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Davis-Besse Nuclear Power Station
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September 12, 2022
L-22-203

10 CFR 50, Appendix E

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

SUBJECT:
Davis-Besse Nuclear PowerStation, Unit No. 1
Docket No. 50-346, License No. NPF-3
Submittal of Evacuation Time Estimates

Pursuant to 10 CFR 50, Appendix E, Energy Harbor Nuclear Corp. is submitting the enclosed Evacuation Time Estimates (ETEs) for Davis-Besse Nuclear Power Station, Unit No. 1.

The ETEs were developed using the guidance contained in NUREG/CR-7002, Revision 1, "Criteria for Development of Evacuation Time Estimate Studies," February 2021. The estimates use 2020 census data.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Phil H. Lashley, Manager - Fleet Licensing, at (330) 696-7208.

Sincerely,

Terry J. Brown

Enclosure: Davis-Besse Nuclear Power Station Development of Evacuation Time Estimates

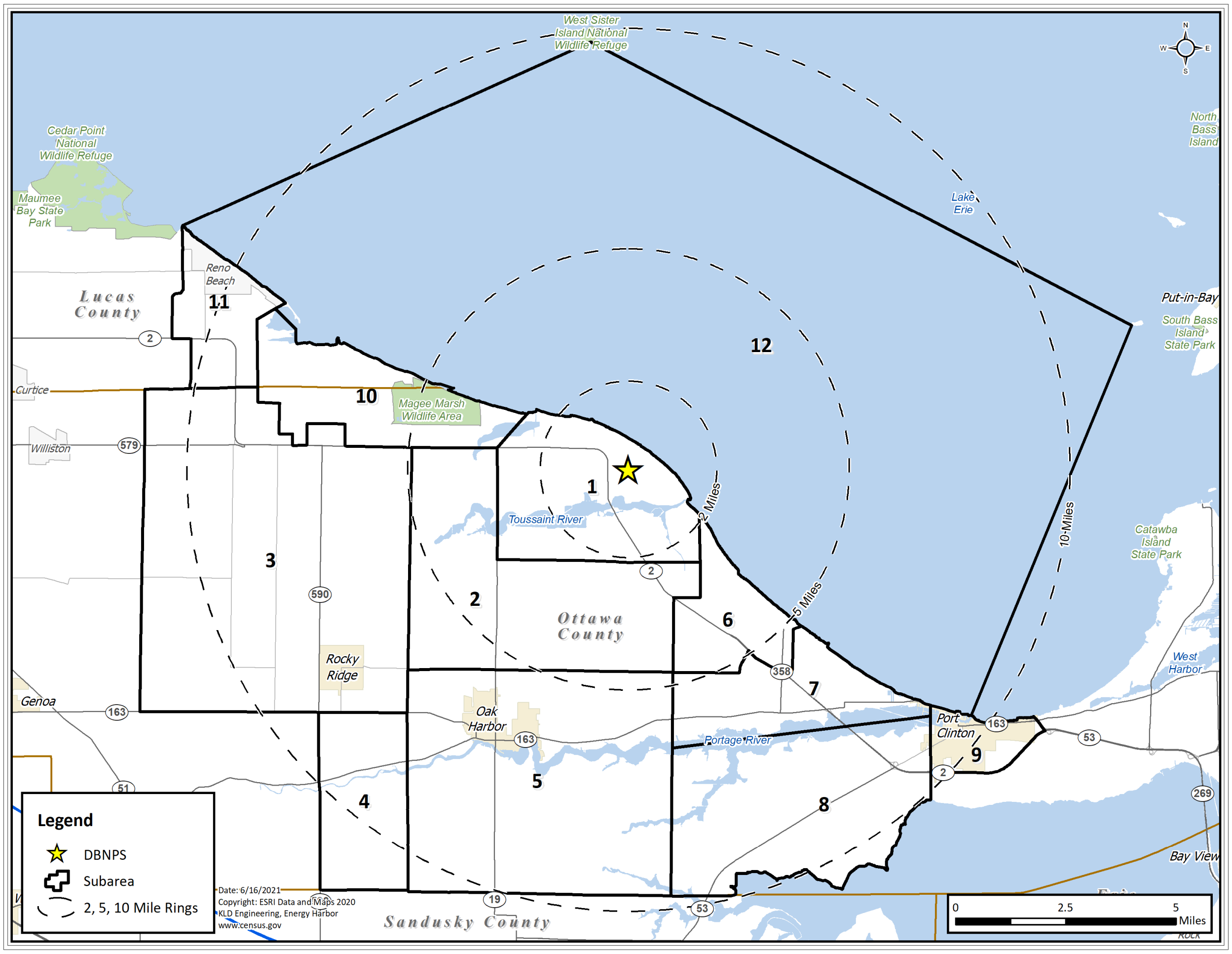
cc: NRC Region III Administrator
NRC Resident Inspector
NRR Project Manager
Executive Director, Ohio Emergency Management Agency
(State of Ohio NRC Liaison)
Utility Radiological Safety Board

Enclosure
L-22-203

Davis-Besse Nuclear Power Station Development of Evacuation Time Estimates
(363 Pages Follow)

Davis-Besse Nuclear Power Station

Development of Evacuation Time Estimates



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August 26, 2022 **Final Report, Rev. 0** **KLD TR – 1259**

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ACRONYM LIST

Table 1. Acronym List

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

mph	Miles Per Hour
MUTCD	Manual on Uniform Traffic Control Devices
MTC	Manual Traffic Control
NB	Northbound
NRC	United States Nuclear Regulatory Commission
O	Origin
O-D	Origin-Destination
ODOT	Ohio Department of Transportation
ODNR	Ohio Department of Natural Resources
ORO	Offsite Response Organization
PAR	Protective Action Recommendation
pce	Passenger Car Equivalent
pcphpl	passenger car per hour per lane
PSL	Path-Size-Logit
QDF	Queue Discharge Flow
RC	Reception Center
RS	Receiving School
SB	Southbound
SH	State Highway
SR	State Route
SV	Service Volume
TA	Traffic Assignment
TCP	Traffic Control Point
TD	Trip Distribution
TI	Time Interval
TMP	Traffic Management Plan
UNITES	Unified Transportation Engineering System
USDOT	United States Department of Transportation
US	US Highway
vph	Vehicles Per Hour
vpm	Vehicles Per Minute
WB	Westbound

EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Davis-Besse Nuclear Power Station (DBNPS) located in Oak Harbor, Ottawa County, Ohio. The ETE are part of the required planning basis and provide Energy Harbor and offsite response organizations (OROs) 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.
- "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/Radiological Emergency Preparedness Program Manual" (FEMA P-1028), December 2019

<u>Project Activities</u>

This project began in September 2020 and extended over a period of approximately 22 months. The major activities performed are briefly described in chronological sequence:

- Conducted a virtual "kickoff" meeting with Energy Harbor personnel and the state and county emergency management agencies.
- Accessed the 2020 U.S. Census Bureau data files.
- Employee data was obtained from the previous ETE study, reviewed and confirmed still accurate for this study by Ottawa County.
- Studied Geographic Information Systems (GIS) maps of the area in the vicinity of the DBNPS, 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.
- Designed and conducted an online demographic survey of residents within the study area (EPZ and Shadow Region), to gather focused data needed for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by the licensee and ORO personnel prior to conducting the survey.
- A data needs matrix (requesting data) was provided to Energy Harbor and the OROS at the kickoff meeting. The data for transient and special facilities (schools, day care centers/nursery schools, medical facilities and correctional facilities) in each county was

based on the data received from the counties within the EPZ, the previous ETE study, supplemented by internet searches and phone calls where data was missing.

- 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 of the study area.
- The EPZ is subdivided into 12 existing Subareas. Following federal guidelines, these Subareas are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define 20 Evacuation Regions (numbered R01 through R20).
- 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, Rain/Light Snow, Heavy Snow). One special event scenario - rifle matches at Camp Perry - was considered. One roadway impact scenario was considered wherein a single lane was closed on State Route 2 (SR 2) for the duration of the evacuation.
- Staged evacuation was considered for those regions wherein the 2-Mile Region and sectors downwind to 5 miles were evacuated.
- As per NUREG/CR-7002 Rev. 1, the Planning Basis for the calculation of ETE is:
    - A rapidly escalating accident at the DBNPS that quickly assumes the status of a general emergency wherein evacuation is ordered promptly, and no early protective actions have been implemented such that the Advisory to Evacuate (ATE) is virtually coincident with the siren notification.
    - 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 and day care centers/nursery schools are in session, the ETE study assumes that the children will be evacuated by bus directly to receiving schools located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at schools or day care center/nursery schools prior to the arrival of the buses dispatched for that purpose. The ETE for children at these facilities are calculated separately.
- Evacuees who do not have access to a private vehicle will either rideshare with relatives, friends or neighbors, or be evacuated by buses provided as specified in the county evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: by bus, wheelchair bus, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees, for access and/or functional needs population, and for those evacuated from special facilities.

- Attended "final" meeting with Energy Harbor personnel and county and state representatives to present results from the study.

<u>Computation of ETE</u>

A total of 280 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 20 Evacuation Regions to evacuate from that Region, under the circumstances defined for one of the 14 Evacuation Scenarios (20 x 14 = 280). Separate ETE are calculated for transit-dependent evacuees, including children at schools and day care centers/nursery schools 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 beyond the EPZ that extends from the EPZ boundary to a distance of approximately 15 miles from the plant will also elect to evacuate. These voluntary evacuees could impede those who are evacuating from within the impacted region. The impedance that could be caused by voluntary evacuees is considered in the computation of ETE for the impacted region.

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

The computational procedure is outlined as follows:

- A link-node representation of the highway network is coded. Each link represents a unidirectional length of highway; each node usually represents an intersection or merge point. The capacity of each link is estimated based on the field survey observations and on established traffic engineering procedures.
- The evacuation trips are generated at locations called "zonal centroids" located within the EPZ and Shadow Region. The trip generation rates vary over time reflecting the mobilization process, and from one location (centroid) to another depending on population density and on whether a centroid is within, or outside, the impacted area.
- The evacuation model computes the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of the plant), 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.

<u>Traffic Management</u>

This study reviewed, modeled and analyzed the existing comprehensive traffic management plans provided in the Lucas and Ottawa County Radiological Emergency Response Plans.

Due to the detailed plans already in place and the limited traffic congestion within the EPZ (discussed in Section 7.3), no additional traffic or access control measures have been identified as a result of this study. See Section 9 and Appendix G.

<u>Selected Results</u>

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 Subarea based on the 2020 Census data.
- Table 6-1 defines each of the 20 Evacuation Regions in terms of their respective groups of Subarea.
- Table 6-2 lists the Evacuation Scenarios.
- Tables 7-1 and 7-2 are compilations of ETE for the general population. 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. These tables also include ETE results for staged evacuation on residents beyond the 2-Mile Region.
- Table 7-3 and Table 7-4 present ETE for the 2 Mile Region when evacuating additional subareas downwind to 5 miles for un-staged and staged evacuations for the 90th and 100th percentile ETE, respectively.
- Table 8-2 presents ETE for the children at schools and day care centers/nursery schools in good weather.
- Table 8-5 presents ETE for the transit-dependent population in good weather.
- Table 8-8 presents ETE for the medical facility population in good weather.
- Table M-3 compares the results of the sensitivity study conducted to determine the effect on ETE due to changes in the permanent resident population within the study area (EPZ plus Shadow Region).
- Figure 6-1 displays a map of the DBNPS EPZ showing the layout of the 12 Subareas that comprise, in aggregate, the EPZ.

- Figure H-7 presents an example of an Evacuation Region (Region R07) 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 280 unique cases – a combination of 20 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document these ETE for the 90th and 100th percentiles. The 90th percentile ETE range from 1:45 (hr:min) to 4:05. The 100th percentile ETE range from 4:45 to 6:25 and are dictated by the trip mobilization of residents (i.e., the time it takes to prepare to evacuate plus the time to travel to the EPZ boundary).
- The comparison of Table 7-1 and Table 7-2 indicate that the 100th percentile ETE are significantly longer than those for the 90th percentile ETE. This is the result of the 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 7-7 through 7-20.
- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation protective action strategy provides no benefits to evacuees from within the 2-Mile Region and adversely impacts evacuees located beyond the 2-Mile Region (compare Regions R18, R19 and R20 and Regions R02, R04 and R05, respectively, in Tables 7-1 and 7-2). See Section 7.6 for additional discussion.
- Comparison of Scenario 3 (summer, weekend, midday, with good weather) and Scenario 13 in Table 7-1 and Table 7-2 indicate that the Special Event – The Camp Perry National Rifle Matches – does not have a significant impact on the ETE for the 90th percentile ETE and no impact to the 100th percentile ETE. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that the roadway closure – a single lane closure on SR 2 eastbound from approximately plant site to just west of the interchange with SR 269/Martins Point Road (Exit 128) – does not impact the 90th or 100th percentile ETE, indicating that there is excess capacity on the highway. See Section 7.5.
- Port Clinton located in Subarea 9 is the most congested area during an evacuation. All links within the EPZ are at LOS A (free-flowing traffic conditions) at 3 hours and 30 minutes after the ATE. See Section 7.3 and Figures 7-3 through 7-6.
- Separate ETE were computed for schools, day care centers/nursing schools, medical facilities, correctional facilities, transit-dependent persons, and access and/or functional needs persons. The average single-wave ETE for this population (except transit-dependents and ambulatory access and/or functional needs persons) 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 transportation resources to evacuate all facilities in a single wave. However, second wave ETEs were calculated for the transit dependent population in the event there is a short fall of resources. See Section 8.1 and 8.2.
- A reduction in the base mobilization time of evacuees by one hour reduces the general population ETE at the 90th percentile by 30 minutes and the 100th percentile by 60 minutes. An increase in mobilization time by one hour has no impact on the 90th percentile ETE but increases the 100th percentile ETE by one hour. See Table M-1.
- The 90th and 100th percentile ETE for the general population is insensitive to decreases or increases in the number of voluntary evacuees in the Shadow Region. When the shadow percent is increased to 100%, the 90th percentile ETE increases by 10 minutes and 100th percentile ETE remains unchanged. See Table M-2.
- An increase in permanent resident population (EPZ plus Shadow Region) of 95% or greater for the 2-Mile Region (R01) 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 or decrease in the average household size from 2.69 people per household to 3.10 or 2.28 people per household minimally impacts ETE with a reduction of at most 5 minutes at the 90th percentile and no impact to the 100th percentile ETE. See Section M.4.
- A bird watching event at Magee Marsh that attracts 2,500 transients in 1,500 vehicles can impact the 90th percentile ETE significantly (up to 40 minutes) if there are no traffic control in place at the intersection of Park Road 1 and SR 2 and can increase at most 10 minutes when traffic control is in place. There are no impacts to the 100th percentile ETE. See Section M.5.

Table 3-1. EPZ Permanent Resident Population

Subarea	2010 Population	2020 Population
1	812	793
2	1,313	1,311
3	2,589	2,430
4	257	241
5	5,370	5,310
6	162	143
7	1,085	1,046
8	1,637	1,446
9	5,898	5,724
10	0	22
11	1,280	1,097
12	0	0
EPZ TOTAL:	**20,403**	**19,563**
EPZ Population Growth (2010-2020):		**-4.12%**

Table 6-1. Description of Evacuation Regions

Region	Description	Subarea											
Radial Regions													
Region	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10[1]**	**11**	**12[1]**
R01	2-Mile Region	X									X		X
R02	5-Mile Region	X	X				X				X		X
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
N/A	Unknown or Lake Breeze	**Refer to Region R02**											
N/A	118° - 278°	**Refer to Region R01**											
R04	279° - 293°	X					X				X		X
N/A	294° - 013°	**Refer to Region R02**											
R05	014° - 117°	X	X								X		X
Evacuate 2-Mile Region and Downwind to the EPZ Boundary													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
N/A	Unknown or Lake Breeze	**Refer to Region R03**											
N/A	141° - 278°	**Refer to Region R01**											
R06	279° - 286°	X					X	X		X	X		X
R07	287° - 293°	X					X	X	X	X	X		X
R08	294° - 330°	X	X				X	X	X	X	X		X
R09	331° - 005°	X	X			X	X	X	X		X		X
R10	006° - 013°	X	X		X	X	X	X	X		X		X
R11	014° - 020°	X	X		X	X					X		X
R12	021° - 065°	X	X	X	X	X					X		X
R13	066° - 072°	X	X	X	X						X		X
R14	073° - 078°	X	X	X							X		X
R15	079° - 117°	X	X	X							X	X	X
R16	118° - 122°	X		X							X	X	X
R17	123° - 140°	X									X	X	X
Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
R18	5-Mile Region	X	X				X				X		X
N/A	118° - 278°	**Refer to Region R01**											
R19	279° - 293°	X					X				X		X
N/A	294° - 013°	**Refer to Region R18**											
R20	014° - 117°	X	X								X		X
Subarea(s) Evacuate		Subarea(s) Shelter-in-Place					Subarea(s) Shelter-in-Place until 90% ETE for R01, then Evacuate						

[1] Site specific protective action recommendations indicate that Subareas 10 and 12 evacuate even though not within the wind direction three-sector keyhole.

Table 6-2. Evacuation Scenario Definitions

Scenarios	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	Summer	Weekend	Midday	Good	Special Event: The Camp Perry National Rifle Matches
14	Summer	Midweek	Midday	Good	Roadway Impact: Single Lane Closure on SR 2 Eastbound

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

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

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(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 full EPZ														
R01	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R02	2:15	2:15	2:15	2:15	2:05	2:45	2:45	3:40	2:25	2:25	3:20	2:35	2:05	2:15
R03	2:55	2:55	2:45	2:55	2:40	3:05	3:05	4:05	2:50	2:50	3:45	2:55	2:45	3:20
2-Mile Ring and Keyhole to 5 Miles														
R04	2:00	2:00	2:05	2:05	1:50	2:20	2:20	3:15	2:05	2:05	3:00	2:15	2:00	2:00
R05	2:10	2:10	2:10	2:10	2:00	2:40	2:40	3:35	2:20	2:20	3:20	2:30	2:10	2:10
2-Mile Ring and Keyhole to EPZ Boundary														
R06	2:40	2:40	2:30	2:45	2:25	2:55	3:00	3:55	2:40	2:40	3:35	2:45	2:30	2:40
R07	2:40	2:45	2:40	2:55	2:25	3:00	3:00	3:55	2:45	2:45	3:40	2:50	2:40	3:05
R08	2:45	2:45	2:40	2:50	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:40	3:05
R09	2:50	2:55	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:25	2:50
R10	2:50	2:50	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:25	2:50
R11	2:50	2:55	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:30	2:50
R12	2:55	2:55	2:40	2:40	2:40	3:05	3:05	4:05	2:50	2:50	3:45	2:55	2:40	3:00
R13	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R14	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R15	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R16	2:40	2:40	2:25	2:25	2:25	3:00	3:00	3:55	2:45	2:45	3:40	2:50	2:25	2:40
R17	2:10	2:10	2:10	2:10	1:55	2:35	2:35	3:30	2:15	2:15	3:15	2:25	2:10	2:10
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R18	2:20	2:20	2:15	2:15	2:15	2:45	2:45	3:30	2:25	2:25	3:20	2:35	2:15	2:20
R19	2:05	2:05	2:10	2:10	2:00	2:20	2:20	3:10	2:15	2:15	3:10	2:20	2:05	2:05
R20	2:15	2:20	2:15	2:15	2:15	2:40	2:40	3:25	2:25	2:25	3:20	2:30	2:15	2:15

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

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(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 full EPZ														
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
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	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R05	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														
R06	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
R07	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
R08	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
R09	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
R10	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
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
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R18	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
R19	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
R20	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. Staged Evacuation Results - *90* Percent ETE of the 2-Mile Area within the Indicated Region

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(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
Un-staged Evacuation - 2-Mile Region and 5-Mile Region														
R01	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R02	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R05	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R18	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R19	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R20	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00

Table 7-4. Staged Evacuation Results – *100* Percent ETE of the 2-Mile Area within the Indicated Region

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(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
Un-staged Evacuation - 2-Mile Region and 5-Mile Region														
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R02	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R05	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R18	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R19	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R20	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45

Table 8-2. School and Day Care Centers/Nursery School Evacuation Time Estimates - Good Weather

School or Day Care Centers/Nursery 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 R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ATE to R.S. (hr:min)
LUCAS COUNTY SCHOOLS									
Jerusalem Elementary School	90	15	Inside Shadow Region			**N/A**	5.9	7	**1:55**
OTTAWA COUNTY SCHOOLS & DAY CARE CENTERS/NURSERY SCHOOLS									
Oak Harbor Middle School	90	15	3.9	14.5	17	**2:05**	7.9	9	**2:15**
R.C. Waters Elementary School	90	15	3.8	13.9	17	**2:05**	7.9	9	**2:15**
St Boniface Elementary School	90	15	3.8	20.5	12	**2:00**	7.9	9	**2:10**
Oak Harbor High School	90	15	4.5	14.8	19	**2:05**	7.9	9	**2:15**
Ottawa County Christian Academy	90	15	4.8	15.1	20	**2:05**	7.9	9	**2:15**
Bataan Memorial Intermediate Elementary School	90	15	3.2	55.0	4	**1:50**	15.5	17	**2:10**
Immaculate Conception School	90	15	2.6	28.0	6	**1:55**	15.5	17	**2:15**
Port Clinton Middle School	90	15	2.7	33.3	5	**1:50**	15.5	17	**2:10**
Port Clinton High School	90	15	2.8	26.0	7	**1:55**	15.5	17	**2:15**
North Point Educational Service	90	15	1.7	46.3	3	**1:50**	18.3	20	**2:10**
St Peter Precious Moments Preschool	90	15	1.1	55.0	2	**1:50**	24.8	28	**2:20**
St. John's Nursery School	90	15	3.7	20.5	11	**2:00**	7.9	9	**2:10**
Rainbow Acres Educational Daycare Center	90	15	3.7	20.5	11	**2:00**	7.9	9	**2:10**
Kersten's Korner Nursery School	90	15	4.5	20.5	14	**2:00**	7.9	9	**2:10**
Port Clinton Nursery School	90	15	2.2	29.0	5	**1:50**	15.5	17	**2:10**
GLCAP Port Clinton Early Childhood Center	90	15	0.8	26.9	2	**1:50**	15.5	17	**2:10**
					Maximum for EPZ:	**2:05**		**Maximum:**	**2:20**
					Average for EPZ:	**2:00**		**Average:**	**2:15**

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

Subarea	Route Number	Number of Buses	Single-Wave							Second-Wave					
			Mobilization (min)	Route Length (miles)	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	**1**	1	195	16.1	52.9	18	30	**4:05**	7.9	9	5	10	44	30	**5:45**
3 & 4	**2**	1	195	13.8	53.9	15	30	**4:05**	10.7	12	5	10	44	30	**5:50**
5	**3**	1	195	5.0	49.0	6	30	**3:55**	7.9	9	5	10	20	30	**5:10**
6 & 7	**4**	1	195	10.1	55.0	11	30	**4:00**	15.5	17	5	10	39	30	**5:45**
8	**5**	1	195	9.4	55.0	10	30	**4:00**	15.5	17	5	10	37	30	**5:40**
9	**6**	1	195	3.0	27.3	7	30	**3:55**	15.5	17	5	10	26	30	**5:25**
11	**7**	1	195	2.4	52.5	3	30	**3:50**	7.2	8	5	10	13	30	**5:00**
							Maximum ETE:	**4:05**						**Maximum ETE:**	**5:50**
							Average ETE:	**4:00**						**Average ETE:**	**5:30**

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)	Speed (mph)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
OTTAWA COUNTY, OH									
Riverview Healthcare Campus	Ambulatory	90	1	23	23	11.0	43.8	15	**2:10**
	Wheelchair bound	90	5	43	75	11.0	45.1	15	**3:00**
	Bedridden	30	15	14	30	11.0	42.5	16	**1:20**
Magruder Hospital	Ambulatory	90	1	4	4	3.1	31.4	6	**1:40**
	Wheelchair bound	90	5	8	40	3.1	33.2	6	**2:20**
	Bedridden	30	15	3	30	3.1	30.9	6	**1:10**
Edgewood Manor Nursing Home	Ambulatory	90	1	13	13	3.1	31.6	6	**1:50**
	Wheelchair bound	90	5	26	75	3.1	33.0	6	**2:55**
	Bedridden	30	15	8	30	3.1	30.7	6	**1:10**
								Maximum ETE:	**3:00**
								Average ETE:	**2:00**

Table M-3. ETE Variation with Population Change

EPZ and 20% Shadow Permanent Resident Population	Base	Population Change		
		94%	95%	96%
	23,251	45,107	45,339	45,572
ETE (hrs:mins) for the 90th Percentile				
		Population Change		
Region	**Base**	**94%**	**95%**	**96%**
2-MILE	3:05	3:30	**3:35**	**3:35**
5-MILE	3:40	3:55	3:55	3:55
Full EPZ	4:05	4:20	4:20	4:25
ETE for the 100th Percentile				
		Population Change		
Region	**Base**	**94%**	**95%**	**96%**
2-MILE	6:15	6:15	6:15	6:15
5-MILE	6:20	6:20	6:20	6:20
Full EPZ	6:25	6:25	6:25	6:25

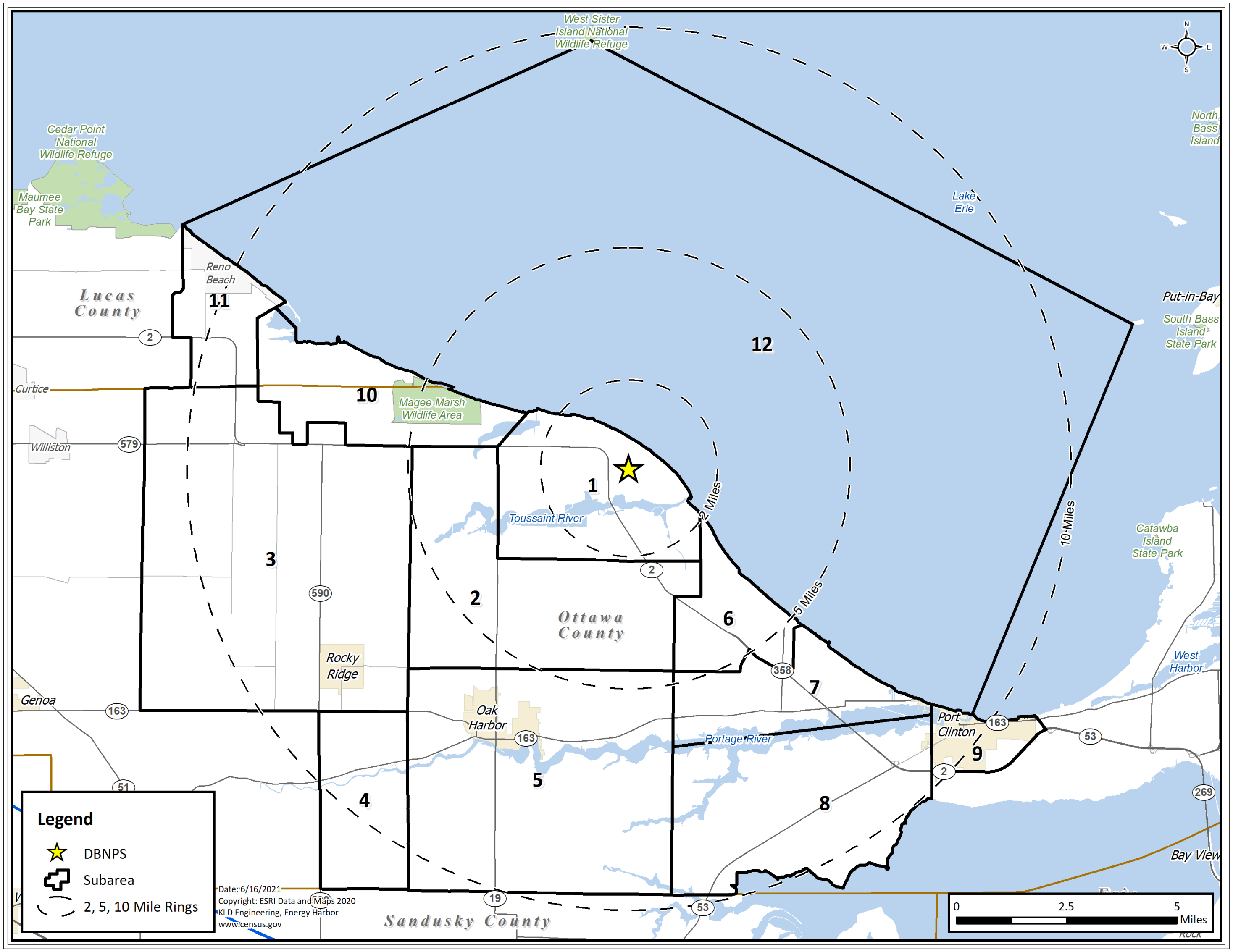


Figure 6-1. Subareas comprising the DBNPS EPZ

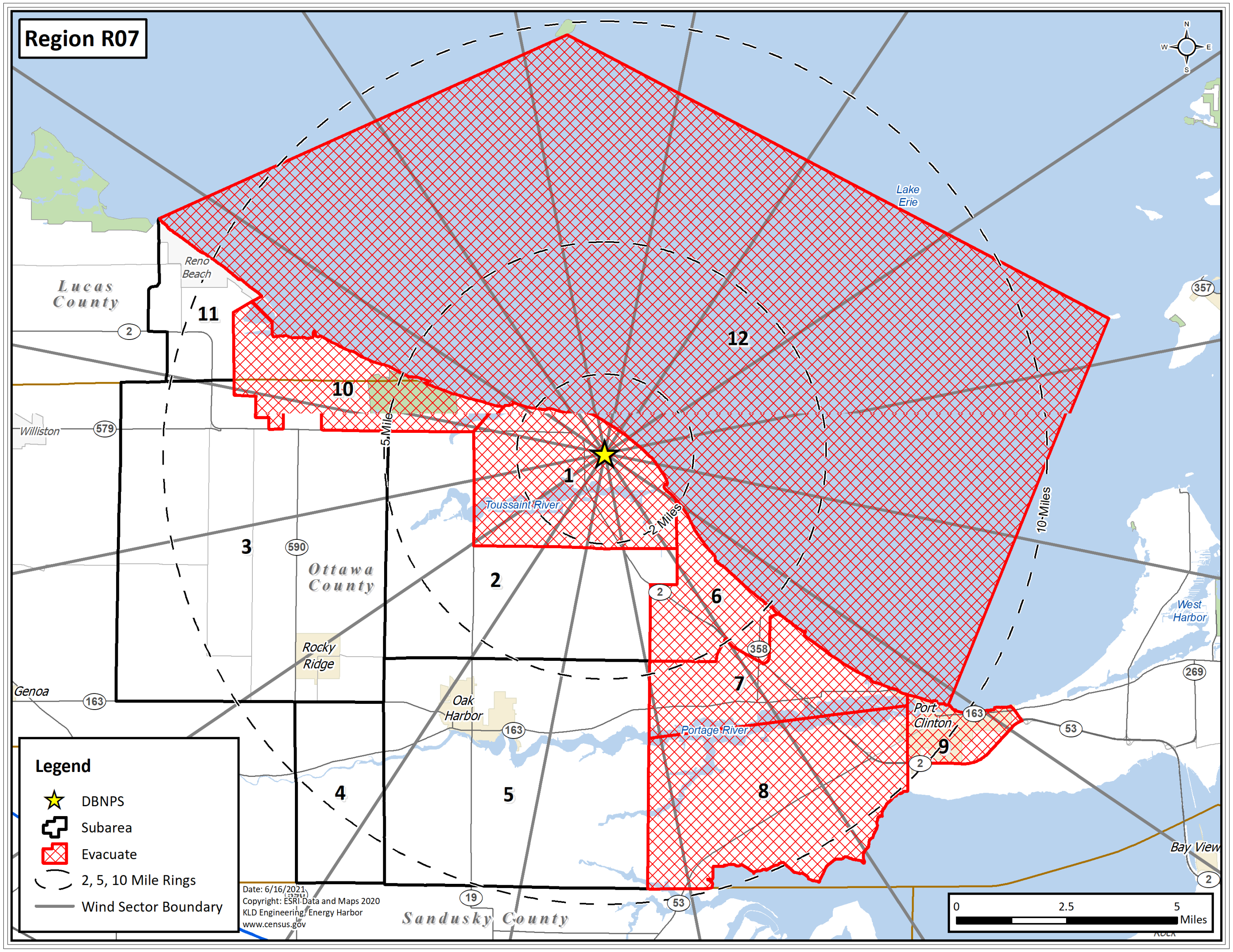


Figure H-7. Region R07

1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Davis-Besse Nuclear Power Station (DBNPS), located in Ottawa County, Ohio. This ETE study provides Energy Harbor, 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.
- "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/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. 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 Energy Harbor.
    b. Attended multiple meetings, including the kickoff meeting, with personnel from Energy Harbor, emergency planners from Ohio EMA, Ottawa and Lucas County EMA to identify issues to discuss methodology, project assumptions and to identify issues to be addressed and resources available.
    c. Conducted a detailed field survey of the highway system and of the area traffic conditions within the Emergency Planning Zone (EPZ) and Shadow Region.
    d. Obtained demographic data from the 2020 Census (See Section 3.1).
    e. Conducted an online demographic survey of the study area residents (See Appendix F).

f. Conducted a data collection effort to identify and describe special facilities (schools/day care centers/nursery schools, medical facilities and correctional facilities), major employers, access and/or functional needs population, transportation resources available, the special event, 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 (See Section 6). These scenarios reflect the variation in demand, in trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Reviewed the existing traffic management plan to be implemented by local and state police in the event of an incident at the plant. Traffic control is applied at specified Traffic Control Points (TCP) and Access Control Points (ACP) located within the EPZ. See Section 9 and Appendix G.

5. Used existing Subareas to define Evacuation Regions. The EPZ is partitioned into 12 Subareas along jurisdictional and geographic boundaries. "Regions" are groups of contiguous subareas for which ETE are calculated. The configurations of these Regions reflect wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a "keyhole section" within the EPZ as recommended by NUREG/CR-7002, Rev 1.

6. Estimated demand for transit services for persons at schools, day care centers/nursery schools, medical facilities, correctional facilities, transit-dependent persons at home and those with access and/or functional needs.

7. Prepared the input streams for the DYNEV II, 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 county and state agencies, Energy Harbor and from the demographic survey.

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

    c. Updated the link-node representation of the evacuation network using the field survey and aerial imagery, which is used as the basis for the computer analysis that calculates the ETE.

    d. Calculated the evacuating traffic demand for each Region and for each Scenario.

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

e. Specified selected candidate destinations of evacuation travel 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 DBNPS.

8. Executed the DYNEV II system to determine optimal evacuation routing and compute ETE for all residents, transients and employees ("general population") with access to private vehicles. Generated a complete set of ETE for all specified Regions and Scenarios.
9. Documented ETE in formats in accordance with NUREG/CR-7002, Rev. 1.
10. Calculated the ETE for all transit activities including those for special facilities (i.e., schools, day care centers/nursery schools, medical and correctional facilities), for the transit-dependent population and for the access and/or functional needs population.

1.2 The Davis-Besse Nuclear Power Station Location

The DBNPS is located along the coast of Lake Erie in Carroll Township, Ottawa County, Ohio. The site is approximately 20 miles northwest of Sandusky, Ohio and 25 miles east of Toledo, Ohio. The EPZ is located in Ottawa and Lucas Counties in Ohio. Figure 1-1 Shows the location of the DBNPS site relative to Toledo and Sandusky, as well as the major population centers and roadways in the area.

1.3 Preliminary Activities

These activities are described below.

Field Surveys of the Highway Network

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

Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures, based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 15-7 in the HCM 2016 indicates that a reduction in lane width from 12 feet (the "base" value) to 10 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two-lane highways. Exhibit 15-46 in the HCM 2016 shows little sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographic information systems (GIS) shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while

preparing the input stream for the DYNEV II System. Roadway types were assigned based on the following criteria:

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

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

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

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

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

Demographic Survey

An online demographic survey was performed 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 received.

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

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 Assessment and Distribution) model, as described in Appendix B.
- A Myopic Traffic Diversion model which diverts traffic to avoid intense, local congestion, if alternative uncongested routes are available.

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 output by the DYNEV II System, such as Level of Service (LOS), vehicles discharged, average speed, and percent of vehicles evacuated. 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 while viewing the animation display.

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 technical terms.

An evaluation of the original I-DYNEV model is provided in the following references:

- 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 expedite the movement of vehicles and 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

The 90th percentile ETE for the entire EPZ increased by 50 minutes for a winter midweek midday scenario and by 20 minutes for a summer weekend midday scenario when compared with the 2012 study. The 100th percentile ETE increased by 10 and 15 minutes for a winter midweek midday scenario and for a summer weekend midday scenario, respectively.

Table 1-3 presents a comparison of the present ETE study with the previous ETE study (KLD TR-482, dated March 2012). The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study are:

- Although the permanent resident population decreased by approximately 4%, the number of evacuating vehicles for the permanent resident population increased by approximately 4% (approximately 500 vehicles). This increase in permanent resident evacuating vehicles is caused by the increased number of evacuating vehicles per household as per the demographic survey, resulting in a decrease in permanent resident vehicle occupancy and can increase ETE.
- The permanent resident population in the Shadow Region has decreased approximately 3%, but due to the decrease in permanent resident occupancy per vehicle, this resulted in an increase (~6%) in the number of Shadow Region permanent resident vehicles. The increase in number of evacuating vehicles in the Shadow Region, which reduces the available roadway capacity for EPZ evacuees and can increase ETE.
- Transient population at transient facilities increased by approximately 48%. Even though this population group mobilizes faster compared to residents, the additional vehicles

cause congestion within the EPZ which can delay the 90% percentile ETE. Additionally, a new population group, seasonal residents, were considered as part of this study. This population group follows the mobilization time for residents without commuters, see Section 6.

- The number of employees commuting into the EPZ decreased significantly by approximately 33%, due to the updated NRC's criteria for major employers from 50 or more employees per shift to 200 or more employees per shift. A decrease in this quickly mobilizing population group can cause the 90th percentile ETE to increase as it will take longer to reach an evacuation of 90% of all vehicles. A decrease in the number of employee vehicles can decrease the 100th percentile ETE.
- There is a decrease in the school/day care center/nursery school population (18%) which decreases the number of evacuating buses within the EPZ, which can decrease the ETE.
- Trip mobilization (also known as trip generation), based on the data collected from the demographic survey, for the following population groups have changed:
    - Permanent residents with and without commuters take an additional 15 minutes to complete their mobilization.
    - Permanent residents with and without commuters with heavy snow conditions take an additional 45 minutes and 75 minutes to complete their mobilization, respectively.
    - This delay in trip generation directly impacts 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.

The various factors, discussed above, that can increase ETE outweigh those that can reduce ETE, thereby explaining 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
Energy Harbor emergency planning personnel	Attended meetings to define project methodology and data requirements and set up contacts with local government agencies. Reviewed and approved of demographic survey instrument and all project assumptions. Engaged in the ETE development and was informed of the study results.
Lucas and Ottawa County Emergency Management Agency	Attended meetings to define project methodology and data requirements. Provided emergency plans and traffic management plans. Provided/ confirmed special facility data, transient data and special event data. Reviewed and approved the demographic survey instrument and all study assumptions. Engaged in the ETE development and was informed of the study results.
Ohio State Emergency Management Office	Attended kickoff meeting to define project methodology and data requirements. Provided State of Ohio Radiological Emergency Preparedness Plans for DBNPS.

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 = 20,403 Vehicles = 11,757	ArcGIS Software using 2020 US Census blocks; area ratio method used. Population = 19,563 Vehicles = 12,234
Resident Population Vehicle Occupancy	2.22 persons per household, 1.28 evacuating vehicles per household, yielding 1.73 persons per evacuating vehicle.	2.69 persons per household, 1.70 evacuating vehicles per household, yielding 1.58 persons per evacuating vehicle.
Shadow Population	ArcGIS Software using 2010 US Census blocks; area ratio method used. 20% Population = 3,785 20% Vehicles = 2,180	ArcGIS Software using 2020 US Census blocks; area ratio method used. 20% Population = 3,688 20% Vehicles = 2,321
Employee Population	Employee estimates based on information provided about major employers in EPZ. 1.05 employees/vehicle based on phone survey results. Employees = 853 Vehicles = 813	Estimates of employees who reside outside the EPZ and commute to work within the EPZ are based upon the previous study data, reviewed and confirmed still accurate for this study by Ottawa County and Energy Harbor 1.13 employees/vehicle based on demographic survey results. Employees = 573 Vehicles = 508
Transient Population	Transient estimates based upon information provided about transient attractions in EPZ, supplemented by observations of the facilities during the road survey and from aerial photography. Seasonal Residents = Not Considered Transients = 15,886 Vehicles = 6,924	Transient estimates are based on the information provided by each county, the previous ETE study, supplemented by internet searches and phone calls where data was missing. Seasonal Residents = 2,193 Transients = 21,147 Vehicles = 12,319

Topic	Previous ETE Study	Current ETE Study
Special Facilities Population	Special facility population based on information provided by each county within the EPZ. **Medical Facilities:** Current census = 184 Buses Required = 3 Wheelchair Bus Required = 9 Ambulances Required = 17 **Correctional Facilities:** Total Population = 48 Buses Required = 2	Special facility population based on information provided by each county within the EPZ, the previous ETE study and supplemented by internet searches. **Medical Facilities:** Current census = 142 Buses Required = 3 Wheelchair Bus Required = 6 Ambulances Required = 13 **Correctional Facilities:** Total Population = 87 Buses Required = 4
Transit-Dependent Population	Transit-Dependent population estimated using population estimates and results of telephone survey. A total of 427 people who do not have access to a personal vehicle, require 14 buses to evacuate. An additional 125 access and/or functional needs persons need special transportation to evacuate (35 require bus, 68 require wheelchair-accessible transportation and 22 require an ambulance).	Transit-Dependent population estimated using population estimates and results of demographic survey. A total of 89 people who do not have access to a personal vehicle, require 7 buses to evacuate. An additional 188 access and/or functional needs persons need special transportation to evacuate (163 require bus, 23 require wheelchair-accessible transportation and 2 require an ambulance).
School Population	School population based on information provided by each county within the EPZ. School Enrollment = 4,117 Buses Required = 78	School population based on information provided by each county within the EPZ, the previous ETE study and supplemented by internet searches School & Day Care/Nursing School Enrollment = 3,396 Buses Required = 67
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)

Topic	Previous ETE Study	Current ETE Study
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	753 Links; 508 Nodes.	877 Links; 610 Nodes.
Roadway Geometric Data	Field surveys conducted in November 2010. Major intersections were video archived. GIS shapefiles of signal locations and roadway characteristics created during road survey. Road capacities based on 2010 HCM.	Field surveys conducted in September 2020. Major intersections were video archived. GIS shapefiles of signal locations and roadway characteristics created during road survey. Road capacities based on 2016 HCM.
School Evacuation	Direct evacuation to designated Receiving School.	Direct evacuation to designated Receiving School.
Ridesharing	50 percent of transit-dependent persons will ride out with a neighbor or friend.	82.4 percent of transit-dependent persons will ride out with a neighbor or friend.
External Traffic	External Traffic is loaded on I-80, US-20 and US-6. External-traffic trips are not stopped within the 2-hour ACP establish time as these routes are outside of the EPZ. Vehicles = 36,850	External Traffic is loaded on I-80, US-20 and US-6. External-traffic trips are not stopped within the 2-hour ACP establish time as these routes are outside of the EPZ. Vehicles = 48,924
Trip Generation for Evacuation	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 270 minutes (330 with heavy snow). Residents without commuters returning leave between 5 and 210 minutes (270 with heavy snow). Employees and transients leave between 5 and 105 minutes. All times measured from the Advisory to Evacuate.	Based on residential demographic survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 285 minutes (375 with heavy snow). Residents without commuters returning leave between 15 and 225 minutes (345 with heavy snow). Employees and transients leave between 5 and 90 minutes. All times measured from the Advisory to Evacuate.
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% for Rain/Light Snow and 25% and 15% for Heavy Snow, respectively.

Topic	Previous ETE Study	Current ETE Study
Modeling	DYNEV II System – Version 4.0.0.0	DYNEV II System – Version 4.0.21.0
Special Events	National Rifle Matches at Camp Perry. Special Event Population = 1,890 additional transients. Special Event Vehicles = 851	National Rifle Matches at Camp Perry. Special Event Population = 4,000 additional transients. Special Event Vehicles = 1,487
Evacuation Cases	21 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 294 unique cases.	20 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 280 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, 90th percentile	Winter Weekday Midday, Good Weather: 2:15 Summer Weekend, Midday, Good Weather: 2:25	Winter Weekday Midday, Good Weather: 3:05 Summer Weekend, Midday, Good Weather: 2:45
Evacuation Time Estimates for the entire EPZ, 100th percentile	Winter Weekday Midday, Good Weather: 4:45 Summer Weekend, Midday, Good Weather: 4:40	Winter Weekday Midday, Good Weather: 4:55 Summer Weekend, Midday, Good Weather: 4:55

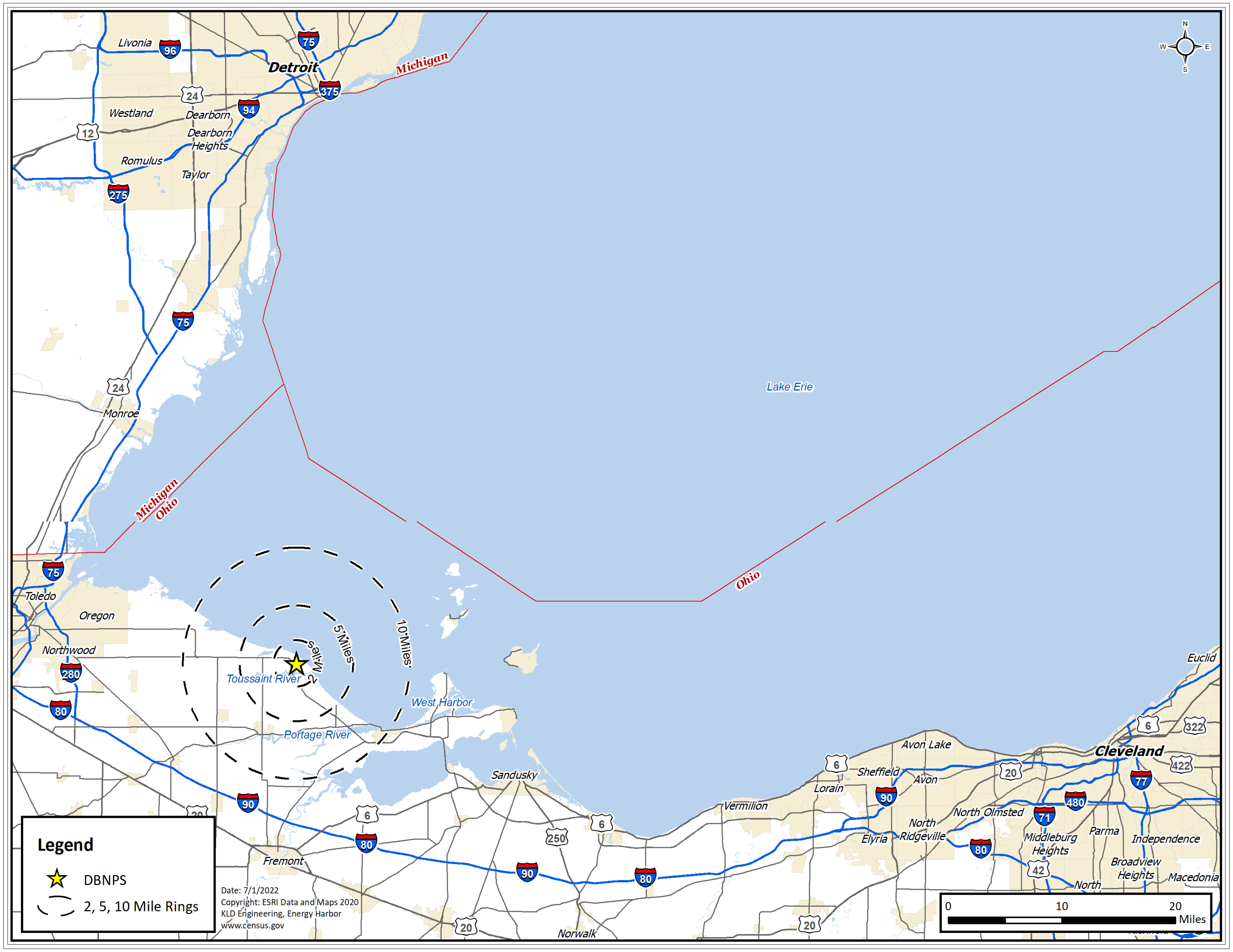


Figure 1-1. DBNPS Location

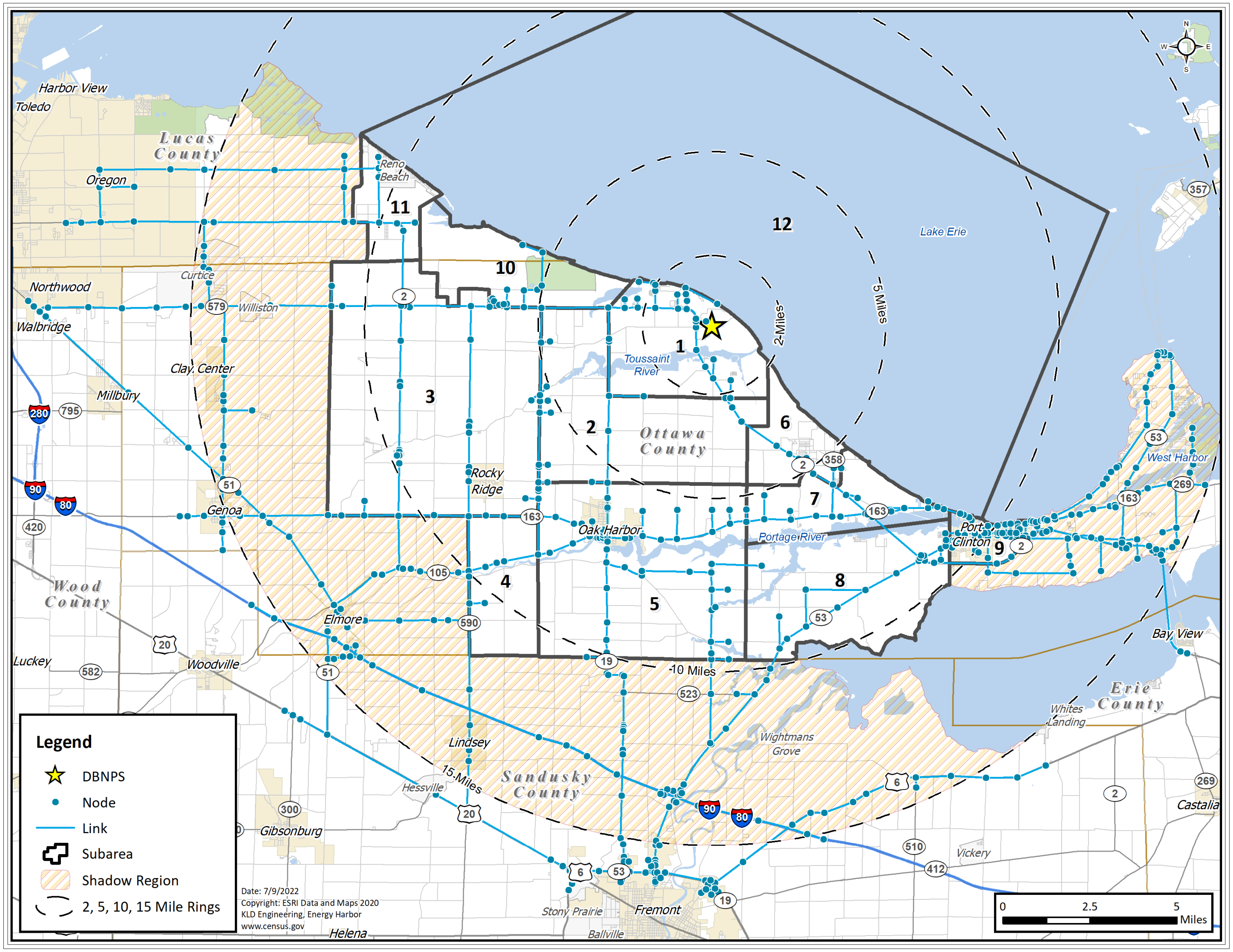


Figure 1-2. DBNPS Link-Node Analysis Network

2 STUDY ESTIMATES AND ASSUMPTIONS

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

2.1 Data Estimate Assumptions

1. The permanent resident population are based on the 2020 U.S. Census population from the Census Bureau website[1]. A methodology, referred to as the "area ratio method," is employed to estimate the population within portions of census blocks that are divided by Subarea boundaries. It is assumed that the population is evenly distributed across a census block in order to employ the area ratio method. (See Section 3.1.)
2. Estimates of employees who reside outside the EPZ and commute to work within the EPZ are based upon data provided Ottawa County and the previous ETE study (reviewed and confirmed by Ottawa 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 and the previous ETE study (reviewed and confirmed by counties within EPZ), supplemented by internet searches where data was missing.
4. After consulting with Energy Harbor, small lodging facilities were assumed to be vacation rentals and/or residents that are there only part of the year. Seasonal residents are included as a new population group to capture the population that are at these small lodging facilities.
5. The relationship between permanent resident population and evacuating vehicles was based on the results of the recent, random-sample demographic survey and 2020 Census data. Based on conversations with Energy Harbor and the local OROs, the average household size of 3.10 (from the demographic survey) and 2.28 (from the 2020 Census data) were averaged (2.69 persons per household) and used as the average household size for the permanent resident population. Based upon the results of the survey, 1.70 evacuating vehicles per household was used. Sensitivity studies were conducted to explore the effect on ETE of varying household sizes (see Appendix M).
6. On average, the relationship between persons and vehicles for transients (see Section 3.3) and the special event (see Section 3.10) are as follows:
    a. Parks: 2.30 people per vehicle
    b. Marinas: 2.31 people per vehicle.
    c. Hunting Areas: 2.27 people per vehicle
    d. Other Recreational Areas (Woodsmoke Ranch): 1.83 people per vehicle
    e. Special Events: 2.61 people per vehicle (the average household size)
    f. Where data was not provided, the average household size is assumed to be the vehicle occupancy rate for transient facilities.

[1] www.census.gov

7. Employee vehicle occupancies are based on the results of the demographic survey. The value of 1.13 employees per vehicle is used in the study. (See Figure F-7.) In addition, it is assumed there are two people per carpool, on average.
8. The maximum bus speed assumed within the EPZ is 55 mph based on Ohio Laws & Administrative Rules[2] for motor vehicles and average posted speed limits on roadways within the study area.
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 siren notification.
    c. The ETE are measured relative to the ATE.
2. The center-point of the plant is located at the center of the containment building 41°35'48.6"N and 83°05'09.8"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 control devices and traffic guides. All major evacuation routes are used in the analysis.
5. The existing EPZ and Subarea 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 Subareas 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).

[2] https://codes.ohio.gov/ohio-revised-code/section-4511.21
[3] 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 stages of an emergency. See Section 5.1 for more detail.
[4] The models of the I-DYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment.

8. Shadow population characteristics (household size, evacuating vehicles per household, and mobilization times) was assumed to be the same as that of the permanent resident population within the EPZ.

9. The ETE are presented at the 90th and 100th percentiles, as well as in graphical and tabular format, as per NRC guidance. The percentile ETE is defined as the elapsed time from the ATE issued to a specific Region of the EPZ, to the time that Region is clear of the indicated percentile of evacuees.

10. The ETE also includes consideration of “through” (External-External traffic that originates its trip outside of the study area and has its destination outside of the study area) trips during the time that such traffic is permitted to enter the evacuated Region (see Section 3.11).

11. This study does not assume that roadways are empty at the start of the first time period. Rather, there is a 30-minute initialization period (often referred to as “fill time in traffic simulation) wherein the traffic volumes from the first time period are loaded onto roadways in the study area. The amount of initialization/fill traffic that is on the roadways in the study area at the start of the first time period depends on the scenario and the region being evacuated. See Section 3.12.

12. To account for boundary conditions (roadway conditions outside the study area that are not specifically modeled due to the limited radius of the study area) beyond the study area, this study assumed a 25% reduction in capacity on two-lane roads and multilane highways for roadways that have traffic signals downstream. The 25% reduction in capacity is based on the prevalence of actuated traffic signals in the study area and the fact that the evacuating traffic volume (“main street”) is more significant than the competing (“side street) traffic volume at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time. There is no reduction in capacity for freeways due to boundary conditions.

2.3 Assumptions on Mobilization Times

1. Trip generation time (also known as mobilization time, or the time required by evacuees to prepare for the evacuation) are based upon the results of the demographic survey (See Section 5 and Appendix F). It is assumed that stated events take place in sequence such that all preceding events must be completed before the current event can occur.

2. One hundred percent (100%) of the EPZ population can be notified within 45 minutes, in accordance with the 2019 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness Program Manual.

3. Commuter percentages (and the percentage of residents awaiting the return of a commuter) are based on the results of the demographic survey. According to the survey results, 83% of the households in the EPZ have at least 1 commuter (see Section F.3.1.); 60% of those households with commuters will await the return of a commuter before beginning their evacuation trip (see Section F.3.2.). Therefore, 50 percent (83% x 60% =

50%) 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 82 percent of the transit-dependent population will rideshare.
2. Transit vehicles are used to transport those without access to private vehicles:
   a. Schools and child care centers
      i. If schools are in session, buses will evacuate students directly to the designated receiving school.
      ii. Buses will evacuate children at day care centers within the EPZ, as needed.
      iii. For the schools 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 transport vehicles, and ambulances will evacuate patients at medical facilities and at any senior facilities within the EPZ, as needed.
      ii. The percent breakdown of ambulatory, wheelchair bound and bedridden patients from the 2012 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 permanent resident 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 (see Section 8).
      iii. Households with 3 or more vehicles were assumed to have no need for transit vehicles.
   d. Buses are used to evacuate the inmate population at correctional facilities to host facilities.
   e. Analysis of the number of required round-trips ("waves") of evacuating transit vehicles is presented.
   f. Transport of transit-dependent evacuees from reception centers to congregate care centers is not considered in this study.

3. Transit vehicle capacities:
    a. School buses = 70 students per bus for elementary schools and 50 students per bus for middle/high schools.
    b. Ambulatory transit-dependent persons, inmates at correctional facilities, and medical facility patients = 30 persons per bus.
    c. Ambulances = 2 bedridden persons (includes advanced and basic life support).
    d. Wheelchair vans = 4 wheelchair bound persons.
    e. Wheelchair buses = 15 wheelchair bound persons.
4. Transit vehicles mobilization times:
    a. Vehicles will arrive at schools, hospitals, medical facilities, senior living facilities, and correctional facilities to be evacuated within 90 minutes of the ATE.
    b. Transit dependent buses are mobilized when approximately 95% of residents with no commuters have completed their mobilization at 195 minutes of the ATE.
    c. Ambulances will arrive at the homes of access and/or functional needs bedridden people to be evacuated within 30 minutes of the ATE.
    d. If necessary, multiple waves of buses will be utilized to gather transit dependent people who mobilize more slowly.
5. Transit Vehicle loading times:
    a. Buses for schools and inmates 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 30 minutes per bedridden passenger.
    f. Buses for inmates will require 15 minutes of loading time per bus and 2 buses can be loaded in parallel.
6. Drivers for all transit vehicles, identified in Table 8-1, 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. The 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 period.
3. It is assumed that all transit vehicles and other responders entering the EPZ to support the evacuation are unhindered by personnel manning TCPs 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. The Camp Perry National Rifle Matches[5], located in Subarea 6 is considered as the special event (single or multi-day event that attracts a significant population into the EPZ; recommended by NRC guidance) for Scenario 13.
    b. As per NRC guidance, one of the 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 State Route (SR) 2 eastbound from approximately plant site to just west of the interchange with SR-269/Martins Point Road (Exit 128) 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 earlier or at about the same time the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed. It is assumed that roads are passable 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 conditions affect roadway capacity and the 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. It is assumed for heavy snow scenarios that some evacuees will need additional time 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 180 minutes. 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. It is also assumed that mobilization and loading times for transit vehicles are slightly longer in adverse weather. It is assumed that mobilization times are 10 minutes and 20 minutes longer in rain/light snow and heavy snow, respectively. It is assumed that loading times

[5] Bird watching event at Magee Marsh, a second event that attracts very similar transients into the EPZ was also considered. A sensitivity study was computed to measure the effects of this event on ETE. See Appendix M.

are 5 minutes and 10 minutes longer in rain/light snow and heavy snow, respectively. Refer to Table 2-2.

