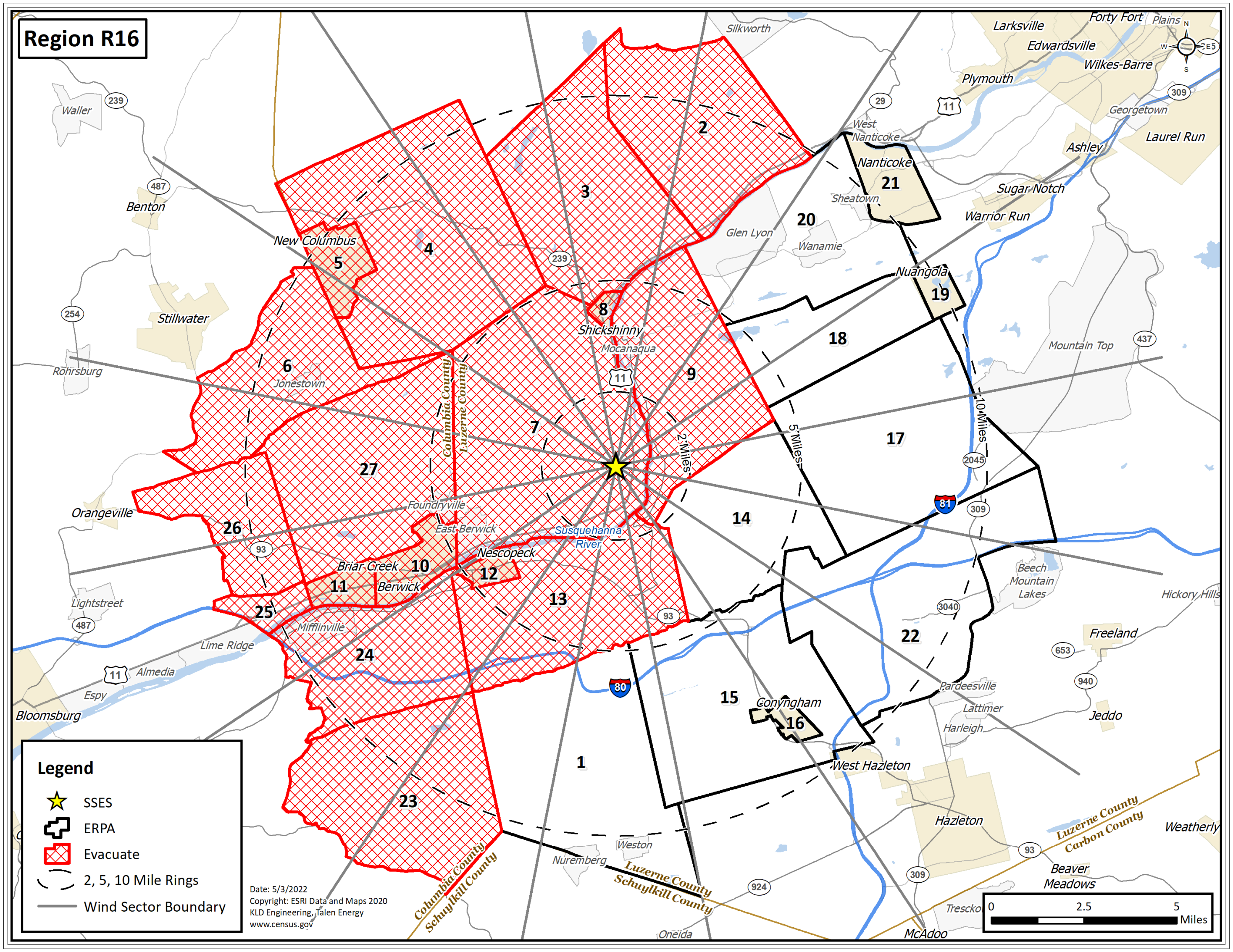


Figure H-16. Region R16

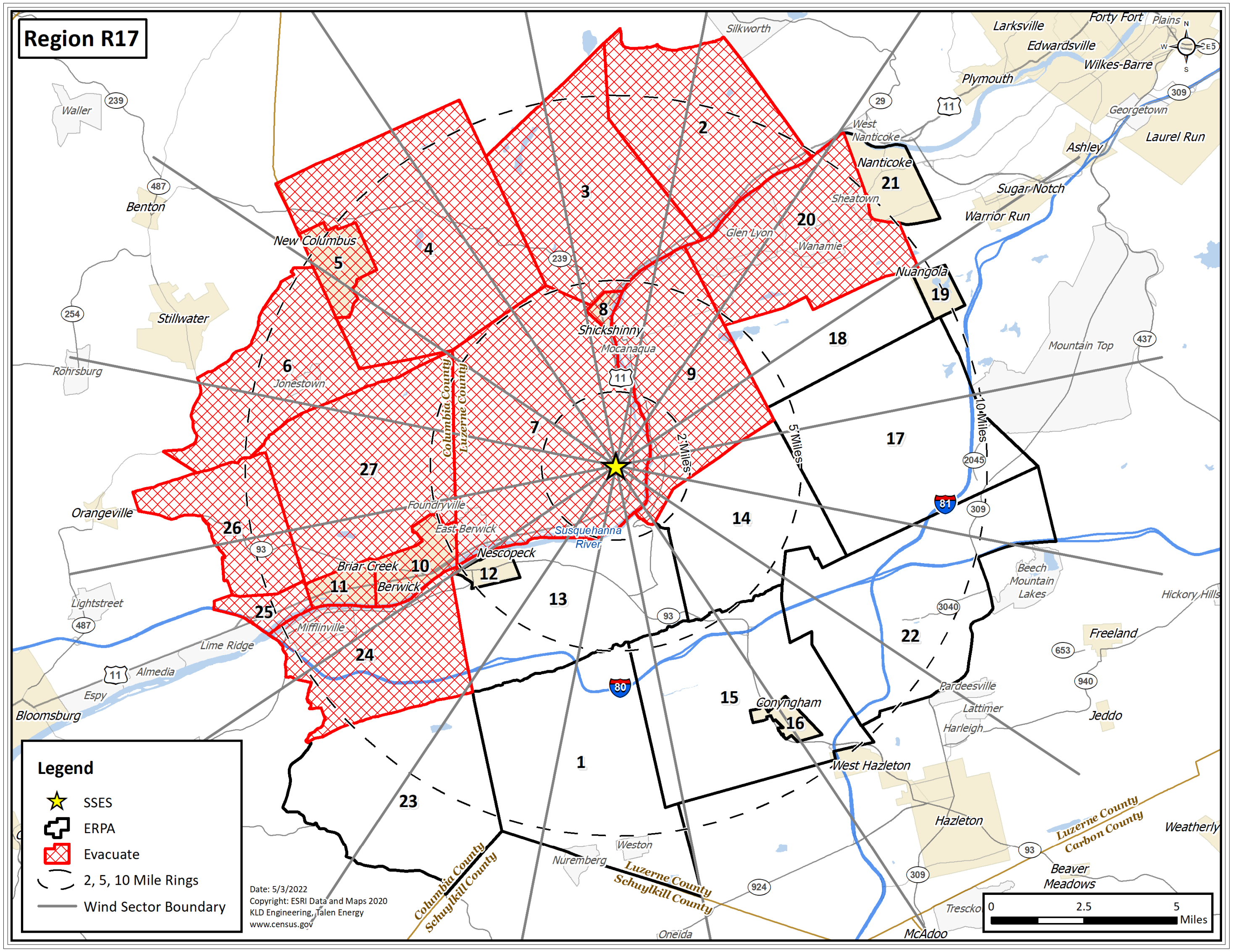


Figure H-17. Region R17

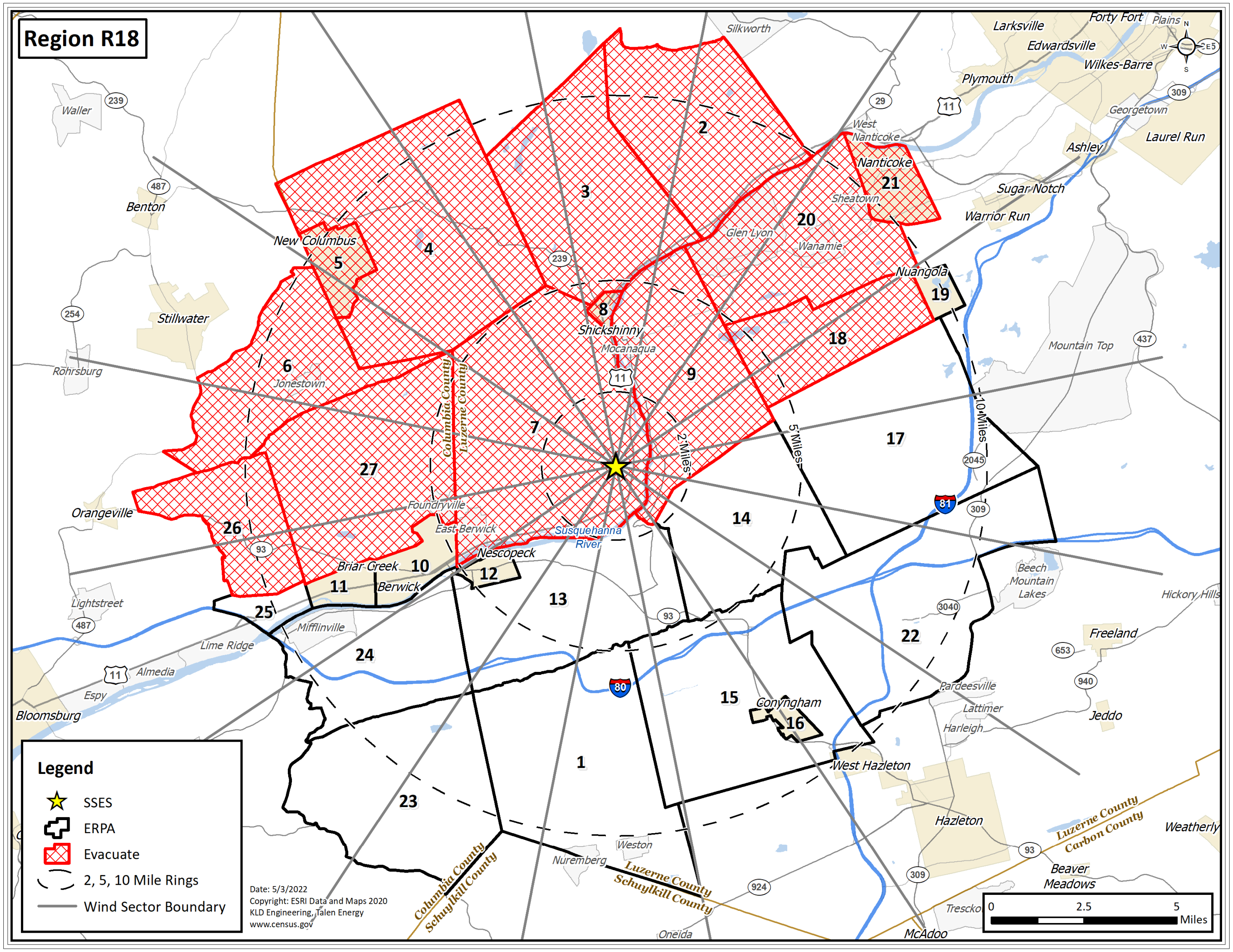


Figure H-18. Region R18

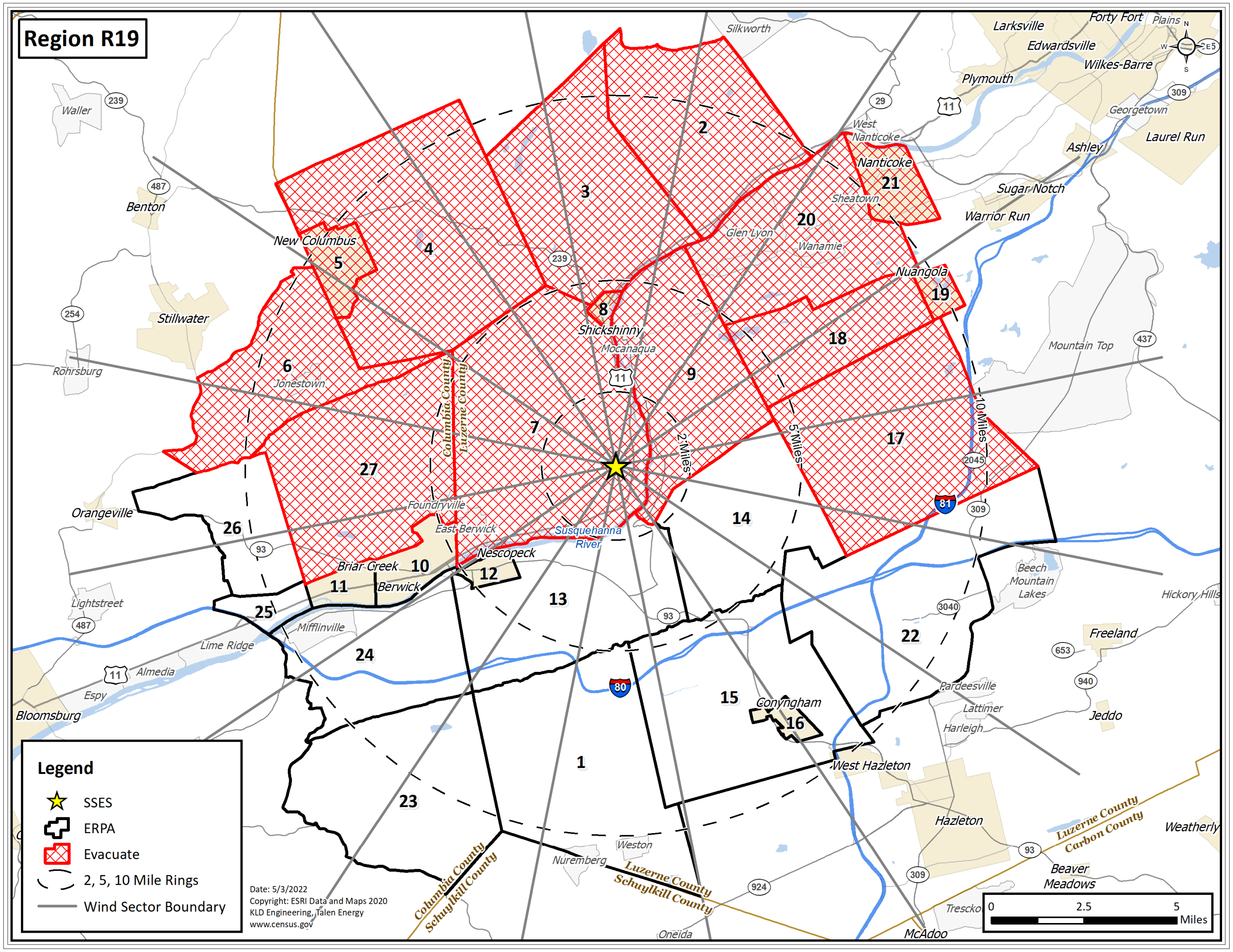


Figure H-19. Region R19

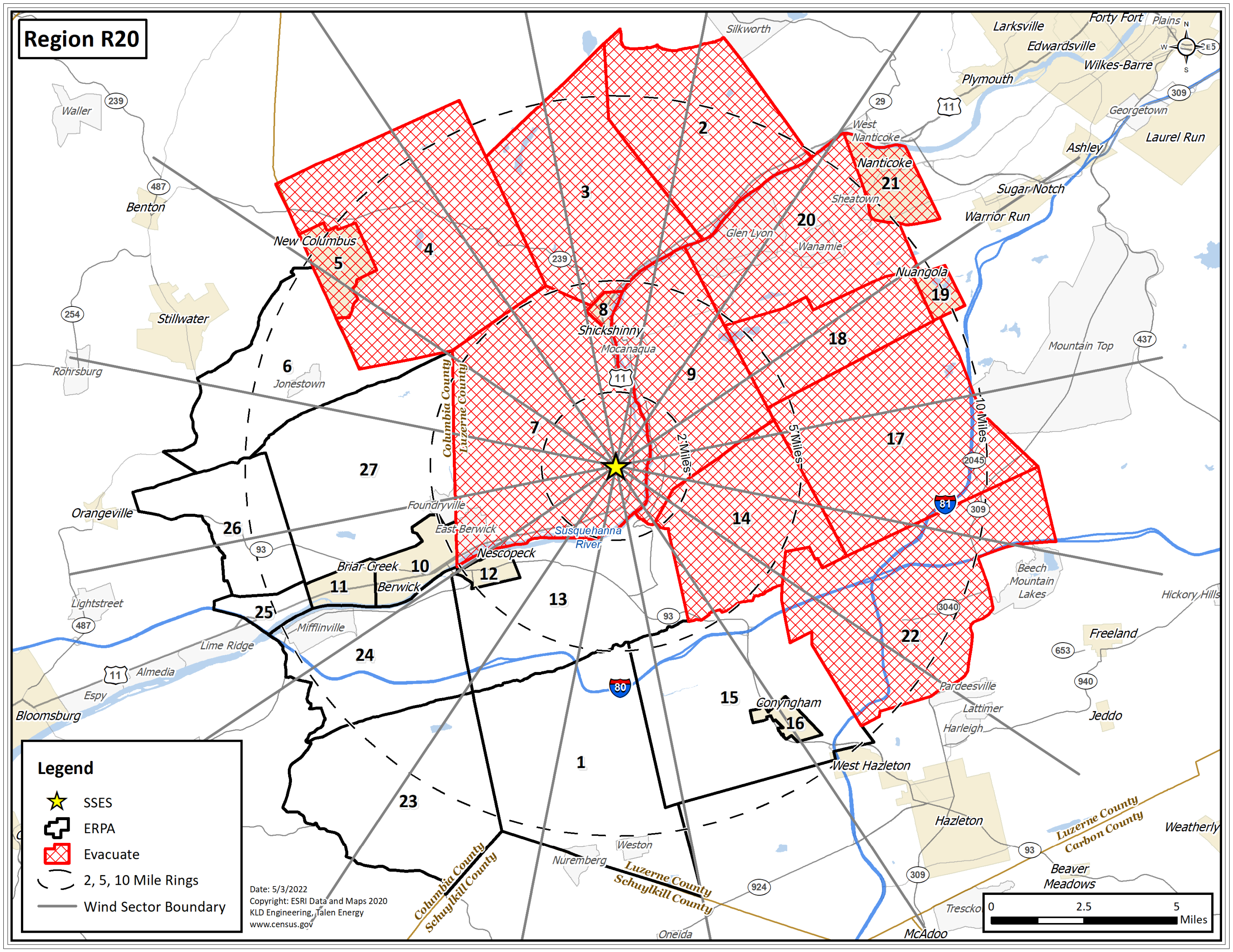


Figure H-20. Region R20

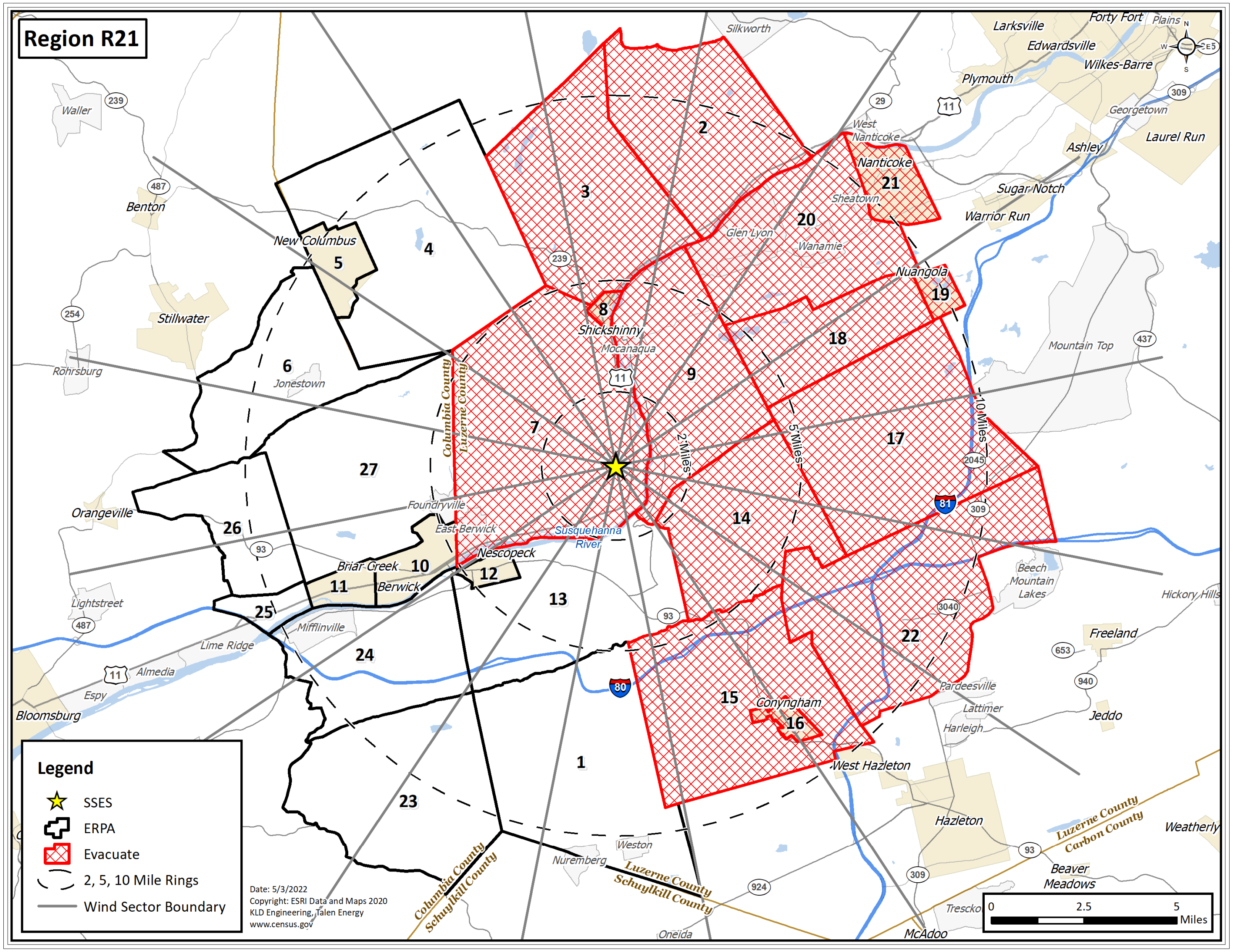


Figure H-21. Region R21

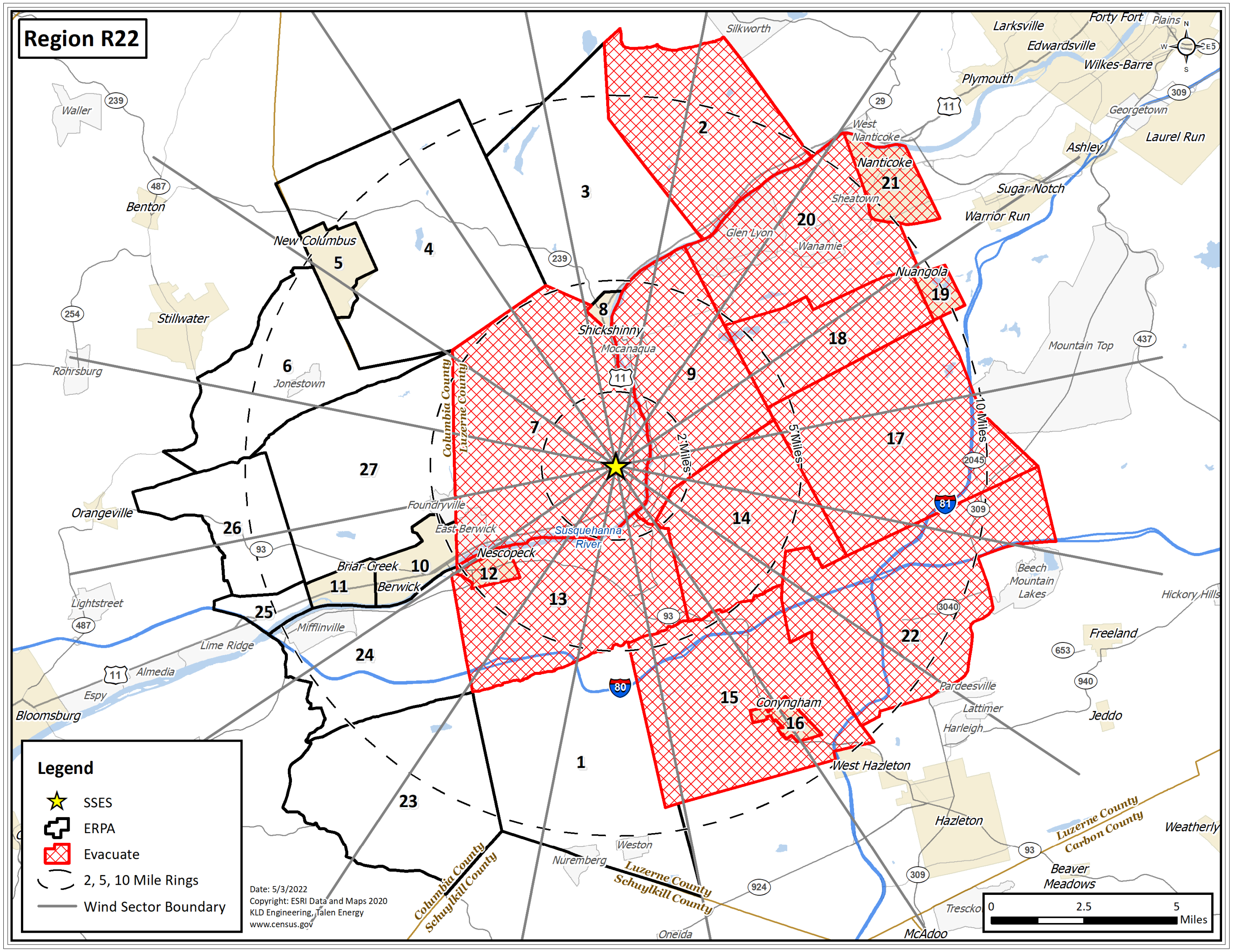


Figure H-22. Region R22

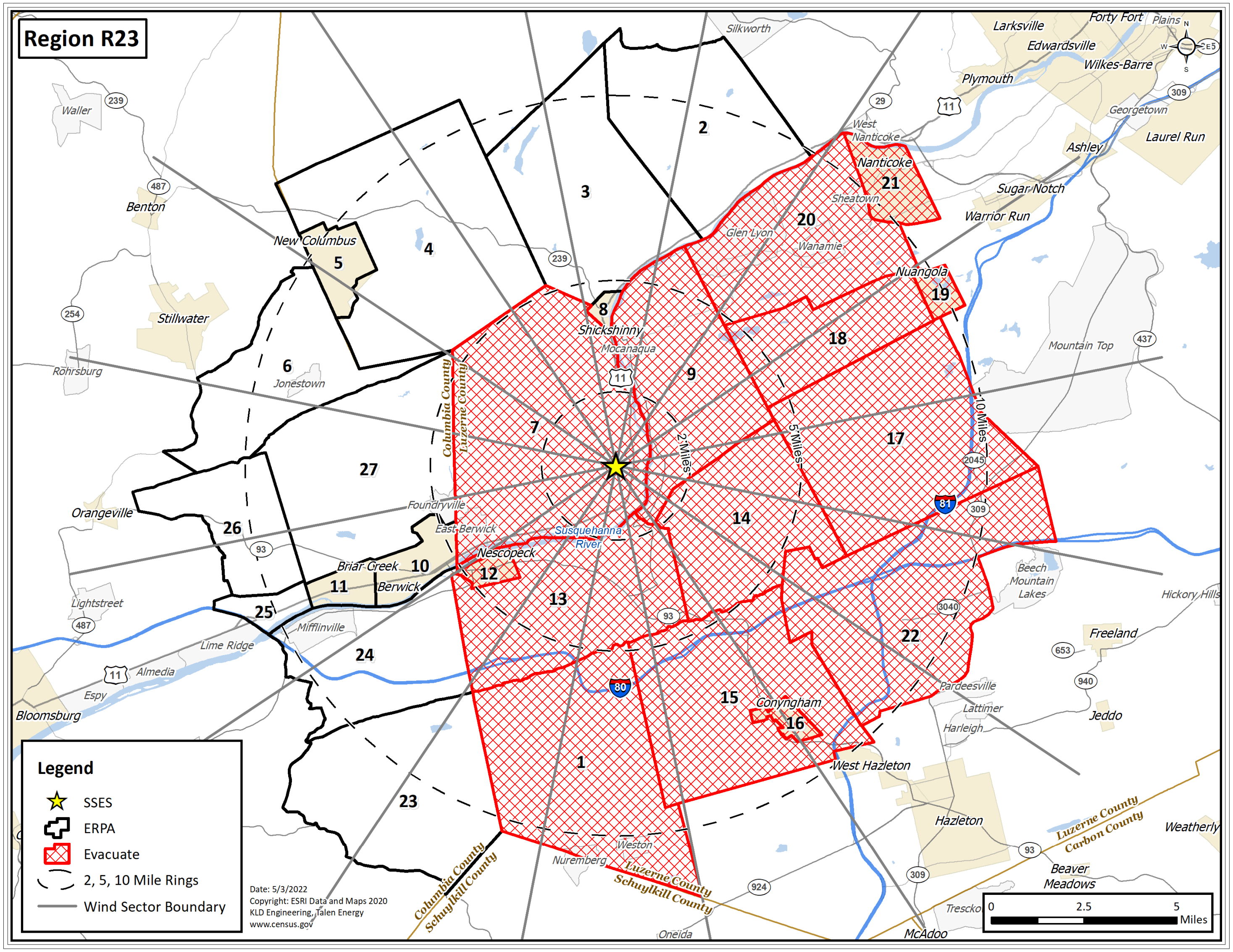


Figure H-23. Region R23

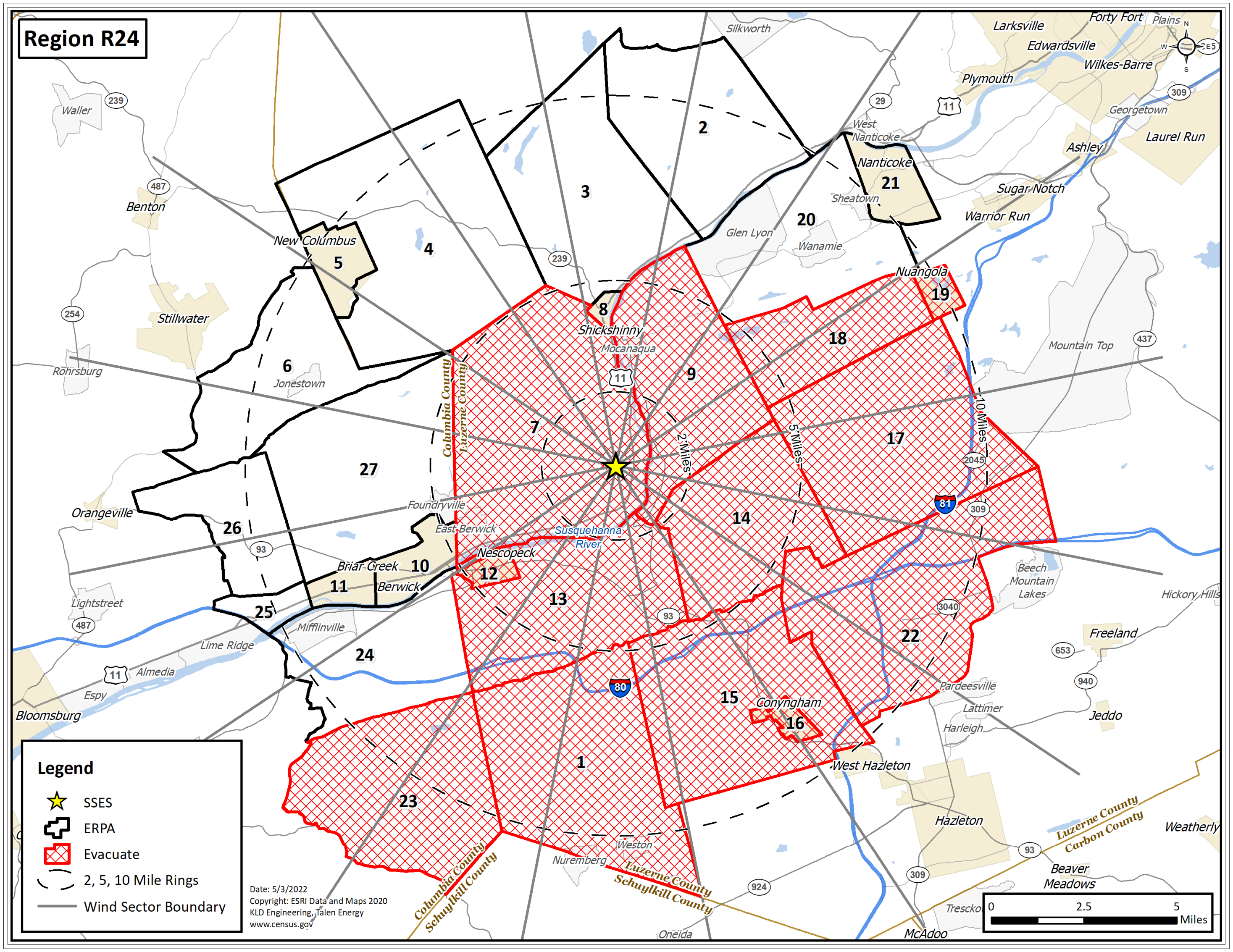


Figure H-24. Region R24

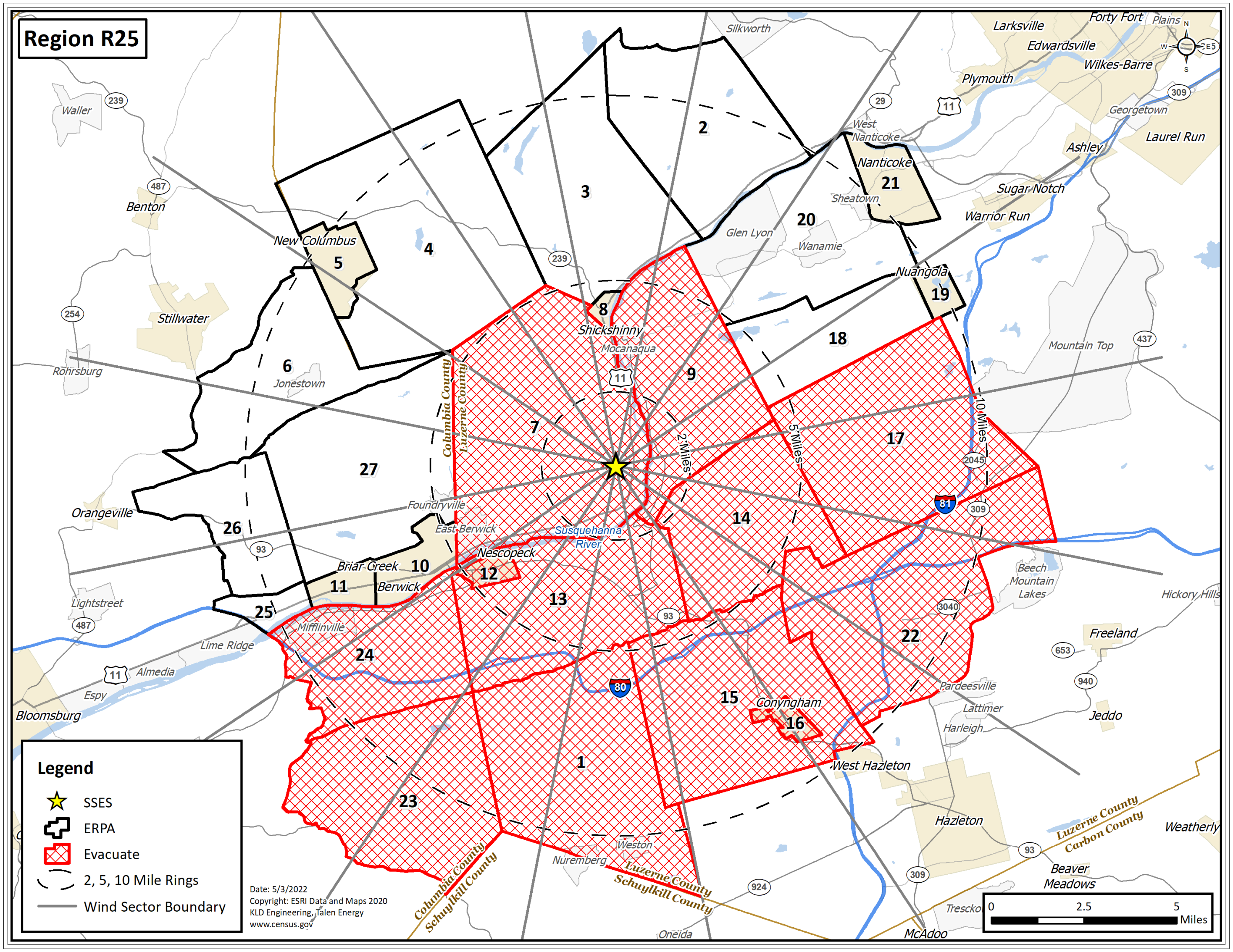


Figure H-25. Region R25

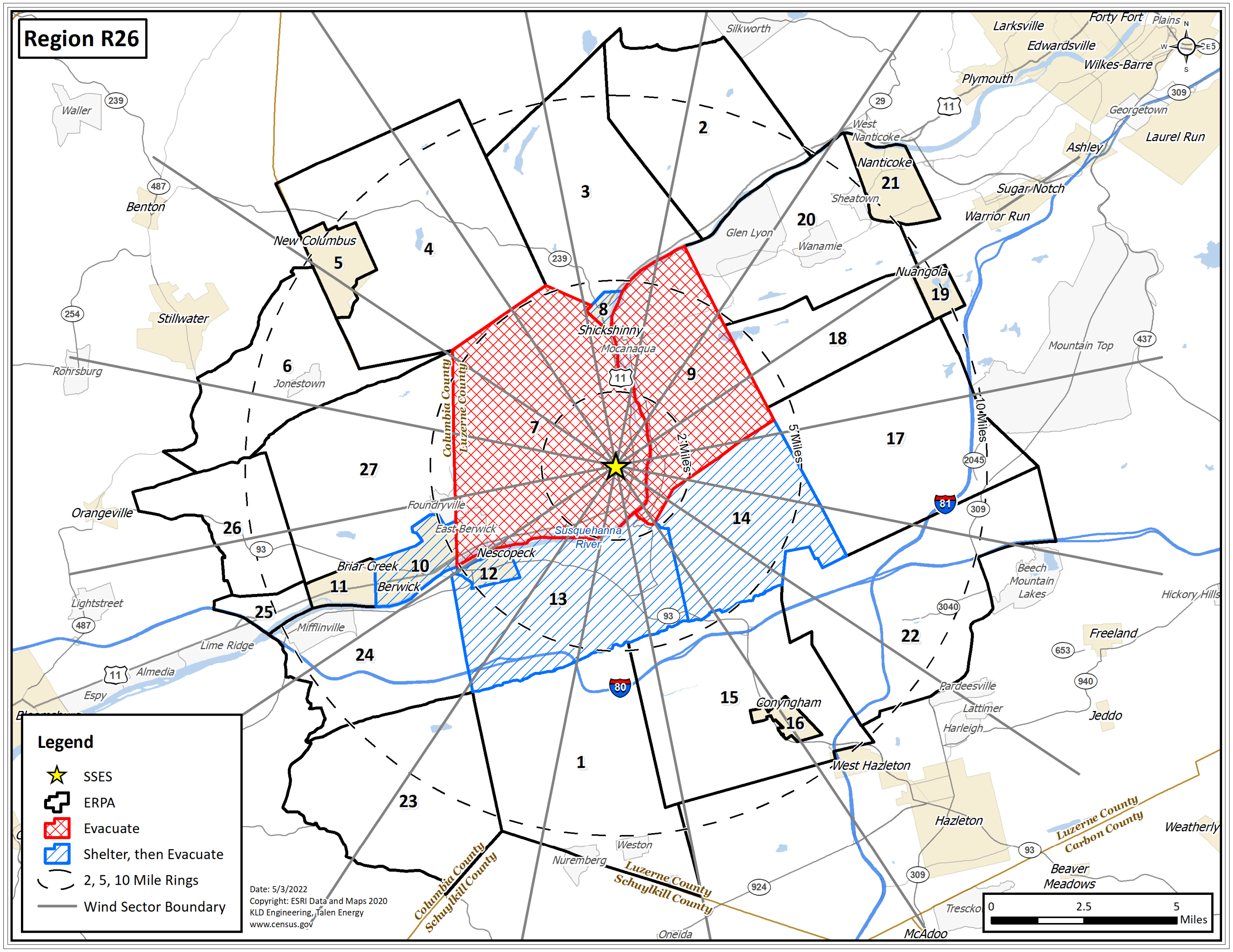


Figure H-26. Region R26

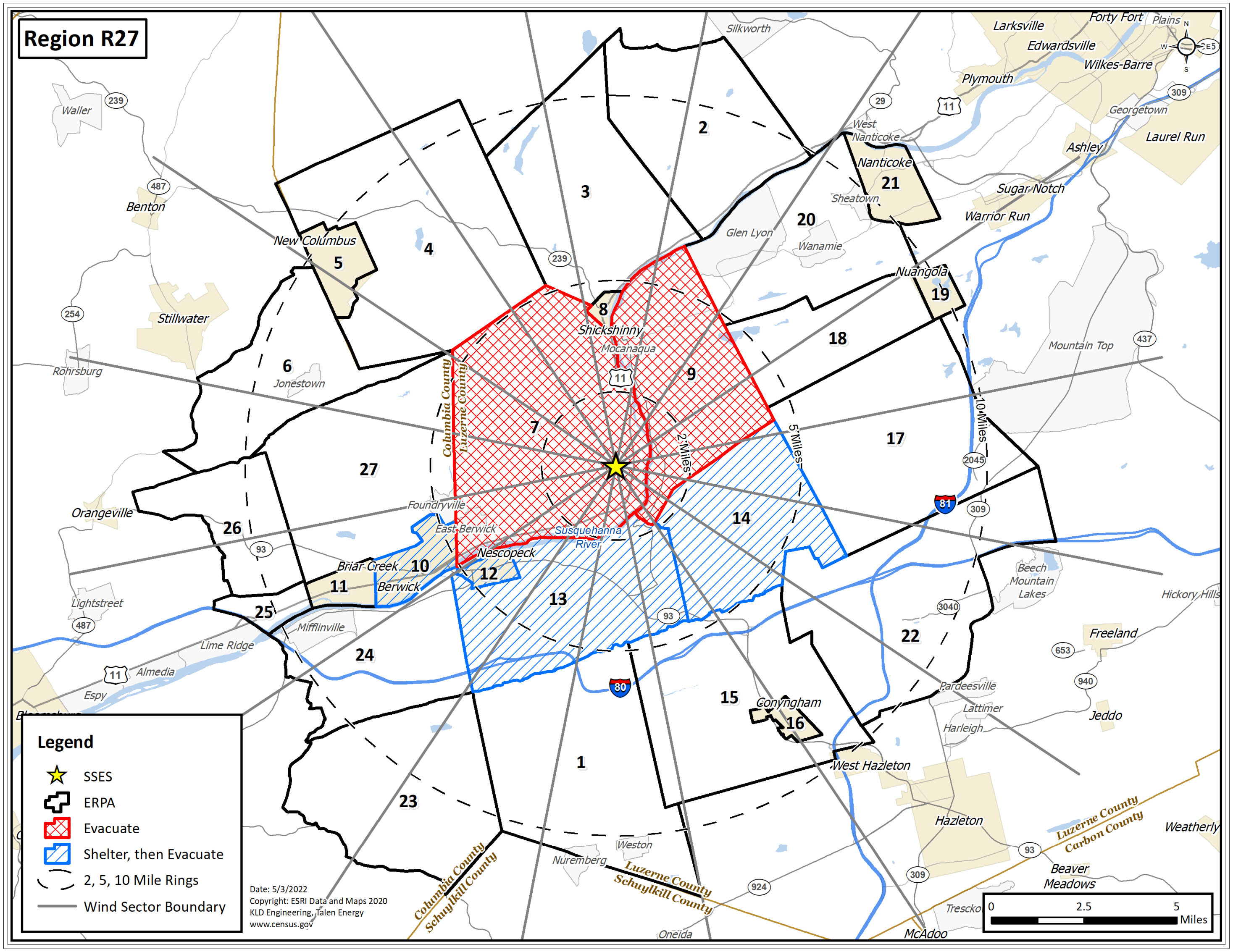


Figure H-27. Region R27

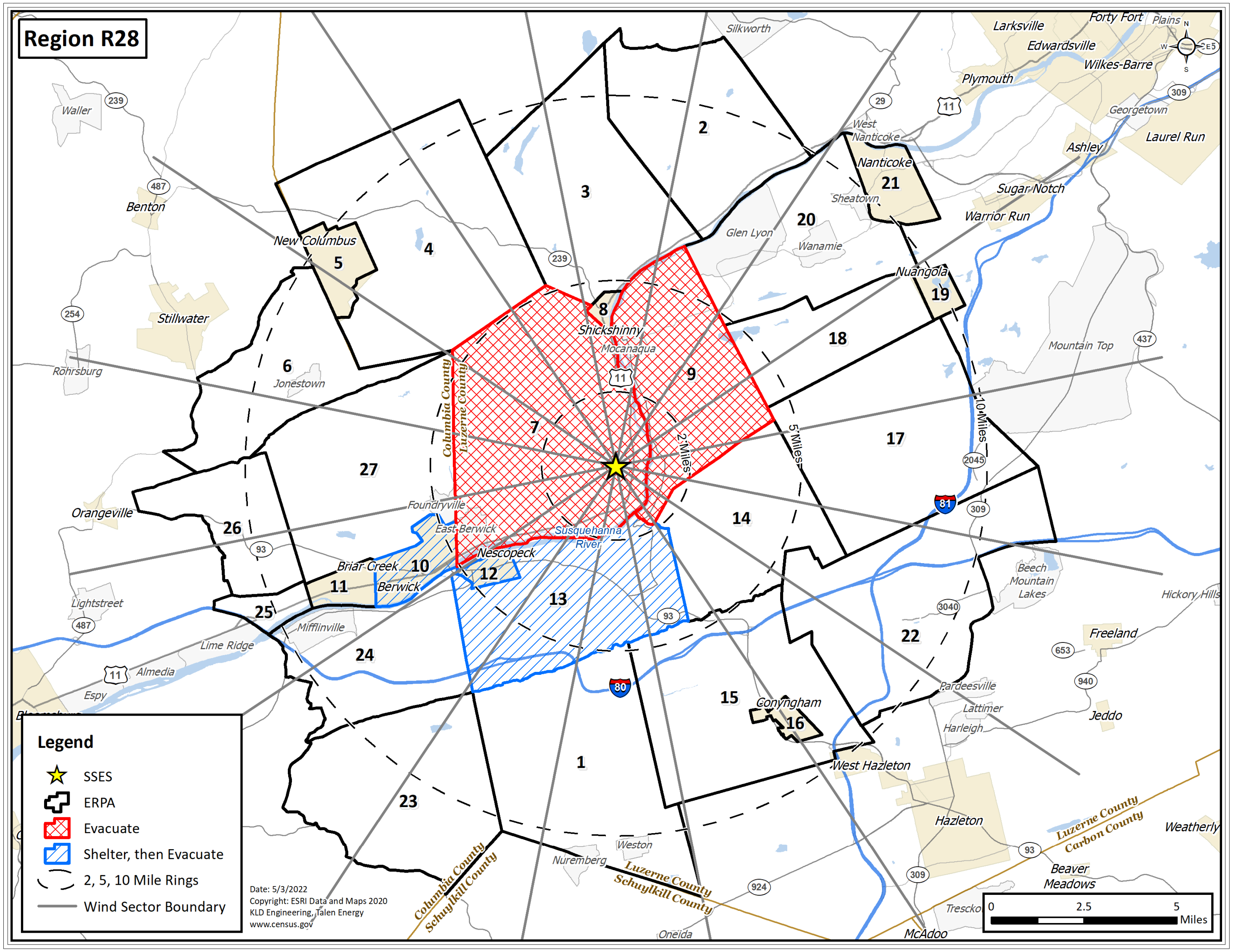


Figure H-28. Region R28

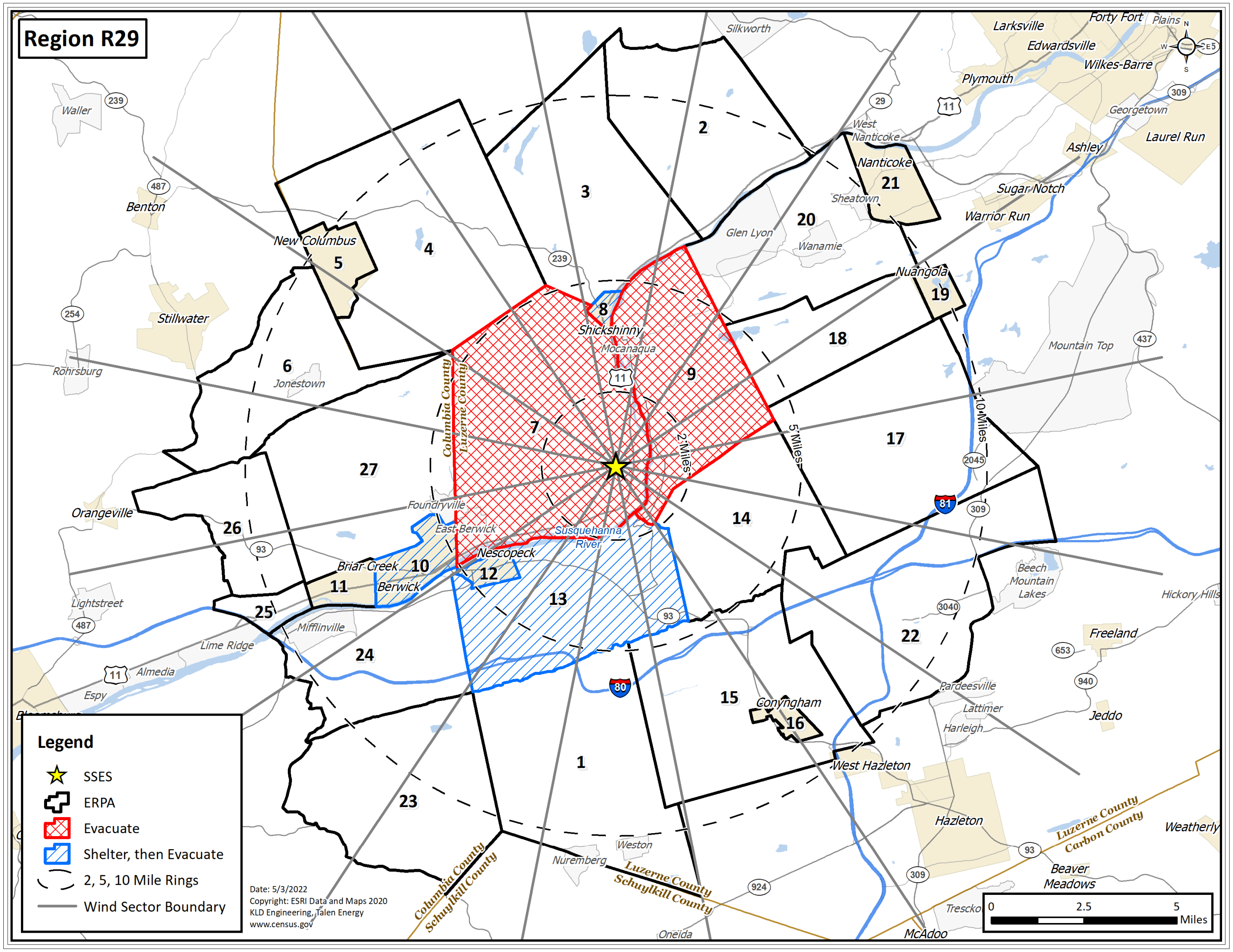


Figure H-29. Region R29

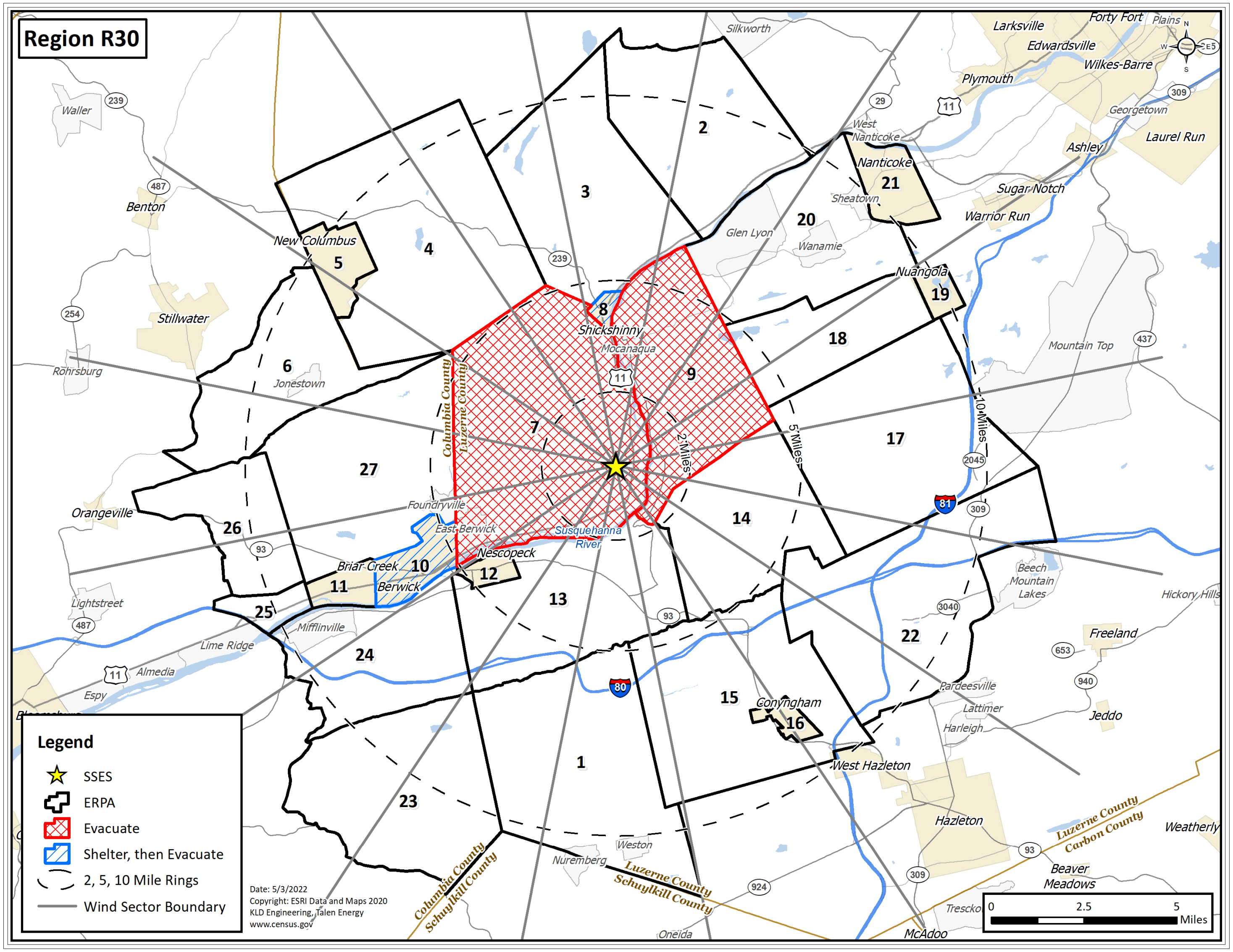


Figure H-30. Region R30

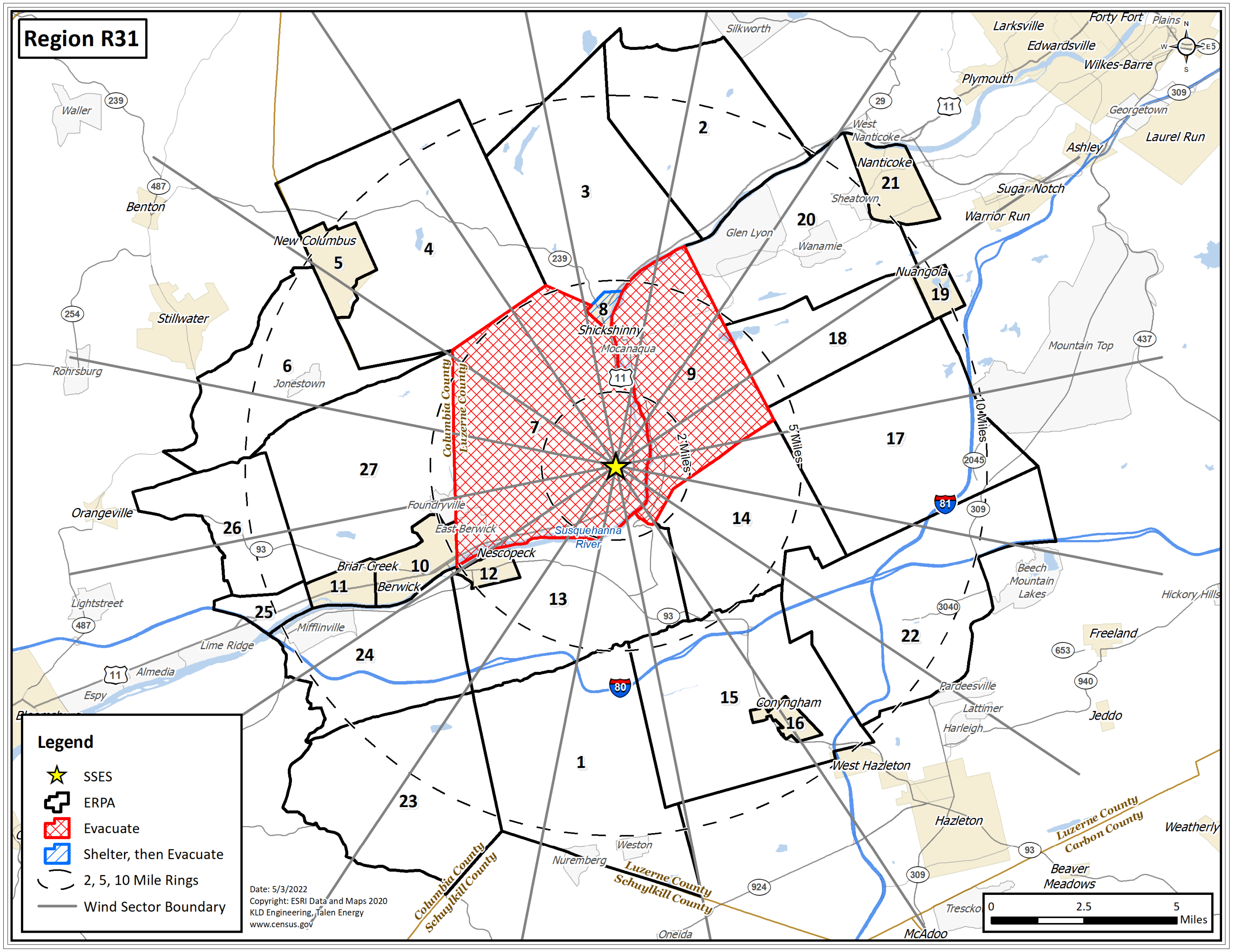


Figure H-31. Region R31

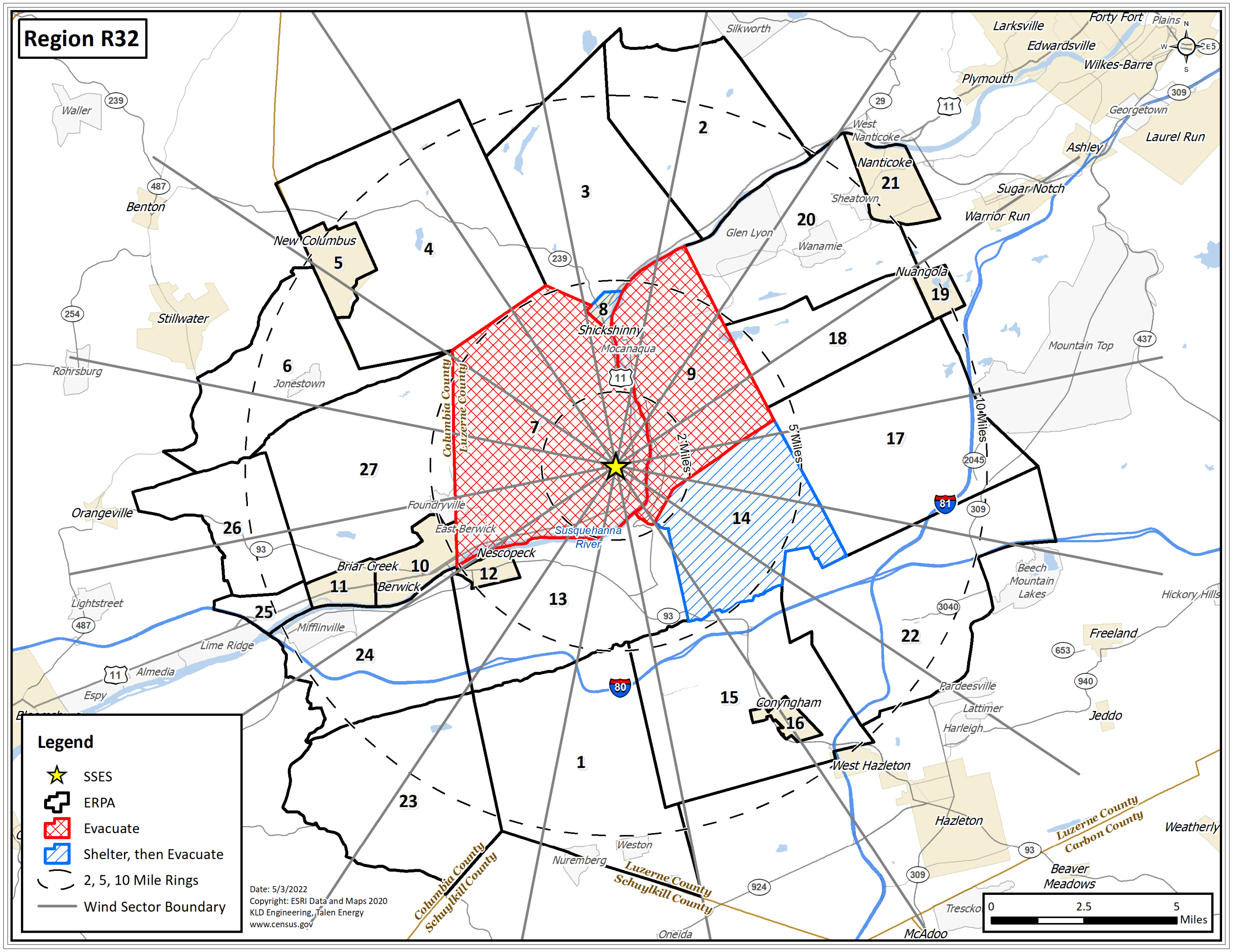


Figure H-32. Region R32

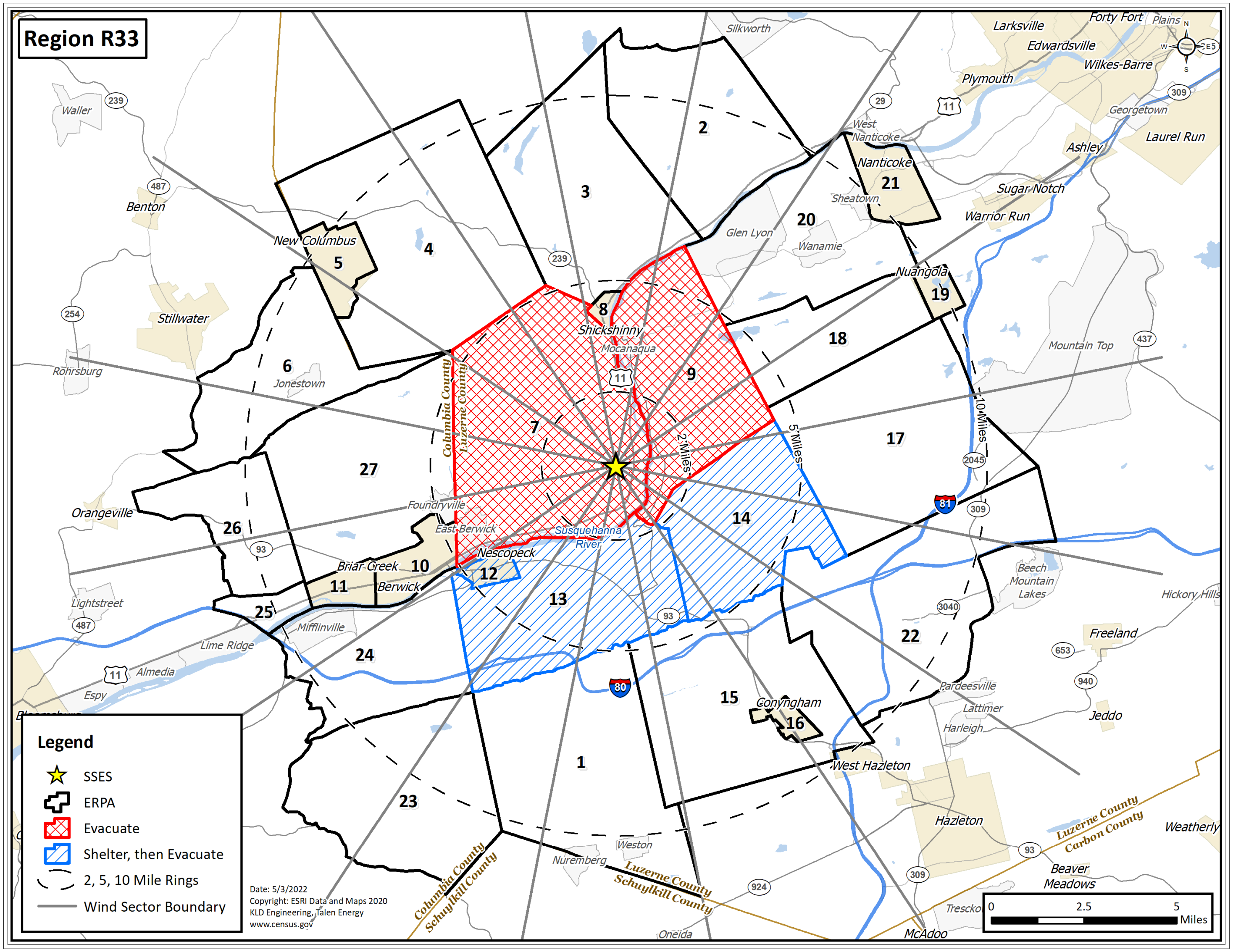


Figure H-33. Region R33

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 591 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 6.17 miles to exit the study area.

Table J-2 provides network–wide statistics (average travel time, average speed and number of vehicles) for an evacuation of the entire EPZ (Region R03) for each scenario. As expected, rain and snow scenarios (Scenarios 2, 4, 7, 8, 10 and 11) exhibit slower average speeds, higher delays and longer average travel times than good weather scenarios. When comparing scenario 13 (special event) and scenario 6, the additional vehicles the special event introduces slightly lowers the average speeds but does not cause longer delays or increase the travel times. When comparing scenario 14 (roadway closure) and scenario 1, the lane closed on US-101 southbound lowers the average speeds, causes higher delays and increases the travel times.

Table J-3 provides statistics (average speed and travel time) for the major evacuation routes – Interstate (I)-80, I-81 and US Route (US)-11 – 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, US-11 is congested for most of the evacuation. As such, the average speeds are comparably slower (and travel times longer) than other evacuation routes for the first two hours of the evacuation.

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.

Figure J-2 through Figure J-15 plot the trip generation time versus the ETE for each of the 14 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-15, the curves are spatially separated as a result of the traffic congestion in the EPZ, which was discussed in detail in Section 7.3.

Table J-1. Sample Simulation Model Input

Route Name	Upstream Node	Downstream Node	Vehicles Entering Network on this Link	Directional Preference	Destination Nodes	Destination Capacity
SSES Plant Exit Road	1146	1147	500	SE	8642	4,500
					8755	4,500
Sweet Valley Road	579	578	228	N	8947	1,700
					8819	1,700
US-11	382	380	491	SW	8091	1,700
					8642	4,500
					8041	1,700
Rittenhouse Mill Road	1164	366	117	W	8642	4,500
					8041	1,700
Blue Ridge Trail	1395	1393	57	NE	8755	4,500
PA-2022	701	1298	52	SW	8780	1,275
Diamond Street	309	308	195	SE	8395	4,500
					8682	4,500
					8400	2,850
Grant Street	523	432	407	SE	8395	4,500
St Marys Road	735	1393	86	NE	8120	1,575
					8709	1,700
Sans Souci Parkway	1072	148	5	NE	8709	1,700
					8121	1,125
					8120	1,575

Table J-2. Selected Model Outputs for the Evacuation of the Entire EPZ (Region R03)

Scenario	1	2	3	4	5	6	7
Network-Wide Average Travel Time (Min/Veh-Mi)	1.8	2.1	1.9	2.3	2.1	1.9	2.1
Network-Wide Average Delay Time (Min/Veh-Mi)	0.4	0.7	0.5	0.9	0.8	0.5	0.8
Network-Wide Average Speed (mph)	34.1	29.2	31.4	26.5	28.1	32.1	28.1