6. It is assumed that employment is reduced slightly (4% reduction) in the summer for vacations.

7. Regions are defined by the underlying “keyhole” or circular configurations as specified in Section 1.4 of NUREG/CR-7002, Rev. 1. These Regions, as defined, display irregular boundaries reflecting the geography of the Subarea included within these underlying configurations. All 16 cardinal and intercardinal wind direction keyhole configurations are considered. Regions to be considered are defined in Table 6-1. It is assumed that everyone within the group of Subareas forming a Region that is issued an ATE will, in fact, respond and evacuate in general accord with the planned routes.

8. 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 R18 through R20 in Table 6-1.

Table 2-1. Evacuation Scenario Definitions

Scenario	Season[6]	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	Summer	Weekend	Midday	Good	Special Event: The Camp Perry National Rifle Matches
14	Summer	Midweek	Midday	Good	Roadway Impact: Single Lane Closure on SR 2 Eastbound

[6] 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 Transit Vehicles[7]
Rain/Light Snow	90%	90%	No Effect	10-minute increase	5-minute increase
Heavy Snow	75%	85%	See Section 5	20-minute increase	10-minute increase
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.					

[7] 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 (resident, employee, transient).
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, vacationers and tourists enter the EPZ. These non-residents may dwell within the EPZ for a short period (e.g., a few hours, a few days or one or two weeks). 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 camps within the EPZ could be counted as a resident, again as an employee and once again as a camper.
- A visitor who stays at a hotel and spends time at a park, then goes camping could be counted three times.

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

Analysis of the population characteristics of the DBNPS 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 (camping, recreation) and then leave the area. Transients also include seasonal residents who may spend several weeks or months in the EPZ.
- 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 Subarea and by polar coordinate representation (population rose). The DBNPS EPZ is subdivided into 12 Subareas. The Subareas 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 (2.69 persons/household – See Section 2.1) was estimated based the average of the demographic survey (see Appendix F, Sub-section F.3.1) and 2020 Census data. The number of evacuating vehicles per household (1.70 vehicles/household – See Sub-section F.3.2) was adapted from the demographic survey.

The permanent resident population is estimated by cutting the census block polygons by Subarea and EPZ boundaries using GIS software. A ratio of the original area of each census block and the updated area (after cutting) is multiplied by the total block population to estimate the population within the EPZ. The methodology (referred to as the "area ratio method") assumes that the population is evenly distributed across a census block. Table 3-1 provides permanent resident population within the EPZ, by Subarea, for 2010 and 2020 (based on the methodology above). As indicated, the permanent resident population within the EPZ has decreased by -4.12% since the 2010 Census.

To estimate the number of vehicles, the 2020 Census permanent resident population is divided by the average household size and then 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 DBNPS. This population "rose" was constructed using GIS software. Note, the 2020 Census includes residents living in group quarters, such as skilled nursing facilities, group homes, prisons, etc. These people are transit dependent (will not evacuate in personal vehicles) and are included in the special facility evacuation demand estimates. To avoid double counting vehicles, the vehicle estimates for these people in Table 3-2 and Figure 3-3 have been removed.

3.2 Shadow Population

A portion of the population living outside the evacuation area extending to 15 miles radially from the DBNPS 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% of the permanent resident population, based on U.S. Census Bureau data, in this Shadow Region will elect to evacuate.

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

3.3 Transient Population

Transient population groups are defined as those people (who are not permanent residents, nor commuting employees) who enter the EPZ for a specific purpose (camping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. Data for these facilities was provided by Lucas County and by Ottawa County. When data was not provided, the number of transient vehicles was estimated based on the parking lot capacity or accommodation capacity obtained from aerial imagery and facility websites. It is assumed that transients would travel to the recreational areas as a family/household. As such, the average household size (2.69 – See Section 3.1) was used to estimate the transient population. The transient facilities within the DBNPS EPZ are summarized as follows:

- Beaches – 100 transients and 50 vehicles; an average of 2.00 transients per vehicle
- Campgrounds – 7,578 transients and 5,632 vehicles; an average of 1.35 transients per vehicle (NOTE: Recreational Vehicles (RVs) are treated as 2 vehicles due to their larger size and more sluggish operating characteristics.)
- Golf Courses – 50 transients and 38 vehicles; an average of 1.32 transients per vehicle
- Hunting/Fishing Areas – 285 transients and 150 vehicles; an average of 1.90 transients per vehicle
- Marinas – 1,818 transients and 1,014 vehicles; an average of 1.79 transients per vehicle (NOTE: vehicles with boat trailers are treated as 2 vehicles.)
- Parks – 7,200 transients and 2,343 vehicles; an average of 3.07 transients per vehicle
- Lodging Facilities – 4,116 transients and 1,701 vehicles; an average of 2.42 transients per vehicle

Appendix E summarizes the transient data that was estimated for the EPZ. Tables E-5 through E-7 present the number of transients visiting recreational areas, while Table E-8 presents the number of transients at lodging facilities within the EPZ.

3.3.1 Seasonal Transient Population

The DBNPS EPZ has a secondary category of transient population which is seasonal residents. This population enters the area during the summer months and may stay considerably longer (several weeks or the entire season) than the average transient using a hotel or motel. The seasonal population use other lodging facilities such as condos, beach houses and summer rentals that otherwise would not be captured in a typical lodging population.

The 2020 Census block data is used to estimate the seasonal resident population. Each census block includes information regarding the number of vacant and occupied households. An average vacant household percentage was calculated for the entire EPZ (23.1%) using this data.

It is assumed that seasonal residents will be renting homes near the Lake Erie shoreline. Using only those census blocks that are within a half mile of the shoreline, the number of seasonal homes was calculated. It is further assumed that 23.1% (EPZ average) of the vacant homes within these census blocks are not rental homes and are in fact vacant homes. The remaining households were considered to be seasonal households. An average household size of 2.69

persons per household is used to determine the seasonal transient population from the number of vacant homes, and 1.70 evacuating vehicles per seasonal household is used to determine the number of seasonal transient vehicles from the number of vacant homes.

Using this methodology, it is estimated that there is a seasonal population of 2,193 transients and 1,391 transient vehicles within the DBNPS EPZ.

In total, there are 23,340 transients in the EPZ at peak times, evacuating in 12,319 vehicles (an average vehicle occupancy of 1.89 transients per vehicle). Table 3-4 presents transient population and transient vehicle estimates by Subarea. Figure 3-6 and Figure 3-7 present these data by sector. Transient population estimates presented here define the maximum number of transients expected in each category. The population in each category varies by season, by day of the week, and by time of day. These variations are presented in Section 6.

3.4 Employees

Employees who work within the EPZ fall into two categories:

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

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

Employment data was provided by the counties within the EPZ, including the maximum shift employment and the percentage of employees living outside of the EPZ. As per the NUREG/CR-7002, Rev. 1, employers with 200 or more employees working in a single shift are considered to be major employers. As such, the employers with less than 200 employees (during the maximum shift) are not considered in this study. The major employers identified in the DBNPS EPZ are presented in Table E-4, Appendix E.

To estimate the evacuating employee vehicles, a vehicle occupancy of 1.13 employees per vehicle obtained from the demographic survey (See Appendix F, Sub-section F.3.1) was used for the major employers. Table 3-5 presents the estimates of employees and vehicles commuting into the EPZ by Subarea. Figure 3-8 and Figure 3-9 present these data by sector.

3.5 Special Facilities Population Demand

In the DBNPS EPA, there are two types of special facilities that will require transit vehicles:

- Medical Facilities
- Correctional Facilities

Section 3.5.1 and Section 3.5.2 below discuss the data in detail at each facility.

3.5.1 Medical Facilities

Medical facility capacity data was provided by Ottawa County. Table E-3 in Appendix E summarizes the data provided. Table 3-6 presents the current census of medical facilities in the

EPZ along with the breakdown of ambulatory, wheelchair bound, and bedridden patients. As shown in these tables, a total of 142 people has been identified as living in or being treated in these facilities. This data was estimated using the previous ETE study. It was assumed that approximately 57% of the facility capacity is present during day-to-day basis (current census) and 28% of these patients are ambulatory, 54% are wheelchair bound, and 18% are bedridden.

The transportation requirements for the medical facility population are also presented in Table 3-6. The number and type of evacuating vehicles that need to be provided depend on the patients' state of health. It is estimated that buses can transport up to 30 people; wheelchair buses up to 15 people; and ambulances, up to two (2) people. Three (3) buses, six (6) wheelchair buses and 13 ambulances are required to evacuate the medical facility population, as shown in Table 3-6. Buses and wheelchair buses are represented as two passenger vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

3.5.2 Correctional Facilities

As detailed in Table E-9, there are two correctional facilities within the EPZ – Ottawa County Detention and Ottawa County Misdemeanor Jail. The total inmate population at these facilities is 87 persons, as per data provided by the county. A total of four (4) buses are needed to evacuate these two facilities, based on a capacity of 30 inmates per bus. Buses are represented as two passenger vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

3.6 School and Day Care Center/Nursery School Population Demand

Table 3-7 presents the school and day care population and transportation requirements for the direct evacuation of all schools and day cares within the EPZ for the 2020-2021 school year. Note that Jerusalem Elementary School is outside of the EPZ but was included because is it stated in the Lucas County Radiological Emergency Response Plans that the school will also be evacuated. The column in Table 3-7 entitled “Bus Required” specifies the number of buses required for each school and day care center/nursery school under the following set of assumptions and estimates:

- No students at schools or children at day care center/nursery schools 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), the estimate of buses required for school evacuation do not consider the use of these private vehicles.
- Bus capacity, expressed in students per bus, is set to 70 for primary schools and day care centers/nursery 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 typically a few percent daily.

Consideration should be given that the counties in the EPZ introduce procedures whereby the schools and day care centers/nursery schools are contacted prior to the dispatch of buses from

the depot (approximately one hour after the Advisory to Evacuate [ATE]), to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools and day cares will reflect the actual number needed. Those buses originally allocated to evacuate schoolchildren that are not needed due to children being absent or 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. School buses are represented as two vehicles in the ETE simulation due to their larger size and more sluggish operating characteristics.

Table 10-3 presents a list of the receiving schools for each school and day care center/nursery school in the EPZ. Students will be transported to these receiving schools where they will be subsequently retrieved by their respective families.

3.7 Transit Dependent Population

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

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

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

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

- Estimates of persons requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the schoolchildren. The actual need for transit vehicles by residents is thereby less than the given estimates. However, estimates of transit vehicles are not reduced when schools are in session.
- It is reasonable and appropriate to consider that many transit-dependent persons will evacuate by ridesharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario[1] who did not use their own cars, shared a ride with neighbors or friends. Other documents report that approximately 70 percent of transit dependent persons were evacuated via ride sharing. **Based on the results of the demographic survey, approximately 82 percent of the transit-dependent population will rideshare.**

The estimated number of bus trips needed to service transit-dependent persons is based on an estimated average bus occupancy of 30 persons at the conclusion of the bus run. Transit vehicle seating capacities typically equal or exceed 60 children (roughly equivalent to 40 adults). If transit vehicle evacuees are two thirds adults and one third children, then the number of “adult

[1] Institute for Environmental Studies, University of Toronto, THE MISSISSAUGA EVACUATION FINAL REPORT, June 1981. The report indicates that 6,600 people of a transit-dependent population of 8,600 people shared rides with other residents; a ride share rate of 77% (Page 5-10).

seats" taken by 30 persons is 20 + (2/3 x 10) = 27. On this basis, the average load factor anticipated is (27/40) x 100 = 68 percent. Thus, if the actual demand for service exceeds the estimates of Table 3-8 by 50 percent, the demand for service can still be accommodated by the available bus seating capacity.

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

Table 3-8 indicates that transportation must be provided for 89 people. Therefore, a total of 3 buses are required from a capacity standpoint. In order to service all of the transit dependent population and have at least one bus drive through each of the Subareas to pick up transit dependent people, **7 buses** are used in the ETE calculations, see Section 10 for further discussion. These buses are represented as two vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

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

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

Where,

A = Percent of households with commuters

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

$$P = 7{,}272 \times [2.00 \times .0037 + 0.103 \times (1.61 - 1) \times 0.83 \times 0.40 + 0.410 \times (2.92 - 2) \times (0.83 \times 0.40)^2] = 7{,}272 \times 0.0698 = 508$$

$$B = ((1 - .824) \times P) \div 30 = 3$$

These calculations are explained as follows:

- The number of households (HH) is computed by dividing the EPZ population by the average household size (19,563 ÷ 2.69) and is 7,272.
- All members (2.00 avg.) of households (HH) with no vehicles (0.37%) will evacuate by public transit or rideshare. The term 7,272 (number of households) x 0.0037 x 2.00, accounts for these people.
- The members of HH with 1 vehicle away (10.3%), who are at home, equal (1.61-1). The number of HH where the commuter will not return home is equal to (7,272 x 0.103 x 0.61 x 0.83 x 0.40), as 83% of EPZ households have a commuter, 40% of which would not return home in the event of an emergency. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.

- The members of HH with 2 vehicles that are away (41.0%), who are at home, equal (2.92 – 2). The number of HH where neither commuter will return home is equal to 7,272 x 0.92 x $(0.83 \times 0.40)^2$. The number of persons who will evacuate by public transit or rideshare is equal to the product of these two terms (the last term is squared to represent the probability that neither commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

3.8 Access and/or Functional Needs Population

Based on data provided by the counties, there are an estimated 173 access and/or functional needs people within the Ottawa County portion of the EPZ and 15 people within the Lucas County portion of the EPZ who require transportation assistance to evacuate. Table 3-9 presents the data provided.

The transportation requirements for this group are also presented. The number of ambulance runs is determined by assuming that 2 patients can be accommodated per ambulance trip; the number of wheelchair bus runs assumes 15 wheelchairs per trip and the number of bus runs estimated assumes 30 ambulatory patients per trip. In total, 8 buses, 7 wheelchair buses and 2 ambulances are needed to evacuate the access and/or functional needs population in a reasonable amount of time.

Table 3-9 shows the total number of people registered for access and/or functional needs by type of need. The table also estimates the number of transportation resources needed to evacuate these people in a timely manner. Buses and wheelchair buses needed to evacuate the access and/or functional needs population are represented as two vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

3.9 Special Events

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 (Scenario 13) identified by the county and state agencies (that attracts transients from outside the EPZ) is The National Rifle Matches take place annually at Camp Perry. The National Rifle Matches occurs annually during the day on summer weekends.

Discussions with Ottawa County EMA personnel indicate the competition draws about 8,000 people (not including permanent residents) on the peak day of the event and 50% of the people visiting for the event will stay in local hotels and the remaining 50% will arrive for a day and then leave the EPZ. Since approximately 95% of campground and hotel transients are already present within the EPZ during the Special Event scenario (Scenario 13), see Table 6-3, the

following assumptions are made in order to estimate the special event population and to reduce the double counting between special event transients and campground/hotel transients:

- There are a total of 7,333 transients that can be hosted hotels and campgrounds within the EPZ and 95% of these transients (6,966 transients) are present during the special event scenario (Scenario 13). Of the 6,966 transients at hotels and campgrounds, it is assumed that 4,000 of them are there for the National Rifle Matches.
- The remaining 4,000 transients that arrive for the day and then leave the EPZ and it is assumed transients attend this event as a household. Hence, the average household size (2.69) is used to estimate the number of vehicles present at the event. It is assumed that there are total of 1,487 additional vehicles (4,000/2.69 = 1,487) present inside the EPZ for the special event.

There are no temporary road closures used for the event. The special event vehicle trips were generated utilizing the same mobilization distributions for transients. Vehicles were loaded at the Camp Perry parking lots. No public transportation is provided for this event and was therefore not considered in this study.

3.10 External Traffic

Vehicles will be traveling through the study area (external-external trips) at the time of an accident. After the ATE is announced, these through-travelers will also evacuate. These through vehicles are assumed to travel on major routes traversing the analysis network - I-80, US Route (US) 20, and US 6. It is assumed that these routes will not be closed during an emergency, as there are no access control points on this roadway. It is assumed that this traffic will continue to traverse these routes throughout the evacuation. State Route (SR 2) is not considered to avoid double counting. Most of the people using SR 2 live, work or recreate within the EPZ. Through traffic is more likely to use the higher speed, higher capacity I-80 which parallels SR 2 through the area.

Average Annual Daily Traffic (AADT) data from 2019 was obtained from Ohio Department of Transportation's website[2] to estimate the number of vehicles per hour on the aforementioned routes. The 2020 AADT data was available, but it was not used in this study due to the significant decrease in traffic on these highways caused by the COVID-19 pandemic. 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 each of the routes considered. The DDHV is then multiplied by 6 hours and 15 minutes, roughly equivalent to the duration of the evacuation to estimate the total source vehicles loaded on the analysis

[2] https://odot.public.ms2soft.com/tcds/tsearch.asp?loc=odot

network. As indicated, there are 48,924 vehicles traversing the shadow region on the indicated routes. 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 5-8, there are 15 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 15^{th} 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 a 30-minute initialization time period (often referred to as “fill time” in traffic simulation) wherein the anticipated traffic volumes from Time Period 1 are loaded onto roadways in the study area. The amount of initialization/fill traffic that is on the roadways in the study area at the start of Time Period 1 depends on the scenario and the region being evacuated (see Section 6). There are 1,970 vehicles on the roadways in the study area at the end of fill time for an evacuation of the entire EPZ (Region R03) under Scenario 1 (summer, midweek, midday, 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 54,878 people and 77,980 vehicles (includes external traffic) are considered in this study.

Table 3-1. EPZ Permanent Resident Population

Subarea	2010 Population	2020 Population
1	812	793
2	1,313	1,311
3	2,589	2,430
4	257	241
5	5,370	5,310
6	162	143
7	1,085	1,046
8	1,637	1,446
9	5,898	5,724
10	0	22
11	1,280	1,097
12	0	0
EPZ TOTAL:	**20,403**	**19,563**
EPZ Population Growth (2010-2020):		**-4.12%**

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

Subarea	2020 Population	Resident Vehicles
1	793	500
2	1,311	828
3	2,430	1,532
4	241	153
5	5,310	3,310
6	143	91
7	1,046	663
8	1,446	914
9	5,724	3,535
10	22	14
11	1,097	694
12	0	0
EPZ TOTAL:	**19,563**	**12,234**

Table 3-3. Shadow Population and Vehicles by Sector

Sector	Population	Evacuating Vehicles
N	0	0
NNE	0	0
NE	0	0
ENE	0	0
E	1,663	1,052
ESE	3,615	2,280
SE	507	320
SSE	283	180
S	2,083	1,319
SSW	1,066	678
SW	2,692	1,703
WSW	2,129	1,341
W	3,266	2,014
WNW	1,134	718
NW	0	0
NNW	0	0
TOTAL:	**18,438**	**11,605**

Table 3-4. Summary of Transients and Transient Vehicles

Subarea	Transients	Transient Vehicles	Seasonal Residents	Seasonal Resident Vehicles	Total Transients	Total Transient Vehicles
1	5,134	3,689	740	467	5,874	4,156
2	86	64	0	0	86	64
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	827	566	0	0	827	566
6	561	291	0	0	561	291
7	1,794	1,203	586	372	2,380	1,575
8	1,546	877	0	0	1,546	877
9	8,814	3,295	745	474	9,559	3,769
10	285	150	0	0	285	150
11	2,100	793	122	78	2,222	871
12	0	0	0	0	0	0
EPZ TOTAL:	**21,147**	**10,928**	**2,193**	**1,391**	**23,340**	**12,319**

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

Subarea	Employees	Employee Vehicles
1	306	271
2	0	0
3	0	0
4	134	119
5	0	0
6	0	0
7	0	0
8	0	0
9	133	118
10	0	0
11	0	0
12	0	0
EPZ TOTAL:	**573**	**508**

Table 3-6. Medical Facility Transit Demand

Subarea	Facility Name	Municipality	Capacity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Bus Runs	Wheel-chair Bus Runs	Ambulance Runs
OTTAWA COUNTY, OH										
5	Riverview Healthcare Campus	Oak Harbor	136	80	23	43	14	1	3	7
9	Magruder Hospital	Port Clinton	25	15	4	8	3	1	1	2
9	Edgewood Manor Nursing Home	Port Clinton	80	47	13	26	8	1	2	4
		TOTAL:	**241**	**142**	**40**	**77**	**25**	**3**	**6**	**13**

Table 3-7. School Population Demand Estimates

Subarea	School & Day Care Center/Nursery School Name	Enrollment	Buses Required
LUCAS COUNTY, OH			
SCHOOLS			
S.R.	Jerusalem Elementary School[3]	355	6
	Lucas County, Subtotal	*355*	*6*
OTTAWA COUNTY, OH			
5	Oak Harbor Middle School	395	8
5	R.C. Waters Elementary School	415	6
5	St Boniface Elementary School	74	2
5	Oak Harbor High School	476	10
5	Ottawa County Christian Academy	48	1
9	Bataan Memorial Intermediate Elementary School	308	5
9	Immaculate Conception School	113	2
9	Port Clinton Middle School	378	8
9	Port Clinton High School	585	12
	Ottawa County, Subtotal	*2,792*	*54*
DAY CARE CENTERS/NURSERY SCHOOLS			
OTTAWA COUNTY, OH			
3	North Point Educational Service	8	1
3	St Peter Precious Moments Preschool	28	1
5	St. John's Nursery School	42	1
5	Rainbow Acres Educational Daycare Center	69	1
5	Kersten's Korner Nursery School	36	1
9	Port Clinton Nursery School	12	1
9	GLCAP Port Clinton Early Childhood Center	54	1
	SCHOOLS TOTAL	**3,147**	**60**
	DAY CARE CENTERS/NURSERY SCHOOL TOTAL	**249**	**7**
	GRAND TOTAL	**3,396**	**67**

[3] Jerusalem Elementary School is within the Shadow Region. Based on Lucas County emergency plans this school would evacuate in the event of an emergency even though it is within the Shadow Region.

Table 3-8. Transit-Dependent Population Estimates

2020 EPZ Population	Survey Average HH Size with Indicated No. of Vehicles			Estimated No. of Households	Survey Percent HH with Indicated No. of Vehicles			Survey Percent HH with Commuters	Survey Percent HH with Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent Population Requiring Public Transit
	0	1	2		0	1	2						
19,563	2.00	1.61	2.92	7,272	0.37%	10.3%	41.0%	83%	40%	508	82.4%	89	0.5%

Table 3-9. Access and/or Functional Needs Population Estimates

Population Group	Population	Vehicles deployed
LUCAS COUNTY, OH		
Buses	9	1 Bus
Wheelchair Buses	5	1 Wheelchair Bus
Ambulances	1	1 Ambulance
Lucas County, Subtotal	*15*	*3*
OTTAWA COUNTY, OH		
Buses	154	7 Buses
Wheelchair Buses	18	6 Wheelchair Buses
Ambulances	1	1 Ambulance
Ottawa County, Subtotal	*173*	*14*
GRAND TOTAL	**188**	**17**

Table 3-10. DBNPS Site External Traffic

Up Node	Dn Node	Road Name	Direction	AADT[4]	K-Factor[5]	D-Factor[5]	Hourly Volume	External Traffic[6]
8079	79	I-80	Westbound	46,006	0.107	0.5	2,461	15,381
8069	69	I-80	Eastbound	46,006	0.107	0.5	2,461	15,381
8435	498	US-20	Westbound	20,862	0.107	0.5	1,116	6,975
8059	59	US-20	Eastbound	20,862	0.107	0.5	1,116	6,975
8053	53	US-6	Eastbound	4,954	0.136	0.5	337	2,106
8447	447	US-6	Westbound	4,954	0.136	0.5	337	2,106
							TOTAL:	**48,924**

[4] https://odot.public.ms2soft.com/tcds/tsearch.asp?loc=odot
[5] HCM 2016
[6] External Traffic displayed is represented for the entire evacuation time, as discussed in Section 3.10.

Table 3-11. Summary of Population Demand[7]

Subarea	Residents	Transit-Dependent	Transients	Employees	Special Facilities[8]	Schools, Day Care Centers & Nursery Schools[9]	Special Event	Shadow Population[10]	External Traffic	Total
1	793	4	5,874	306	0	0	0	0	0	6,977
2	1,311	6	86	0	0	0	0	0	0	1,403
3	2,430	11	0	0	0	36	0	0	0	2,477
4	241	1	0	134	0	0	0	0	0	376
5	5,310	24	827	0	80	1,555	0	0	0	7,796
6	143	1	561	0	0	0	4,000	0	0	4,705
7	1,046	5	2,380	0	0	0	0	0	0	3,431
8	1,446	7	1,546	0	0	0	0	0	0	2,999
9	5,724	25	9,559	133	149	1,450	0	0	0	17,040
10	22	0	285	0	0	0	0	0	0	307
11	1,097	5	2,222	0	0	0	0	0	0	3,324
12	0	0	0	0	0	0	0	0	0	0
Shadow Region	0	0	0	0	0	355	0	3,688	0	4,043
EPZ TOTAL:	**19,563**	**89**	**23,340**	**573**	**229**	**3,396**	**4,000**	**3,688**	**0**	**54,878**

7 Since the spatial distribution of the access and/or functional needs population is unknown, they are not included in this table.
8 Special Facilities includes both medical facilities and correctional facilities
9 According to Lucas County emergency plans, Jerusalem Elementary School will evacuate even though they are located in the Shadow Region.
10 Shadow Population has been reduced to 20%. Refer to Figure 2-1 for additional information.

Table 3-12. Summary of Vehicle Demand[11]

Subarea	Residents	Transit-Dependent[12]	Transients[13]	Employees	Special Facilities[14]	Schools, Day Care Centers & Nursery Schools [15]	Special Event	Shadow Vehicles[16]	External Traffic	Total
1	500	2	4,156	271	0	0	0	0	0	4,929
2	828	0	64	0	0	0	0	0	0	892
3	1,532	2	0	0	0	4	0	0	0	1,538
4	153	0	0	119	0	0	0	0	0	272
5	3,310	2	566	0	15	60	0	0	0	3,953
6	91	2	291	0	0	0	1,487	0	0	1,871
7	663	0	1,575	0	0	0	0	0	0	2,238
8	914	2	877	0	0	0	0	0	0	1,793
9	3,535	2	3,769	118	24	58	0	0	0	7,506
10	14	0	150	0	0	0	0	0	0	164
11	694	2	871	0	0	0	0	0	0	1,567
12	0	0	0	0	0	0	0	0	0	0
Shadow Region	0	0	0	0	0	12	0	2,321	48,924	51,257
EPZ TOTAL:	**12,234**	**14**	**12,319**	**508**	**39**	**134**	**1,487**	**2,321**	**48,924**	**77,980**

[11] Since the spatial distribution of the access and/or functional needs population is unknown, they are not included in this table.
[12] Buses evacuating transit-dependent residents are represented as two passenger vehicles. Refer to Section 3.7 and Section 8 for additional information.
[13] Recreational Vehicles (RV) and boat trailers are represented as two passenger vehicles. Refer to Section 3.3 for additional information.
[14] Special Facilities includes medical and correctional facilities. Buses and Wheelchair Buses represented as two passenger vehicles. Refer to Section 3.5 and Section 8 for additional information.
[15] Buses evacuating children from schools and day care centers/nursery schools are represented as two passenger vehicles. Refer to Section 3.6 and Section 8 for additional information.
[16] Shadow vehicles has been reduced to 20%. Refer to Figure 2-1 for additional information.

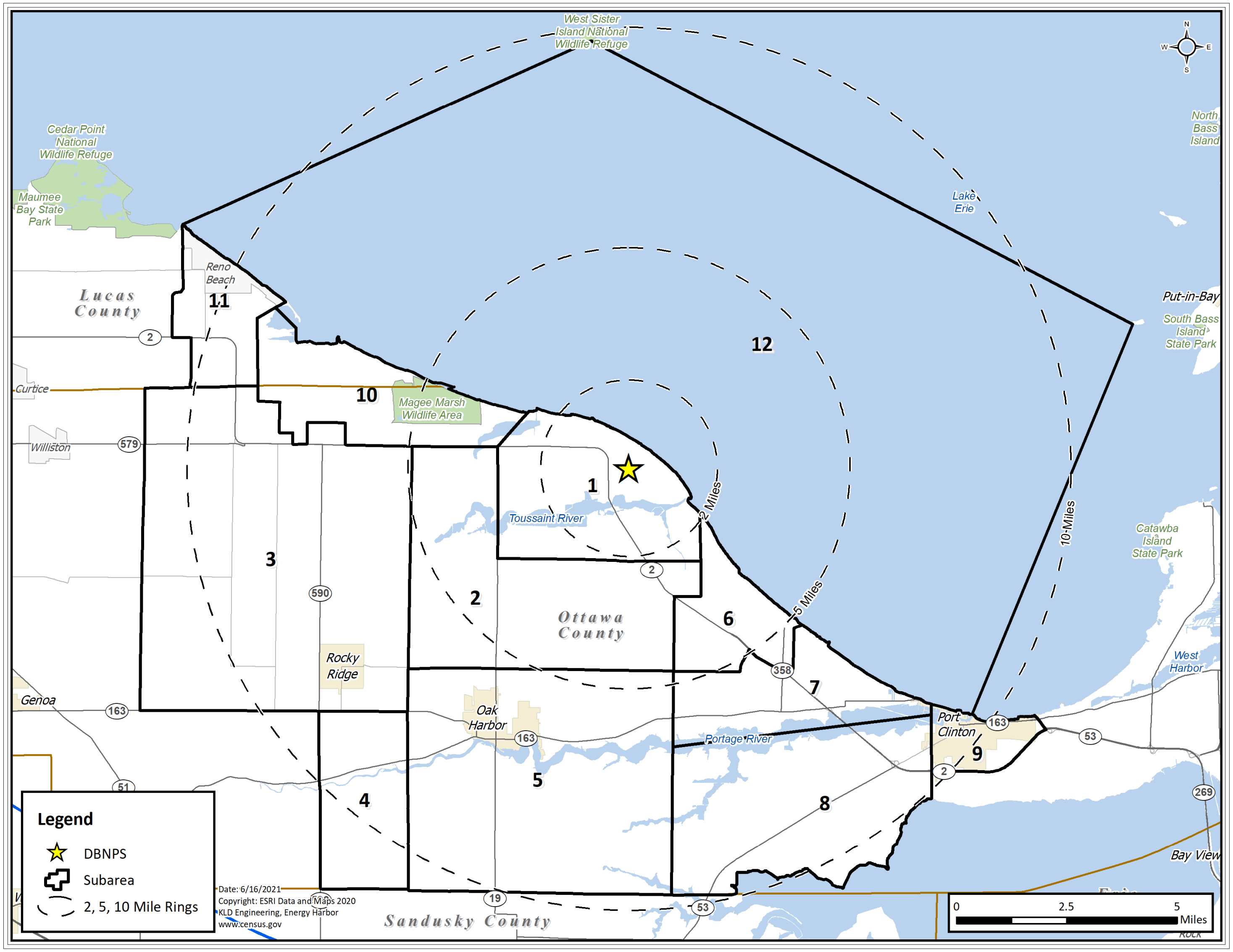
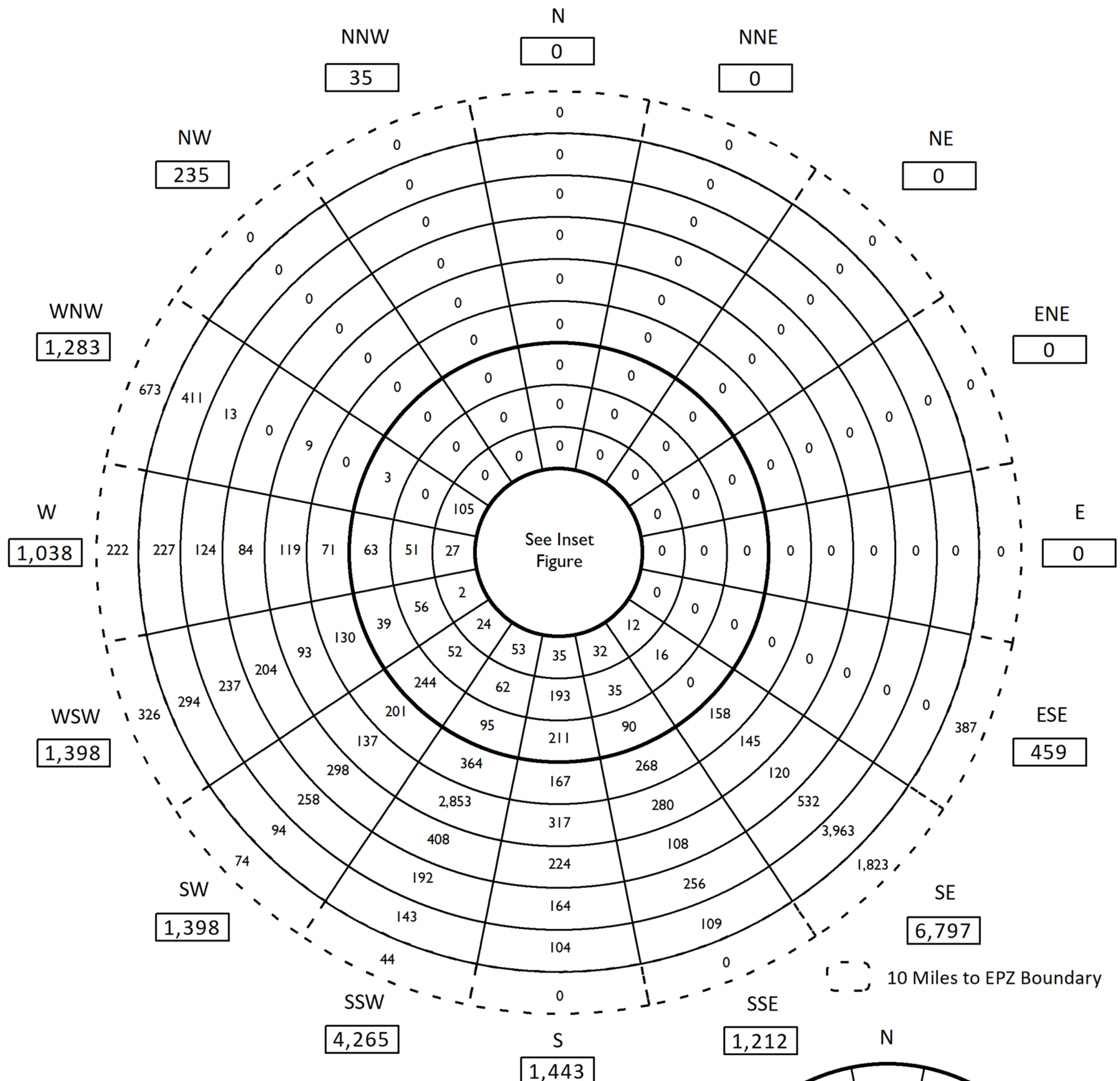


Figure 3-1. Subareas Comprising the DBNPS EPZ



2020 Permanent Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	190	190
1 - 2	445	635
2 - 3	290	925
3 - 4	465	1,390
4 - 5	745	2,135
5 - 6	1,359	3,494
6 - 7	3,953	7,447
7 - 8	1,446	8,893
8 - 9	1,776	10,669
9 - 10	5,345	16,014
10 - EPZ	3,549	19,563
	Total:	19,563

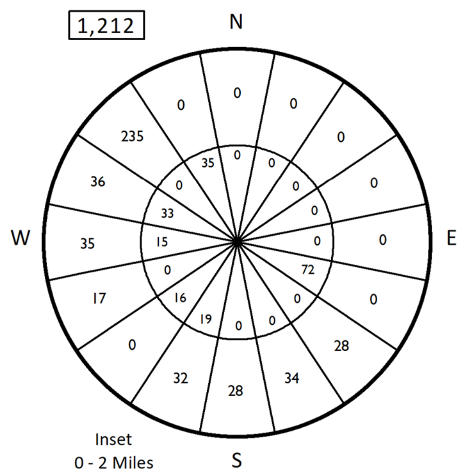
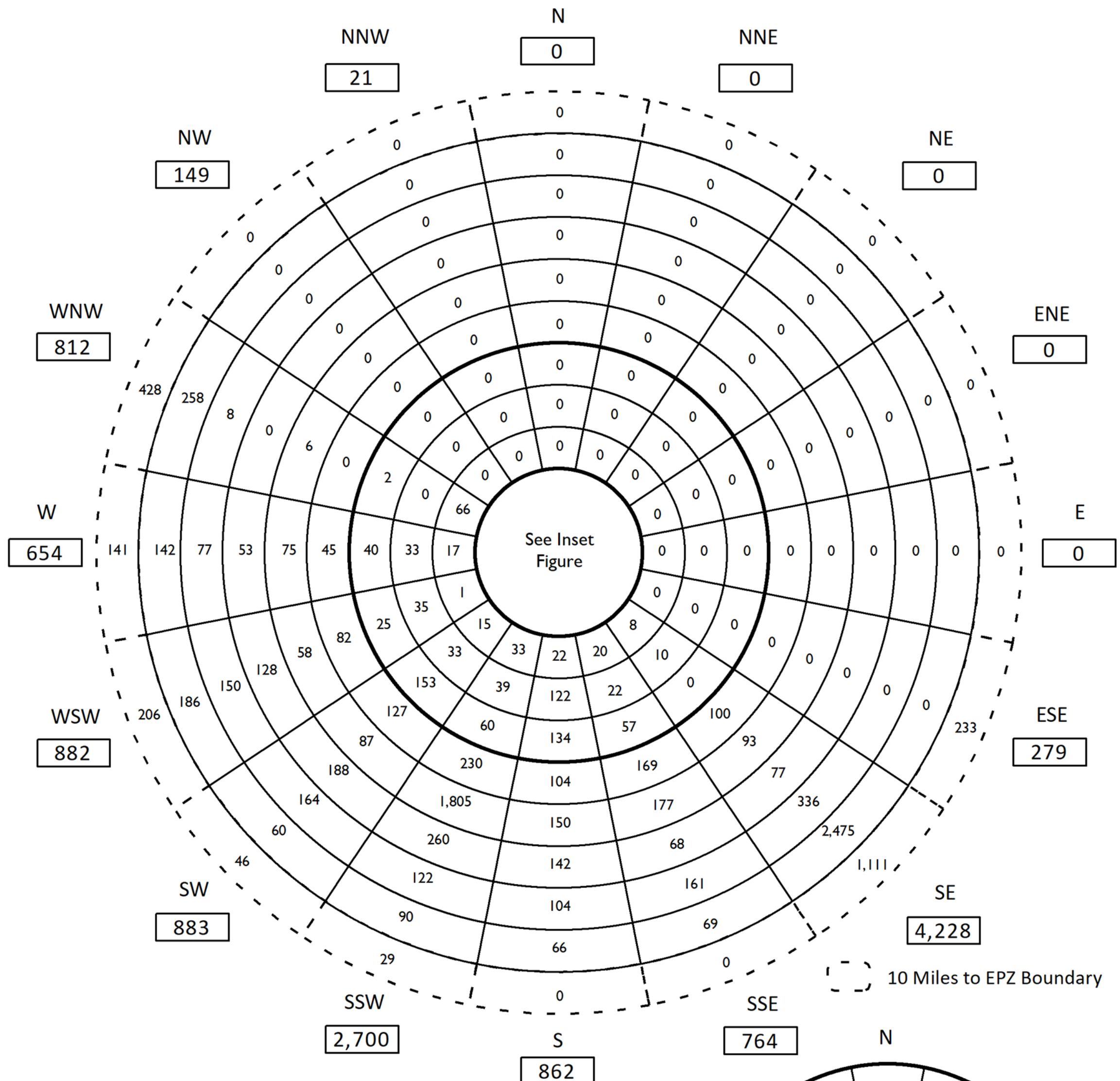


Figure 3-2. Permanent Resident Population by Sector



Resident Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	119	119
1 - 2	282	401
2 - 3	182	583
3 - 4	294	877
4 - 5	471	1,348
5 - 6	857	2,205
6 - 7	2,451	4,656
7 - 8	916	5,572
8 - 9	1,122	6,694
9 - 10	3,346	10,040
10 - EPZ	2,194	12,234
	Total:	12,234

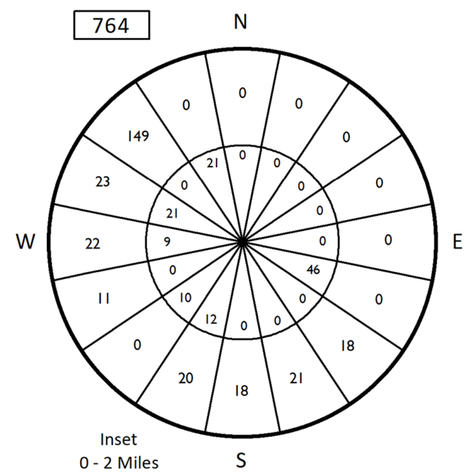
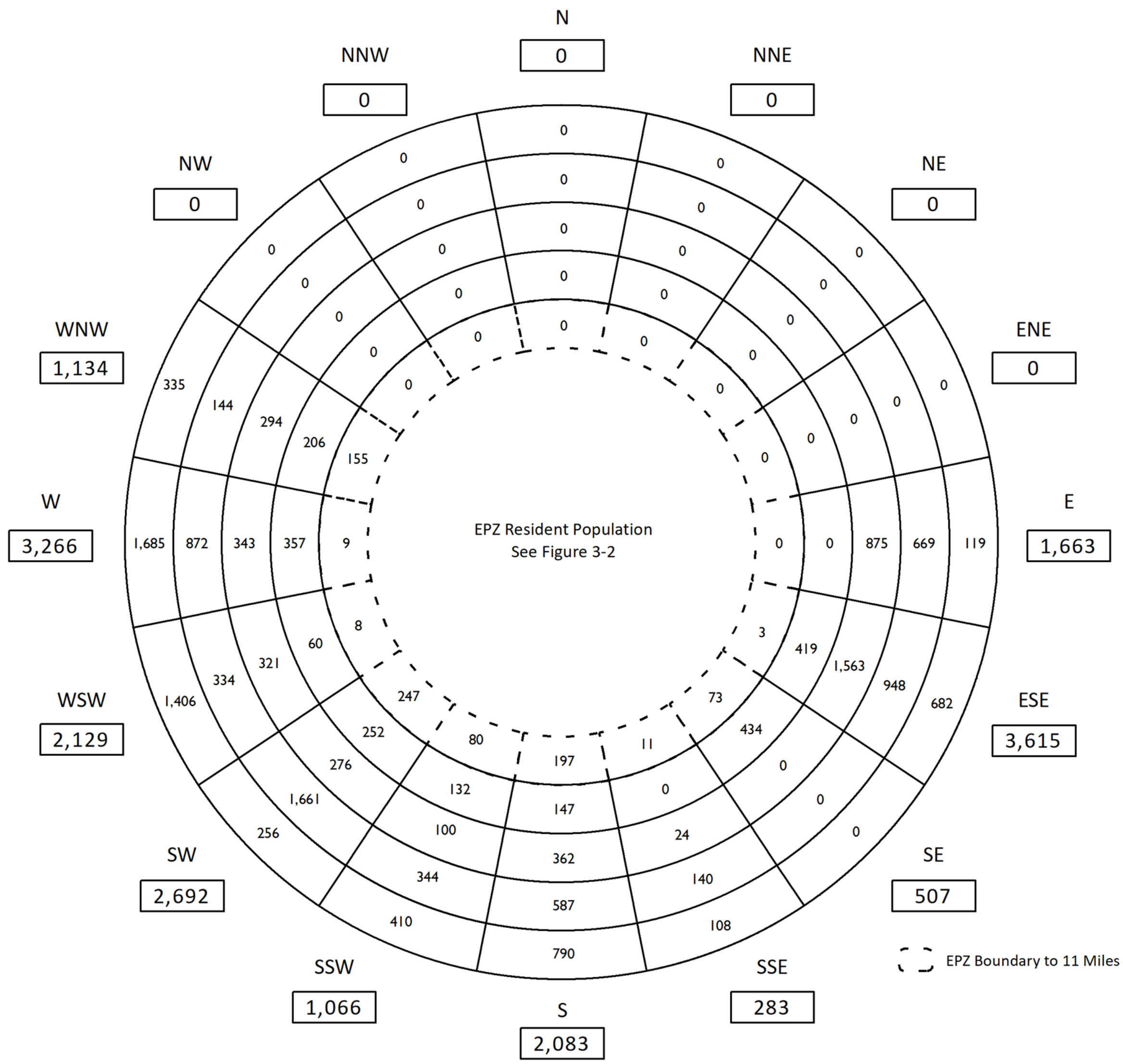


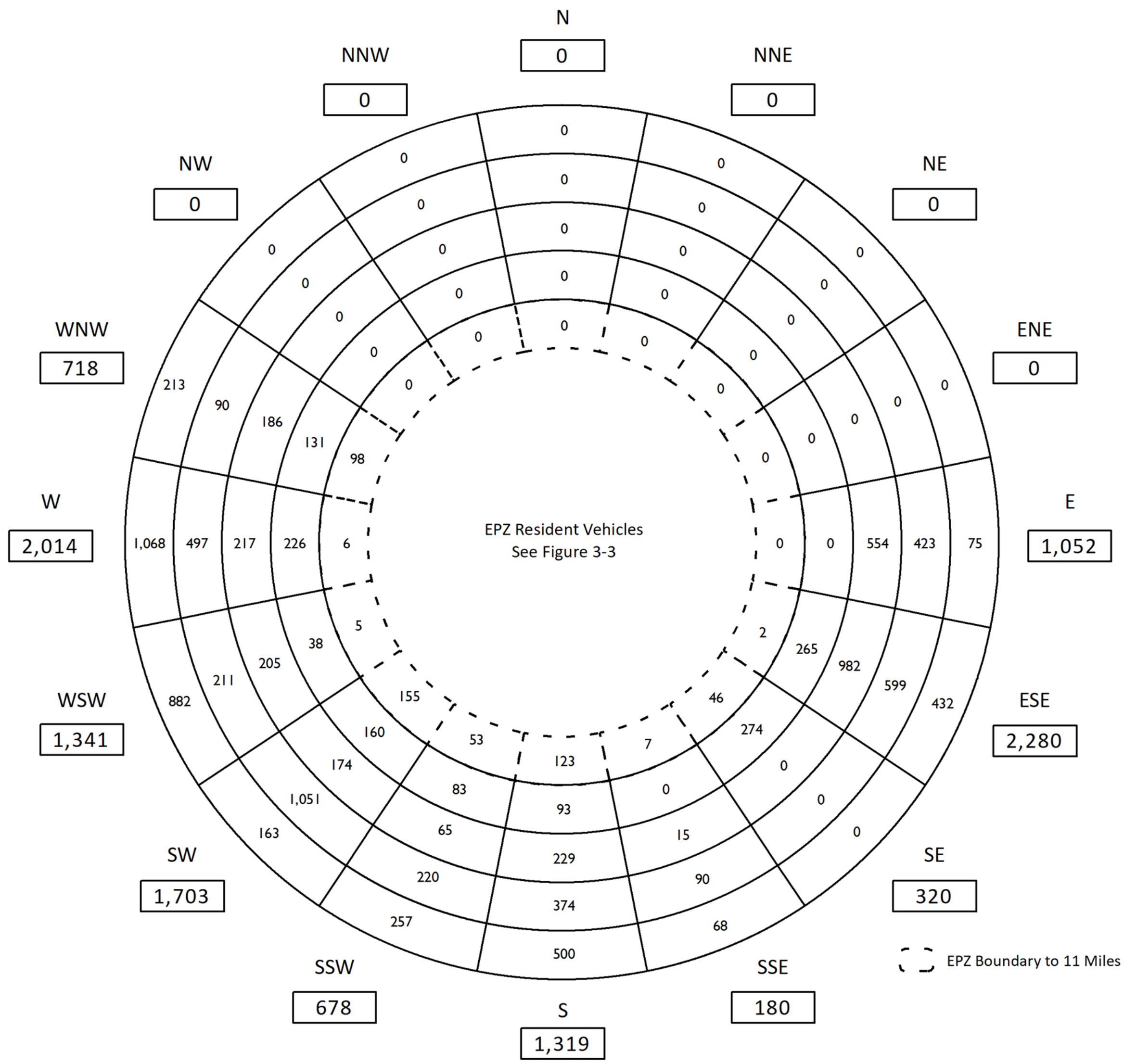
Figure 3-3. Permanent Resident Vehicles by Sector



2020 Shadow Population

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	783	783
11 - 12	2,007	2,790
12 - 13	4,158	6,948
13 - 14	5,699	12,647
14 - 15	5,791	18,438
	Total:	18,438

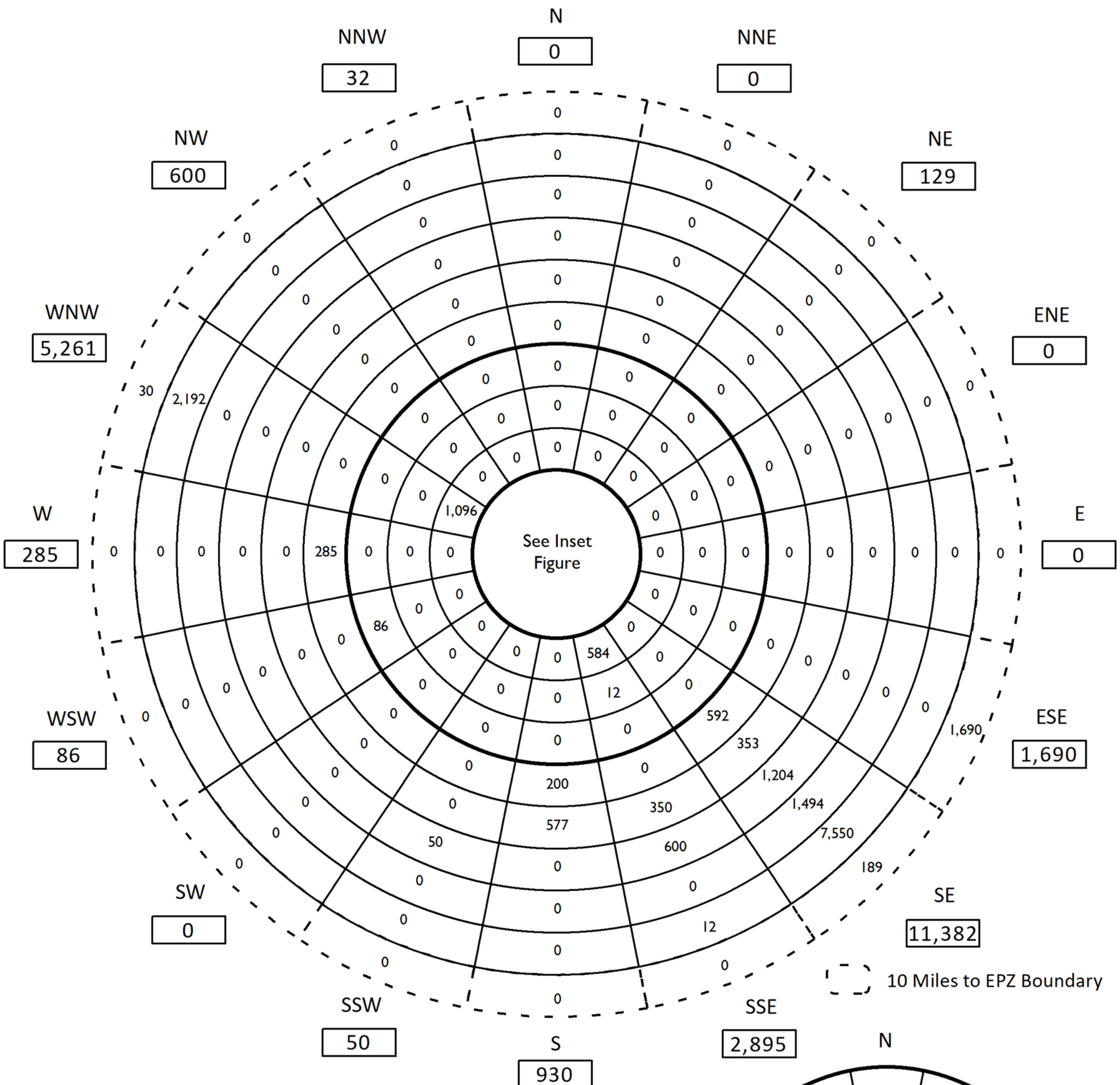
Figure 3-4. Shadow Population by Sector



Shadow Vehicles

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	495	495
11 - 12	1,270	1,765
12 - 13	2,627	4,392
13 - 14	3,555	7,947
14 - 15	3,658	11,605
	Total:	11,605

Figure 3-5. Shadow Vehicles by Sector



Transients

Miles	Subtotal by Ring	Cumulative Total
0 - 1	231	231
1 - 2	3,963	4,194
2 - 3	1,680	5,874
3 - 4	12	5,886
4 - 5	86	5,972
5 - 6	1,077	7,049
6 - 7	1,280	8,329
7 - 8	1,854	10,183
8 - 9	1,494	11,677
9 - 10	9,754	21,431
10 - EPZ	1,909	23,340
	Total:	23,340

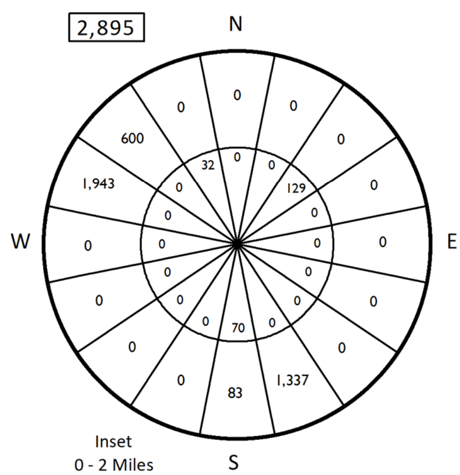
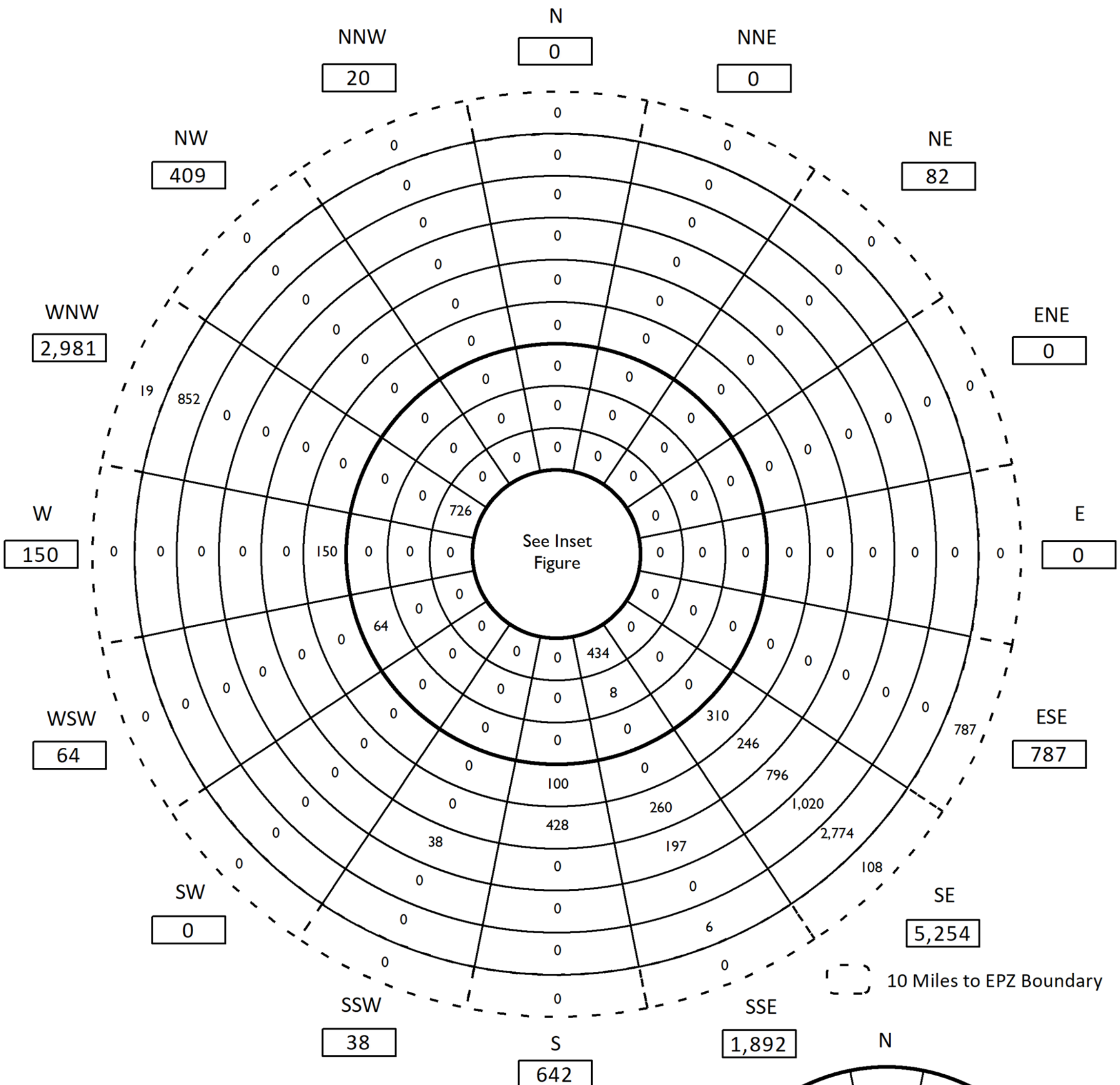


Figure 3-6. Transient Population by Sector



Transient Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	154	154
1 - 2	2,842	2,996
2 - 3	1,160	4,156
3 - 4	8	4,164
4 - 5	64	4,228
5 - 6	560	4,788
6 - 7	934	5,722
7 - 8	1,031	6,753
8 - 9	1,020	7,773
9 - 10	3,632	11,405
10 - EPZ	914	12,319
	Total:	12,319

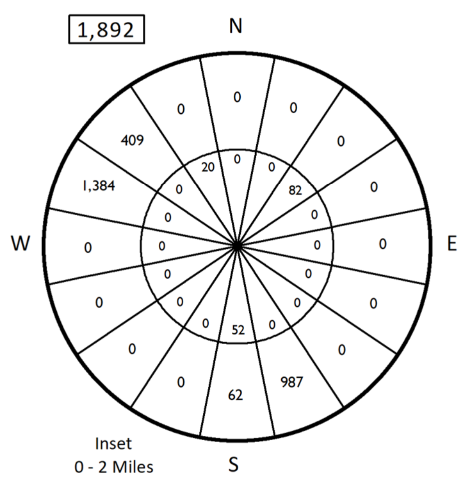
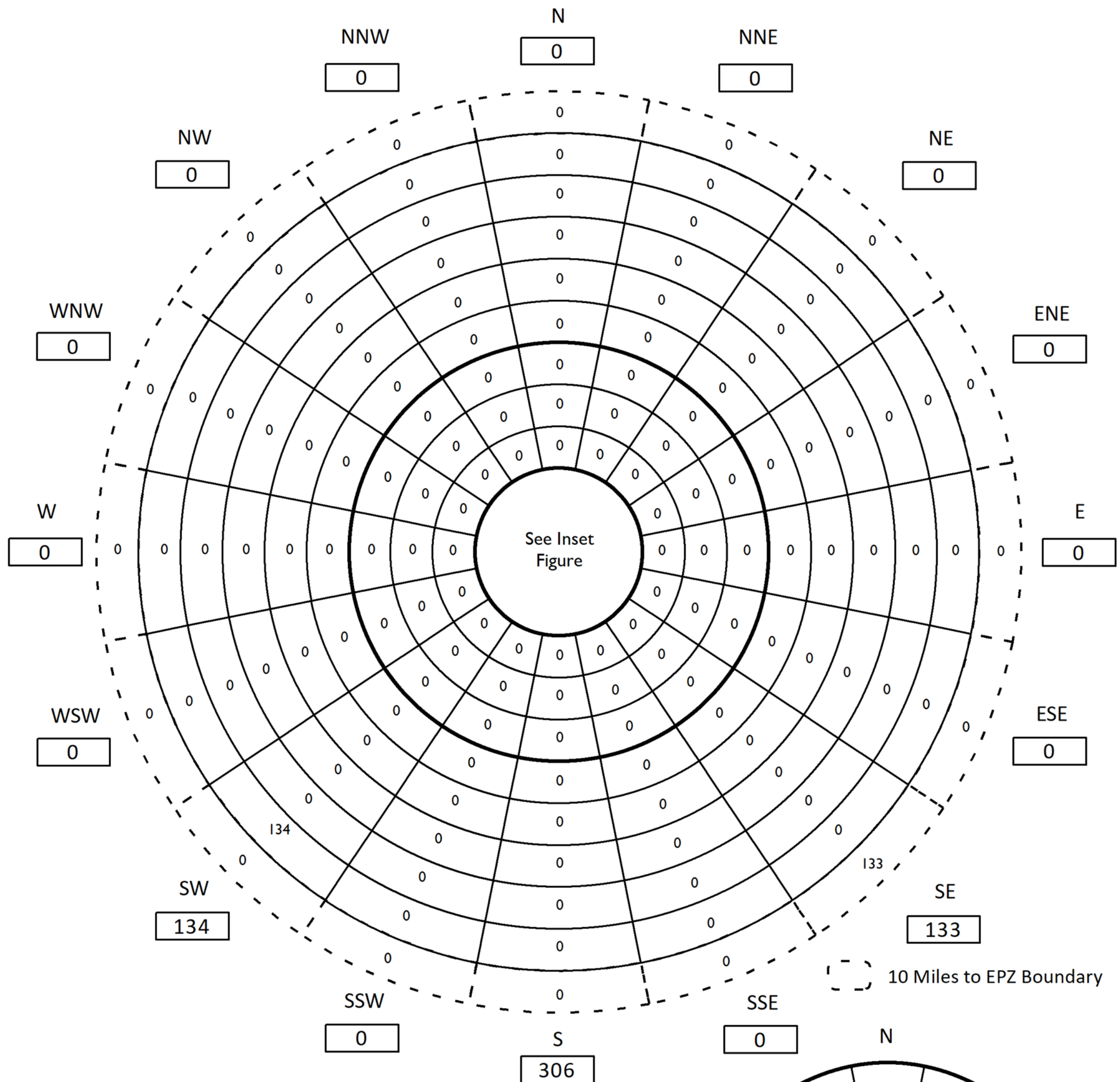


Figure 3-7. Transient Vehicles by Sector



Employees

Miles	Subtotal by Ring	Cumulative Total
0 - 1	306	306
1 - 2	0	306
2 - 3	0	306
3 - 4	0	306
4 - 5	0	306
5 - 6	0	306
6 - 7	0	306
7 - 8	0	306
8 - 9	0	306
9 - 10	134	440
10 - EPZ	133	573
	Total:	573

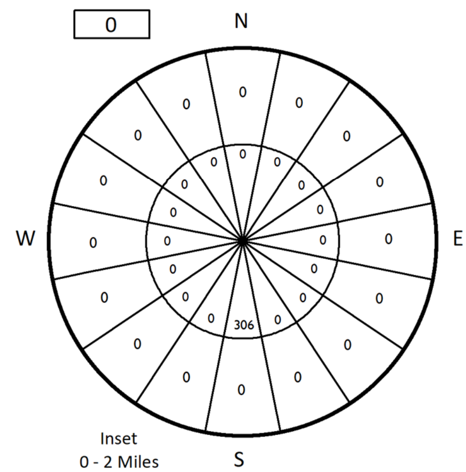
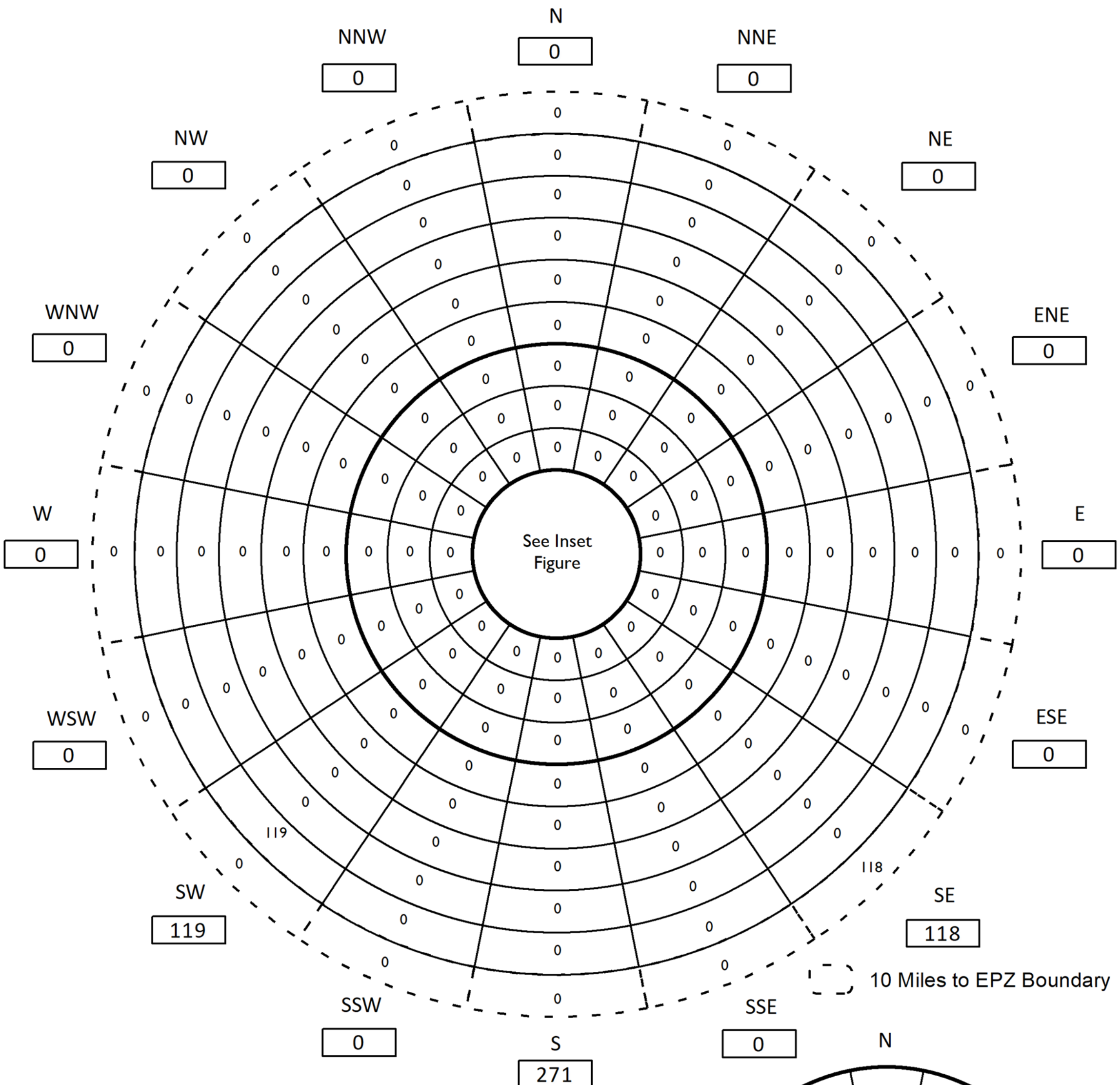


Figure 3-8. Employee Population by Sector



Employee Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	271	271
1 - 2	0	271
2 - 3	0	271
3 - 4	0	271
4 - 5	0	271
5 - 6	0	271
6 - 7	0	271
7 - 8	0	271
8 - 9	0	271
9 - 10	119	390
10 - EPZ	118	508
	Total:	508

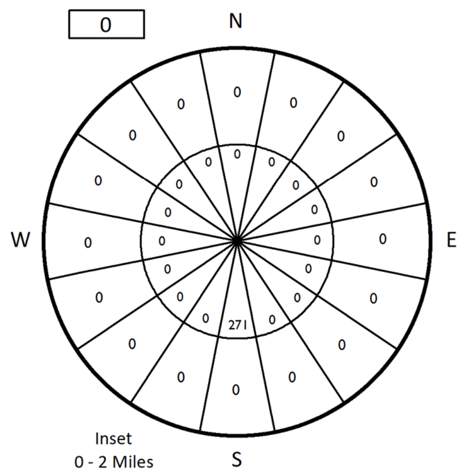


Figure 3-9. Employee Vehicles by Sector

4 ESTIMATION OF HIGHWAY CAPACITY

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

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

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

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

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

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

- Lane width
- Shoulder width
- Pavement condition
- Horizontal and vertical alignment (curvature and grade)
- Percent truck traffic
- Control device (and timing, if it is a signal)
- Weather conditions (rain, snow, fog, wind speed)

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

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

measurements of lane or shoulder width were taken. Horizontal and vertical alignment can influence both FFS and capacity. The estimated FFS were measured using the survey vehicle's speedometer and observing local traffic, under free flow conditions. Free flow speeds ranged from 15 mph to 70 mph in the study area. 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).