Total Vehicles Exiting Network	79,105	79,553	77,107	77,576	67,928	82,110	82,652
Scenario	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Network-Wide Average Travel Time (Min/Veh-Mi)	2.4	1.9	2.2	2.3	2.2	1.9	2.1
Network-Wide Average Delay Time (Min/Veh-Mi)	1.0	0.6	0.9	0.9	0.8	0.5	0.7
Network-Wide Average Speed (mph)	25.0	31.2	26.8	26.2	27.8	32.0	28.9
Total Vehicles Exiting Network	82,652	76,870	77,152	76,949	67,701	83,355	79,111

Table J-3. Average Speed (mph) and Travel Time (min) for Major Evacuation Routes (Region R03, Scenario 1)

		1		2		3		4		5	
Route Name	Length (miles)	Speed (mph)	Travel Time (min)	Speed	Travel Time	Speed	Travel Time	Speed	Travel Time	Speed	Travel Time
I-80 Eastbound	25.2	69.6	21.7	69.5	21.8	69.6	21.7	68.6	22.0	69.6	21.7
I-80 Westbound	25.2	69.5	21.7	69.5	21.7	69.2	21.8	68.4	22.1	69.6	21.7
I-81 Northbound	13.4	66.8	12.0	66.6	12.1	66.6	12.1	63.6	12.6	66.8	12.0
I-81 Southbound	13.4	67.5	11.9	67.4	11.9	67.5	11.9	63.3	12.7	67.5	11.9
US-11 Eastbound	11.4	54.3	12.6	53.7	12.7	53.9	12.7	52.9	12.9	56.1	12.2
US-11 Westbound	12.6	32.8	23.0	18.1	41.8	28.9	26.2	39.3	19.2	43.7	17.3

Table J-4. Simulation Model Outputs at Network Exit Links for Region R03, Scenario 1

Route Name	Upstream Node	Downstream Node	Elapsed Time (hours) 1	2	3	4	5
			Cumulative Vehicles Discharged by the Indicated Time				
			Cumulative Percent of Vehicles Discharged by the Indicated Time Interval				
US-11 Westbound	35	41	554	2,016	3,488	4,947	5,856
			5%	5%	5%	6%	7%
I-80 Eastbound	167	682	1,885	5,461	7,404	7,769	7,832
			16%	14%	12%	10%	10%
PA-93 Eastbound	312	436	321	1,817	3,280	4,296	4,486
			3%	5%	5%	6%	6%
I-81 Southbound	385	395	2,065	5,571	8,120	9,291	9,486
			17%	14%	13%	12%	12%
South Street Eastbound	681	1010	5	125	229	271	282
			0%	0%	0%	0%	0%
I-81 Northbound	754	755	2,693	7,053	10,694	12,576	12,817
			23%	18%	17%	16%	16%
I-80 Westbound	756	765	2,387	6,146	9,995	12,730	13,049
			20%	15%	16%	17%	17%
PA-437 Southbound	761	762	175	1,087	1,880	2,186	2,245
			1%	3%	3%	3%	3%
PA-487 Northbound	779	780	48	417	697	811	834
			0%	1%	1%	1%	1%
PA-118 Eastbound	946	947	111	739	1,325	1,530	1,569
			1%	2%	2%	2%	2%
PA-309 Northbound	1129	268	49	707	1,376	1,546	1,578
			0%	2%	2%	2%	2%

Route Name	Upstream Node	Downstream Node	Elapsed Time (hours)				
			1	2	3	4	5
			Cumulative Vehicles Discharged by the Indicated Time				
			Cumulative Percent of Vehicles Discharged by the Indicated Time Interval				
PA-339/924 Southbound	1534	633	37	306	511	596	611
			0%	1%	1%	1%	1%
Sans Souci Parkway Northbound	1591	1020	275	1,199	2,053	2,325	2,380
			2%	3%	3%	3%	3%
South Main Street Northbound	1593	1162	61	407	832	925	944
			1%	1%	1%	1%	1%
PA-254 Westbound	1668	1091	158	1,244	2,180	2,921	3,030
			1%	3%	3%	4%	4%
PA-118 Westbound	1807	940	127	1,019	1,986	2,347	2,423
			1%	3%	3%	3%	3%
PA-29 Northbound	1817	1818	131	818	1,440	1,657	1,696
			1%	2%	2%	2%	2%
US-11 Eastbound	1819	709	474	2,108	3,765	4,541	4,614
			4%	5%	6%	6%	6%
South Main Street Northbound	1824	1021	277	756	1,244	1,399	1,423
			2%	2%	2%	2%	2%
PA-309 Southbound	1830	1829	30	672	1,422	1,850	1,952
			0%	2%	2%	2%	2%

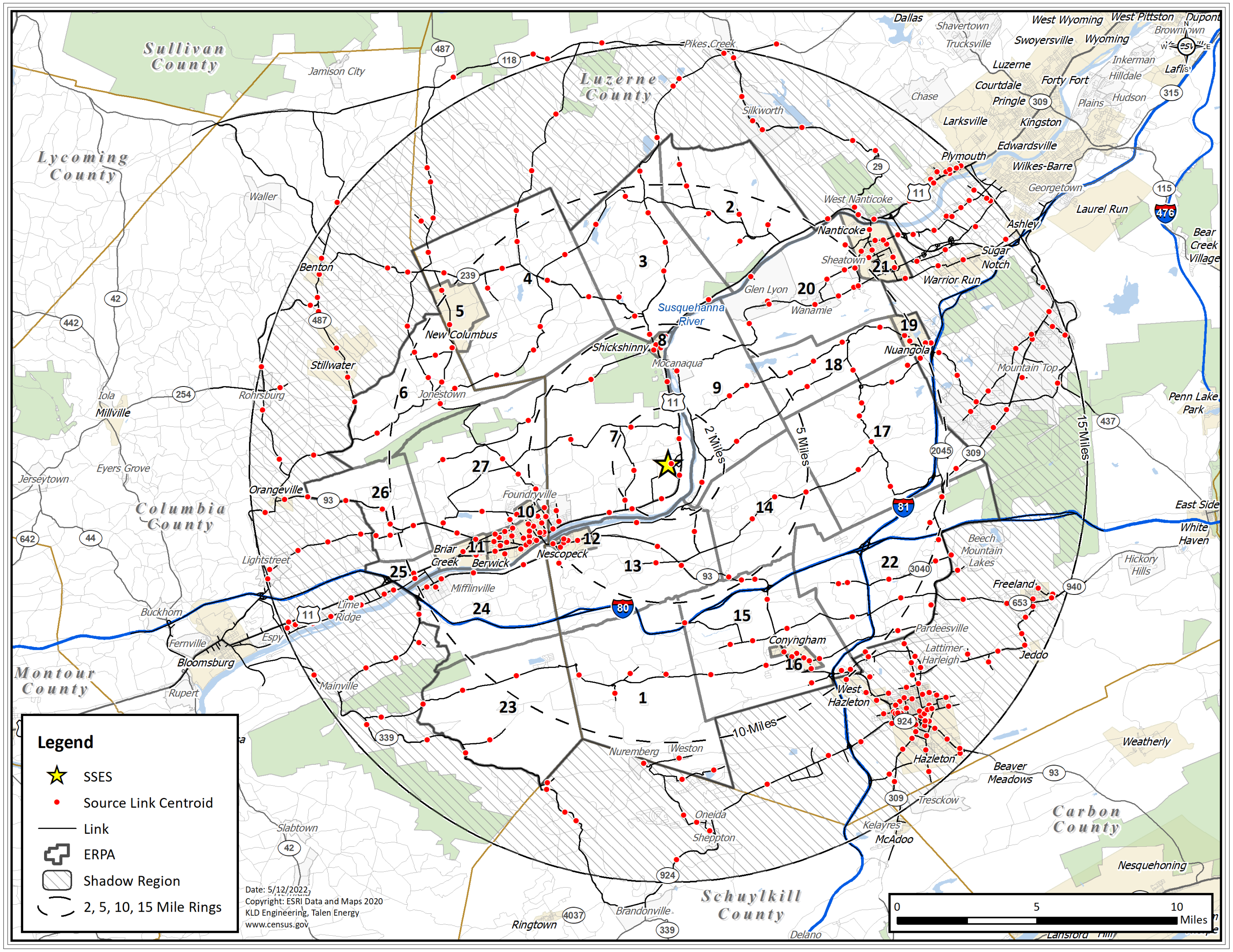


Figure J-1. Network Sources/Origins

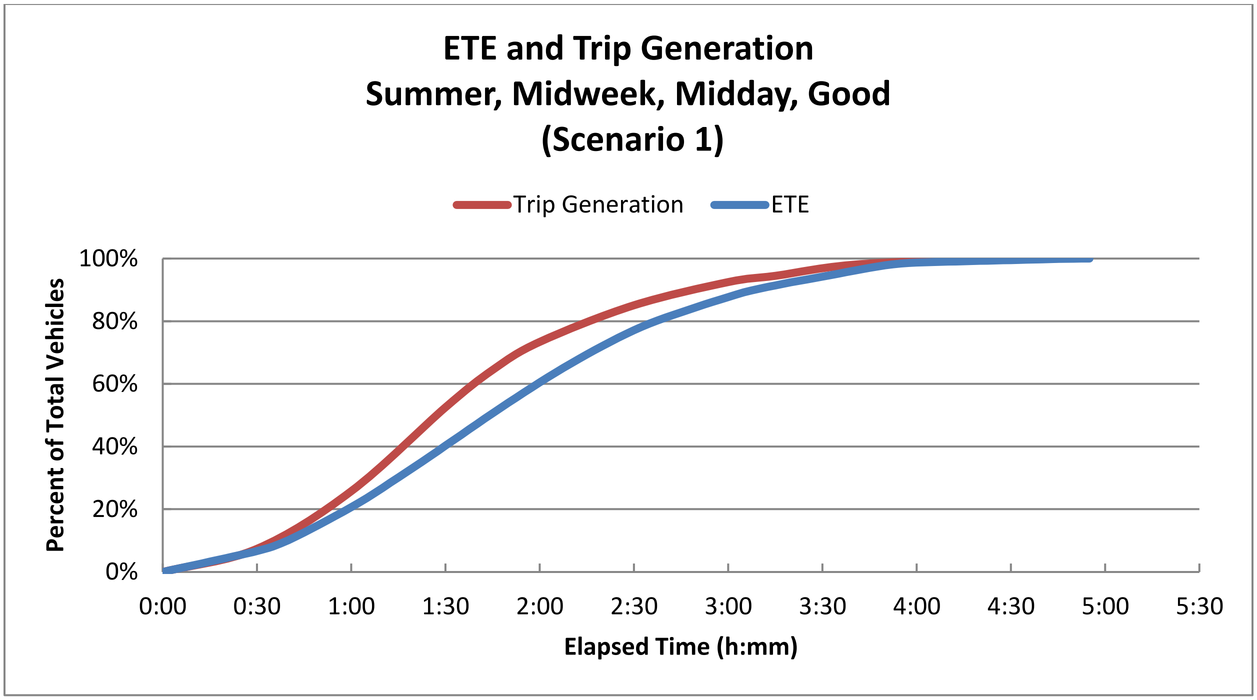


Figure J-2. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather (Scenario 1)

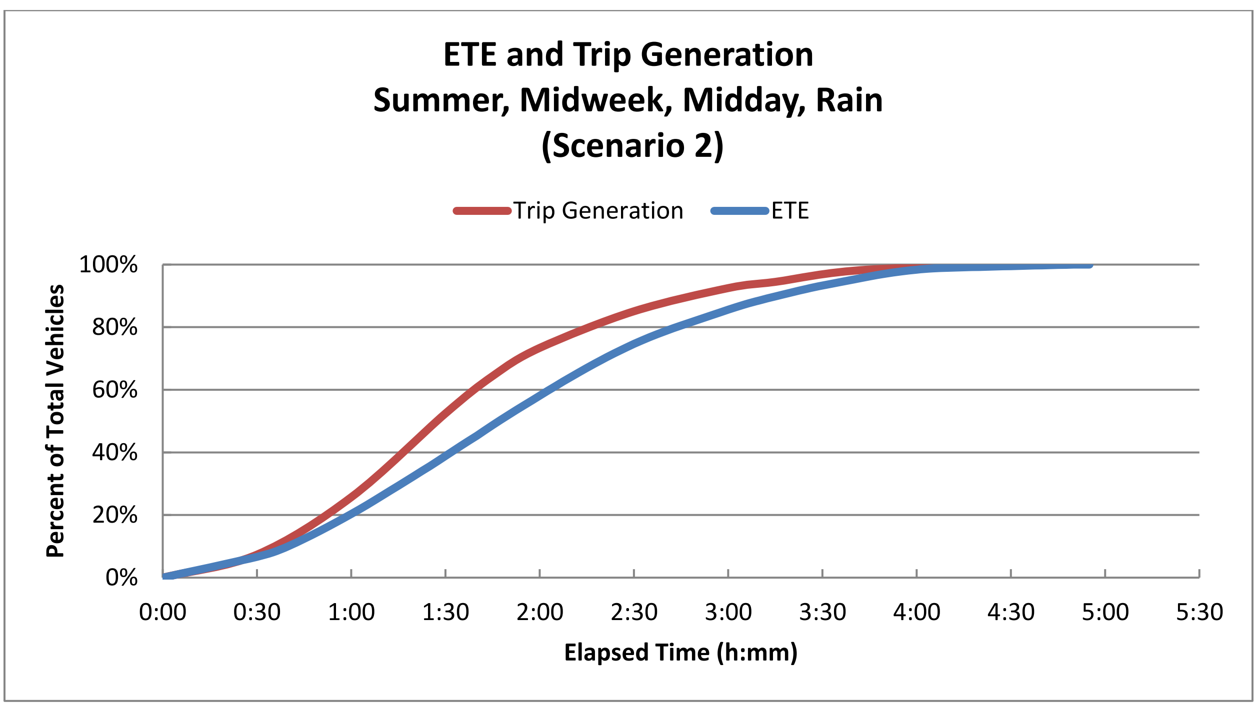


Figure J-3. ETE and Trip Generation: Summer, Midweek, Midday, Rain (Scenario 2)

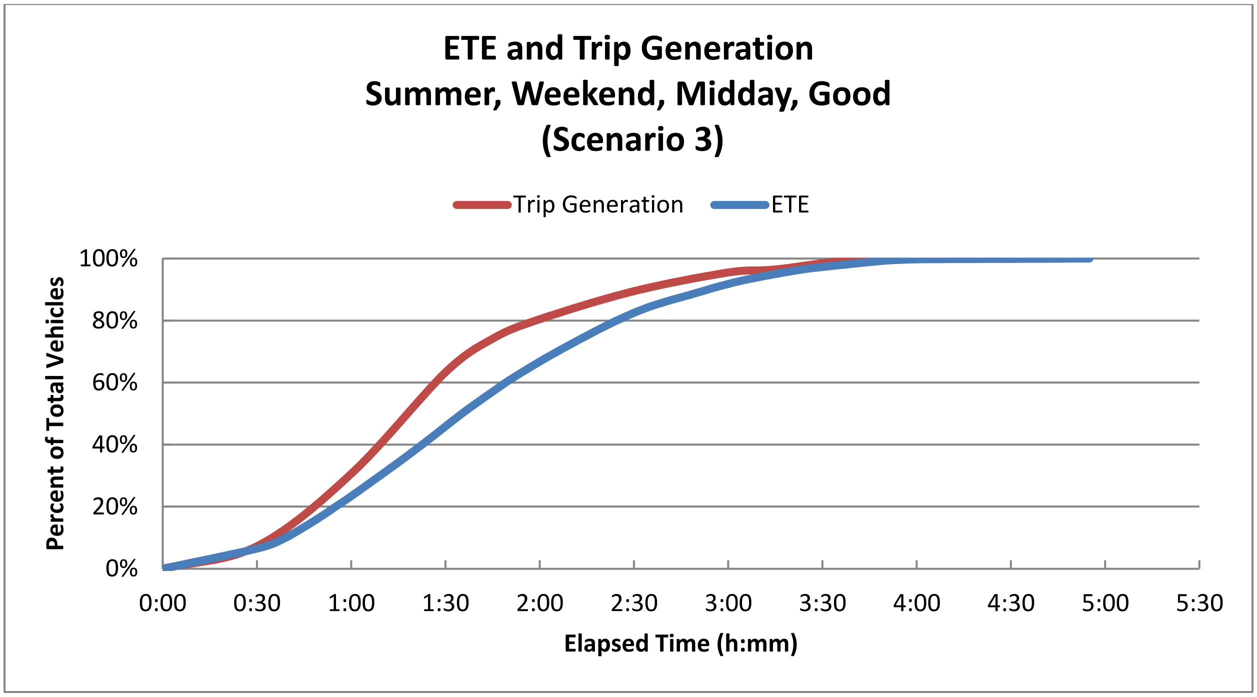


Figure J-4. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather (Scenario 3)

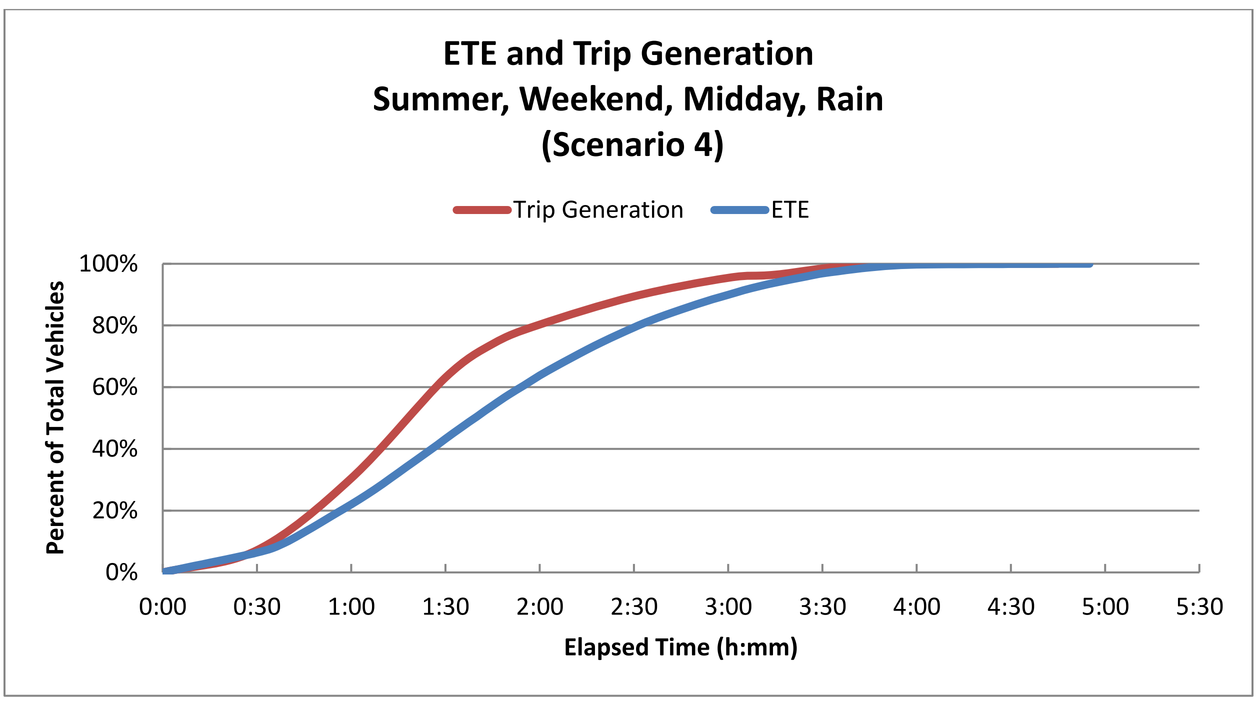


Figure J-5. ETE and Trip Generation: Summer, Weekend, Midday, Rain (Scenario 4)

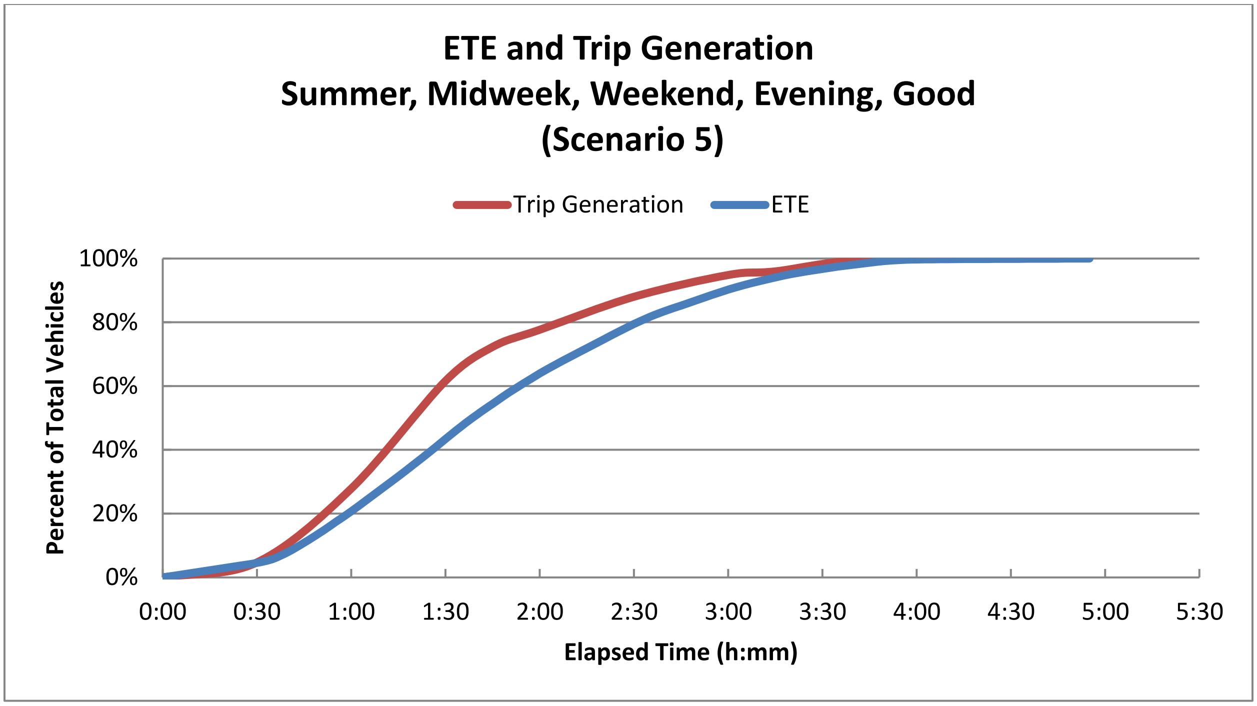


Figure J-6. ETE and Trip Generation: Summer, Midweek, Weekend, Evening, Good Weather (Scenario 5)

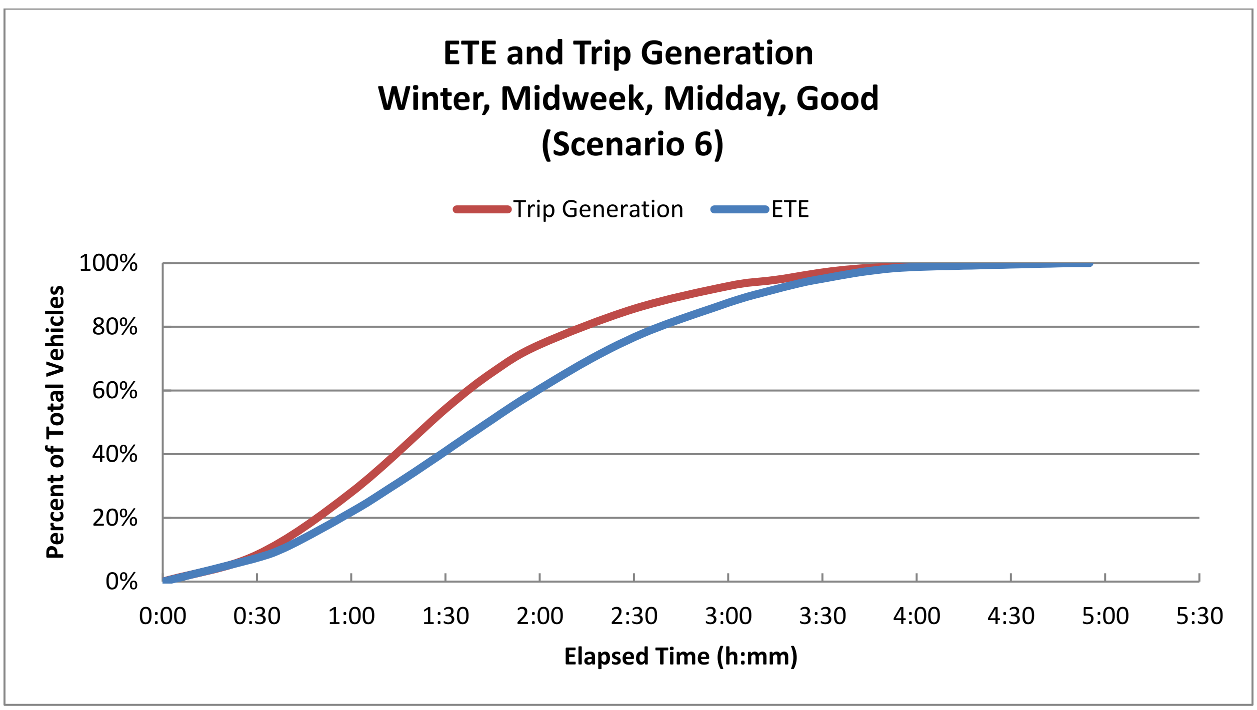


Figure J-7. ETE and Trip Generation: Winter, Midweek, Midday, Good Weather (Scenario 6)