The amount of traffic that can flow on a roadway is effectively governed by vehicle speed and spacing. The faster that vehicles can travel when closely spaced, the higher the amount of flow. As discussed in Section 2.6, it is necessary to adjust capacity figures to represent the prevailing conditions. Adverse conditions like inclement weather, construction, and other incidents tend to slow traffic down and often, also increase vehicle-to-vehicles separation, thus decreasing the amount of traffic flow. Based on limited empirical data, weather conditions such as rain reduce the values of free-flow speed and of highway capacity by approximately 10 percent. Over the last decade new studies have been made on the effects of rain on traffic capacity. These studies indicate a range of effects between 5 and 20 percent depending on wind speed and precipitation rates. As indicated in Section 2.6, we employ a reduction in free speed and in highway capacity of 10 percent for rain\light snow. During heavy snow conditions, the free speed and highway capacity reductions are 15 percent and 25 percent , 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,

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

where:

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

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

$$h_m \geq h_{sat}$$

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

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

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

4.2 Capacity Estimation along Sections of Highway

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

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

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

The value of V_F can be expressed as:

$$V_F = R \times Capacity$$

where:

R = Reduction factor which is less than unity

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

Since the principal objective of ETE analyses is to develop a "realistic" estimate of evacuation times, use of the representative value for this capacity reduction factor (R=0.90) is justified. This factor is applied only when flow breaks down, as determined by the simulation model.

Rural roads, like freeways, are classified as "uninterrupted flow" facilities. (This is in contrast with urban street systems which have closely spaced signalized intersections and are classified as "interrupted flow" facilities.) As such, traffic flow along rural roads is subject to the same effects as freeways in the event traffic demand exceeds the nominal capacity, resulting in queuing and lower QDF rates. As a practical matter, rural roads rarely break down at locations away from intersections. Any breakdowns on rural roads are generally experienced at intersections where other model logic applies, or at lane drops which reduce capacity there. Therefore, the application of a factor of 0.90 is appropriate on rural roads, but rarely, if ever, activated.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. Exhibit 15-46 in the HCM 2016 was referenced to estimate saturation flow rates. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction as is the case during an evacuation.

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

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

4.3 Application to the DBNPS Study Area

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

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

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

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

Each of these classifications will be discussed below.

4.3.1 Two-Lane Roads

Ref: HCM 2016 Chapter 15

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

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

- Most sections of two-lane roads within the study area is 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 2016 Chapter 12

Exhibit 12-8 of the HCM 2016 presents a set of curves that indicate a per-lane capacity ranging from approximately 1,900 to 2,300 pc/h, for free-speeds of 45 to 70 mph, respectively. Based on observation, the multilane highways outside of urban areas within the study area, service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand and capacity relationship and the impact of control at intersections. A conservative estimate of per-lane capacity of 1,900 pc/h is adopted for this study for multilane highways outside of urban areas.

4.3.3 Freeways

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

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

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

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

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

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

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

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

4.3.4 Intersections

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

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

The simulation model explicitly models intersections: Stop/yield controlled intersections (both 2-way and all-way) and traffic signal controlled intersections. Where intersections are controlled by fixed time controllers, traffic signal timings are set to reflect average (non-evacuation) traffic conditions. Actuated traffic signal settings respond to the time-varying demands of evacuation traffic to adjust the relative capacities of the competing intersection approaches.

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

4.4 Simulation and Capacity Estimation

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

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

This statement succinctly describes the analyses required to determine traffic operations across an area encompassing a study area operating under evacuation conditions. The model utilized for this study, DYNEV II is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM 2016 – they *replace* these procedures by describing the complex interactions of traffic flow and computing

Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location. The DYNEV II simulation model includes some HCM 2016 procedures only for the purpose of estimating capacity.

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

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

4.5 Boundary 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 extends 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 i outside 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.

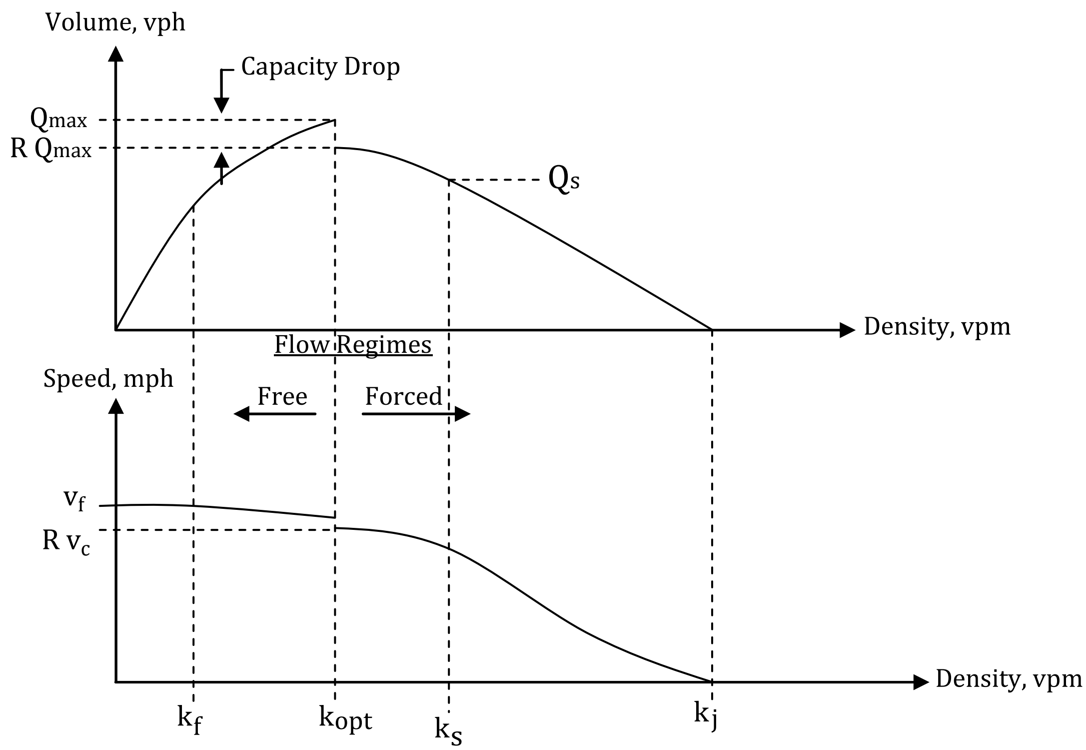


Figure 4-1. Fundamental Diagrams

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. The sum of these distributions describing the elapsed times of each activity, is the Trip Generation Time Distribution.

5.1 Background

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

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

At each level, the Federal guidelines specify a set of Actions to be undertaken by the licensee, and by state and local offsite authorities. As a Planning Basis, we 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.

The following assumptions apply:

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

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

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

It is likely that a longer time will elapse between the various classes of an emergency. For example, suppose one hour elapses from the siren alert to the ATE. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the 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 notification systems (ANS) available within the EPZ (e.g., sirens, tone alerts, EAS broadcasts, and loudspeakers).
2. Receiving and correctly interpreting the information that is transmitted.

The population within the EPZ is dispersed over an area of approximately 160 square miles and people are 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 and, coincidentally, advising them to evacuate.

This 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 the study area permanent residents. Such a demographic survey was conducted in support of this ETE study. Appendix F discusses the survey sampling plan, the number of completed surveys obtained, documents the survey instrument utilized, and provides the raw survey results. It is important to note that the shape and duration of the evacuation trip mobilization distribution is important at sites where traffic congestion is not expected to cause the ETE to extend 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 (i.e., depart work, arrive home)
- An Activity is a 'process' that takes place over some elapsed time (i.e., prepare to leave work, travel home)

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

An employee who lives outside the EPZ will follow sequence (c) of Figure 5-1. A household within the EPZ that has one or more commuters at work and will await their return before beginning the evacuation trip will follow the first sequence of Figure 5-1(a). A household within the EPZ that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day.

Households with no commuters on weekends or in the evening/ nighttime, 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 that certain events occur in sequence (for instance, a commuter returning home before beginning the preparation to leave or removing snow only after preparing 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 operates 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 within the entire plume exposure pathway who may not have received the initial notification."

Given the federal regulations and guidance, and the assumed presence of sirens within the EPZ, it is assumed that 100% 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 for employees working inside or outside of the EPZ who returns home prior to evacuating. This distribution is also applicable for residents to leave stores, restaurants, parks and other locations within the EPZ. This distribution is plotted in Figure 5-2.

Distribution No. 3, Travel Home: Activity 2, 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 → 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 plowing 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. (Note – evacuation may not be a prudent protective action under such blizzard conditions).

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.

Note that those respondents (7%) who answered that they would not take time to clear their driveway were assumed to be ready immediately at the start of this activity. Essentially, they would drive through the snow on the driveway to access the roadway and begin their evacuation trip.

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 → 4) must precede Activity 4 → 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-7 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 already mentioned, 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 540 responses, almost all of them estimate less than two hours for a given answer, but 3 say "four hours" and 4 say "six or more hours".

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

In assessing outliers, there are three alternatives to consider:

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

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

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

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

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

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

1) It is recognized that the overall trip generation distributions are <u>conservative</u> estimates, because they assume a household will do the mobilization activities sequentially, with no overlap of activities;
2) The individual mobilization <u>activities</u> (prepare to leave work, travel home, prepare home, clear snow are reviewed for outliers, and <u>then</u> 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., access and/or functional needs, transit dependent) <u>or</u> 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 3.5 standard deviations from the mean are allowed to be considered outliers, with gaps in the histogram expected. Values more than 3.25 standard deviations from the mean were removed for Distribution 4 (Prepare to Leave Home).

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

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

6) In particular, the cumulative distribution differs from the normal distribution in two key aspects, both very important in loading a network to estimate evacuation times:
   - 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 some traffic still loading at later times.

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

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

This is done by using the data sets and distributions under different scenarios (e.g., commuter returning, no commuter returning, 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 sequential – travel home from work follows preparation to leave work; 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.

Figure 5-4 presents the resultant trip generation distributions for each of the population groups identified. 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. Subareas comprising the 2-Mile Region are advised to evacuate immediately.
2. Subareas 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 to prepare for an 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 evacuates across the 2-Mile Region boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%.

<u>Assumptions</u>

1. The EPZ population in Subareas 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 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 in place.

<u>Procedure</u>

1. Trip generation for population groups in the 2-Mile Region will be as computed based upon the results of the demographic survey and analysis.
2. Trip generation for the population subject to staged evacuation will be formulated as follows:

a. Identify the 90th percentile evacuation time for the Subareas comprising the 2-Mile Region. This value, T_{Scen}^*, obtained from simulation results is scenario-specific. 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 2:00 for non-heavy snow scenarios and 3:00 for heavy 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 120 minutes for non-heavy snow scenarios and 180 minutes for heavy snow scenarios. At the 90th percentile evacuation time, 20% of the permanent resident population (who normally would have completed their mobilization activities for an un-staged evacuation) advised to shelter has nevertheless departed the area. These people do not comply with the shelter advisory. Also included on the plot are the trip generation distributions for these groups as applied to the regions advised to evacuate immediately.

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

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

5.4.3 Trip Generation for Waterways and Recreational Areas

The Ottawa County RERP Plan (Rev.34, Page II-A-8) indicates that the Ohio Department of Natural Resources (ODNR) ensures that staff and visitors at the Magee Marsh Wildlife Area are notified of the emergency. ODNR also maintains traffic control in areas designated for anchorage of boats and control vessel traffic in harbors and channels. ODNR provides the alternate aircraft and pilots for waterway notification of recreational boaters on Lake Erie, as well as personnel, watercraft, and equipment.

The NOAA National Weather Service (NWS), over NOAA weather radio, will instruct the public to refer to an EAS station for emergency information. In addition, the NWS shall provide weather information upon request to responding federal, state or local agencies. The FAA will restrict air traffic within a ten-mile radius of the affected area when requested by Ohio EMA.
Upon request, the Coast Guard will broadcast an emergency notice to mariners. In addition to broadcasting the notice to mariners, the Ninth District USCG stations will provide available resources (i.e., vessels, aircraft and personnel) to begin notifying boaters on Lake Erie.

As indicated in Table 5-2, this study assumes 100% notification in 45 minutes. Table 5-9 indicates that all transients will have mobilized within 1 hour 30 minutes. It is assumed that this timeframe is sufficient time for boaters, 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	93%
5	31%	40	95%
10	52%	45	96%
15	69%	50	98%
20	75%	55	98%
25	79%	60	100%
30	89%		

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	87%
5	17%	40	91%
10	32%	45	94%
15	49%	50	96%
20	65%	55	98%
25	73%	60	100%
30	81%		

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

Table 5-5. Time Distribution for Population to Prepare to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate	Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0%	120	83%
15	3%	135	91%
30	23%	150	93%
45	36%	165	94%
60	56%	180	96%
75	69%	195	99%
90	73%	210	100%
105	78%		

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 of Households Completing Activity	Elapsed Time (Minutes)	Cumulative Percent of Households Completing Activity
0	7%	105	86%
15	21%	120	91%
30	35%	135	98%
45	52%	150	99%
60	67%	165	99%
75	81%	180	100%
90	84%		

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[1]

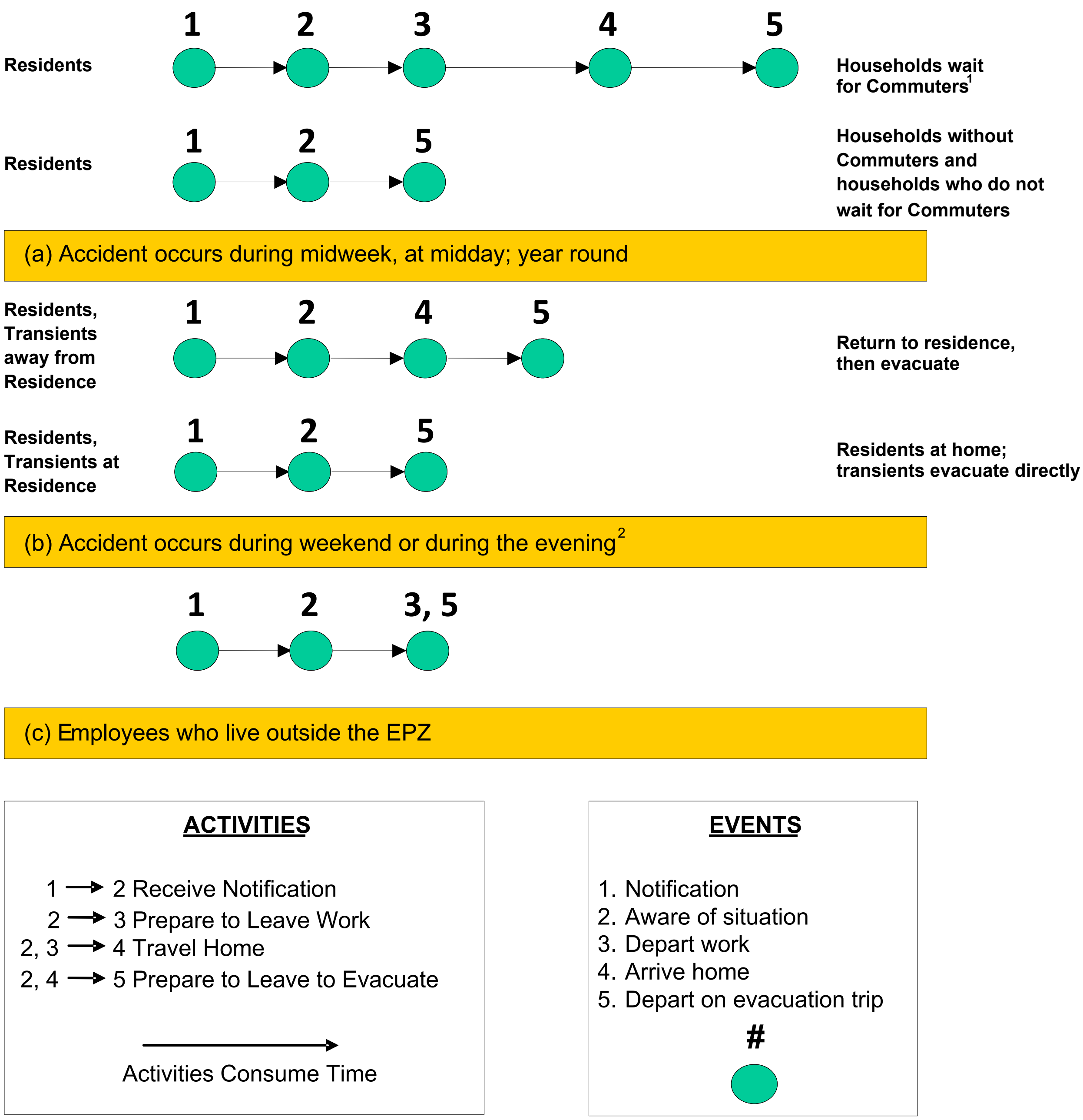
Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period					
		Employees (Distribution A)	Transients (Distribution A)	Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	15	6%	6%	0%	0%	0%	0%
2	15	30%	30%	0%	3%	0%	0%
3	30	55%	55%	4%	26%	1%	5%
4	30	9%	9%	20%	32%	4%	15%
5	30	0%	0%	28%	14%	12%	21%
6	15	0%	0%	11%	5%	9%	9%
7	60	0%	0%	25%	15%	36%	29%
8	30	0%	0%	6%	5%	14%	10%
9	30	0%	0%	4%	0%	10%	5%
10	30	0%	0%	2%	0%	7%	4%
11	30	0%	0%	0%	0%	4%	1%
12	30	0%	0%	0%	0%	2%	1%
13	15	0%	0%	0%	0%	0%	0%
14	15	0%	0%	0%	0%	1%	0%
15	600	0%	0%	0%	0%	0%	0%

[1] 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[2]				
		Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Duration (Min)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	15	0%	0%	15	0%	0%
2	15	0%	1%	15	0%	0%
3	30	1%	5%	30	0%	1%
4	30	4%	6%	30	1%	3%
5	30	5%	3%	15	1%	2%
6	15	53%	65%	60	7%	7%
7	60	25%	15%	15	2%	2%
8	30	6%	5%	15	51%	64%
9	30	4%	0%	30	14%	10%
10	30	2%	0%	30	10%	5%
11	30	0%	0%	30	7%	4%
12	30	0%	0%	30	4%	1%
13	15	0%	0%	30	2%	1%
14	15	0%	0%	30	1%	0%
15	600	0%	0%	600	0%	0%

[2] 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

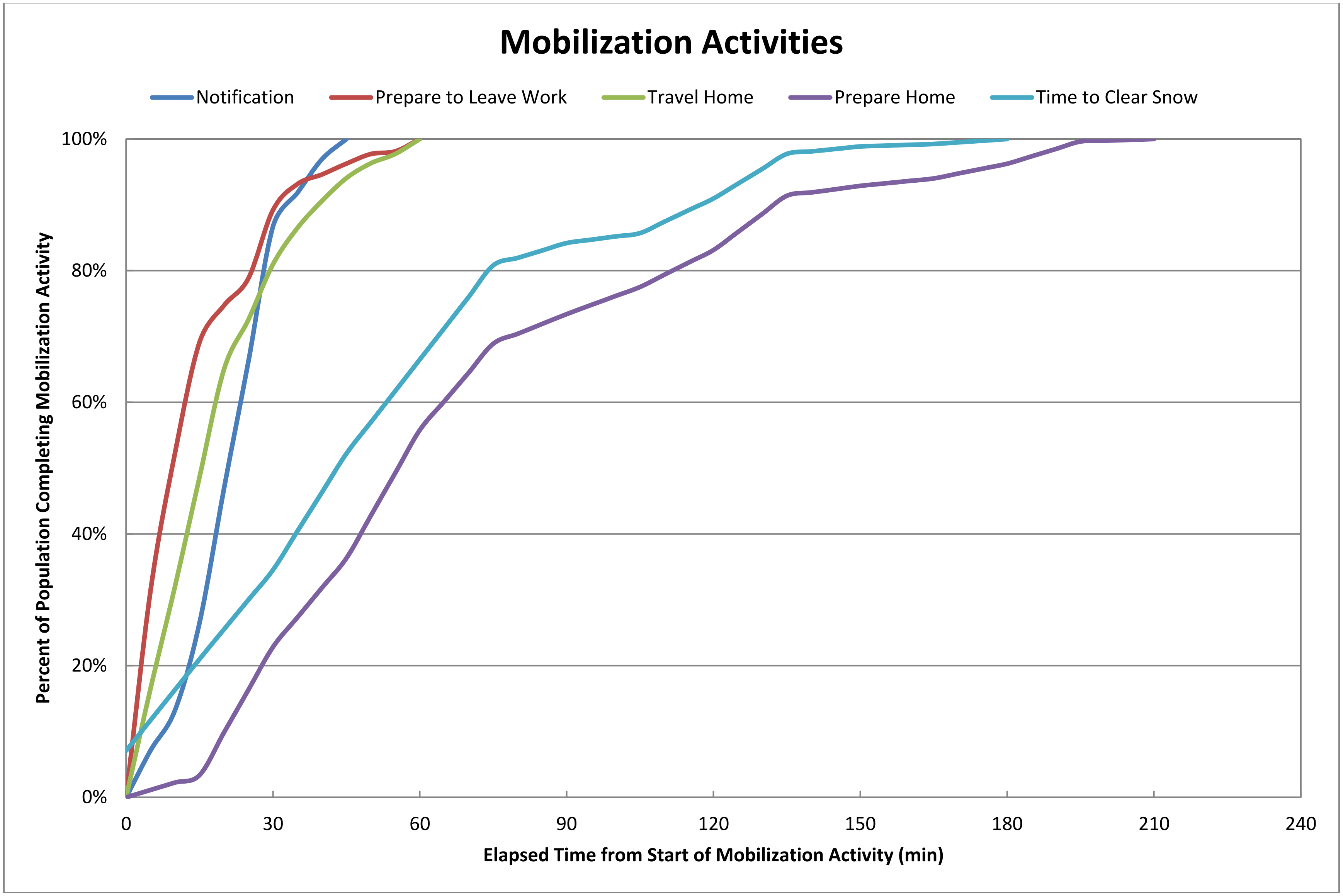


Figure 5-2. Evacuation Mobilization Activities

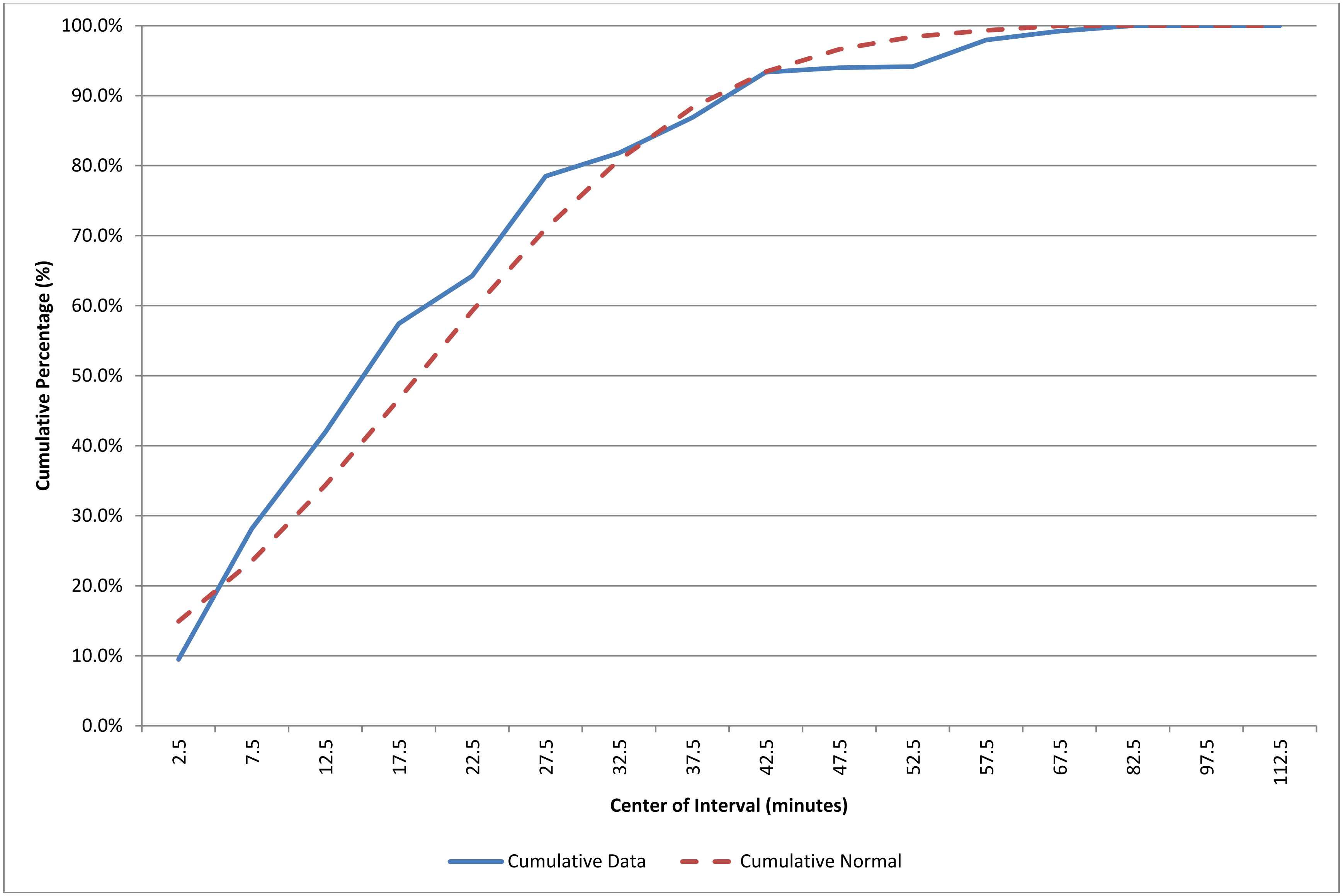


Figure 5-3. Comparison of Data Distribution and Normal Distribution

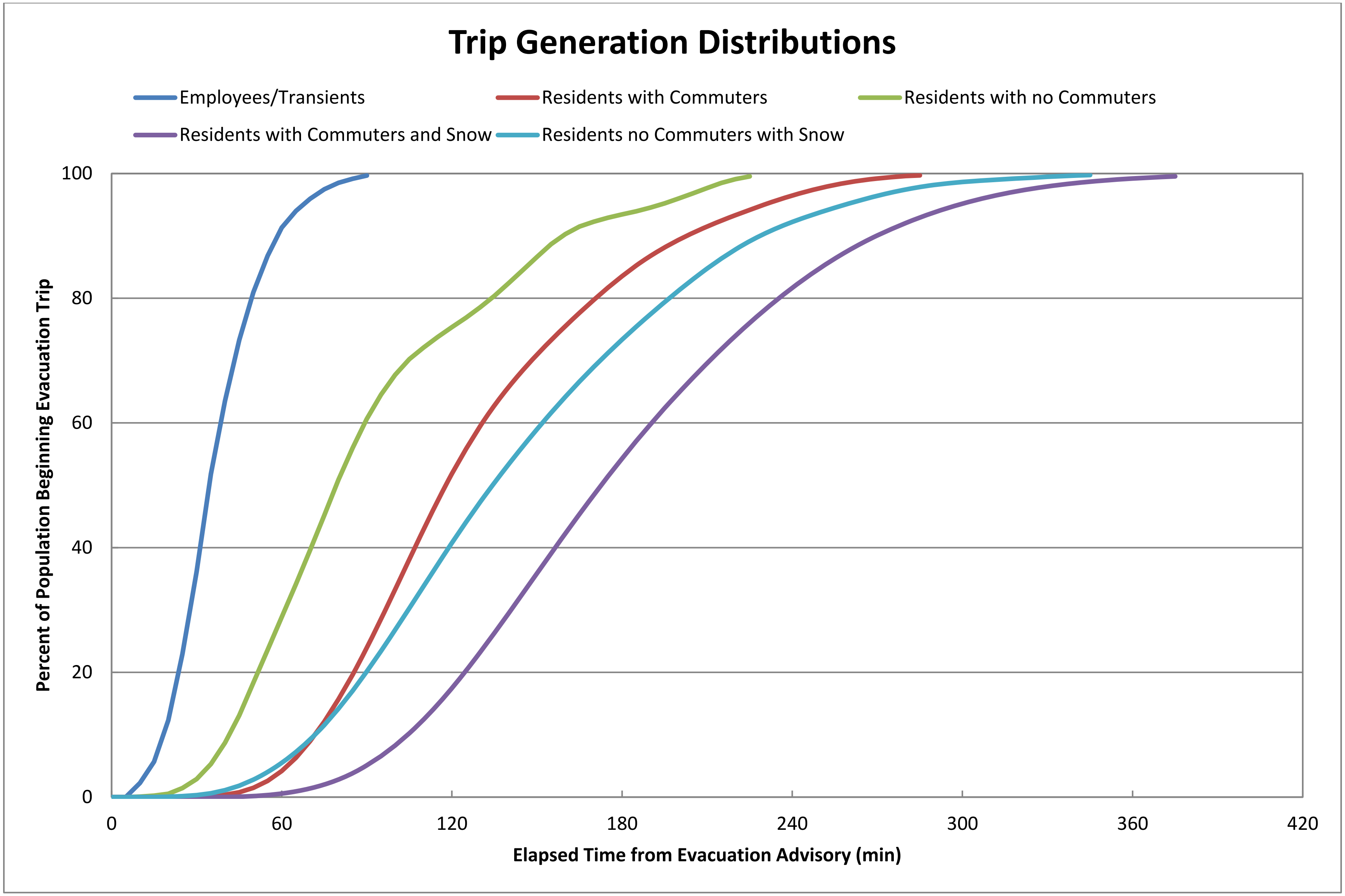


Figure 5-4. Comparison of Trip Generation Distributions

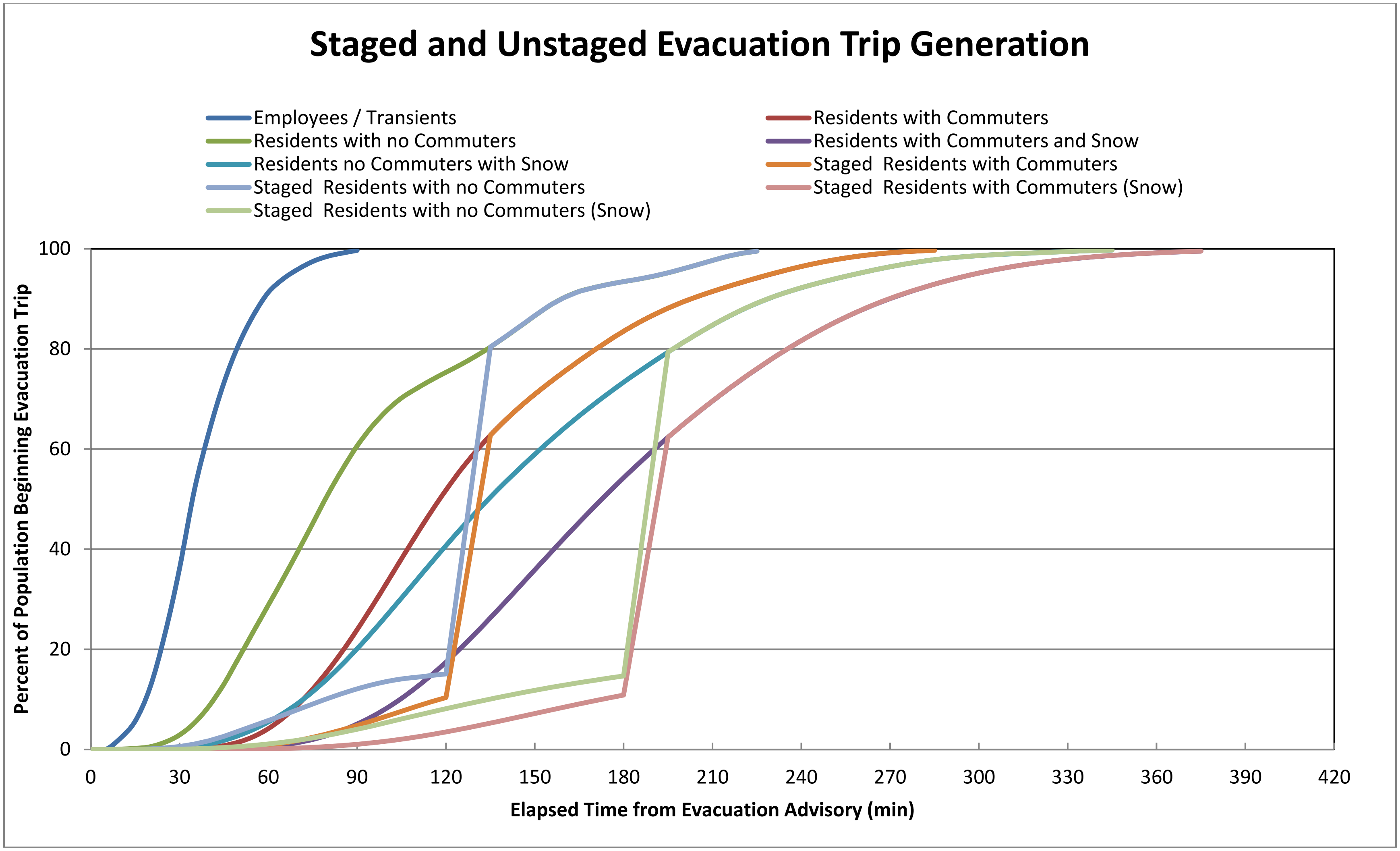


Figure 5-5. Comparison of Staged and Un-staged Trip Generation Distributions in the 2 to 5-Mile Regions

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 Subareas 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 20 Regions were identified which encompass all the groupings of Subareas considered. These Regions are defined in Table 6-1. The Subarea 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, each with a central angle of 22.5 degrees, as per NUREG/CR-7002, Rev. 1 guidance. The central sector coincides with the wind direction. These sectors extend to 5 miles from the plant (Regions R04 and R05) or to the EPZ boundary (Regions R06 through R17).

Regions R01, R02 and R03 represent evacuations of circular areas with radii of 2, 5 and 10 miles, respectively. Regions R18, R19 and R20 are identical to Regions R02, R04 and R05, respectively; however, those Subareas between 2 miles and 5 miles are staged until 90% of the 2-Mile Region (Region R01) has evacuated. Note that based on local procedures, Subareas 10 and 12 evacuate under all circumstances. Thus, Subareas 10 and 12 are included in all Regions in Table 6-1.

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 14 x 20=280 evacuation cases. Table 6-2 provides a description of all Scenarios.

Each combination of Region and Scenario implies a specific population to be evacuated.

The population and 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 population is considered for each evacuation case. The scenario percentages of each population groups 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 number of residents with commuters during the week (when workforce is at its peak) is equal to 50%, which is the product of 83% (the number of households with at least one commuter) and 60% (the number of households with a commuter who 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 (50%)

will have a commuter at work during those times, or approximately 5% (10% x 50% = 5%) of households overall.

It can be argued that the 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 assumption 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 assumed that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is assumed that only 10% of the employees are working in the evenings and during the weekends.

Transient and seasonal population activity is estimated to be at its peak (95%) during summer weekends and is less (75%) during the week. As shown in Appendix E, there is a significant amount of lodging and campgrounds offering overnight accommodations in the EPZ. This is offset by the other transient facilities with larger transient populations in which evening use is minimal (parks and golf centers); thus, transient activity is estimated to be lower during evening hours, – 70% for summer and 25% for winter. Since seasonal residents are not present in the EPZ in the winter, transient activity on winter weekends is estimated to be low (35%) and even less (30%) during the week.

The shadow percentages are computed using a base of 20% (see assumption 7 in Section 2.2), as noted in the shadow footnote to Table 6-3. 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:

$$20\% \times \left(1 + \frac{488}{6{,}086 + 6{,}148}\right) = 21\%$$

One special event, National Rifle Matches at Camp Perry, was considered as Scenario 13 (during the summer, weekend, midday, with good weather). Thus, the special event traffic is 100% evacuated for Scenario 13, and 0% for all other scenarios.

It is assumed that summer school (including day care centers/nursery schools) enrollment is approximately 10% of enrollment during the regular school year for summer, midweek, midday scenarios. School is not in session during weekends and evening, thus no buses to evacuate school/day care center/nursery school children are needed under those circumstances. As discussed in Section 7, schools and day care centers/nursery schools are assumed to be in session during the winter season, midweek, midday and 100% of buses will be needed under those circumstances.

Transit buses for the transit-dependent population, medical and correctional 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 estimated to be 100% for all midday scenarios, while it is significantly less (40%) during evening scenarios.

Table 6-1. Description of Evacuation Regions

Radial Regions													
Region	Description	Subarea											
		1	2	3	4	5	6	7	8	9	10[1]	11	12[1]
R01	2-Mile Region	X									X		X
R02	5-Mile Region	X	X				X				X		X
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles													
Region	Wind Direction From:	Subarea											
		1	2	3	4	5	6	7	8	9	10	11	12
N/A	Unknown or Lake Breeze	Refer to Region R02											
N/A	118° - 278°	Refer to Region R01											
R04	279° - 293°	X					X				X		X
N/A	294° - 013°	Refer to Region R02											
R05	014° - 117°	X	X								X		X
Evacuate 2-Mile Region and Downwind to the EPZ Boundary													
Region	Wind Direction From:	Subarea											
		1	2	3	4	5	6	7	8	9	10	11	12
N/A	Unknown or Lake Breeze	Refer to Region R03											
N/A	141° - 278°	Refer to Region R01											
R06	279° - 286°	X					X	X		X	X		X
R07	287° - 293°	X					X	X	X	X	X		X
R08	294° - 330°	X	X				X	X	X	X	X		X
R09	331° - 005°	X	X			X	X	X	X		X		X
R10	006° - 013°	X	X		X	X	X	X	X		X		X
R11	014° - 020°	X	X		X	X					X		X
R12	021° - 065°	X	X	X	X	X					X		X
R13	066° - 072°	X	X	X	X						X		X
R14	073° - 078°	X	X	X							X		X
R15	079° - 117°	X	X	X							X	X	X
R16	118° - 122°	X		X							X	X	X
R17	123° - 140°	X									X	X	X
Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles													
Region	Wind Direction From:	Subarea											
		1	2	3	4	5	6	7	8	9	10	11	12
R18	5-Mile Region	X	X				X				X		X
N/A	118° - 278°	Refer to Region R01											
R19	279° - 293°	X					X				X		X
N/A	294° - 013°	Refer to Region R18											
R20	014° - 117°	X	X								X		X

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

[1] Site specific protective action recommendations indicate that Subareas 10 and 12 evacuate even though not within the wind direction three-sector keyhole.

Table 6-2. Evacuation Scenario Definitions

Scenarios	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	Summer	Weekend	Midday	Good	Special Event: The Camp Perry National Rifle Matches
14	Summer	Midweek	Midday	Good	Roadway Impact: Single Lane Closure on SR 2 Eastbound

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

Scenario	Residents with Commuters in Household	Residents with no Commuters in Household	Employees	Transients and Seasonal Population	Shadow	Special Events	Medical and Correctional Facilities	School Buses[3]	Transit Buses	External Through Traffic
1	50%	50%	96%	75%	21%	0%	100%	10%	100%	100%
2	50%	50%	96%	75%	21%	0%	100%	10%	100%	100%
3	5%	95%	10%	95%	20%	0%	100%	0%	100%	100%
4	5%	95%	10%	95%	20%	0%	100%	0%	100%	100%
5	5%	95%	10%	70%	20%	0%	100%	0%	100%	40%
6	50%	50%	100%	30%	21%	0%	100%	100%	100%	100%
7	50%	50%	100%	30%	21%	0%	100%	100%	100%	100%
8	50%	50%	100%	30%	21%	0%	100%	100%	100%	100%
9	5%	95%	10%	35%	20%	0%	100%	0%	100%	100%
10	5%	95%	10%	35%	20%	0%	100%	0%	100%	100%
11	5%	95%	10%	35%	20%	0%	100%	0%	100%	100%
12	5%	95%	10%	25%	20%	0%	100%	0%	100%	40%
13	5%	95%	10%	95%	20%	100%	100%	0%	100%	100%
14	50%	50%	96%	75%	21%	0%	100%	10%	100%	100%

Resident Households with Commuters ....Households of EPZ residents who await the return of commuters prior to beginning the evacuation trip.
Resident Households with No Commuters ..Households of EPZ residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.
Employees ....EPZ employees who live outside the EPZ
Transients & Seasonal Population...............People who are in the EPZ at the time of an accident for recreational or other (non-employment) purposes.
Shadow..Residents and employees in the shadow region (outside of the EPZ) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 20% relocation of shadow residents along with a proportional percentage of shadow employees.
Special Events ....Additional vehicles in the EPZ due to the identified special events.
Medical and Correctional Facility Buses......Vehicle-equivalents present on the road during evacuation servicing patients and inmates (1 bus is equivalent to 2 passenger vehicles).
School and Transit Buses ....Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).
External Through Traffic..............................Traffic on interstates and major arterial roads at the start of the evacuation. This traffic continues throughout the entire evacuation.

[3] School buses also includes buses being used at Day Care Centers and Nursery Schools within the EPZ.

Table 6-4. Vehicle Estimates by Scenario[4]

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Events	Medical and Correctional Facilities	Seasonal population	School Buses	Transit Buses	External Traffic	Total Scenario Vehicles
1	6,086	6,148	488	8,196	2,414	0	39	1,043	13	14	48,924	73,365
2	6,086	6,148	488	8,196	2,414	0	39	1,043	13	14	48,924	73,365
3	609	11,625	51	10,382	2,331	0	39	1,321	0	14	48,924	75,296
4	609	11,625	51	10,382	2,331	0	39	1,321	0	14	48,924	75,296
5	609	11,625	51	7,650	2,331	0	39	974	0	14	19,570	42,863
6	6,086	6,148	508	3,278	2,417	0	39	417	134	14	48,924	67,965
7	6,086	6,148	508	3,278	2,417	0	39	417	134	14	48,924	67,965
8	6,086	6,148	508	3,278	2,417	0	39	417	134	14	48,924	67,965
9	609	11,625	51	3,825	2,331	0	39	487	0	14	48,924	67,905
10	609	11,625	51	3,825	2,331	0	39	487	0	14	48,924	67,905
11	609	11,625	51	3,825	2,331	0	39	487	0	14	48,924	67,905
12	609	11,625	51	2,732	2,331	0	39	348	0	14	19,570	37,319
13	609	11,625	51	10,382	2,331	1,487	39	1,321	0	14	48,924	76,783
14	6,086	6,148	488	8,196	2,414	0	39	1,043	13	14	48,924	73,365

[4] Vehicle estimates are for an evacuation of the entire EPZ (Region R03).

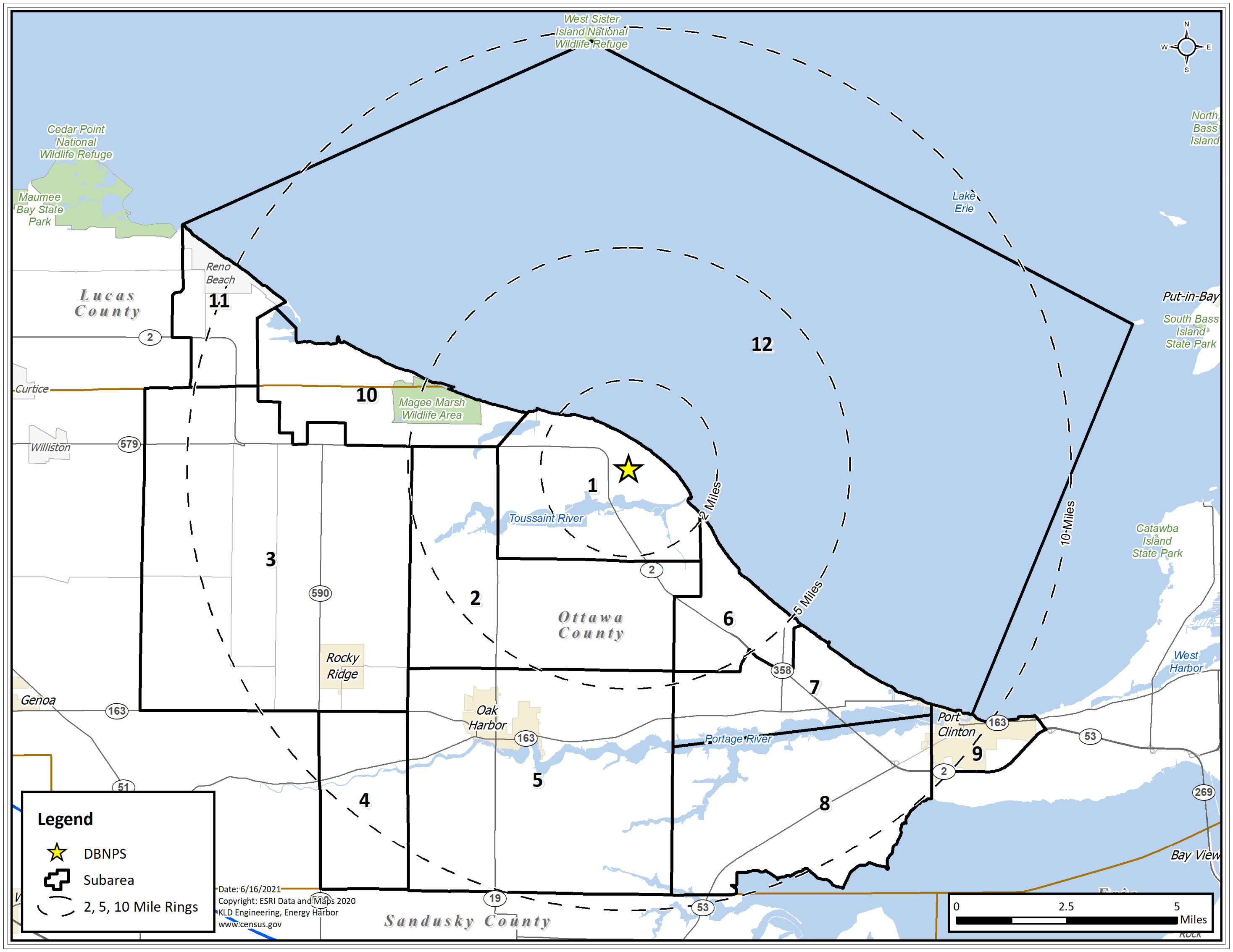


Figure 6-1. Subareas comprising the DBNPS EPZ

7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 20 Evacuation Regions within the Davis-Besse Nuclear Power Station (DBNPS) 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 permanent residents within the EPZ in Subareas for which an Advisory to Evacuate (ATE) has not been issued, yet who elect to evacuate. "Shadow evacuation" is the voluntary outward movement of some permanent residents from the Shadow Region (outside the EPZ) for whom no protective action recommendation has been issued. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for the DBNPS EPZ addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the EPZ, 20% of permanent residents located in Subareas outside of the Evacuation Region who are not advised to evacuate, are assumed to elect to evacuate. Similarly, it is assumed that 20% of the permanent residents in the Shadow Region will also 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 the permanent residents within the EPZ (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 18,438 permanent residents 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. Subarea comprising the 2-Mile Region are advised to evacuate immediately.

2. Subarea 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 begin evacuating when approximately 90% of those originally within the 2-Mile Region evacuate crosses the 2-Mile Region boundary.
5. The population between the 5-Mile Region boundary to the full EPZ boundary (approximately 10 miles radially from plant) 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 7-6 presents the patterns of traffic congestion that arise for the case when the entire EPZ (Region R03) is advised to evacuate during the summer, midweek, midday period under good weather conditions (Scenario 1).

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

> The HCM uses LOS F to define operations that have either broken down (i.e., demand exceeds capacity) or have reached a point that most users would consider unsatisfactory, as described by a specified service measure value (or combination of service measure values). However, analysts may be interested in knowing just how bad the LOS F condition is, particularly for planning applications where different alternatives may be compared. Several measures are available 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 and traffic bottlenecks, most noticeably on the local roadways in Port Clinton.

Figure 7-3 presents the developing congestion just one (1) hour after the ATE. Inside the 2-mile ring (Subarea 1), permanent residents and transients leaving from marinas and campgrounds just west of the plant experience significant congestion (LOS F) along North Humphrey Road and North Russell Road. Inside Port Clinton (Subarea 9), local roadways are operating at LOS F conditions leading onto State Route 2 (SR 2). South of the EPZ (inside the Shadow Region), roads that carry external traffic throughout the evacuation are operating at LOS B conditions. At this time, approximately 46% of evacuees have mobilized, and approximately 32% of vehicles have evacuated the EPZ.

At two (2) hours after the ATE, as shown in Figure 7-4, congestion within the 2-Mile Region has dissipated and all roadways are operating at LOS D or better, which clears ten minutes later at 2 hours and 10 minutes after the ATE. The significant congestion within Port Clinton still continues. There are only two on-ramps (West Fremont Road and SR 63) in this area that give access to SR 2 and both of these roads are operating at LOS F conditions at or near the ramps. There are approximately 5,700 residents and 3,500 vehicles (see Table 3-2) leaving Subarea 9 all which need to use Fremont Road or SR 163. Evacuees leaving Oak Harbor travelling southbound along Oak Harbor Road, experience LOS F conditions at the Glasser Road intersection. Even though Oak Harbor Road has no traffic control at this location, the sharp bend in the road reduces speeds and capacity. At this time, approximately 79% of evacuees have mobilized, and approximately 73% of vehicles have evacuated the EPZ.

At 2 hours and 30 minutes after the ATE, as shown in Figure 7-5, congestion in Port Clinton dissipates and the only road operating at LOS F conditions within the EPZ is along Oak Harbor Road, which clears 10-minutes later at 2 hours and 40 minutes. Congestion inside the Shadow Region (just outside of Port Clinton) still remains. At this time, approximately 89% of evacuees have mobilized, and approximately 85% of vehicles have evacuated the EPZ.

As shown in Figure 7-6, at 3 hours and 30 minutes after the ATE, the congestion is fully clear within the EPZ, and roads are now operating at a LOS A. At this time, approximately 97% of evacuees have mobilized, and approximately 96% of vehicles have evacuated the EPZ. Therefore, this indicates that the trip generation time (plus 10-minute travel time to the EPZ boundary) is dictating the 100th percentile ETE, as evacuees who depart at this time are encountering no traffic congestion or delay within the EPZ. The only congestion that remains within the study area is along routes that service the external traffic vehicles (Interstate [I]-80, US 20 and US 6).

7.4 Evacuation Rates

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

As indicated in Figure 7-7, there is typically a long "tail" to these distributions due to congestion and mobilization. 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, there are a few evacuation routes servicing the remaining evacuees (those with the longest mobilization times).

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

7.5 Evacuation Time Estimate (ETE) Results

Table 7-1 through Table 7-2 present the ETE values for all 20 Evacuation Regions and all 14 Evacuation Scenarios. Table 7-3 through Table 7-4 present the ETE values for 2-Mile Region for both staged and un-staged regions downwind to 5 miles. The tables are organized as follows:

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

The animation snapshots described in Section 7.3 reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in Figure 7-3 through Figure 7-6. The majority of the prolonged congestion (LOS F) in the EPZ occurs within the 2-Mile Region in Subarea 1 and also located within Subarea 9. This is reflected in the ETE statistics:

- The majority (90%) of the 2-Mile Region (R01) consists of transient and employee vehicles and a small percentage (10%) are permanent resident vehicles. Due to the significant congestion within Subarea 1, the 90th percentile ETE for the 2-Mile Region (R01) range from 1:45 to 3:05.
- The 90th percentile ETE for the 5-Mile Region (R02) are 10 to 35 minutes longer than the ETE for R01 and range from 2:05 to 3:40.

- The 90th percentile ETE for the full EPZ (R03) are 20 to 65 minutes longer than the ETE for R02 due to the significant congestion on roadways leaving Port Clinton (Subarea 9). The 90th percentile ETE ranges between 2:40 and 4:05.
- At the 90th percentile, rain increases the ETE by up to 10 minutes; heavy snow by up to 60 (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 are comparable to Region R02, ranging from 1 hour and 50 minutes to 2 hours and 40 minutes for non-heavy snow cases.
- The 90th percentile ETE for the keyhole regions downwind to the EPZ boundary range between 1 hour and 55 minutes to 3 hours and 5 minutes for non-heavy snow cases and are up to 45 minutes less (not including special cases, Scenario S13 and S14) compared to Region R03.
- The 100th percentile ETE for all Regions and Scenarios parallel mobilization time (plus 10-minute travel time to the EPZ, as the congestion with the EPZ dissipates (no speed and capacity reductions exist) after 2 hours and 40 minutes after the ATE, as discussed in Section 7.3 (at time 2 hours and 30 minutes). The 100th percentile ETE ranges from 4:45 to 4:55 for non-heavy snow scenarios and 6:15 to 6:25 for heavy snow scenarios.

Comparison of Scenarios 3 and 13 in Table 7-1 and Table 7-2 indicate that the Special Event – The Camp Perry National Rifle Matches – has minimal impact (at most 10 minutes) on the 90th percentile ETE. The additional 1,487 vehicles that are inside the EPZ for the rifle matches do not overwhelm the roadway system to cause any significant delays. The 100th percentile ETE is dictated by the permanent resident mobilization time. Thus, the 100th percentile ETE is not impacted by the Special Event.

Comparison of Scenarios 1 and 14 in Table 7-1 and in Table 7-2 indicate that the roadway closure – a single lane closure on SR 2 eastbound from approximately plant site to just west of the interchange with SR 269/Martins Point Road (Exit 128) – does not impact the 90th and 100th percentile ETE. The ramps to access the SR 2 are the bottlenecks, such that the main thoroughfare SR 2 is underutilized. Thus, a reduction in capacity along SR 2 does not significantly impact ETE. The single lane closure has no impact on the 100th percentile ETE, as the trip generation (plus the travel time to the EPZ boundary) dictates the 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 results. Note that Regions R18, R19 and R20 are the same geographic areas as Regions R02, R04 and R05, respectively. The times shown in Table 7-3 and Table 7-4 are when the 2-Mile Region is 90% clear and 100% clear, respectively.

The objective of a staged evacuation is to show that the ETE for the 2-Mile Region can be significantly reduced (30 minutes or 25%, whichever is less) without significantly impacting people beyond the regions between 2 miles and 5 miles. As shown in Table 7-3 and Table 7-4, the 90th ETE for the 2-Mile Region is unchanged when a staged evacuation is implemented for

all Scenarios and Regions. 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 Region. The 100th percentile ETE remains the same, as the trip generation (plus the travel time to the EPZ boundary) dictates the ETE. 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.

To determine the effect of staged evacuation on the residents beyond the 2-Mile Region, the ETE for Regions R18, R19 and R20 are compared to R02, R04 and R05, respectively, in Table 7-1 and Table 7-2. A comparison of ETE between these similar regions, reveals that staging delays the 90th percentile ETE for those in the 2 to 5-mile area by up to 15minutes and has no impact to the 100th percentile ETE. The increase in the 90th percentile ETE is due to the large number of evacuating vehicles, beyond the 2-Mile Region, sheltering and delaying the start of their evacuation. As shown in Figure 5-5, staging the evacuation causes a significant "spike" (sharp increase) in mobilization (trip generation rate) of evacuating vehicles. This spike oversaturates evacuation routes, which increases traffic congestion and prolongs ETE. that follows their eventual ATE, in creating congestion within the EPZ area beyond 2 miles. The 100th percentile ETE is unaffected by staging as it is dictated by the trip generation time.

Therefore, staging evacuation provides no benefits to evacuees within the 2-Mile Region and adversely impacts many evacuees located beyond the 2-Mile Region. Based on the guidance in NUREG-0654, Supplement 3, this analysis would result in staged evacuation not being implemented for this site.

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
  - National Rifle Matches at Camp Perry
- Roadway Impact
  - A single lane closure on SR 2 eastbound from approximately at the plant site to just west of the interchange with SR 269/Martins Point Road (Exit 128)
- 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 school 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 traveling 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 degrees.
   - 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 and R05 and staged regions R18 through R20)
     - To EPZ Boundary (Regions R03, R06 through R17)
   - 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 **Evacuation 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.

<u>Example</u>

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 66 degrees to 72 degrees.
- Wind speed is such that the distance to be evacuated is judged to be a 2-Mile Region 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 90th 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 Region and Downwind to the EPZ Boundary" for wind direction from 066° - 072° 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 2:45.

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

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(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 full EPZ														
R01	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R02	2:15	2:15	2:15	2:15	2:05	2:45	2:45	3:40	2:25	2:25	3:20	2:35	2:05	2:15
R03	2:55	2:55	2:45	2:55	2:40	3:05	3:05	4:05	2:50	2:50	3:45	2:55	2:45	3:20
2-Mile Ring and Keyhole to 5 Miles														
R04	2:00	2:00	2:05	2:05	1:50	2:20	2:20	3:15	2:05	2:05	3:00	2:15	2:00	2:00
R05	2:10	2:10	2:10	2:10	2:00	2:40	2:40	3:35	2:20	2:20	3:20	2:30	2:10	2:10
2-Mile Ring and Keyhole to EPZ Boundary														
R06	2:40	2:40	2:30	2:45	2:25	2:55	3:00	3:55	2:40	2:40	3:35	2:45	2:30	2:40
R07	2:40	2:45	2:40	2:55	2:25	3:00	3:00	3:55	2:45	2:45	3:40	2:50	2:40	3:05
R08	2:45	2:45	2:40	2:50	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:40	3:05
R09	2:50	2:55	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:25	2:50
R10	2:50	2:50	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:25	2:50
R11	2:50	2:55	2:30	2:30	2:35	3:05	3:05	4:05	2:50	2:50	3:45	2:50	2:30	2:50
R12	2:55	2:55	2:40	2:40	2:40	3:05	3:05	4:05	2:50	2:50	3:45	2:55	2:40	3:00
R13	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R14	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R15	2:45	2:45	2:25	2:25	2:30	3:00	3:00	4:00	2:45	2:45	3:40	2:50	2:25	2:45
R16	2:40	2:40	2:25	2:25	2:25	3:00	3:00	3:55	2:45	2:45	3:40	2:50	2:25	2:40
R17	2:10	2:10	2:10	2:10	1:55	2:35	2:35	3:30	2:15	2:15	3:15	2:25	2:10	2:10
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R18	2:20	2:20	2:15	2:15	2:15	2:45	2:45	3:30	2:25	2:25	3:20	2:35	2:15	2:20
R19	2:05	2:05	2:10	2:10	2:00	2:20	2:20	3:10	2:15	2:15	3:10	2:20	2:05	2:05
R20	2:15	2:20	2:15	2:15	2:15	2:40	2:40	3:25	2:25	2:25	3:20	2:30	2:15	2:15

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

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(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 full EPZ														
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
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	4:50	4:50	4:50	4:50	4:50	4:50	6:20	4:50	4:50	6:20	4:50	4:50	4:50
R05	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														
R06	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
R07	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
R08	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
R09	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
R10	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
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
Staged Evacuation - 2-Mile Ring and Keyhole to 5 Miles														
R18	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
R19	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
R20	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 ETE of the 2-Mile Area within the Indicated Region

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(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
Un-staged Evacuation - 2-Mile Region and 5-Mile Region														
R01	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R02	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R05	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R18	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R19	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00
R20	2:00	2:00	2:05	2:05	1:45	2:10	2:10	3:05	2:00	2:00	2:55	2:10	2:05	2:00

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

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(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
Un-staged Evacuation - 2-Mile Region and 5-Mile Region														
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R02	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R04	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R05	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
Staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R18	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R19	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45
R20	4:45	4:45	4:45	4:45	4:45	4:45	4:45	6:15	4:45	4:45	6:15	4:45	4:45	4:45

Table 7-5. Description of Evacuation Regions

Region	Description	1	2	3	4	5	6	7	8	9	10[1]	11	12[1]
Radial Regions													
R01	2-Mile Region	X									X		X
R02	5-Mile Region	X	X				X				X		X
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2-Mile Region and Downwind to 5 Miles													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
N/A	Unknown or Lake Breeze	Refer to Region R02											
N/A	118° - 278°	Refer to Region R01											
R04	279° - 293°	X					X				X		X
N/A	294° - 013°	Refer to Region R02											
R05	014° - 117°	X	X								X		X
Evacuate 2-Mile Region and Downwind to the EPZ Boundary													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
N/A	Unknown or Lake Breeze	Refer to Region R03											
N/A	141° - 278°	Refer to Region R01											
R06	279° - 286°	X					X	X		X	X		X
R07	287° - 293°	X					X	X	X	X	X		X
R08	294° - 330°	X	X				X	X	X	X	X		X
R09	331° - 005°	X	X			X	X	X	X		X		X
R10	006° - 013°	X	X		X	X	X	X	X		X		X
R11	014° - 020°	X	X		X	X					X		X
R12	021° - 065°	X	X	X	X	X					X		X
R13	066° - 072°	X	X	X	X						X		X
R14	073° - 078°	X	X	X							X		X
R15	079° - 117°	X	X	X							X	X	X
R16	118° - 122°	X		X							X	X	X
R17	123° - 140°	X									X	X	X
Staged Evacuation - 2-Mile Region Evacuates, then Evacuate Downwind to 5 Miles													
Region	**Wind Direction From:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
R18	5-Mile Region	X	X				X				X		X
N/A	118° - 278°	Refer to Region R01											
R19	279° - 293°	X					X				X		X
N/A	294° - 013°	Refer to Region R18											
R20	014° - 117°	X	X								X		X
Subarea(s) Evacuate	Subarea(s) Shelter-in-Place	Subarea(s) Shelter-in-Place until 90% ETE for R01, then Evacuate											

[1] Site specific protective action recommendations indicate that Subareas 10 and 12 evacuate even though not within the wind direction three-sector keyhole.

Figure 7-1. Voluntary Evacuation Methodology

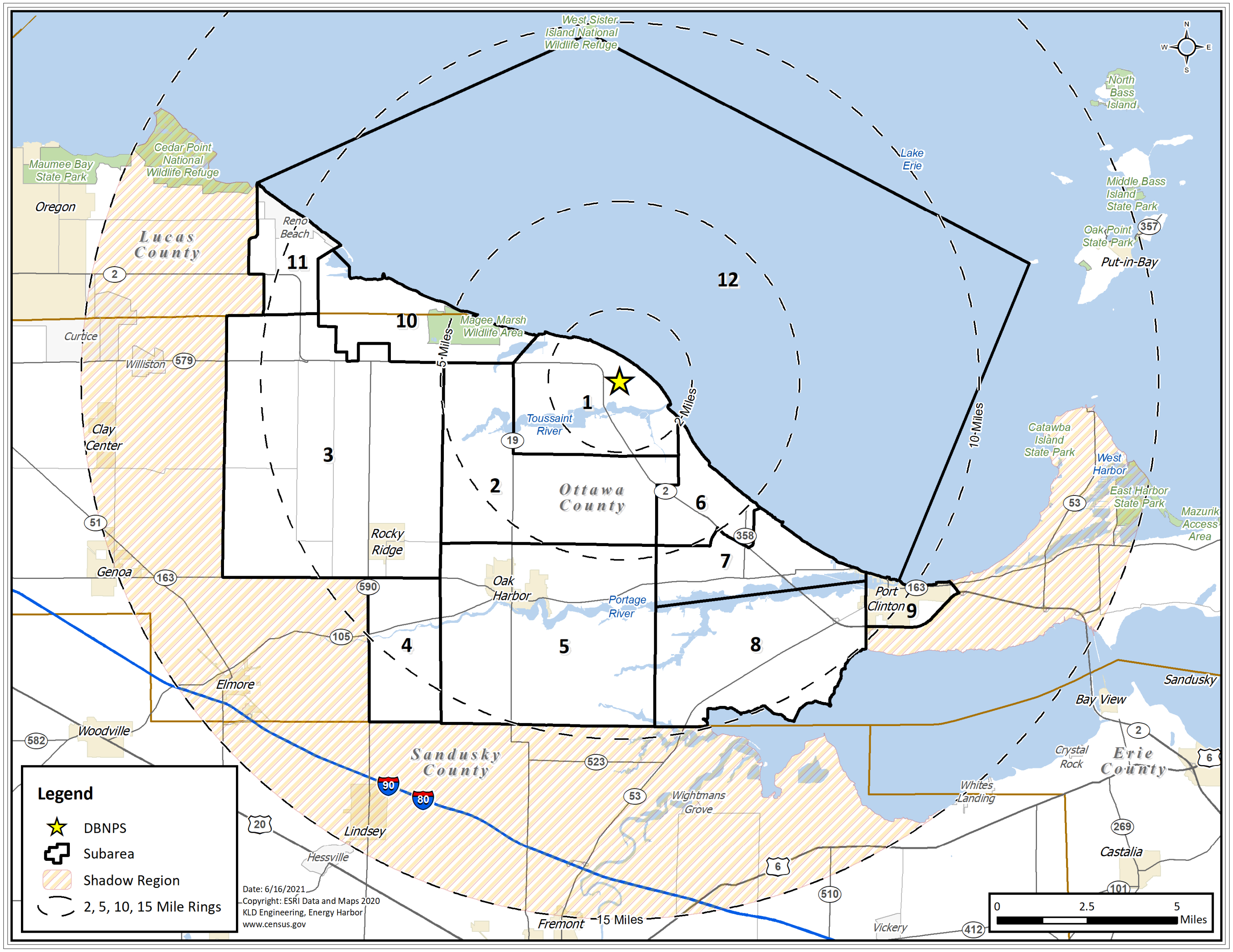


Figure 7-2. DBNPS Shadow Evacuation Region

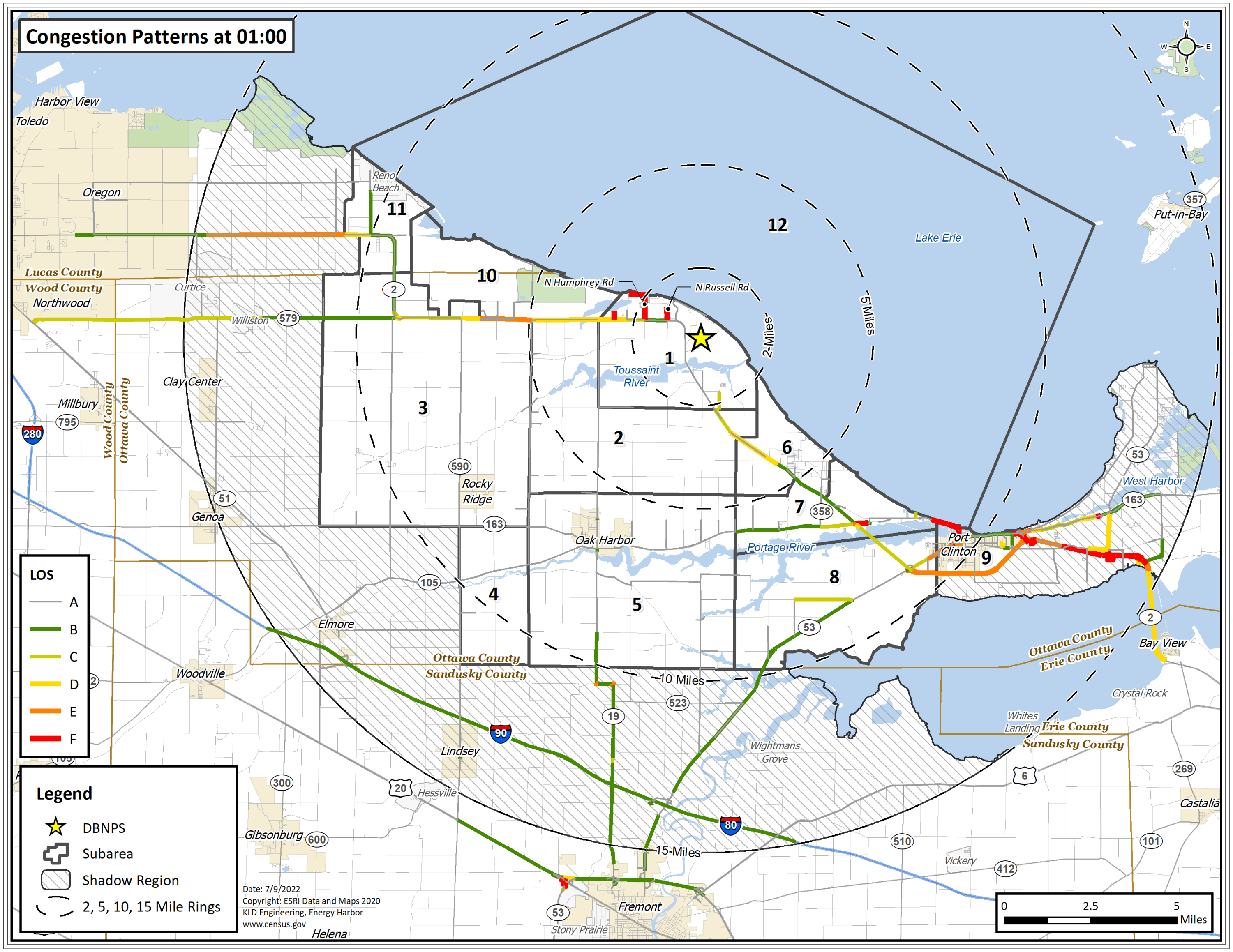


Figure 7-3. Congestion Patterns at 1 Hour after the Advisory to Evacuate

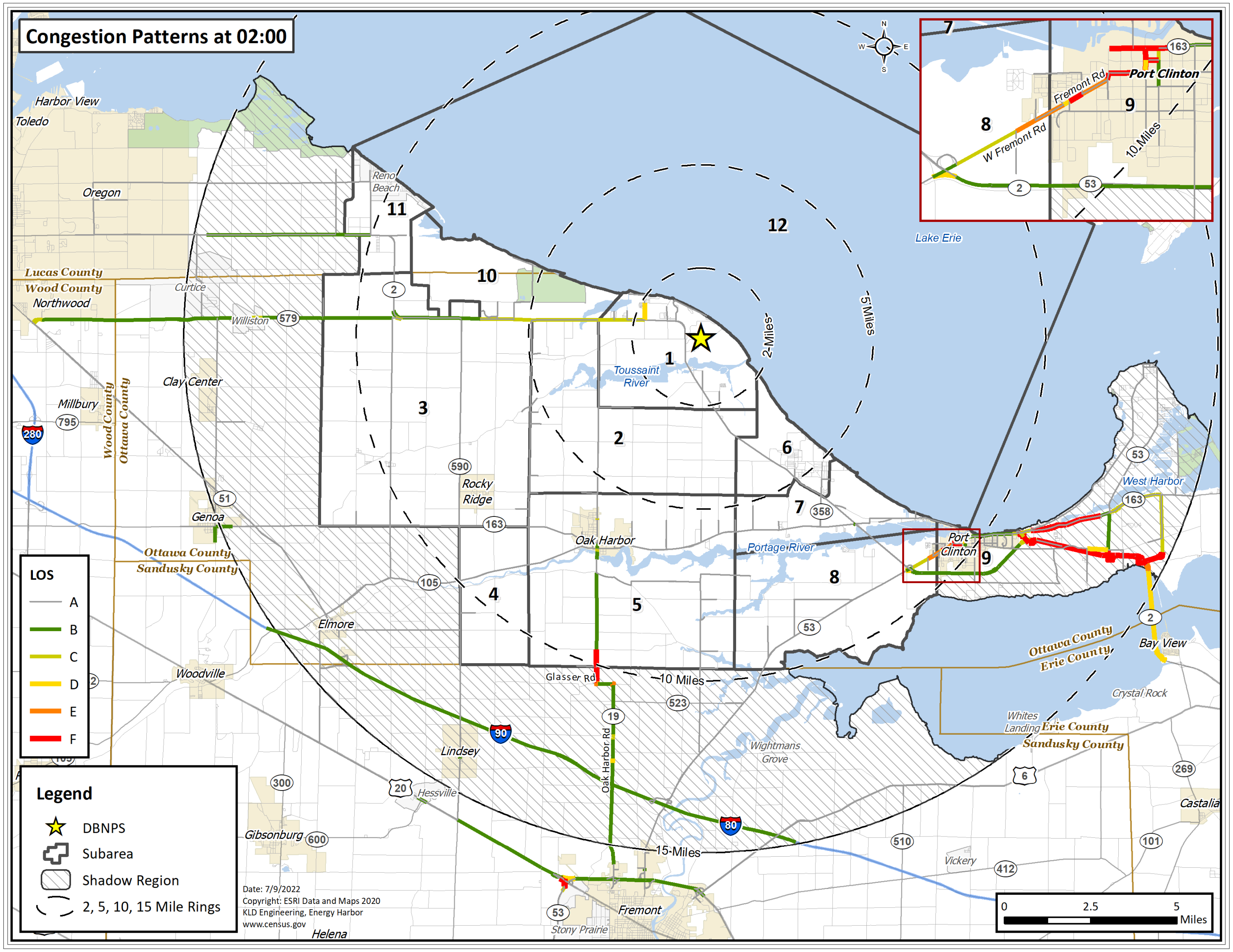


Figure 7-4. Congestion Patterns at 2 Hours after the Advisory to Evacuate

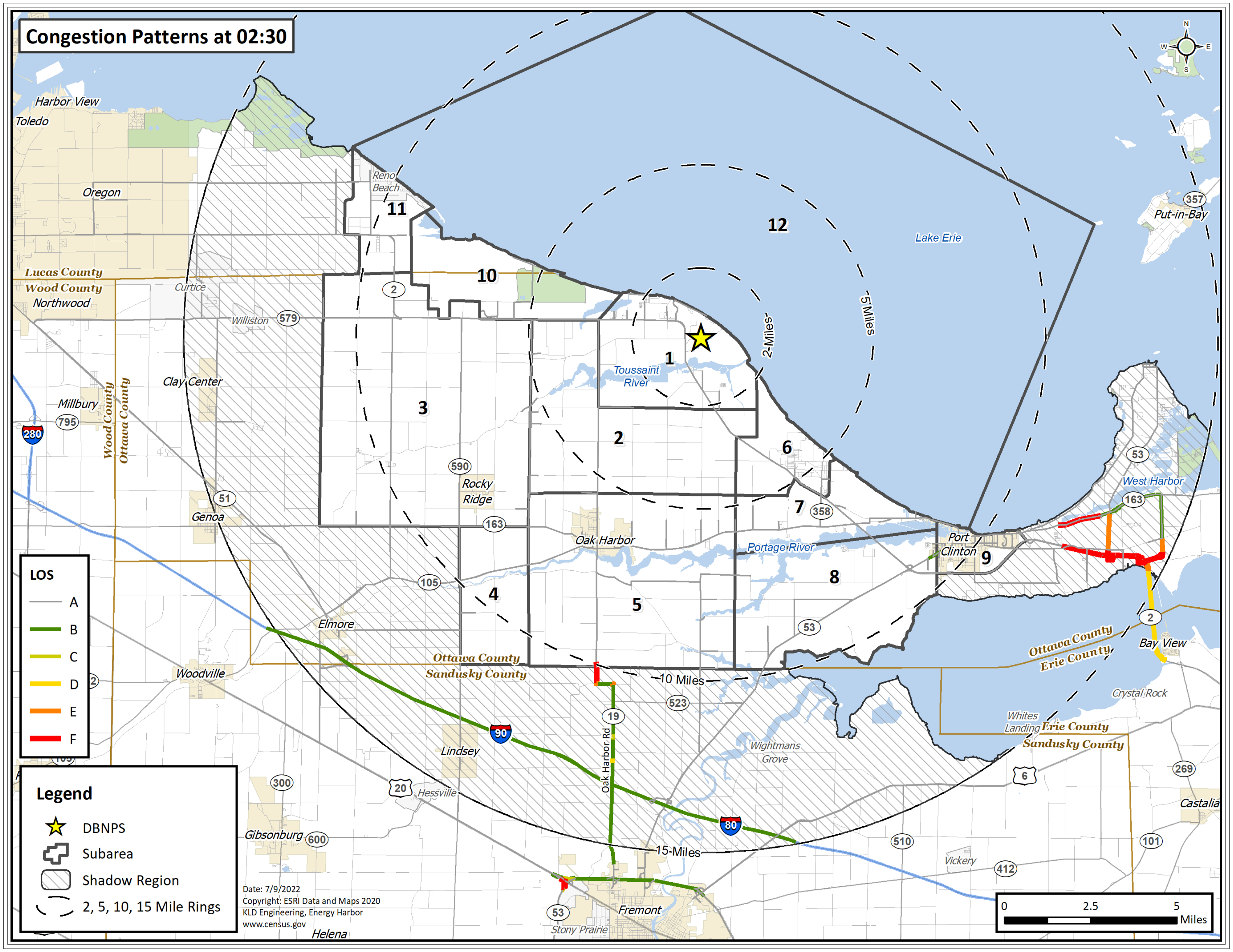


Figure 7-5. Congestion Patterns at 2 Hours and 30 Minutes after the Advisory to Evacuate

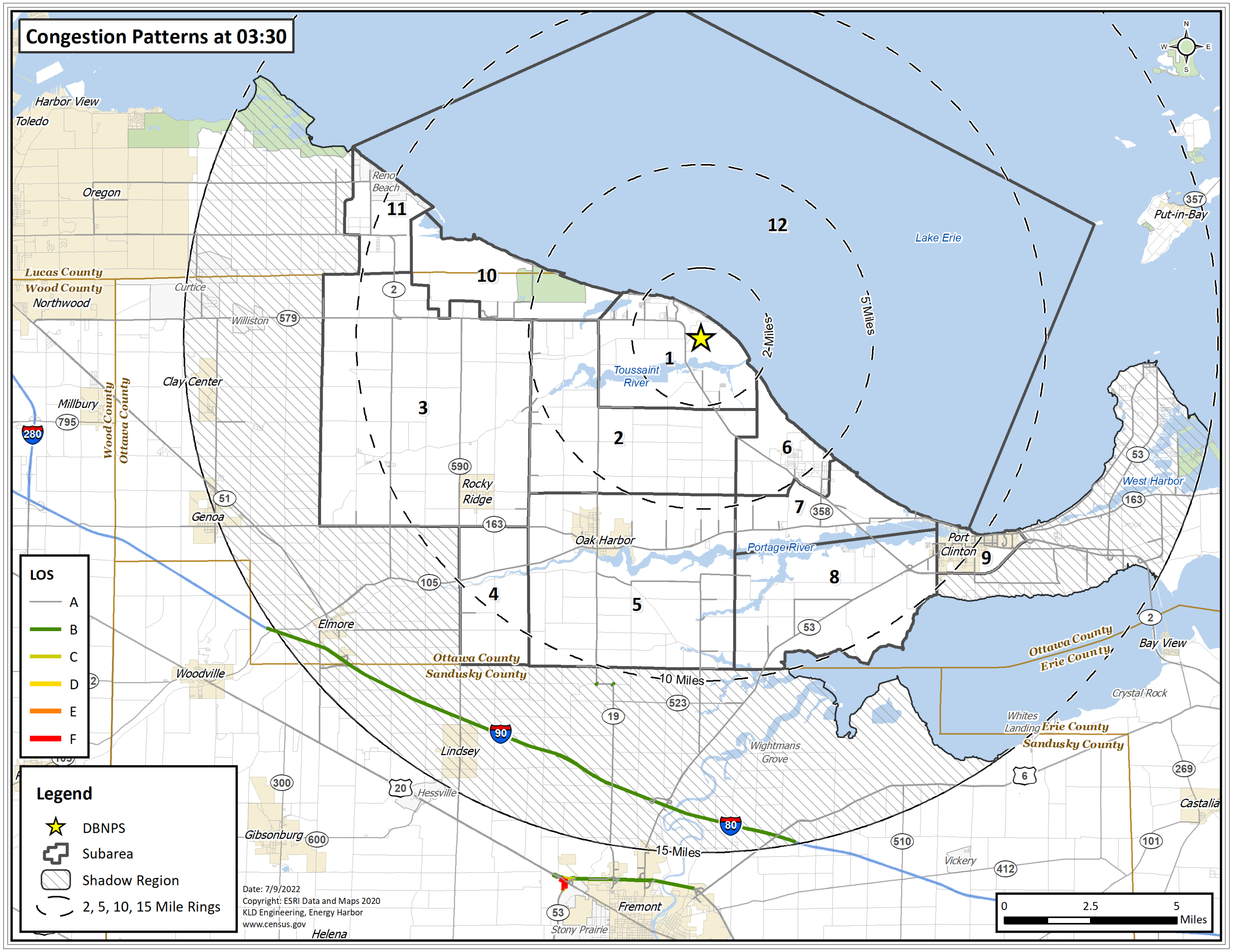


Figure 7-6. Congestion Patterns at 3 Hours and 30 Minutes after the Advisory to Evacuate