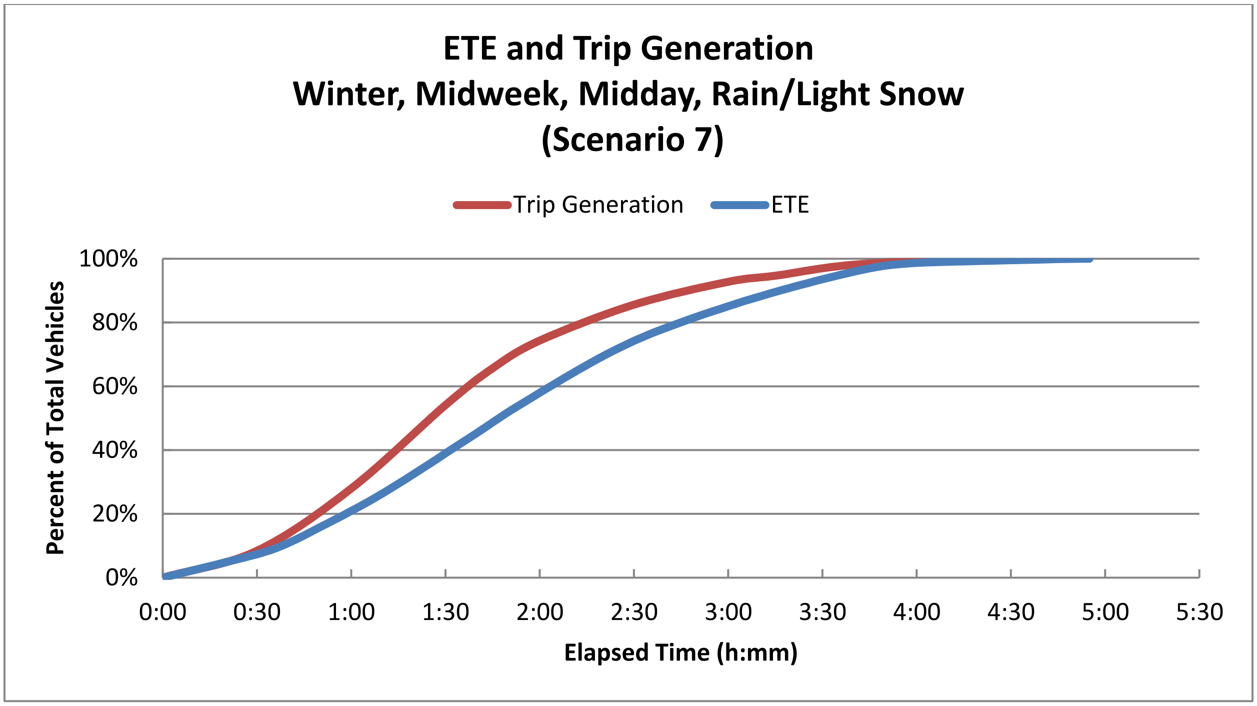


Figure J-8. ETE and Trip Generation: Winter, Midweek, Midday, Rain/Light Snow (Scenario 7)

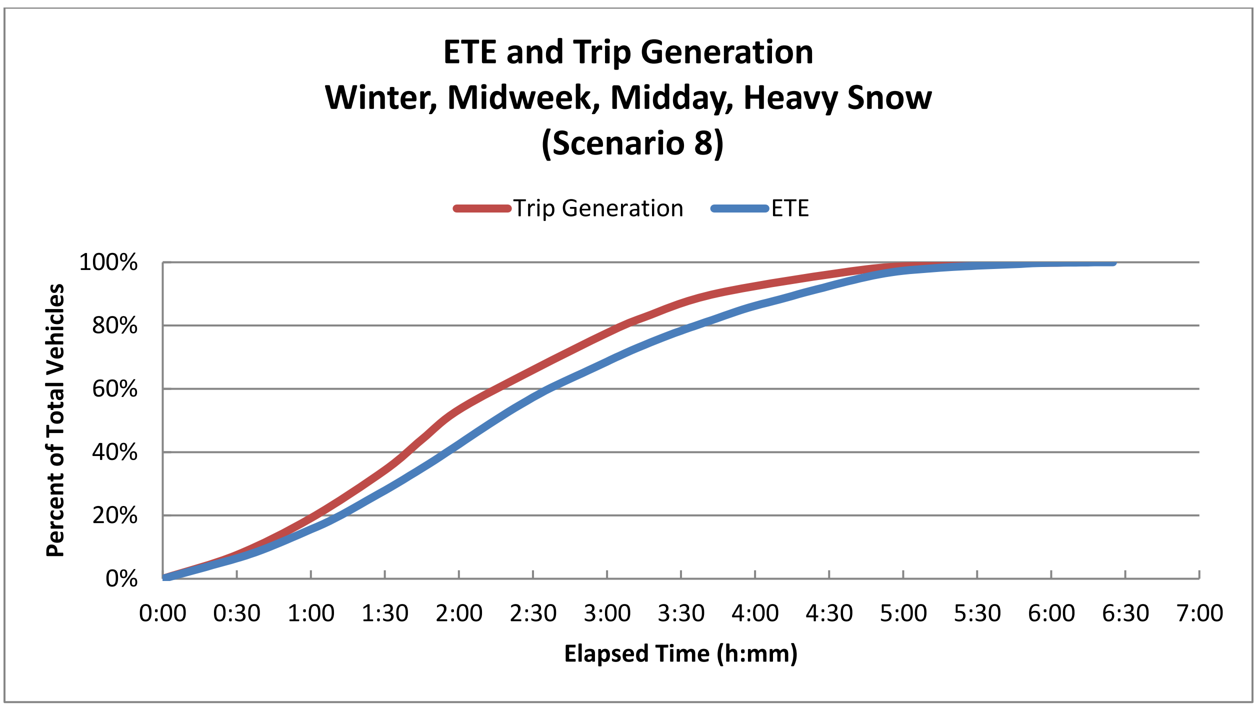


Figure J-9. ETE and Trip Generation: Winter, Midweek, Midday, Heavy Snow (Scenario 8)

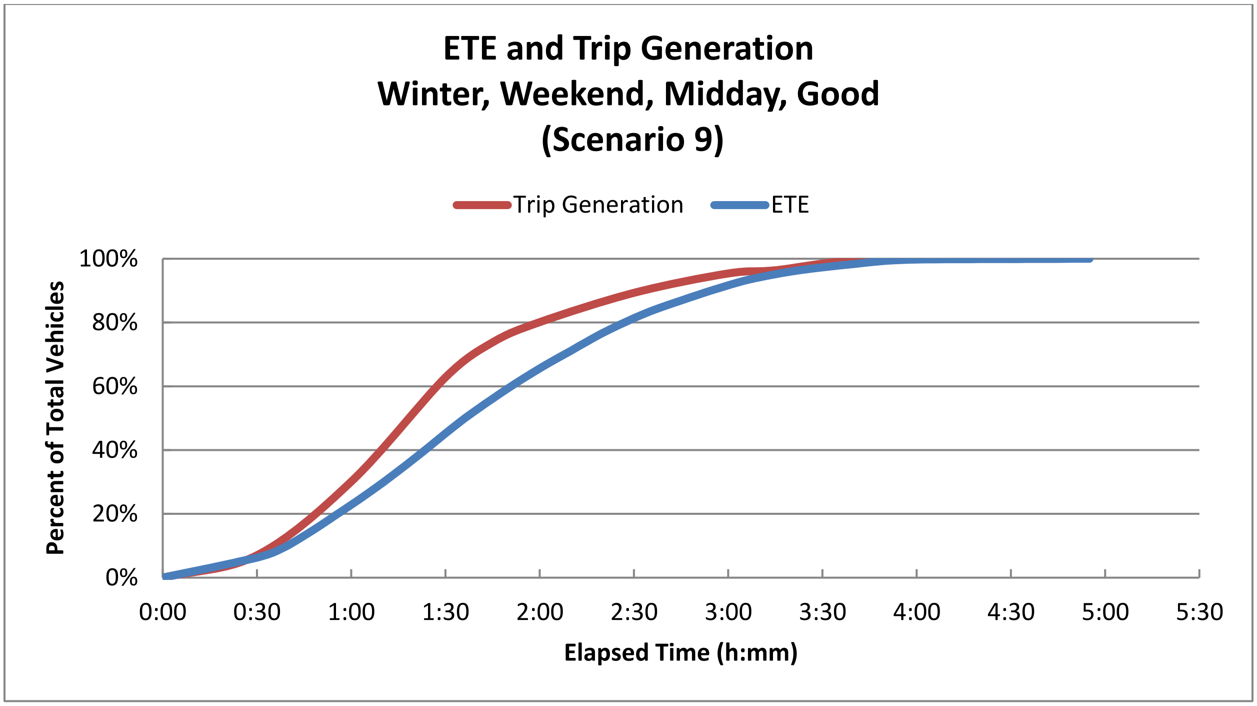


Figure J-10. ETE and Trip Generation: Winter, Weekend, Midday, Good Weather (Scenario 9)

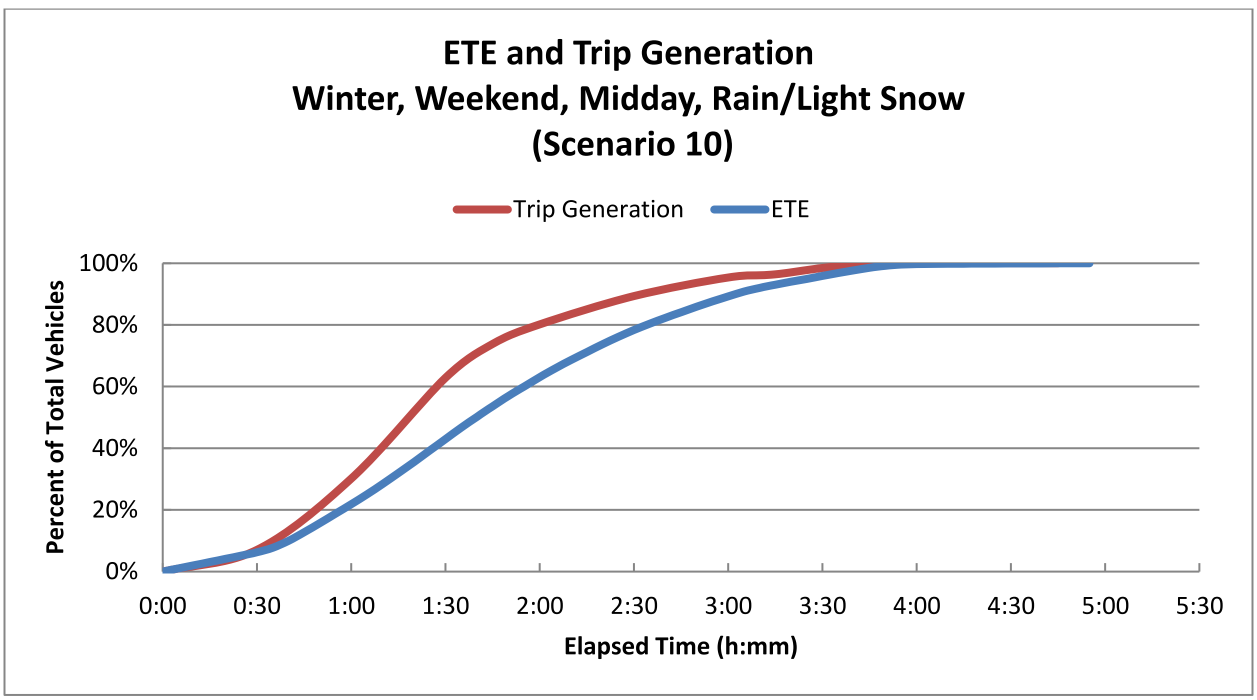


Figure J-11. ETE and Trip Generation: Winter, Weekend, Midday, Rain/Light Snow (Scenario 10)

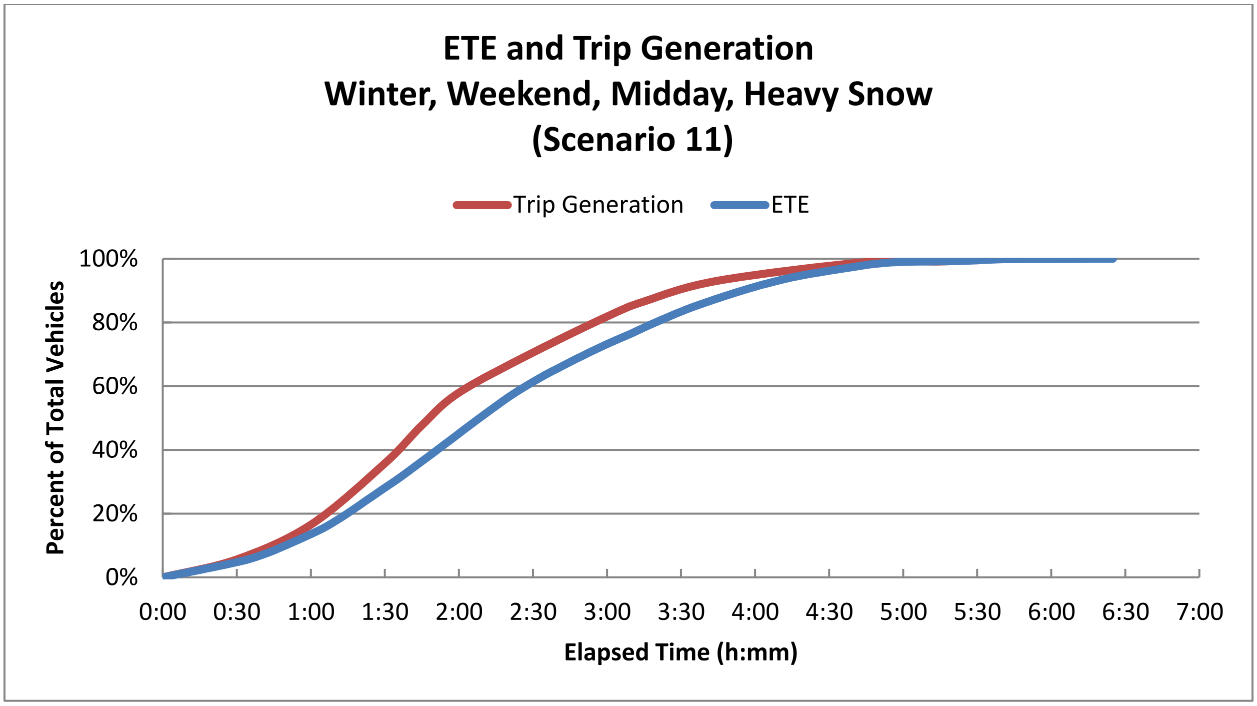


Figure J-12. ETE and Trip Generation: Winter, Weekend, Midday, Heavy Snow (Scenario 11)

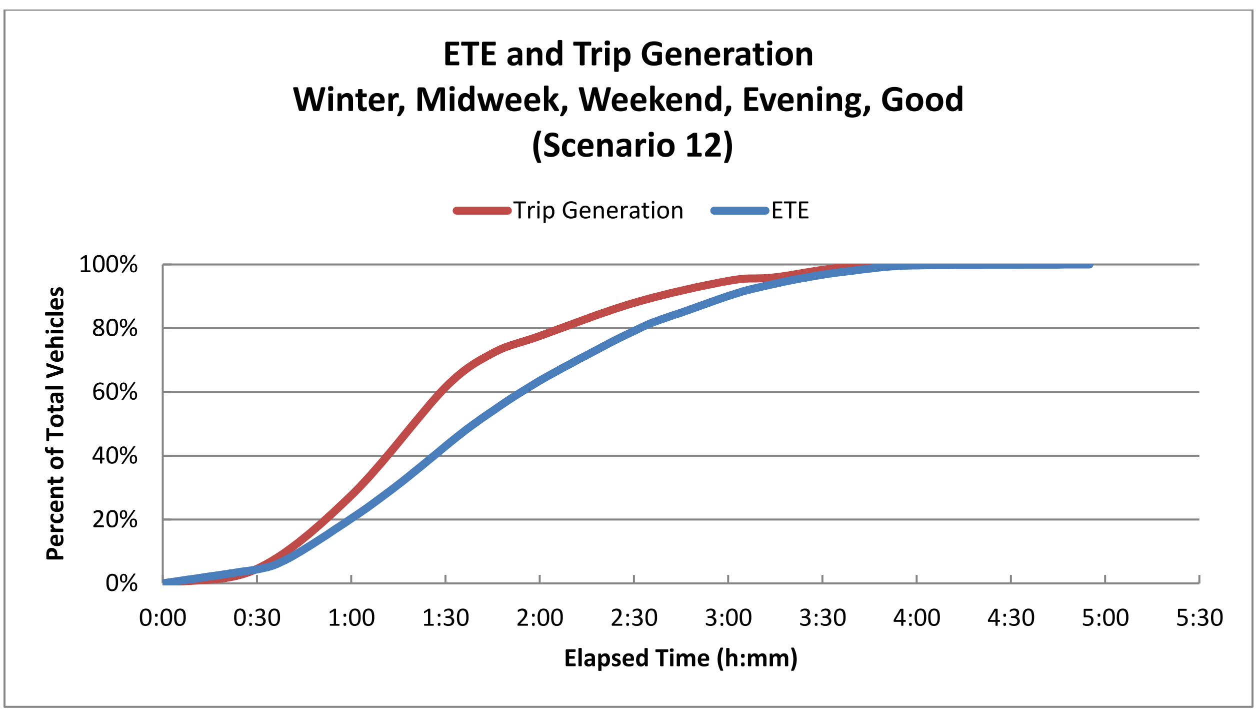


Figure J-13. ETE and Trip Generation: Winter, Midweek, Weekend, Evening, Good Weather (Scenario 12)

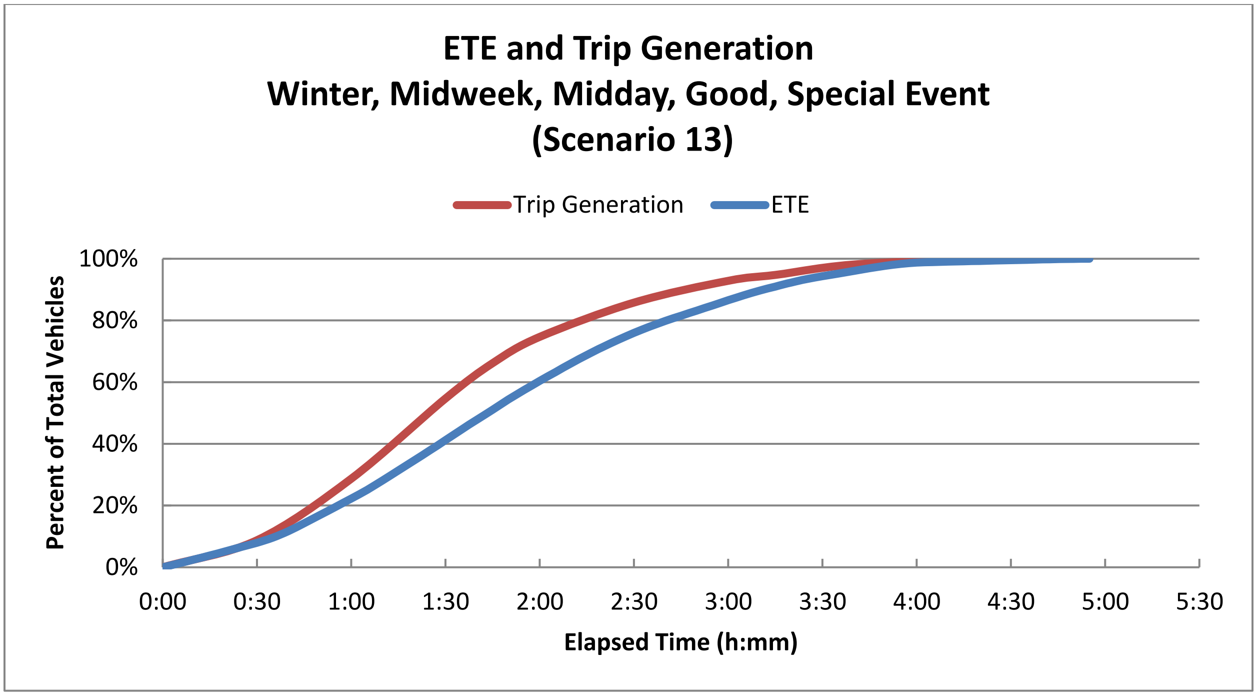


Figure J-14. ETE and Trip Generation: Winter, Midweek, Midday, Good Weather, Special Event (Scenario 13)

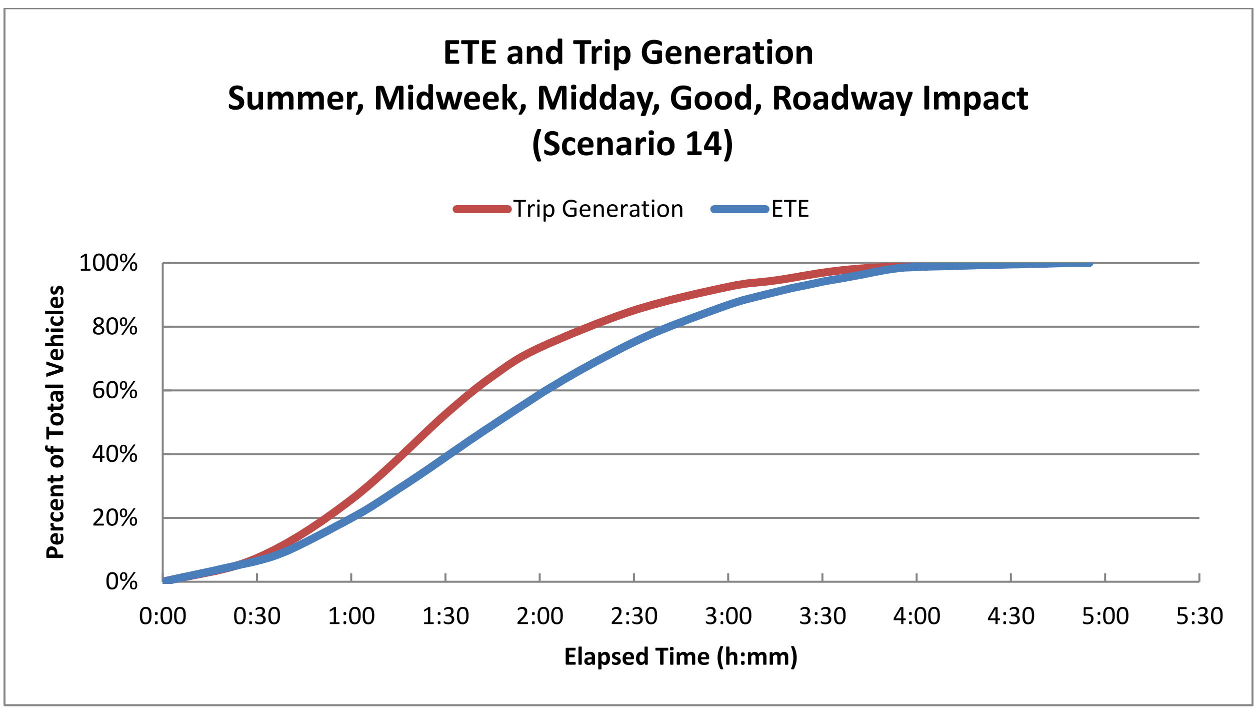


Figure J-15. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather, Roadway Impact (Scenario 14)

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 66 more detailed figures (Figure K-2 through Figure K-67) 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 September 2020.

Table K-1 summarizes the number of nodes by the type of control (stop sign, yield sign, pre-timed signal, actuated signal, traffic control point [TCP], and uncontrolled).

Table K-1. Summary of Nodes by the Type of Control

Control Type	Number of Nodes
Uncontrolled	1,431
Pretimed	2
Actuated	109
Stop	134
TCP	164
Yield	27
Total:	**1,867**