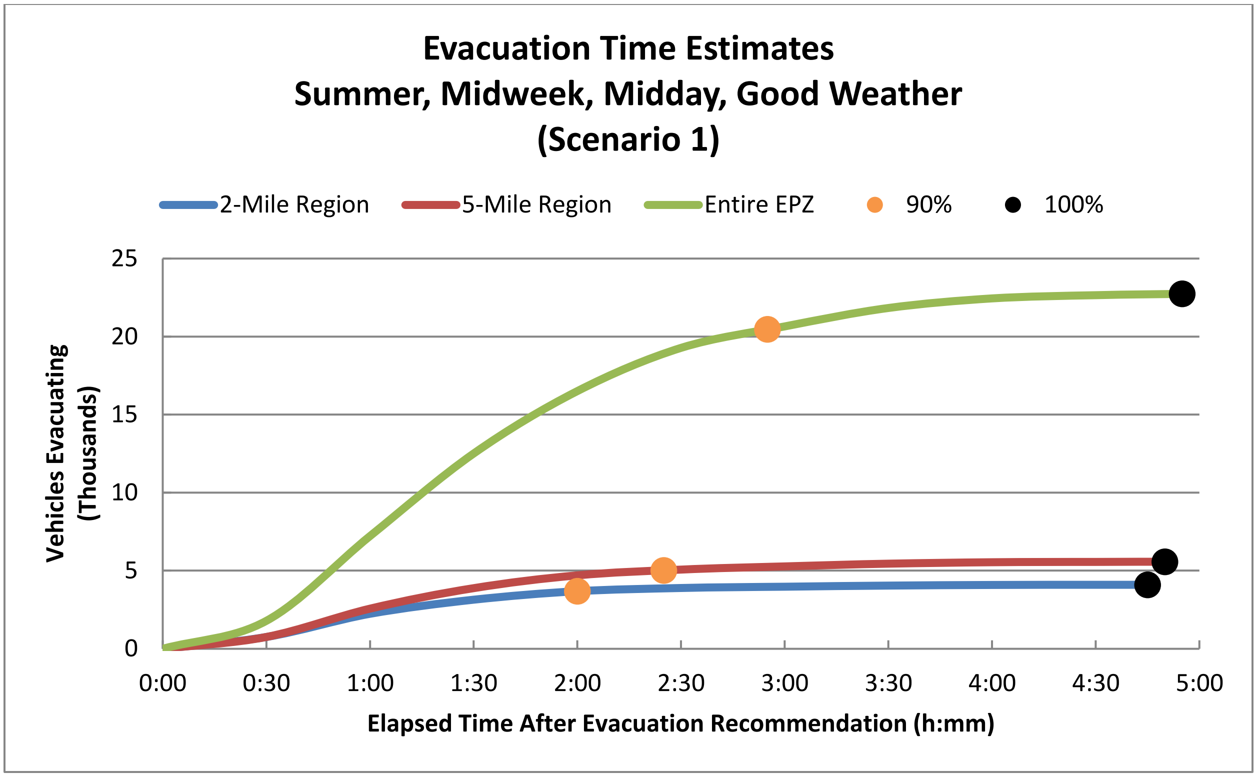


Figure 7-7. Evacuation Time Estimates - Scenario 1 for Region R03

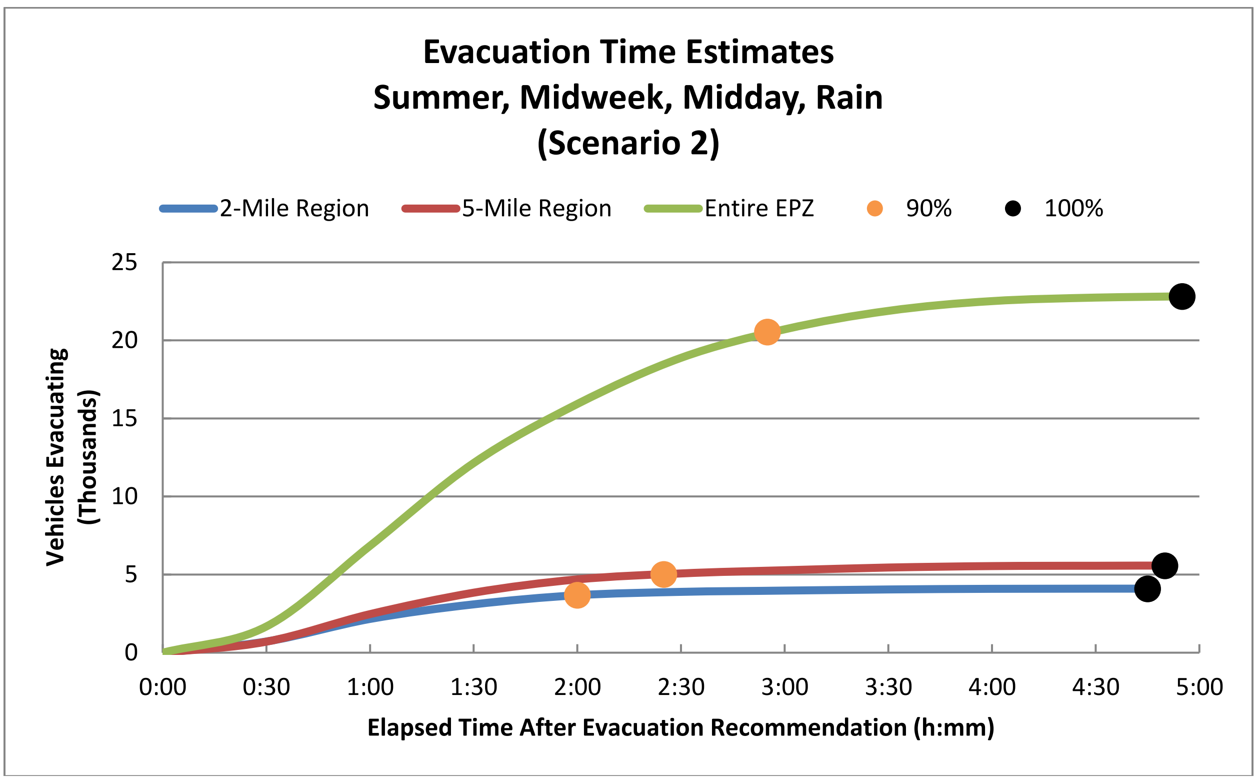


Figure 7-8. Evacuation Time Estimates - Scenario 2 for Region R03

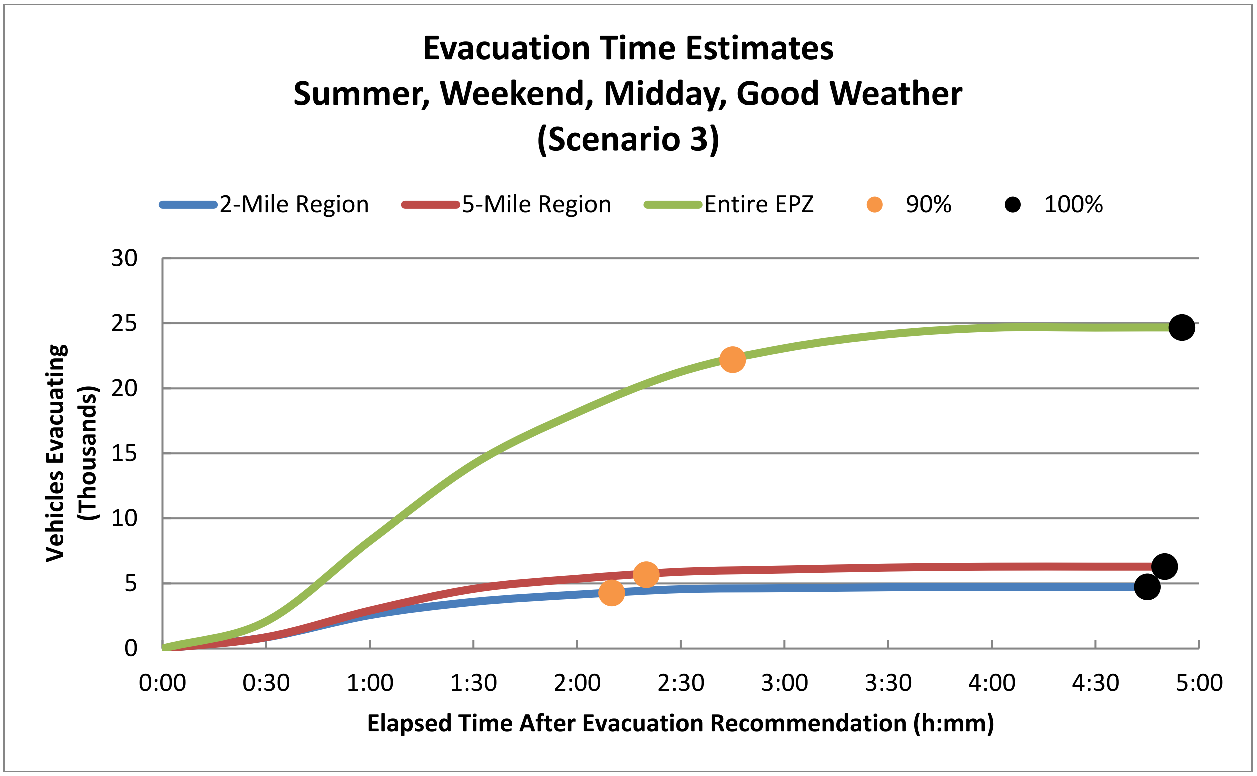


Figure 7-9. Evacuation Time Estimates - Scenario 3 for Region R03

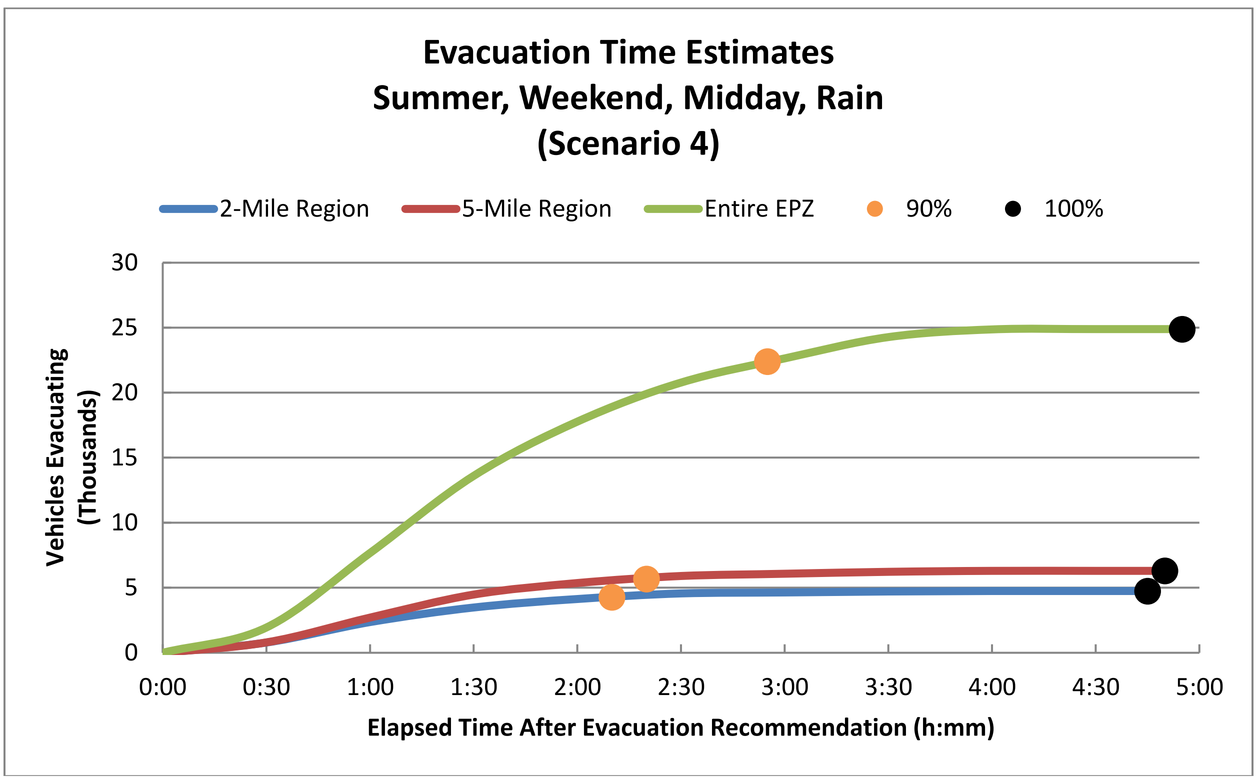


Figure 7-10. Evacuation Time Estimates - Scenario 4 for Region R03

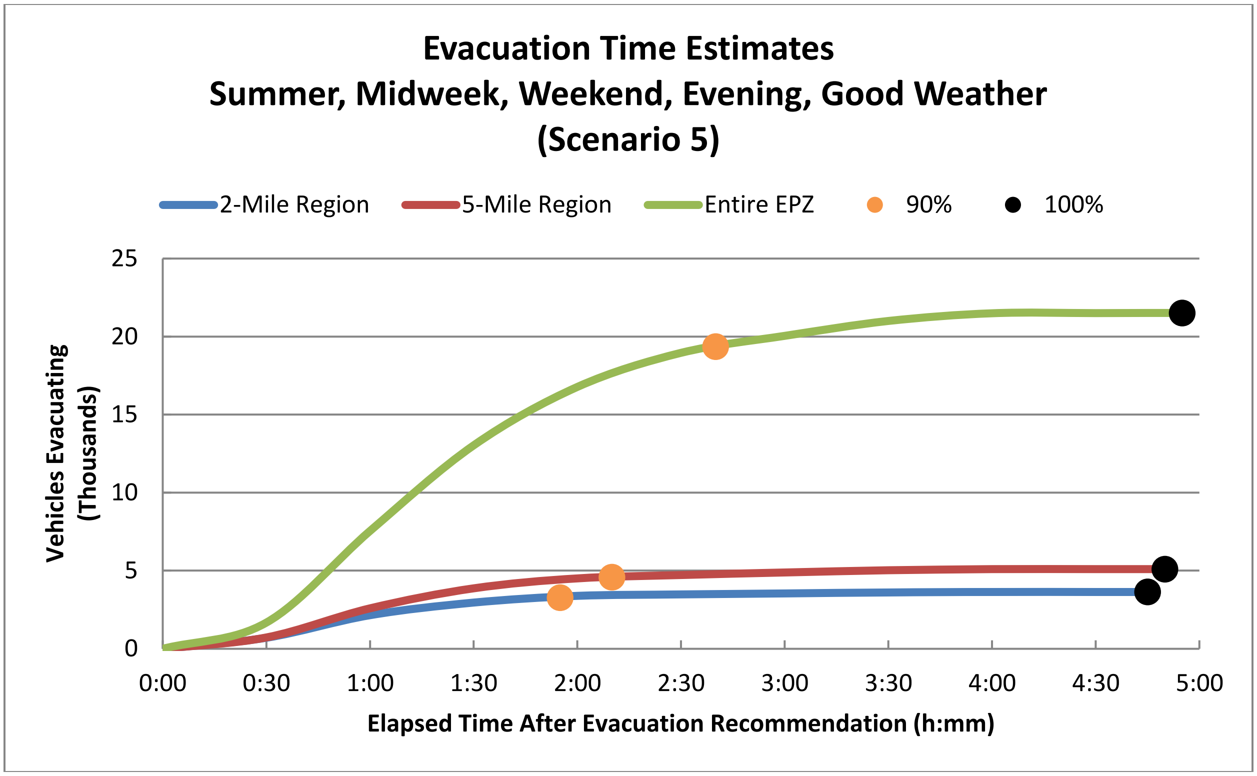


Figure 7-11. Evacuation Time Estimates - Scenario 5 for Region R03

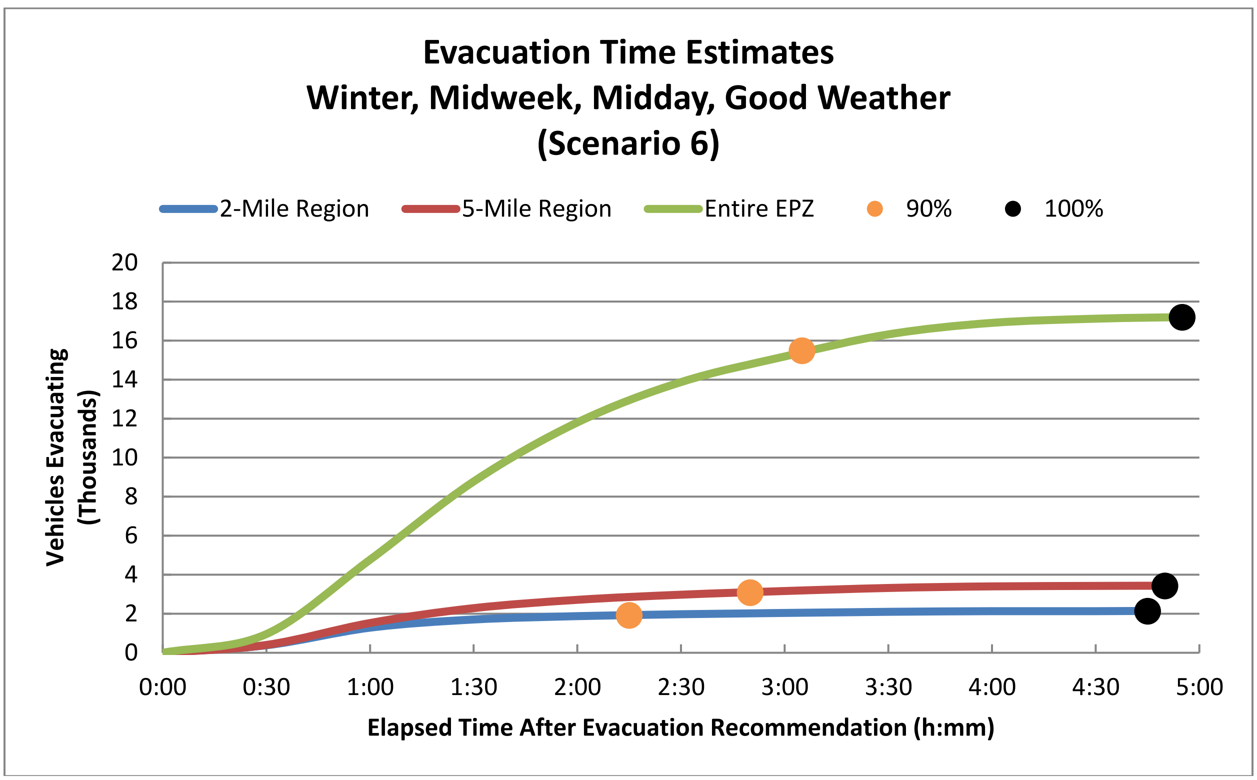


Figure 7-12. Evacuation Time Estimates - Scenario 6 for Region R03

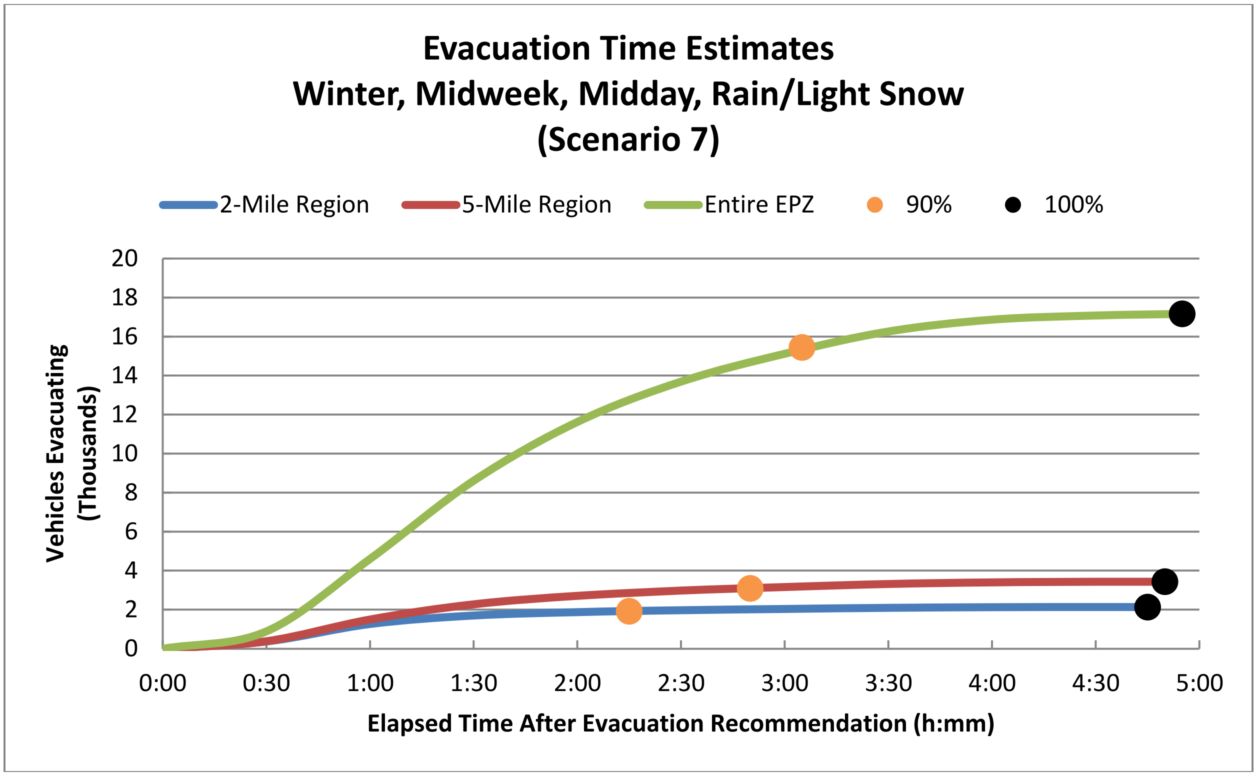


Figure 7-13. Evacuation Time Estimates - Scenario 7 for Region R03

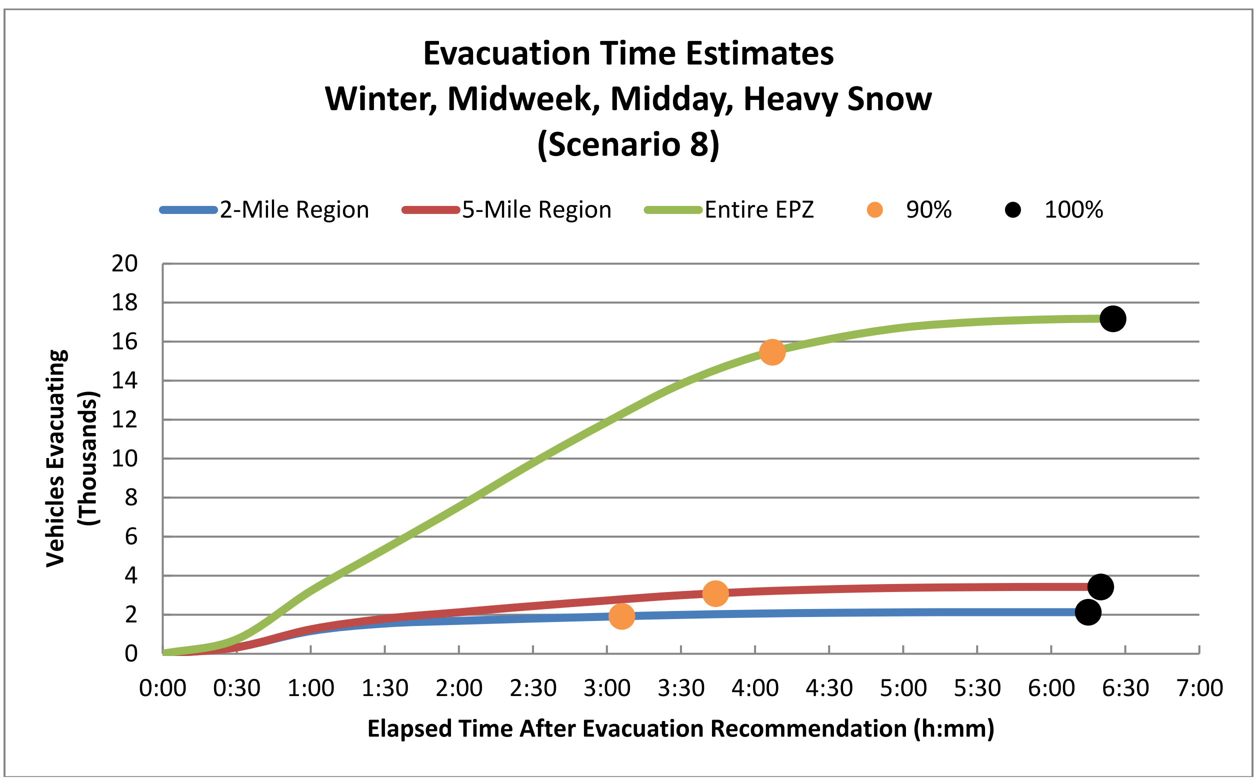


Figure 7-14. Evacuation Time Estimates - Scenario 8 for Region R03

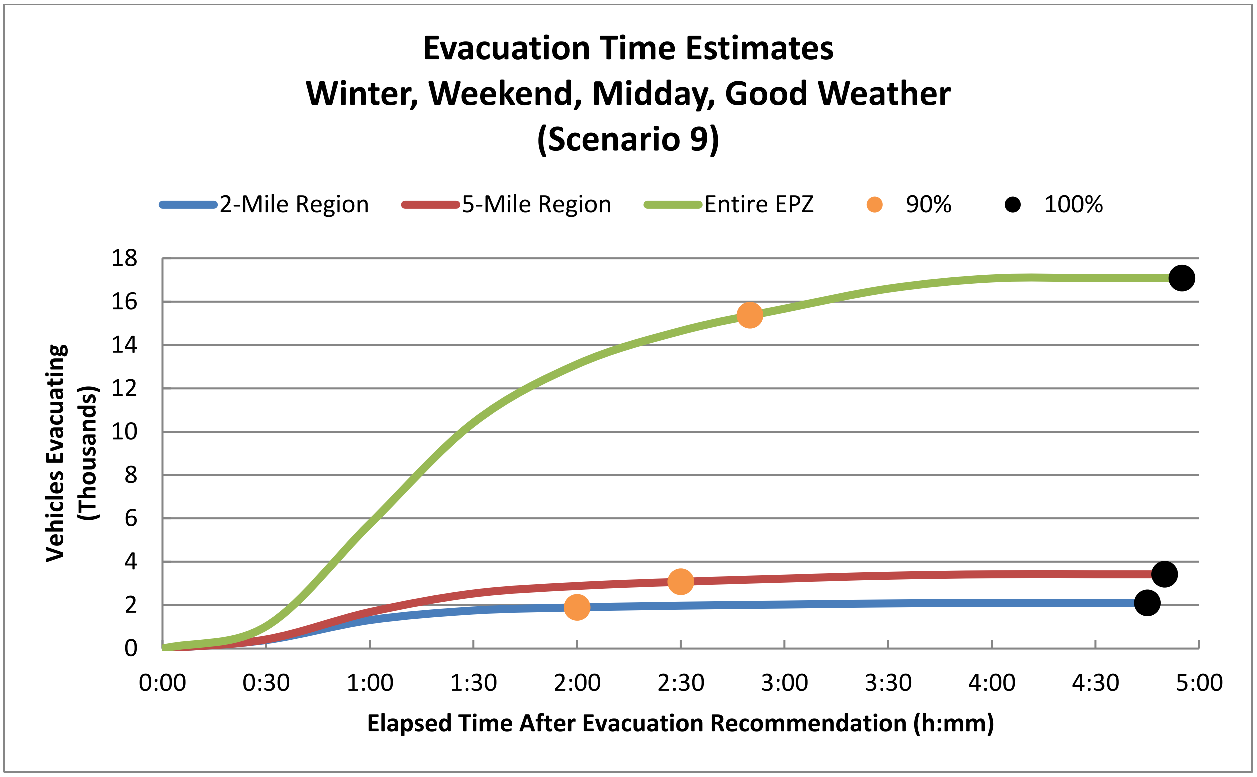


Figure 7-15. Evacuation Time Estimates - Scenario 9 for Region R03

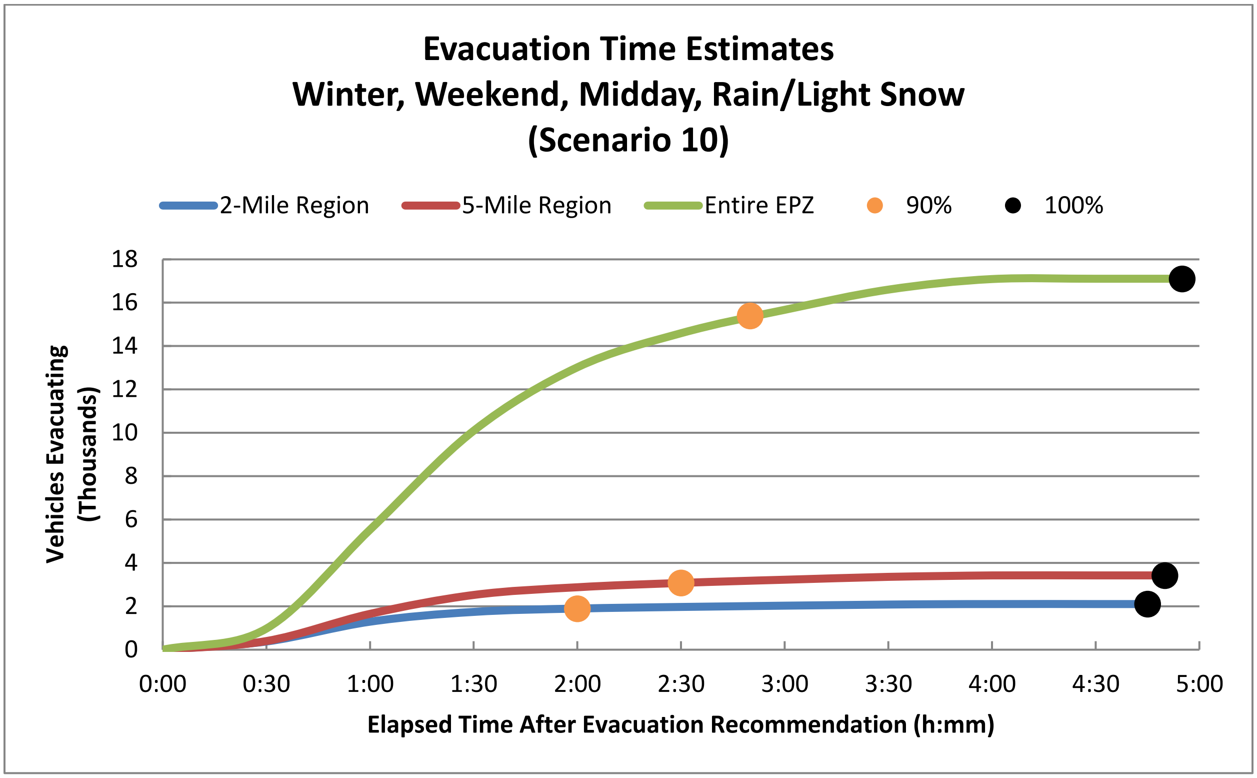


Figure 7-16. Evacuation Time Estimates - Scenario 10 for Region R03

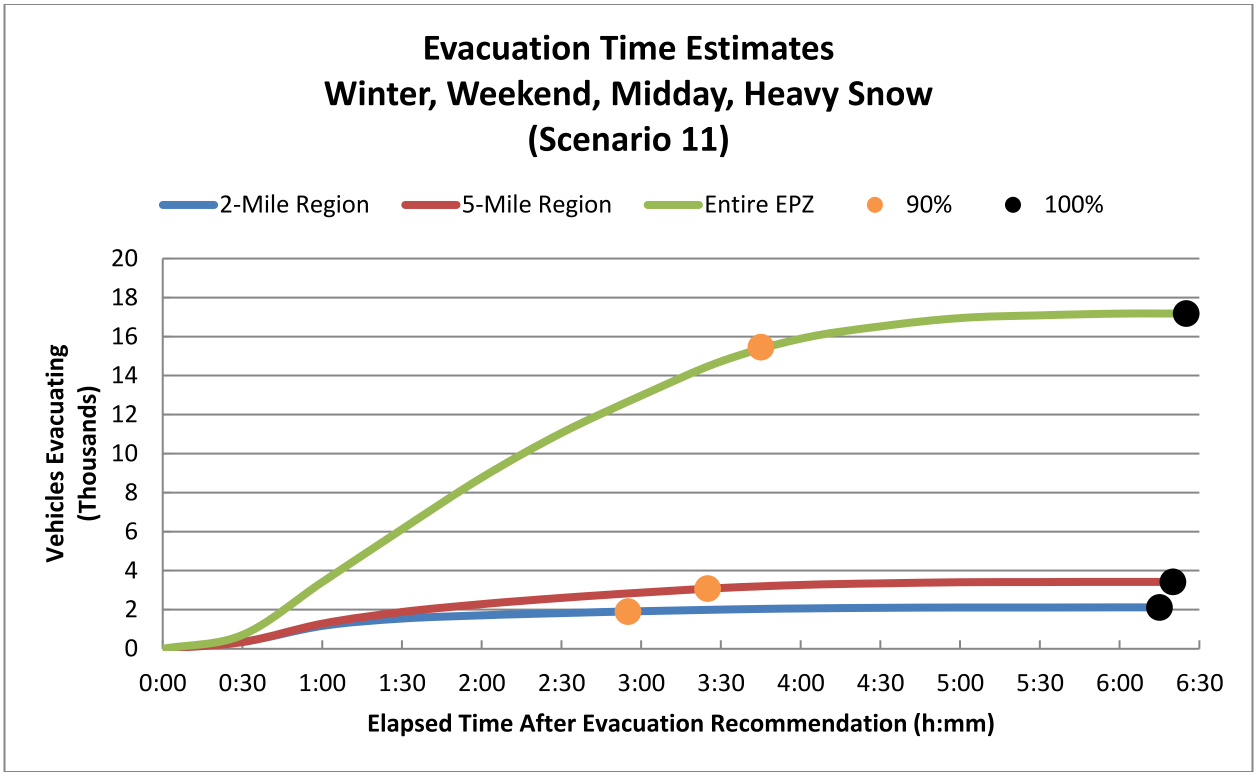


Figure 7-17. Evacuation Time Estimates - Scenario 11 for Region R03

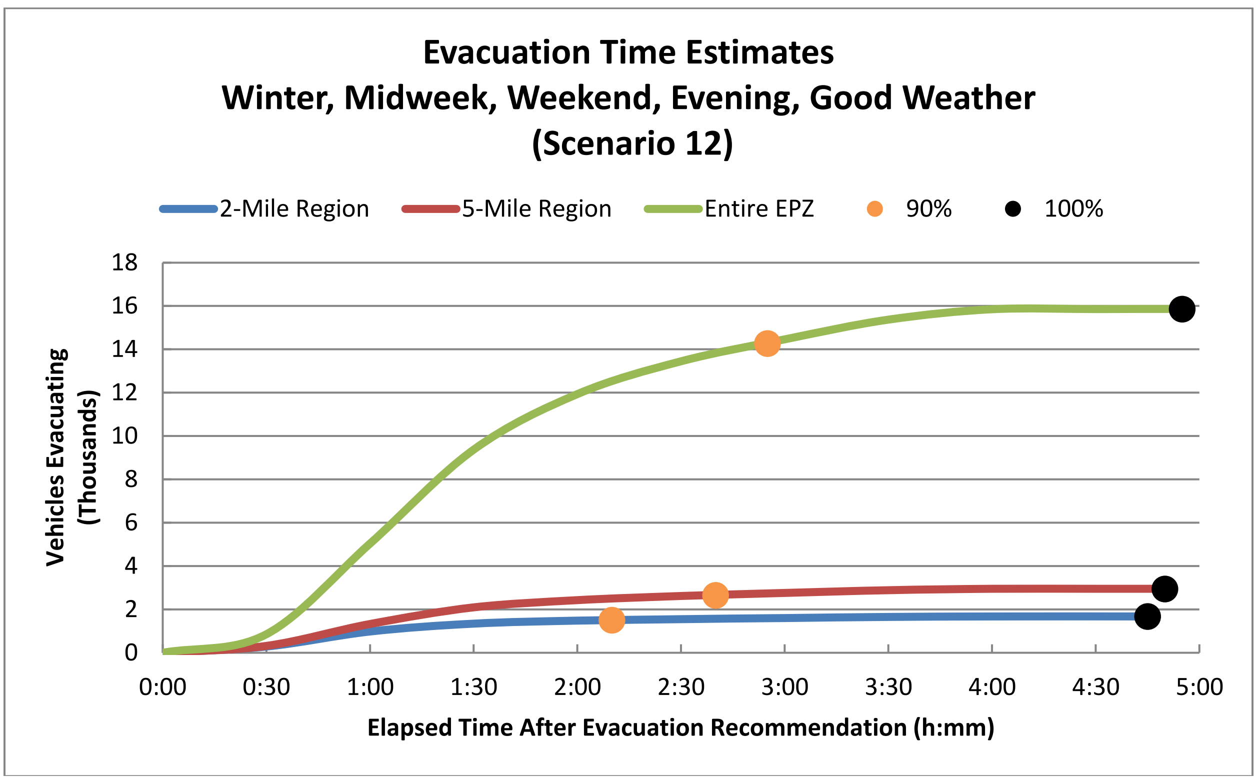


Figure 7-18. Evacuation Time Estimates - Scenario 12 for Region R03

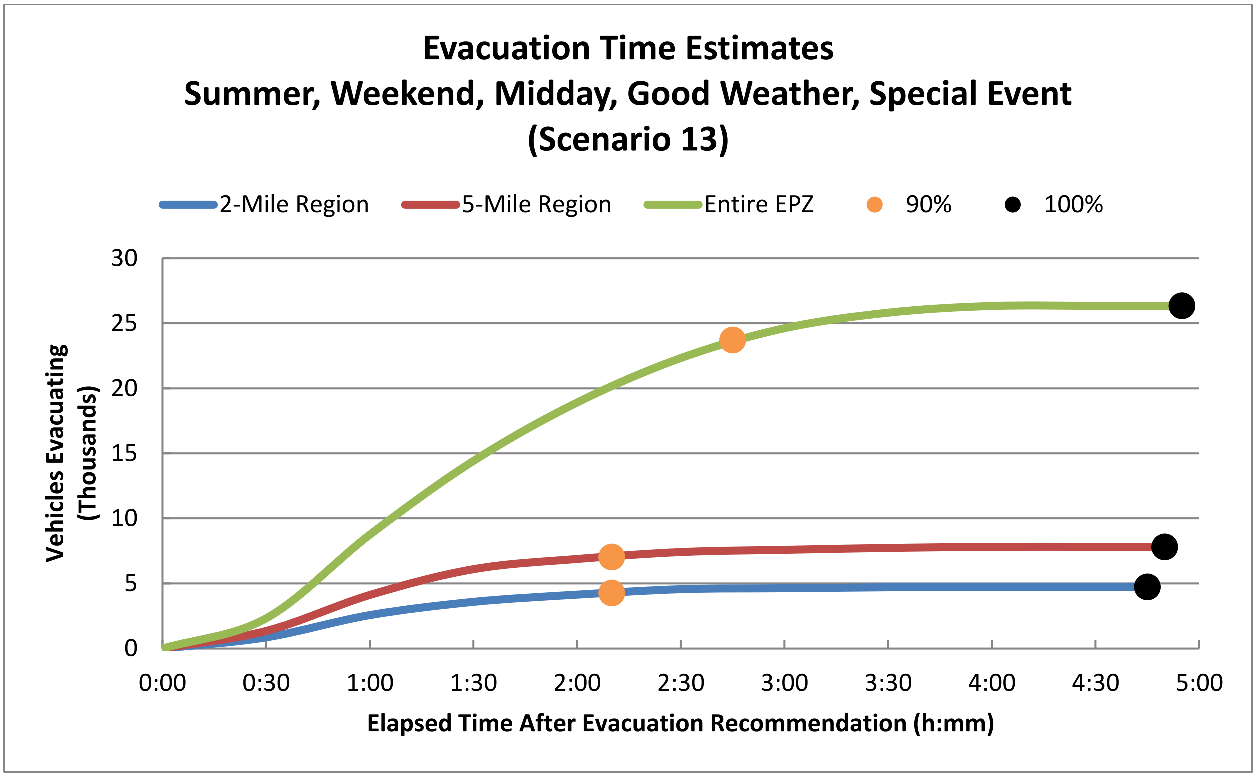


Figure 7-19. Evacuation Time Estimates - Scenario 13 for Region R03

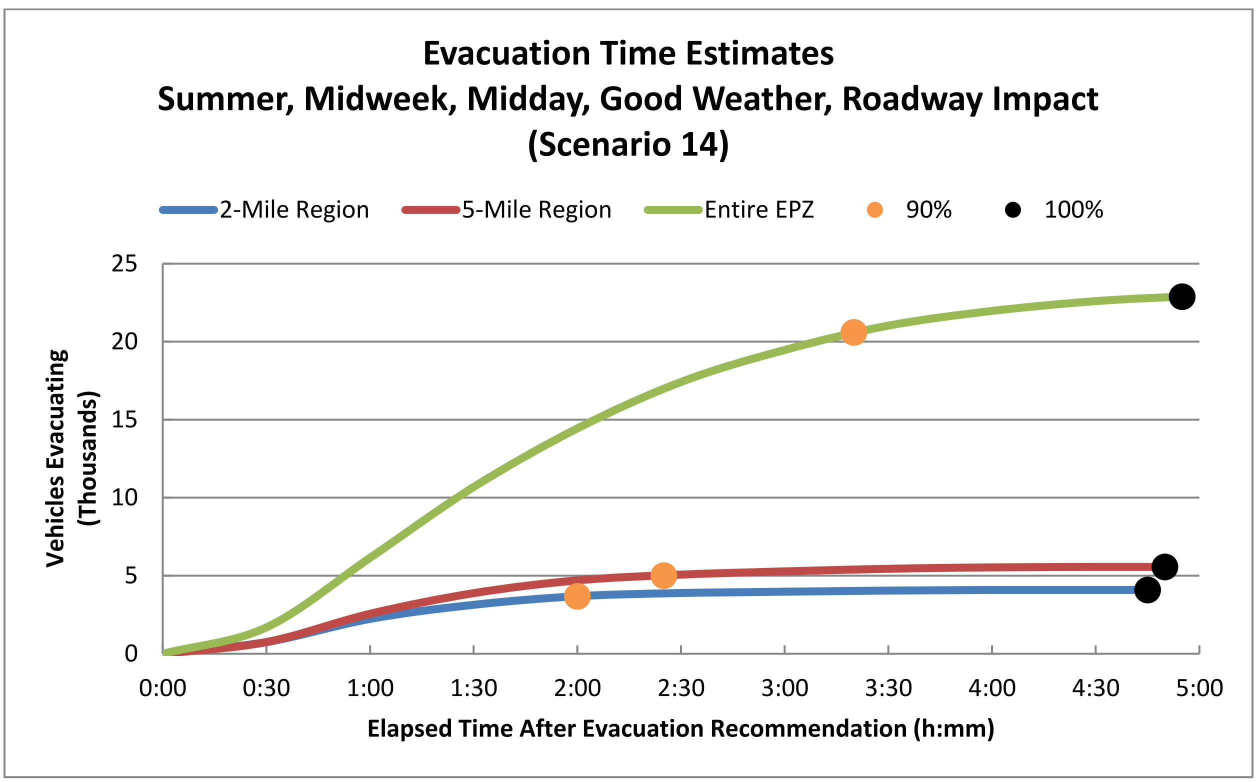


Figure 7-20. Evacuation Time Estimate - Scenario 14 for Region 03

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 vehicles, 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, day care centers/nursery schools, medical facilities and correctional 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 buses 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. Ambulances are treated as one 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 DBNPS EPZ indicates that schoolchildren will be evacuated to receiving schools at emergency classification levels of Alert or higher, and that parents should pick schoolchildren up at receiving schools. This is also assumed for those at day care centers/nursery schools.

As discussed in Section 2, this study assumes a rapidly escalating accident, wherein evacuation is ordered promptly and no early protective actions have been implemented. Therefore, schools, day care centers/nursery schools and special facilities receive initial notification at the same time as the rest of the EPZ. Children at schools and day care centers/nursery schools are evacuated to receiving schools. Picking up children at schools and day care centers/nursery schools could add to traffic congestion at these facilities, delaying the departure of the buses evacuating the children at schools and day care/nursery schools, 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.

The procedure for computing transit dependent ETE is to:

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

The 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/Day Care Centers/Nursery Schools, Transit-Dependent People, and Special Facilities

The EPZ bus resources are assigned to evacuating schoolchildren (if school is in session at the time of the ATE) as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat “inefficient”, or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the receiving schools 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 single wave transit evacuation and for a second wave. 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.

The number of available transportation resources was based on information provided by the offsite agencies. 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 resources to evacuate all schoolchildren, the transit dependent population, patients at medical facilities, inmates at correctional facilities and the access and/or functional needs population in a single wave.

When school and day care center/nursery 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.

Evacuation of School and Day Care Center/Nursery School Evacuation

Activity: Mobilize Drivers (A→B→C)

The 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 accident with no observable

indication before the fact, bus drivers would require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the schools and day care centers/nursery schools. Mobilization time is slightly longer in adverse weather – 100 minutes for rain/light snow and 110 minutes for heavy snow conditions.

Activity: Board Passengers (C→D)

Based on discussions with offsite agencies, a loading time of 15 minutes for good weather (20 minutes for rain/light snow and 25 minutes for heavy snow) for school and day care center/nursery 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 and day care centers/nursery school 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 receiving school. This is done in UNITES by interactively selecting the series of nodes from the school/day care center/nursery 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 school and day care center/nursery school in the EPZ is shown in Table 8-2 through Table 8-4 for school and day care center/nursery school evacuation, in Table 8-5 through Table 8-7 for the transit vehicles evacuating transit-dependent persons, Table 8-8 through Table 8-10 for transport vehicles for medical facility patients and Table 8-11, which are discussed in detail later in this Section. 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 receiving school was computed assuming an

average speed of 55 mph, 50 mph and 47 mph for good weather, rain/light snow and heavy snow, respectively. Speeds were reduced in Table 8-2 through Table 8-4 to 55 mph (50 mph for rain/light snow 10% decrease and 47 mph for heavy snow 15% decrease) for those calculated bus speeds which exceed 55 mph, as the bus speed limit in Ohio is 55 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 and day care centers/nursery 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 receiving school (ETA to R.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 minutes + 15 + 17 = 2:05 (rounded up to 5 minutes) for Oak Harbor Middle School, with good weather; here, 17 minutes is the time to travel 3.9 miles at 14.5 mph.

The average single-wave ETE, for schools/day care centers/nursery 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 receiving school is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

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

The distances from the EPZ boundary to the receiving school are measured using GIS software along the most likely route from the EPZ exit point to the receiving school. The receiving school 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 55 mph, 50 mph, and 47 mph for good weather, rain/light snow and heavy snow, respectively, are applied for this activity for the buses servicing the school and day care center/nursery 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). Thus, the second wave ETE is not considered.

<u>*Evacuation of Transit Dependent Population (Residents without access to a vehicle)*</u>

A detailed computation of the transit dependent population was done and is discussed in Section 3.7. The total number of transit dependent people per Subarea was determined using a weighted distribution based on population (see Table 3-11 for the distribution used). As discussed in Section 3.7, the number of buses required to evacuate this population was determined by the capacity of 30 people per bus. KLD designed 7 bus routes to service the

major evacuation routes, for the purposes of this study. The bus routes are shown graphically in Figure 10-2 and described in Table 10-1. Those buses servicing the transit-dependent evacuees will first travel along these routes, gather people at the pickup points, then proceed out of the EPZ.

The ETEs for the transit trips were developed using both good weather and adverse weather conditions. Table 8-5 (good weather), Table 8-6 (rain/light snow) and Table 8-7 (heavy snow) show the ETE breakdown for each step (discussed below) in the transit-dependent evacuation process.

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 95% of the evacuees will have completed their mobilization when the buses will begin their routes, approximately 195 minutes after the ATE for good weather. Mobilization time is slightly longer in adverse weather – 205 minutes in rain/light snow and 215 in heavy snow conditions.

Activity: Board Passengers (C→D)

For multiple stops along a route (transit-dependent bus routes) estimation of travel time must allow for the delay associated with stopping and starting at each pick-up point. The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

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

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

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

Assigning reasonable estimates:

- B = 50 seconds: a generous value for a single passenger, carrying personal items, to board per stop
- v = 25 mph = 37 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 1 minute per stop. Allowing 30 minutes pick-up time per bus run implies 30 stops per run, for good weather. It is assumed that bus acceleration and speed will be less in rain/light snow and heavy snow resulting in 10-minute 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 Subarea 1 & 2 (Route 1) is computed as 195 + 18 + 30 = 4:05 for good weather (rounded up to nearest 5 minutes). Here, 18 minutes is the time to travel 16.1 miles at 52.9 mph, the average speed output by the model for this route starting at 195 minutes.

The average ETE for a single wave evacuation of transit-dependent people is greater 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. This is results of the high mobilization times for residents without any commuters.

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.

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 10-3. For a single-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. Assumed bus speeds of 55 mph, 50 mph and 47 mph for good weather, rain/light snow and heavy snow, respectively, will be applied for this activity for buses servicing 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. Bus travel times within the EPZ are computed using average speeds computed by DYNEV, using the aforementioned methodology that was used for school evacuation.

The second wave ETE for the bus route servicing Subarea 1 & 2 (Route 1) is computed as follows for good weather:

- Bus arrives at reception center at 4:14 in good weather (4:05 to exit EPZ + 9-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 wave service along the route: 8.6 minutes (equal to travel time to reception center) + 17.6 minutes (16.1 miles @ 55 mph – assumed speed to return to the start of route) + 18.1 minutes (16.1 miles @ 53.3 mph – network wide speed at time bus starts route for the second time) = 44 minutes.
- Bus completes pick-ups along route: 30 minutes.
- Bus exits EPZ at time 4:14 + 0:15 + 0:44 + 0:30 = 5:45 after the ATE (rounded up to the nearest 5 minutes).

The ETE for the completion of the second wave for all transit-dependent bus routes are provided in Table 8-5, Table 8-6 and Table 8-7. The average ETE for a second 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

The evacuation of medical facilities is similar to those for school and pre-school evacuation except:

- Buses are assigned on the basis of 30 patients to allow for staff to accompany the patients.
- Wheelchair buses can accommodate 4 patients.
- Ambulances can accommodate 2 patients.

Activity: Mobilization (A→B→C)

As discussed in Section 2.4 and in Table 2-2, it is assumed that the mobilization time for medical facilities average 90 minutes for buses and wheelchair buses and 30 minutes for ambulances in good weather. These times are increased by 10 minutes for rain/light snow and 20 minutes for heavy snow. Specially trained medical support staff (working their regular shift) will be on site to assist in the evacuation of patients. It is further assumed that additional staff (if needed) could be mobilized over the same 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. Loading times were not adjusted for rain/light snow and heavy snow weather for medical facilities.

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, respectively. The distances shown were estimated using GIS software. 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 55 mph (50 mph for rain/light snow and 47 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 buses, and ambulances at capacity is assumed such that the maximum loading times for buses, wheelchair vans and ambulances are 30, 75 and 30 minutes, respectively. All ETE are rounded up to the nearest 5 minutes.

For example, the calculation of ETE for the Riverview Healthcare Campus with 23 ambulatory residents during good weather is:

> ETE: 90 + (23 x 1) + 15 (11 miles at 43.8 mph) = 128 min or 2:10 (rounded up 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.

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

As shown in Table 8-1, there are sufficient resources to evacuate all patients at medical facilities in a single wave. Thus, the second wave ETE is not considered.

Evacuation of Correctional Facilities

Activity: Mobilization (A→B→C)

As discussed in Section 2.4 and in Table 2-2, it is assumed that the mobilization time for correctional facilities average 90 minutes in good weather, 100 minutes in rain/light snow and 110 for heavy snow. Specially trained officers will be on site to assist in the evacuation of

inmates. It is further assumed that additional officers (if needed) could be mobilized over this same 90-minute timeframe.

Activity: Board Passengers (C→D)

Item 5 of Section 2.4 discusses bus loading times for inmates. Loading times are assumed to be 15-minute per bus and buses can be loaded in parallel. Item 3 of Section 2.4 discusses transit vehicle capacities to cap loading times per vehicle type.

Activity: Travel to EPZ Boundary (D→E)

Using GIS software, the shortest route from the correctional facilities to the EPZ boundary, traveling away from the plant, is 2.6 miles for Ottawa County Detention and 1.2 miles for Ottawa County Misdemeanor Jail. As shown in Table 8-11, the travel time to traverse 2.6 miles for Ottawa County Detention is 6 minutes (2.6 miles @ 28 mph [network wide average speed at this time]) in good weather, rain/light snow and heavy snow. All ETE are rounded to the nearest 5 minutes.

For example, for Ottawa County Detention, buses exit EPZ at time: 90 + 15 + 6 = 1:55, rounded to the nearest 5-minutes, after the ATE.

The average ETE for a single wave evacuation for the correctional facilities are less than the general population ETE at the 90^{th} percentile for an evacuation of the entire EPZ (Region R03), during Scenario 6 conditions.

Activity: Buses Travel to Host Facilities (E→F), Inmates Leave (F→G), Buses Returns to Route for Second Wave Evacuation (G→C→D→E)

As shown in Table 8-1, there are sufficient resources to evacuate all inmates at correctional facilities in a single wave. Thus, the second wave ETE is not considered.

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 3.8. Table 8-12 summarizes the ETE for access and/or functional needs population who would need transportation assistance in the event of an emergency. The table is categorized by type of vehicle required and then broken down by weather condition. The table takes into consideration the deployment of multiple vehicles (not filled to capacity) to reduce the number of stops per vehicle.

Due to limitations on driving for the access and/or functional needs population, it is assumed they will be picked up from their homes. Furthermore, it is conservatively assumed that bedridden households are spaced 3 miles apart. Vehicle speeds approximate 20 mph between households in good weather (10% slower in rain/light snow and 15% slower in heavy snow). Mobilization times of 90 minutes were used (100 minutes for rain/light snow and 110 minutes for heavy snow) for buses and wheelchair buses and 30 minutes (40 minutes for rain/light snow and 50 minutes for heavy snow) for ambulances. The last household (HH) is assumed to be 5 miles from the EPZ boundary, and the network-wide average speed, capped at 55 mph (50 mph

for rain/light snow and 47 mph for heavy snow), after the last pickup is used to compute travel time after the last pick up.

The 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 access and/or functional needs person per household implies that 188 households need to be serviced. It is assumed that 7 buses are needed for ambulatory people, 7 wheelchair vans for wheelchair bound people, and 2 ambulances for bedridden people to evacuate in a reasonable amount of time.

The following outlines the ETE calculation for ambulances:

1. Assume 8 buses are deployed, each with about 21 stops, to service a total of 163 HH.
2. The ETE is calculated as follows:
    a. Buses arrive at the first pickup location: 90 minutes
    b. Load passenger at first pickup: 1 minute
    c. Travel to next pickup locations: 180 minutes (assumed 3 miles @ 20 mph for 20 stops)
    d. Load passenger at subsequent pickup location: 21 minutes
    e. Travel to EPZ boundary: 5 minutes (5 miles @ 55 mph).

ETE: 90 + 1 + 180 + 21 + 5 = 5:00

The ETE of a single wave evacuation of the ambulatory access and/or functional needs population within the EPZ is greater 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. If there are more buses available during an evacuation, it should be allocated to the access and/or functional needs population. However, the ETE of a single wave evacuation of the wheelchair and 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).

As shown in Table 8-1, there are sufficient resources to evacuate all access and/or functional needs population in a single wave. Thus, the second wave ETE is not considered.

Table 8-1. Summary of Transportation Resources

Transportation Resource	Buses	Wheelchair Buses	Wheelchair Vans	Ambulances
Resources Available				
Jerusalem Elementary School	10	1	0	0
Ottawa County Transportation Agency	0	1	21	0
Port Clinton	18	2	0	4
Benton-Carroll-Salem	23	4	0	0
Danbury Township	9	2	0	3
Genoa Area	17	2	0	0
Woodmore	12	1	0	0
ACJFD Station 34	0	0	0	2
ACJFD Station 35	0	0	0	1
ACJFD Station 36	0	0	0	2
Carroll Township	0	0	0	2
Catawba Island Township	0	0	0	1
Erie Township	0	0	0	2
Harris-Elmore	0	0	0	2
Mid County EMS	0	0	0	3
TOTAL:	**89**	**13**	**21**	**22**
Resources Needed				
School/Day Care Center/Nursery School Transportation Needs (Table 3-7):	67	0	0	0
Medical Facility Transportation Needs (Table 3-6):	3	6	0	13
Access and/or Functional Population Transportation Needs (Table 3-9):	8	7	0	2
Correctional Facility Transportation Needs (Section 3.5.2):	4	0	0	0
Transit-Dependent Transportation Needs (Section 3.7):	7	0	0	0
TOTAL TRANSPORTATION NEEDS:	**89**	**13**	**0**	**15**

Table 8-2. School and Day Care Center/Nursery School Evacuation Time Estimates - Good Weather

School or Day Care Centers/Nursery 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 R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ATE to R.S. (hr:min)
LUCAS COUNTY SCHOOLS									
Jerusalem Elementary School	90	15	Inside Shadow Region			**N/A**	5.9	7	**1:55**
OTTAWA COUNTY SCHOOLS & DAY CARE CENTERS/NURSERY SCHOOLS									
Oak Harbor Middle School	90	15	3.9	14.5	17	**2:05**	7.9	9	**2:15**
R.C. Waters Elementary School	90	15	3.8	13.9	17	**2:05**	7.9	9	**2:15**
St Boniface Elementary School	90	15	3.8	20.5	12	**2:00**	7.9	9	**2:10**
Oak Harbor High School	90	15	4.5	14.8	19	**2:05**	7.9	9	**2:15**
Ottawa County Christian Academy	90	15	4.8	15.1	20	**2:05**	7.9	9	**2:15**
Bataan Memorial Intermediate Elementary School	90	15	3.2	55.0	4	**1:50**	15.5	17	**2:10**
Immaculate Conception School	90	15	2.6	28.0	6	**1:55**	15.5	17	**2:15**
Port Clinton Middle School	90	15	2.7	33.3	5	**1:50**	15.5	17	**2:10**
Port Clinton High School	90	15	2.8	26.0	7	**1:55**	15.5	17	**2:15**
North Point Educational Service	90	15	1.7	46.3	3	**1:50**	18.3	20	**2:10**
St Peter Precious Moments Preschool	90	15	1.1	55.0	2	**1:50**	24.8	28	**2:20**
St. John's Nursery School	90	15	3.7	20.5	11	**2:00**	7.9	9	**2:10**
Rainbow Acres Educational Daycare Center	90	15	3.7	20.5	11	**2:00**	7.9	9	**2:10**
Kersten's Korner Nursery School	90	15	4.5	20.5	14	**2:00**	7.9	9	**2:10**
Port Clinton Nursery School	90	15	2.2	29.0	5	**1:50**	15.5	17	**2:10**
GLCAP Port Clinton Early Childhood Center	90	15	0.8	26.9	2	**1:50**	15.5	17	**2:10**
					Maximum for EPZ:	**2:05**		**Maximum:**	**2:20**
					Average for EPZ:	**2:00**		**Average:**	**2:15**

Table 8-3. School and Day Care Center/Nursery School Evacuation Time Estimates – Rain/Light Snow

School or Day Care Centers/Nursery 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 R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ATE to R.S. (hr:min)
LUCAS COUNTY SCHOOLS									
Jerusalem Elementary School	100	20	Inside Shadow Region			**N/A**	5.9	8	**2:10**
OTTAWA COUNTY SCHOOLS & DAY CARE CENTERS/NURSERY SCHOOLS									
Oak Harbor Middle School	100	20	3.9	9.7	25	**2:25**	7.9	10	**2:35**
R.C. Waters Elementary School	100	20	3.8	9.1	25	**2:25**	7.9	10	**2:35**
St Boniface Elementary School	100	20	3.8	12.1	19	**2:20**	7.9	10	**2:30**
Oak Harbor High School	100	20	4.5	9.7	28	**2:30**	7.9	10	**2:40**
Ottawa County Christian Academy	100	20	4.8	10.0	29	**2:30**	7.9	10	**2:40**
Bataan Memorial Intermediate Elementary School	100	20	3.2	50.0	4	**2:05**	15.5	19	**2:25**
Immaculate Conception School	100	20	2.6	26.3	6	**2:10**	15.5	19	**2:30**
Port Clinton Middle School	100	20	2.7	30.8	6	**2:10**	15.5	19	**2:30**
Port Clinton High School	100	20	2.8	24.2	7	**2:10**	15.5	19	**2:30**
North Point Educational Service	100	20	1.7	42.1	3	**2:05**	18.3	22	**2:30**
St Peter Precious Moments Preschool	100	20	1.1	50.0	2	**2:05**	24.8	30	**2:35**
St. John's Nursery School	100	20	3.7	12.1	19	**2:20**	7.9	10	**2:30**
Rainbow Acres Educational Daycare Center	100	20	3.7	12.1	19	**2:20**	7.9	10	**2:30**
Kersten's Korner Nursery School	100	20	4.5	11.7	24	**2:25**	7.9	10	**2:35**
Port Clinton Nursery School	100	20	2.2	26.5	5	**2:05**	15.5	19	**2:25**
GLCAP Port Clinton Early Childhood Center	100	20	0.8	24.7	2	**2:05**	15.5	19	**2:25**
					Maximum for EPZ:	**2:30**		**Maximum:**	**2:40**
					Average for EPZ:	**2:15**		**Average:**	**2:30**

Table 8-4. School and Day Care Center/Nursery School Evacuation Time Estimates – Heavy Snow

School or Day Care Centers/Nursery 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 R.S. (mi.)	Travel Time from EPZ Bdry to R.S. (min)	ATE to R.S. (hr:min)
LUCAS COUNTY SCHOOLS									
Jerusalem Elementary School	110	25	Inside Shadow Region			**N/A**	5.9	8	**2:25**
OTTAWA COUNTY SCHOOLS & DAY CARE CENTERS/NURSERY SCHOOLS									
Oak Harbor Middle School	110	25	3.9	20.8	12	**2:30**	7.9	11	**2:45**
R.C. Waters Elementary School	110	25	3.8	20.5	12	**2:30**	7.9	11	**2:45**
St Boniface Elementary School	110	25	3.8	37.6	7	**2:25**	7.9	11	**2:40**
Oak Harbor High School	110	25	4.5	21.0	13	**2:30**	7.9	11	**2:45**
Ottawa County Christian Academy	110	25	4.8	21.3	14	**2:30**	7.9	11	**2:45**
Bataan Memorial Intermediate Elementary School	110	25	3.2	47.0	5	**2:20**	15.5	20	**2:40**
Immaculate Conception School	110	25	2.6	25.2	7	**2:25**	15.5	20	**2:45**
Port Clinton Middle School	110	25	2.7	29.2	6	**2:25**	15.5	20	**2:45**
Port Clinton High School	110	25	2.8	23.1	8	**2:25**	15.5	20	**2:45**
North Point Educational Service	110	25	1.7	39.8	3	**2:20**	18.3	24	**2:45**
St Peter Precious Moments Preschool	110	25	1.1	46.0	2	**2:20**	24.8	32	**2:55**
St. John's Nursery School	110	25	3.7	37.6	6	**2:25**	7.9	11	**2:40**
Rainbow Acres Educational Daycare Center	110	25	3.7	37.6	6	**2:25**	7.9	11	**2:40**
Kersten's Korner Nursery School	110	25	4.5	37.6	8	**2:25**	7.9	11	**2:40**
Port Clinton Nursery School	110	25	2.2	26.3	6	**2:25**	15.5	20	**2:45**
GLCAP Port Clinton Early Childhood Center	110	25	0.8	26.3	2	**2:20**	15.5	20	**2:40**
					Maximum for EPZ:	**2:30**		**Maximum:**	**2:55**
					Average for EPZ:	**2:25**		**Average:**	**2:45**

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

Subarea	Route Number	Number of Buses	Single Wave						Distance to Rec. Ctr (miles)	Second Wave					
			Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)		Travel Time to Rec. Ctr (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1 & 2	**1**	1	195	16.1	52.9	18	30	**4:05**	7.9	9	5	10	44	30	**5:45**
3 & 4	**2**	1	195	13.8	53.9	15	30	**4:05**	10.7	12	5	10	44	30	**5:50**
5	**3**	1	195	5.0	49.0	6	30	**3:55**	7.9	9	5	10	20	30	**5:10**
6 & 7	**4**	1	195	10.1	55.0	11	30	**4:00**	15.5	17	5	10	39	30	**5:45**
8	**5**	1	195	9.4	55.0	10	30	**4:00**	15.5	17	5	10	37	30	**5:40**
9	**6**	1	195	3.0	27.3	7	30	**3:55**	15.5	17	5	10	26	30	**5:25**
11	**7**	1	195	2.4	52.5	3	30	**3:50**	7.2	8	5	10	13	30	**5:00**
							Maximum ETE:	**4:05**						**Maximum ETE:**	**5:50**
							Average ETE:	**4:00**						**Average ETE:**	**5:30**

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

Subarea	Route Number	Number of Buses	Single Wave						Distance to Rec. Ctr (miles)	Second Wave					
			Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)		Travel Time to Rec. Ctr (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1 & 2	**1**	1	205	16.1	48.5	20	35	**4:20**	7.9	9	5	10	48	35	**6:10**
3 & 4	**2**	1	205	13.8	49.1	17	35	**4:20**	10.7	13	5	10	46	35	**6:10**
5	**3**	1	205	5.0	44.9	7	35	**4:10**	7.9	9	5	10	22	35	**5:35**
6 & 7	**4**	1	205	10.1	50.0	12	35	**4:15**	15.5	19	5	10	43	35	**6:10**
8	**5**	1	205	9.4	50.0	11	35	**4:15**	15.5	19	5	10	41	35	**6:05**
9	**6**	1	205	3.0	25.6	7	35	**4:10**	15.5	19	5	10	28	35	**5:50**
11	**7**	1	205	2.4	47.9	3	35	**4:05**	7.2	9	5	10	14	35	**5:20**
							Maximum ETE:	**4:20**						**Maximum ETE:**	**6:10**
							Average ETE:	**4:15**						**Average ETE:**	**5:55**

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

Subarea	Route Number	Number of Buses	Single Wave							Second Wave					
			Mobilization (min)	Route Length (miles)	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	**1**	1	215	16.1	36.1	27	40	**4:45**	7.9	10	5	10	52	40	**6:45**
3 & 4	**2**	1	215	13.8	45.1	18	40	**4:35**	10.7	14	5	10	49	40	**6:35**
5	**3**	1	215	5.0	19.1	16	40	**4:35**	7.9	10	5	10	24	40	**6:05**
6 & 7	**4**	1	215	10.1	47.0	13	40	**4:30**	15.5	20	5	10	46	40	**6:35**
8	**5**	1	215	9.4	47.0	12	40	**4:30**	15.5	20	5	10	44	40	**6:30**
9	**6**	1	215	3.0	23.4	8	40	**4:25**	15.5	20	5	10	31	40	**6:15**
11	**7**	1	215	2.4	44.6	3	40	**4:20**	7.2	9	5	10	15	40	**5:40**
							Maximum ETE:	**4:45**						**Maximum ETE:**	**6:45**
							Average ETE:	**4:35**						**Average ETE:**	**6:20**

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)	Speed (mph)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
OTTAWA COUNTY, OH									
Riverview Healthcare Campus	Ambulatory	90	1	23	23	11.0	43.8	15	**2:10**
	Wheelchair bound	90	5	43	75	11.0	45.1	15	**3:00**
	Bedridden	30	15	14	30	11.0	42.5	16	**1:20**
Magruder Hospital	Ambulatory	90	1	4	4	3.1	31.4	6	**1:40**
	Wheelchair bound	90	5	8	40	3.1	33.2	6	**2:20**
	Bedridden	30	15	3	30	3.1	30.9	6	**1:10**
Edgewood Manor Nursing Home	Ambulatory	90	1	13	13	3.1	31.6	6	**1:50**
	Wheelchair bound	90	5	26	75	3.1	33.0	6	**2:55**
	Bedridden	30	15	8	30	3.1	30.7	6	**1:10**
								Maximum ETE:	**3:00**
								Average ETE:	**2:00**

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)	Speed (mph)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
OTTAWA COUNTY, OH									
Riverview Healthcare Campus	Ambulatory	100	1	23	23	11.0	40.4	16	**2:20**
	Wheelchair bound	100	5	43	75	11.0	41.1	16	**3:15**
	Bedridden	40	15	14	30	11.0	40.2	16	**1:30**
Magruder Hospital	Ambulatory	100	1	4	4	3.1	29.1	6	**1:50**
	Wheelchair bound	100	5	8	40	3.1	30.7	6	**2:30**
	Bedridden	40	15	3	30	3.1	29.3	6	**1:20**
Edgewood Manor Nursing Home	Ambulatory	100	1	13	13	3.1	28.8	6	**2:00**
	Wheelchair bound	100	5	26	75	3.1	30.3	6	**3:05**
	Bedridden	40	15	8	30	3.1	29.0	6	**1:20**
								Maximum ETE:	**3:15**
								Average ETE:	**2:10**

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

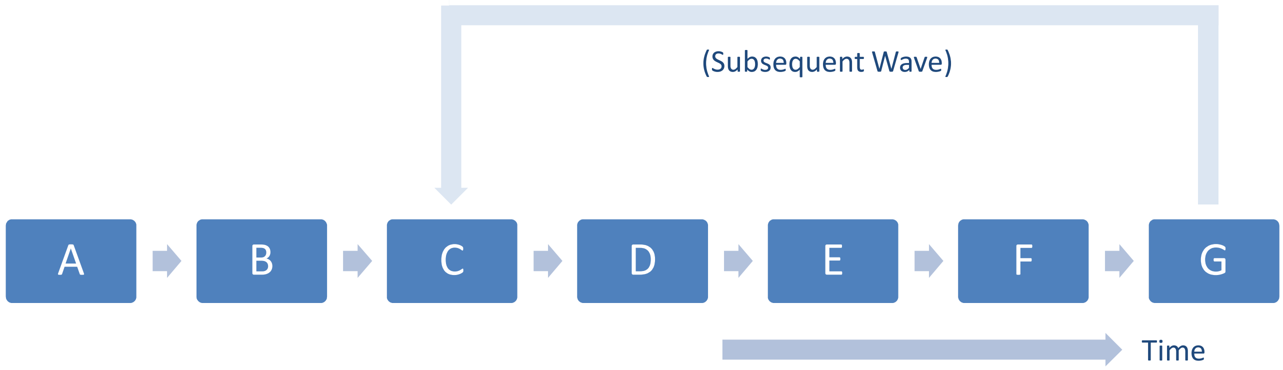
Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Speed (mph)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
OTTAWA COUNTY, OH									
Riverview Healthcare Campus	Ambulatory	110	1	23	23	11.0	37.5	18	**2:35**
	Wheelchair bound	110	5	43	75	11.0	37.5	18	**3:25**
	Bedridden	50	15	14	30	11.0	38.0	17	**1:40**
Magruder Hospital	Ambulatory	110	1	4	4	3.1	28.1	7	**2:05**
	Wheelchair bound	110	5	8	40	3.1	28.5	7	**2:40**
	Bedridden	50	15	3	30	3.1	28.7	6	**1:30**
Edgewood Manor Nursing Home	Ambulatory	110	1	13	13	3.1	27.9	7	**2:10**
	Wheelchair bound	110	5	26	75	3.1	28.2	7	**3:15**
	Bedridden	50	15	8	30	3.1	28.4	7	**1:30**
								Maximum ETE:	**3:25**
								Average ETE:	**2:20**

Table 8-11. Correctional Facilities Evacuation Time Estimates

Correctional Facility	Weather Conditions	Mobilization (min)	Number of Inmates	Number of Buses	Total Loading Time (mins)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Ottawa County Detention	Good	90	39	2	15	2.6	6	**1:55**
	Rain/Light Snow	100			20		6	**2:10**
	Heavy Snow	110			25		6	**2:25**
Ottawa County Misdemeanor Jail	Good	90	48	2	15	1.2	2	**1:50**
	Rain/Light Snow	100			20		2	**2:05**
	Heavy Snow	110			25		3	**2:20**
							Maximum ETE:	**2:25**
							Average ETE:	**2:10**

Table 8-12. Access and/or Functional Needs Population Evacuation Time Estimates

Vehicle Type	Households Requiring Vehicle	Vehicles deployed	Stops per Vehicle	Weather Conditions	Mobiliza-tion Time (min)	Loading Time at 1st Stop (min)	Travel to Subsequent Stops (min)	Total Loading Time at Subsequent Stops (min)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Buses	163	8	21	Normal	90	1	180	20	5	**5:00**
				Rain/Light Snow	100		200		6	**5:30**
				Heavy Snow	110		220		6	**6:00**
Wheelchair Buses	23	7	4	Normal	90	5	27	15	5	**2:25**
				Rain/Light Snow	100		30		6	**2:40**
				Heavy Snow	110		33		6	**2:50**
Ambulances	2	2	1	Normal	30	15	0	0	5	**0:50**
				Rain/Light Snow	40		0		6	**1:05**
				Heavy Snow	50		0		6	**1:15**
									Maximum ETE:	**6:00**
									Average ETE:	**3:05**



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

Figure 8-1. Chronology of Transit Evacuation Operations

9 TRAFFIC MANAGEMENT STRATEGY

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

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

The functions to be performed in the field are:

1. 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.

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

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

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

The TMP is the outcome of the following process:

1. The 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.
2. The ETE analysis treated all controlled intersections that are existing TCP or ACP locations in the county plans as being controlled by actuated signals. In Appendix K, Table K-1 identifies the number of intersections that were modeled as TCPs/ACPs.
3. Evacuation simulations were run using DYNEV II to predict traffic congestion during evacuation (see Section 7.3 and Figure 7-3 through Figure 7-6). 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 agency plans are examined. No additional TCPs or ACPs were identified, which could benefit the ETE, as part of this study.

4. Prioritization of TCPs and ACPs.
   a. Application of traffic and access control at some TCPs and ACPs will have a more pronounced influence on expediting traffic movements than at other TCPs and ACPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located farther from the power plant. Key locations for manual traffic control (MTC) were analyzed and their impact to ETE was quantified, as per NUREG/CR-7002, Rev. 1. See Appendix G for more detail.

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

9.1 Assumptions

The following are TMP assumptions made for this study:

- The ETE calculations documented in Sections 7 and 8 assume that the TMP is implemented during evacuation.
- The ETE calculations reflect the assumption that all "external-external" trips along highways outside of the EPZ continue throughout the evacuation. No ACPs will be established for external traffic roadways because they are outside the EPZ.
- All transit vehicles and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCPs and ACPs.
- Study assumptions 1 through 3 in Section 2.5 further discuss the TCP and ACP operations.

9.2 Additional Considerations

The use of Intelligent Transportation Systems (ITS) technologies can reduce the manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) can also be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. The 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 Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins their trip, while the on-board navigation systems (GPS units) and smartphones can be used to provide information during the evacuation trip.

These are only several examples of how ITS technologies can benefit the evacuation process. 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 a Subarea being evacuated to the boundary of the Evacuation Region and thence out of the EPZ.
- Routing of transit-dependent evacuees (schools, day care centers/nursery schools, medical facilities, correctional facilities, employees, transients or permanent residents, who do not own or have access to a private vehicle) from the EPZ boundary to receiving 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 (i.e., 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. KLD designed the 7 bus routes, shown graphically in Figure 10-2 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, day care centers/nursery schools, medical facilities and correctional facilities were routed along the most likely path from the facility being evacuated to the EPZ boundary, traveling toward the appropriate receiving schools and host facilities.

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/receiving schools to congregate care centers if the counties do make the decision to relocate evacuees.

10.2 Reception Centers

Figure 10-3 presents a map showing the primary reception centers and receiving schools for evacuees. Table 10-3 identifies the receiving school for each of the school and day care center/nursery schools in the EPZ. Transit-dependent evacuees are transported to the nearest reception center for each county. It is assumed that all school and day care center/nursery school evacuees will be taken to the appropriate receiving school and will be subsequently picked up by parents or guardians. Medical and correctional facilities are taken to the appropriate host facility[1].

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

Route	No. of Buses	Servicing	Length (mi.)
1	1	Subarea 1 and 2	16.1
2	1	Subarea 3 and 4	13.8
3	1	Subarea 5	5.0
4	1	Subarea 6 and 7	10.1
5	1	Subarea 8	9.4
6	1	Subarea 9	3.0
7	1	Subarea 11	2.4
Total:	**7**		

[1] It is assumed that all hospitals and nursing homes will be evacuated to Promedica Memorial Hospital in Sandusky County or Firelands Community Hospital in Erie County as per Ottawa County Radiological Emergency Response Plan, Rev 34.

Table 10-2. Bus Route Descriptions

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
1	Transit Dependent Routes for Subarea 1 and 2	128, 130, 131, 132, 134, 136, 141, 241, 540, 240, 456, 239, 238, 520, 237, 236, 519, 223, 224, 225, 226, 227, 228, 231, 256, 258, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
2	Transit Dependent Routes for Subarea 3 and 4	143, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 487, 185
3	Transit Dependent Routes for Subarea 5	263, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
4	Transit Dependent Routes for Subarea 6 and 7	123, 114, 113, 120, 112, 111, 110, 105, 104, 103, 102, 101, 100, 96, 94
5	Transit Dependent Routes for Subarea 8	20, 21, 22, 23, 24, 103, 102, 101, 100, 96, 94
6	Transit Dependent Routes for Subarea 9	323, 322, 321, 320, 319, 316, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97
7	Transit Dependent Routes for Subarea 11	151, 452, 149, 562, 154
8	Ottawa County Christian Academy	225, 226, 227, 228, 231, 256, 258, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
9	Oak Harbor High School	226, 227, 228, 231, 256, 258, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
10	Oak Harbor Middle School	416, 263, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
11	R. C. Waters Elementary School	417, 263, 260, 261, 264, 473, 265, 266, 267, 567, 268, 269
12	Port Clinton High School	307, 306, 308, 311, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97
13	Bataan Elementary School	302, 301, 300, 298, 550, 106, 25, 24, 103, 102, 101, 100, 96, 94, 95
14	Port Clinton Middle School	308, 311, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95
15	St. Bonafice Elementary School, St. John's Nursery School, Rainbow Acres Educational Daycare Center & Kersten's Korner Nursery School	415, 263, 260, 261, 264, 473, 265, 266, 267, 567, 268
16	Immaculate Conception School	305, 314, 313, 316, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
17	Port Clinton Nursery School	315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97
18	GLCAP Port Clinton Early Childhood	331, 334, 335, 98, 97
19	North Point Educational Service	243, 245, 222, 564, 246
20	St Peter Precious Moments Preschool	173, 563, 170, 169
21	Riverview Healthcare Campus	411, 410, 409, 408, 407, 406, 405, 404, 513, 109, 403, 402, 401, 400, 399, 398, 324, 323, 322, 321, 320, 319, 316, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95
22	Magruder Hospital	309, 310, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95
23	Edgewood Manor Nursing	568, 309, 310, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95
24	Ottawa County Misdmeaner Jail	333, 331, 334, 335, 98, 97, 99, 94, 95
25	Ottawa County Detention	305, 314, 313, 316, 312, 315, 326, 327, 328, 329, 330, 331, 334, 335, 98, 97, 99, 94, 95

Table 10-3. List of Receiving Schools

School	Receiving School
LUCAS COUNTY SCHOOLS	
Jerusalem Elementary School	Clay High School
OTTAWA COUNTY SCHOOLS & DAY CARES CENTERS/NURSERY SCHOOLS	
Oak Harbor Middle School	Fremont Ross High School
R.C. Waters Elementary School	
St Boniface Elementary School	
Oak Harbor High School	
Ottawa County Christian Academy	
North Point Educational Service	
St Peter Precious Moments Preschool	
St. John's Nursery School	
Rainbow Acres Educational Daycare Center	
Kersten's Korner Nursery School	
Bataan Memorial Intermediate Elementary School	Sandusky High School
Immaculate Conception School	
Port Clinton Middle School	
Port Clinton High School	
Port Clinton Nursery School	
GLCAP Port Clinton Early Childhood Center	

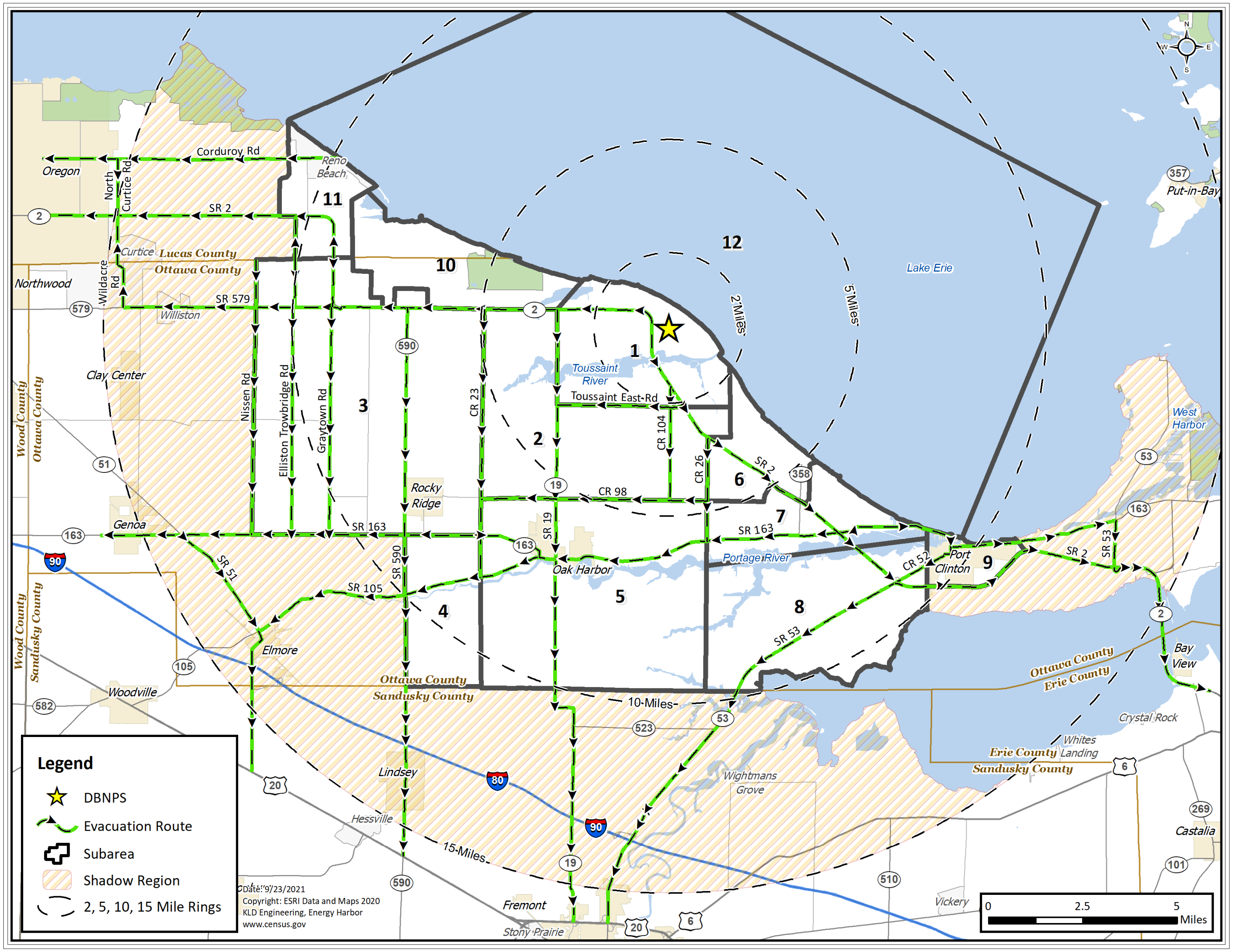


Figure 10-1. Evacuation Route Map

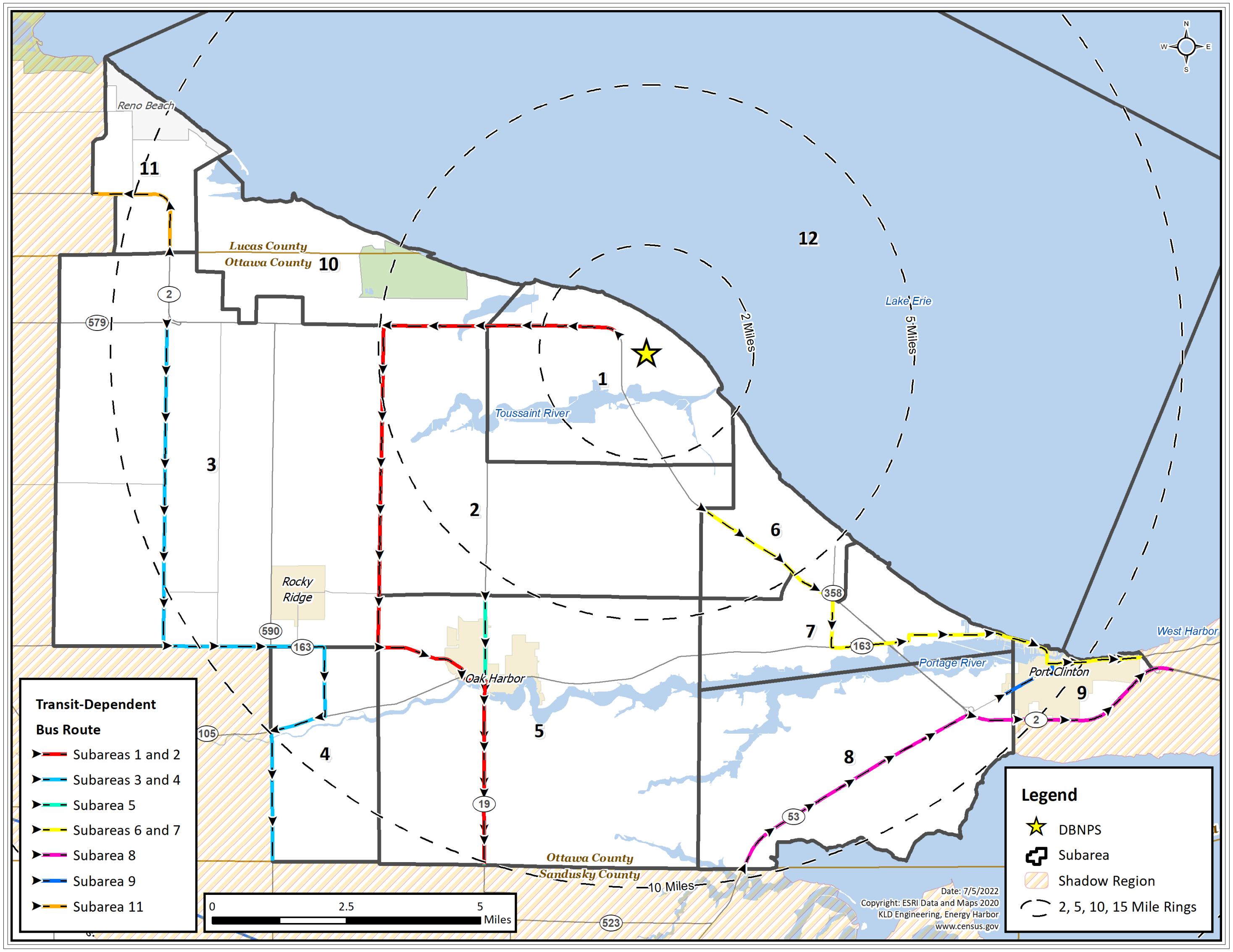


Figure 10-2. Transit-Dependent Bus Routes

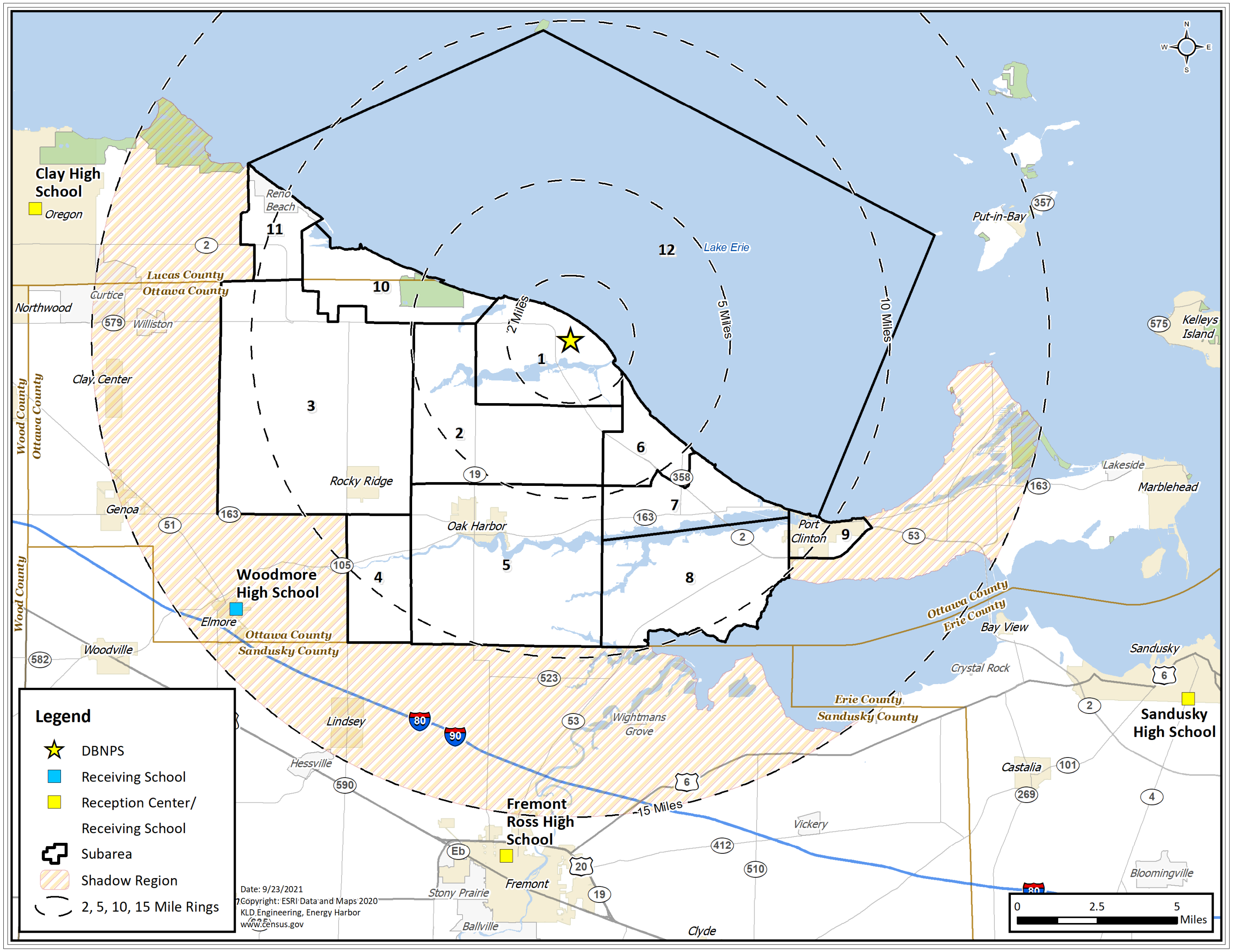


Figure 10-3. General Population Reception Centers

APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

This appendix provides a glossary of traffic engineering terms that are used throughout this report.

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 (MOE).
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 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, c, 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:

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

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

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

The value of d_o = 12 miles, the outer distance of the EPZ. Note that the supplemental cost, s_a, of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

B.2.2 Network Equilibrium

In 1952, John Wardrop wrote:

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

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

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

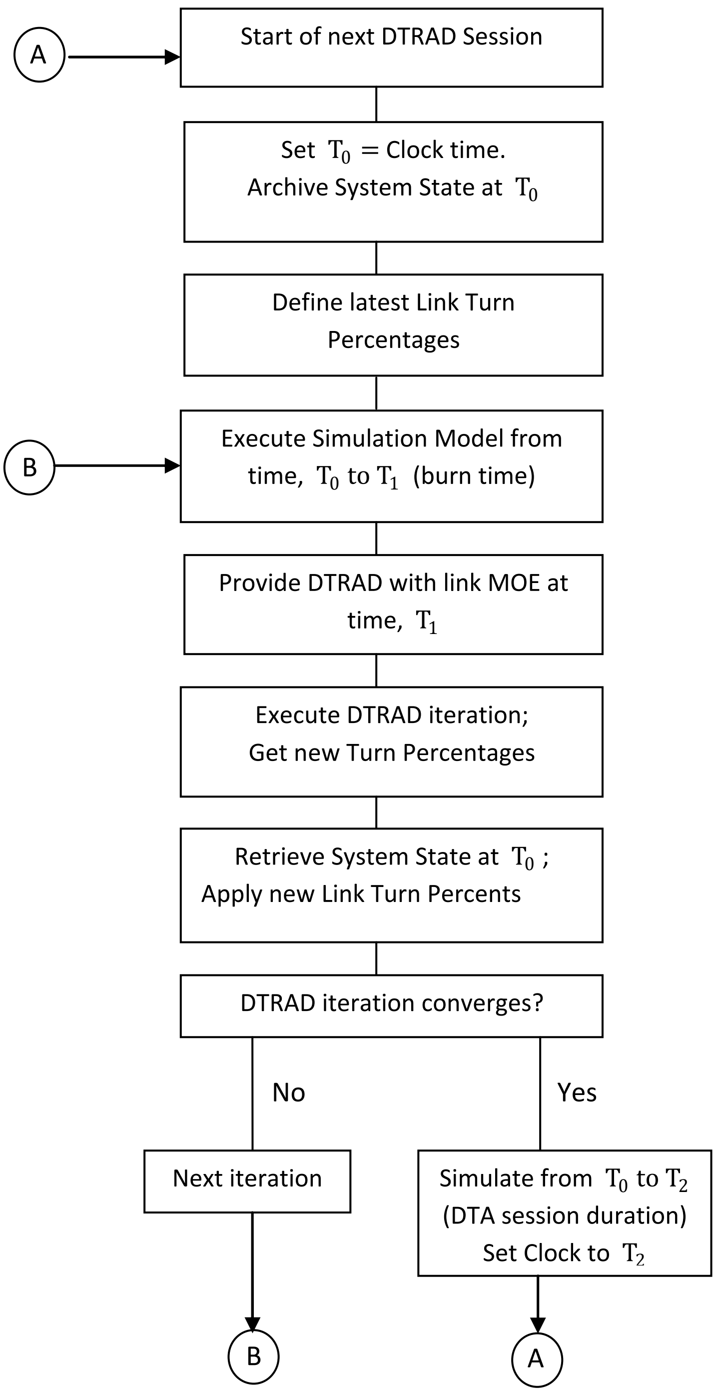


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

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

Model Features Include:

- Explicit consideration is taken of the variation in density over the time step; an iterative procedure is employed to calculate an average density over the simulation time step for the purpose of computing a mean speed for moving vehicles.
- Multiple turn movements can be serviced on one link; a separate algorithm is used to estimate the number of (fractional) lanes assigned to the vehicles performing each turn movement, based, in part, on the turn percentages provided by the 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, $k_f \le k \le k_c = 45$ vpm, the density at capacity. In the flow-density plane, a quadratic relationship is prescribed in the range, $k_c < k \le k_s = 95$ 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 moving 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 $0 \le \bar{k} \le \bar{k}_s = 50$. It can be shown that $Q = \left(0.98 - 0.0056\,\bar{k}\right) RQ_{max}$ for $\bar{k}_s \le \bar{k} \le \bar{k}_j$, where $\bar{k}_s = 50$ and $\bar{k}_j = 175$.

C.1.2 The Simulation Model

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

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

Given $= Q_b , M_b , L , TI , E_0 , LN , {}^{G}/_{C} , h , L_v , R_0 , L_c , E , M$

Compute $= O , Q_e , M_e$

Define $O = O_Q + O_M + O_E$; $E = E_1 + E_2$

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

2. Calculate $v(k)$ such that $k \leq 130$ using the analytical representations of the fundamental diagram.
   Calculate $\text{Cap} = \frac{Q_{max}(TI)}{3600} \left({}^{G}/_{C}\right) \text{LN}$, 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 $(t_1 = 0)$

$$O_M = \left(\frac{v(TI)-L_b}{L-L_b}\right) M_b \text{ and } O_E = 0$$
$$M_e = M_b - O_M + E\ ;\ Q_e = 0$$

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$, then

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

Calculate Q_e and M_e using Algorithm A

10. Else $(t_1 = 0)$

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

If $M_d > RCap$, *then*

$O_M = RCap$

$Q'_e = M_d - O_M$

Apply Algorithm A to calculate Q_e and M_e

Else

$O_M = M_d$

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

End if

End if

End if

End if

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

where k_b = density at the beginning of the TI

k_e = density at the end of the TI

k_m = density at the mid-point of the TI

All values of density apply only to the moving vehicles.

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

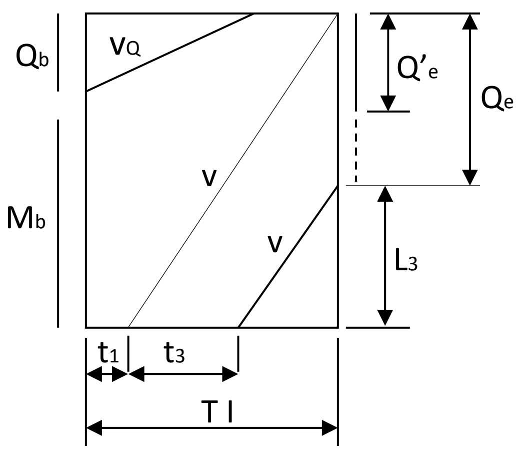
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W) \cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

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

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

C.2 Implementation

C.2.1 Computational Procedure

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

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

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

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

Experience has shown that the system converges (i.e., the values of E, M and S "settle down" for all network links) in just two sweeps if the network is entirely under-saturated or in four sweeps in the presence of extensive congestion with link spillback. (The initial sweep over each link uses the final values of E and M, of the prior TI). At the completion of the final sweep for a TI, the procedure computes and stores all 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 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 <u>moving</u> 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.

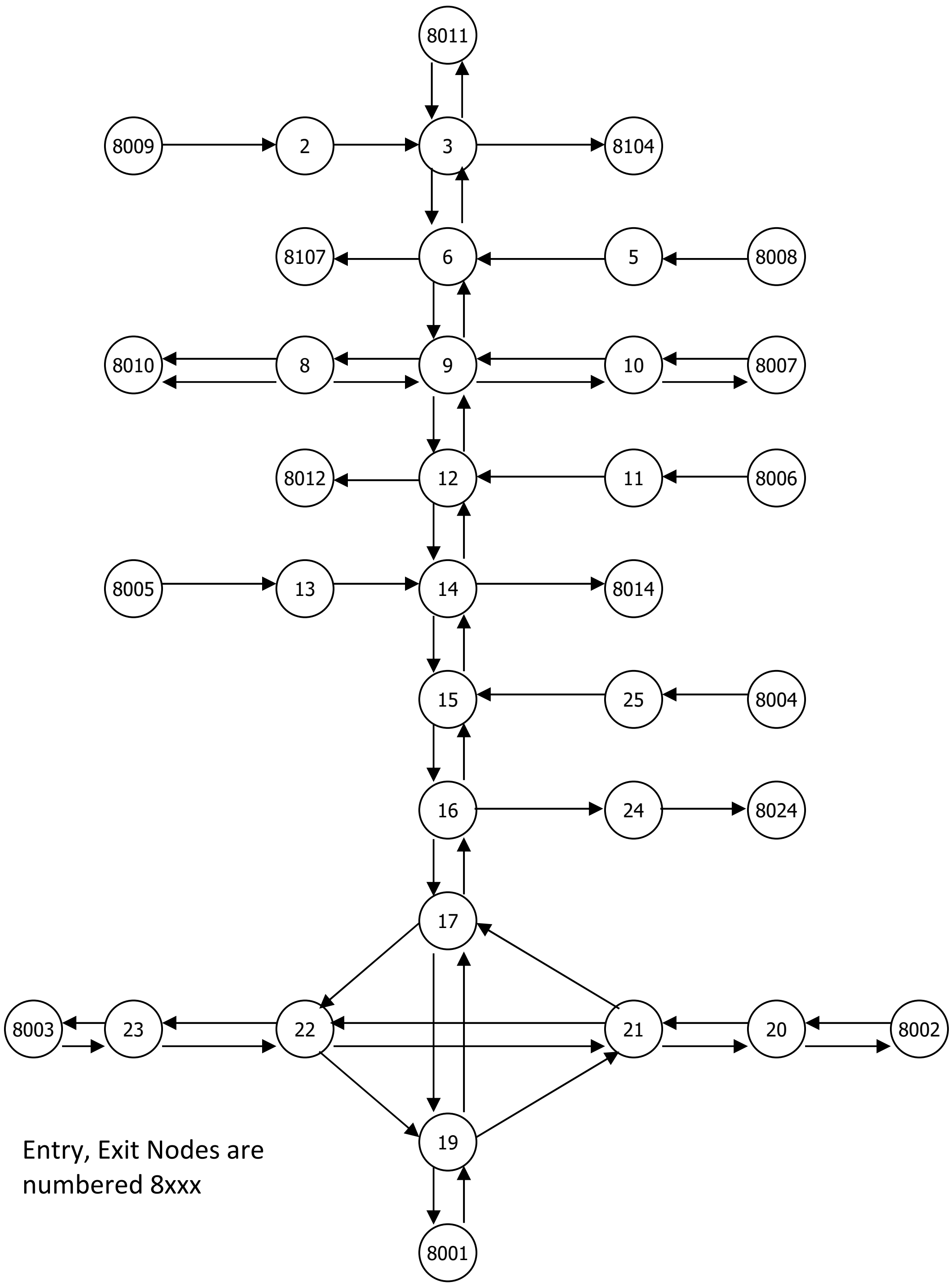


Figure C-1. Representative Analysis Network

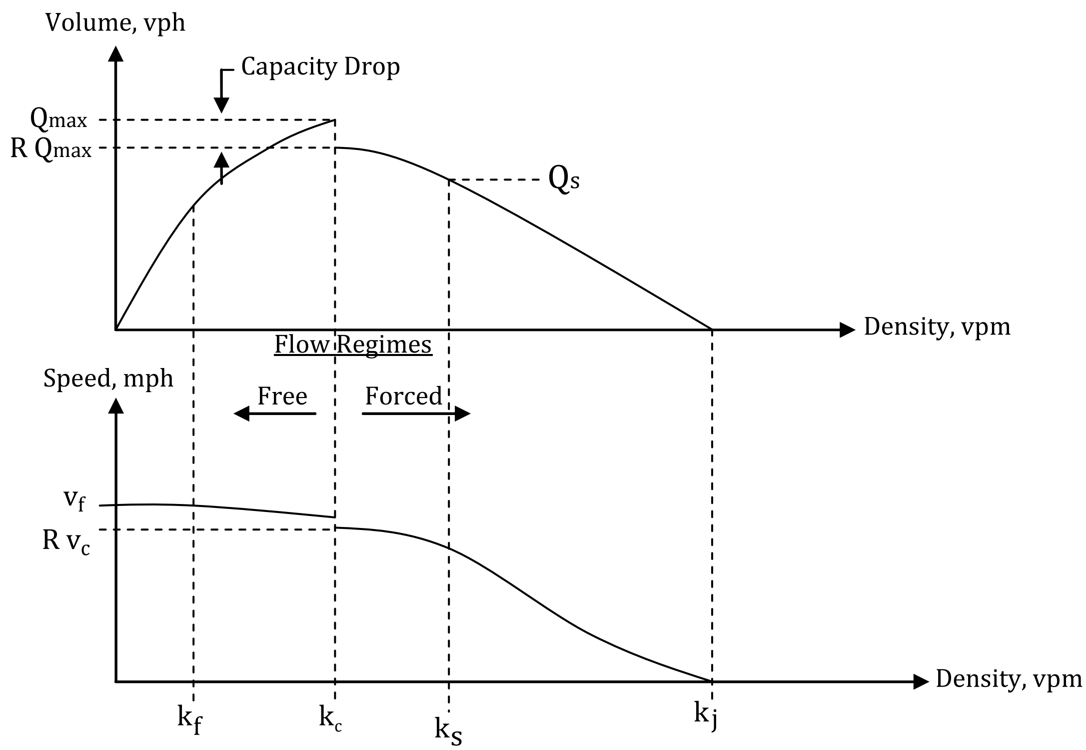


Figure C-2. Fundamental Diagrams

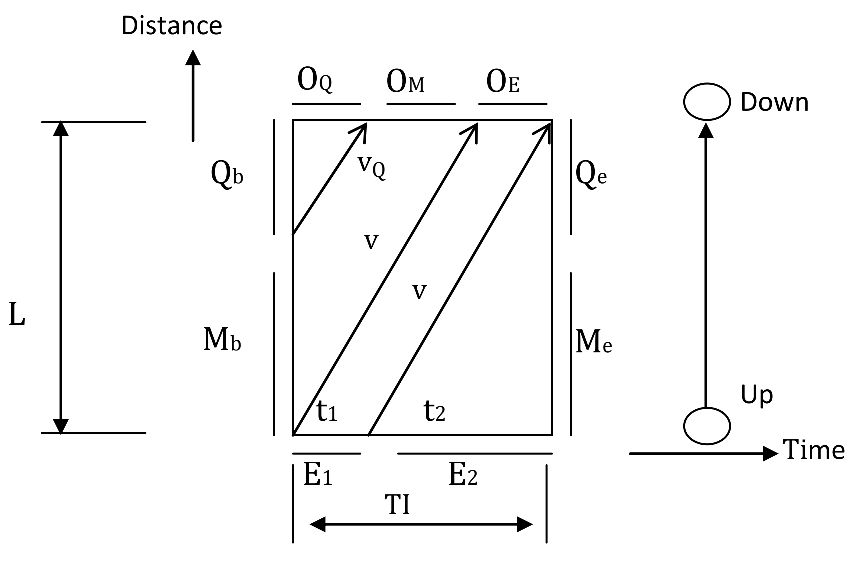


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

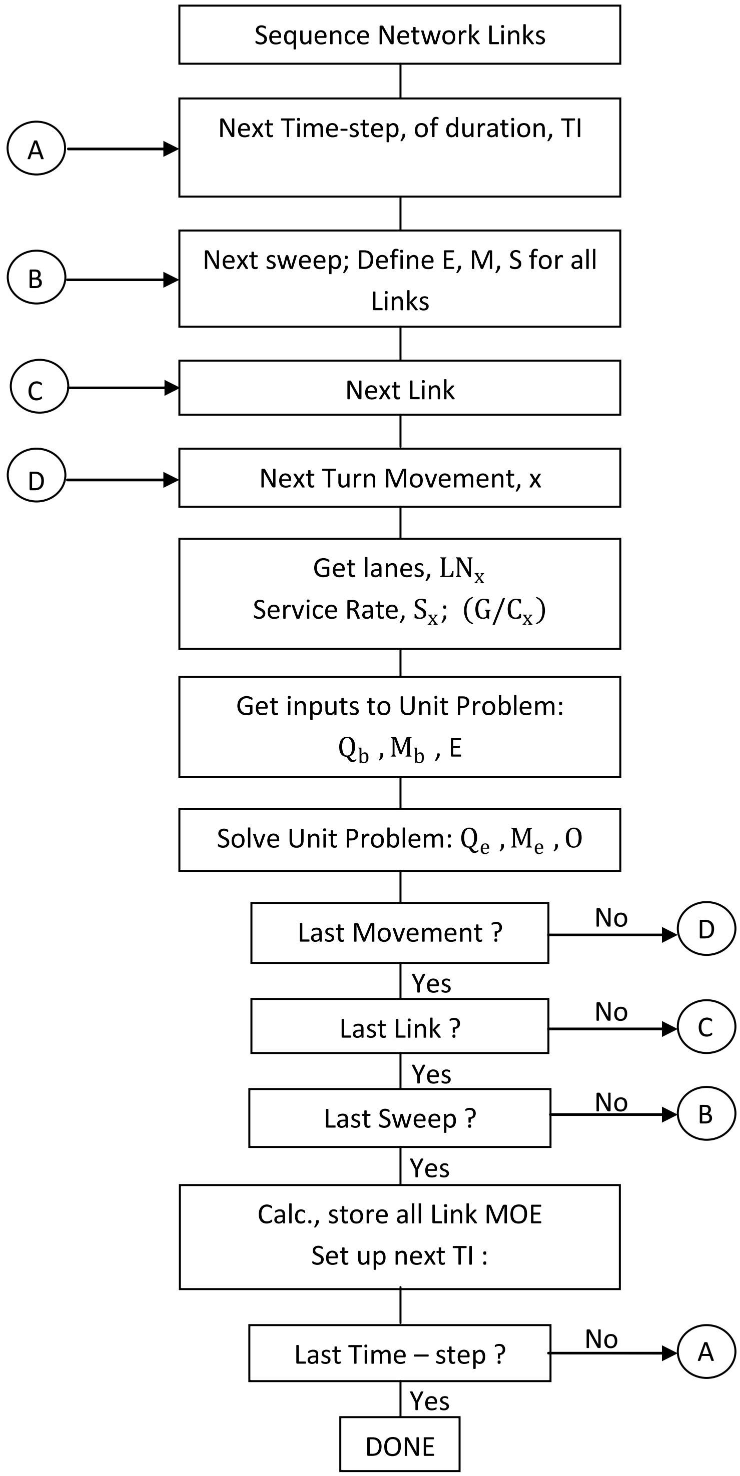


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

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 the Emergency Planning Zone (EPZ) boundary information and create a Geographic 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 boundaries.

Step 2

The 2020 Census block population information was obtained in GIS format. This information was used to estimate the permanent resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. Employee data was based upon the previous study (reviewed and confirmed to be still accurate for this study by Ottawa County) and Energy Harbor. Transient, school, medical, and other types of special facility data were obtained from the county emergency management agencies and from phone calls to facilities where data was missing.

Step 3

A kickoff meeting was conducted with major stakeholders (state and county emergency officials and Energy Harbor 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 to the state and county officials. 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 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 study area (EPZ and Shadow Region) was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the study area population for this study. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the most recent UNITES software (see Section 1.3) developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4) and information obtained from aerial imagery. Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. The 2020 permanent resident population 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 12 Subareas. Based on wind direction and speed, Regions (groupings of Subareas 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 – which operates on data produced by DYNEV II) 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 minor routes (which are paved and traversable) that were not previously modelled but may assist in an evacuation and increase the available roadway network capacity, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 12

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

Step 13

Evacuation of transit-dependent evacuees and special facilities are included in the evacuation analysis. Fixed routing for transit buses, school buses, wheelchair buses and ambulances 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 changes 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.

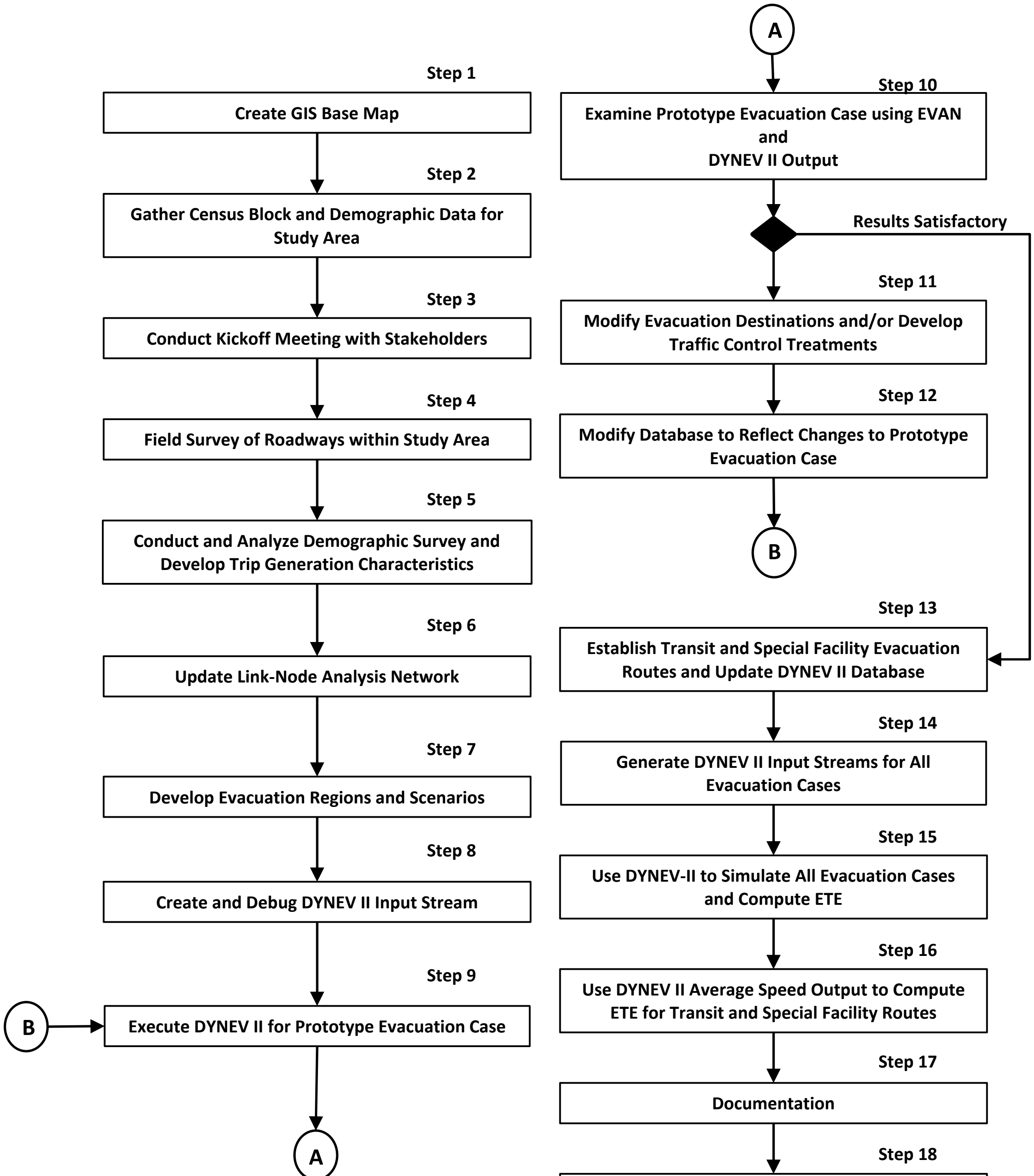


Figure D-1. Flow Diagram of Activities

APPENDIX E

Facility Data

E. FACILITY DATA

The following tables list population information, as of June 2022, for special facilities that are located within the DBNPS EPZ. Special facilities are defined as schools, day care centers/nursery schools, medical facilities, and correctional facilities. Transient population data are included in the tables for recreational areas (beaches, campgrounds, golf courses, hunting/fishing areas, marinas, parks) and lodging facilities. Employment data are 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 and by Subarea. Maps identifying the locations of each school, day care center/nursery school, medial facility, major employer, recreational area (beach, campground, golf course, hunting/fishing area, marina, park), lodging facility, and correctional facility are also provided.

Table E-1. Schools within the Study Area

Subarea	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Enroll-ment
LUCAS COUNTY, OH						
S.R.	12.0	WNW	Jerusalem Elementary School[1]	535 S Yondota Rd	Curtice	355
					Lucas County Subtotal:	*355*
OTTAWA COUNTY, OH						
5	6.6	SSW	Oak Harbor Middle School	315 N Church St	Oak Harbor	395
5	6.6	SSW	R.C. Waters Elementary School	220 E Ottawa St	Oak Harbor	415
5	6.7	SSW	St Boniface Elementary School	215 N Church St	Oak Harbor	74
5	6.8	SSW	Oak Harbor High School	11661 W OH-163	Oak Harbor	476
5	7.1	SW	Ottawa County Christian Academy	325 S Toussaint-Portage Rd	Oak Harbor	48
9	9.5	SE	Bataan Memorial Intermediate Elementary School	525 W 6th St	Port Clinton	308
9	9.7	SE	Immaculate Conception School	109 W 4th St	Port Clinton	113
9	10.0	SE	Port Clinton Middle School	807 Jefferson St	Port Clinton	378
9	10.1	SE	Port Clinton High School	821 Jefferson St	Port Clinton	585
					Ottawa County Subtotal:	*2,792*
					STUDY AREA TOTAL:	**3,147**

Table E-2. Day Care Centers and Nursery Schools within the EPZ

Subarea	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Enroll-ment
OTTAWA COUNTY, OH						
3	9.7	WSW	North Point Educational Service	1661 N Walker St	Graytown	8
3	9.9	W	St Peter Precious Moments Preschool	17877 OH-579	Martin	28
5	6.7	SSW	St. John's Nursery School	122 Ottawa St	Oak Harbor	42
5	7.0	SSW	Rainbow Acres Educational Daycare Center	115 Portage St	Oak Harbor	69
5	7.4	SSW	Kersten's Korner Nursery School	11969 OH-105	Oak Harbor	36
9	9.8	SE	Port Clinton Nursery School	135 Adams St	Port Clinton	12
9	10.8	ESE	GLCAP Port Clinton Early Childhood Center	1846 E Perry St	Port Clinton	54
					Ottawa County Subtotal:	*249*
					EPZ TOTAL:	**249**

[1] Jerusalem Elementary School is located in the Shadow Region (S.R.). According to the 2021 Ottawa County Radiological Emergency Response Plan, children at Jerusalem Elementary School will be relocated to the pre-designated school in the event of an emergency at Davis-Besse.

Table E-3. Medical Facilities within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Cap-acity	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
OTTAWA COUNTY, OH										
5	6.1	S	Riverview Healthcare Campus	8180 OH-163	Oak Harbor	136	80	23	43	14
9	10.2	SE	Magruder Hospital	615 Fulton St	Port Clinton	25	15	4	8	3
9	10.4	SE	Edgewood Manor Nursing Home	1330 S Fulton St	Port Clinton	80	47	13	26	8
Ottawa County Subtotal:						*241*	*142*	*40*	*77*	*25*
EPZ TOTAL:						**241**	**142**	**40**	**77**	**25**

Table E-4. Major Employers within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Employees (Max Shift)	% Employees Commuting into the EPZ	Employees Commuting into the EPZ	Employee Vehicles Commuting into the EPZ
OTTAWA COUNTY, OH									
1	-	-	Davis-Besse Nuclear Power Station	5501 OH-2	Oak Harbor	499	61%	306	271
4	10.0	SW	Brush Wellman	14710 W Portage River South Rd	Elmore	219	61%	134	119
9	10.2	SE	H.B. Magruder Hospital	615 Fulton St	Port Clinton	217	61%	133	118
Ottawa County Subtotal:						*935*	*-*	*573*	*508*
EPZ TOTAL:						**935**	**-**	**573**	**508**

Table E-5. Campgrounds within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
OTTAWA COUNTY, OH							
1	1.0	S	E & C	4620 N Toussaint South Rd	Oak Harbor	70	52
1	1.0	S	Toussaint River Marina	4685 N Toussaint South Rd	Oak Harbor	83	62
1	1.2	WNW	Wild Wings Campground & Marina	6395 N Russell Rd	Oak Harbor	1,038	772
1	1.2	NW	Wild Wings Camp & Boat-O-Minium	6242 N Russell Rd	Oak Harbor	266	198
1	1.5	SSE	Paradise Acres Campgrounds and Marina	4225 N Rider Rd	Oak Harbor	1,307	972
1	1.9	WNW	Turtle Creek Marina & Campground	6338 N Humphrey Rd	Oak Harbor	597	444
1	2.0	SSE	Floro's Camping	3585 N State Route 2	Oak Harbor	584	434
1	2.5	WNW	Turtle Point Campground	10275 W Lakeview Blvd	Oak Harbor	261	194
1	2.5	WNW	Magee East Marina & Campground	10481 OH-2	Oak Harbor	336	250
2	4.1	WSW	Camp Sabroske	4405 W Toussaint North Rd	Oak Harbor	86	64
5	6.0	S	Harbor Landing Campground	7490 W Harbor Rd	Port Clinton	135	100
5	6.2	S	Chet's Place Campground & Marina	7154 W Harbor Rd	Port Clinton	315	234
5	6.2	S	L & J River Ranch	8534 W OH-163	Oak Harbor	54	40
5	6.4	S	Young's Suburban On the Portage	8980 W OH-163	Oak Harbor	73	54
6	5.3	SE	Camp Perry RV Park	Building 600 Camp Perry Training Site	Port Clinton	135	100
7	6.2	SSE	Portage Lagoon Park	185 S Wolfe Rd	Port Clinton	30	22
7	6.3	SSE	Portage View Campground	265 S Meacham Rd	Port Clinton	320	238
7	6.9	SE	River Retreat Campground & Marina	3830 W Harbor Rd	Port Clinton	210	156
7	7.9	SE	Riverview Campgrounds	2044 W Lakeshore Dr	Port Clinton	105	78
7	7.9	SE	Sunset Shore Campground	1745 W Lakeshore Dr	Port Clinton	100	74
7	8.3	SE	Vacationland Park and Marina	1220 W Richey Rd	Port Clinton	334	248
7	8.4	SE	Rock Pointe Campground & Marina	1170 W Richey Rd	Port Clinton	73	54
7	8.4	SE	Witterhaven Marina & Campground	1100 W Richey Rd	Port Clinton	83	62
7	8.4	SE	Riverside RV Park & Marina	1090 W Richey Rd	Port Clinton	129	96
8	7.4	SE	Johnny's Resort Inc	3942 W Oliver Dr	Port Clinton	471	350
8	7.6	SE	Julie's Place	540 S Schau Rd	Port Clinton	30	22
8	7.7	SE	Portage Cove Park and Marina	531 S Findlay St	Port Clinton	151	112
8	8.9	SE	Goldeneye Campgrounds	1030 Helendale Ln	Port Clinton	202	150
					Ottawa County Subtotal:	*7,578*	*5,632*
					EPZ TOTAL:	**7,578**	**5,632**

Table E-6. Marinas within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
LUCAS COUNTY, OH							
11	9.0	WNW	Meinke Marina East	12805 Bono Rd	Curtice	100	50
					Lucas County Subtotal:	*100*	*50*
OTTAWA COUNTY, OH							
1	1.0	S	Toussaint River Marina	4685 N Toussaint S Rd	Oak Harbor	See Table E-5	
1	1.1	WNW	Wild Wings Marina	6395 N Russell Rd	Oak Harbor	200	100
1	1.4	SSE	Beef Creek Marina	4385 N Rider Rd	Oak Harbor	30	15
1	2.3	WNW	Fenwick Marina	10261 W OH-2	Oak Harbor	200	100
1	2.4	WNW	Locust Point Marina	10178 W Locust Point Rd	Oak Harbor	62	46
1	2.5	WNW	Turtle Point Marina	10275 W Lakeview Blvd	Oak Harbor	100	50
7	6.9	SE	River Retreat Campground & Marina	3830 W Harbor Rd	Port Clinton	See Table E-5	
7	7.9	SE	Safe Harbor Lakefront Marina	1805 W Lakeshore Dr	Port Clinton	200	70
7	7.8	SE	White Caps Motel & Marina	2186 W Lakeshore Dr	Port Clinton	See Table E-8	
7	8.3	SE	Vacationland Park and Marina	1220 W Richey Rd	Port Clinton	See Table E-5	
7	8.4	SE	Rock Pointe Campground & Marina	1170 W Richey Rd	Port Clinton	See Table E-5	
7	8.4	SE	Witterhaven Marina & Campground	1100 W Richey Rd	Port Clinton	See Table E-5	
7	8.4	SE	Riverside RV Park & Marina	1090 W Richey Rd	Port Clinton	See Table E-5	
8	7.9	SE	Nugent's Canal Yacht Club	3035 W Canal St	Port Clinton	Local residents only	
8	8.8	SE	Portage River Marina	204 Rose Ln	Port Clinton	80	40
9	8.8	SE	Clinton Reef Club	800 Clinton Reef Dr	Port Clinton	60	30
9	8.9	SE	Coastal Marine	537 W Lakeshore Dr	Port Clinton	70	70
9	9.0	SE	Brands' Marina	451 W Lakeshore Dr	Port Clinton	242	180
9	9.2	SE	Brands Dry Dock Marina	315 W Lakeshore Dr	Port Clinton	58	31
9	9.3	SE	Drawbridge Marina	242 W Lakeshore Dr	Port Clinton	200	70
9	9.4	SE	Port Clinton Yacht Club	127 Brooklyn Ave	Port Clinton	116	62
9	9.6	SE	Port Clinton Municipal Pier	Jefferson St	Port Clinton	100	100
					Ottawa County Subtotal:	*1,718*	*964*
					EPZ TOTAL:	**1,818**	**1,014**

Table E-7. Other Recreational Areas within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Facility Type	Transients	Vehicles
LUCAS COUNTY, OH								
11	9.7	WNW	Howard Marsh Metropark	611 S Howard Rd	Curtice	Park	2,000	743
						Lucas County Subtotal:	*2,000*	*743*
OTTAWA COUNTY, OH								
5	5.9	S	Ottawa County Fairgrounds	7870 OH-163	Oak Harbor	Park	200	100
5	7.5	SSW	Oak Harbor Golf Club	10433 W Oak Harbor SE Rd	Oak Harbor	Golf Course	50	38
9	9.5	SE	Jet Express	3 Monroe St	Port Clinton	Park	5,000	1,500
9	10.2	SE	Port Clinton City Beach	1100 E Perry St	Port Clinton	Beach	100	50
10	5.5	W	Magee Marsh Wildlife Area	13531 OH-2	Oak Harbor	Hunting/Fishing	85	50
10	5.9	W	Ottawa National Wildlife Refuge	14000 OH-2	Oak Harbor	Hunting/Fishing	200	100
						Ottawa County Subtotal:	*5,635*	*1,838*
						EPZ TOTAL:	**7,635**	**2,581**

Table E-8. Lodging Facilities within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
OTTAWA COUNTY, OH							
6	3.2	SSE	ANJ Lodging	6797 W Lakeshore Dr	Port Clinton	12	8
6	5.2	SE	Camp Perry Lodging and Conference Center	1000 Lawrence Rd	Port Clinton	414	183
7	7.8	SE	White Caps Motel	2186 W Lakeshore Dr	Port Clinton	26	13
7	8.7	SE	Clinton Reef Club	800 Clinton Reef Dr	Port Clinton	184	92
8	8.0	SSE	The Resort at Erie Landing	4495 W Darr-Hopfinger Rd	Port Clinton	600	197
8	9.0	SSE	Lake Erie Fishing Adventures Lodge	4972 W Fremont Rd	Port Clinton	12	6
9	9.3	SE	Commodore Perry Inn & Suites	255 W Lakeshore Dr	Port Clinton	180	120
9	9.3	SE	Beachfront Resorts	252 W Lakeshore Dr	Port Clinton	30	20
9	9.4	SE	Waterfront Condominium	220 W Lakeshore Dr	Port Clinton	765	191
9	9.5	SE	The Island House Hotel	102 Madison St	Port Clinton	114	76
9	9.6	SE	Arlington Inn	121 E Perry St	Port Clinton	82	31
9	9.6	SE	Our Guest Inn & Suites	220 E Perry St	Port Clinton	200	100
9	9.9	SE	The Bashful Mermaid	503 E 2nd St	Port Clinton	6	3
9	10.4	ESE	Super 8 by Wyndham Port Clinton	1704 E Perry St	Port Clinton	54	27

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
9	10.4	ESE	Village at Waters Edge	Waters Edge Dr	Port Clinton	149	43
9	10.5	ESE	Best Western Port Clinton	1734 E Perry St	Port Clinton	70	35
9	10.5	ESE	Budget Inn & Suites	1735 E Perry St	Port Clinton	244	122
9	10.5	ESE	Quality Inn	1723 E Perry St	Port Clinton	145	54
9	10.5	ESE	Clinton Inn & Suites	1735 E Perry St	Port Clinton	244	122
9	10.6	ESE	Shores of Port Clinton	1801 E Perry St	Port Clinton	325	130
9	10.6	ESE	Fairfield Inn & Suites by Marriott Port Clinton Waterfront	1811 E Perry St	Port Clinton	244	122
9	10.7	ESE	Suite Marie's Lake Erie Retreat	125 Buckeye Blvd	Port Clinton	16	6
					Ottawa County Subtotal:	*4,116*	*1,701*
					EPZ TOTAL:	**4,116**	**1,701**

Table E-9. Correctional Facilities within the EPZ

Subarea	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Cap-acity
OTTAWA COUNTY, OH						
9	9.7	SE	Ottawa County Detention	315 Madison St RM 110	Port Clinton	39
9	10.9	ESE	Ottawa County Misdemeanor Jail	1862 Buckeye Blvd	Port Clinton	48
					Ottawa County Subtotal:	*87*
					EPZ TOTAL:	**87**

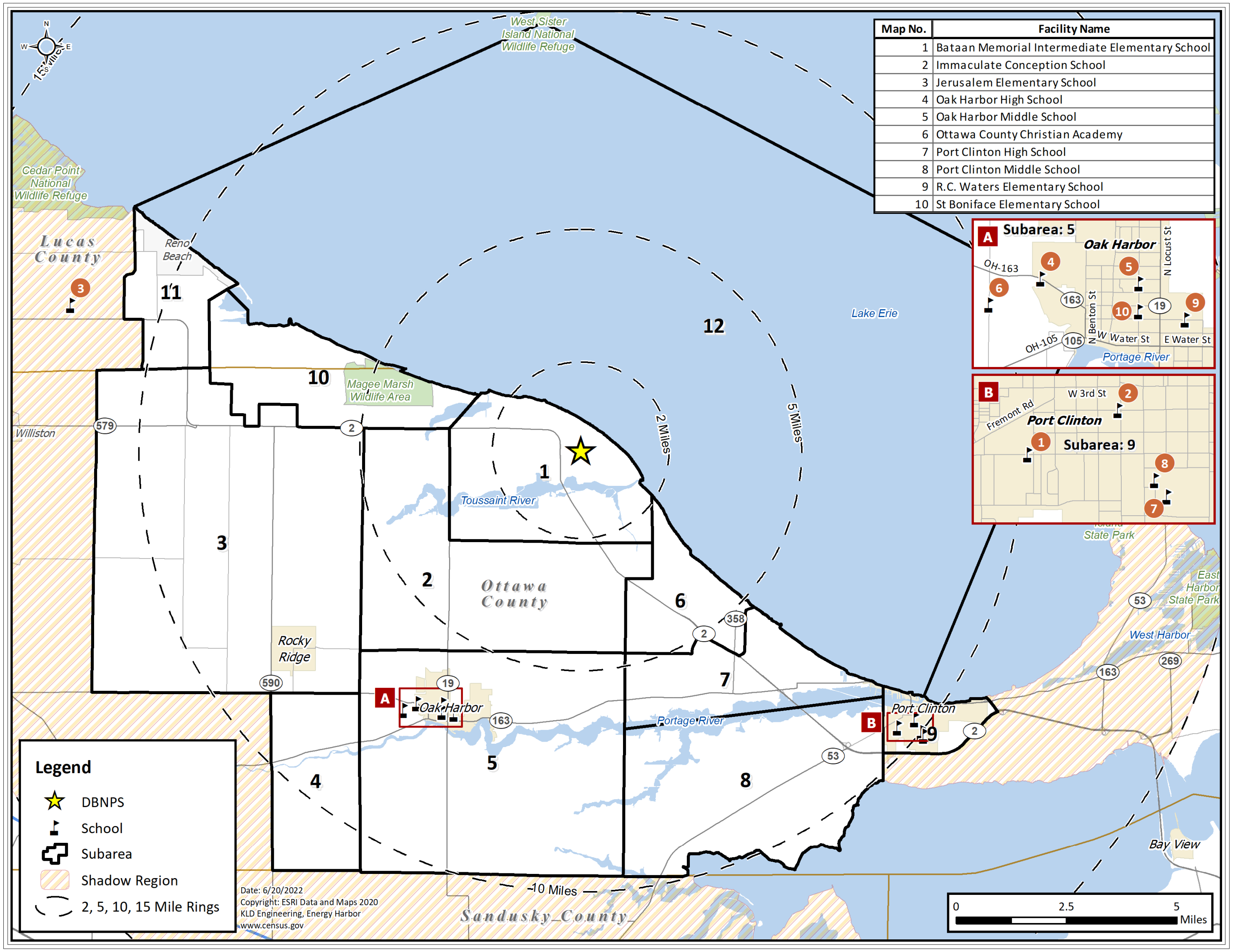


Figure E-1. Schools within the Study Area

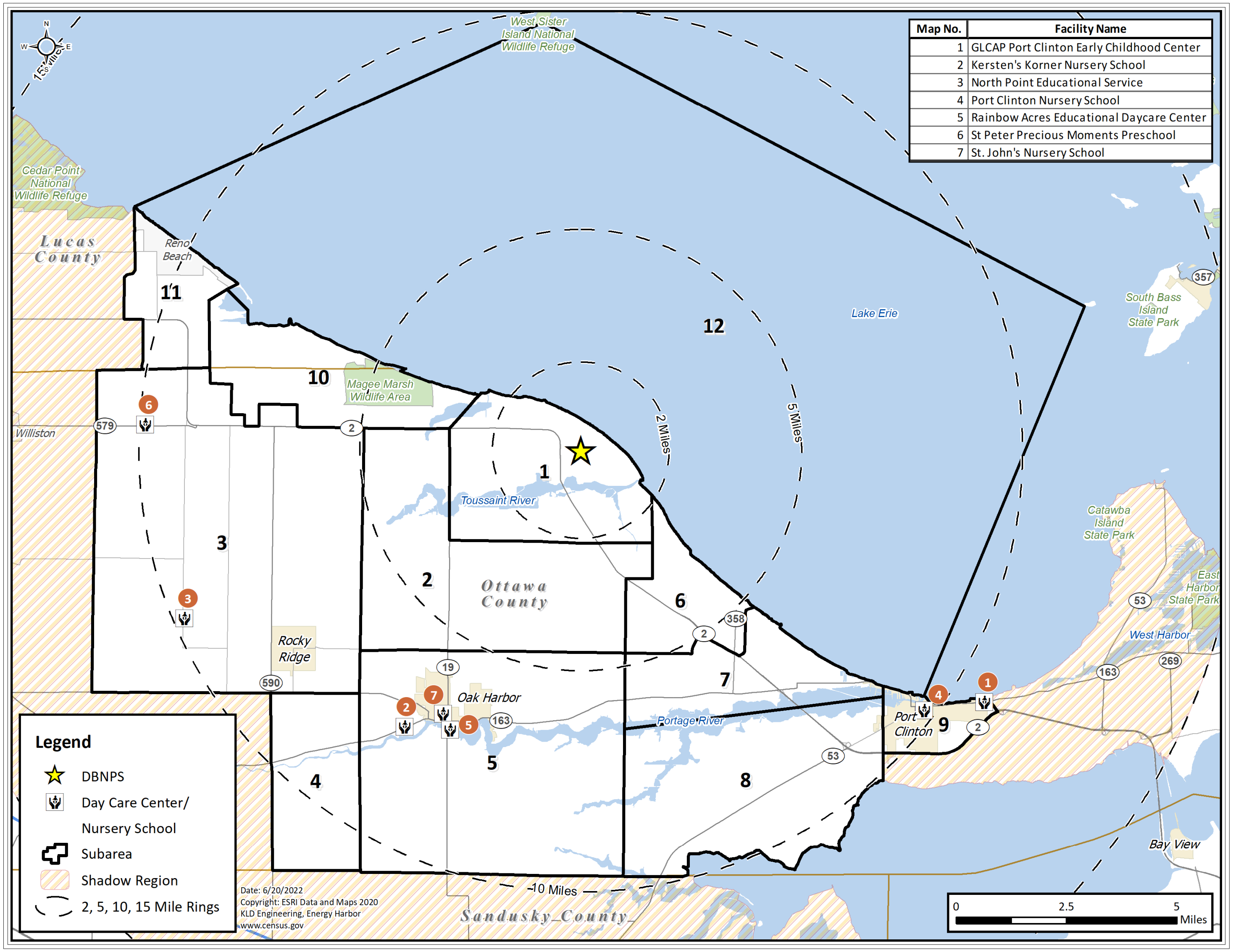


Figure E-2. Day Care Centers/Nursery Schools within the EPZ

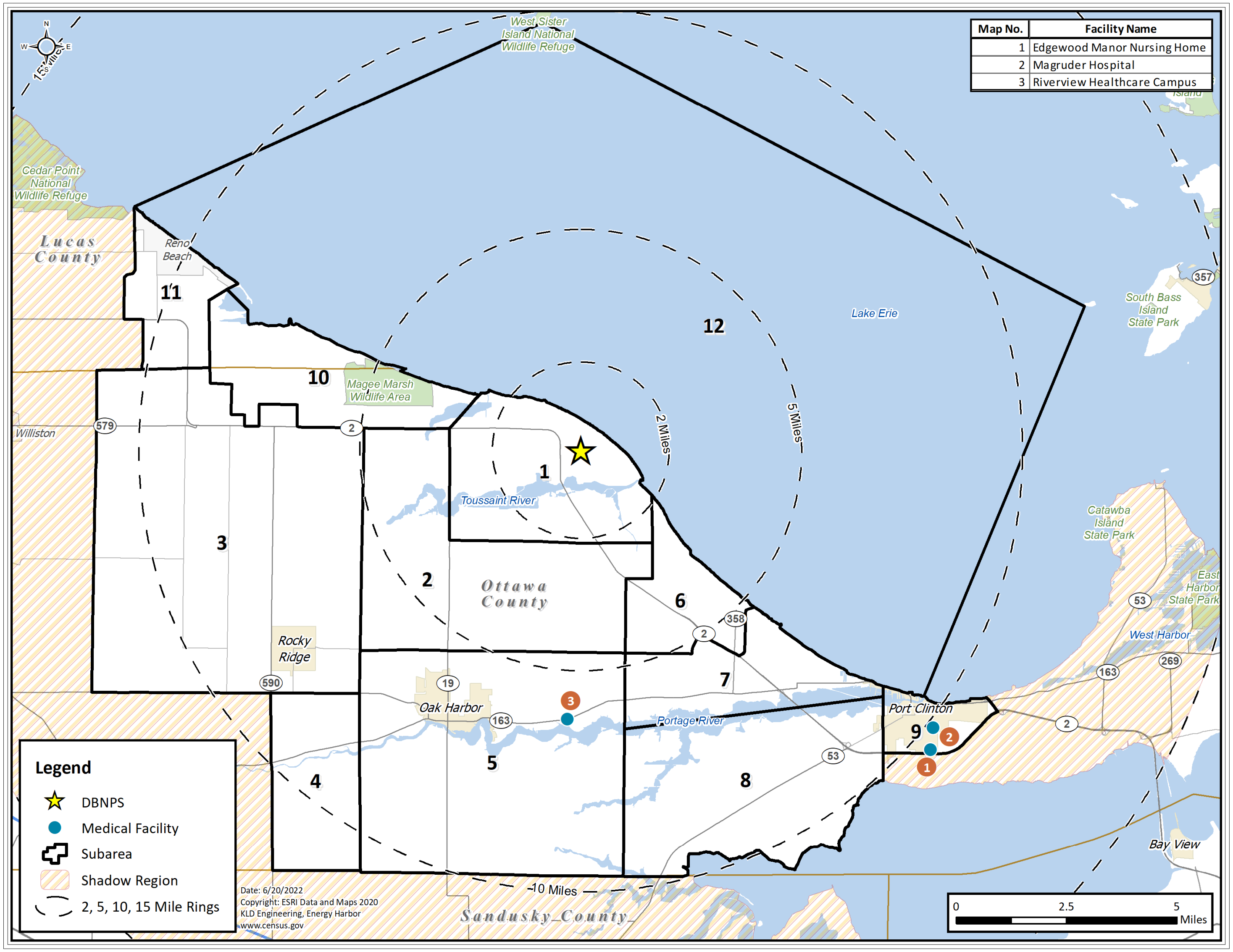


Figure E-3. Medical Facilities within the EPZ

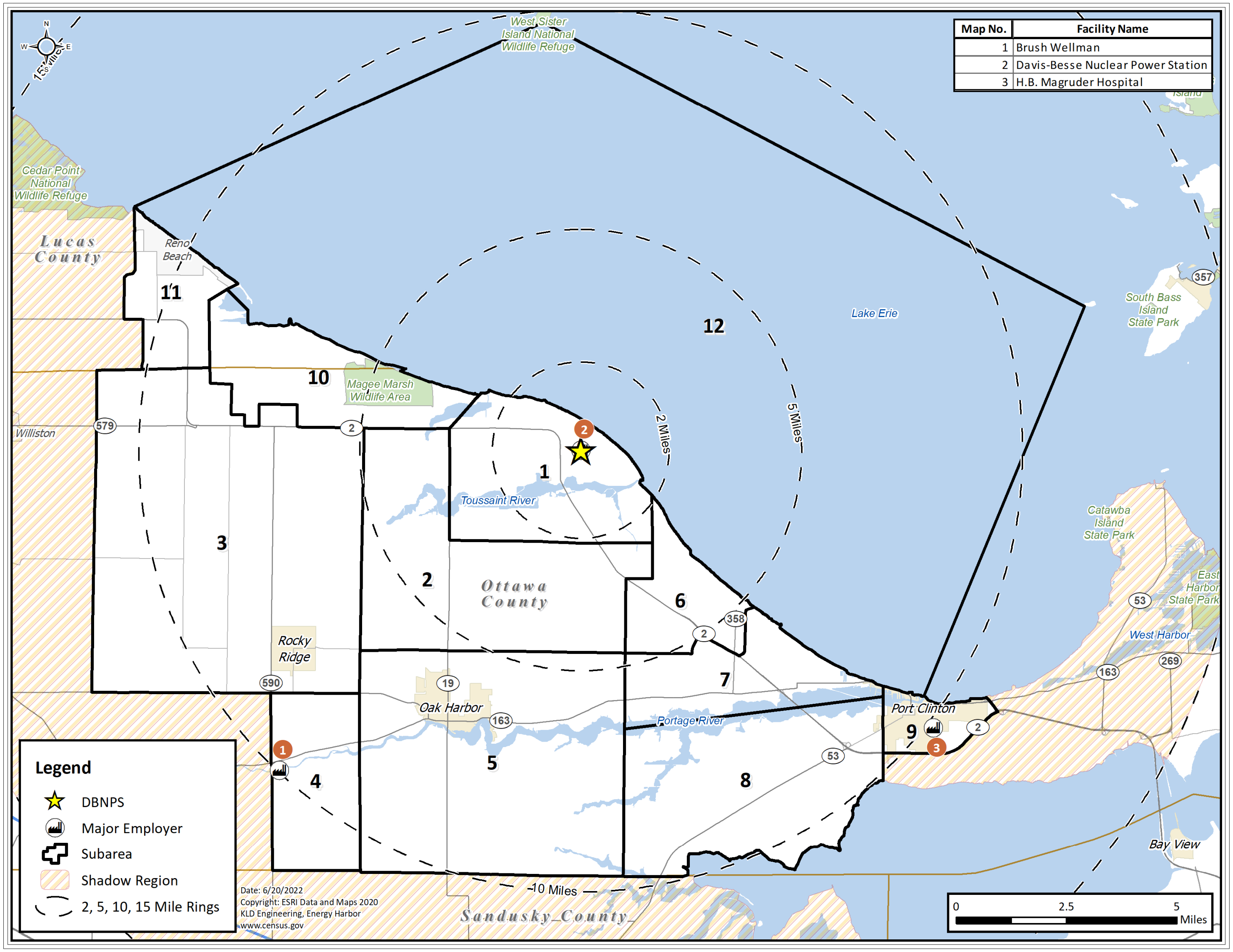
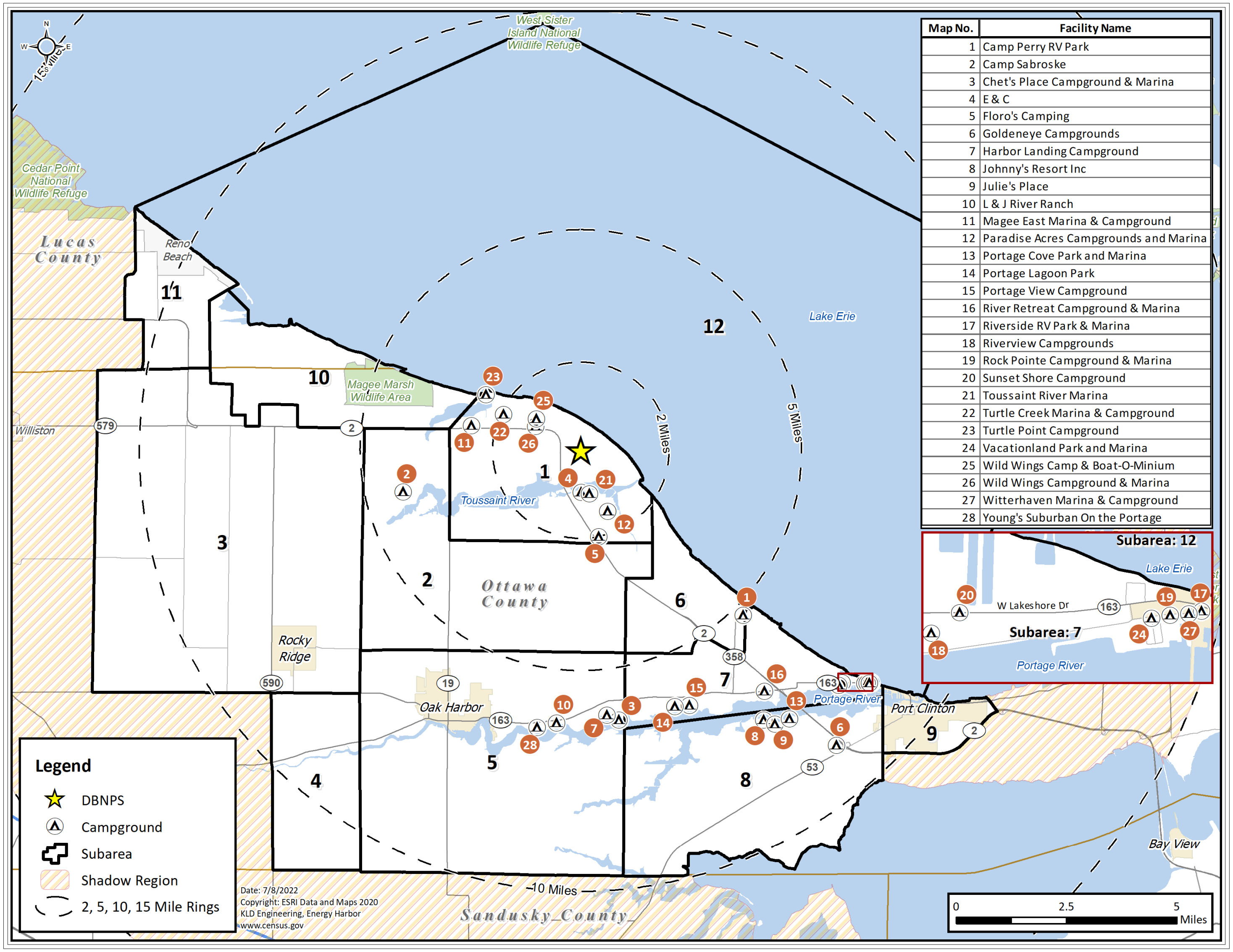


Figure E-4. Major Employers within the EPZ



Map No.	Facility Name
1	Camp Perry RV Park
2	Camp Sabroske
3	Chet's Place Campground & Marina
4	E & C
5	Floro's Camping
6	Goldeneye Campgrounds
7	Harbor Landing Campground
8	Johnny's Resort Inc
9	Julie's Place
10	L & J River Ranch
11	Magee East Marina & Campground
12	Paradise Acres Campgrounds and Marina
13	Portage Cove Park and Marina
14	Portage Lagoon Park
15	Portage View Campground
16	River Retreat Campground & Marina
17	Riverside RV Park & Marina
18	Riverview Campgrounds
19	Rock Pointe Campground & Marina
20	Sunset Shore Campground
21	Toussaint River Marina
22	Turtle Creek Marina & Campground
23	Turtle Point Campground
24	Vacationland Park and Marina
25	Wild Wings Camp & Boat-O-Minium
26	Wild Wings Campground & Marina
27	Witterhaven Marina & Campground
28	Young's Suburban On the Portage