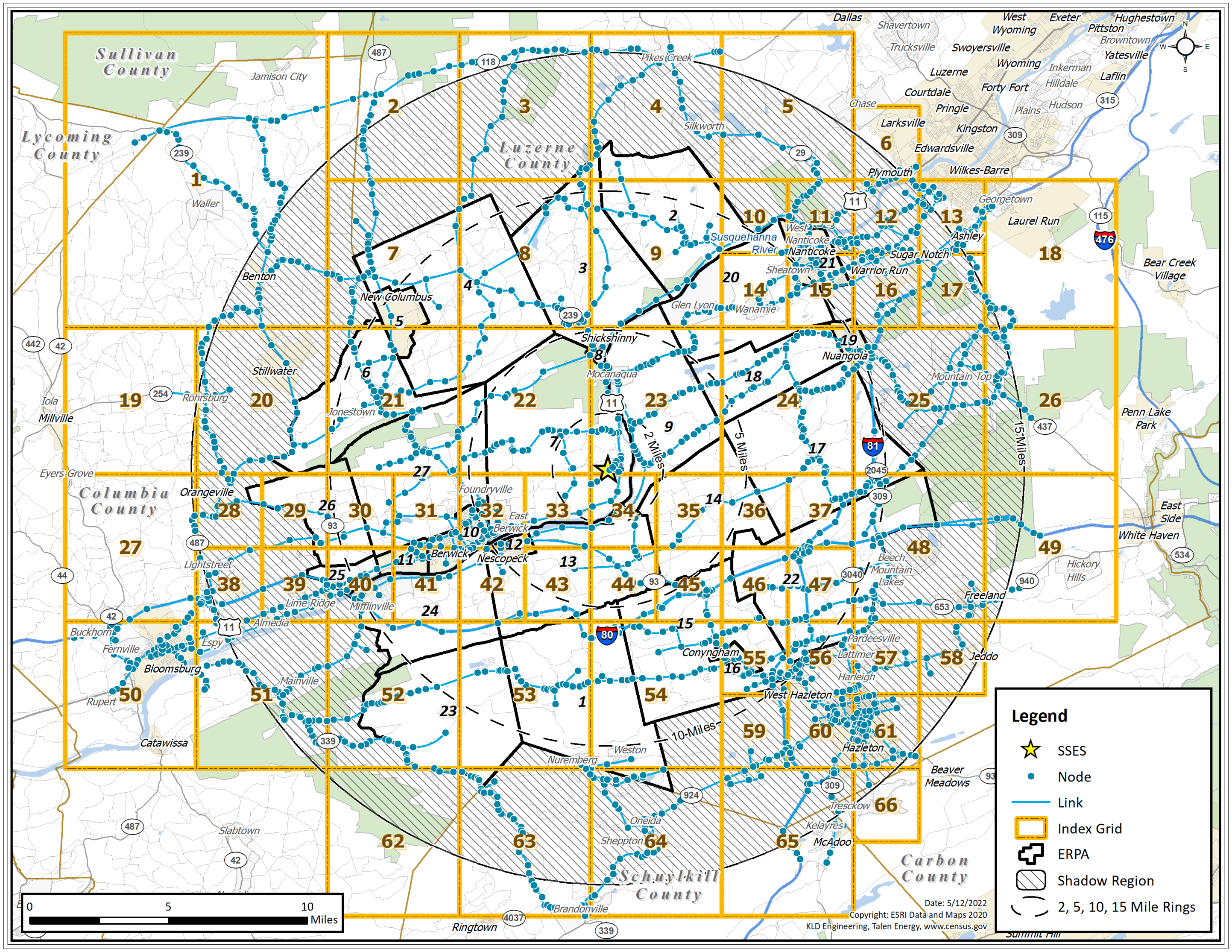


Figure K-1. SSES Link-Node Analysis Network

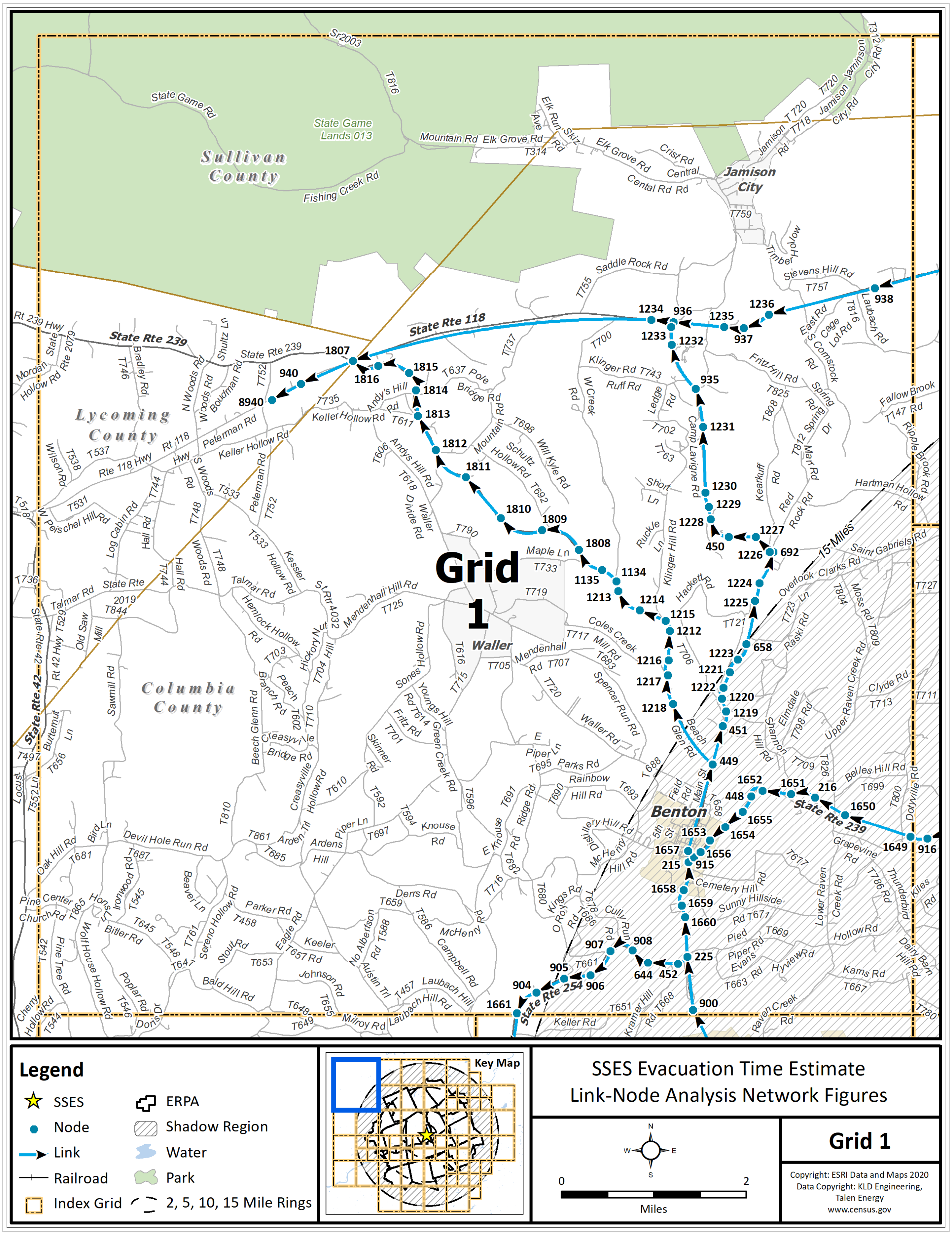


Figure K-2. Link-Node Analysis Network – Grid 1

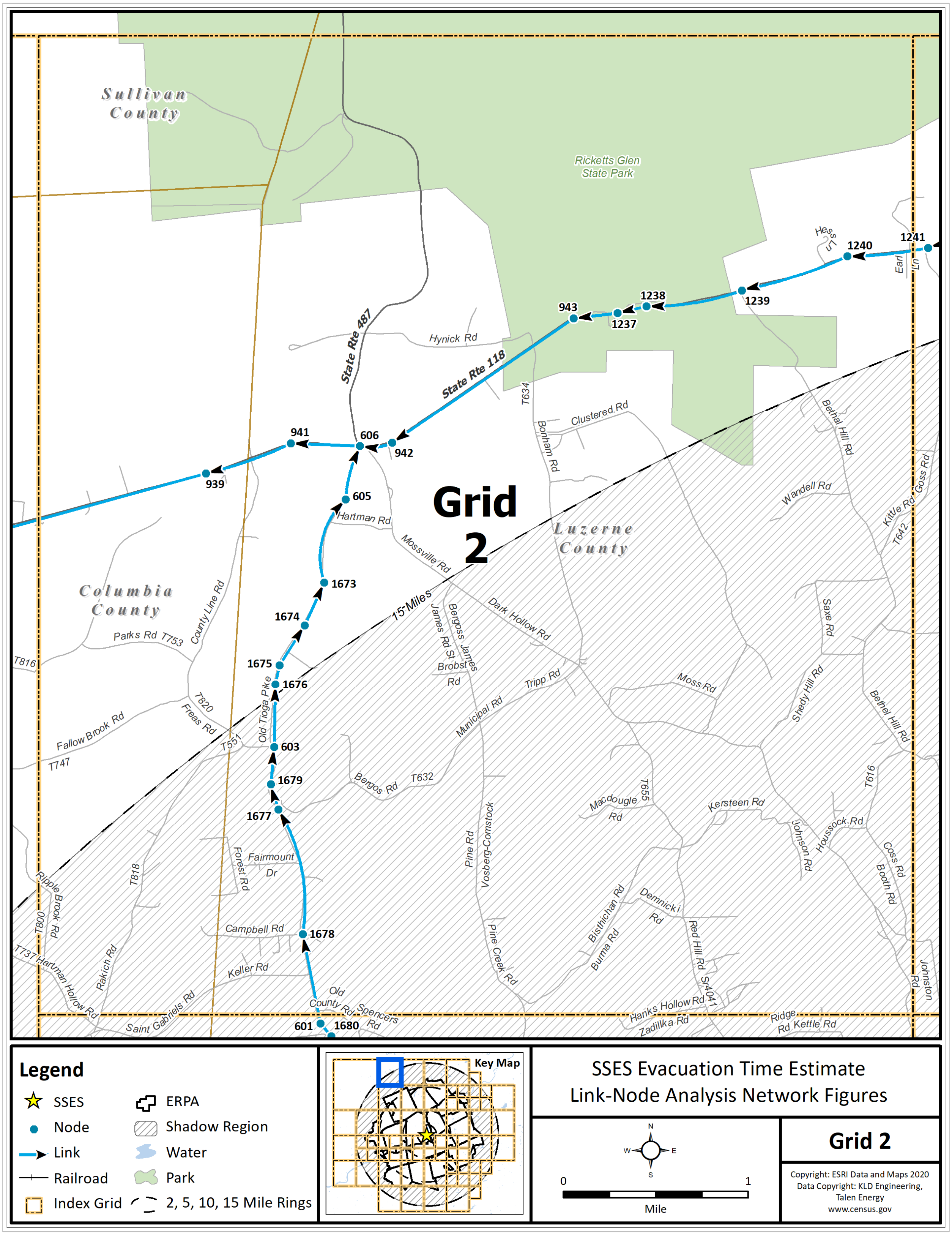


Figure K-3. Link-Node Analysis Network – Grid 2

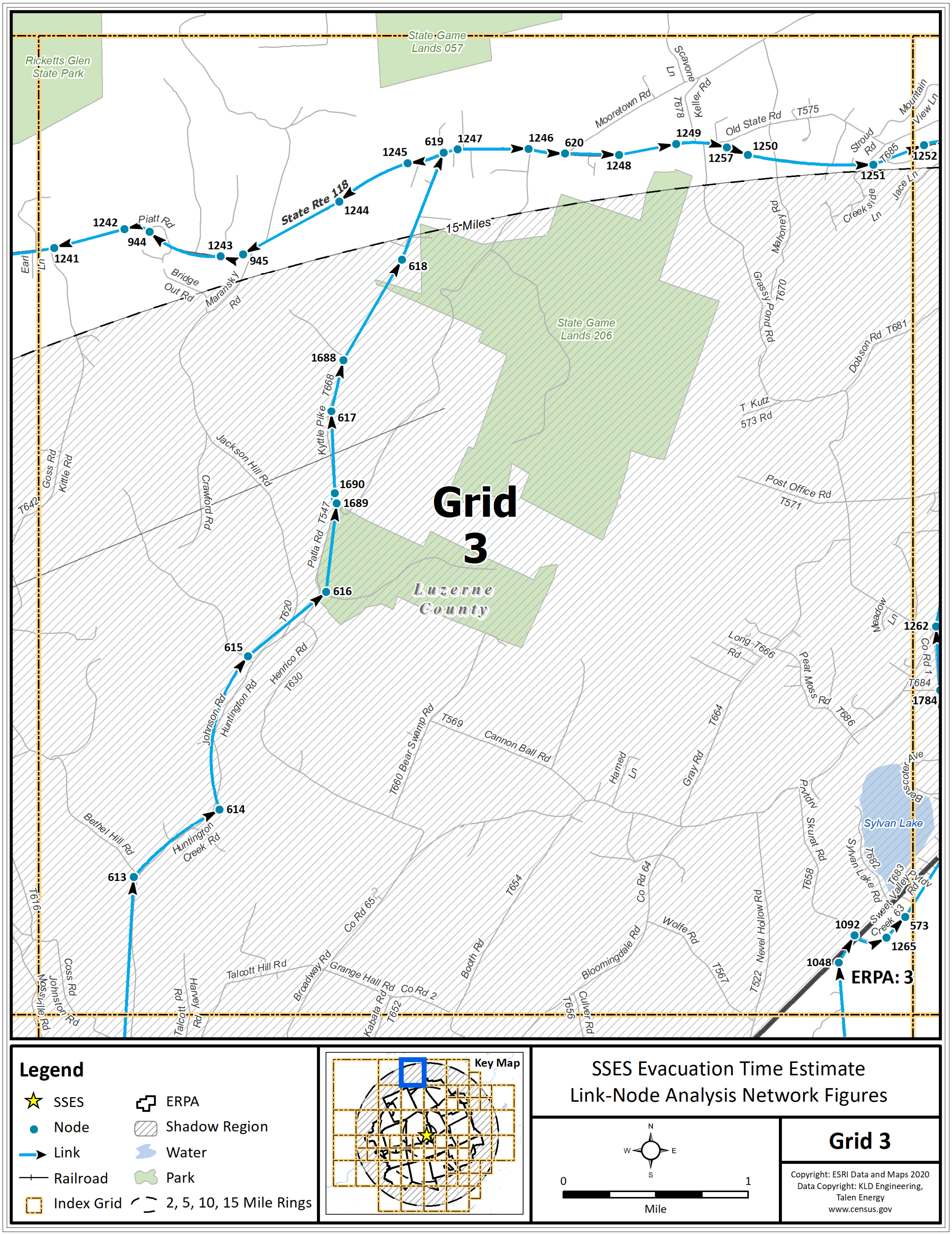


Figure K-4. Link-Node Analysis Network – Grid 3

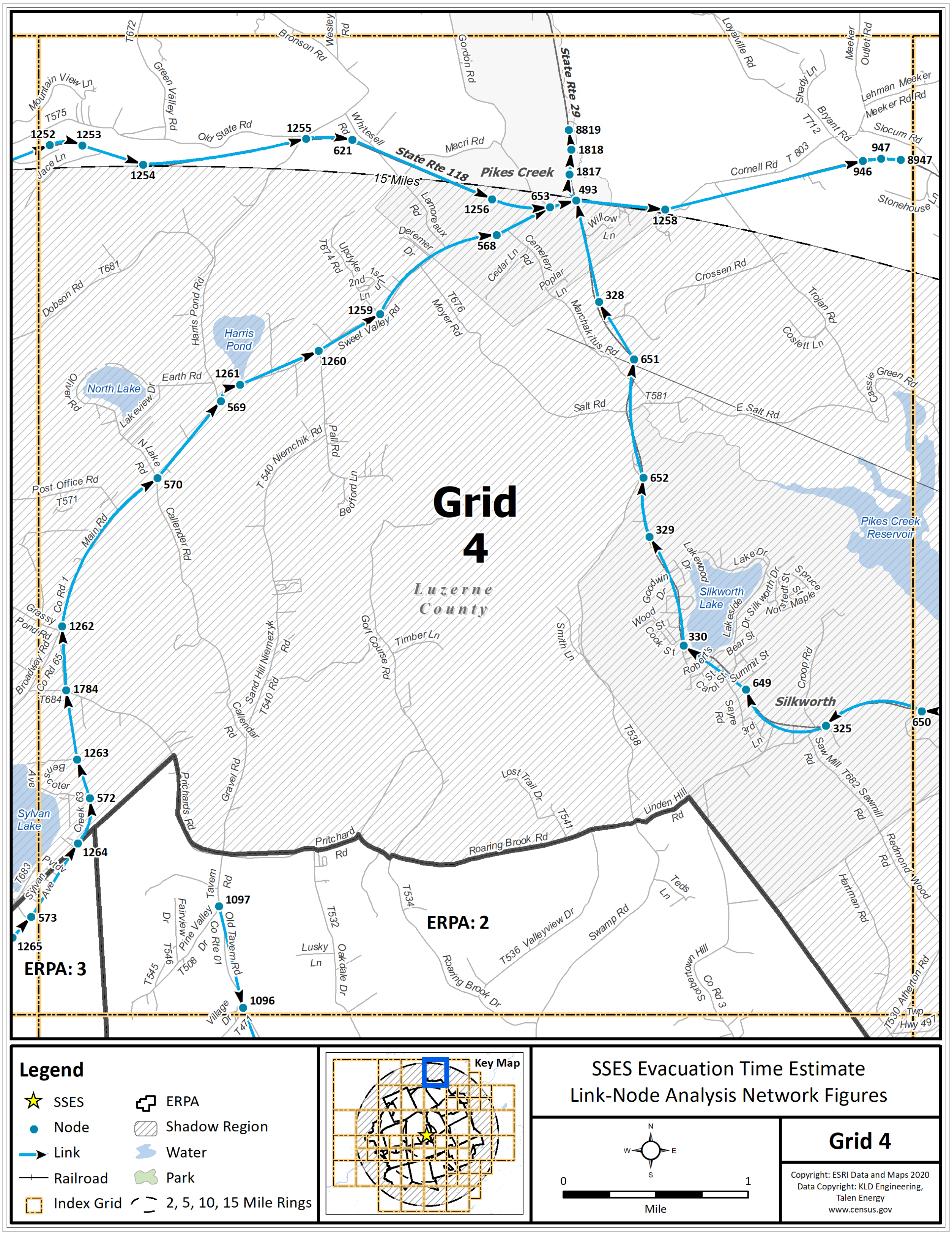


Figure K-5. Link-Node Analysis Network – Grid 4

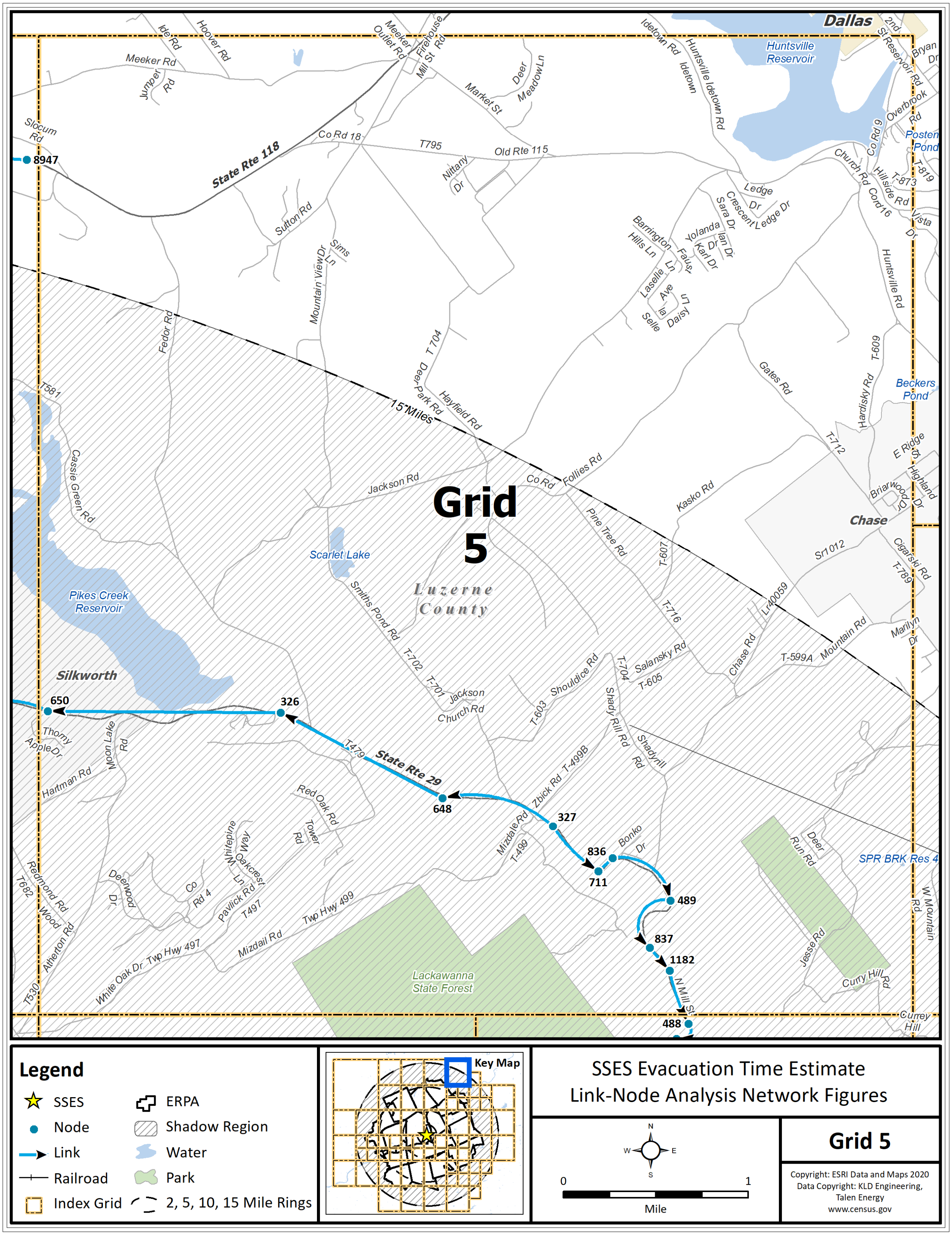


Figure K-6. Link-Node Analysis Network – Grid 5

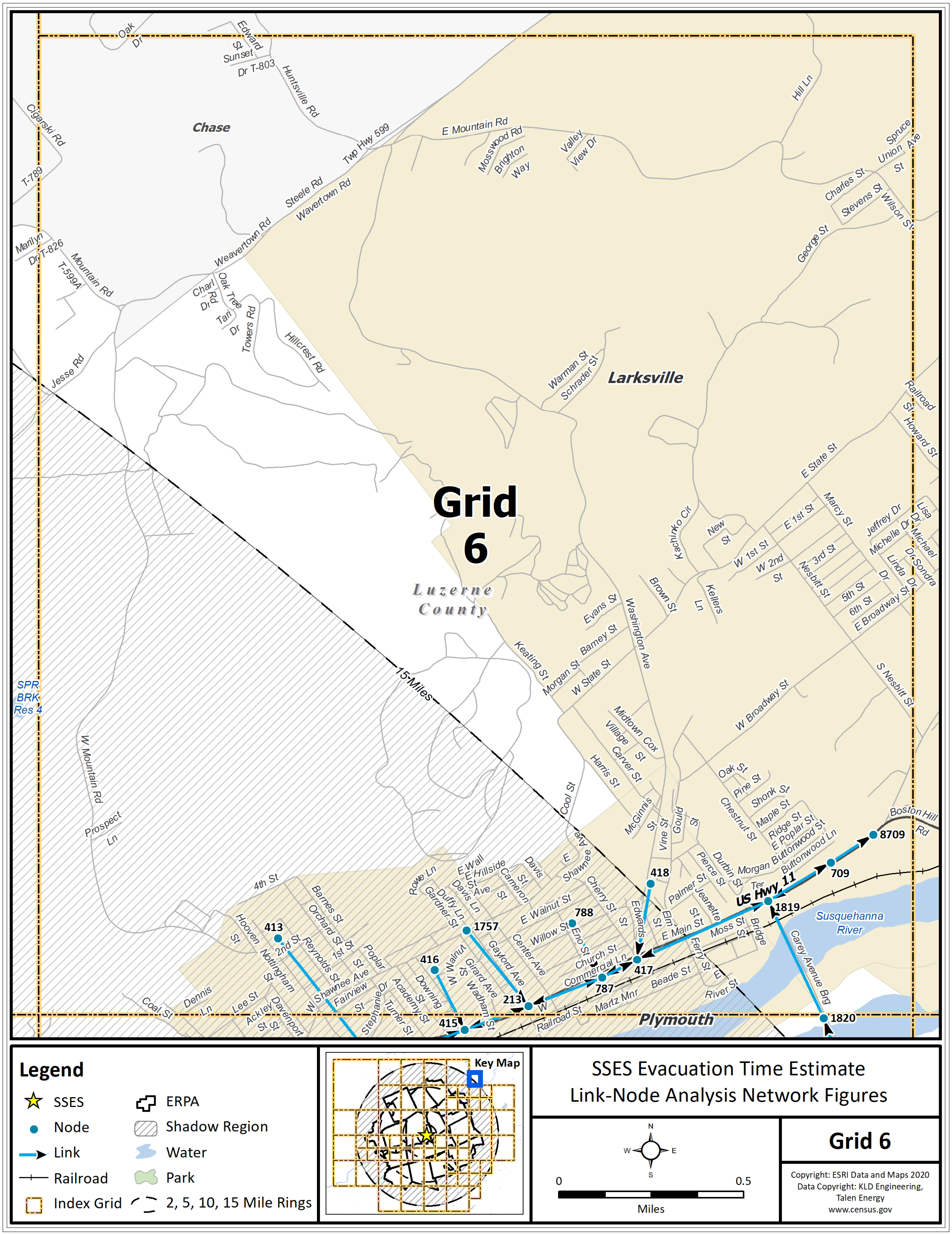


Figure K-7. Link-Node Analysis Network – Grid 6

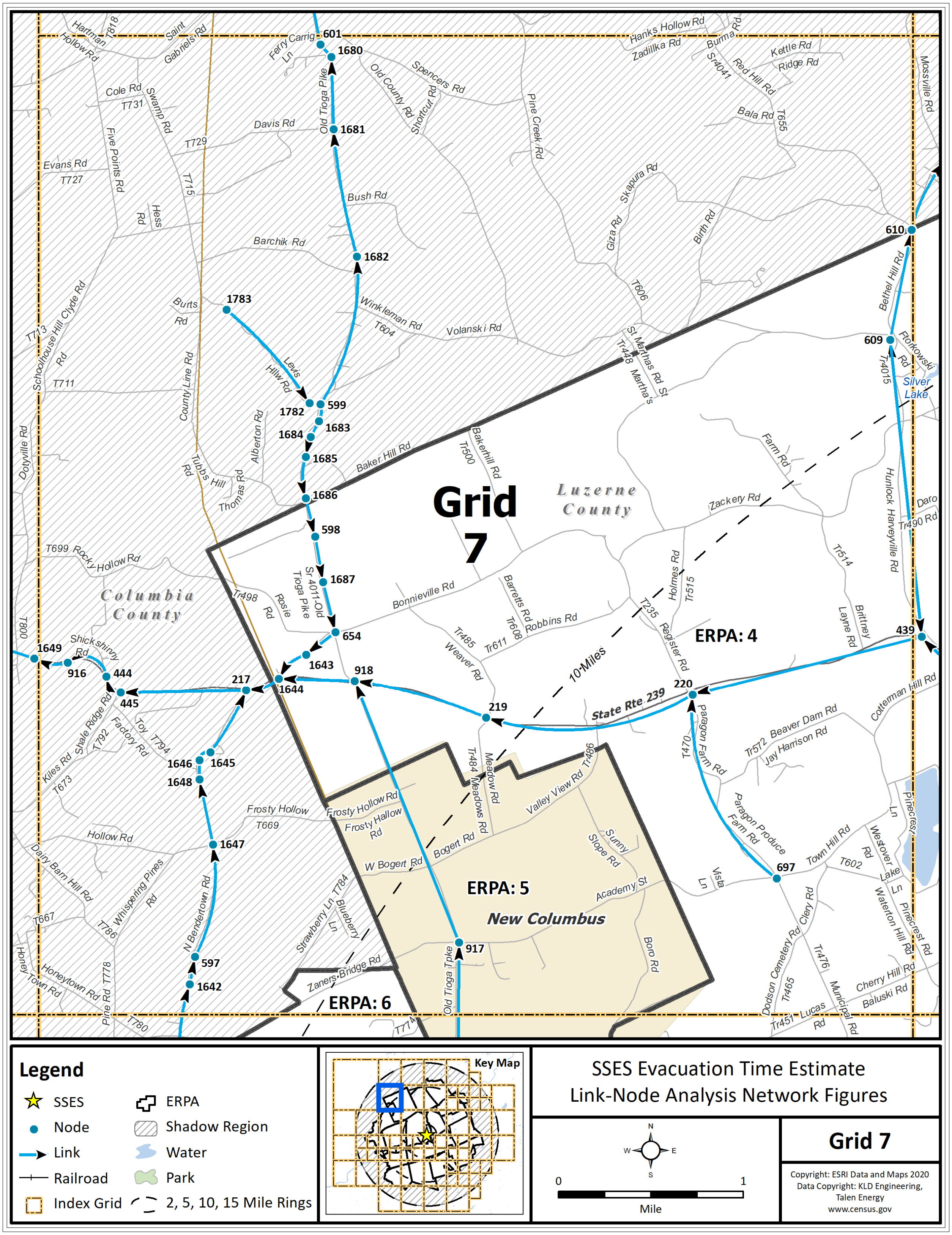


Figure K-8. Link-Node Analysis Network – Grid 7

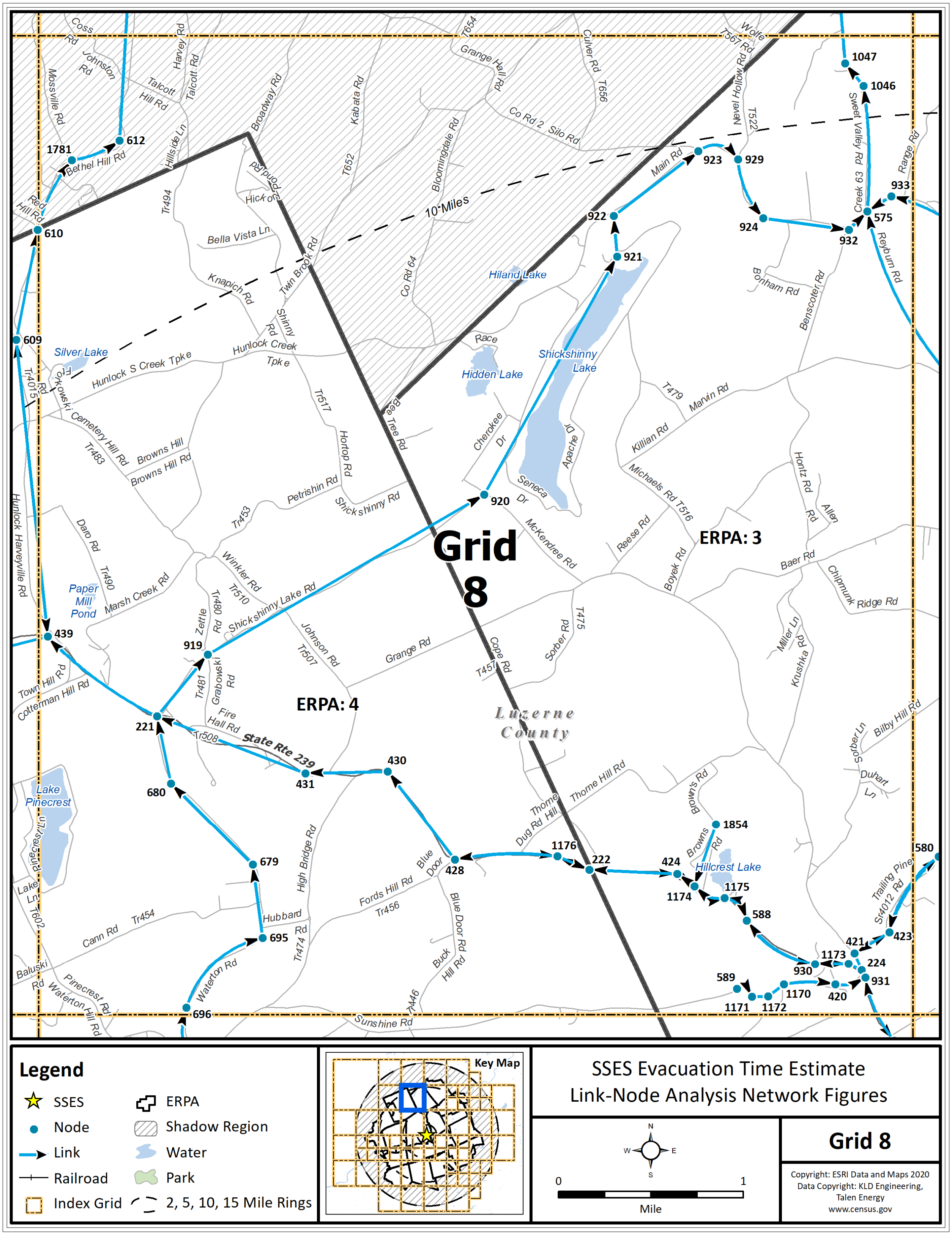


Figure K-9. Link-Node Analysis Network – Grid 8

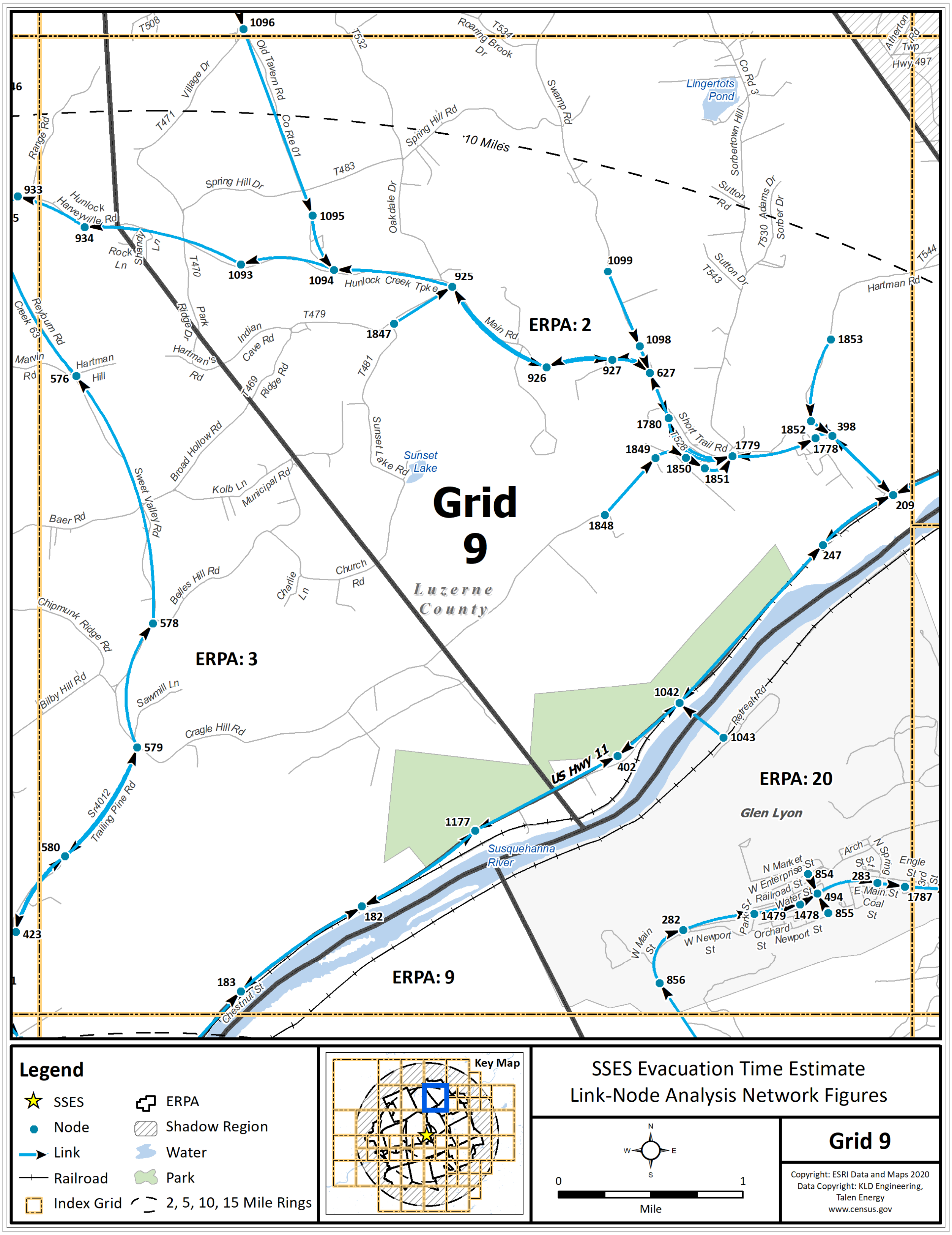


Figure K-10. Link-Node Analysis Network – Grid 9

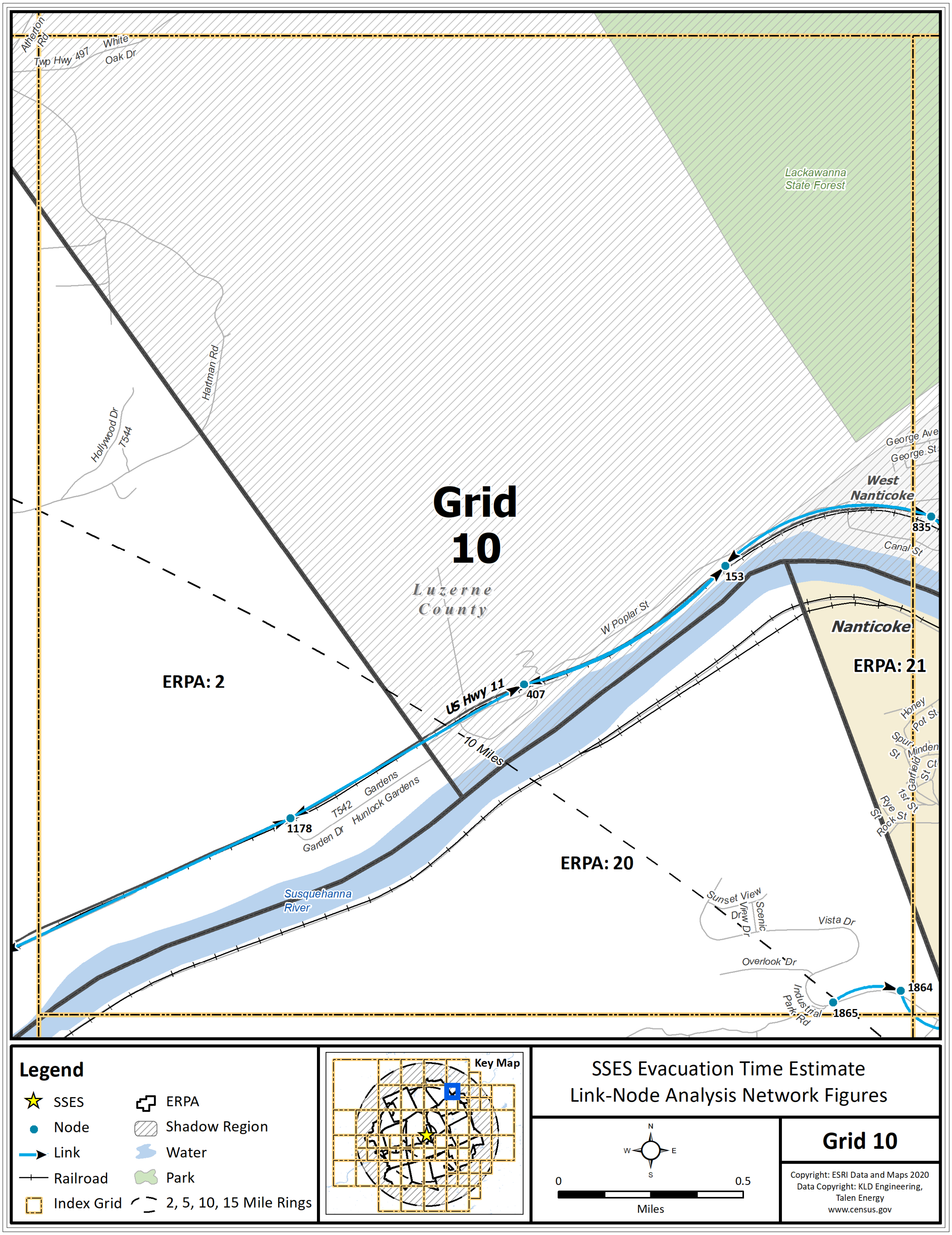


Figure K-11. Link-Node Analysis Network – Grid 10

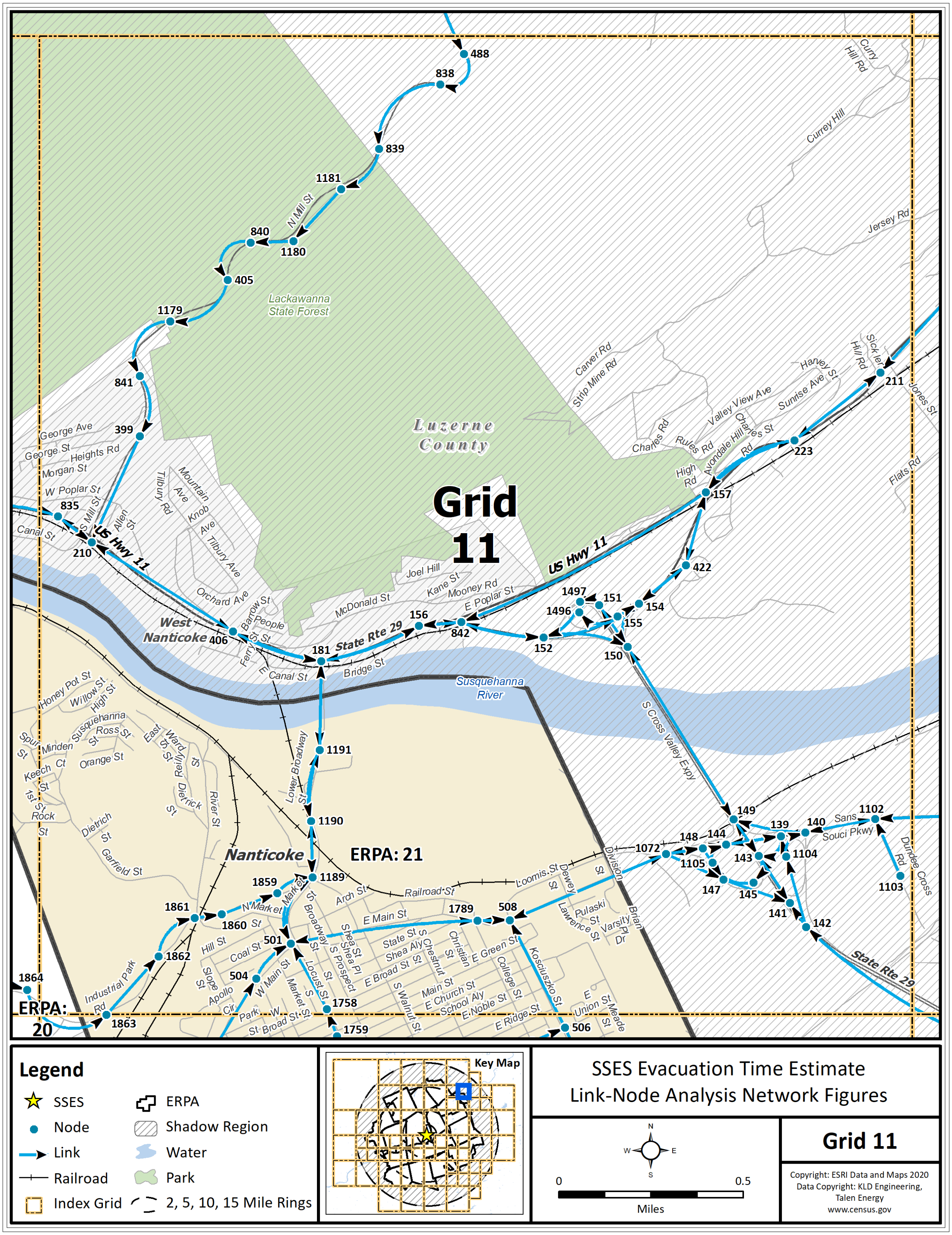


Figure K-12. Link-Node Analysis Network – Grid 11

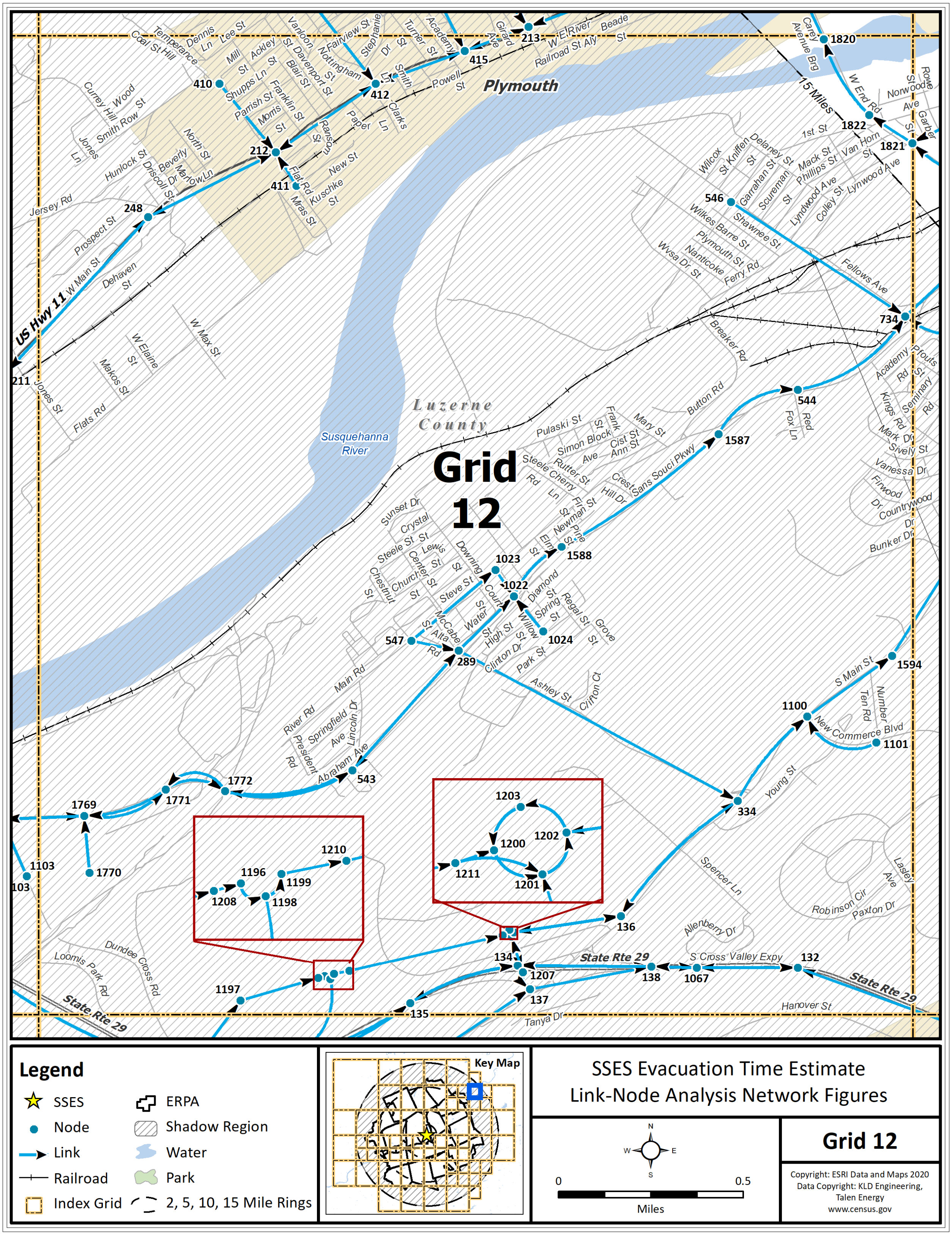


Figure K-13. Link-Node Analysis Network – Grid 12

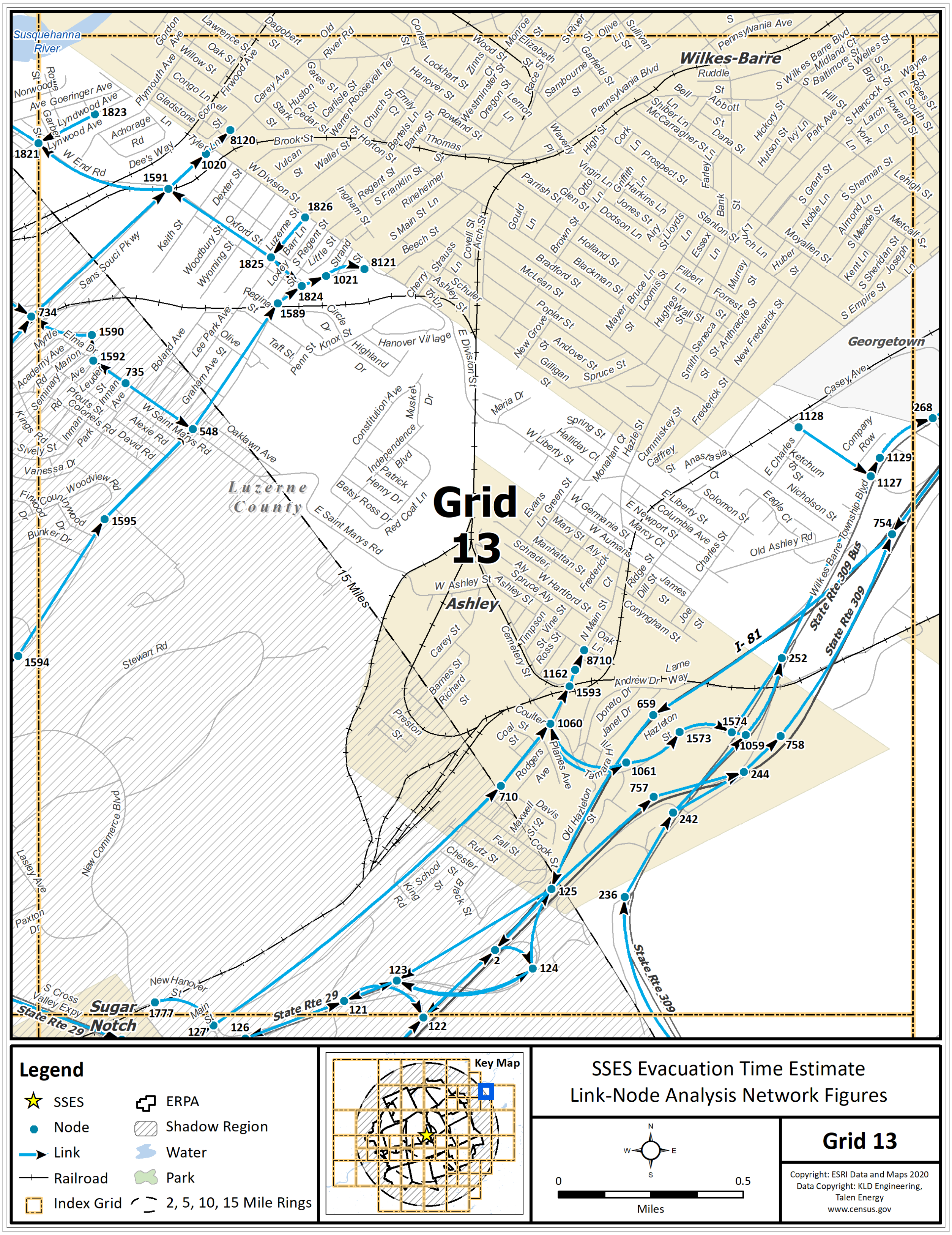


Figure K-14. Link-Node Analysis Network – Grid 13

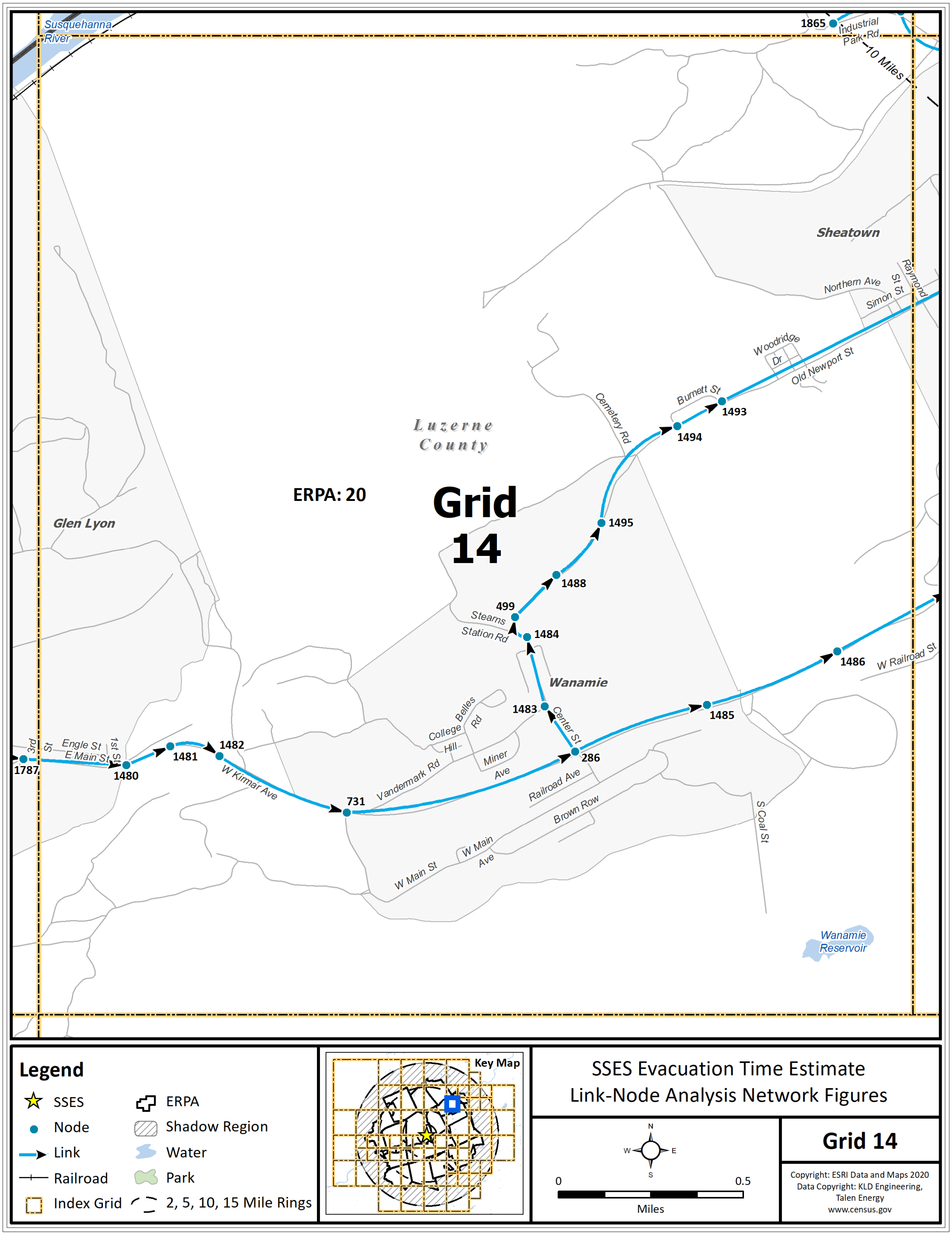


Figure K-15. Link-Node Analysis Network – Grid 14

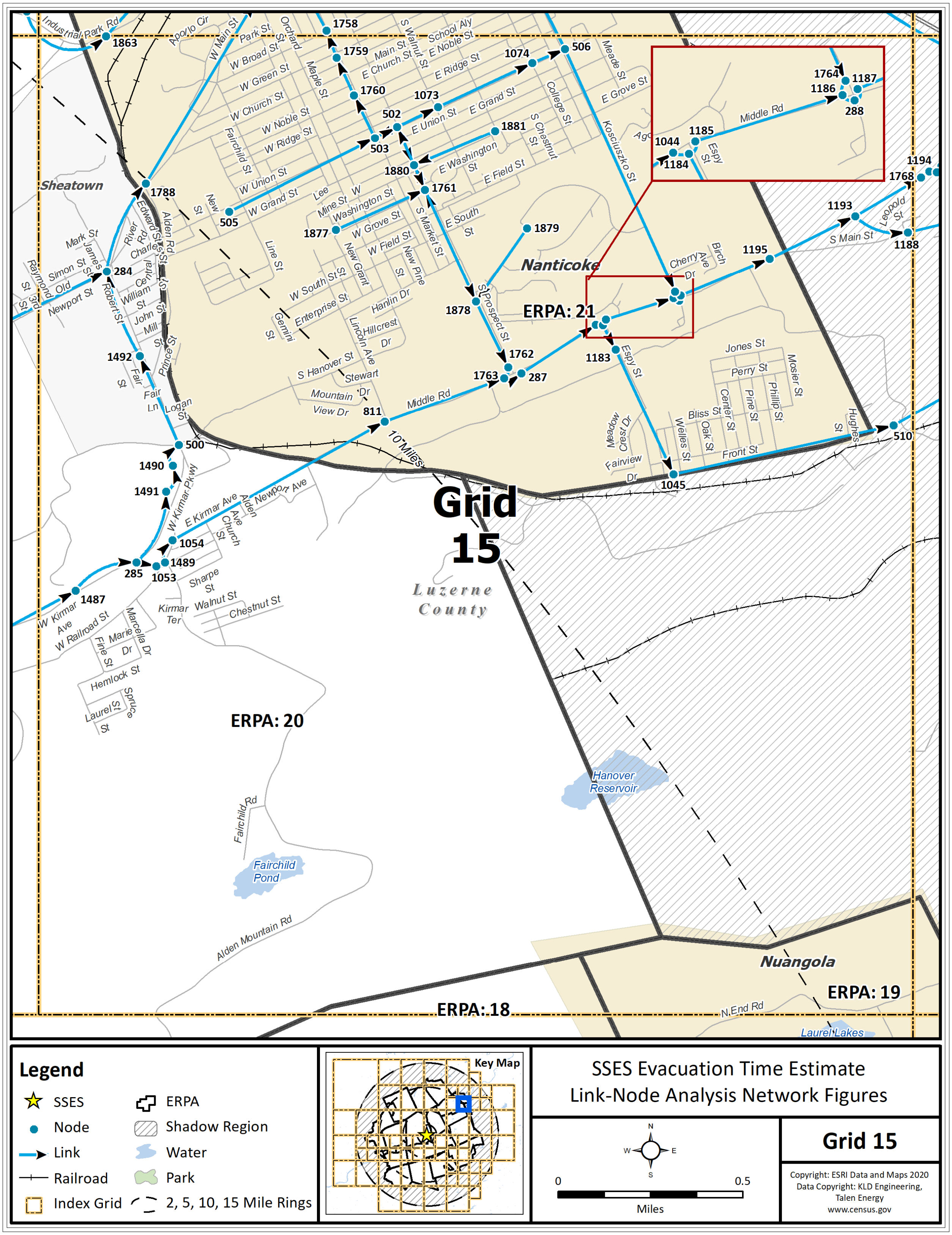


Figure K-16. Link-Node Analysis Network – Grid 15

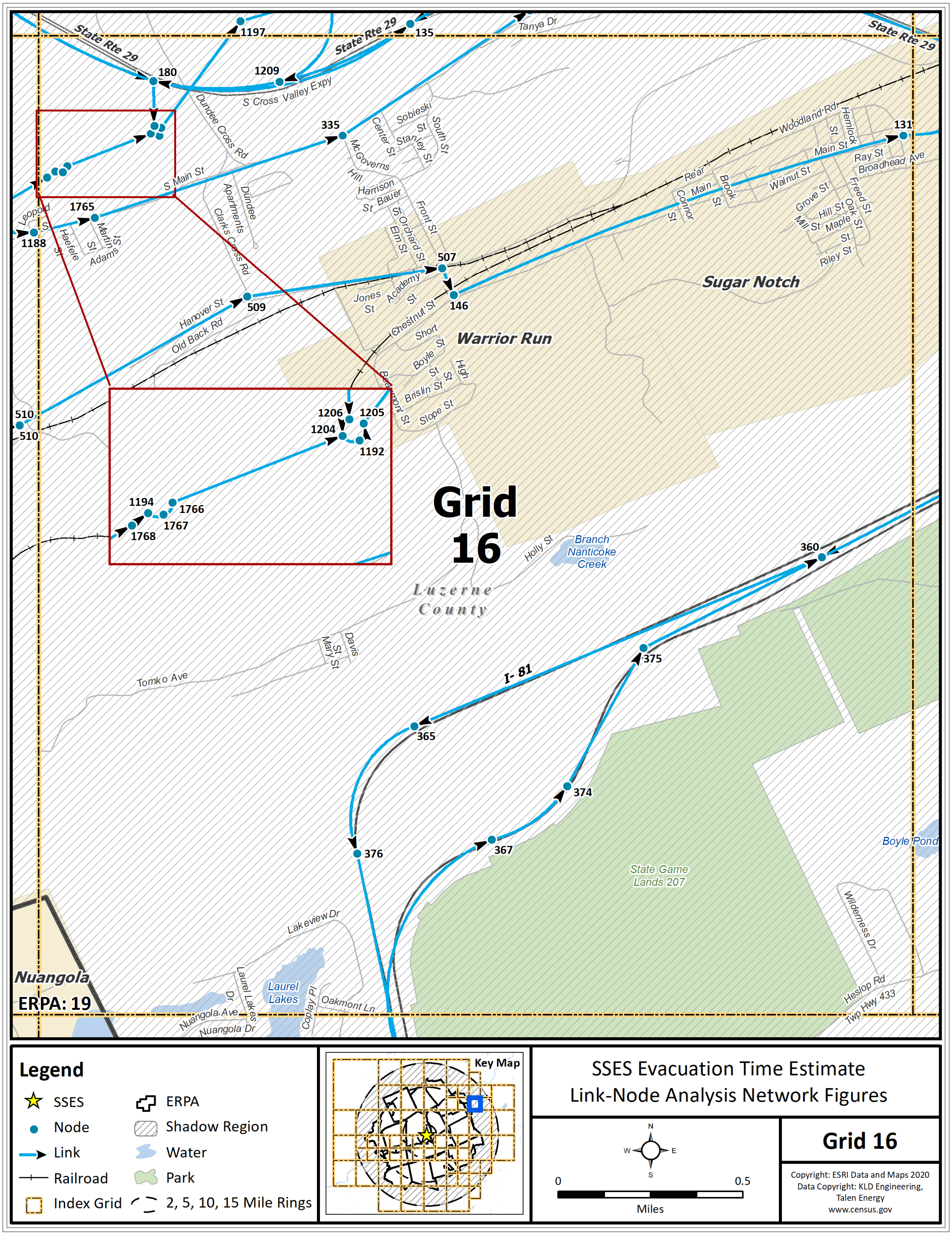


Figure K-17. Link-Node Analysis Network – Grid 16

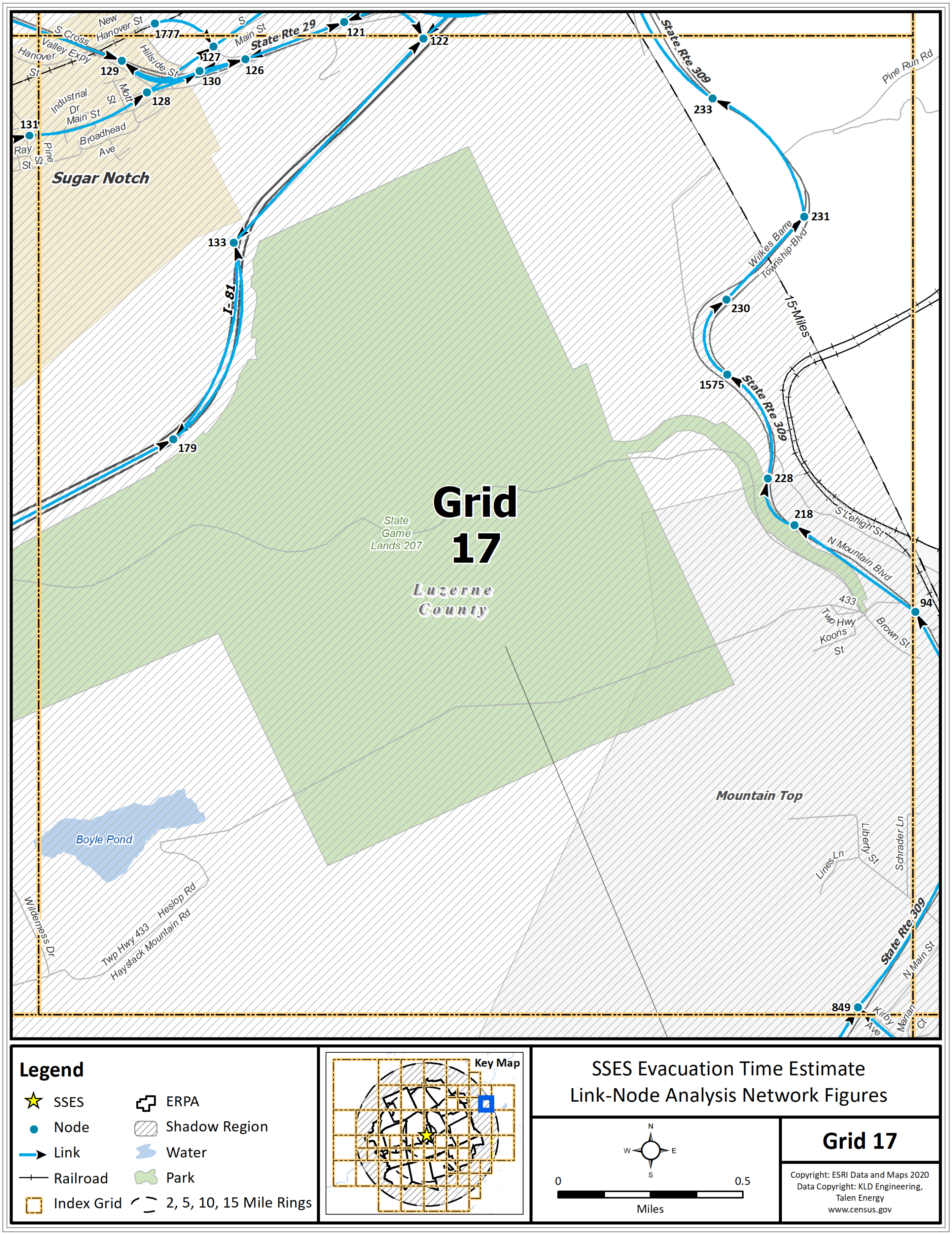


Figure K-18. Link-Node Analysis Network – Grid 17

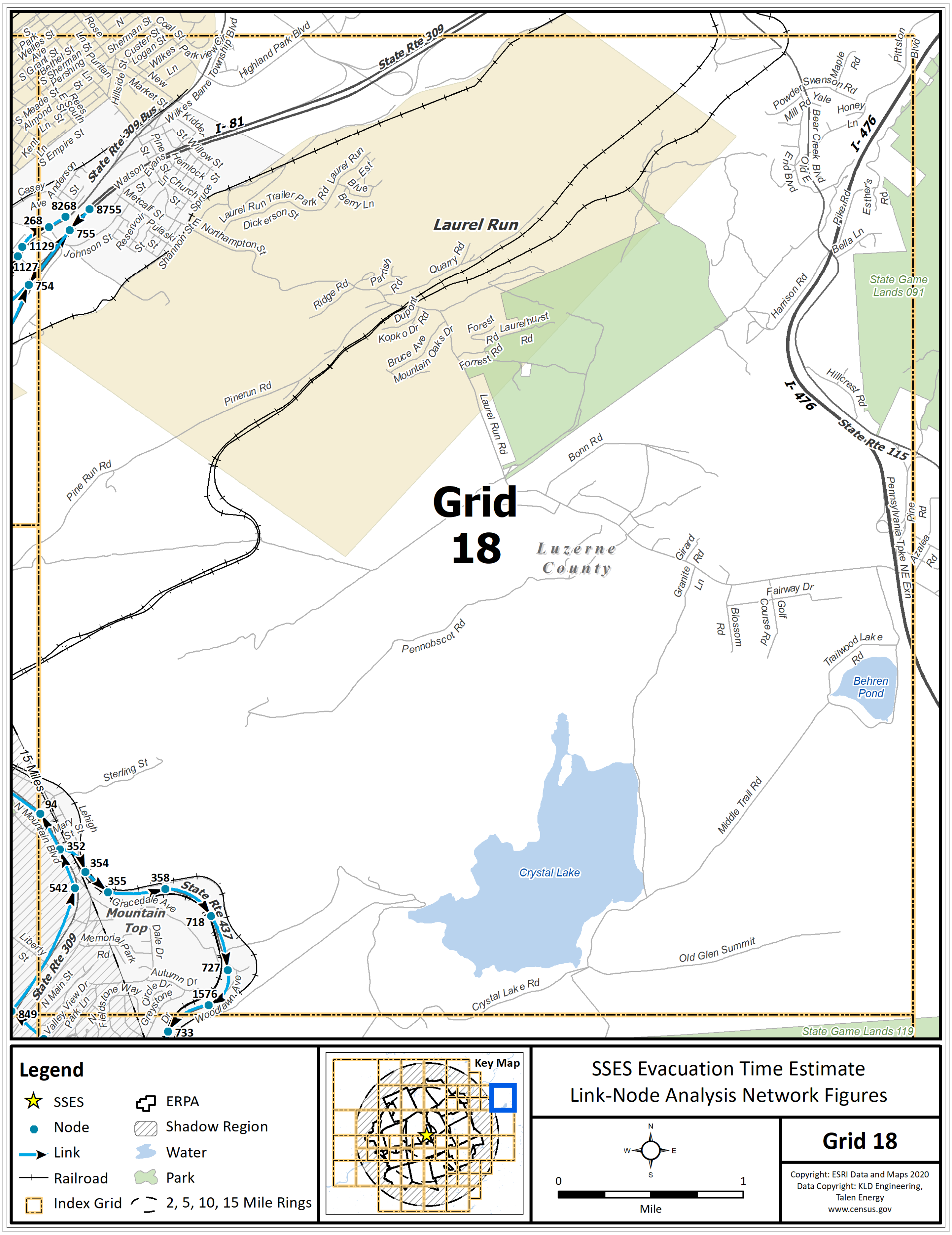


Figure K-19. Link-Node Analysis Network – Grid 18

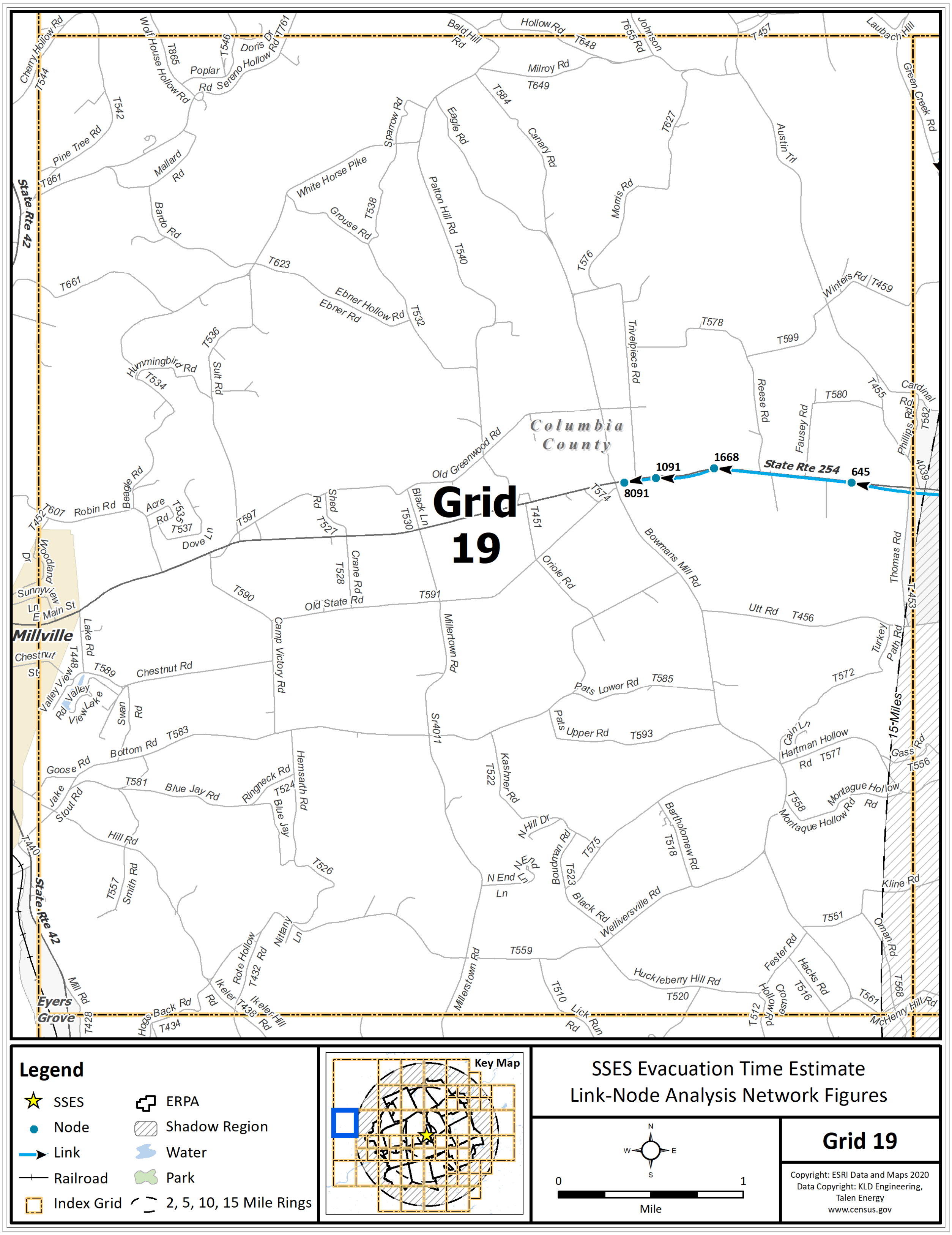


Figure K-20. Link-Node Analysis Network – Grid 19

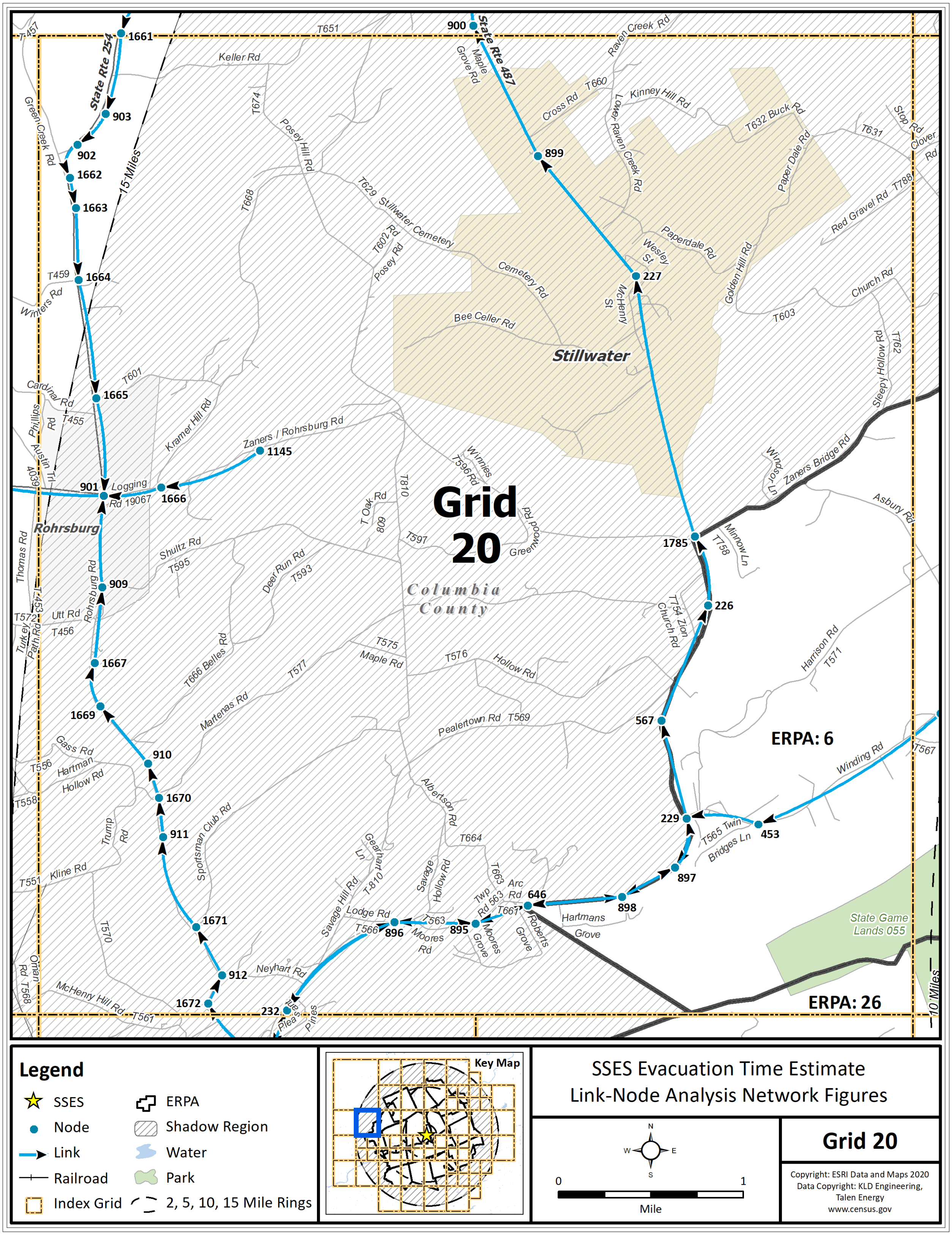


Figure K-21. Link-Node Analysis Network – Grid 20

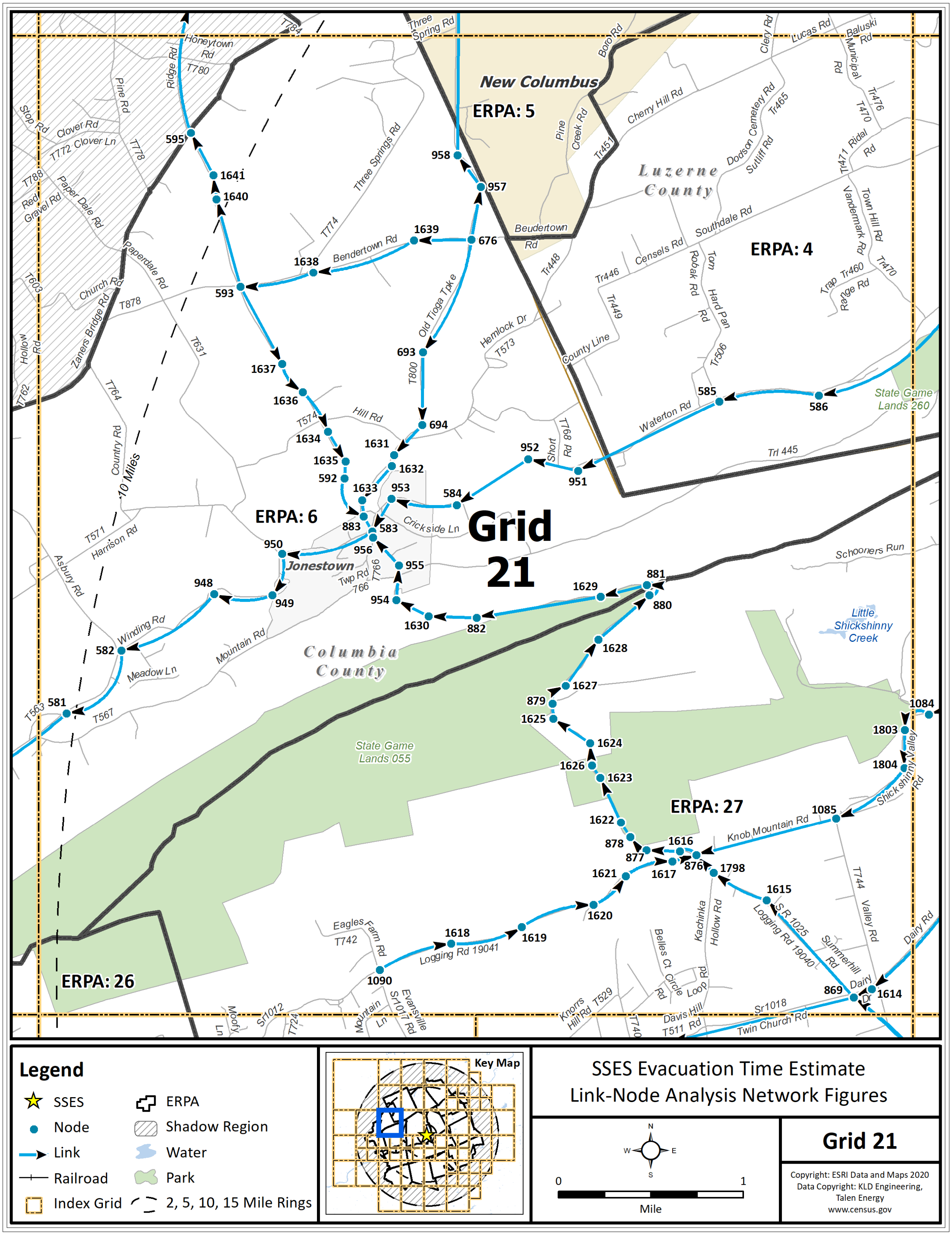


Figure K-22. Link-Node Analysis Network – Grid 21

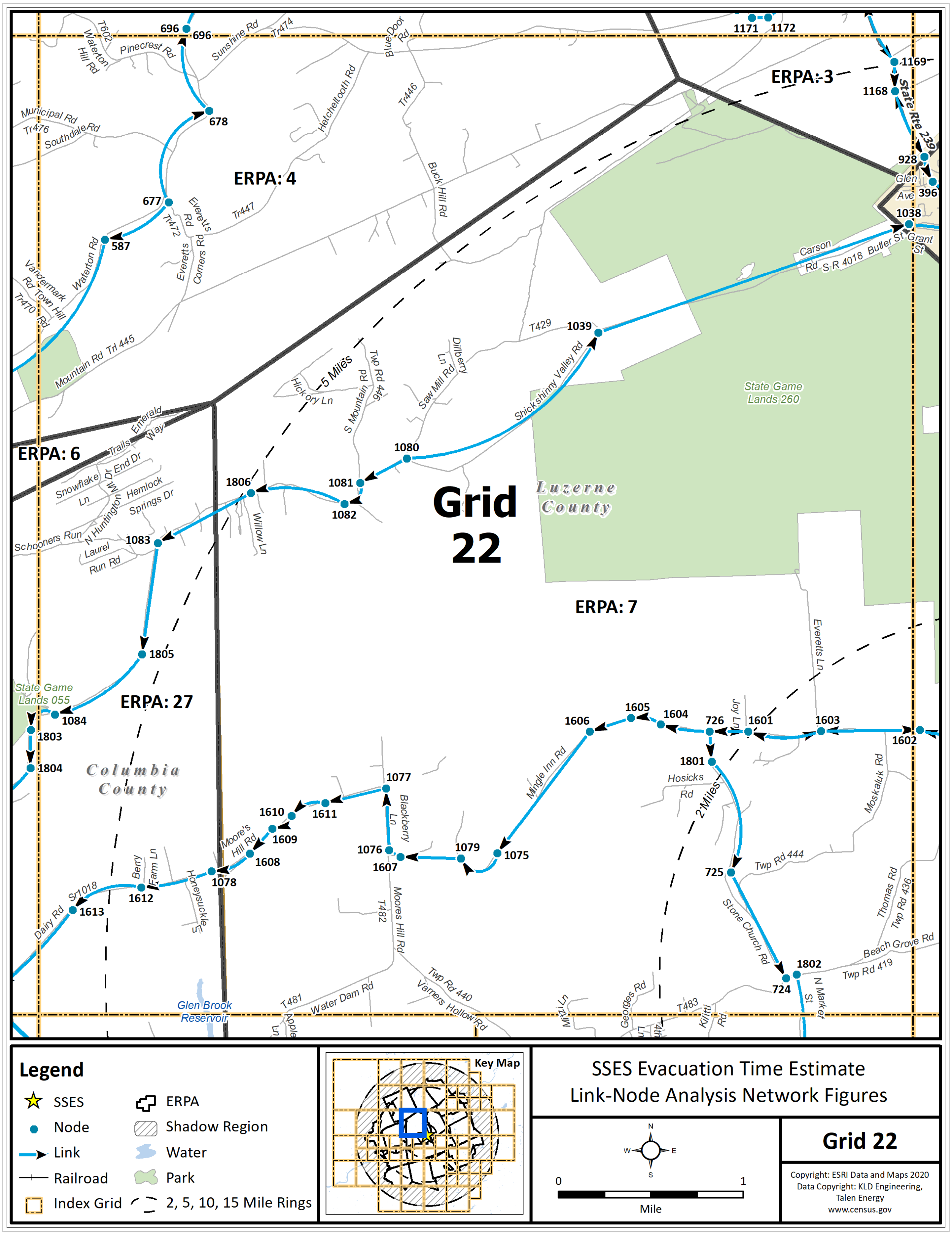


Figure K-23. Link-Node Analysis Network – Grid 22

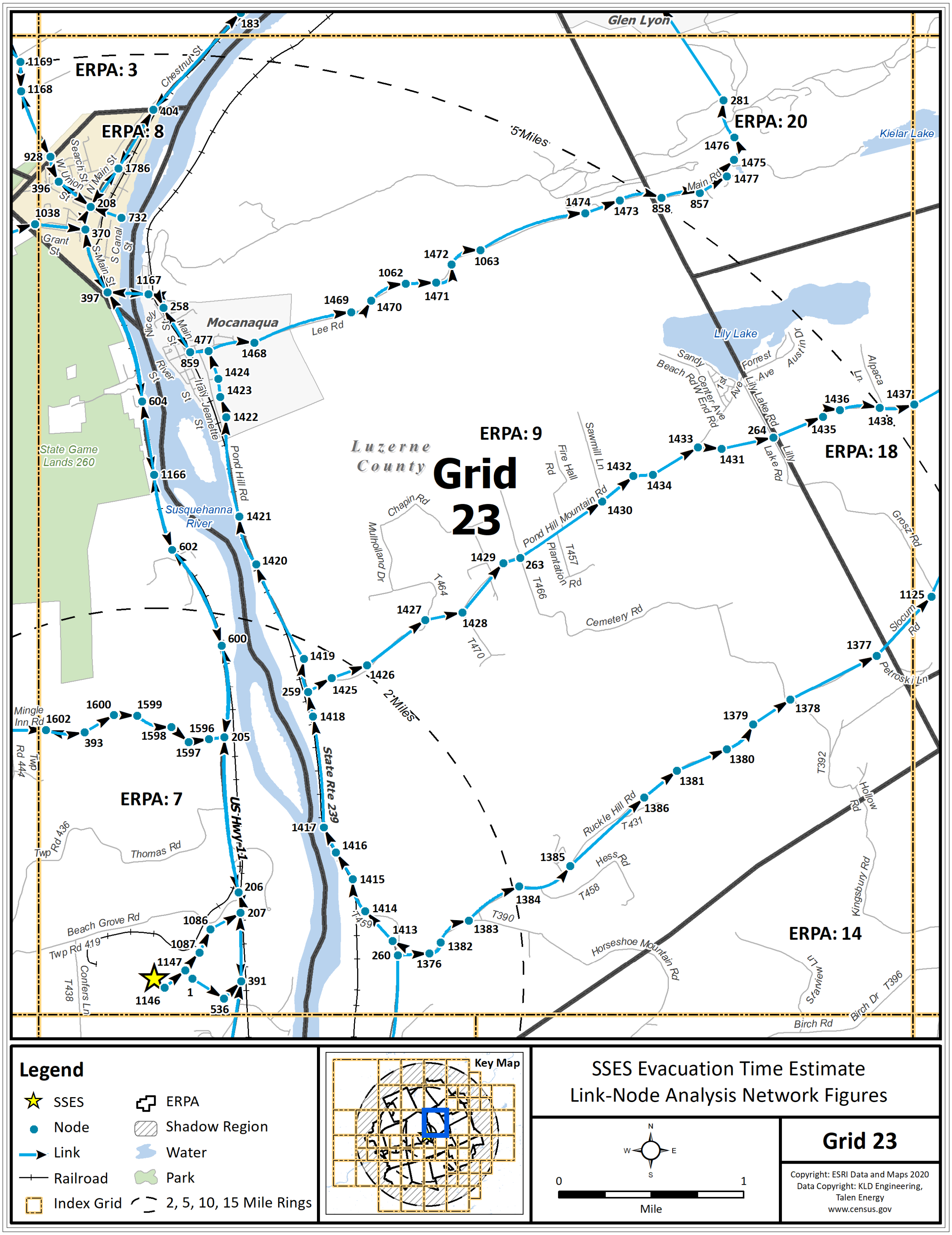


Figure K-24. Link-Node Analysis Network – Grid 23

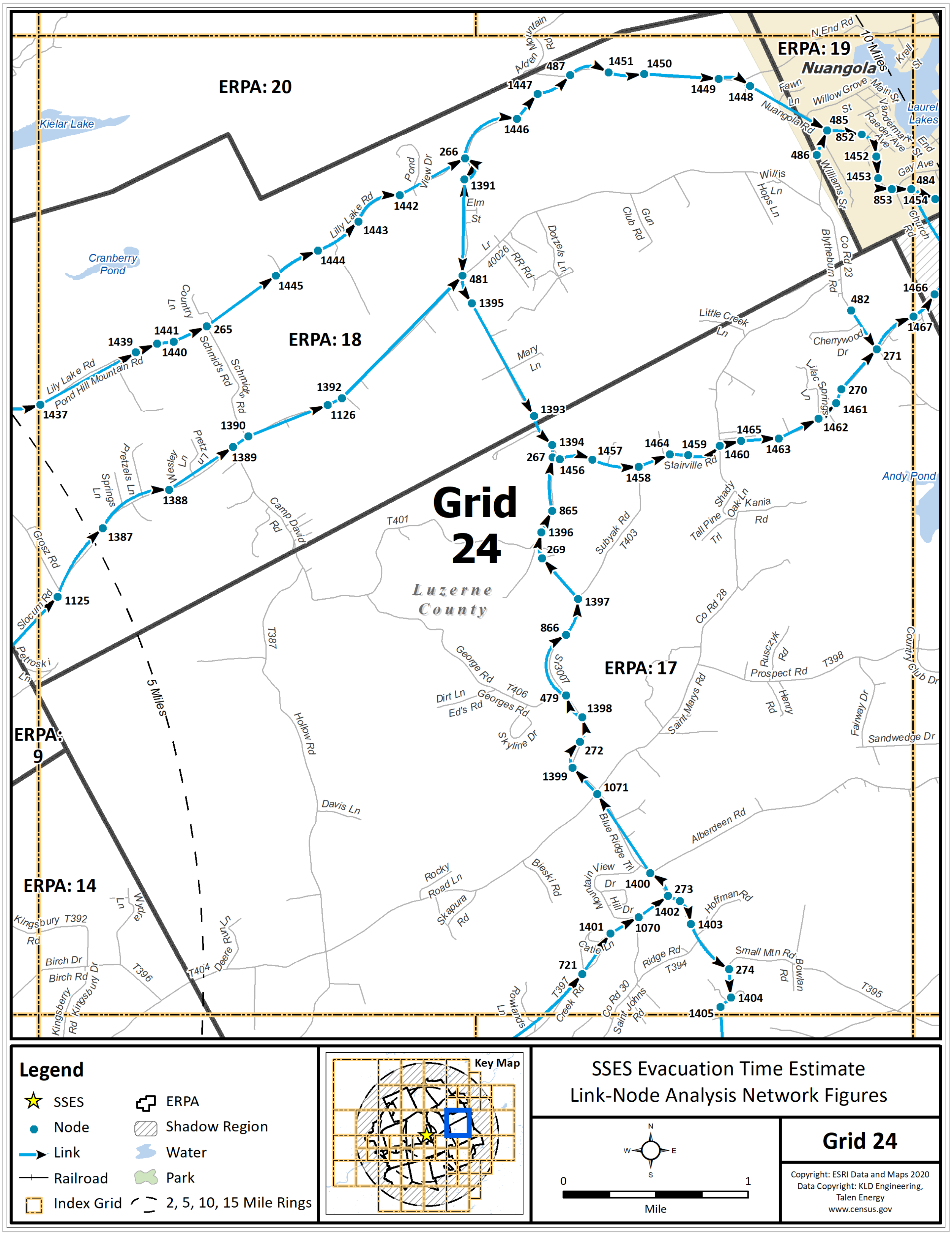


Figure K-25. Link-Node Analysis Network – Grid 24

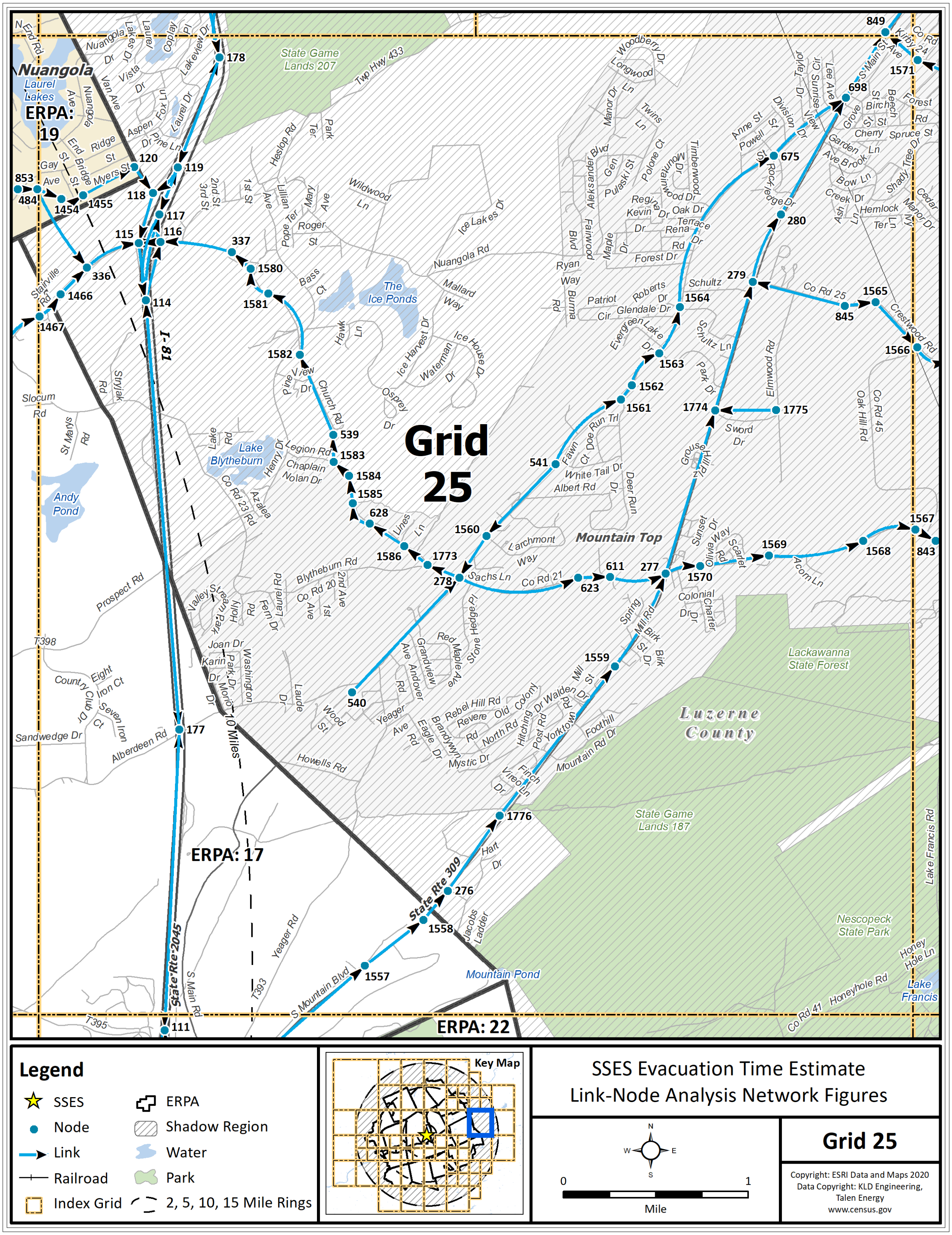


Figure K-26. Link-Node Analysis Network – Grid 25

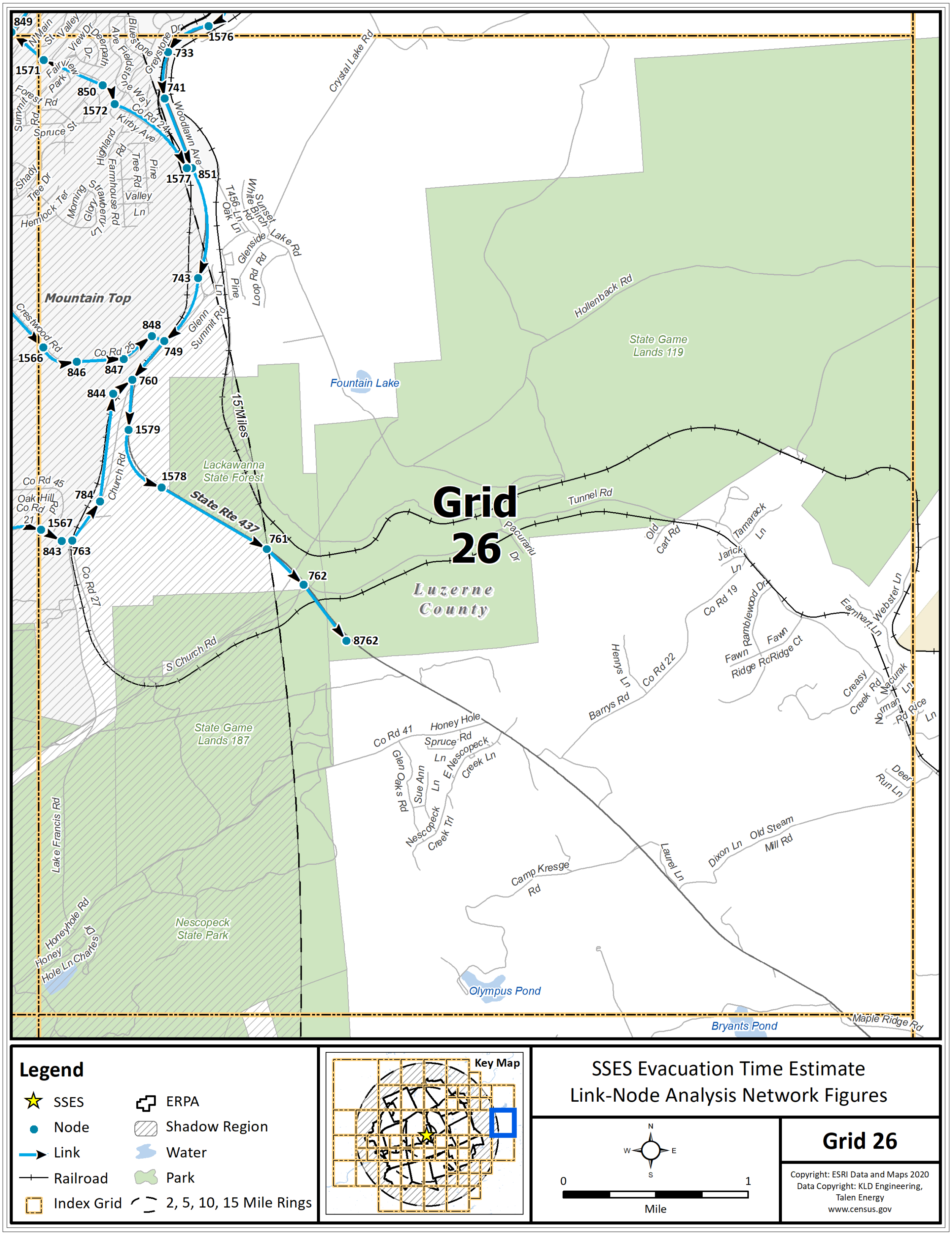


Figure K-27. Link-Node Analysis Network – Grid 26

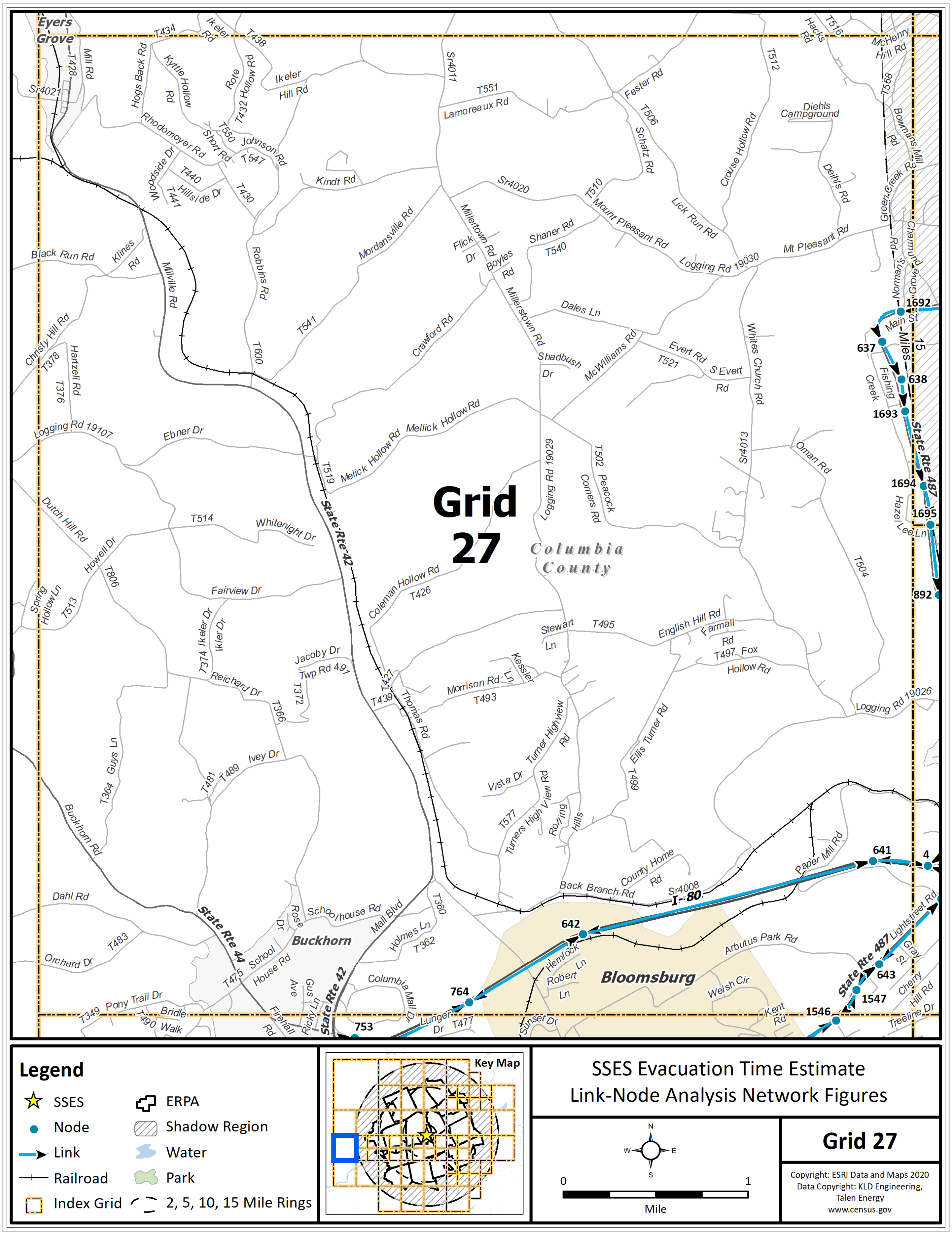


Figure K-28. Link-Node Analysis Network – Grid 27

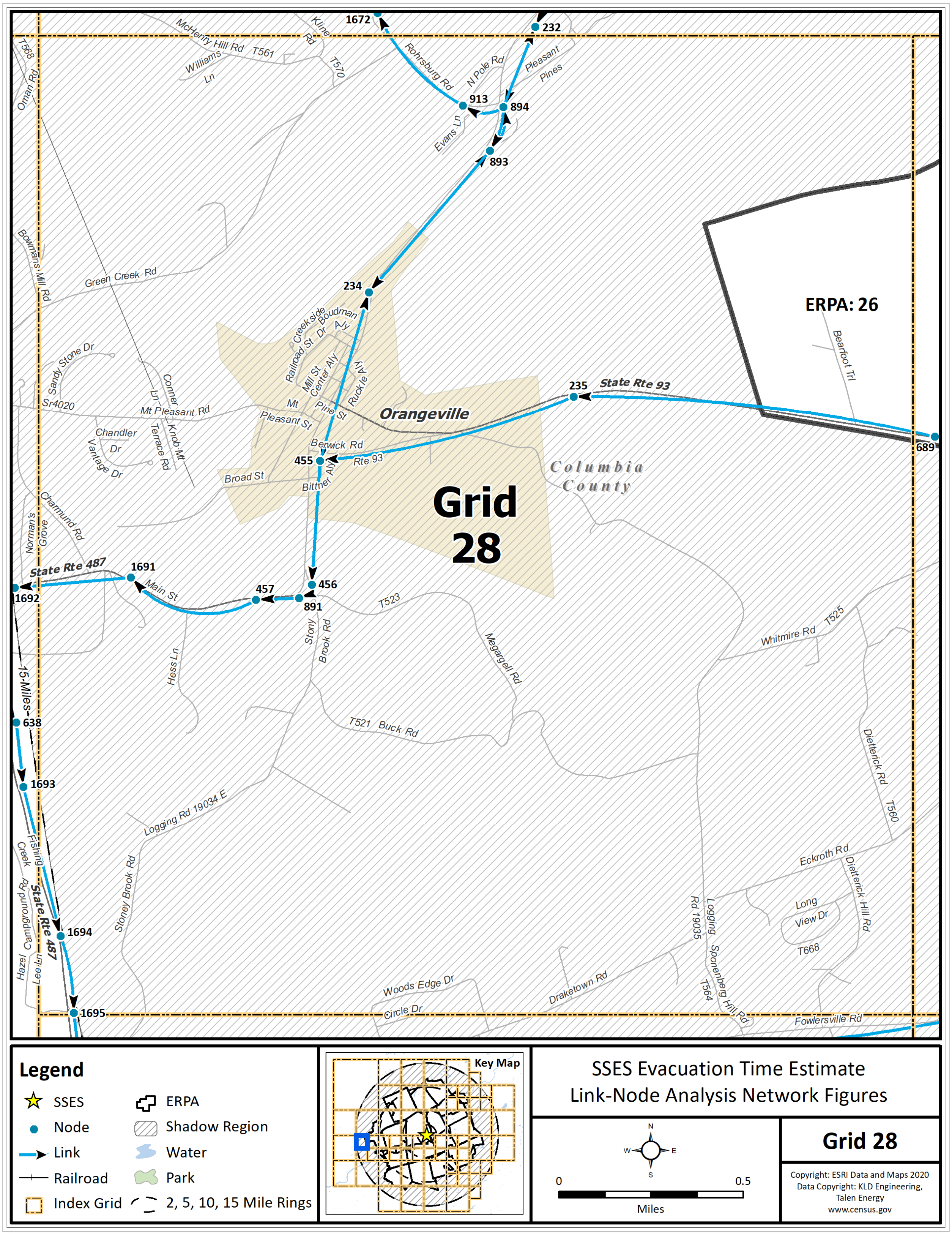


Figure K-29. Link-Node Analysis Network – Grid 28

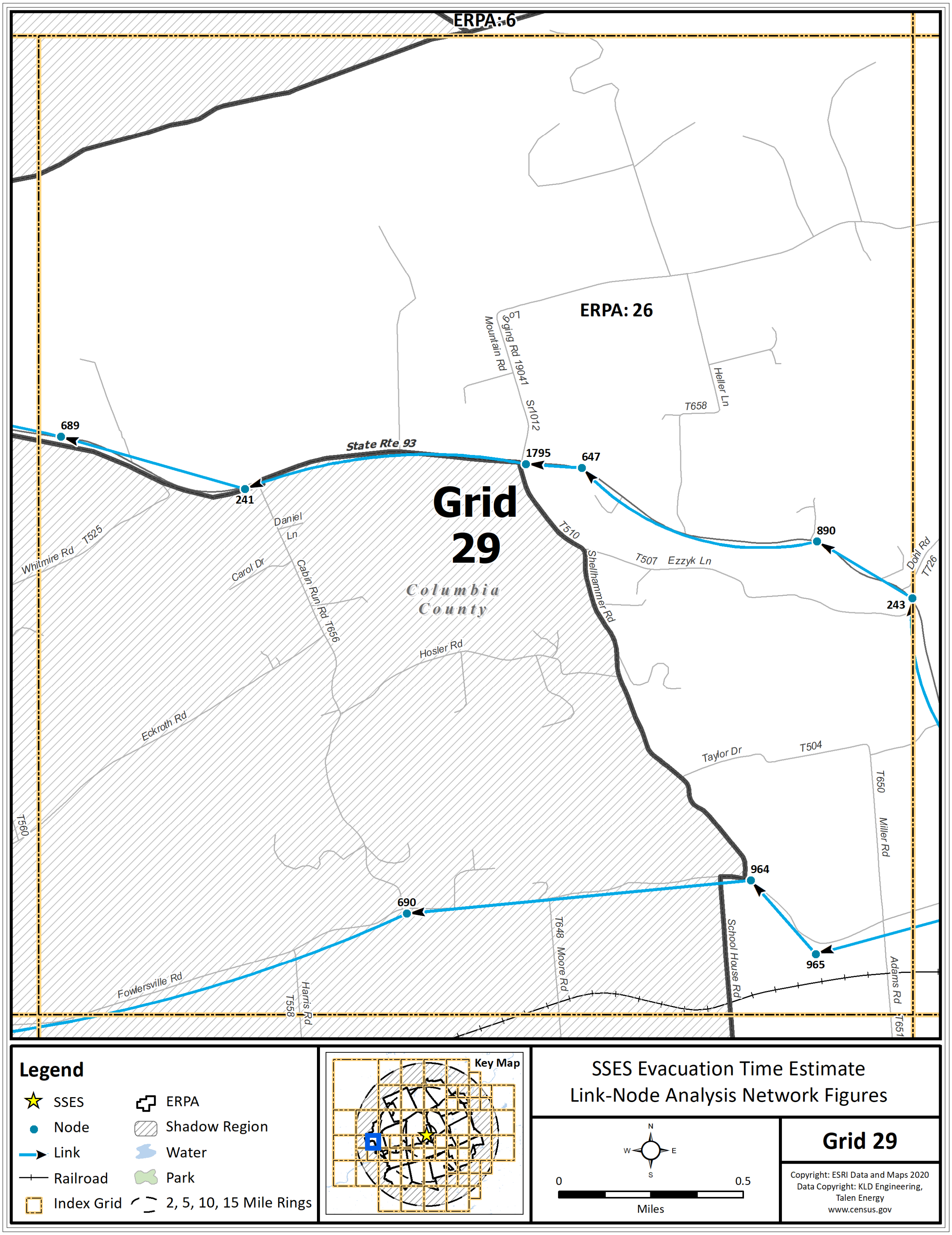


Figure K-30. Link-Node Analysis Network – Grid 29

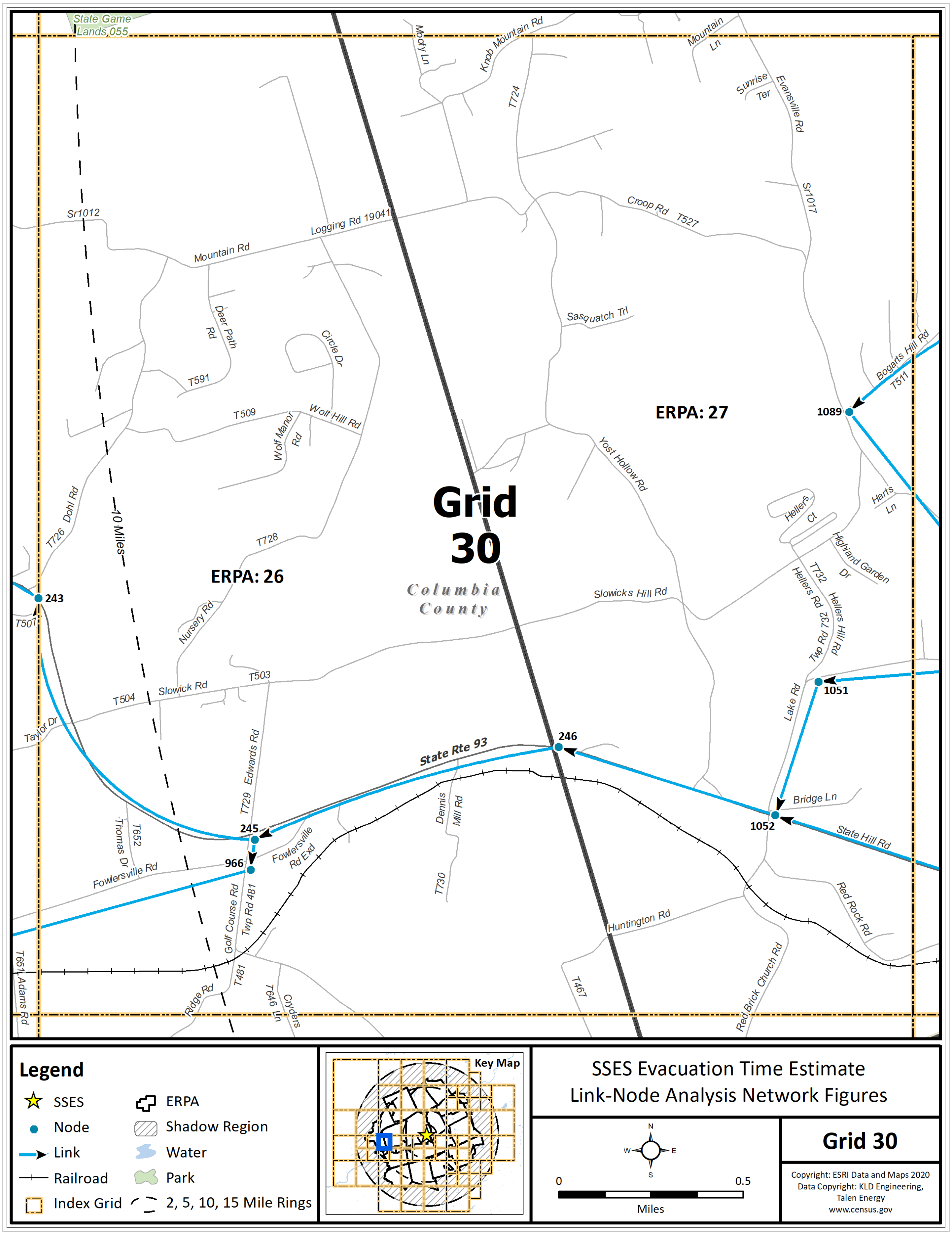


Figure K-31. Link-Node Analysis Network – Grid 30

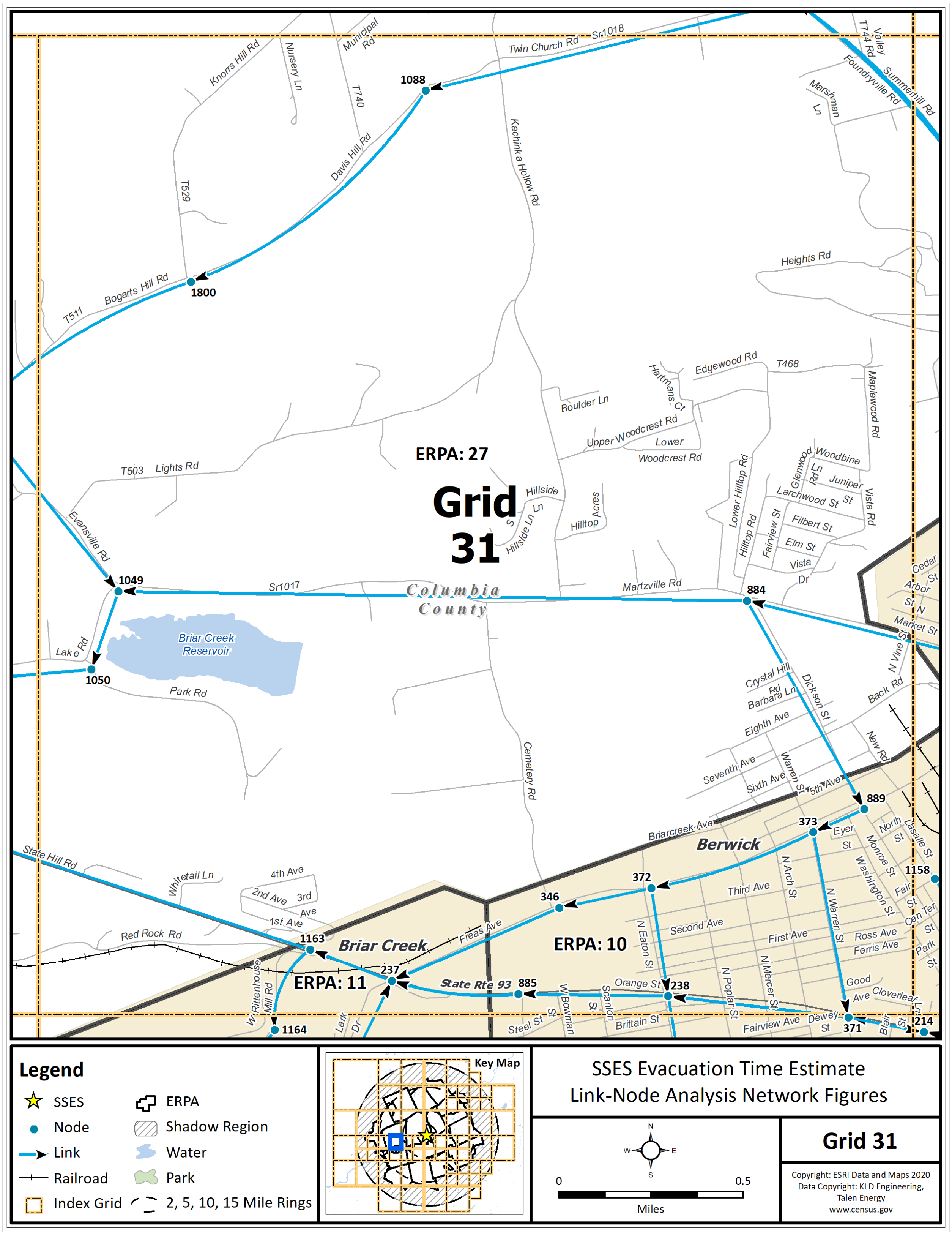


Figure K-32. Link-Node Analysis Network – Grid 31

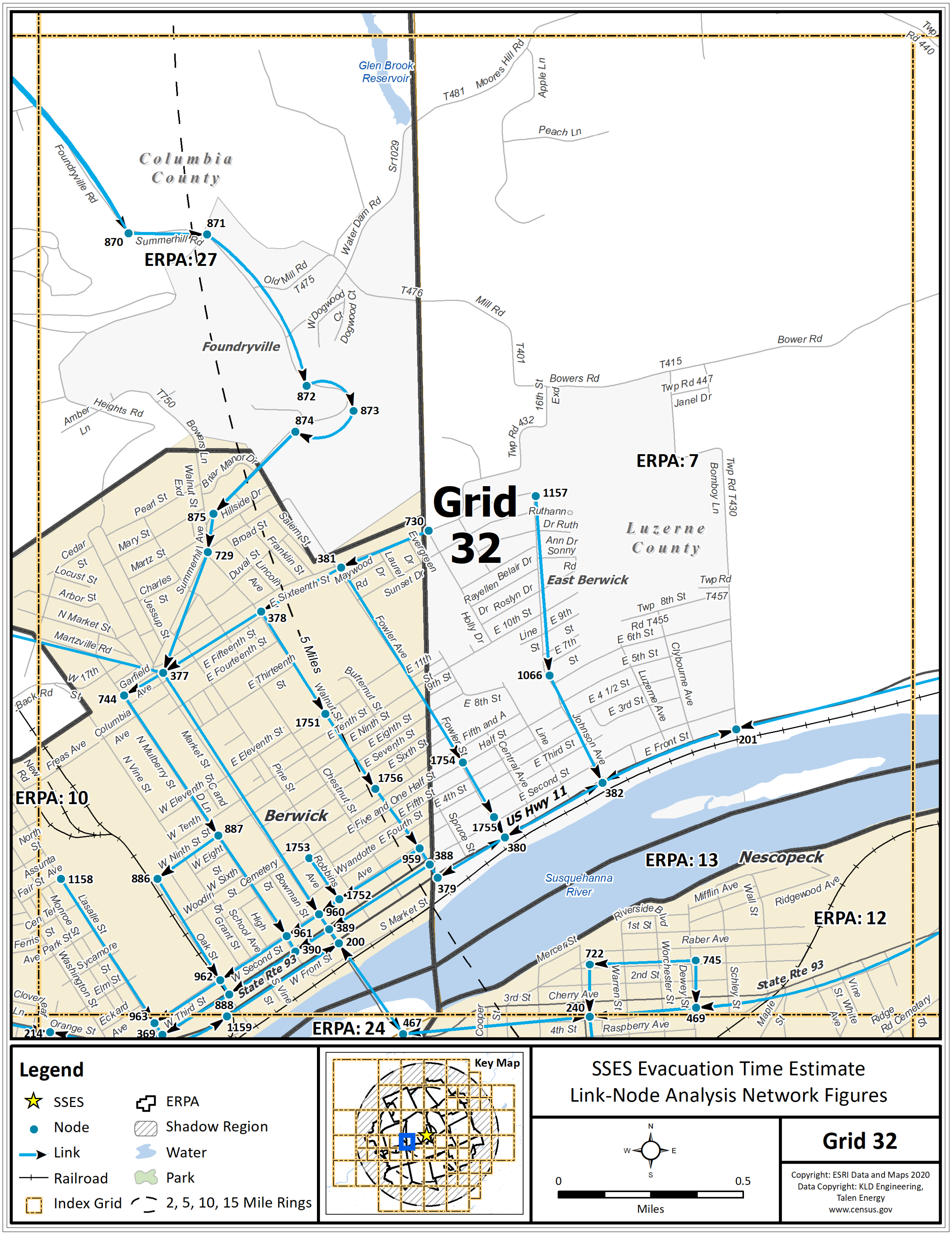


Figure K-33. Link-Node Analysis Network – Grid 32

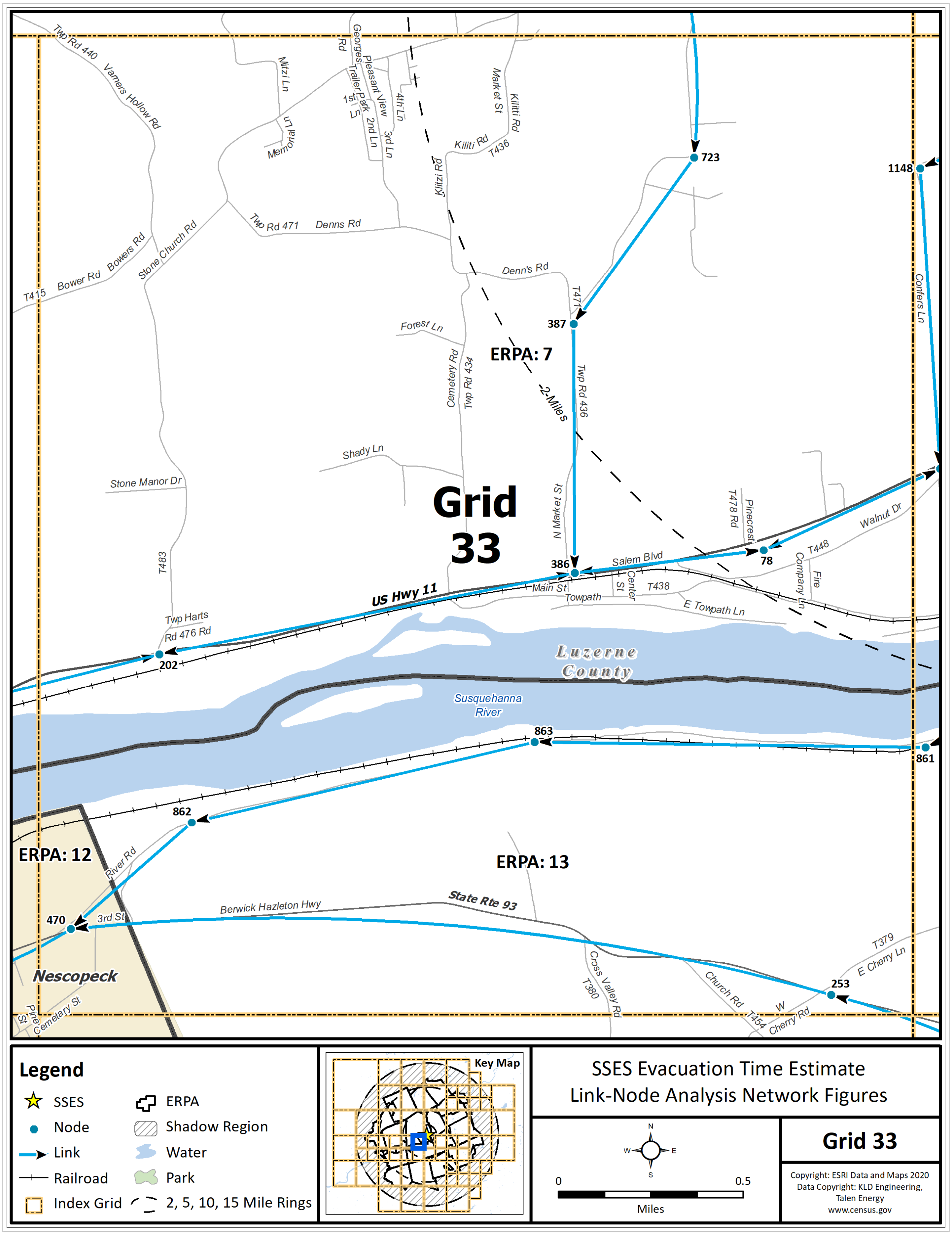


Figure K-34. Link-Node Analysis Network – Grid 33

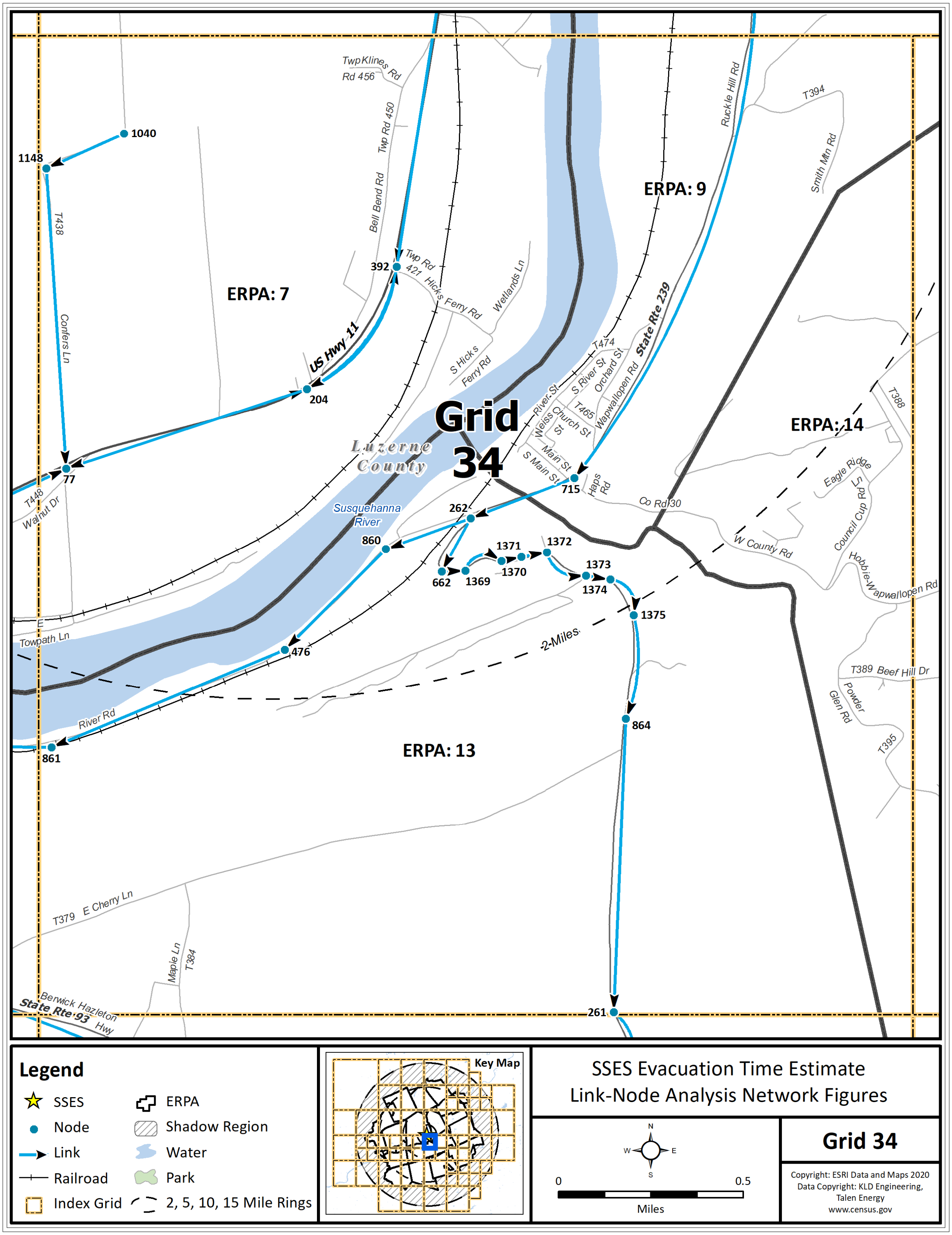


Figure K-35. Link-Node Analysis Network – Grid 34

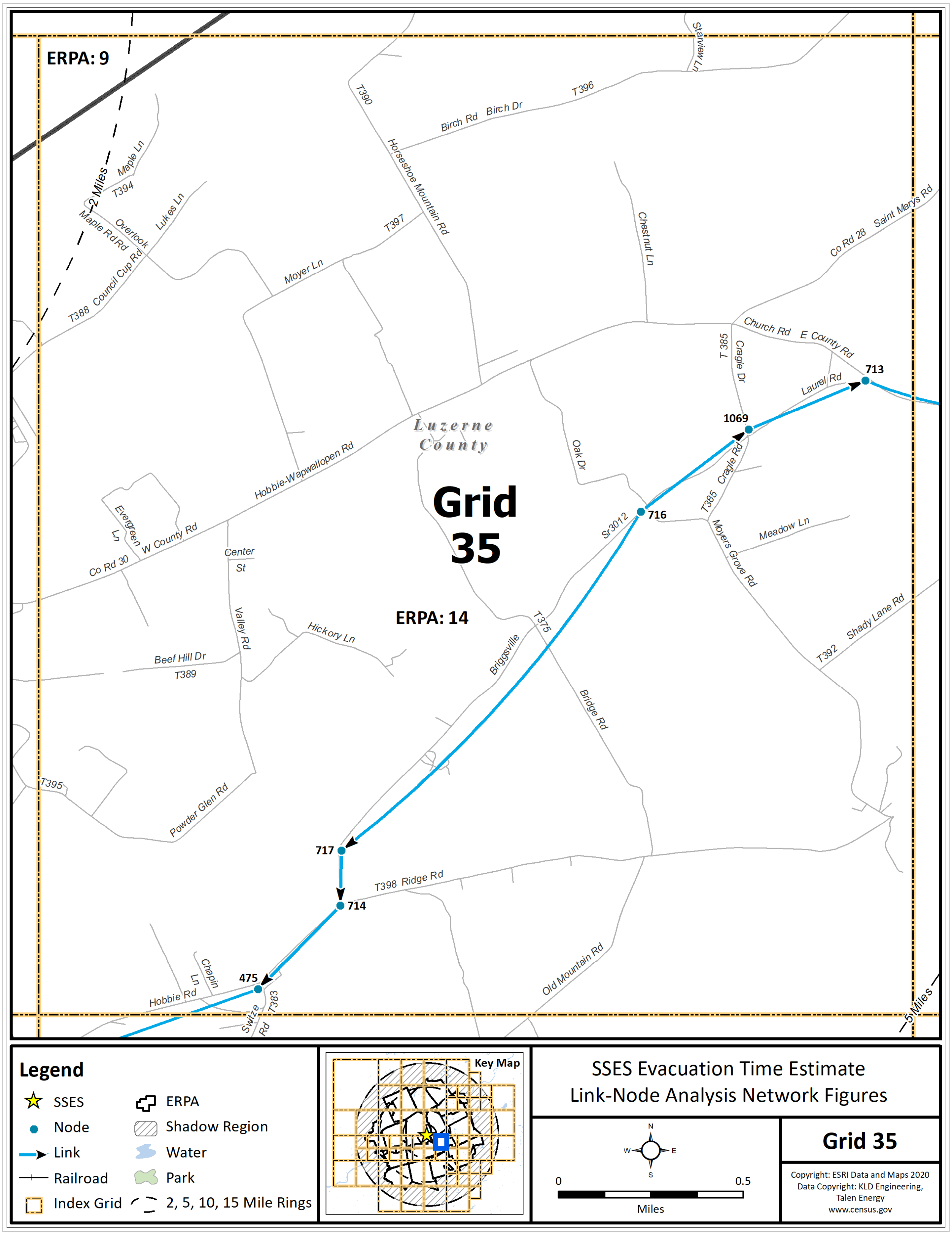


Figure K-36. Link-Node Analysis Network – Grid 35

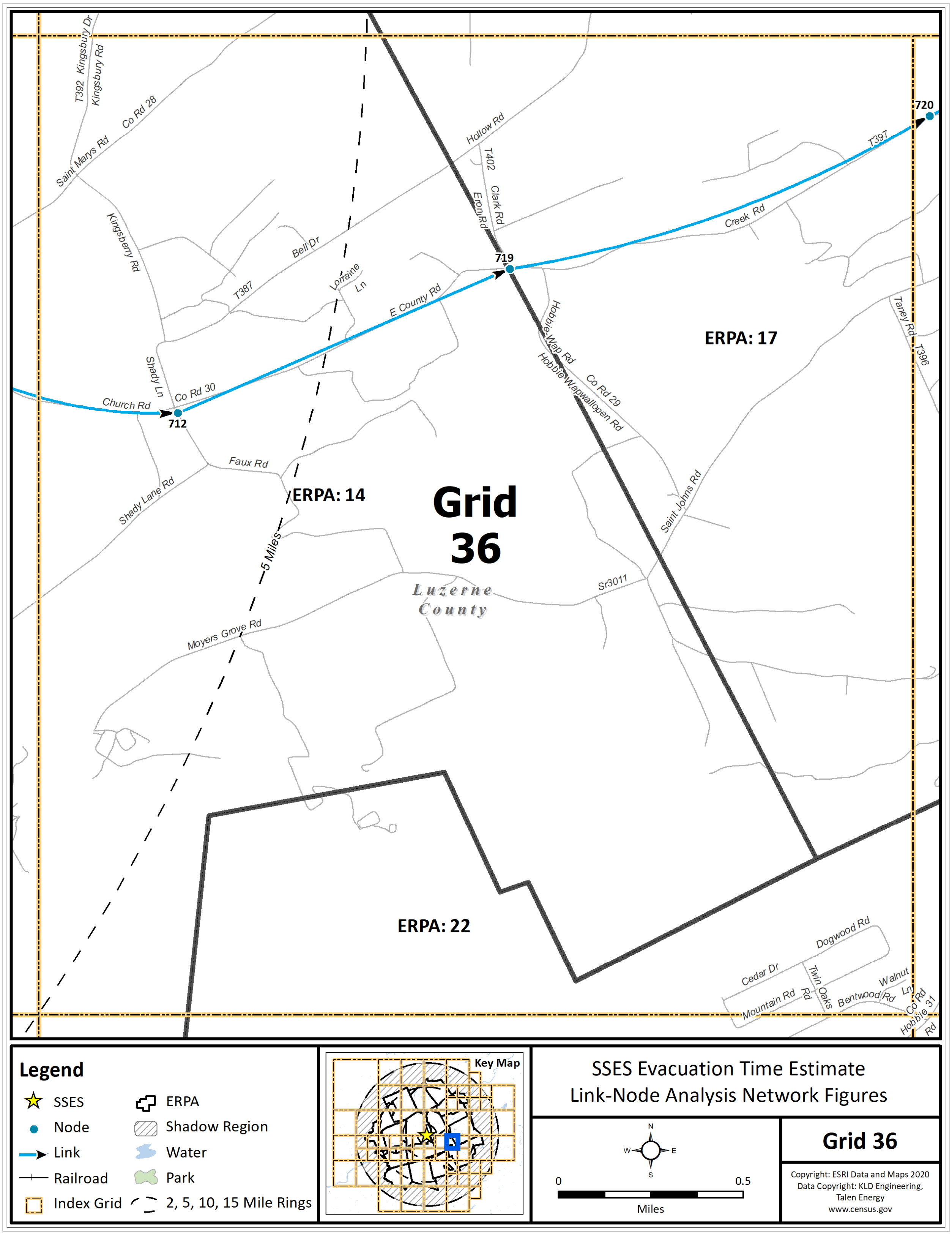


Figure K-37. Link-Node Analysis Network – Grid 36

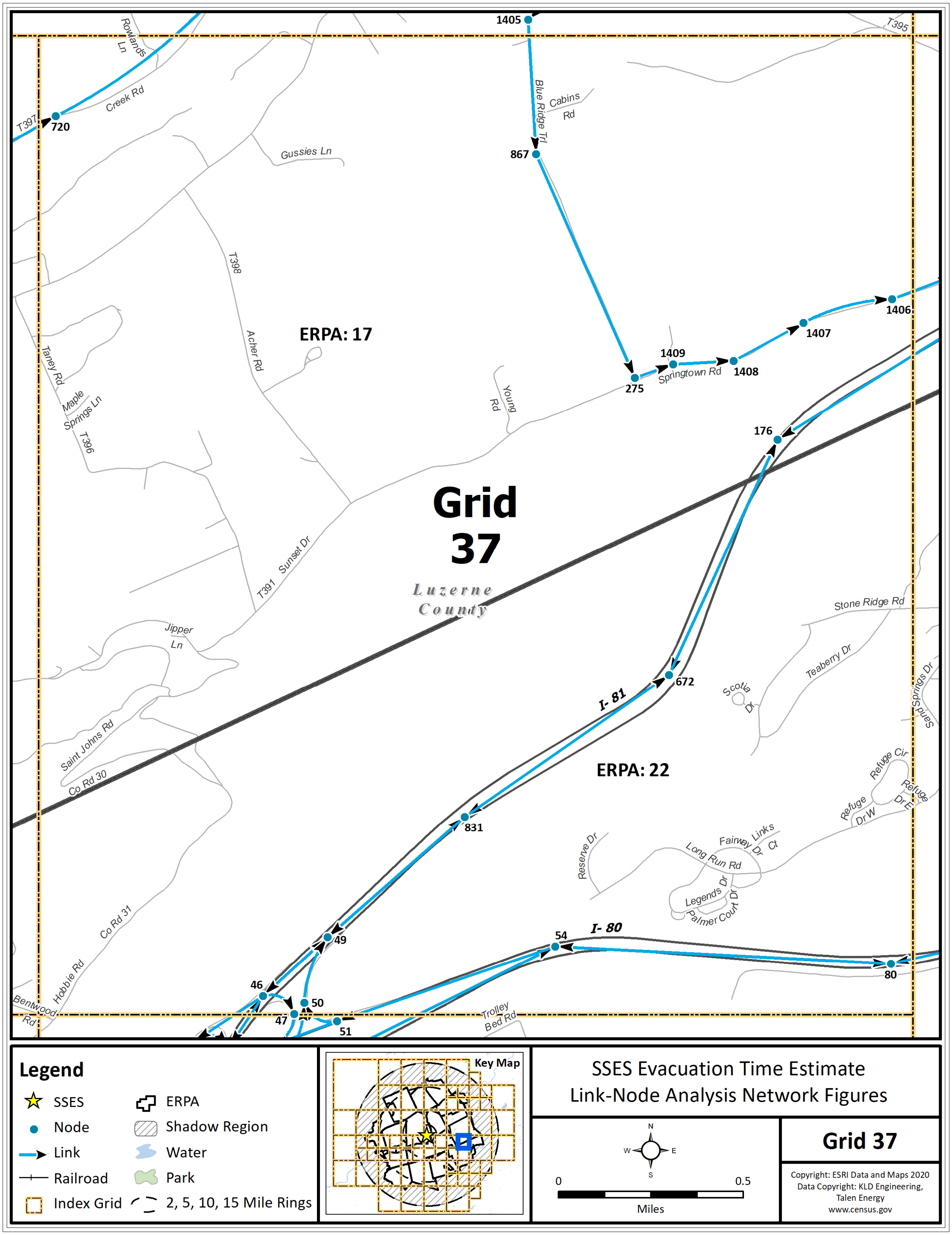


Figure K-38. Link-Node Analysis Network – Grid 37

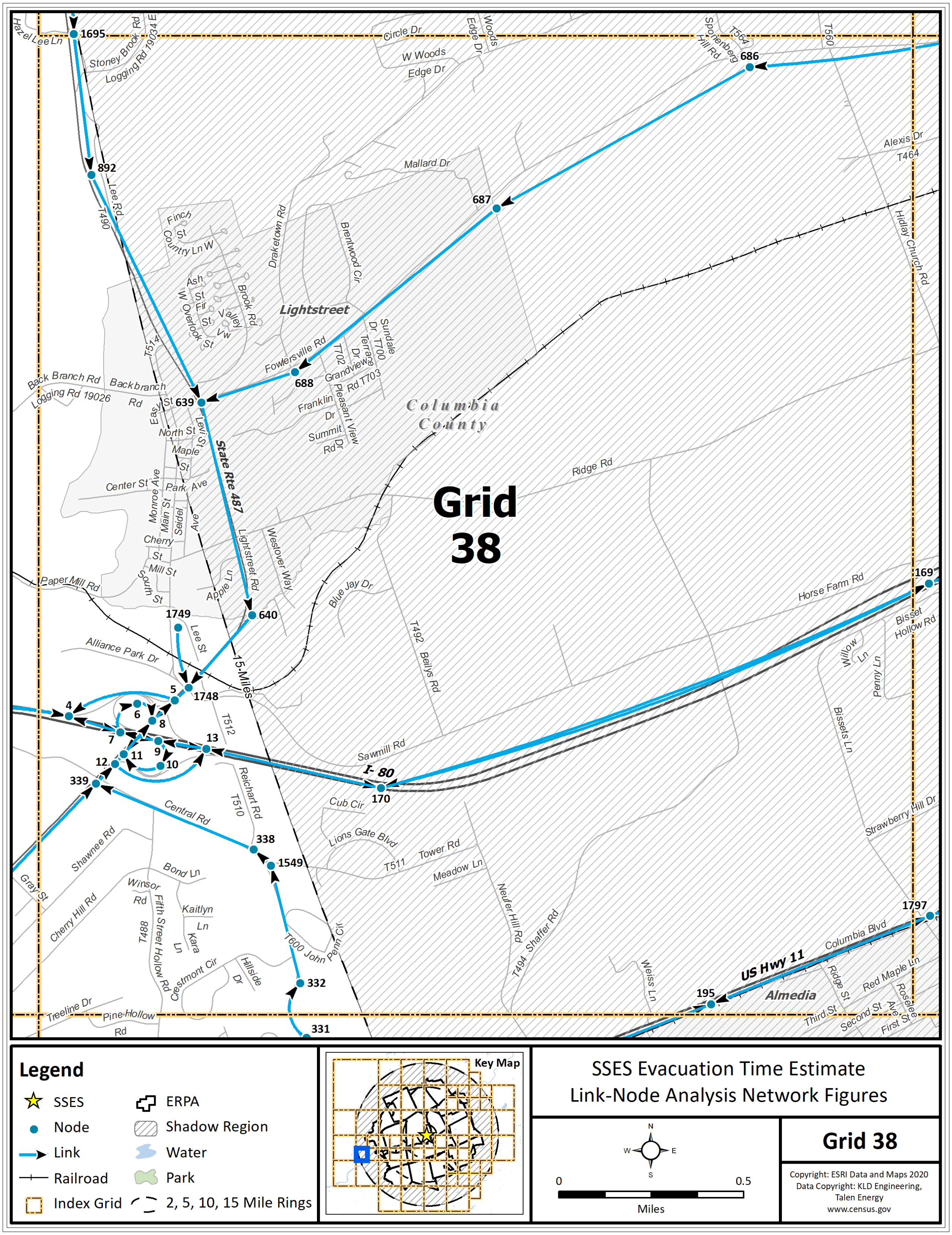


Figure K-39. Link-Node Analysis Network – Grid 38

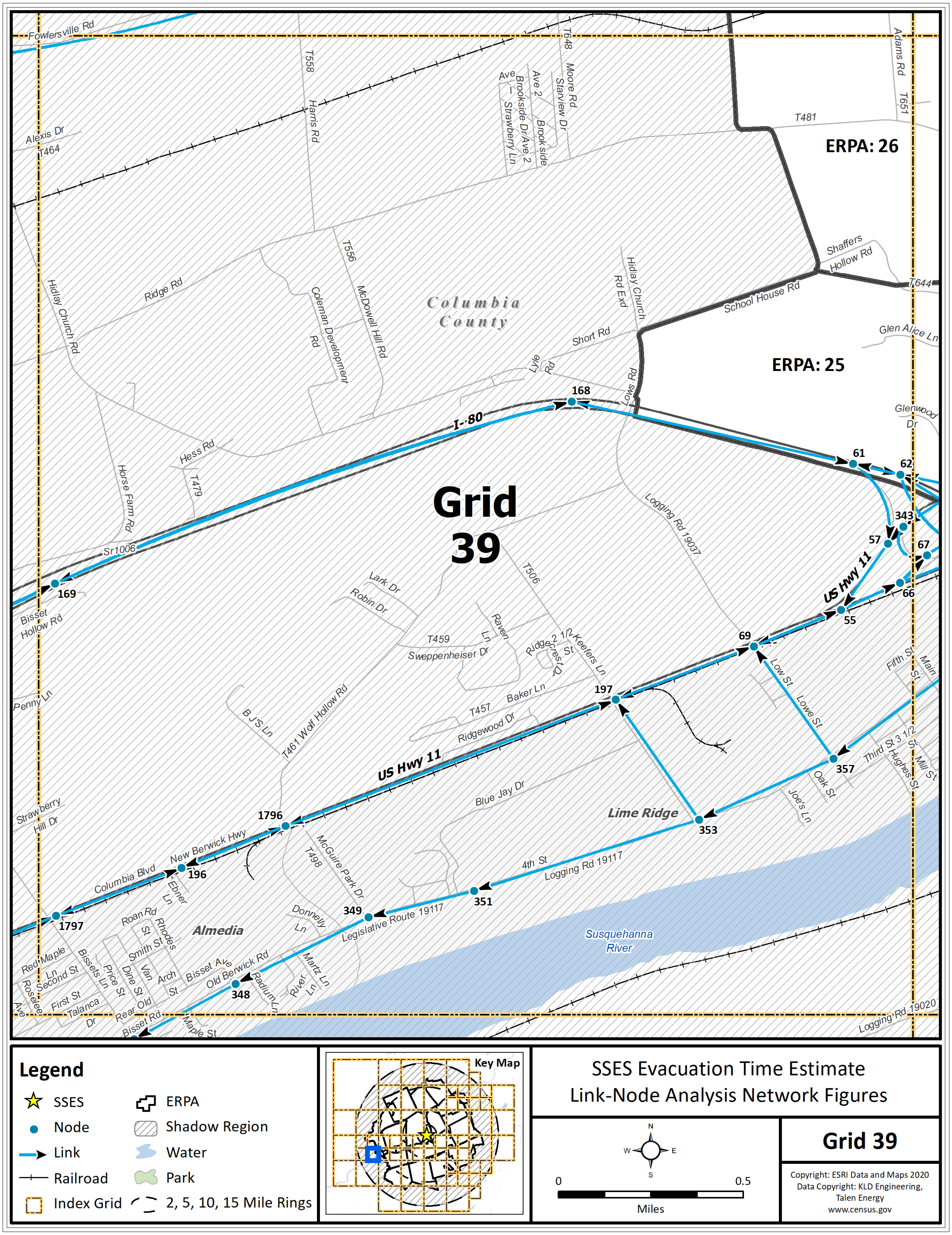


Figure K-40. Link-Node Analysis Network – Grid 39

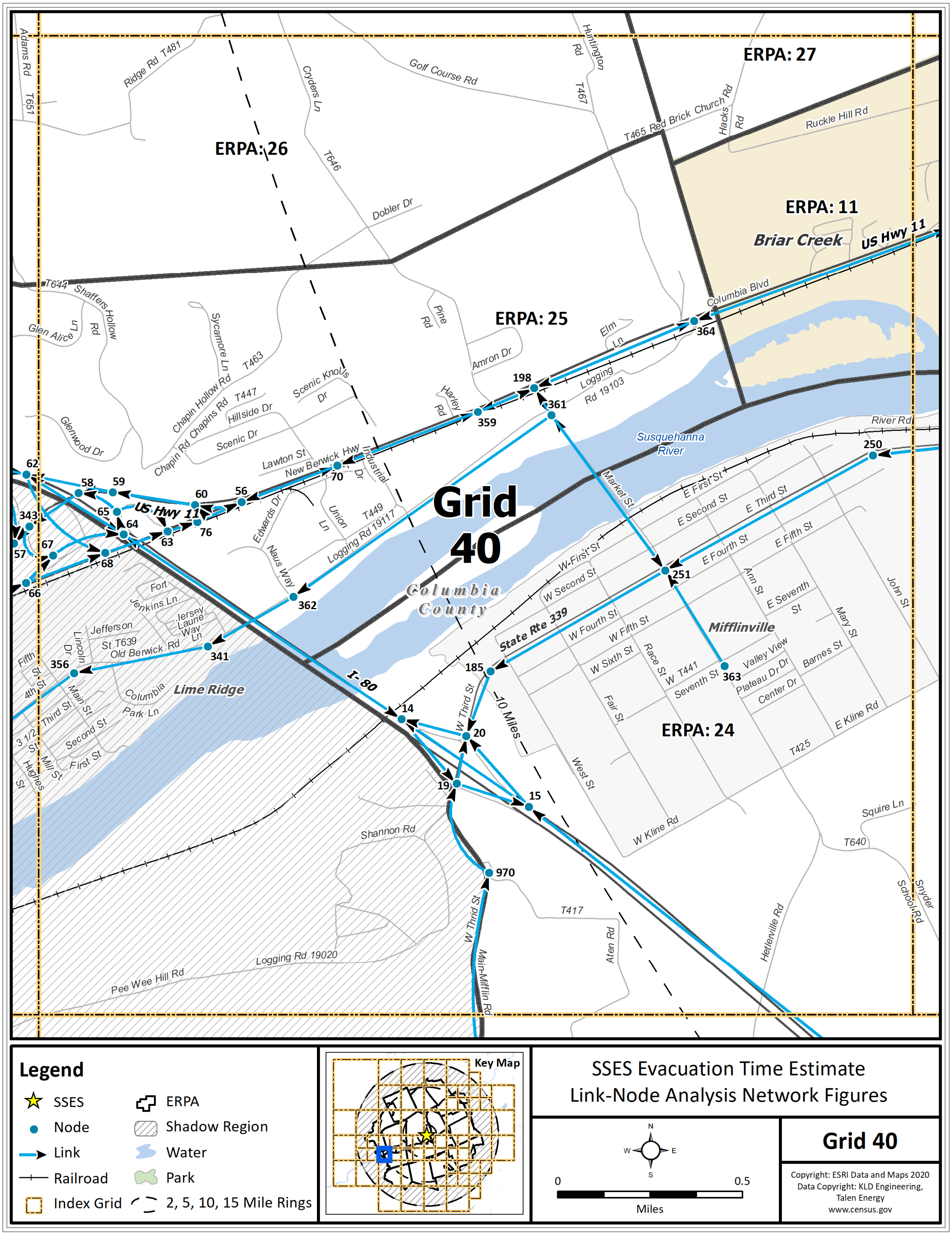


Figure K-41. Link-Node Analysis Network – Grid 40

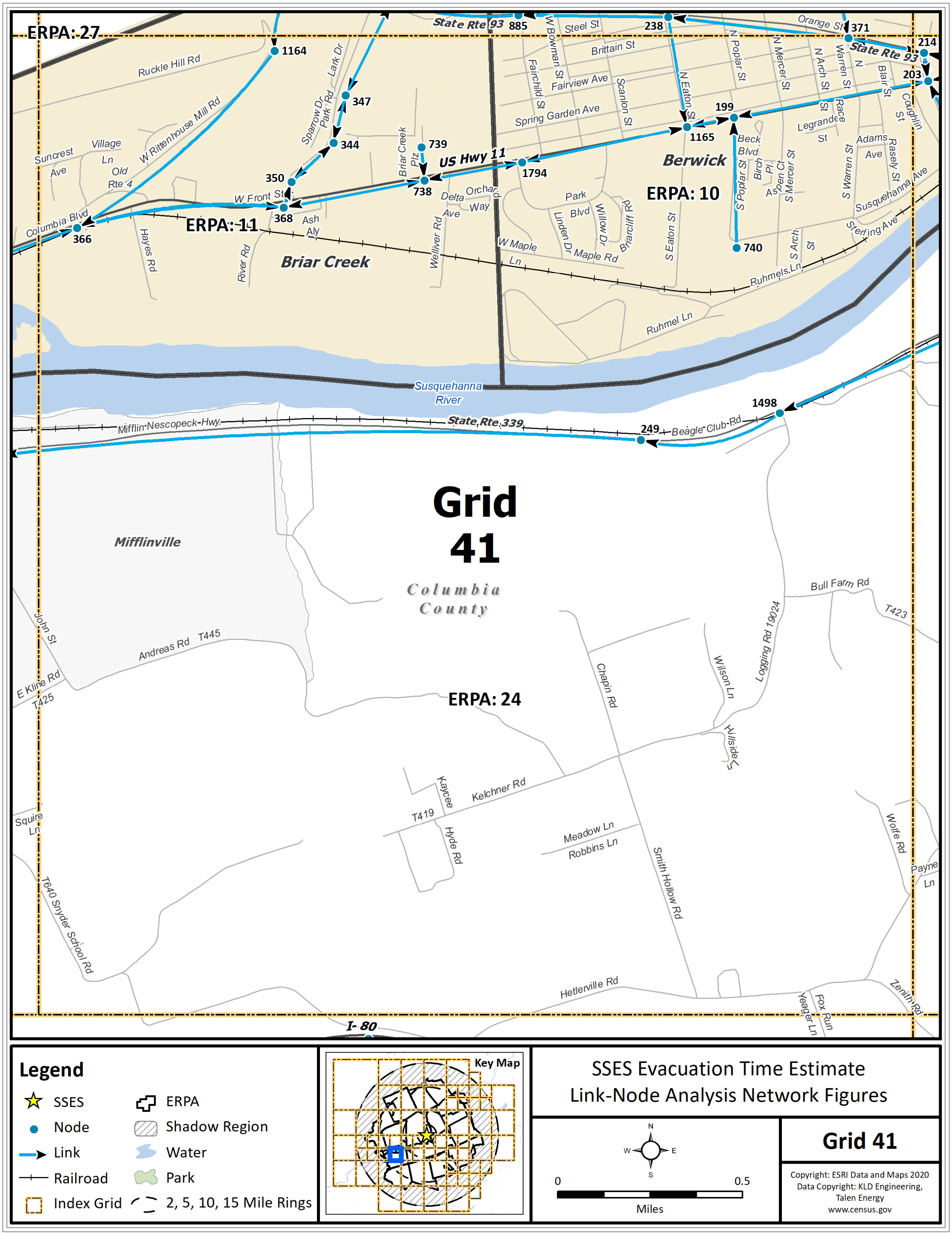


Figure K-42. Link-Node Analysis Network – Grid 41

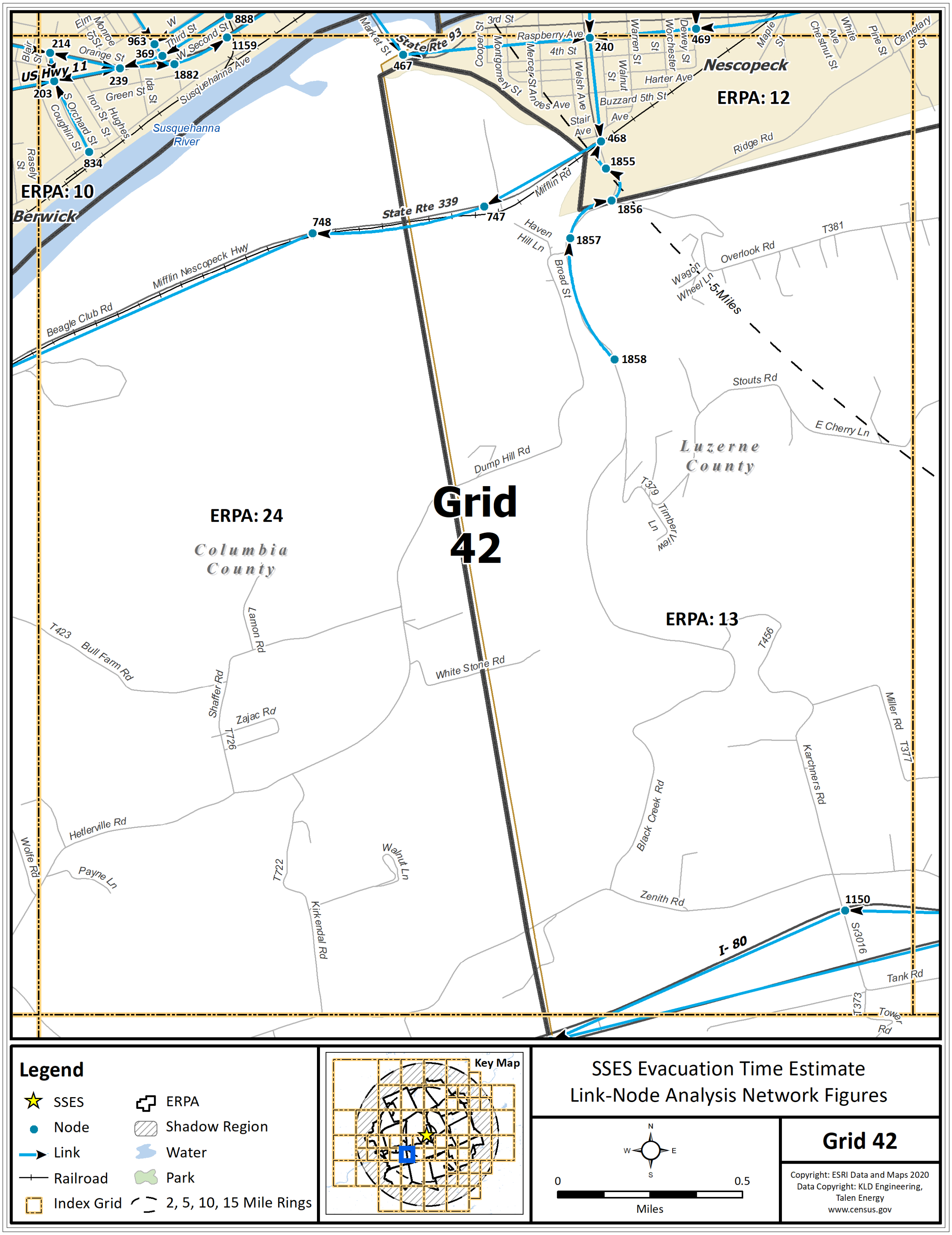


Figure K-43. Link-Node Analysis Network – Grid 42

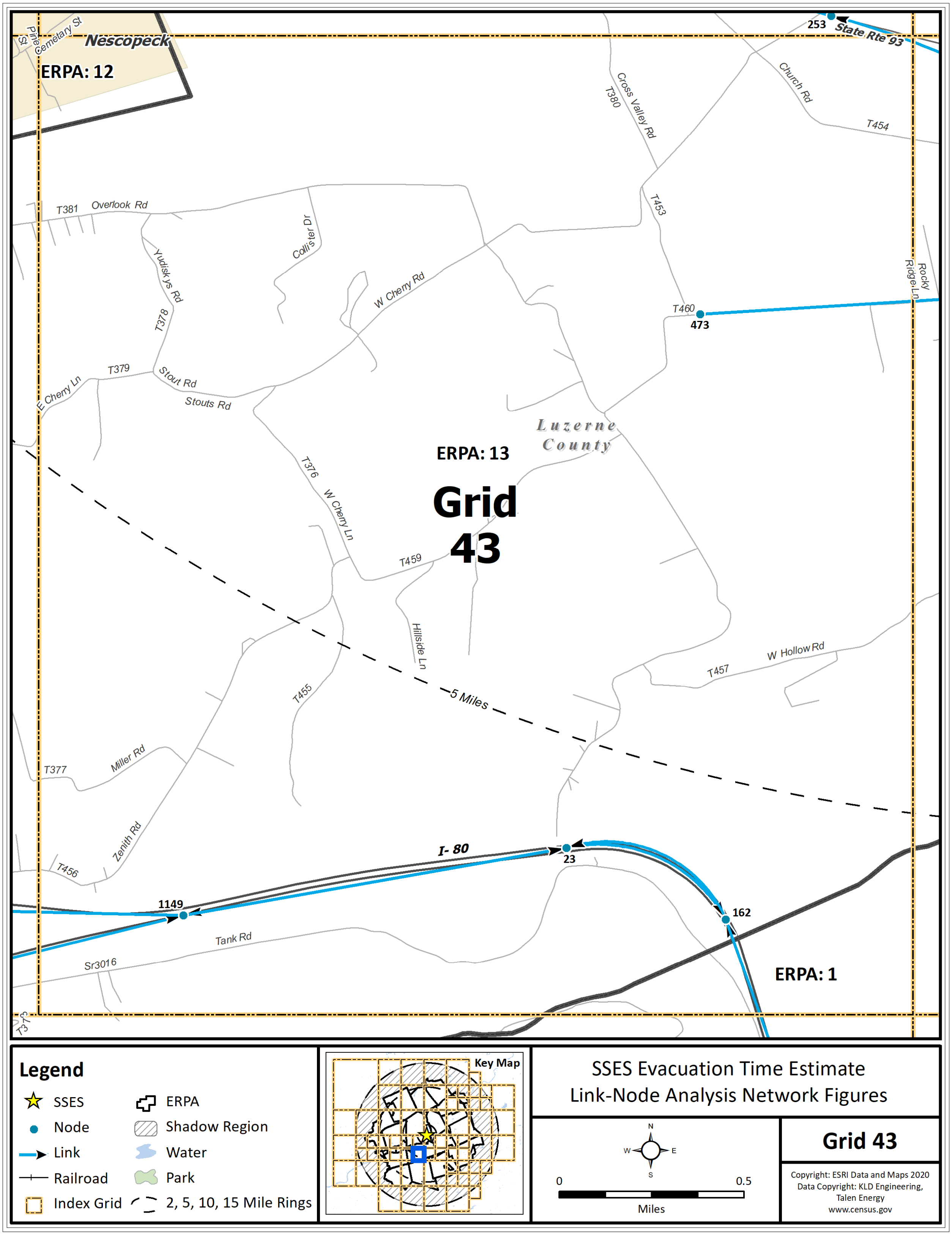


Figure K-44. Link-Node Analysis Network – Grid 43

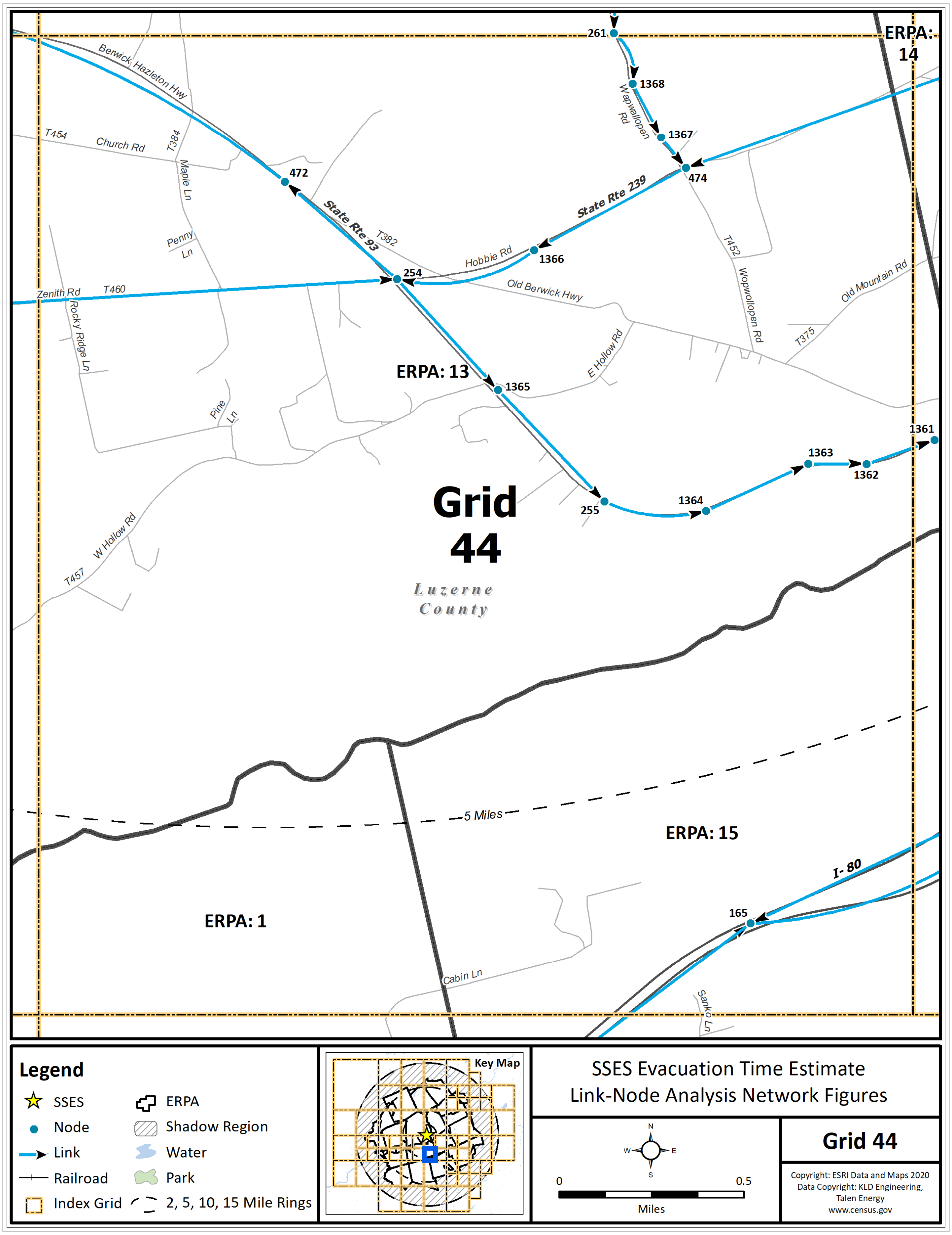


Figure K-45. Link-Node Analysis Network – Grid 44

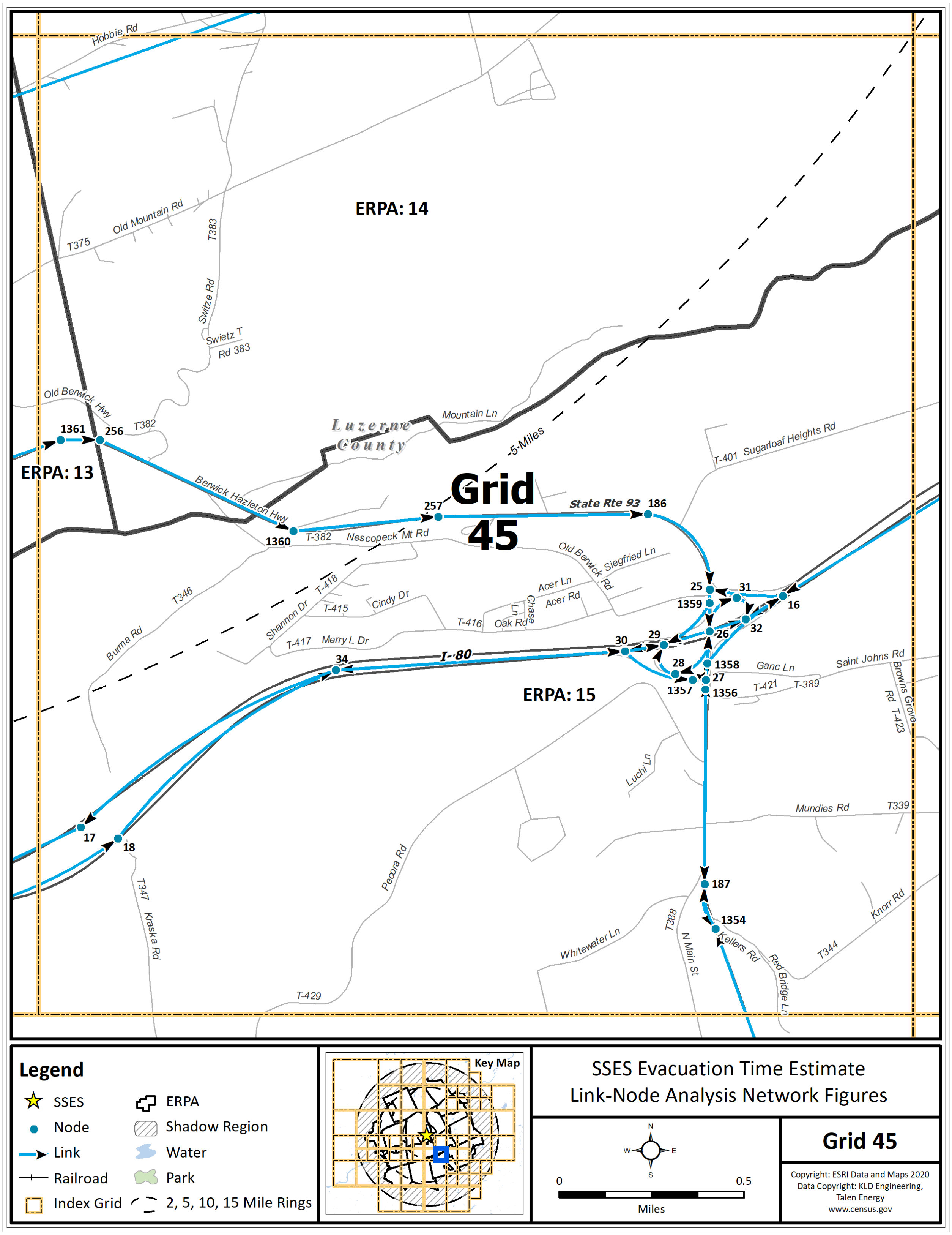


Figure K-46. Link-Node Analysis Network – Grid 45

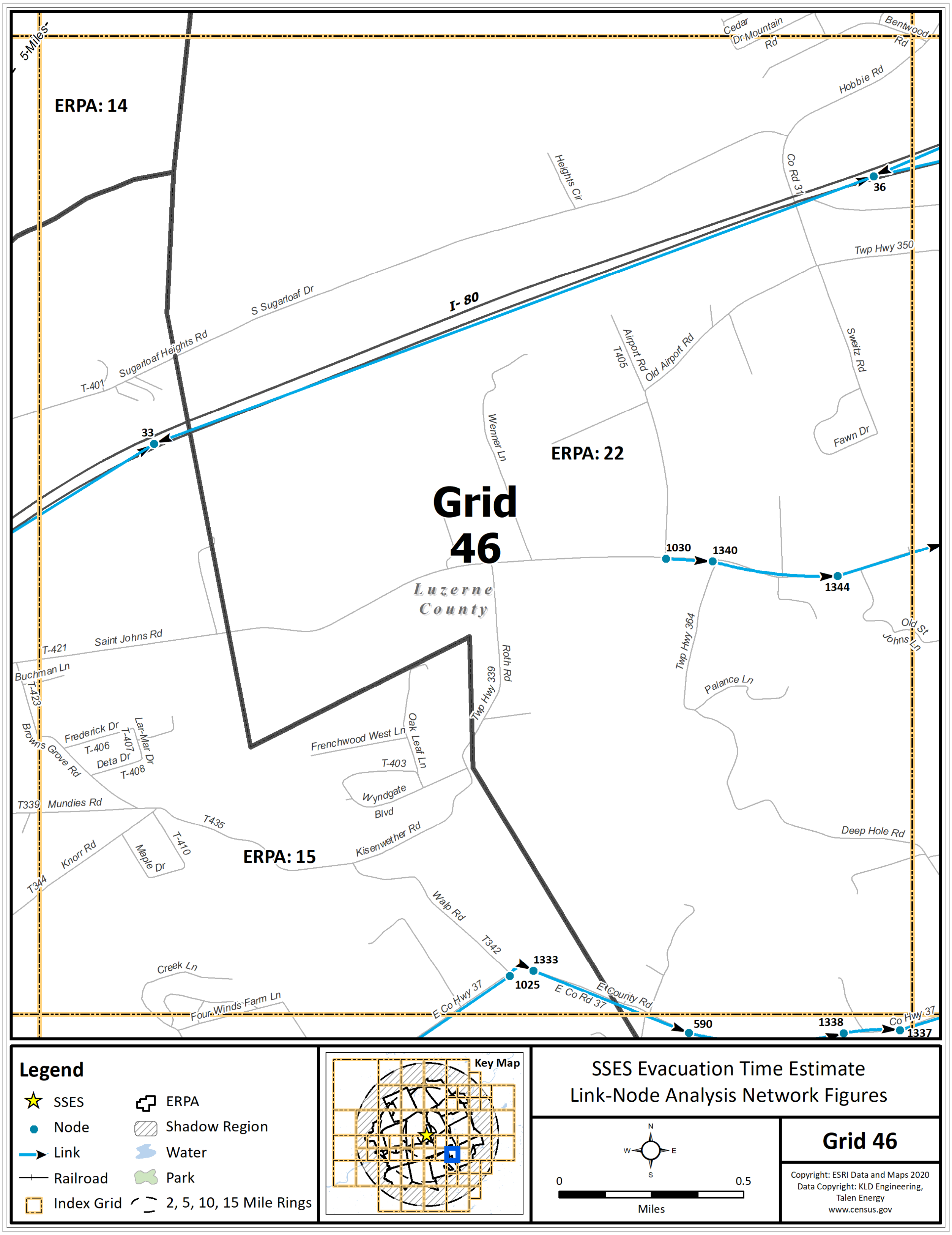


Figure K-47. Link-Node Analysis Network – Grid 46

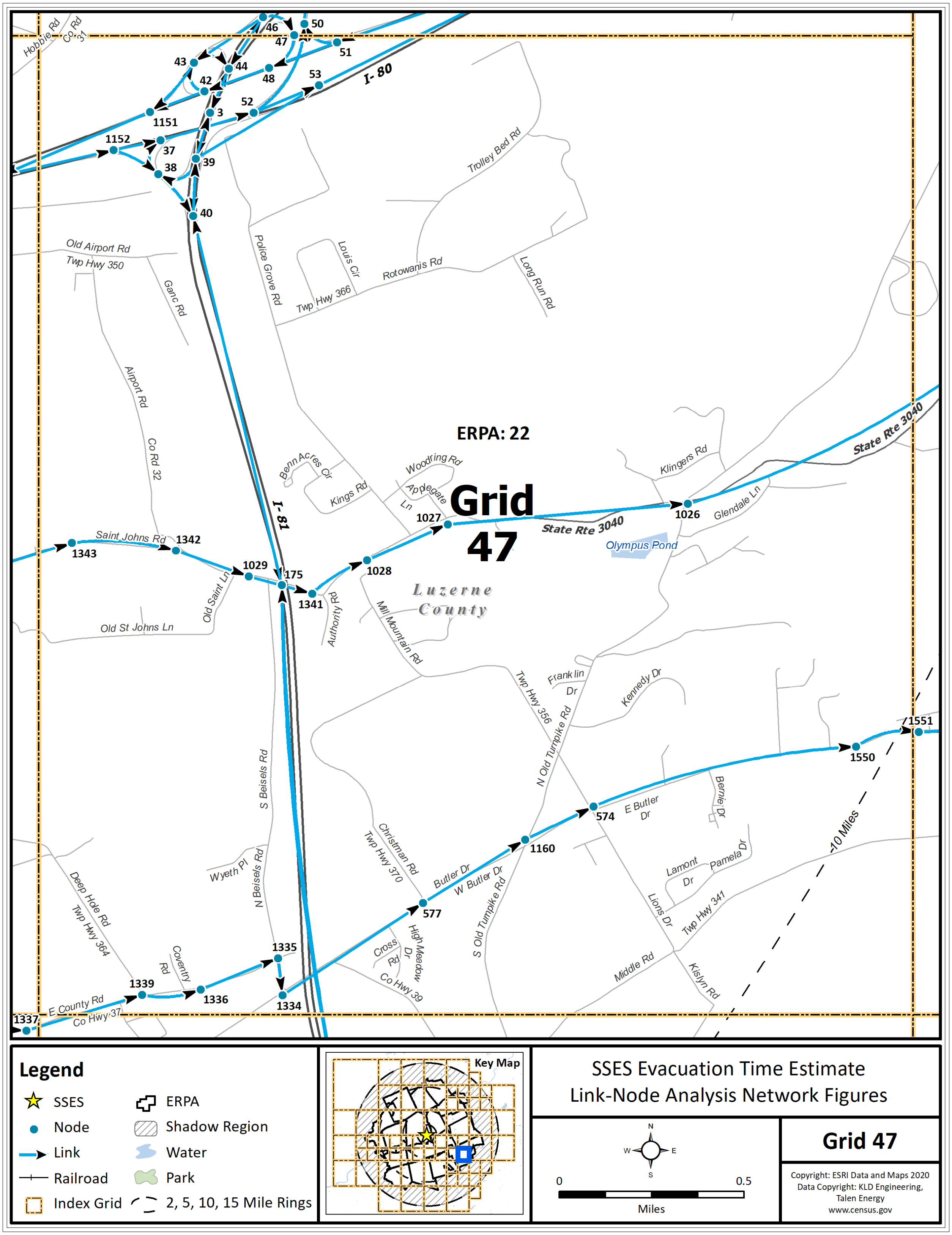


Figure K-48. Link-Node Analysis Network – Grid 47

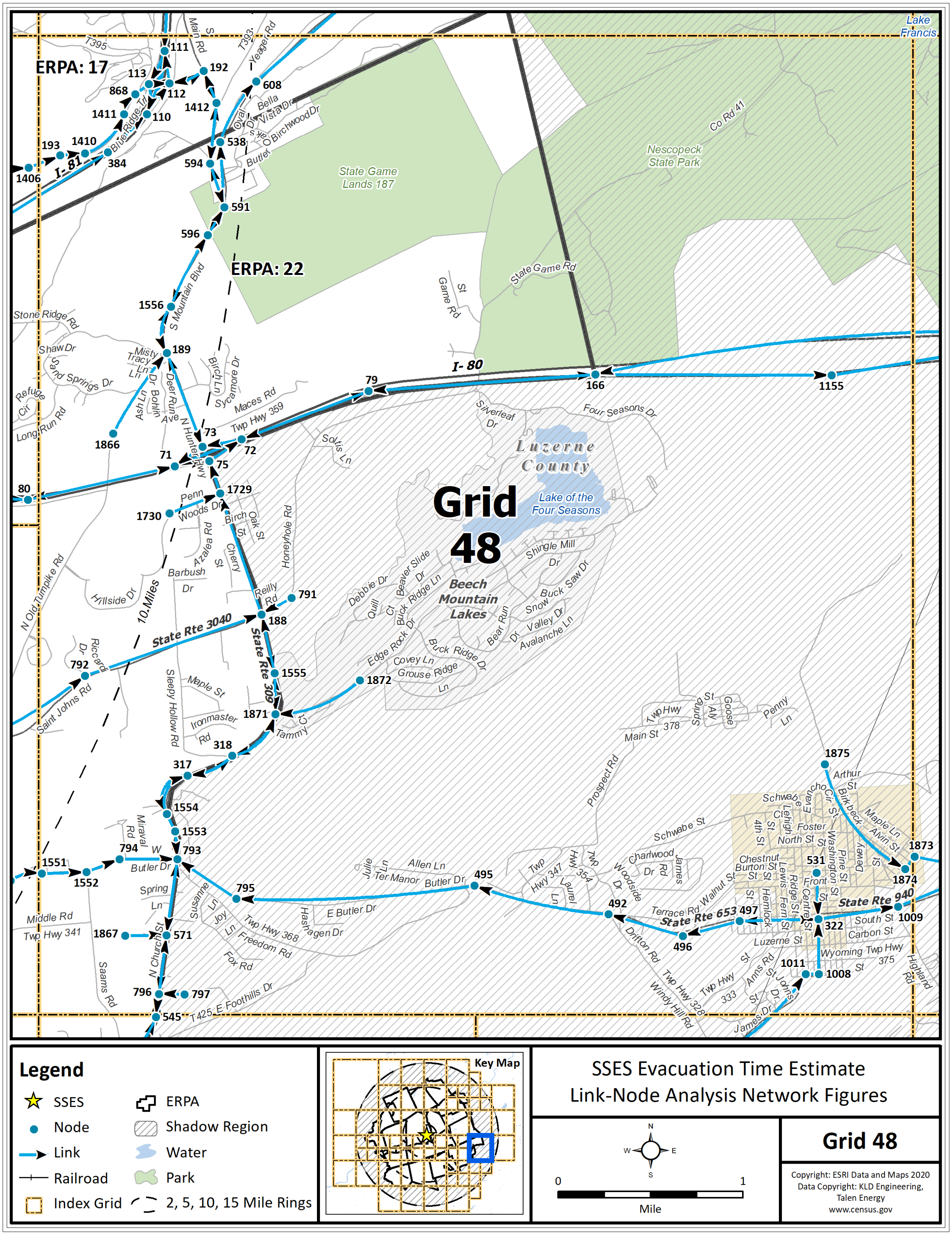


Figure K-49. Link-Node Analysis Network – Grid 48

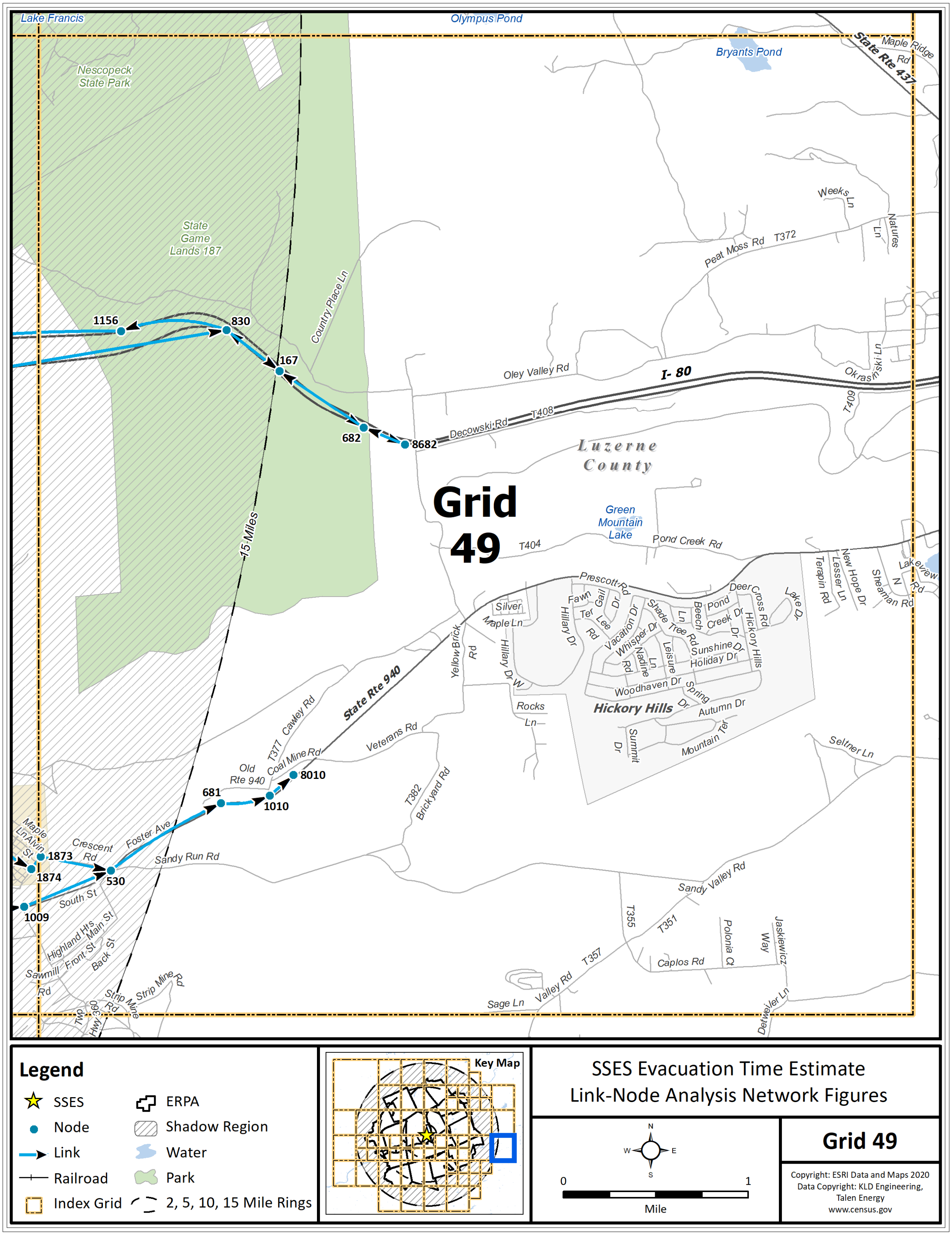


Figure K-50. Link-Node Analysis Network – Grid 49

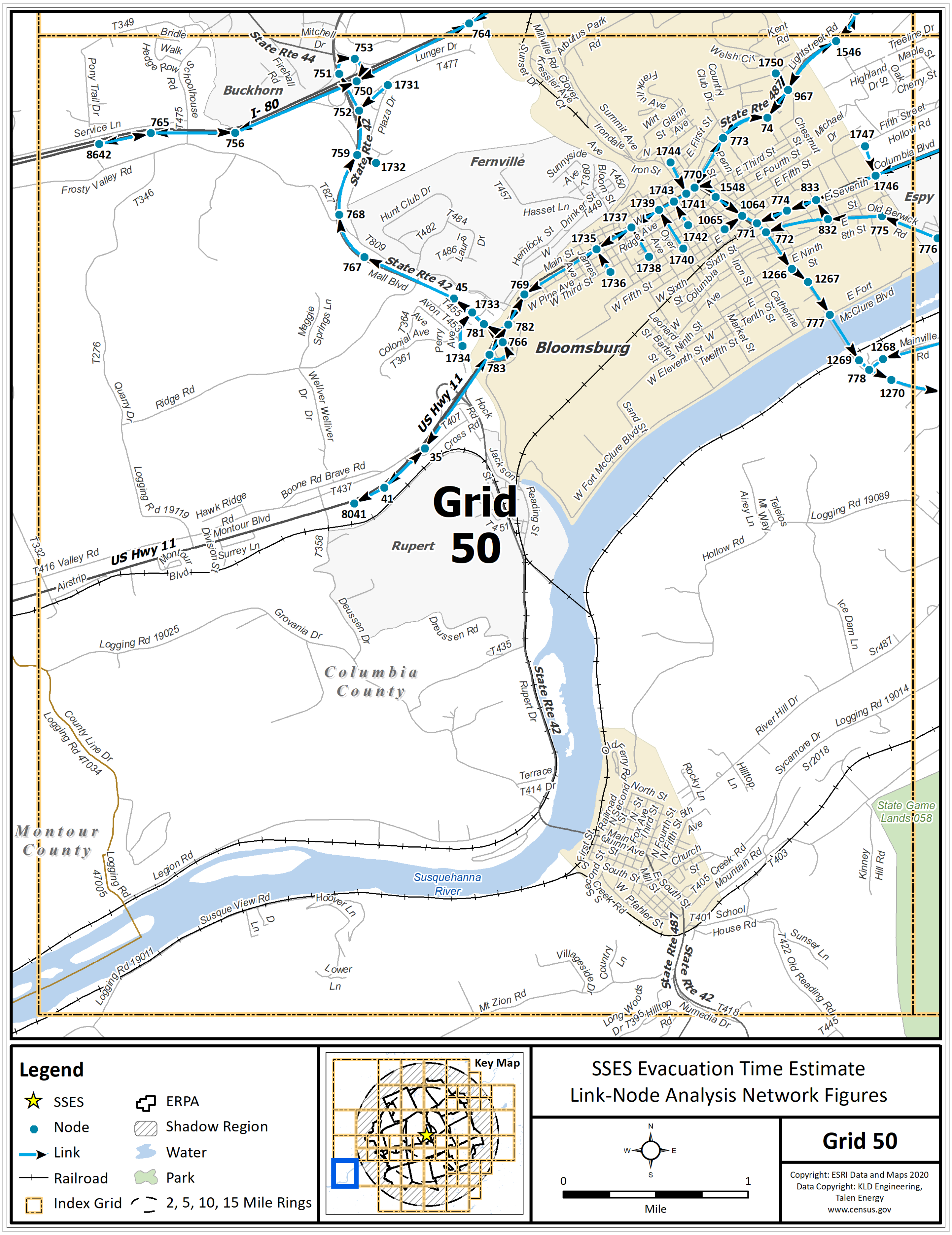


Figure K-51. Link-Node Analysis Network – Grid 50

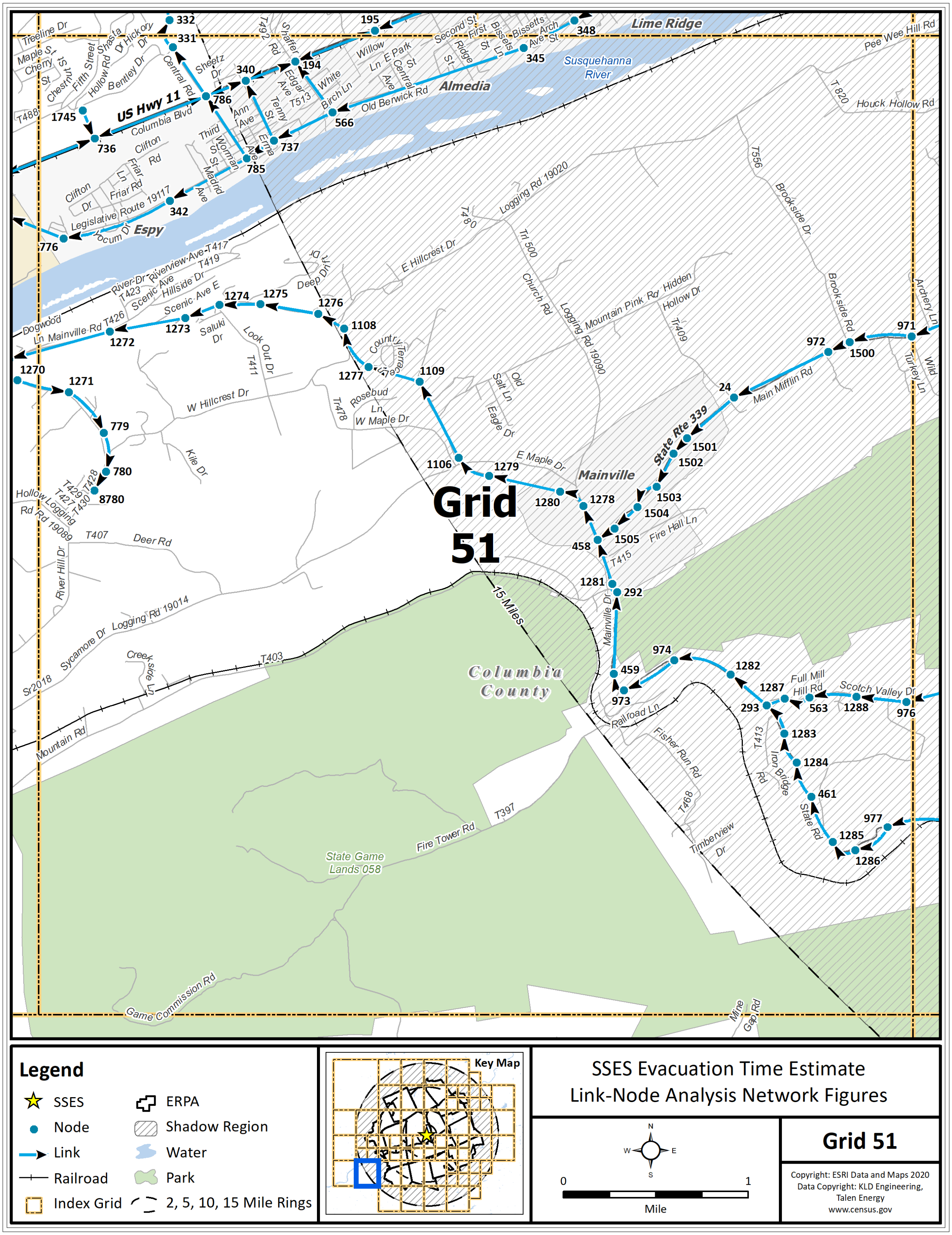


Figure K-52. Link-Node Analysis Network – Grid 51

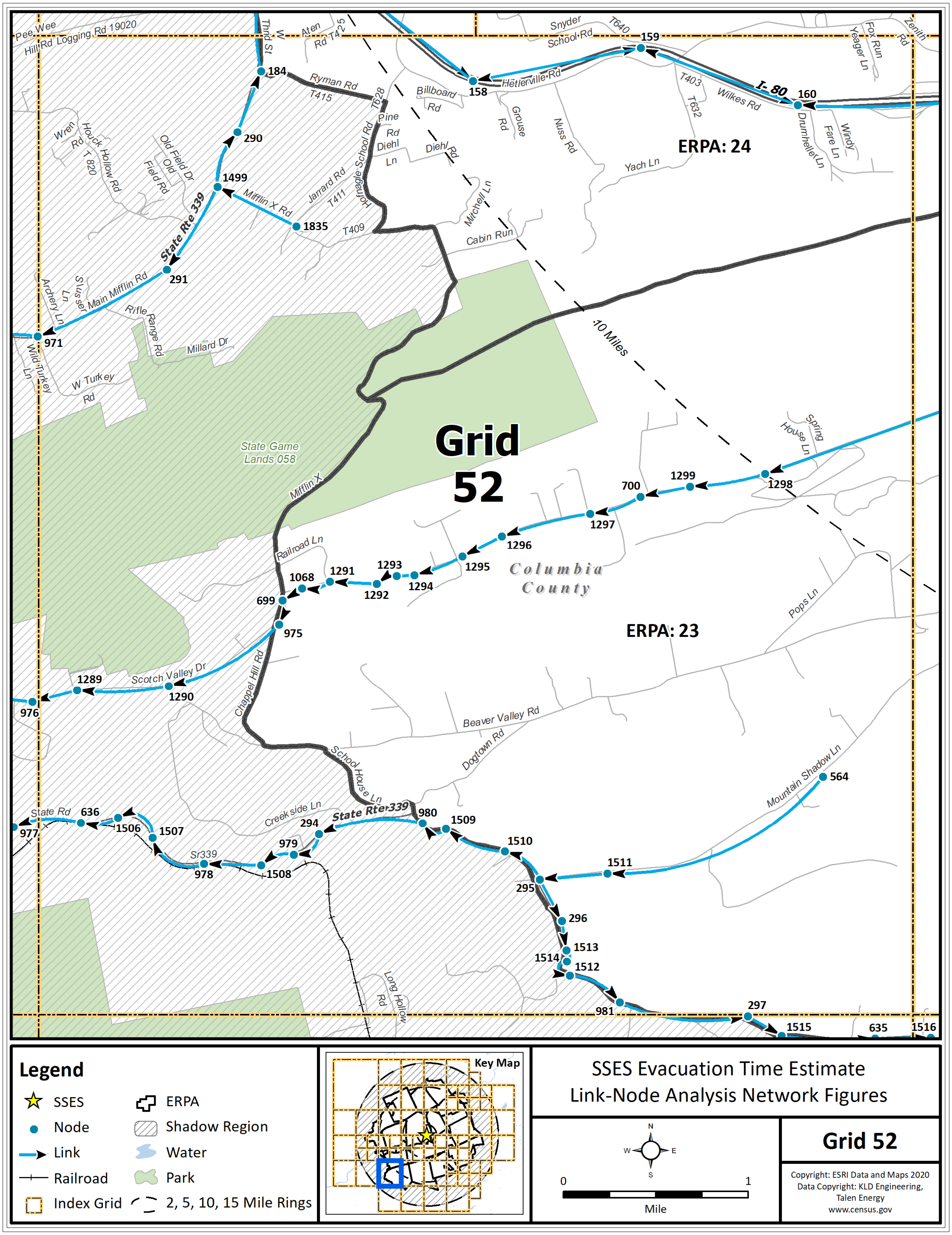


Figure K-53. Link-Node Analysis Network – Grid 52

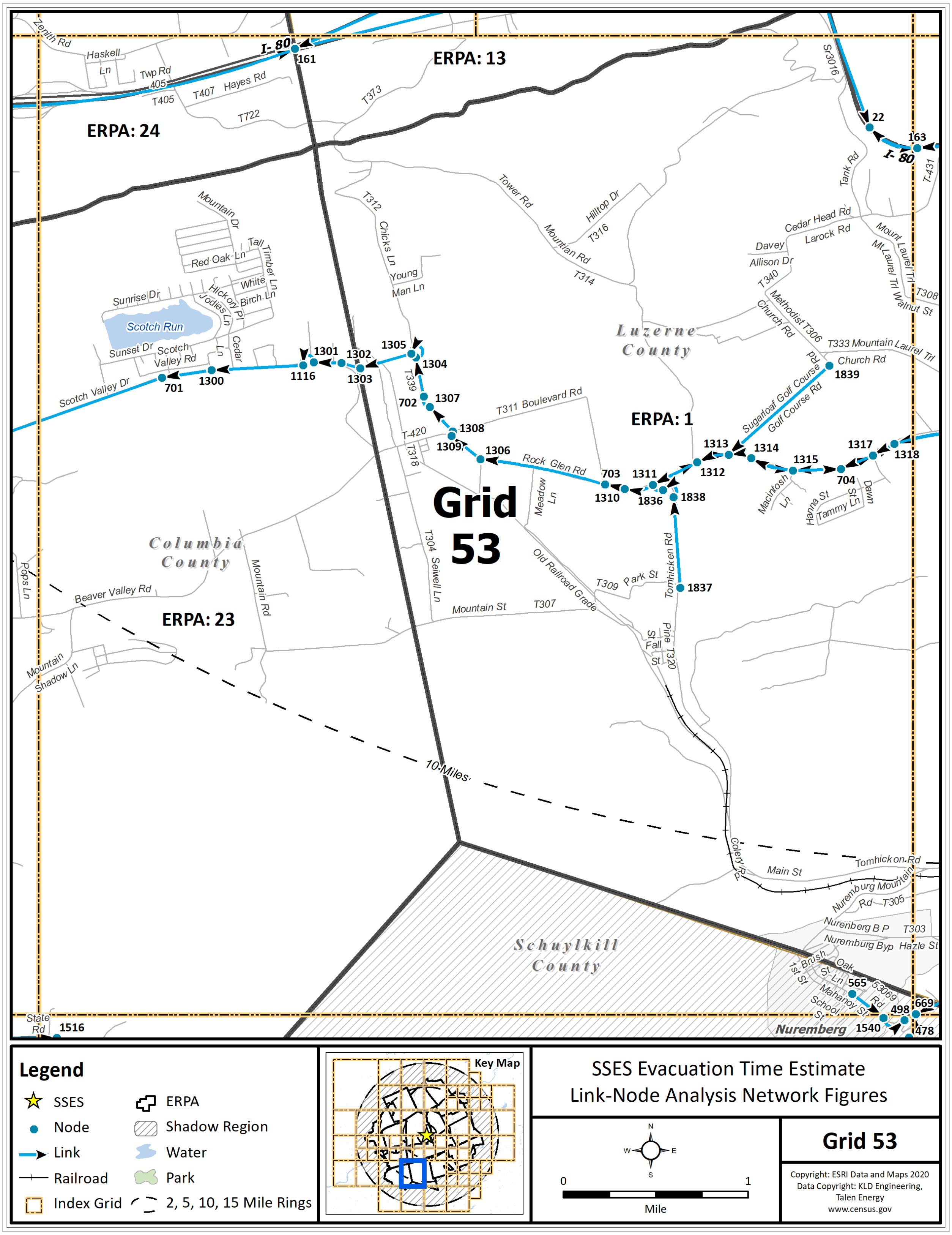


Figure K-54. Link-Node Analysis Network – Grid 53

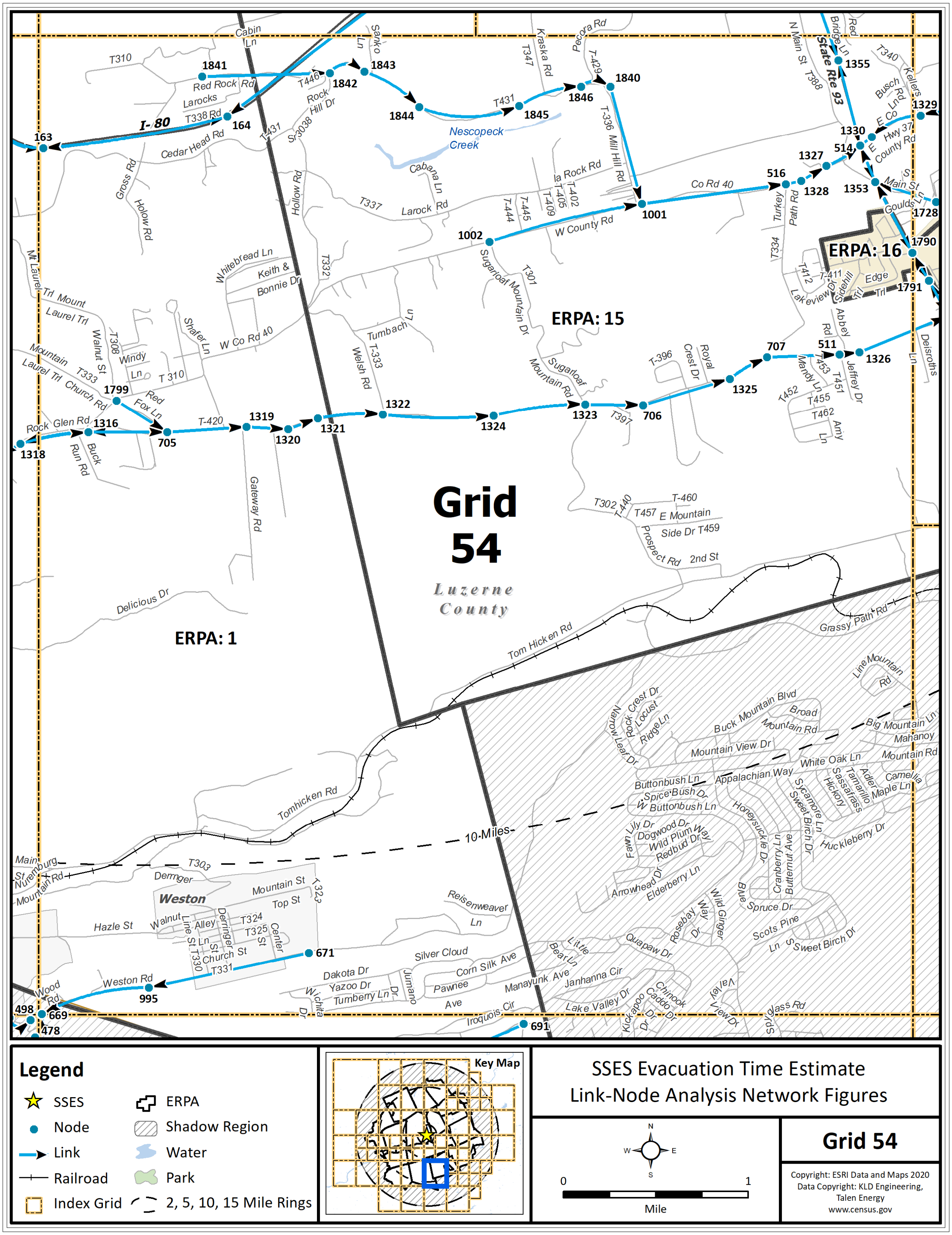


Figure K-55. Link-Node Analysis Network – Grid 54

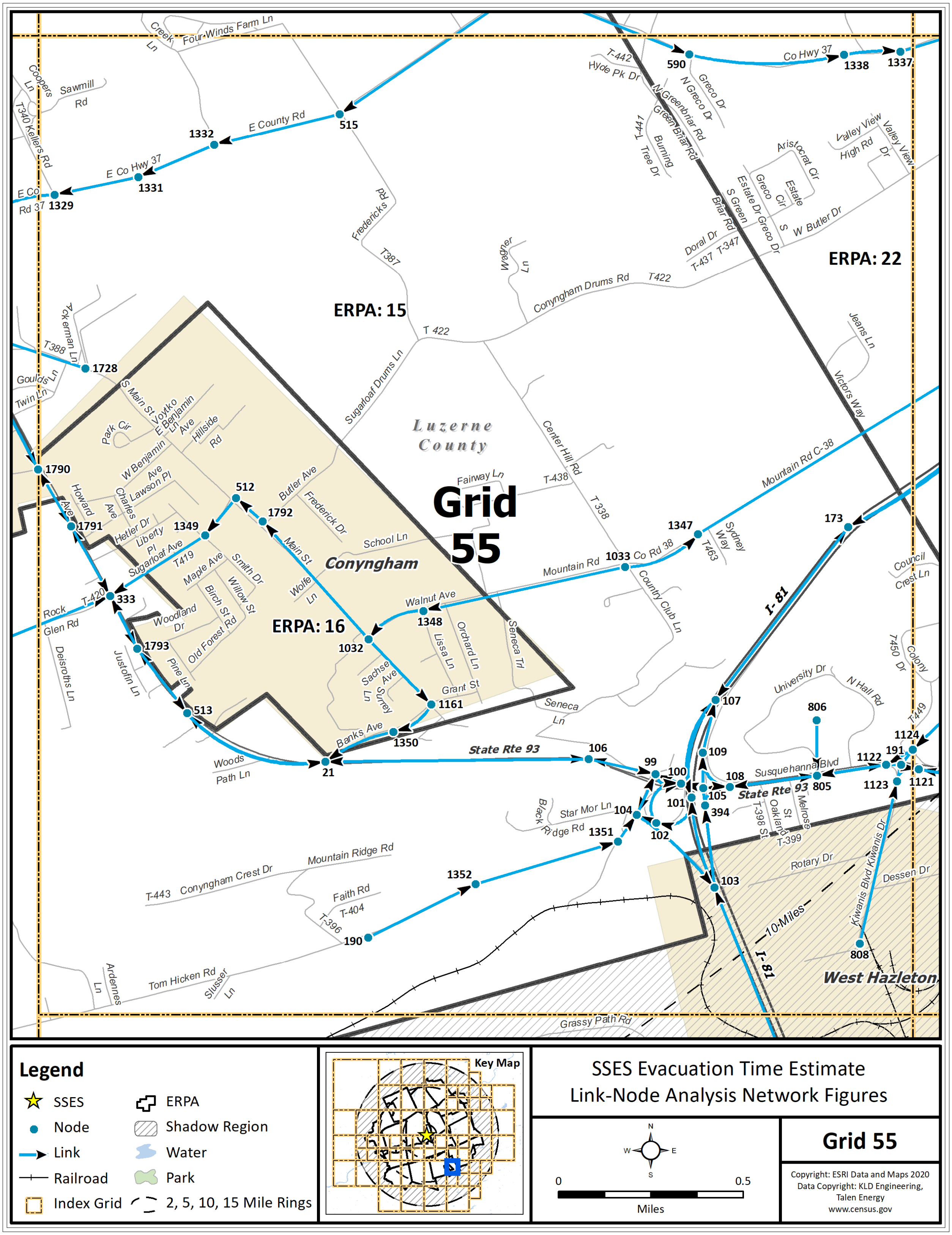


Figure K-56. Link-Node Analysis Network – Grid 55

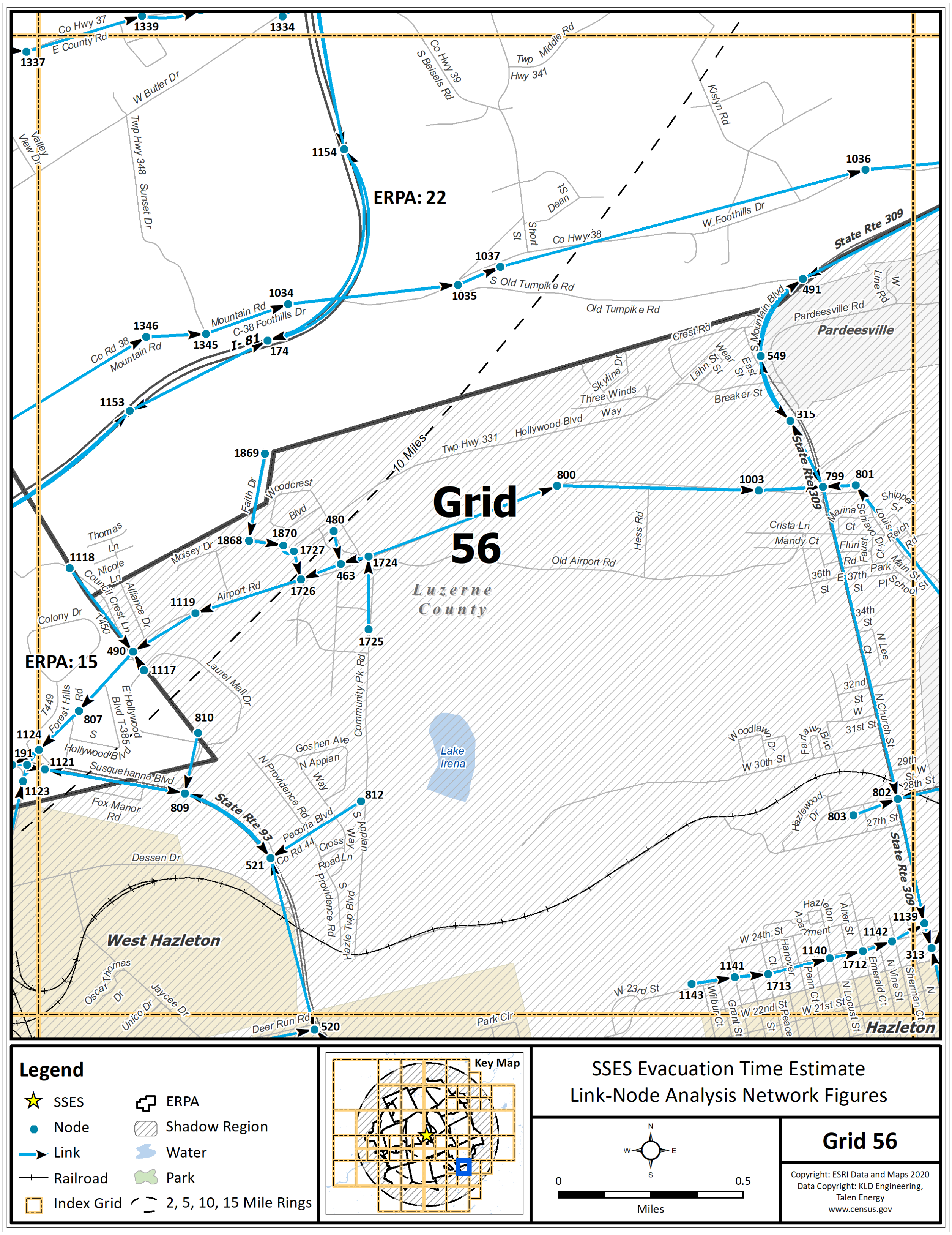


Figure K-57. Link-Node Analysis Network – Grid 56

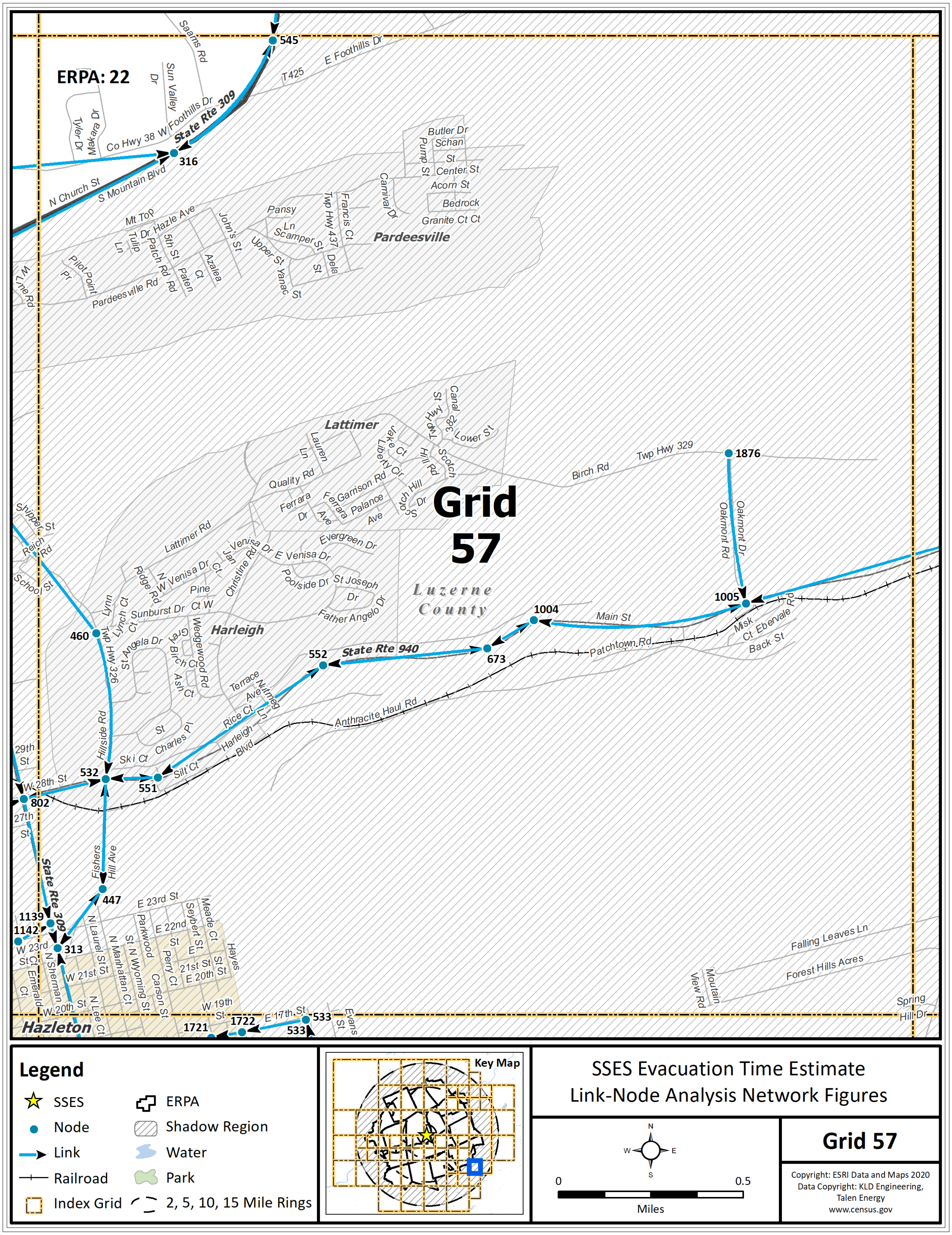


Figure K-58. Link-Node Analysis Network – Grid 57

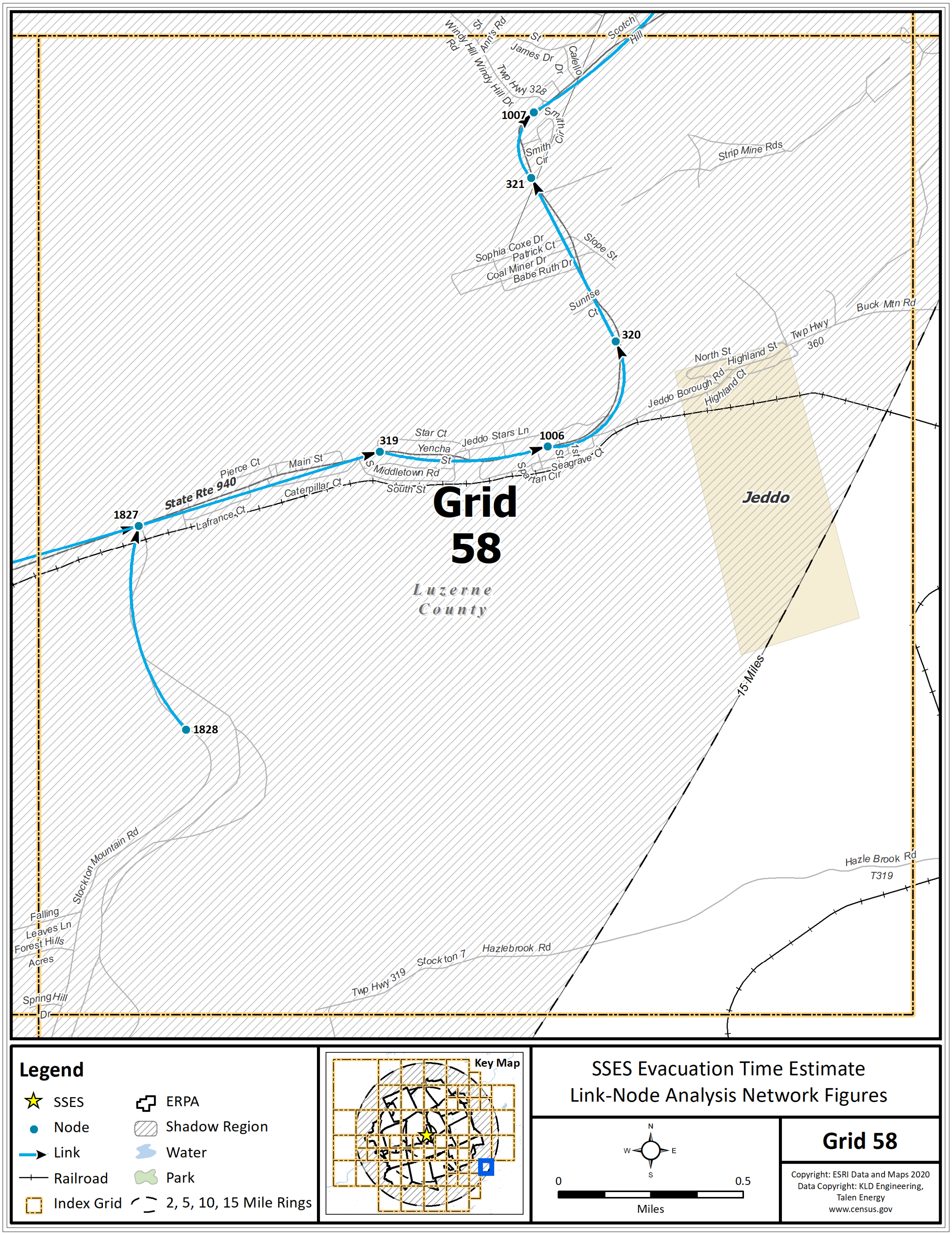


Figure K-59. Link-Node Analysis Network – Grid 58

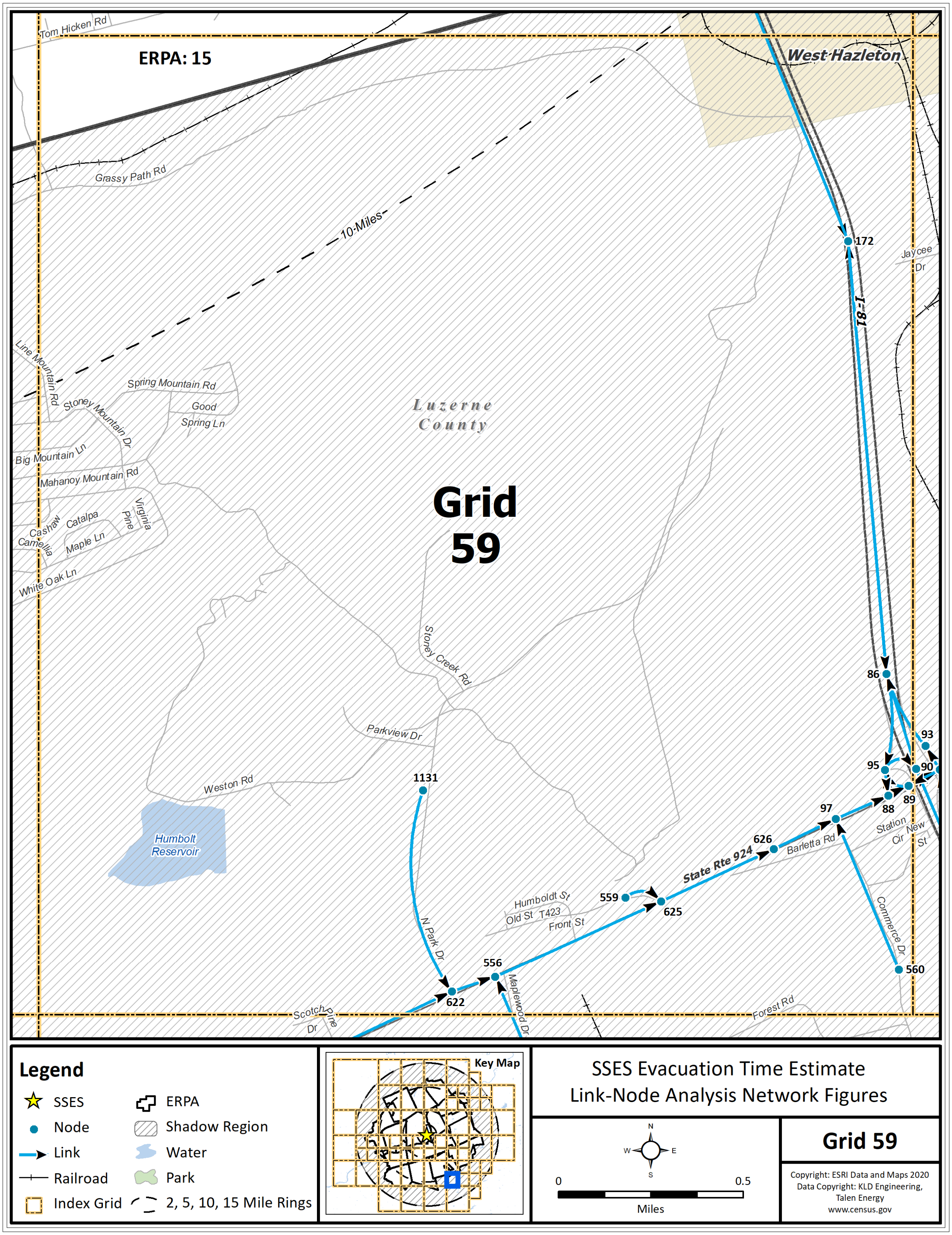


Figure K-60. Link-Node Analysis Network – Grid 59

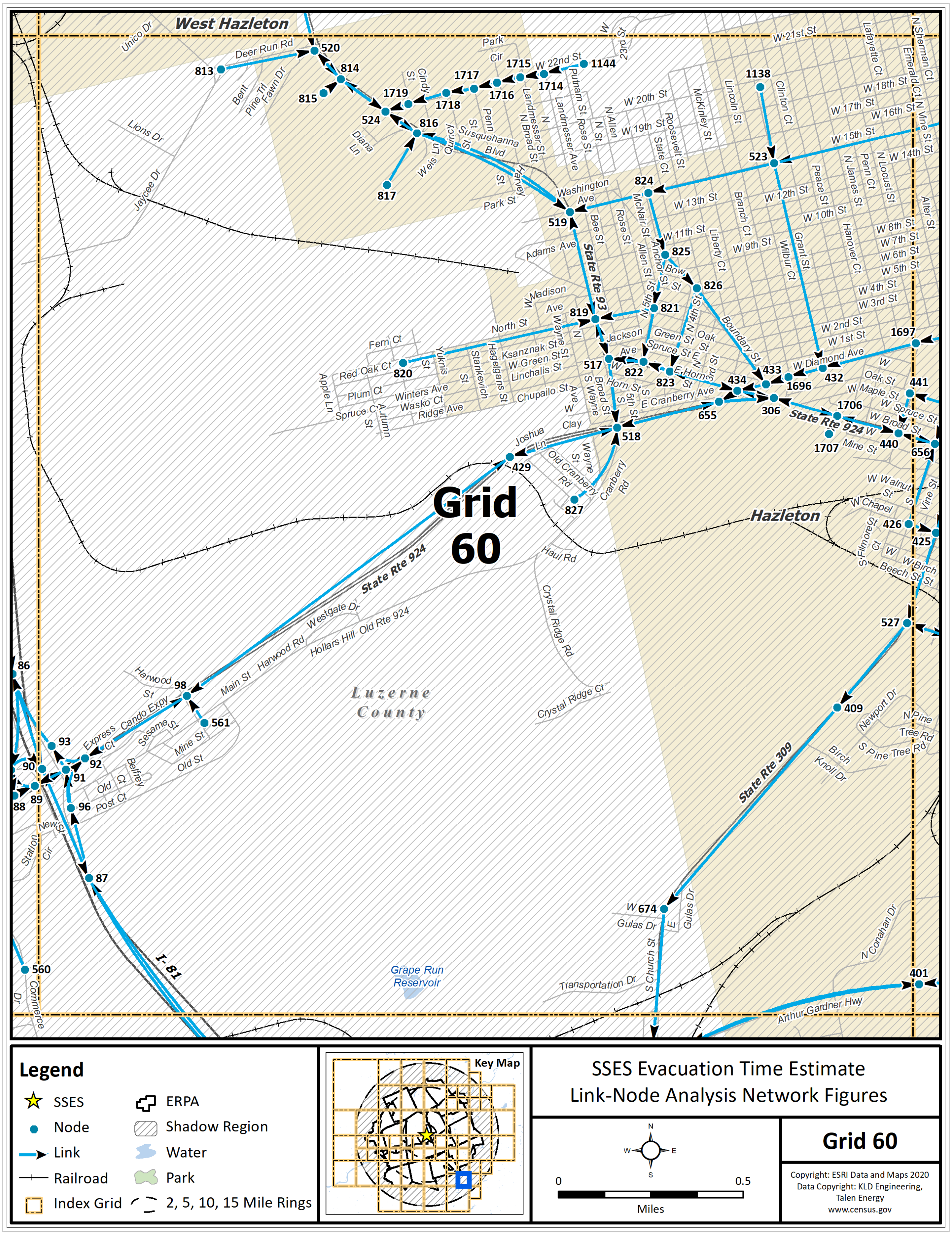


Figure K-61. Link-Node Analysis Network – Grid 60

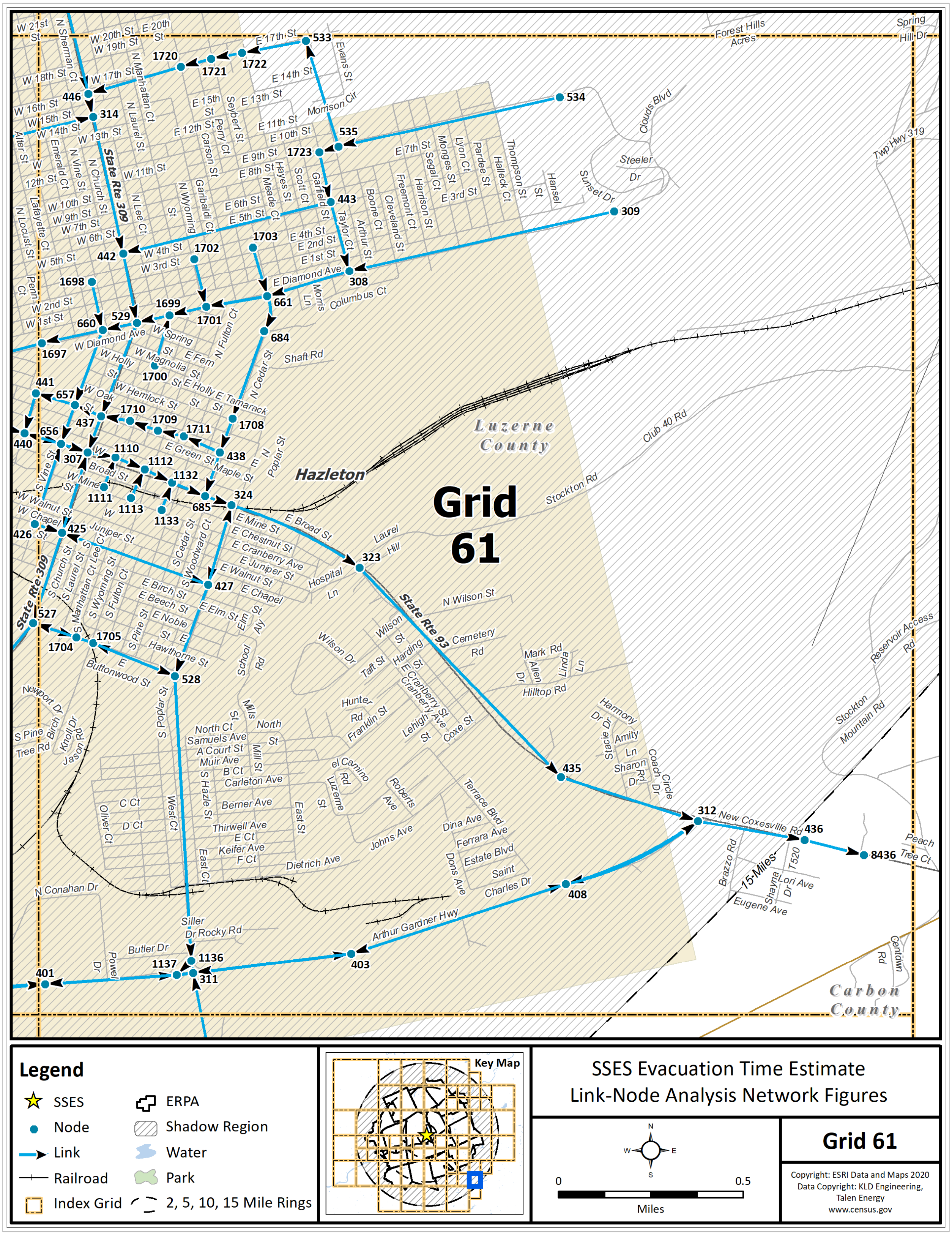


Figure K-62. Link-Node Analysis Network – Grid 61

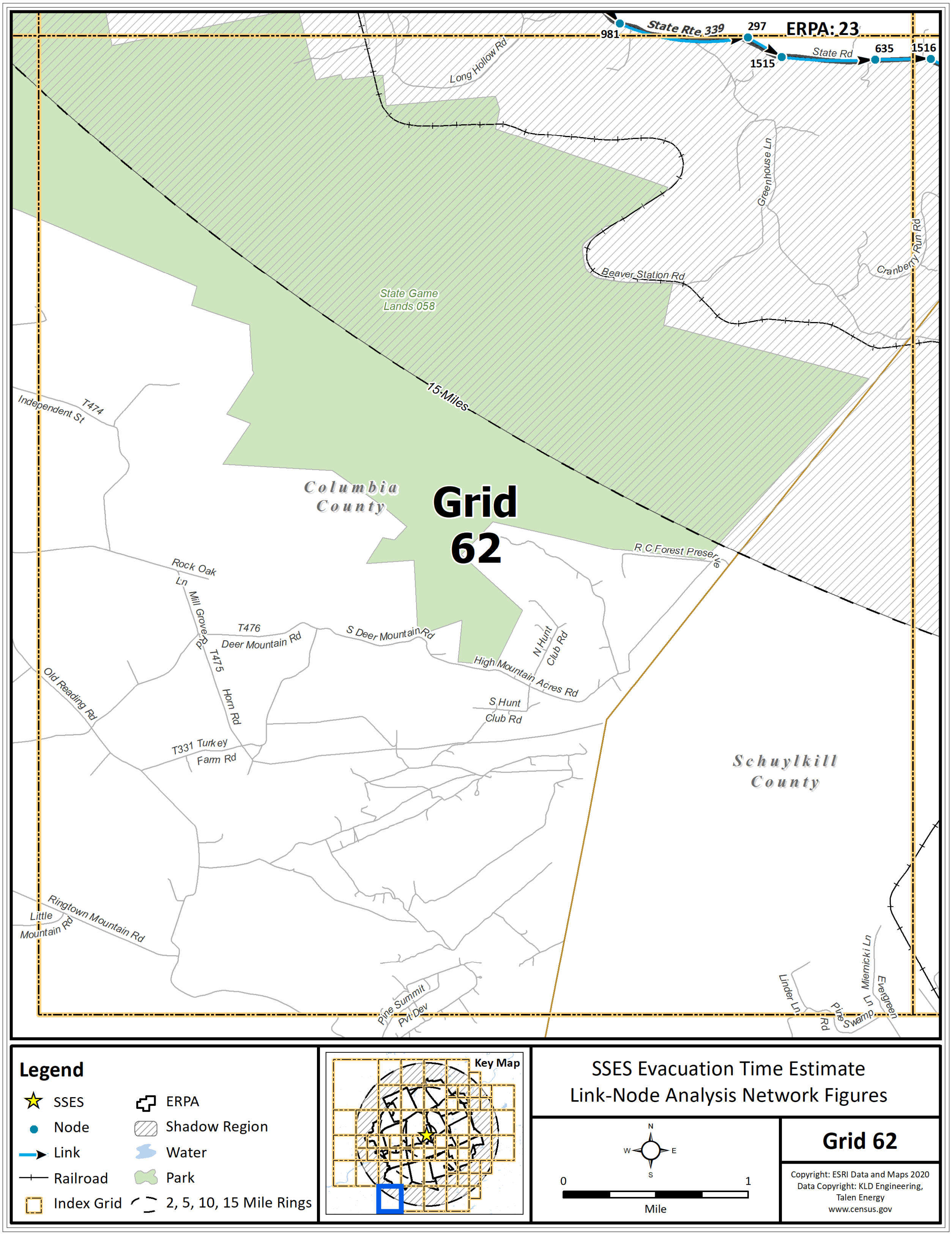


Figure K-63. Link-Node Analysis Network – Grid 62

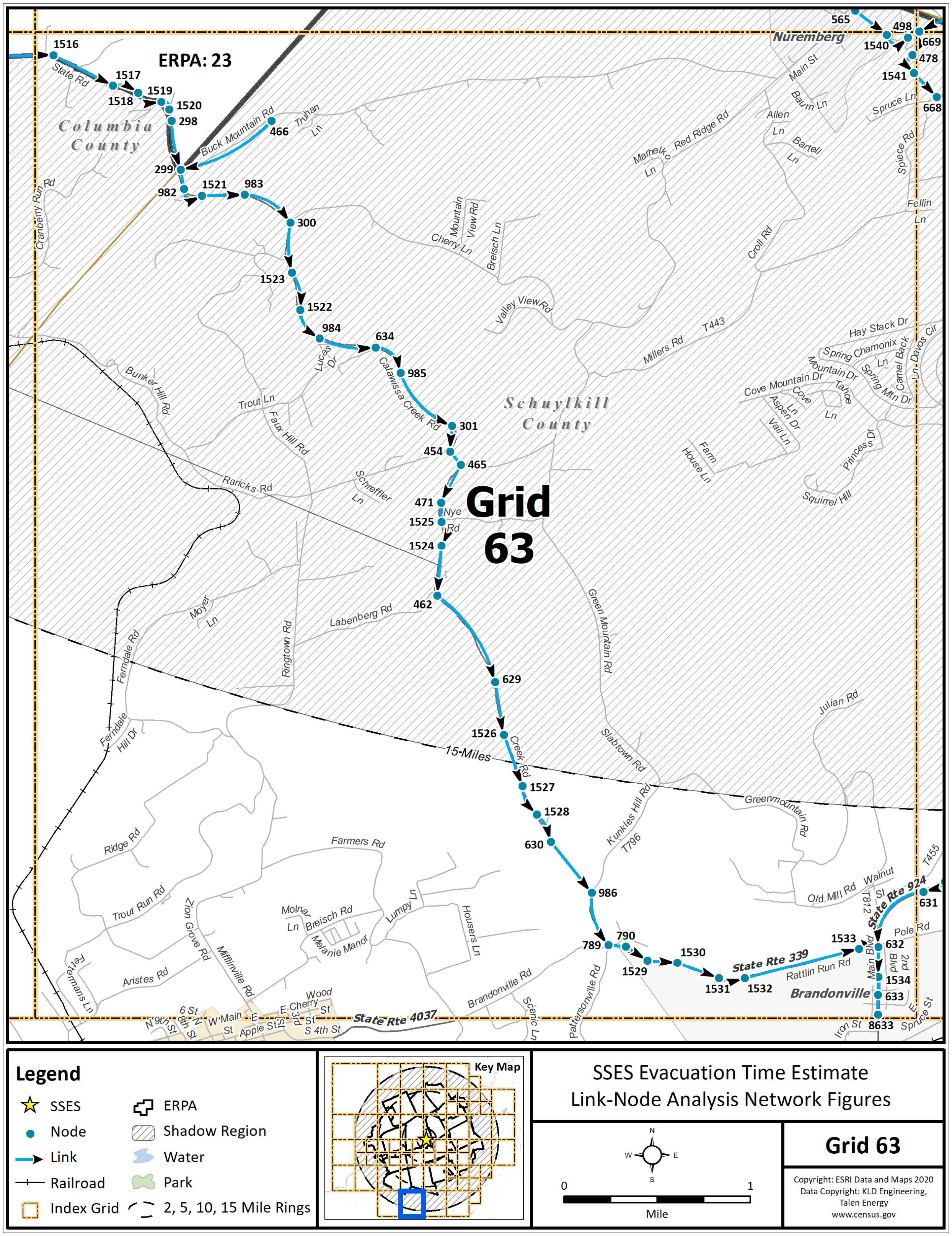


Figure K-64. Link-Node Analysis Network – Grid 63

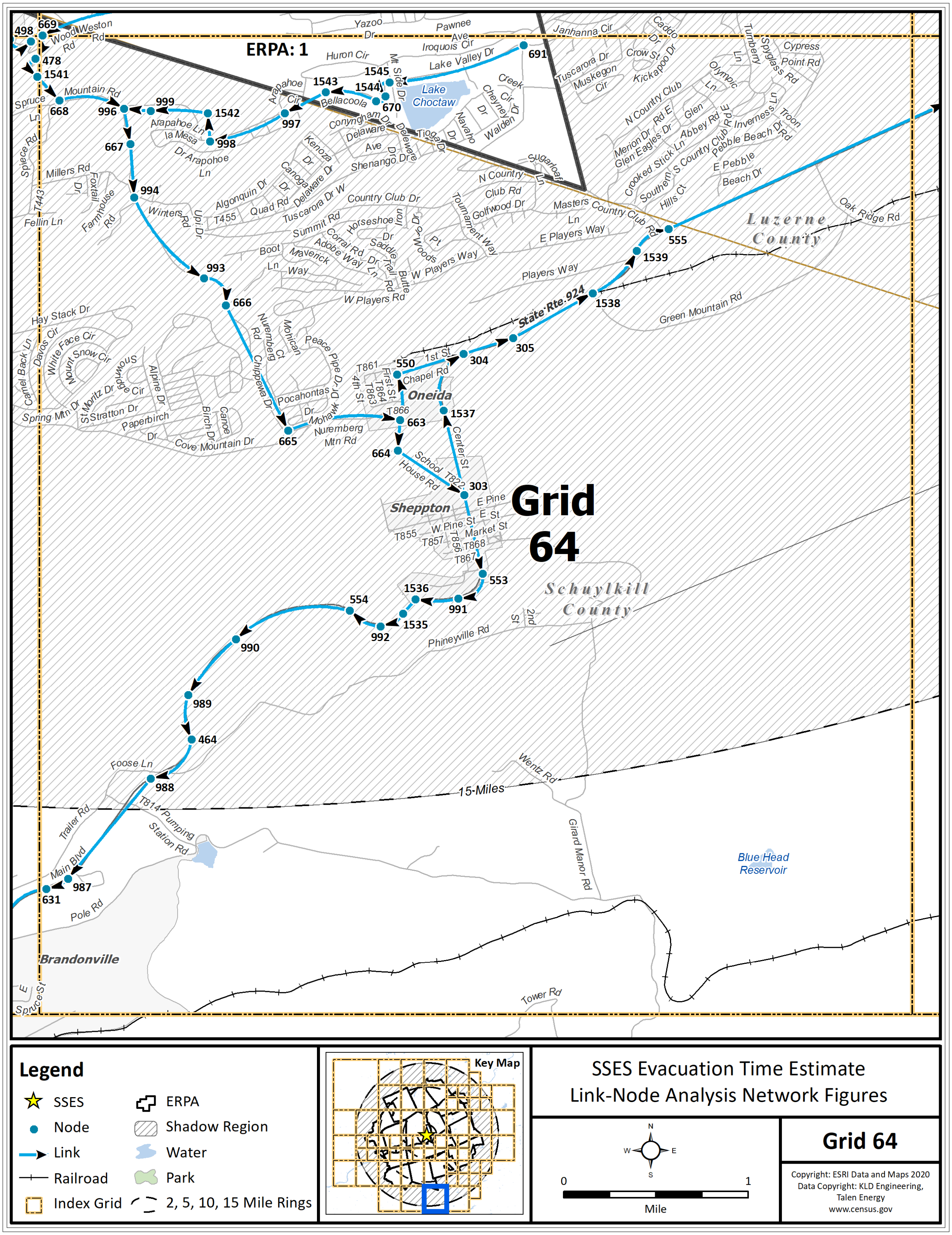


Figure K-65. Link-Node Analysis Network – Grid 64

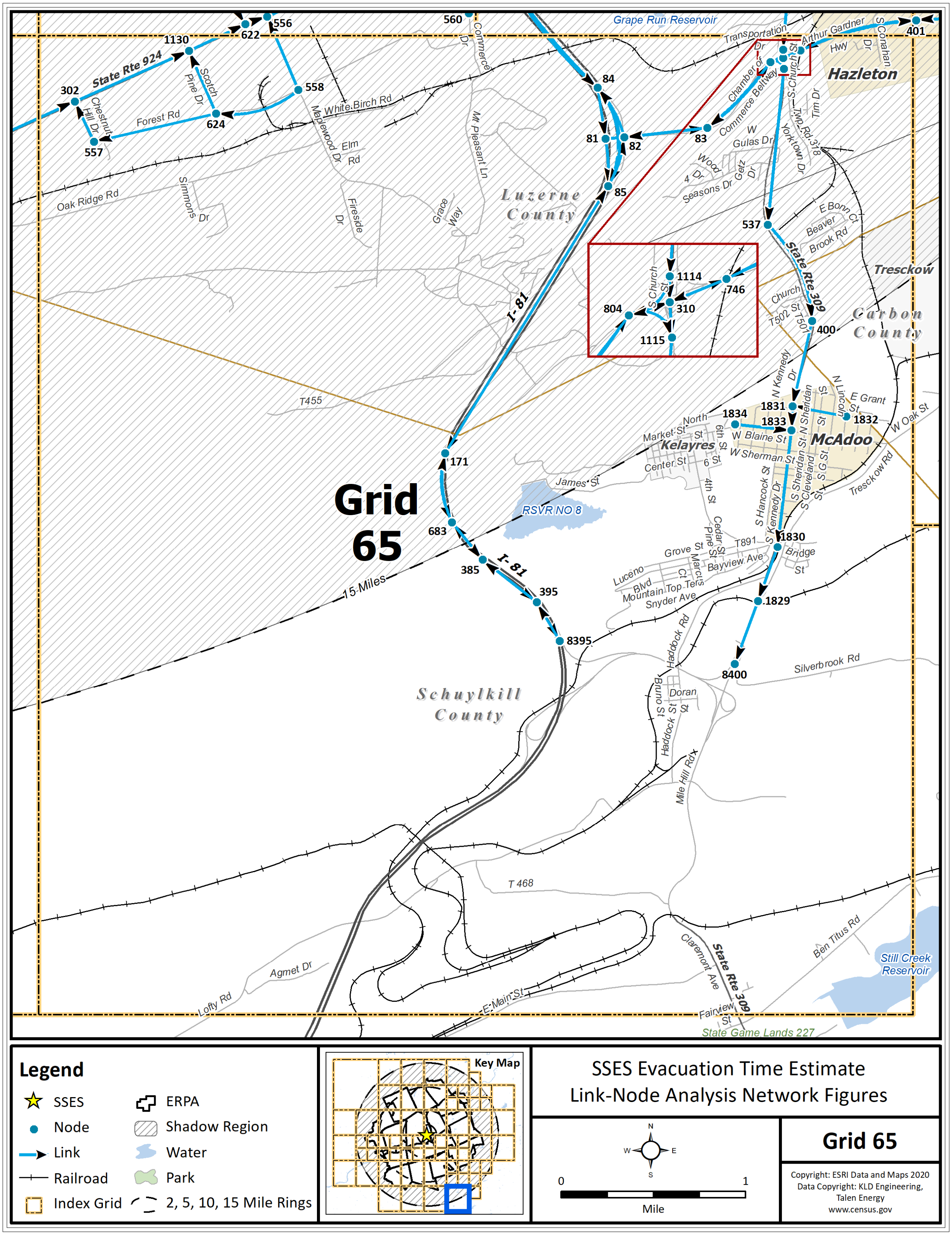


Figure K-66. Link-Node Analysis Network – Grid 65

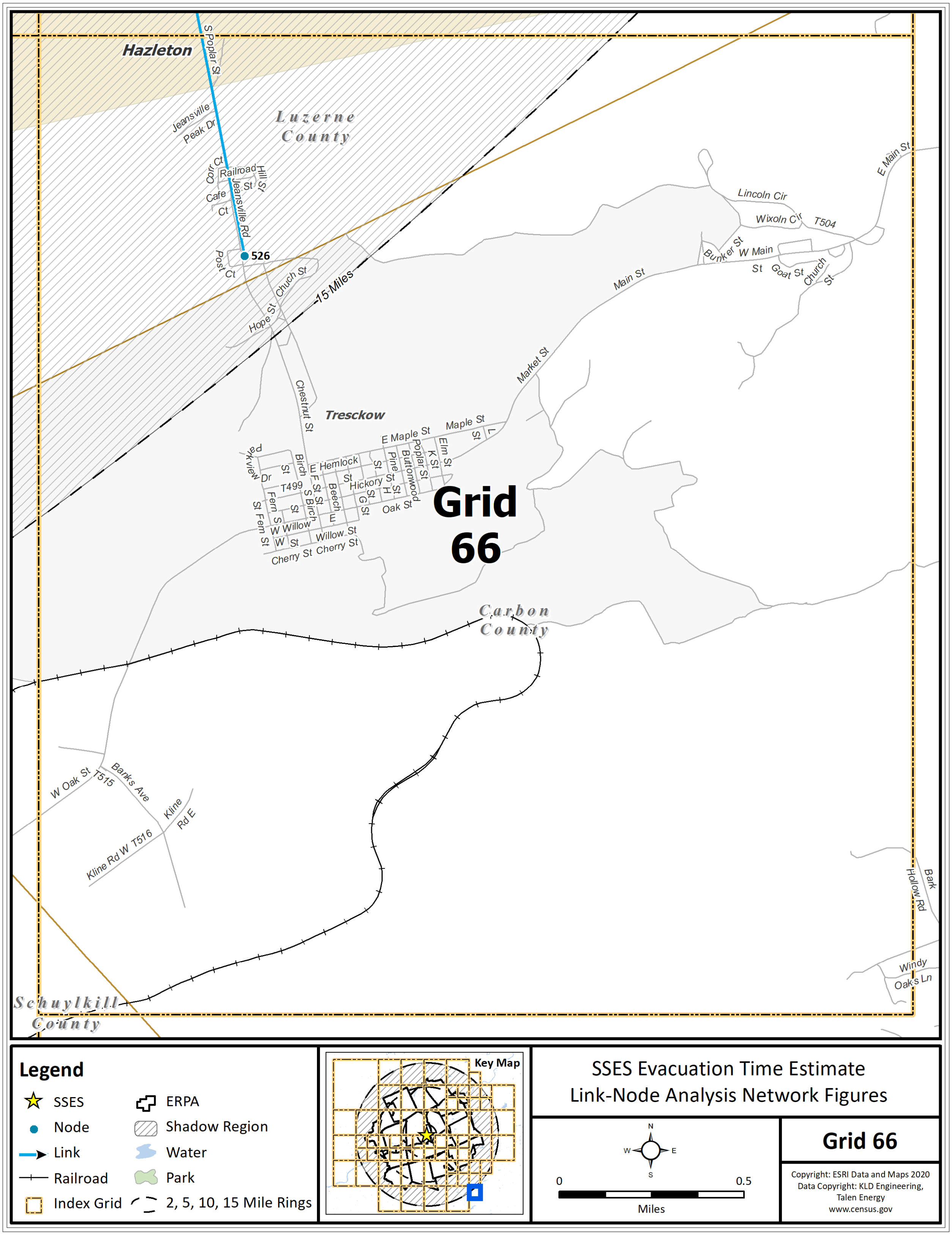


Figure K-67. Link-Node Analysis Network – Grid 66

APPENDIX L

Emergency Response Planning Area (ERPA) Boundaries

L. ERPA BOUNDARIES

ERPA 1	County: Luzerne Defined as the area within the following boundary: Black Creek Township boundary.
ERPA 2	County: Luzerne Defined as the area within the following boundary: Hunlock Township bounded by Pritchards Road (SR 4026) to the north, Hunlock Township Corporate Boundary to the east, south and west.
ERPA 3	County: Luzerne Defined as the area within the following boundary: Union Township boundary.
ERPA 4	County: Luzerne Defined as the area within the following boundary: Huntington Township boundary.
ERPA 5	County: Luzerne Defined as the area within the following boundary: New Columbus Borough boundary.
ERPA 6	County: Columbia Defined as the area within the following boundary: Bounded to the north by Benton Township and Fishing Creek Township boundary, Strawberry Lane, Zaners Bridge Road (SR 1022), Ridge Rd and Frosty Hollow Rd; to the east by Columbia/Luzerne County Boundaries; to the south by Fishing Creek Township Corporate Boundary; to the west by Fishing Creek Township Corporate Boundary and State Highway 487.
ERPA 7	County: Luzerne Defined as the area within the following boundary: Salem Township boundary.
ERPA 8	County: Luzerne Defined as the area within the following boundary: Shickshinny Borough boundary.
ERPA 9	County: Luzerne Defined as the area within the following boundary: Conyngham Township boundary.

County: Columbia

ERPA 10 Defined as the area within the following boundary: Berwick Borough boundary.

County: Columbia

ERPA 11 Defined as the area within the following boundary: Briar Creek Borough boundary

County: Luzerne

ERPA 12 Defined as the area within the following boundary: Nescopeck Borough boundary.

County: Luzerne

ERPA 13 Defined as the area within the following boundary: Nescopeck Township boundary.

County: Luzerne

ERPA 14 Defined as the area within the following boundary: Hollenback Township boundary.

County: Luzerne

ERPA 15 Defined as the area within the following boundary: Sugarloaf Township boundary.

County: Luzerne

ERPA 16 Defined as the area within the following boundary: Conyngham Township boundary.

County: Luzerne

ERPA 17 Defined as the area within the following boundary: Dorrance Township boundary.

County: Luzerne

ERPA 18 Defined as the area within the following boundary: Slocum Township boundary.

County: Luzerne

ERPA 19 Defined as the area within the following boundary: Nuangola Borough boundary.