Figure E-5. Campgrounds within the EPZ

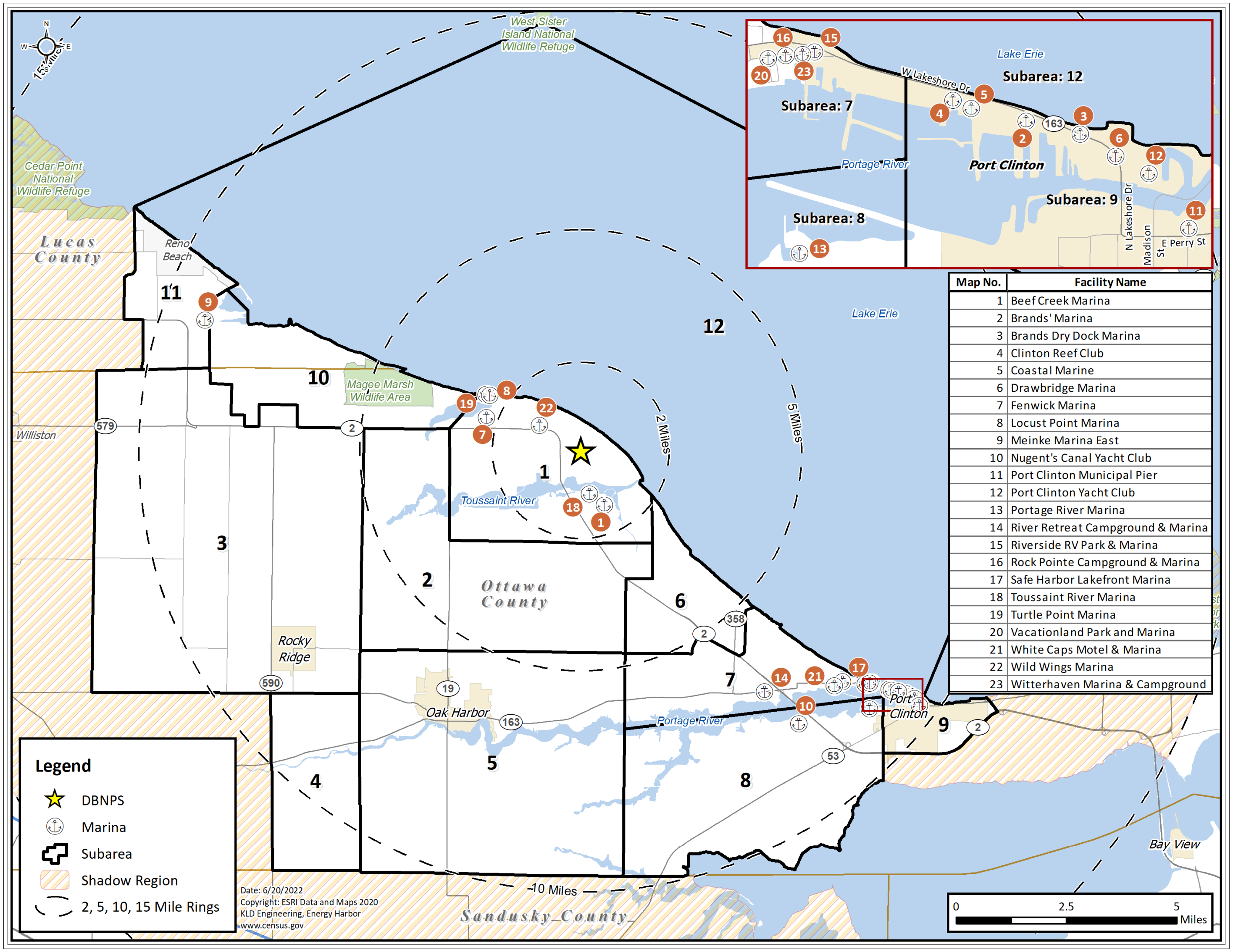


Figure E-6. Marinas within the EPZ

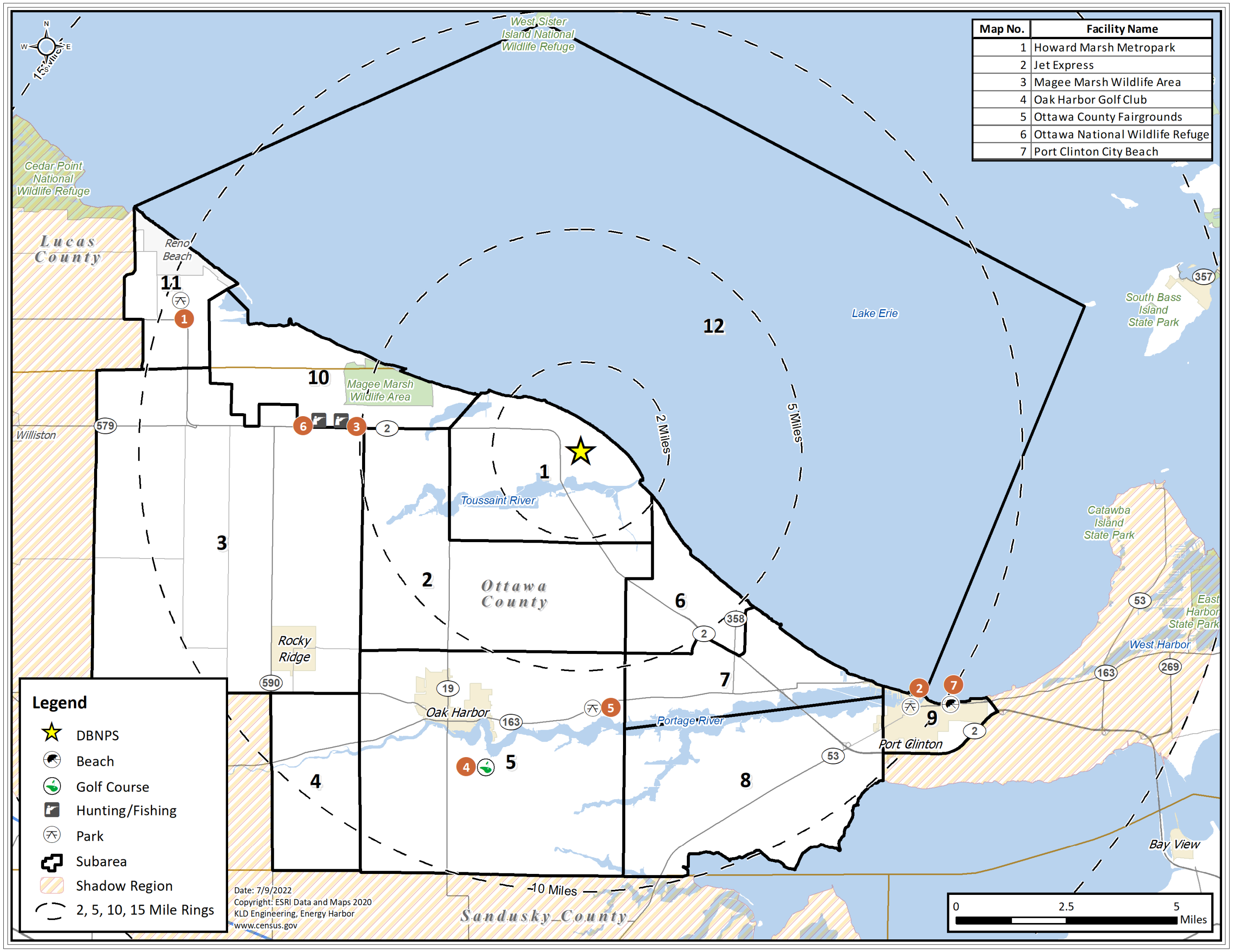
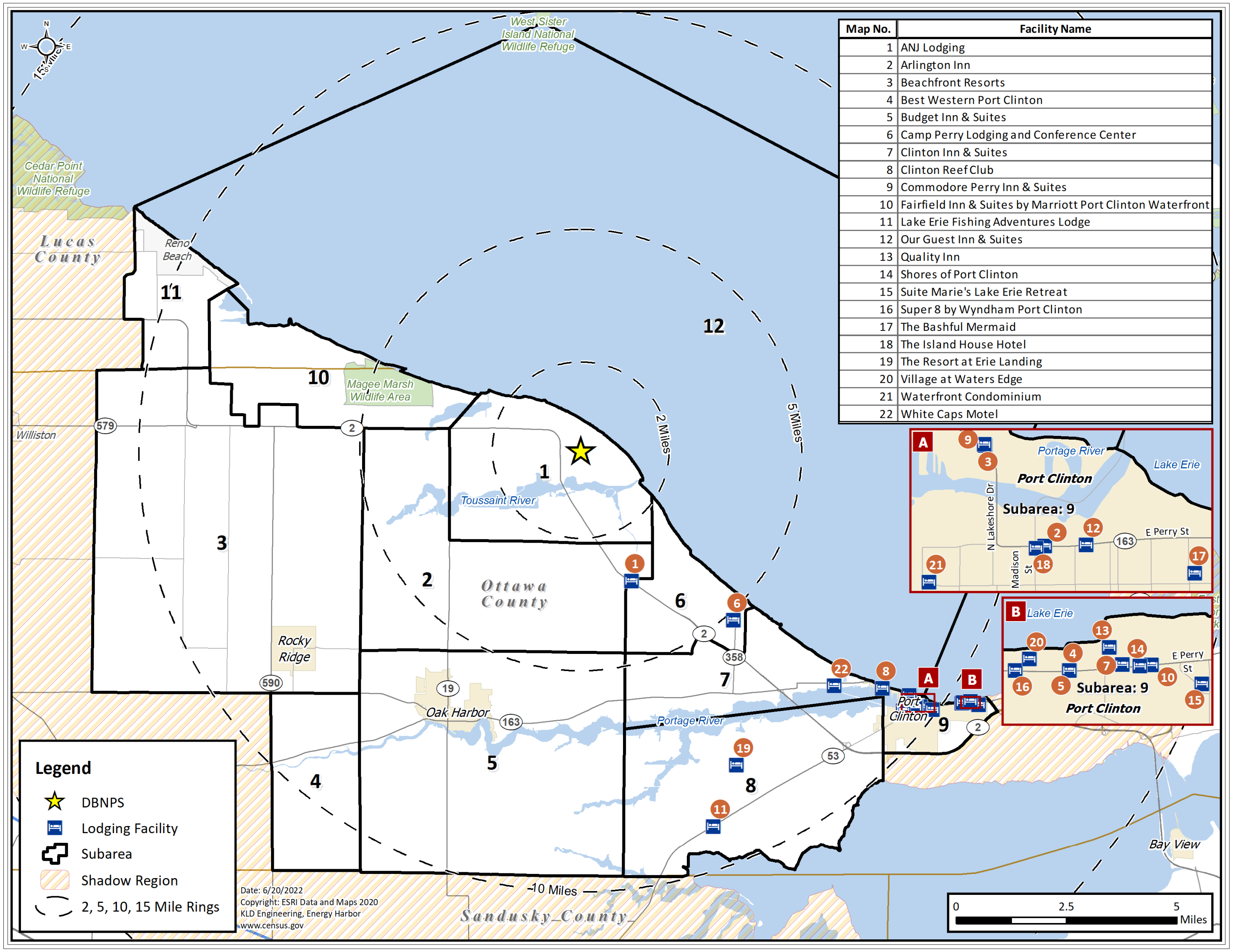


Figure E-7. Other Recreational Areas within the EPZ



Map No.	Facility Name
1	ANJ Lodging
2	Arlington Inn
3	Beachfront Resorts
4	Best Western Port Clinton
5	Budget Inn & Suites
6	Camp Perry Lodging and Conference Center
7	Clinton Inn & Suites
8	Clinton Reef Club
9	Commodore Perry Inn & Suites
10	Fairfield Inn & Suites by Marriott Port Clinton Waterfront
11	Lake Erie Fishing Adventures Lodge
12	Our Guest Inn & Suites
13	Quality Inn
14	Shores of Port Clinton
15	Suite Marie's Lake Erie Retreat
16	Super 8 by Wyndham Port Clinton
17	The Bashful Mermaid
18	The Island House Hotel
19	The Resort at Erie Landing
20	Village at Waters Edge
21	Waterfront Condominium
22	White Caps Motel

Figure E-8. Lodging Facilities within the EPZ

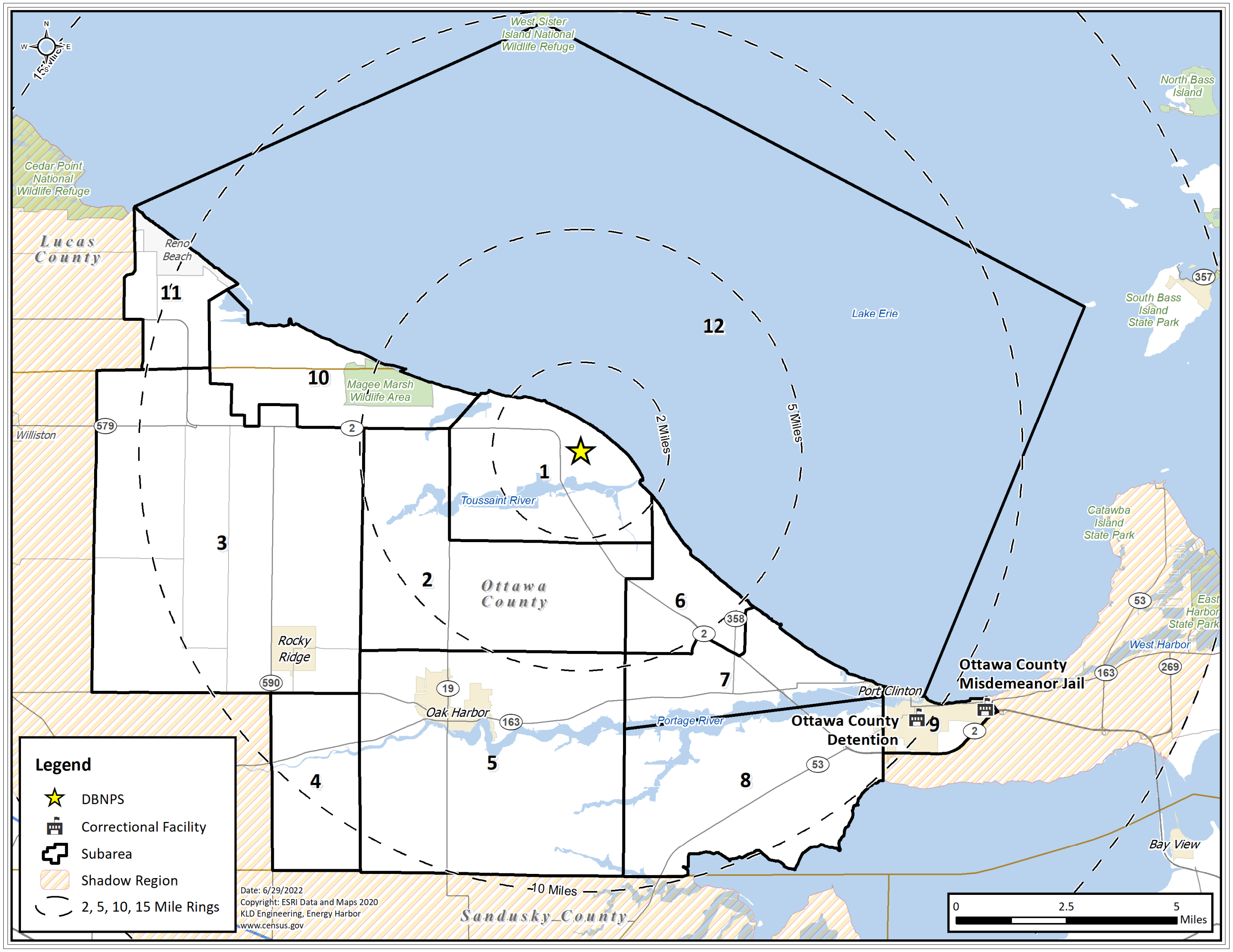


Figure E-9. Correctional Facilities within the EPZ

APPENDIX F

Demographic Survey

F. DEMOGRAPHIC SURVEY

F.1 Introduction

The development of evacuation time estimates for the Davis-Besse Nuclear Power Station (DBNPS) Emergency Planning Zone (EPZ) requires the identification of travel patterns, car ownership and household size of the population within the EPZ. Demographic information can be obtained from Census data. The use of this data has several limitations when applied to emergency planning. First, the Census data do not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data do not contain attitudinal responses needed from the population of the EPZ and consequently many 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 …?") that have direct relevance to evacuation planning.

F.2 Survey Instrument and Sampling Plan

Attachment A presents the final survey instrument used in this study, as the demographic survey. A draft of the instrument was submitted to stakeholders for comment. Comments were received and the survey instrument was modified accordingly, prior to conducting the survey.

Following the completion of the instrument, a sampling plan was developed. Since the demographic survey discussed herein was performed in early 2021 and the 2020 Census data had not been released, 2010 Census data was used to develop the sampling plan.

A sample size of approximately 455 **completed** survey forms yield results with a sampling error of ±4.5% at the 95% confidence level. The sample must be drawn from the EPZ population. Consequently, a list of zip codes in the EPZ was developed using GIS software. This list is shown in Table F-1. Along with each zip code, an estimate of the population and number of households in each area was determined by overlaying 2010 Census data and the EPZ boundary, again using GIS software. The proportional number of desired completed survey interviews for each area was identified, as shown in Table F-1. Note that the average household size computed in Table F-1 was an estimate for sampling purposes and was not used in the ETE study.

As shown in Table F-1, a total of 278 completed samples were obtained corresponding to a sampling error of ±5.83% at the 95% confidence level based on the 2020 Census data (with a total of 15,922 households in the sampled zip codes). Table F-1 also shows the number of samples obtained within each zip code. Of the 278 completed survey samples, 251 were obtained from the EPZ population and 27 were obtained from the Shadow Region. After consulting Energy Harbor, it was deemed that the demographics between the EPZ and the

Shadow Region were similar. As a result, the surveys gathered from zip codes within the Shadow Region were included in the analysis to reduce the sampling error.

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 is 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 study area (EPZ plus the shadow region). According to the survey results, the average household contains 3.10 people. The estimated household size from the 2020 Census data is 2.28 people. The difference between the 2020 Census data and survey data is approximately 30%, which is greater than the survey sampling error (±5.83%). This was discussed with Energy Harbor and the average (2.69) of the two household sizes ((3.10+2.28)/2 =2.69) was used for this ETE analysis. A sensitivity study was conducted to estimate the impact of the household size on ETE – see Table M-4 in Appendix M.

Automobile Ownership

The average number of automobiles available per household in the EPZ is 2.68. Approximately 0.4 percent of households 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 82 percent of the households surveyed responded that they would share a ride with a neighbor, relative, or friend if a car was not available to them when advised to evacuate in the event of an emergency, as shown in Figure F-5.

Commuters

Figure F-6 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data show an average of 1.81 commuters per household in the study area, and 83% of households have at least one commuter.

Commuter Travel Modes

Figure F-7 presents the mode of travel that commuters use on a daily basis. The vast majority (84%) of commuters use their private automobiles to travel to work. The data shows an average of 1.13 commuters per vehicle, assuming 2 people per vehicle – on average – for carpools.

Impact of COVID-19 on Commuters

Figure F-8 presents the distribution of the number of commuters in each household that were temporarily impacted by the COVID-19 pandemic. The data shows an average of 0.66 commuters per household were affected by the COVID-19 pandemic. Approximately 30 percent of households surveyed indicated someone in their household had a work and/or school commute that was temporarily impacted by the COVID-19 pandemic.

The results from the 2012 survey were compared to the results of this survey to determine the impact of COVID-19 on commuter responses and travel patterns. The commuter patterns (mode of travel to work, time to commute home from work/college, and time to prepare to leave work/college) were very similar (nearly identical in some cases) when the survey results were compared. As a result, the impact was determined to be minimal, and the results obtained from this survey were used in this study as is.

Functional or Transportation Needs

Figure F-9 presents the distribution of the number of individuals with functional or transportation need. The survey results indicate that approximately 5% of households have functional or transportation needs. Of those with functional or transportation needs, 34% require a bus, 7% require a medical bus/van, 7% require a wheelchair accessible van, and 52% require other modes 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-10. On average, evacuating households would use 1.70 vehicles.

"Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, 60 percent said they would await the return of other family members before evacuating and 40 percent indicated that they would not await the return of other family members.

"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 approximately 81 percent of households who are advised to shelter in place would do so; the remaining 19 percent would choose to evacuate the area. 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, Revision 1. Thus, the data obtained above is slightly lower than the federal guidance.

"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 64 percent of households would follow instructions and delay the start of evacuation until so advised, while the balance of 36 percent 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 56 percent of households indicated that they would evacuate to a friend or relatives' home, about five percent to a reception center, 16 percent to a hotel, motel or campground, three percent to a second or seasonal home, one percent of households would not evacuate, and the remaining 19 percent answered other/don't know to this question. See Figure F-11.

"What would you do with your pet(s) and/or animal(s) if you had to evacuate?" Based on responses from the survey, 97 percent of households have pet(s) and/or animal(s). Of the households with pet(s) and/or animal(s), about 24 percent indicated that they would take their pet(s) and/or animal(s) with them to a shelter, about 72 percent indicated that they would take their pet(s) and/or animal(s) somewhere else and only 4 percent would leave their pet(s) and/or animal(s) at home, as shown in Figure F-12. Of the households that would evacuate with their pet(s) and/or animal(s), 95 percent indicated that they have sufficient room in their vehicle to evacuate with their pet(s)/animal(s), two percent said they did not, and three percent would use a trailer.

"What type of pet(s) and/or animal(s) do you have?" Based on responses from the survey, 93 percent of households have a household pet (dog, cat, bird, reptile, rabbit, hermit crab, guinea pig, hamster or fish), 7% of households have farm animals (horse, chicken, goat, pig, duck, or cow), and less than half a percent of households have other small pets or animals, as shown in Figure F-13.

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.

As discussed in Section F.3.1 and shown in Figure F-8, the majority (68%) of respondents indicated no commuters were impacted by the COVID-19 pandemic; therefore, the results for the time distribution of commuters (time to prepare to leave work/college and time to travel home from work/college) were used as is in this study.

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.

"How long does it take the commuter to complete preparation for leaving work?" Figure F-14 presents the cumulative distribution for the survey responses. In all cases, the activity is completed within one hour. Approximately 90 percent can leave within 30 minutes.

"How long would it take the commuter to travel home?" Figure F-15 presents the work to home travel time for the EPZ. About 81 percent of commuters can arrive home within 30 minutes of leaving work; all commuters within 60 minutes.

"How long would it take the family to pack clothing, secure the house, and load the car?" Figure F-16 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities.

The distribution shown in Figure F-16 has a long "tail." Approximately 55 percent of households can be ready to leave home within 60 minutes; the remaining households require up to an additional two and a half hours.

"How long would it take you to clear 6 to 8 inches of snow from your driveway?" During adverse, snowy weather conditions, an additional activity must be performed before residents can depart on the evacuation trip. Although snow scenarios assume that the roads and highways have been plowed and are passable (albeit at lower speeds and capacities), it may be necessary to clear a private driveway prior to leaving the home so that the vehicle can access the street.

Figure F-17 presents the time distribution for removing 6 to 8 inches of snow from a driveway. The time distribution for clearing the driveway has a long tail; about 80 percent of driveways are passable within 75 minutes. The last driveway is cleared three hours after the start of this activity. Note, those respondents (7%) who answered that they would not take time to clear their driveway were assumed to be ready immediately at the start of this activity. Essentially, they would drive through the snow on the driveway to access the roadway and begin their evacuation trip.

Table F-1. Davis-Besse Nuclear Power Station Demographic Survey Sampling Plan

Location	Zip Code	2010 Population per Zip Code[1]	2010 Household in Zip Code	2020 Population in Zip Code	2020 Household in Zip Code	Desired Sample	Sample Obtained
EPZ	43412	3,853	1,487	3,807	1,440	41	10
	43416	2,875	1,256	2,757	1,166	35	3
	43430	1,846	798	1,650	729	22	3
	43432	1,366	499	1,376	496	14	22
	43439	113	41	110	34	1	1
	43445	1,161	440	1,126	438	12	2
	43449	8,278	3,338	8,117	3,558	92	149
	43452	13,664	8,468	13,253	6,260	234	60
	43458	414	158	312	122	4	1
EPZ Total:		**33,570**	**16,485**	**32,508**	**14,243**	**455**	**251**
Shadow	43420	2,747	1,270	2,553	1,108	N/A	12
	43616	513	204	481	196		9
	43440	698	923	769	375		6
Shadow Total:		**3,958**	**2,397**	**3,803**	**1,679**	**-**	**27**
Grant Total:		**37,528**	**18,882**	**36,311**	**15,922**	**455**	**278**
Average HH Size:		**1.99**		**2.28**			

[1] Note that the population and household numbers presented inside this table include all population and households within the zip code boundary and not just within the EPZ and the shadow region boundary.