County: Luzerne

ERPA 20 Defined as the area within the following boundary: Newport Township boundary.

ERPA 21	County: Luzerne Defined as the area within the following boundary: Nanticoke City boundary.
ERPA 22	County: Luzerne Defined as the area within the following boundary: Butler Township, bounded by the Butler Township Corporate Boundary to the north, east and west and by Butler Township Corporate Boundary, State Highway 309 and I-8 to the south.
ERPA 23	County: Columbia Defined as the area within the following boundary: Beaver Township, bounded by the Beaver Township Corporate Boundary to the north, east and south and by Mifflin X Rd, Chapel Hill Road, Beaver Valley Road and State Highway 339 to the west.
ERPA 24	County: Columbia Defined as the area within the following boundary: Mifflin Township, bounded by the Susquehanna River to the north, Nescopeck Town Ship to the east, Beaver Township Corporate Boundary to the south and I-80, Main-Mifflin Road, Ryman Road, Hofnagle School Road and Mifflin X Road to the west.
ERPA 25	County: Columbia Defined as the area within the following boundary: South Centre Township, bounded on the north, east and south by South Center Township Corporate Boundary and by I-80 and Lows Road to the west.
ERPA 26	County: Luzerne Defined as the area within the following boundary: North Centre Township. Bounded to the north, east and south by North Centre Township Corporate Boundary; to the west by Lows Road, School House Road, Fowlersville Road, Shelhamer Road and SR 93.
ERPA 27	County: Luzerne Defined as the area within the following boundary: Briar Creek Township boundary.

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 Estimate (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 evacuees to limit the demand during peak times), how would the ETE be affected? The case considered was Scenario 6, Region 3; a winter, midweek, midday, with good weather evacuation of the entire EPZ. Table M-1 presents the results of this study.

If evacuees mobilize in one less hour, the ETE is 20 minutes and 55 minutes shorter for the 90th and 100th percentile ETE, respectively. If evacuees take an additional hour to mobilize, the 90th and 100th percentile ETE increase by 20 minutes and 1 hour, respectively. As discussed in Section 7.3, traffic congestion persists within the EPZ for approximately 3 hours and 30 minutes. As such, 100th percentile ETE are dictated by trip generation time as long as the time is greater than 3 hours and 30 minutes.

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 6, Region 3; a winter, 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 the ETE is not impacted by shadow evacuation from 0% to 20%. Tripling the shadow percentage increases the 90th percentile ETE by 10 minutes – not a significant change. Increasing the shadow percentage to 100% increases the ETE by 45 minutes and 2 hours and 20 minutes for the 90th and 100th percentiles, respectively – significant changes. The increase in ETE is due to the shadow region being highly populated. The Shadow Region includes Hazleton, Almedia and suburbs of Wilkes-Barre (Plymouth and Sugar Notch), which house approximately 65,000 residents (see Figure 3-4). Evacuation of these cities in the Shadow Region exacerbates the traffic congestion in Berwick, Briar Creek and Nanticoke which was discussed in Section 7.3, thereby delaying the departure of evacuees and prolonging 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 longest 90th percentile ETE (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 the population within the study area was increased by up to 27%. Changes in population were applied to permanent residents only (as per federal guidance), in both the EPZ and 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 highest 90th percentile ETE values was selected as the case to be considered in this sensitivity study (Scenario 8 – Winter, Midweek, Midday with Heavy Snow).

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 the base ETE values are greater than 2 hours; 25 percent of these base ETE is always greater than 30 minutes. Therefore, 30 minutes is the lesser and is the criterion for updating.

Those percent population changes which result in 90th percentile ETE changes greater than or equal to 30 minutes are highlighted in red in Table M-3 – a 26% or greater increase in the 5-Mile Region population. Talen Energy will have to estimate the EPZ population on an annual basis. If the 5-Mile Region population increases by 26% or more, an updated ETE analysis will be needed.

M.4 Effect of Changes in Average Household Size

As discussed in Appendix F, the average household size obtained from averaging the results from the demographic survey (3.00 people per household) and the results from the 2020 census (2.37 people per household) differ by 21%, which exceeds the sampling error of 4.71%. Upon discussions with Talen Energy, it was decided that the 2020 Census household size would be used in the study. A sensitivity study was performed to determine how sensitive the ETE is to changes in the average household size. It should be noted that only resident and shadow vehicles were changed for this sensitivity study. The case considered was Scenario 6, Region 3; a winter, midweek, midday, with good weather evacuation of the 2-mile region, 5-mile region, and the entire EPZ. Table M-4 presents the results of this study.

Increasing the average household size (decreasing the total number of evacuating vehicles) to 3.00 people per household has little impact on ETE (decreasing the 90th percentile ETE by 15 minutes at most). The traffic congestion in Berwick and Briar Creek is the last to clear in the EPZ. The 21% decrease in evacuating vehicles lessens the congestion in these areas reducing the 90th percentile ETE slightly. The 100th percentile ETE remains dictated by trip generation time and is not impacted by the change in people per household.

M.5 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 or prolonging the trip generation time by an hour impacts the 90th percentile ETE 20 minutes and the 100th percentile ETE by up to 1 hour, since trip generation within the EPZ dictates ETE (Section M.1). Public outreach encouraging evacuees to mobilize more quickly or in a timely manner will decrease ETE.
- Increasing the shadow evacuation percent can impact the 90th percentile ETE by up to 45 minutes (Section M.2). 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 in more evacuating vehicles, which could increase ETE (Section M.3). 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.
- Increasing the average household size (decreasing the total number of evacuating vehicles), has little impact on ETE (impacting the 90th percentile ETE by at most 15 minutes) and no impact to the 100th percentile ETE, since trip generation within the EPZ dictates ETE (Appendix M.4). Thus, 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 the 90th percentile ETE.

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

Trip Generation Period	Evacuation Time Estimate for Entire EPZ	
	90th Percentile	100th Percentile
3 hours and 45 minutes	2:50	4:00
4 hours and 45 minutes (Base)	3:10	4:55
5 hours and 45 minutes	3:30	5:55

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	3:10	4:55
20 (Base)	14,353	3:10	4:55
40	28,706	3:15	4:55
60	43,059	3:20	5:20
80	57,412	3:40	5:55
100	71,765	3:55	7:15

Table M-3. ETE Variation with Population Change

EPZ and 20% Shadow Permanent Resident Population	Base	Population Change		
		25%	26%	27%
	87,679	109,599	110,476	111,352
ETE (hrs:mins) for the 90th Percentile				
Region	**Base**	**Population Change**		
		25%	**26%**	**27%**
2-MILE	3:55	3:55	3:55	3:55
5-MILE	3:55	4:20	4:25	4:25
Full EPZ	4:20	4:40	4:40	4:45
ETE (hrs:mins) for the 100th Percentile				
Region	**Base**	**Population Change**		
		25%	**26%**	**27%**
2-MILE	6:15	6:20	6:20	6:20
5-MILE	6:20	6:20	6:20	6:20
Full EPZ	6:25	6:25	6:25	6:30

[1] The evacuating Shadow Vehicles represent the residents and employees in the Shadow Region 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.

Table M-4. ETE Results for Change in Average Household Size

EPZ and 20% Shadow Resident Vehicles	Average HH Size of 3.00 people per household	Base (Average HH Size of 2.37 people per household)
	47,284	59,707
ETE for 90th Percentile		
2-MILE	2:55	2:55
5-MILE	2:40	2:55
FULL EPZ	2:55	3:10
ETE for 100th Percentile		
2-MILE	4:50	4:50
5-MILE	4:50	4:50
FULL EPZ	4:55	4:55

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
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
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	Section 6, Table 6-2

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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, Table 7-5, Table H-1
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 6-1, Table 7-5, Table H-1
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
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.	Yes	N/A - 2020 used as the base year of the analysis

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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
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-5 and Table E-6
b. Major employers are listed.	Yes	Section 3.4, Table E-4
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 6-3 to estimate average transient population by scenario – see Table 6-4.
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 8.1
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 3.9
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 3-7, Table 3-11
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 3-12, Table 8-1

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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-3 lists all medical facilities by facility name, location, and average population.
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 There are no Correctional Facilities within the EPZ
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 3-8, Table E-1, 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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 3.8
b. The special event that encompasses the peak transient population is analyzed in the ETE.	Yes	Section 3.8
c. The percentage of permanent residents attending the event is estimated.	Yes	Section 3.8
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 5-9 (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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 6-3 – 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
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 3-11, Table 3-12, and Table 6-4
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
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
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.

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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
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
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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.	Yes	Appendix F
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 6-3 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
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 3.8 Public Transportation is not provided for the special event and was therefore not considered.

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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. 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 8-5 though Table 8-7
f. A map of bus routes is included.	Yes	Figure 10-2 and Figure 10-3
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, Table 8-8 through Table 8-10

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
b. The logistics of evacuating wheelchair and bed bound residents are discussed.	Yes	Section 8.1, Table 8-8 through Table 8-10
c. Time for loading of residents is provided.	Yes	Section 2.4, Section 8.1, Table 8-8 through Table 8-10
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
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
f. Supporting information is provided to quantify the time elements for each trip, including destinations if return trips are needed.	Yes	Section 8.1
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 8-4
b. Time for loading of students is provided.	Yes	Section 2.4, Section 8.1, Table 8-2 through Table 8-4
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, Table 10-3

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 8-4
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	
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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%. 100 percent ETE is based on the time the last vehicle exits the evacuation zone 5. Figures J-2 through J-15 (one plot for each scenario considered) 6. Table J-3
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	100 percent ETE is based on the time the last vehicle exits the evacuation zone.

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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		
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