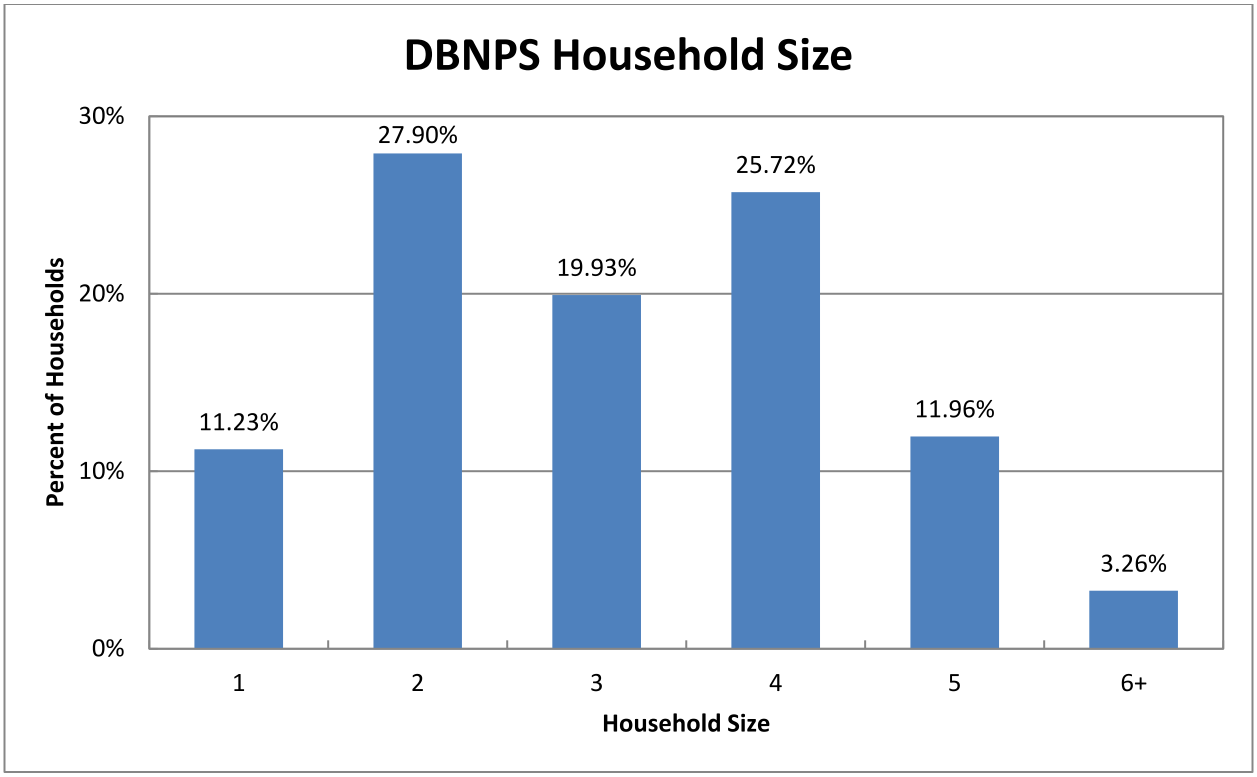


Figure F-1. Household Size in the EPZ

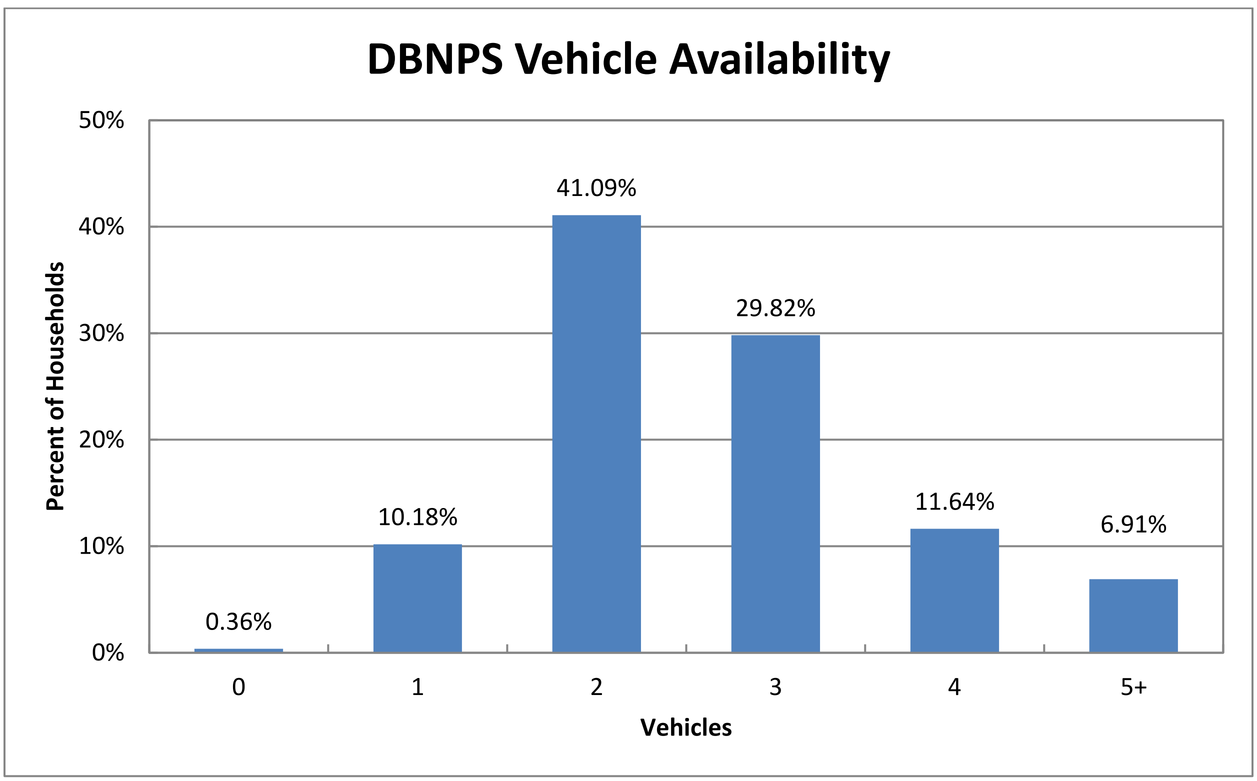


Figure F-2. Household Vehicle Availability

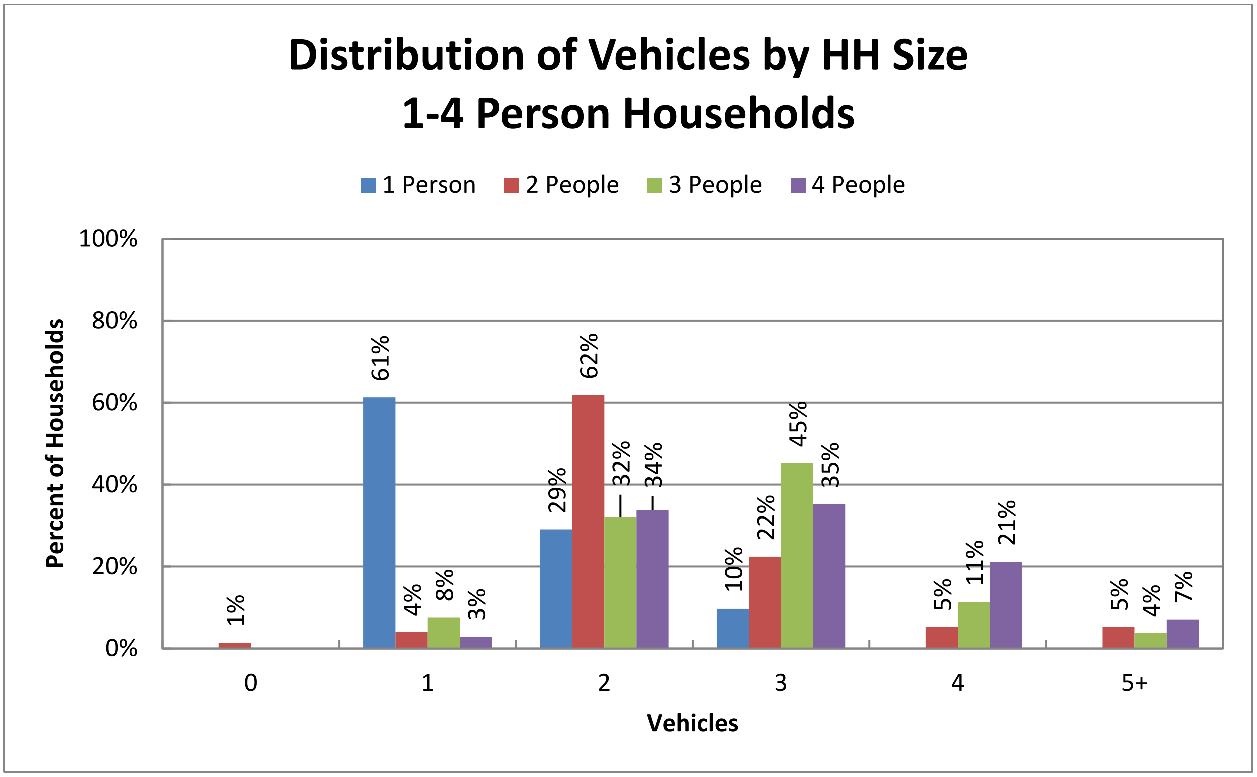


Figure F-3. Vehicle Availability - 1 to 4 Person Households

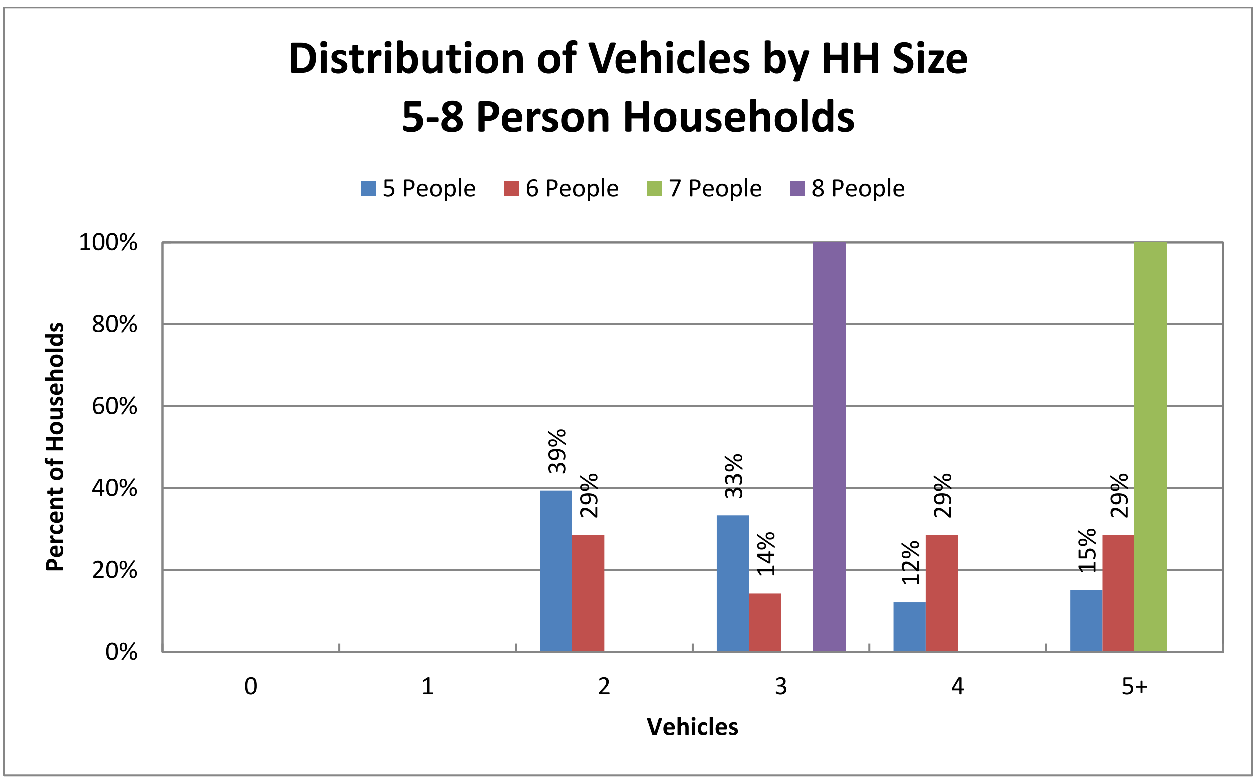


Figure F-4. Vehicle Availability - 5 to 8 Person Households

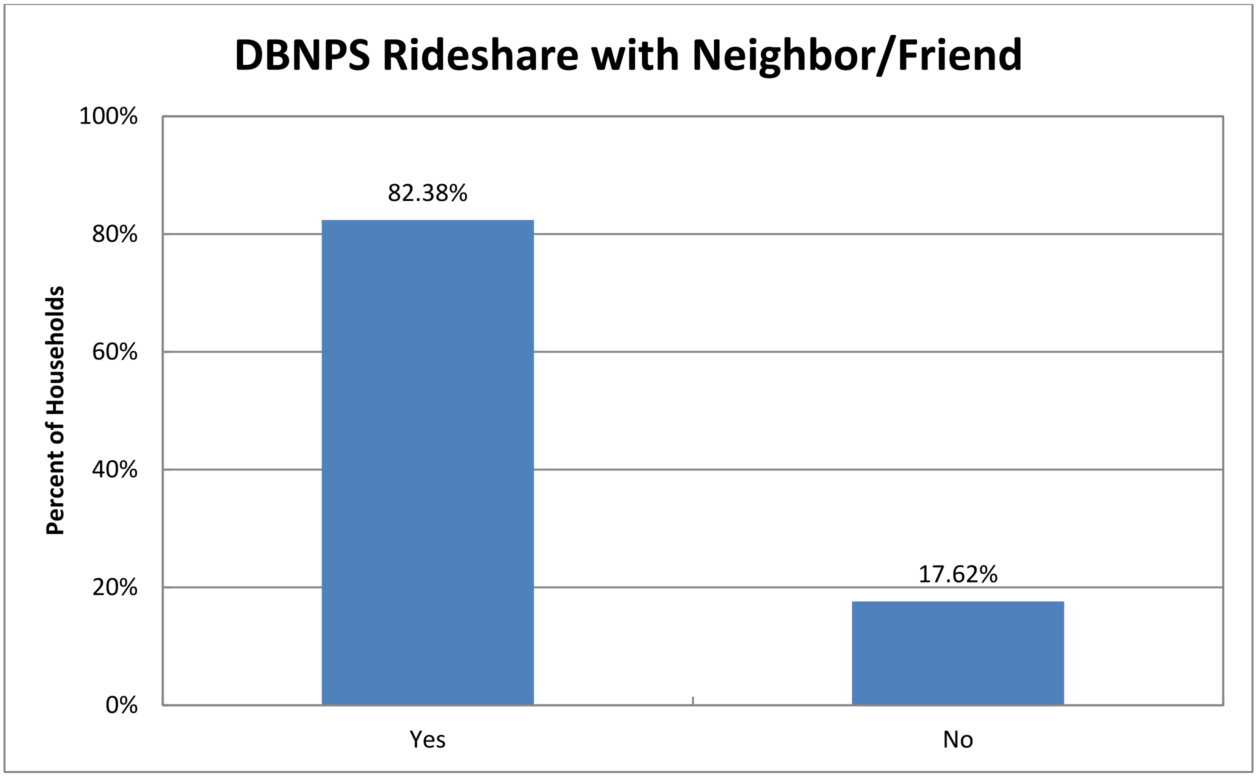


Figure F-5. Household Ridesharing Preference

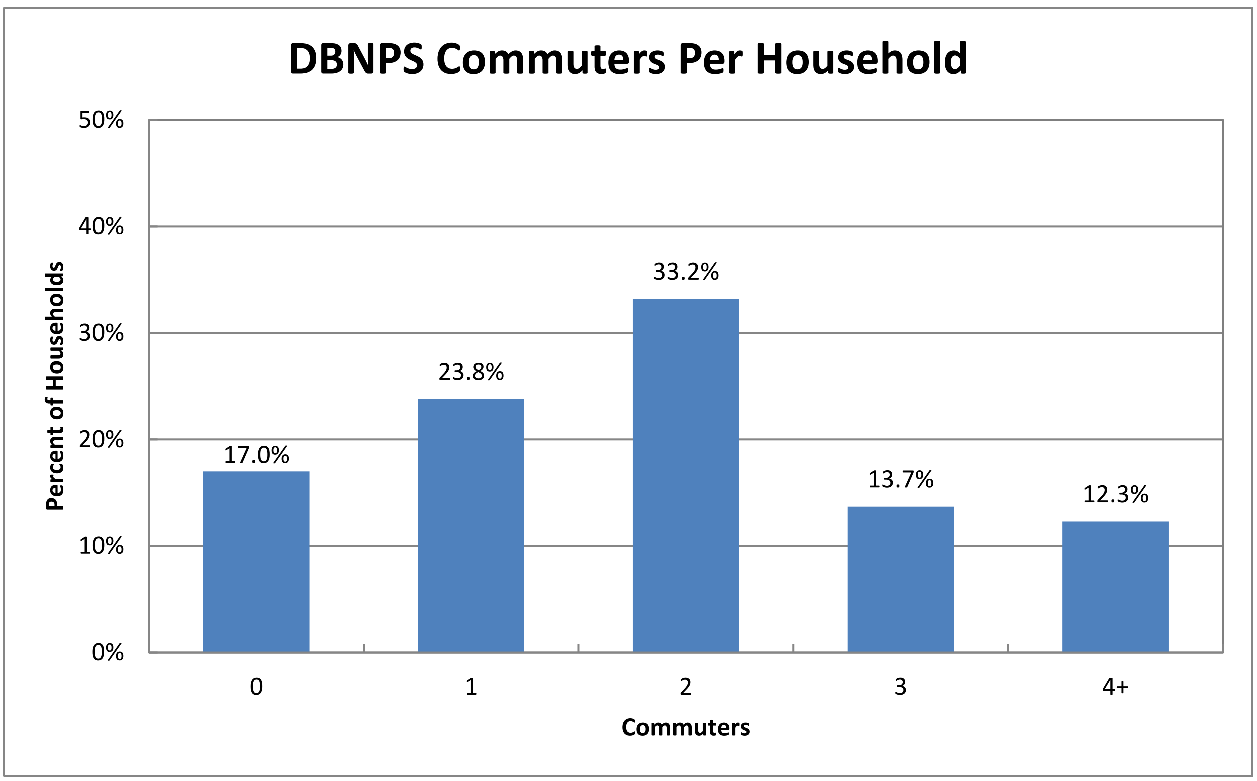


Figure F-6. Commuters per Households in the EPZ

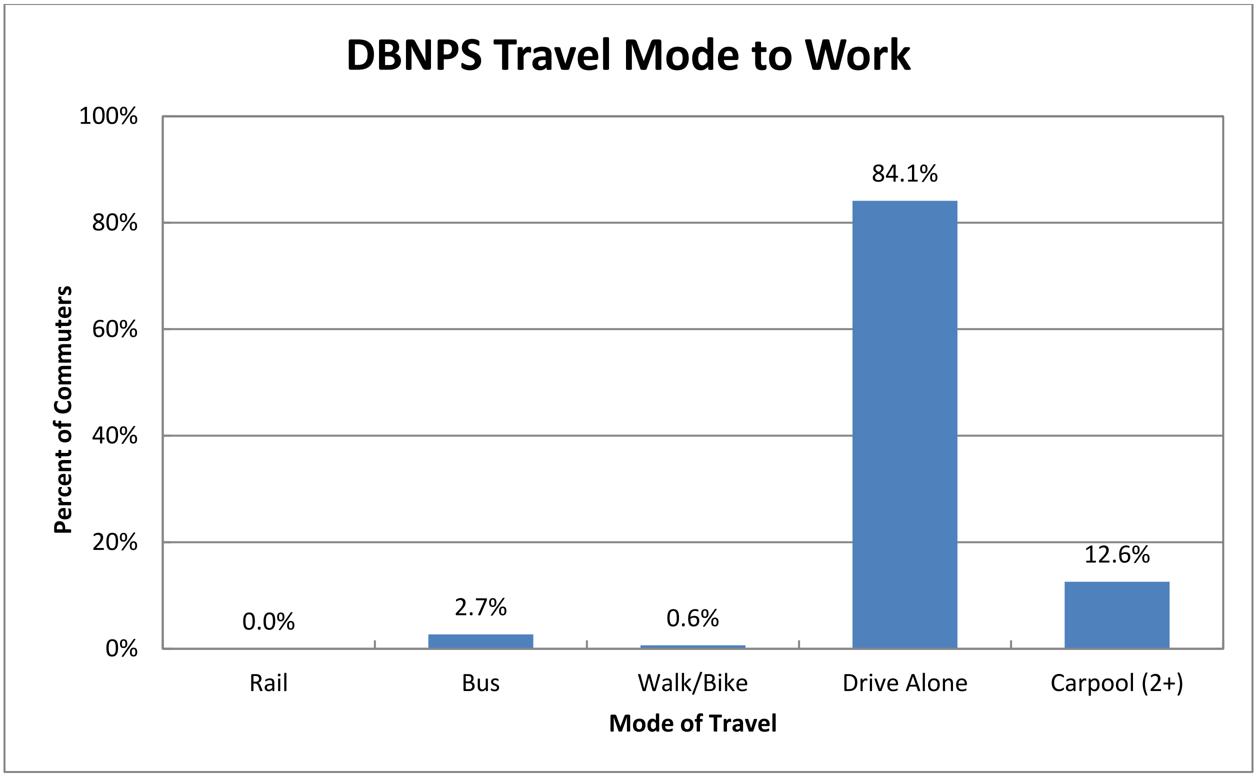


Figure F-7. Modes of Travel in the Study Area

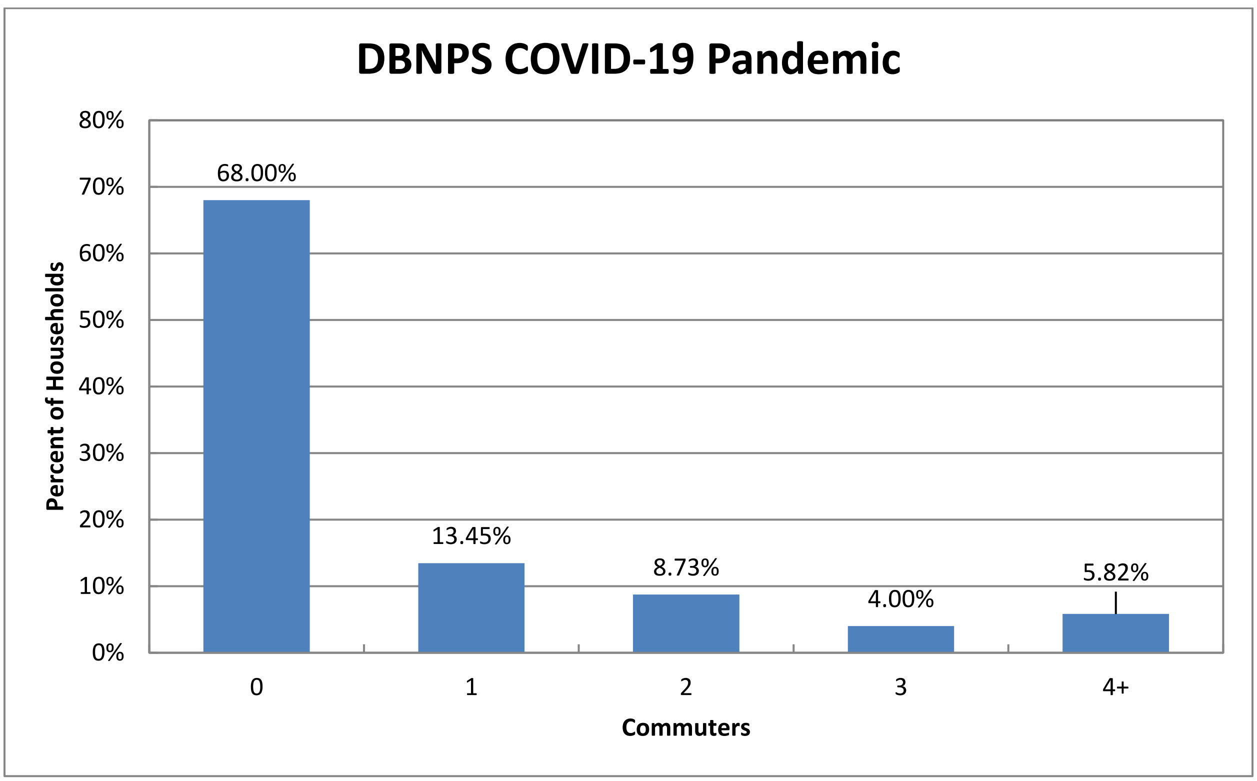


Figure F-8. Impact to Commuters due to the COVID-19 Pandemic

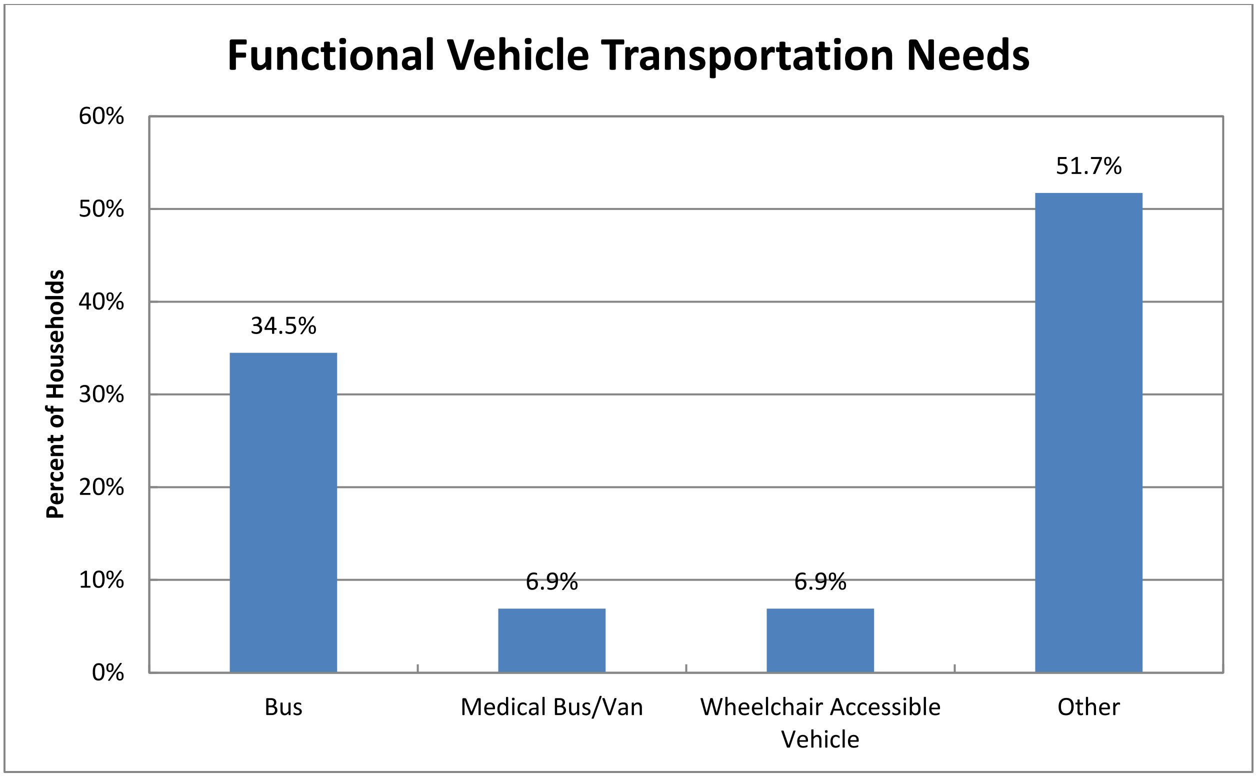


Figure F-9. Households with Functional or Transportation Needs

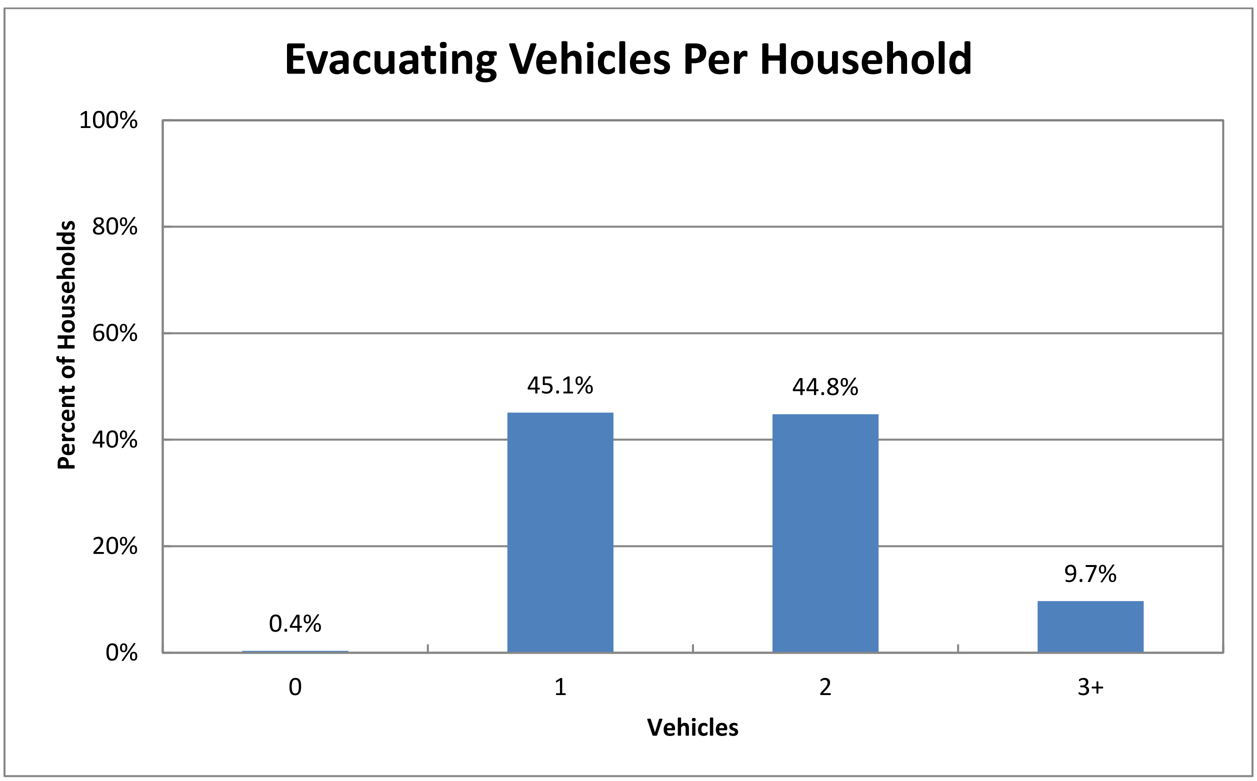


Figure F-10. Number of Vehicles Used for Evacuation

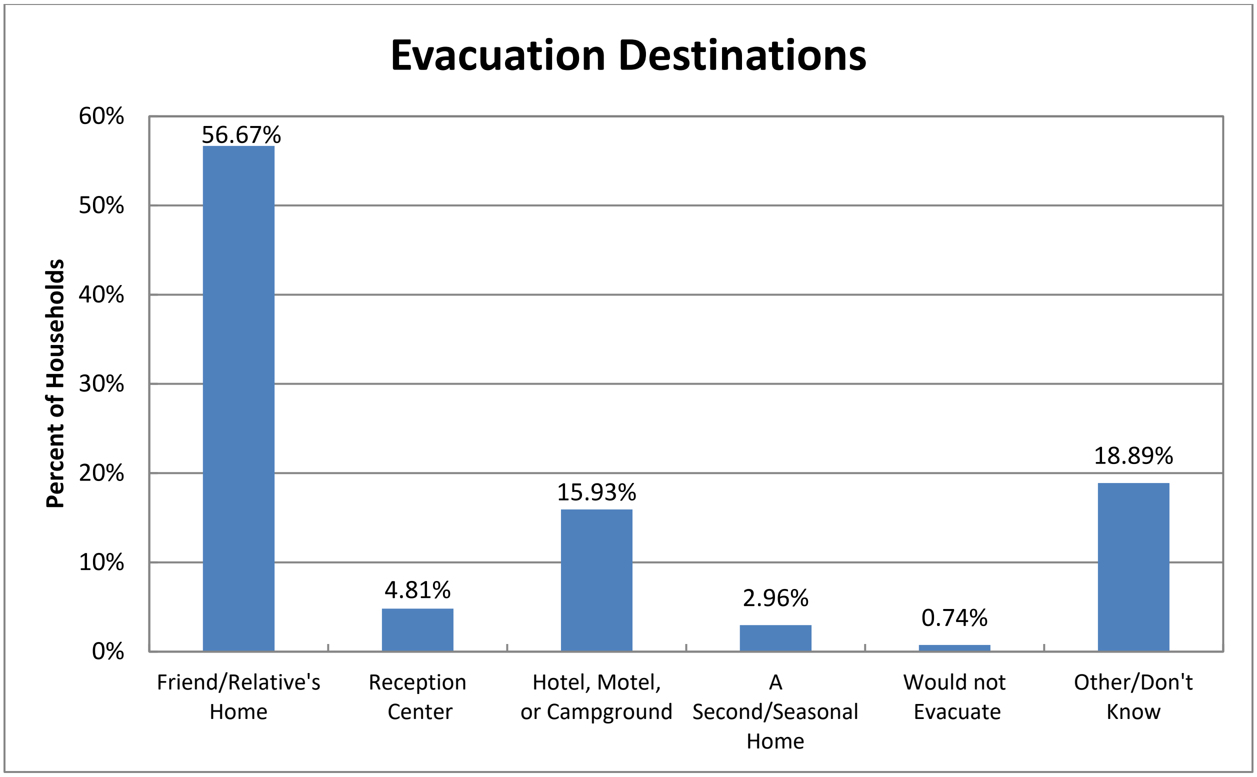


Figure F-11. Study Area Evacuation Destinations

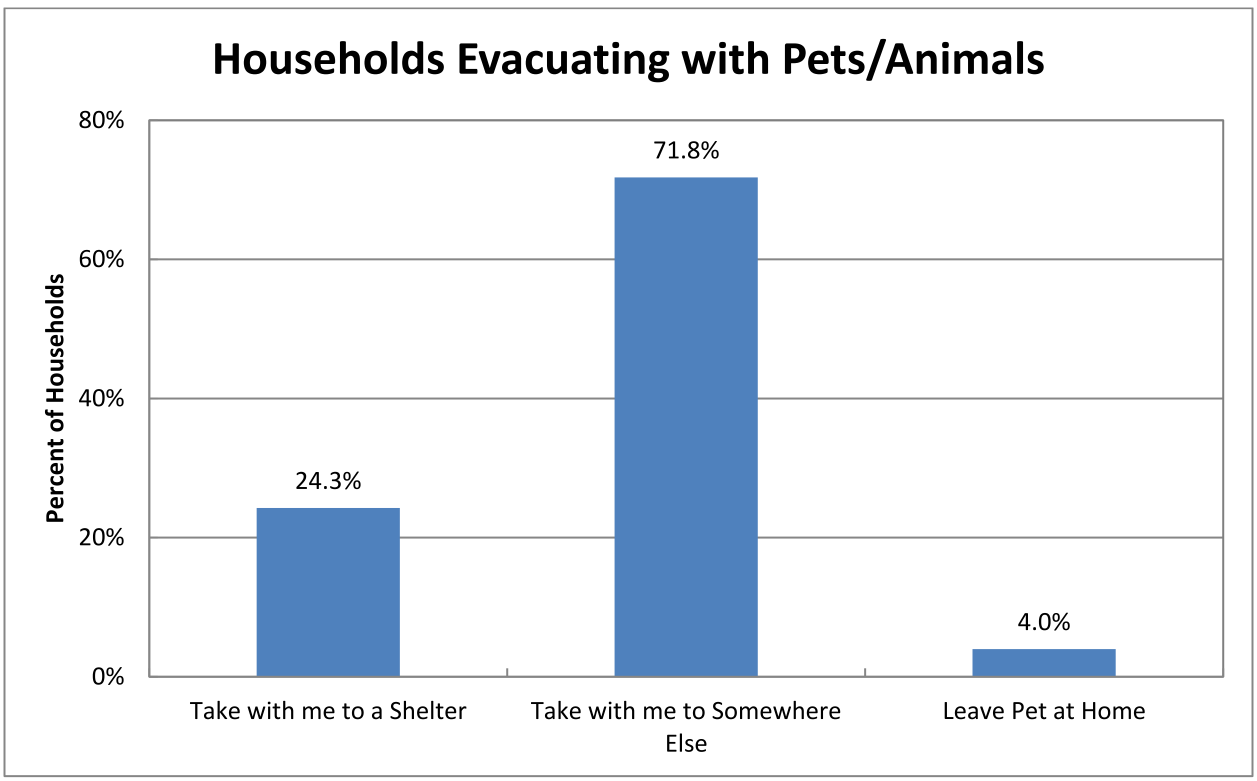


Figure F-12. Households evacuating with Pets/Animals to Shelters

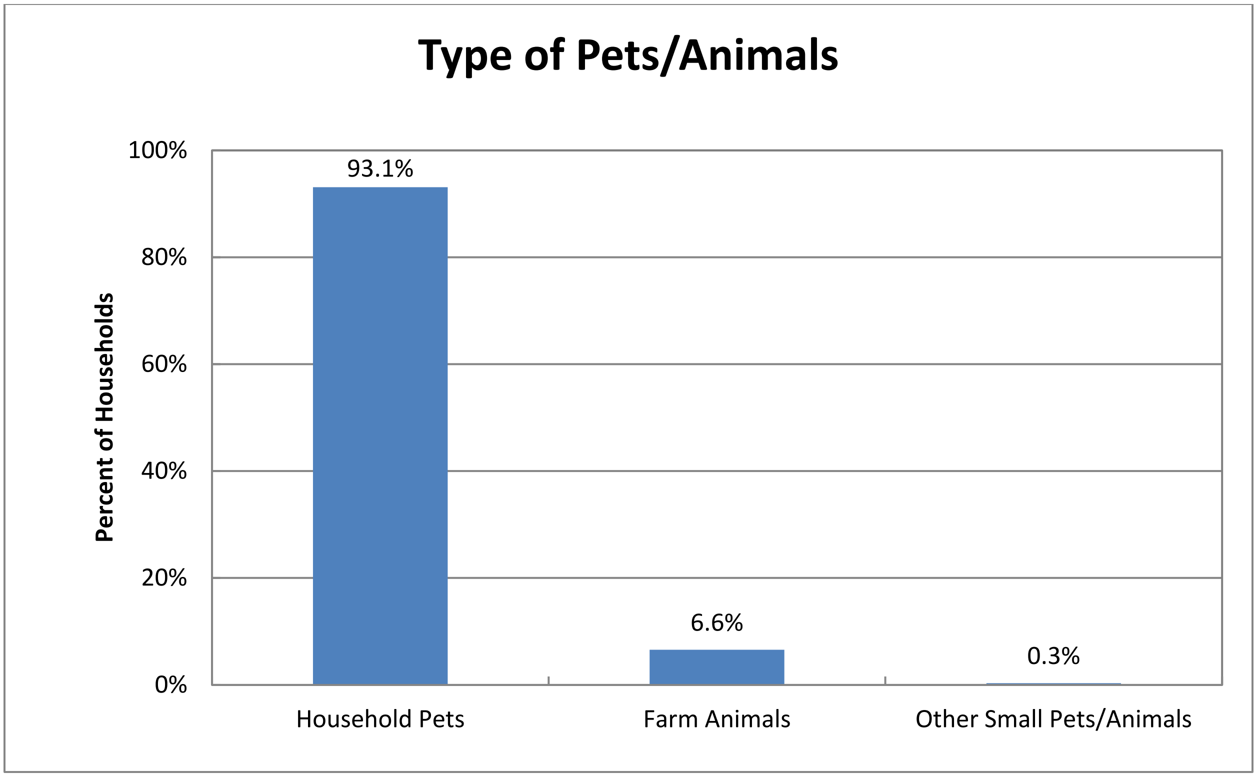


Figure F-13. Types of Pets/Animals

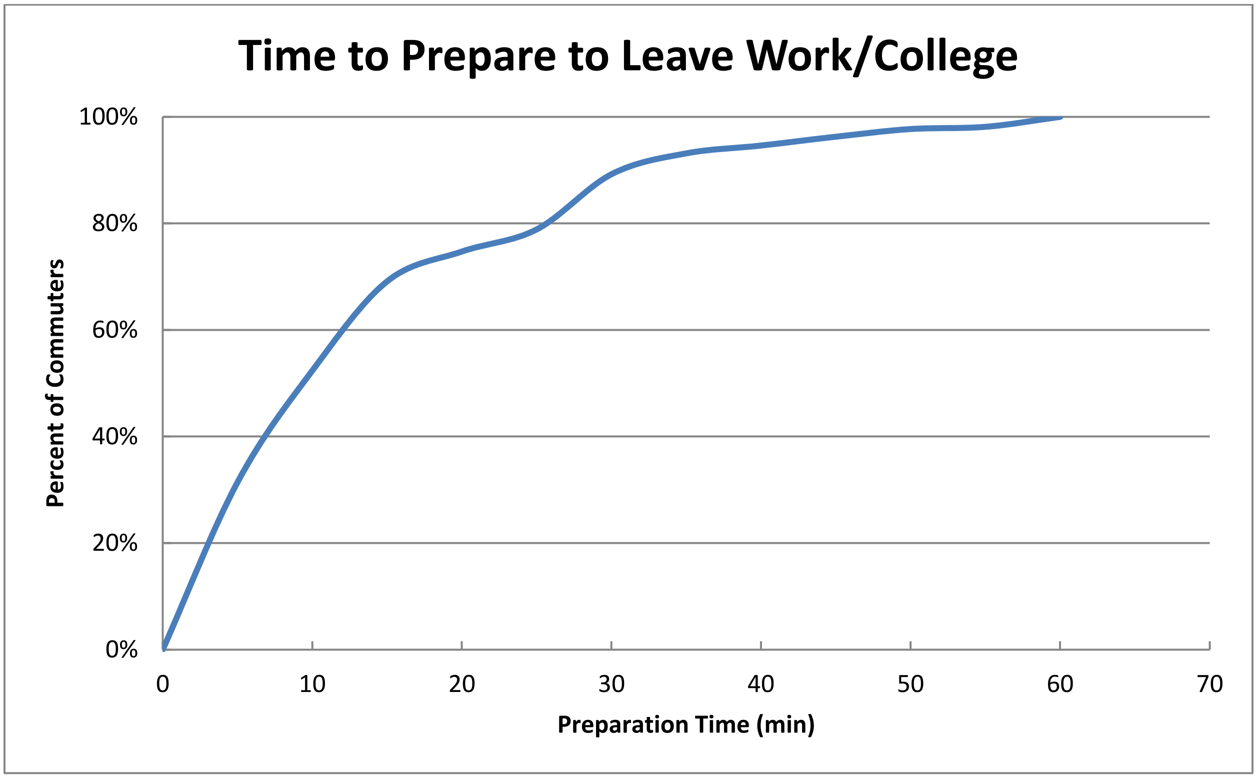


Figure F-14. Time Required to Prepare to Leave Work/School

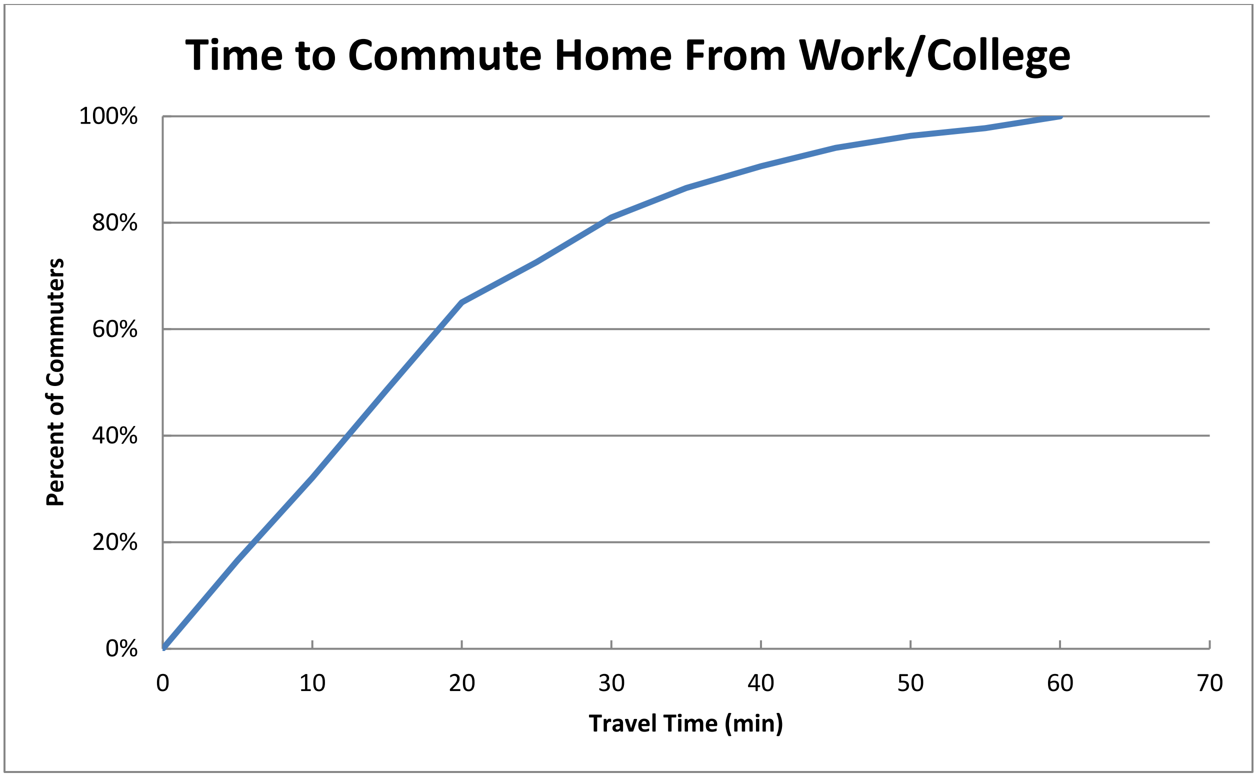


Figure F-15. Time to Commute Home from Work

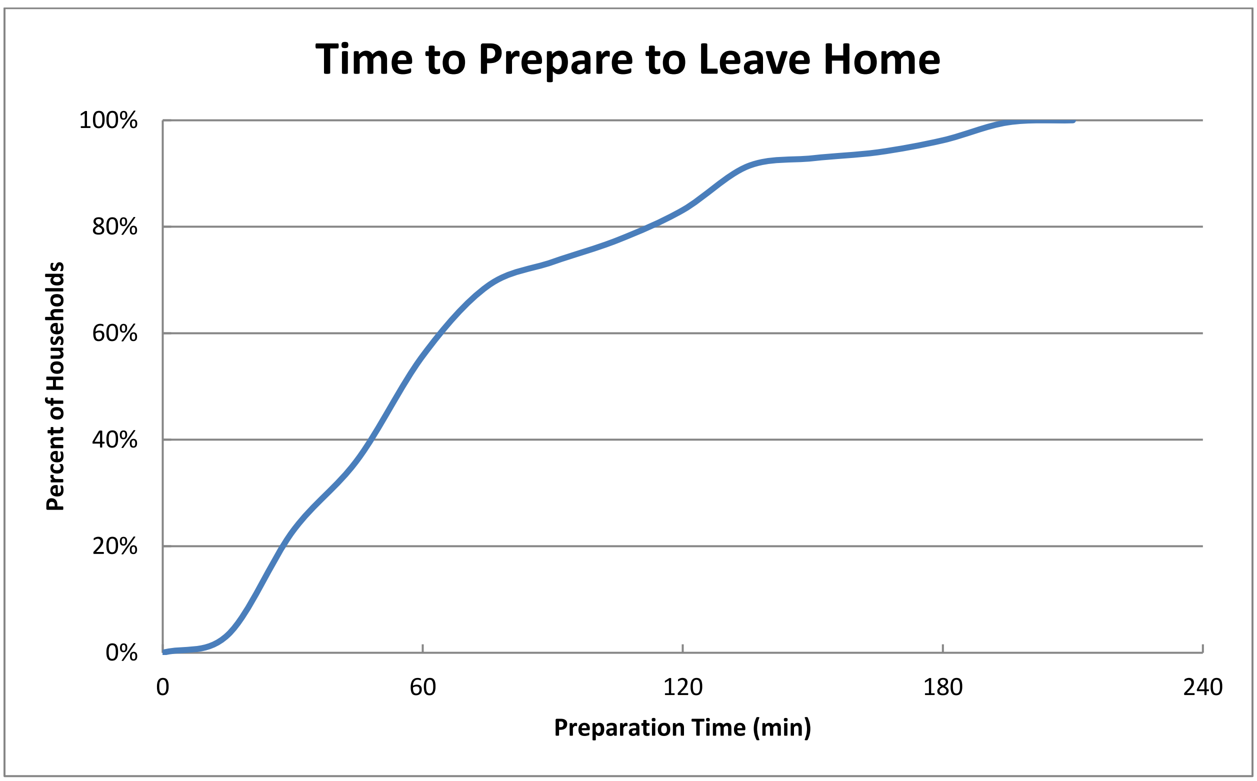


Figure F-16. Time to Prepare Home for Evacuation

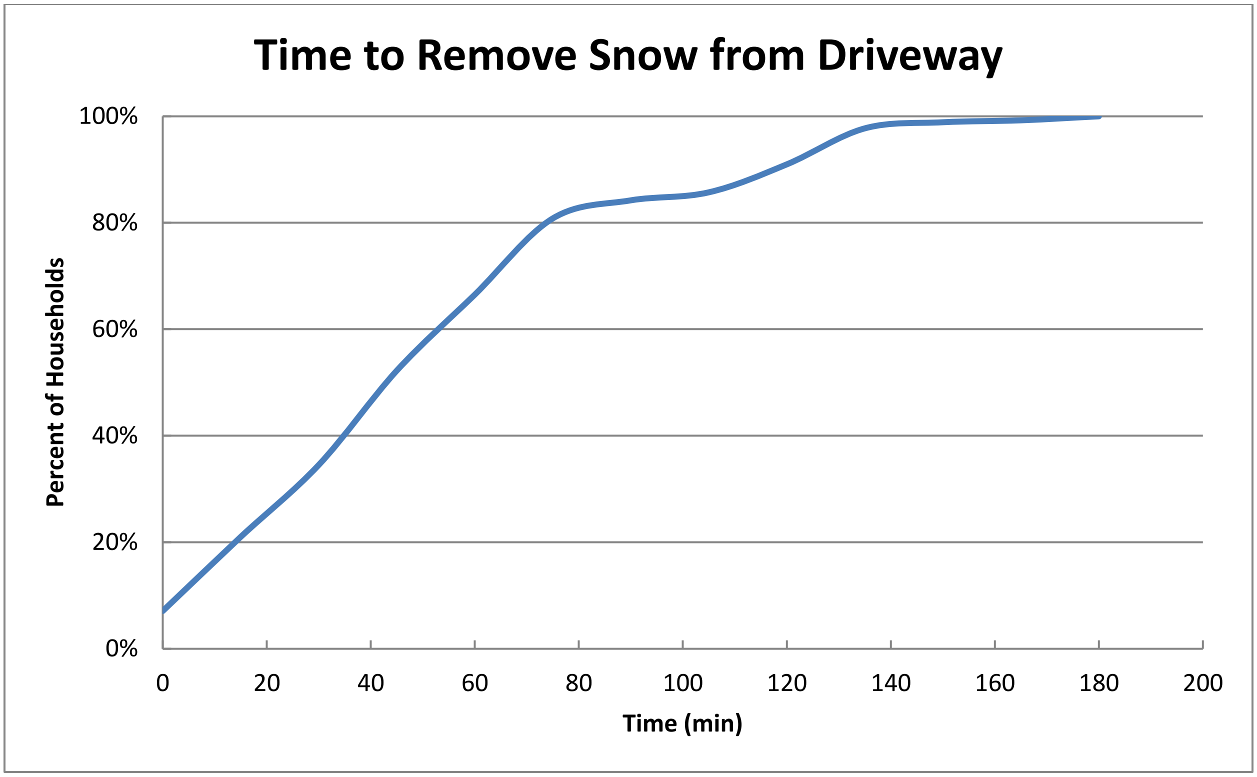


Figure F-17. Time to Clear Driveway of 6"-8" of Snow

ATTACHMENT A

Demographic Survey Instrument

Davis-Besse Nuclear Power 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 Ottawa and Lucas County emergency officials 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

COVID-19

7. 6. How many people in your household have a work and/or school commute that has been temporarily impacted due to the COVID-19 pandemic?

Mark only one oval.

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

Commuters

8. 7. How many people in the household normally (during non-COVID conditions) commute to a job, or to college on a daily basis? *

Mark only one oval.

- ZERO *Skip to question 53*
- ONE *Skip to question 9*
- TWO *Skip to question 10*
- THREE *Skip to question 11*
- FOUR OR MORE *Skip to question 12*
- DECLINE TO STATE *Skip to question 53*

Mode of Travel

9. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

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

Skip to question 13

Mode of Travel

10. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

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

Skip to question 15

Mode of Travel

11. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

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

Skip to question 19

Mode of Travel

12. 8. Thinking about each commuter, how does each person usually travel to work or college?

Mark only one oval per row.

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

Skip to question 25

Travel Home From Work/College

13. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- ⬭ 5 MINUTES OR LESS
- ⬭ 6-10 MINUTES
- ⬭ 11-15 MINUTES
- ⬭ 16-20 MINUTES
- ⬭ 21-25 MINUTES
- ⬭ 26-30 MINUTES
- ⬭ 31-35 MINUTES
- ⬭ 36-40 MINUTES
- ⬭ 41-45 MINUTES
- ⬭ 46-50 MINUTES
- ⬭ 51-55 MINUTES
- ⬭ 56 - 1 HOUR
- ⬭ OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- ⬭ BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- ⬭ BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- ⬭ BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- ⬭ OVER 2 HOURS
- ⬭ DECLINE TO STATE

14. If Over 2 Hours for Question 9-1, Specify Here

leave blank if your answer for Question 9-1, is under 2 hours.

____

Skip to question 33

Travel Home From Work/College

15. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

16. If Over 2 Hours for Question 9-1, Specify Here

leave blank if your answer for Question 9-1, is under 2 hours.

17. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

18. If Over 2 Hours for Question 9-2, Specify Here

leave blank if your answer for Question 9-2, is under 2 hours.

Skip to question 35

Travel Home From Work/College

19. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

20. If Over 2 Hours for Question 9-1, Specify Here

leave blank if your answer for Question 9-1, is under 2 hours.

21. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

22. If Over 2 Hours for Question 9-2, Specify Here

leave blank if your answer for Question 9-2, is under 2 hours.

23. 9-3. How much time on average, would it take Commuter #3 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

24. If Over 2 Hours for Question 9-3, Specify Here
leave blank if your answer for Question 9-3, is under 2 hours.

Skip to question 39

Travel Home From Work/College

25. 9-1. How much time on average, would it take Commuter #1 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

26. If Over 2 Hours for Question 9-1, Specify Here
leave blank if your answer for Question 9-1, is under 2 hours.

27. 9-2. How much time on average, would it take Commuter #2 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

28. If Over 2 Hours for Question 9-2, Specify Here
leave blank if your answer for Question 9-2, is under 2 hours.

29. 9-3. How much time on average, would it take Commuter #3 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

30. If Over 2 Hours for Question 9-3, Specify Here
leave blank if your answer for Question 9-3, is under 2 hours.

31. 9-4. How much time on average, would it take Commuter #4 to travel home from work or college?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

32. If Over 2 Hours for Question 9-4, Specify Here

leave blank if your answer for Question 9-4, is under 2 hours.

Skip to question 45

Preparation to leave Work/College

33. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

Skip to question 53

Preparation to leave Work/College

35. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

36. If Over 2 Hours for Question 10-1, Specify Here
leave blank if your answer for Question 10-1, is under 2 hours.

37. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

38. If Over 2 Hours for Question 10-2, Specify Here
leave blank if your answer for Question 10-2, is under 2 hours.

Skip to question 53

Preparation to leave Work/College

39. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

41. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

43. 10-3. Approximately how much time would it take Commuter #3 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

____

Skip to question 53

Preparation to leave Work/College

45. 10-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

____

47. 10-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

49. 10-3. Approximately how much time would it take Commuter #3 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

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

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

51. 10-4. Approximately how much time would it take Commuter #4 to complete preparation for leaving work or college prior to starting the trip home?

Mark only one oval.

- 5 MINUTES OR LESS
- 6-10 MINUTES
- 11-15 MINUTES
- 16-20 MINUTES
- 21-25 MINUTES
- 26-30 MINUTES
- 31-35 MINUTES
- 36-40 MINUTES
- 41-45 MINUTES
- 46-50 MINUTES
- 51-55 MINUTES
- 56 - 1 HOUR
- OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
- BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
- BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
- BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
- OVER 2 HOURS
- DECLINE TO STATE

52. If Over 2 Hours for Question 10-4, Specify Here

leave blank if your answer for Question 10-4, is under 2 hours.

Skip to question 53

Additional Questions

53. 11. If you were advised by local authorities to evacuate, how much time would it take the household to pack clothing, medications, secure the house, load the car, and complete preparations prior to evacuating the area?

Mark only one oval.

- LESS THAN 15 MINUTES
- 15-30 MINUTES
- 31-45 MINUTES
- 46 MINUTES - 1 HOUR
- 1 HOUR TO 1 HOUR 15 MINUTES
- 1 HOUR 16 MINUTES TO 1 HOUR 30 MINUTES
- 1 HOUR 31 MINUTES TO 1 HOUR 45 MINUTES
- 1 HOUR 46 MINUTES TO 2 HOURS
- 2 HOURS TO 2 HOURS 15 MINUTES
- 2 HOURS 16 MINUTES TO 2 HOURS 30 MINUTES
- 2 HOURS 31 MINUTES TO 2 HOURS 45 MINUTES
- 2 HOURS 46 MINUTES TO 3 HOURS
- 3 HOURS TO 3 HOURS 15 MINUTES
- 3 HOURS 16 MINUTES TO 3 HOURS 30 MINUTES
- 3 HOURS 31 MINUTES TO 3 HOURS 45 MINUTES
- 3 HOURS 46 MINUTES TO 4 HOURS
- 4 HOURS TO 4 HOURS 15 MINUTES
- 4 HOURS 16 MINUTES TO 4 HOURS 30 MINUTES
- 4 HOURS 31 MINUTES TO 4 HOURS 45 MINUTES
- 4 HOURS 46 MINUTES TO 5 HOURS
- 5 HOURS TO 5 HOURS 30 MINUTES
- 5 HOURS 31 MINUTES TO 6 HOURS
- OVER 6 HOURS
- WILL NOT EVACUATE
- DECLINE TO STATE

54. If Over 6 Hours for Question 11, Specify Here

leave blank if your answer for Question 11, is under 6 hours.

55. 12. 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

56. If Over 3 Hours for Question 12, Specify Here
leave blank if your answer for Question 12, is under 3 hours.

57. 13. 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						

58. Specify "Other" Transportation Need Below

59. 14. 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

60. 15A. 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

61. 15B. 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

62. 15C. 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

63. Fill in OTHER answers for question 15C

____

Pet Questions

64. 16A. Do you have any pet(s) and/or animal(s)?

Mark only one oval.

- ( ) YES
- ( ) NO
- ( ) DECLINE TO STATE

Pet Questions

65. 16B. 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: ______________________________

66.

Mark only one oval.

- ( ) DECLINE TO STATE

Pet Questions

67. 16C. 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

68. 16D. Do you have sufficient room in your vehicle(s) to evacuate with your pet(s) and/or animal(s)?

Mark only one oval.

- YES
- YES WITH A TRAILER
- 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. An analysis of the TCP and ACP locations was performed, and it was determined to model the ETE simulations with existing TCPs and ACPs that were provided by the county emergency, with no additional TCP and ACP recommended. Figure G-1 maps the existing TCPs and ACPs.

G.1 Manual Traffic Control

The TCPs and ACPs are forms of manual traffic control (MTC). As discussed in Section 9, MTC at intersections (which are controlled) are modeled as actuated signals. If an intersection has a pre-timed signal, stop, or yield control, and the intersection is identified as a TCP or ACP, 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 and ACPs 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 or ACP, the control type is indicated as a TCP/ACP in Table K-1. These TCP and ACP within the study area are mapped as blue dots and red squares, respectively, in Figure G-1. The TCPs and ACPs identified in the emergency plans of Ottawa and Lucas Counties. State and county police/sheriff 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. No additional locations for MTC are suggested in this study.

It is assumed that ACPs will be established within 2 hours of the Advisory to Evacuate (ATE) to discourage through travelers from using major through evacuation routes which traverse the EPZ. As discussed in Section 3.11, external traffic was considered on Interstate (I)-35 which traverses the Shadow Region in this analysis. The generation of the external trips on I-80, US Route (US) 20, and US 6 exists for the entire evacuation as there are no ACPs on these roadways.

G.2 Analysis of Key TCP/ACP Locations

As discussed in Section 5.2 of NUREG/CR-7002, Rev. 1, MTC at intersections could benefit from the ETE analysis. The MTC locations contained within the TMP were analyzed to determine key locations where MTC would be most useful and can be readily implemented. As previously mentioned, signalized intersections that were actuated based on field data collection were

essentially left as actuated traffic signals in the model, with modifications to green time allocation as needed. Other controlled intersections (pre-timed signals, stop signs and yield signs) were changed to actuated traffic signals to represent the MTC that would be implemented according to the TMP.

The majority of the TCPs/ACPs 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 MTC points in the TMP that were not previously actuated signals, including the type of control that currently exists at each location. To determine the impact of MTC at these locations, a summer, midweek, midday, with good weather conditions (Scenario 1) evacuation of the 2-Mile Region (R01), 5-Mile Region (R02) and the entire EPZ (Region R03) were simulated wherein these intersections were left as is (without MTC). The results are shown in Table G-2.

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 compared to the base cases wherein these controlled intersections were modeled as actuated signals (with MTC),, as shown in Table G-2. The remaining TCPs/ACPs were left as actuated signals in the model and, therefore, had no impact to ETE.

As shown in Figure 7-3 through Figure 7-6 and discussed in Section 7.3, the majority of the congestion within the EPZ is located in Port Clinton. As there is minimal congestion outside of this area, TCPs and ACPs within the EPZ do very little to reduce the 90^{th} percentile ETE. In addition, congestion within the EPZ clears prior to the completion of the trip generation time (the time to mobilize, plus travel time to EPZ boundary, dictates the 100^{th} percentile ETE); as a result, the MTC has no impact on the 100^{th} percentile ETE.

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

Table G-1. List of Key TCP Locations

TCP*/ACP	Intersection	Node #	Previous Control
1-1*	SR 2 and CR 104 (Toussaint South Road)	126	Stop
1-4	SR 19 and CR 93 (Toussaint East Road)	423	Stop
1-8	CR 93 (Toussaint East Road) and SR 2	118	Stop
1-9	SR 2 and SR 19 S	136	Stop
2-1*	SR 2 and CR 23 (Benton-Carroll Road)	141	Stop
2-2	CR 23 (Benton-Carroll Road) and T-91 (Zenser Road)	241	Stop
2-4	CR 23 (Benton-Carroll Road) and T-62 (Toussaint North Road)	540	Stop
2-5	CR 23 (Benton-Carroll Road) and CR 93 (Toussaint East Road)	240	stop
2-6	CR 23 (Benton-Carroll Road) and T-94 (Strickle-Toussaint Road)	456	Stop
2-7	CR 23 (Benton-Carroll Road) and T-97 (Bier Road)	239	Stop
2-8	CR 23 (Benton-Carroll Road) and CR 98 (Salem-Carroll Road)	520	Stop
2-10	CR 98 (Salem-Carroll Road) and SR 19	421	Stop
3-1*	SR 2 and SR 579	145	Stop
3-2	CR 213 (Nissen Road) and SR 579	170	Stop
3-9	SR 163 and CR 208 (Elliston-Trowbridge Road)	221	stop
3-10	SR 163 and CR 19 (Graytown Road)	222	Stop
3-12	SR 163 and SR 590	181	stop
3-15	CR 23 (Benton-Carroll Road) and T-79 (Kolb Road)	519	Stop
4-1*	SR 590 and SR 105	182	stop
4-4	SR 590 and T-83 (Weis Road)	184	Stop
4-5	SR 590 and CR 6 (Elmore-Eastern Road)	487	Stop
5-1*	SR 163 and CR 23 (Benton-Carroll Road)	223	Stop
5-4	SR 105 and CR 23 (Benton-Carroll Road)	234	Stop
5-9	SR 19 and T-10 (Leaser Road)	268	Stop
5-12	T-11 (Woodrich Road) and T-217 (Muddy Creek North Road)	483	Stop
5-17	SR 163 and CR 26 (Carroll-Erie Road)	409	Stop
6-1*	SR 2 and Erie Industrial Park (Tettau Road/CR 14)	120	Stop
6-2*	SR 2 and SR 358	111	Stop
8-3	T-217 (Muddy Creek North Road) and CR 18 (Portage River South Road)	479	Stop
8-4	T-217 (Muddy Creek North Road) and CR 17 (Oak Harbor Southeast Road)	508	stop
8-5	T-217 (Muddy Creek North Road) and T-112 (Little Portage East Road)	534	Stop
8-6	T-217 (Muddy Creek North Road) and CR 113 (Boysen Road)	474	Stop
9-4*	West Perry Street and Monroe Street	319	Stop
9-9	CR 8 (State Road) and CR 34 (Plasterbed Road)	461	Stop
10-3	SR 2 and SR 590/T-44 (Lindsey-Limestone Road)	143	Stop
11-1*	Teachout Road and SR 2	154	Stop
11-2*	Teachout and Corduroy Roads	153	Stop
11-4	Howard Road and SR 2	149	Stop
11-5	Corduroy and Howard Road	151	Stop
SC-29	SR 53 and SR 523 S (Fremont Post)	15	Stop

Table G-2. ETE with No MTC

Region	Scenario 1					
	90th Percentile ETE			100th Percentile ETE		
	Base	No MTC	Difference	Base	No MTC	Difference
R01 (2-Mile)	2:00	2:00	0:00	4:45	4:45	0:00
R02 (5-Mile	2:15	2:15	0:00	4:50	4:50	0:00
R03 (Full EPZ)	2:55	2:55	0:00	4:55	4:55	0:00

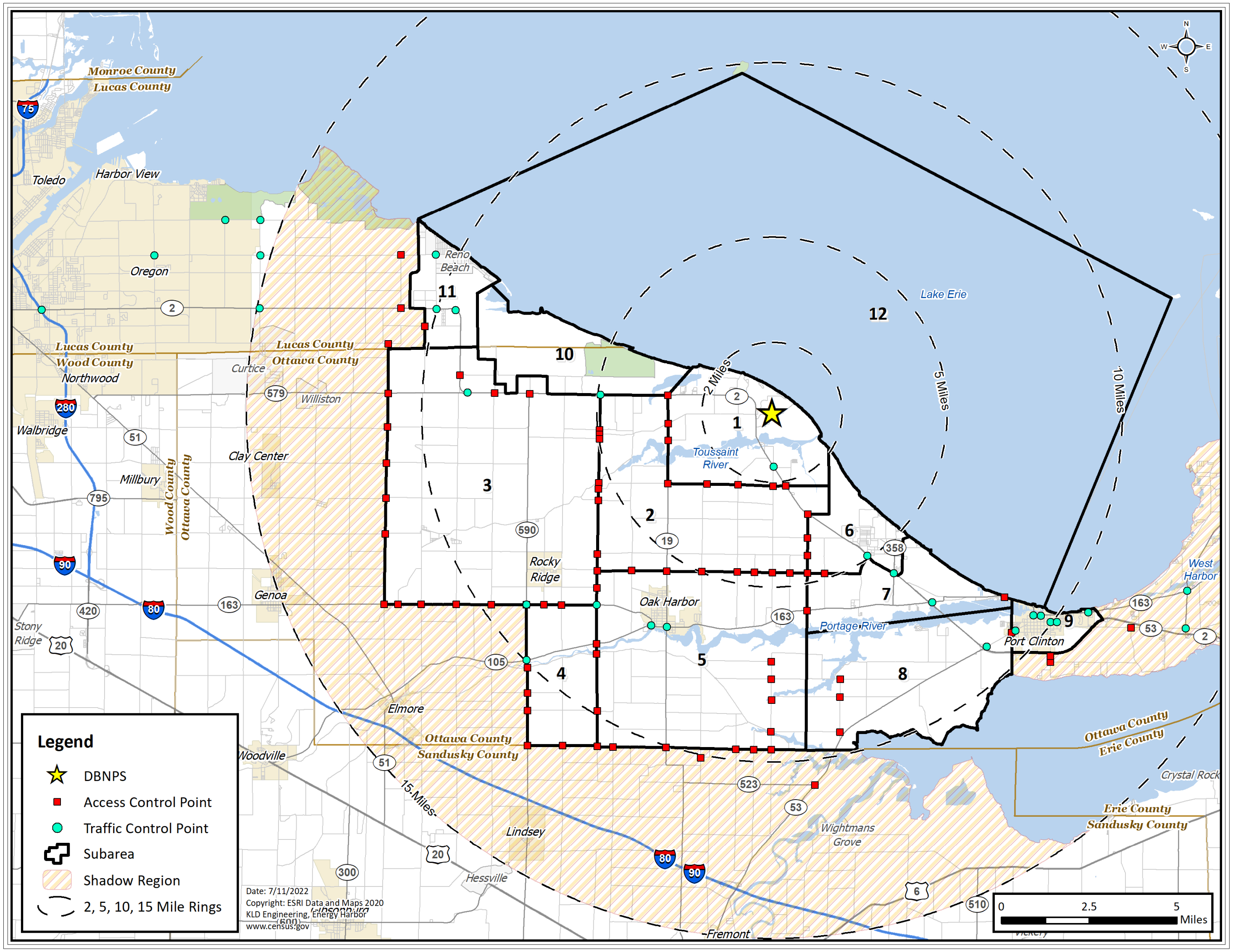


Figure G-1. DBNPS Traffic and Access Control Points

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-20). 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. As discussed in Section 6, based on local procedures, Subareas 10 and 12 evacuate under all circumstances and are included in all Regions.

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.

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

Radial Regions

Region	Description	Subarea 1	2	3	4	5	6	7	8	9	10[1]	11	12[1]
R01	2-Mile Region	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	20%	100%
R02	5-Mile Region	100%	100%	20%	20%	20%	100%	20%	20%	20%	100%	20%	100%
R03	Full EPZ	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Evacuate 2-Mile Region and Downwind to 5 Miles

Region	Wind Direction From:	Subarea 1	2	3	4	5	6	7	8	9	10	11	12
N/A	Unknown or Lake Breeze	**Refer to Region R02**											
N/A	118° - 278°	**Refer to Region R01**											
R04	279° - 293°	100%	20%	20%	20%	20%	100%	20%	20%	20%	100%	20%	100%
N/A	294° - 013°	**Refer to Region R02**											
R05	014° - 117°	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	100%

Evacuate 2-Mile Region and Downwind to the EPZ Boundary

Region	Wind Direction From:	Subarea 1	2	3	4	5	6	7	8	9	10	11	12
N/A	Unknown or Lake Breeze	**Refer to Region R03**											
N/A	141° - 278°	**Refer to Region R01**											
R06	279° - 286°	100%	20%	20%	20%	20%	100%	100%	20%	100%	100%	20%	100%
R07	287° - 293°	100%	20%	20%	20%	20%	100%	100%	100%	100%	100%	20%	100%
R08	294° - 330°	100%	100%	20%	20%	20%	100%	100%	100%	100%	100%	20%	100%
R09	331° - 005°	100%	100%	20%	20%	100%	100%	100%	100%	20%	100%	20%	100%
R10	006° - 013°	100%	100%	20%	100%	100%	100%	100%	100%	20%	100%	20%	100%
R11	014° - 020°	100%	100%	20%	100%	100%	20%	20%	20%	20%	100%	20%	100%
R12	021° - 065°	100%	100%	100%	100%	100%	20%	20%	20%	20%	100%	20%	100%
R13	066° - 072°	100%	100%	100%	100%	20%	20%	20%	20%	20%	100%	20%	100%
R14	073° - 078°	100%	100%	100%	20%	20%	20%	20%	20%	20%	100%	20%	100%
R15	079° - 117°	100%	100%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%
R16	118° - 122°	100%	20%	100%	20%	20%	20%	20%	20%	20%	100%	100%	100%
R17	123° - 140°	100%	20%	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%

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

Region	Wind Direction From:	Subarea 1	2	3	4	5	6	7	8	9	10	11	12
R18	5-Mile Region	100%	100%	20%	20%	20%	100%	20%	20%	20%	100%	20%	100%
N/A	118° - 278°	**Refer to Region R01**											
R19	279° - 293°	100%	20%	20%	20%	20%	100%	20%	20%	20%	100%	20%	100%
N/A	294° - 013°	**Refer to Region R18**											
R20	014° - 117°	100%	100%	20%	20%	20%	20%	20%	20%	20%	100%	20%	100%

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

[1] Site specific protective action recommendations indicate that Subareas 10 and 12 evacuate even though not within the wind direction three-sector keyhole.

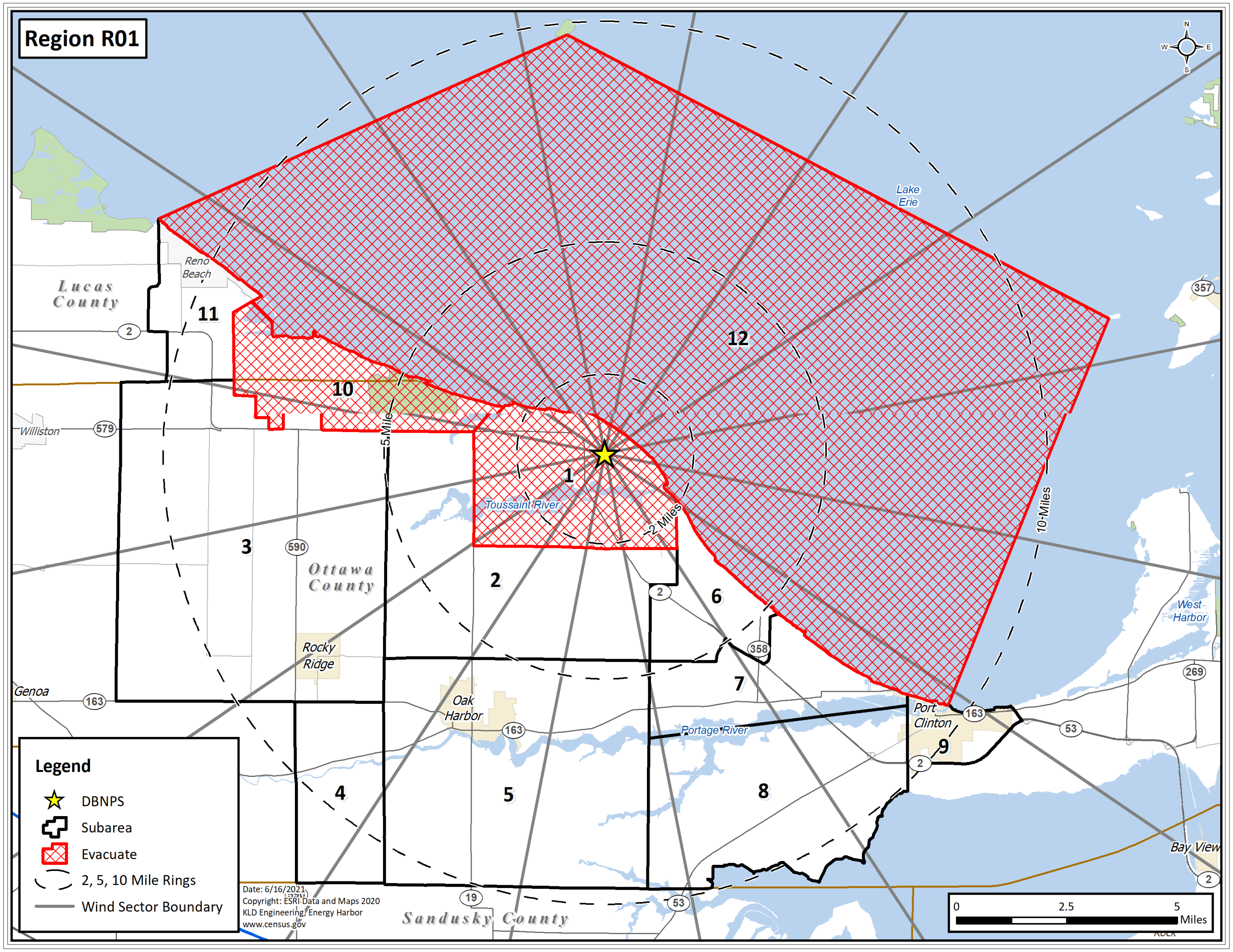


Figure H-1. Region R01

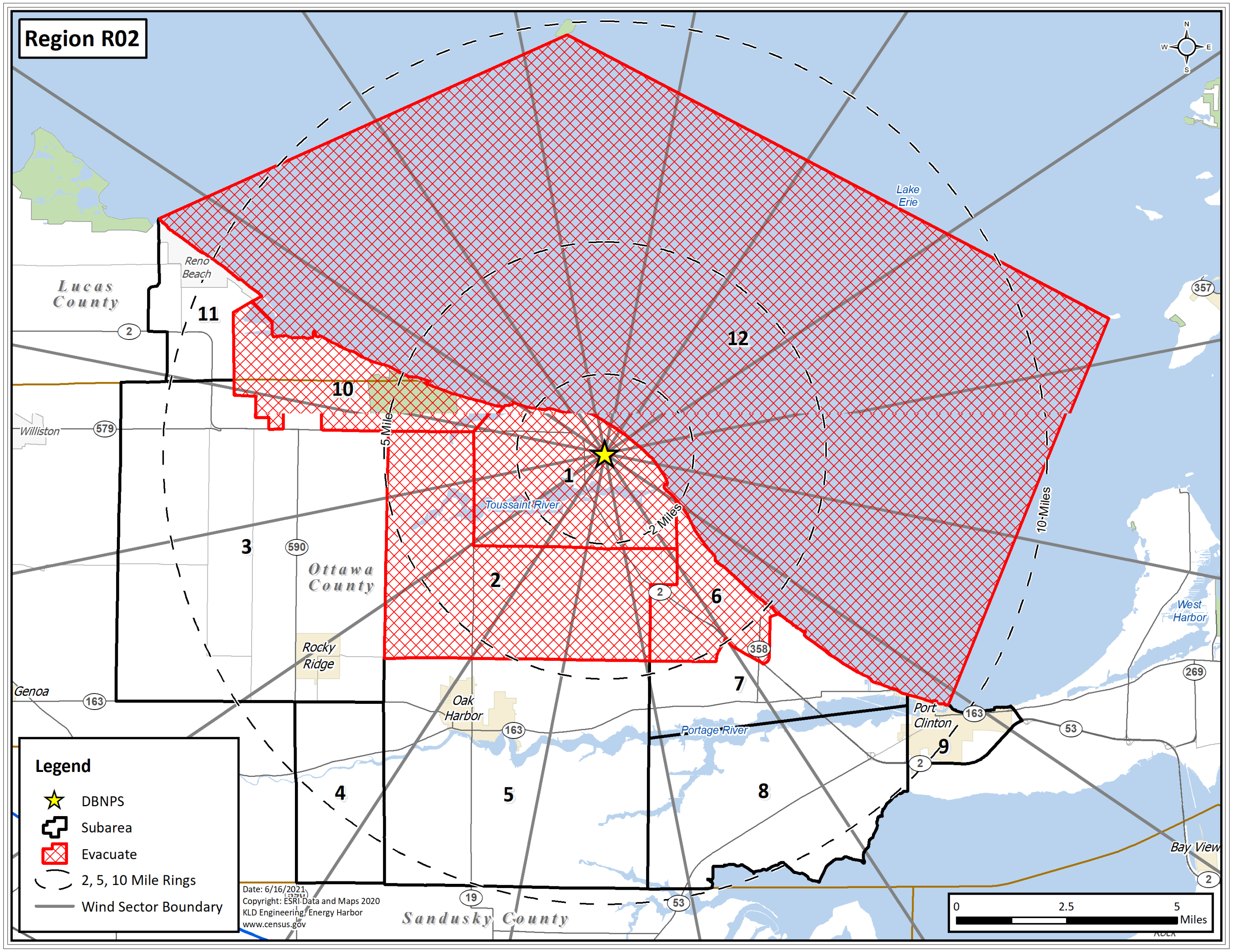


Figure H-2. Region R02

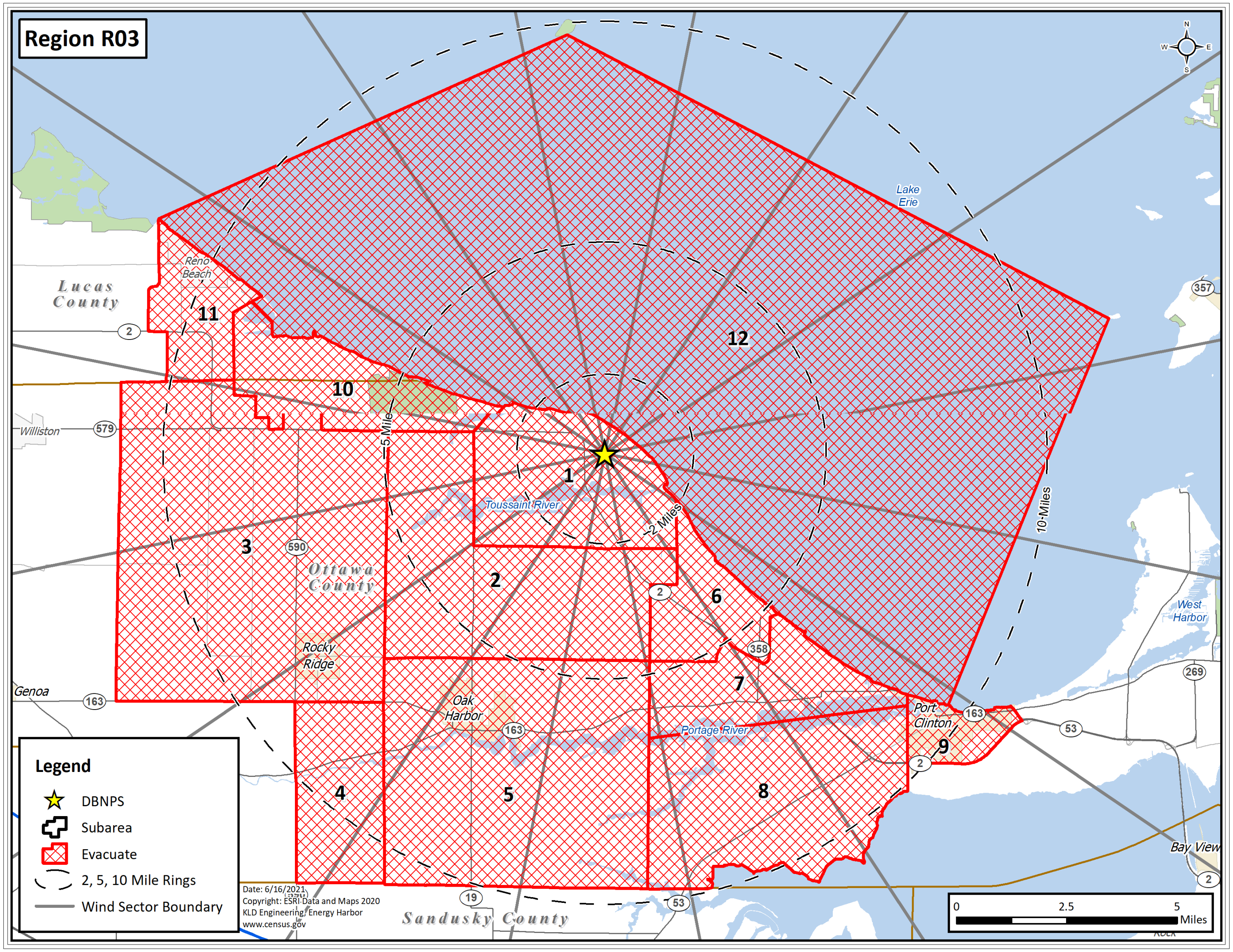


Figure H-3. Region R03

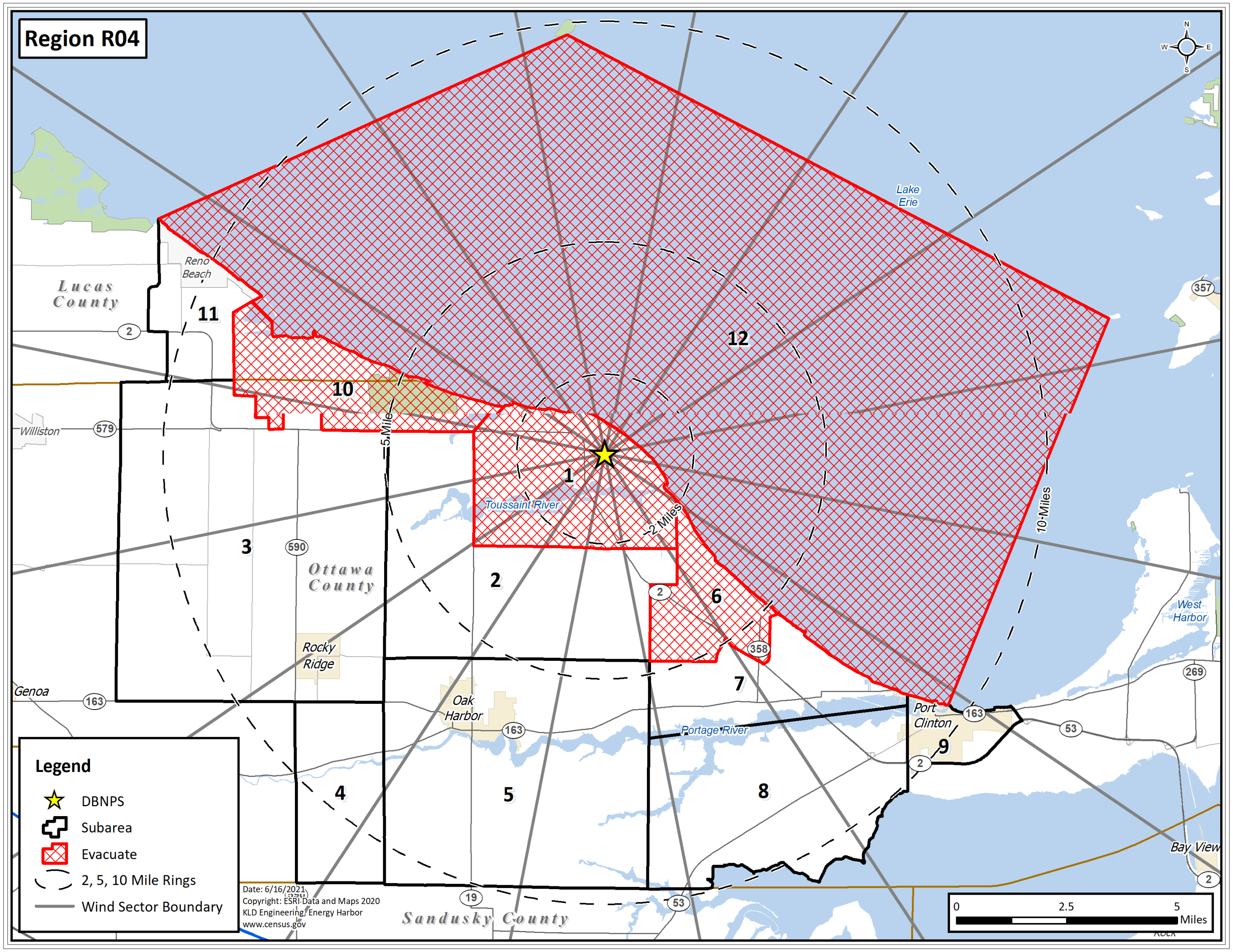


Figure H-4. Region R04

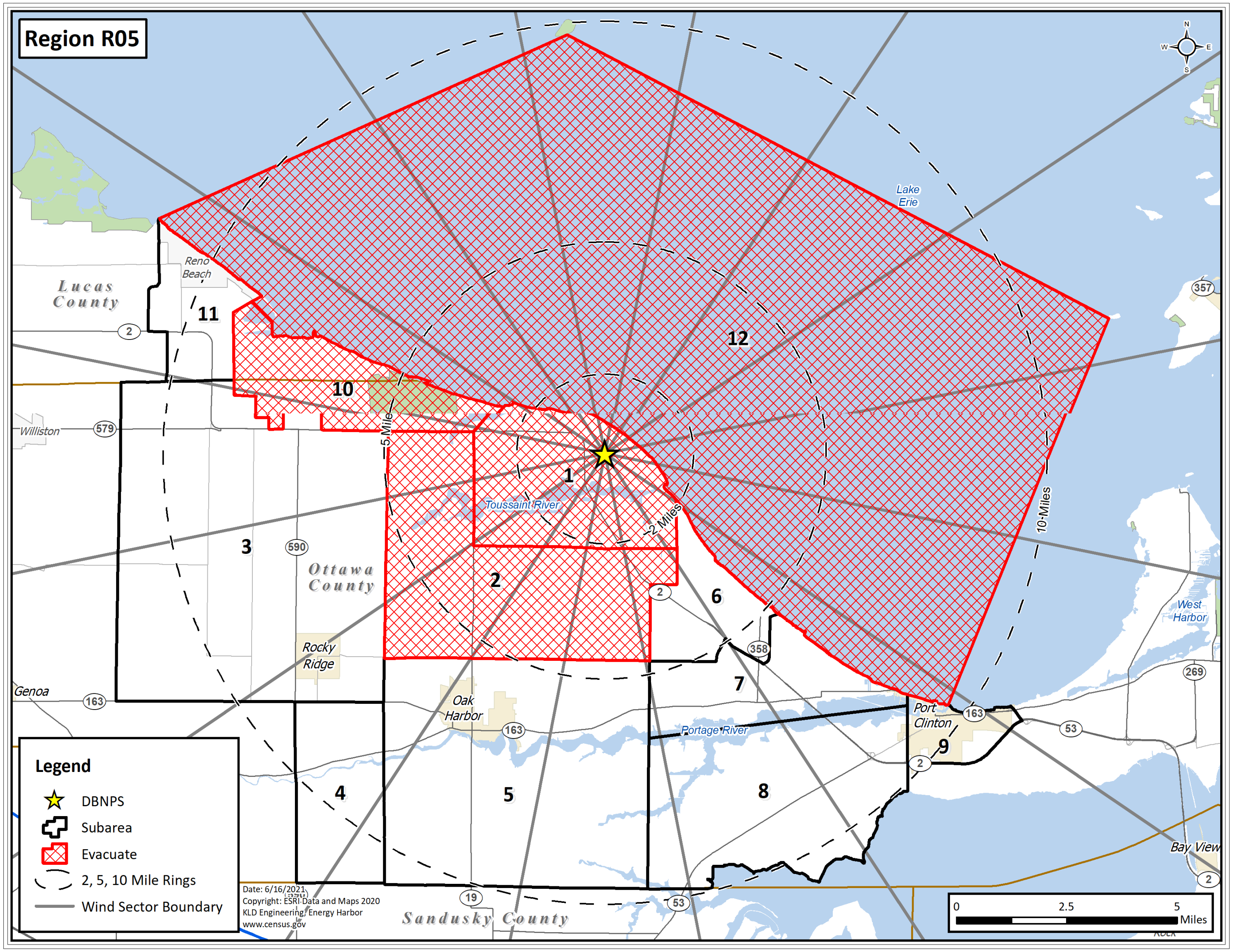


Figure H-5. Region R05

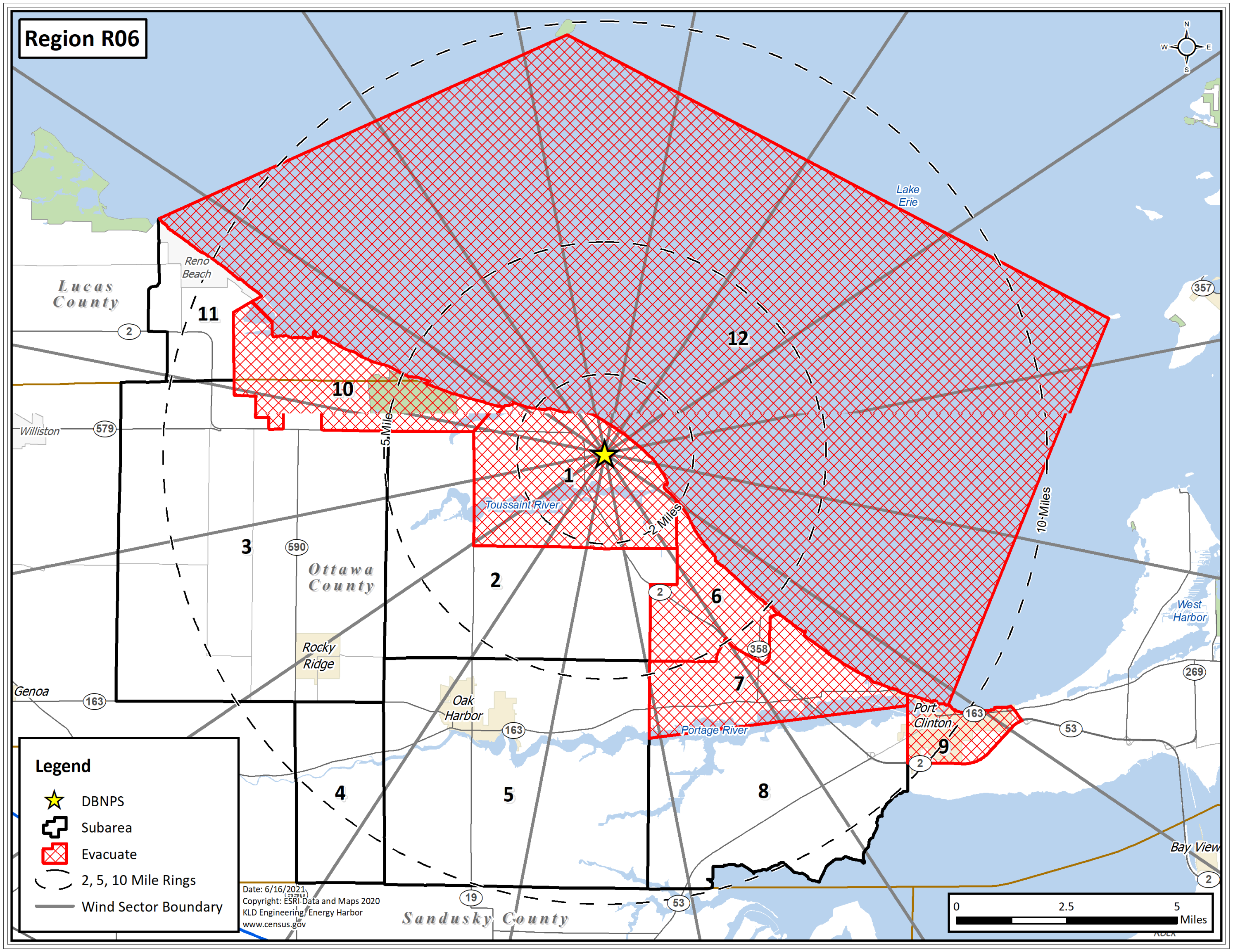


Figure H-6. Region R06

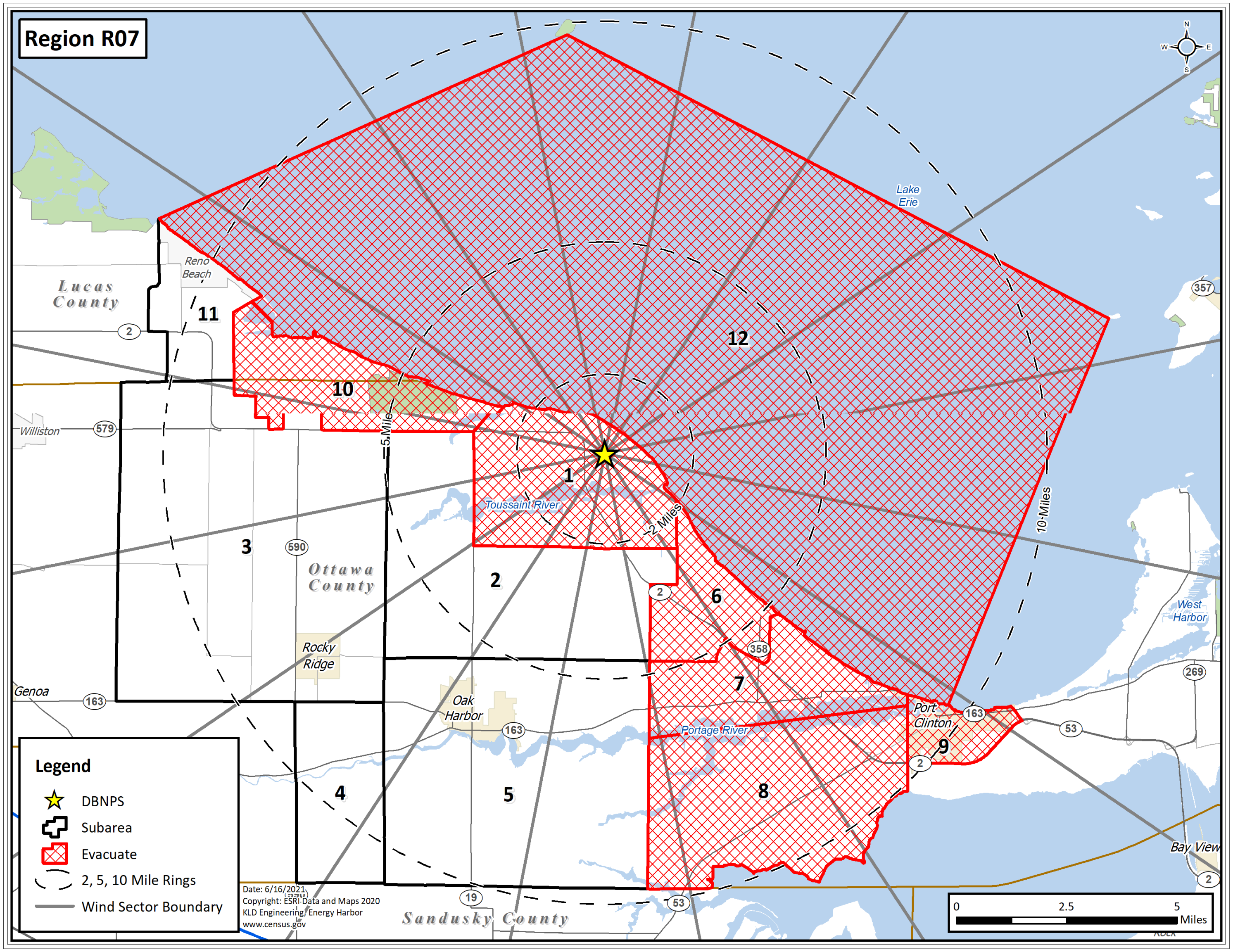


Figure H-7. Region R07

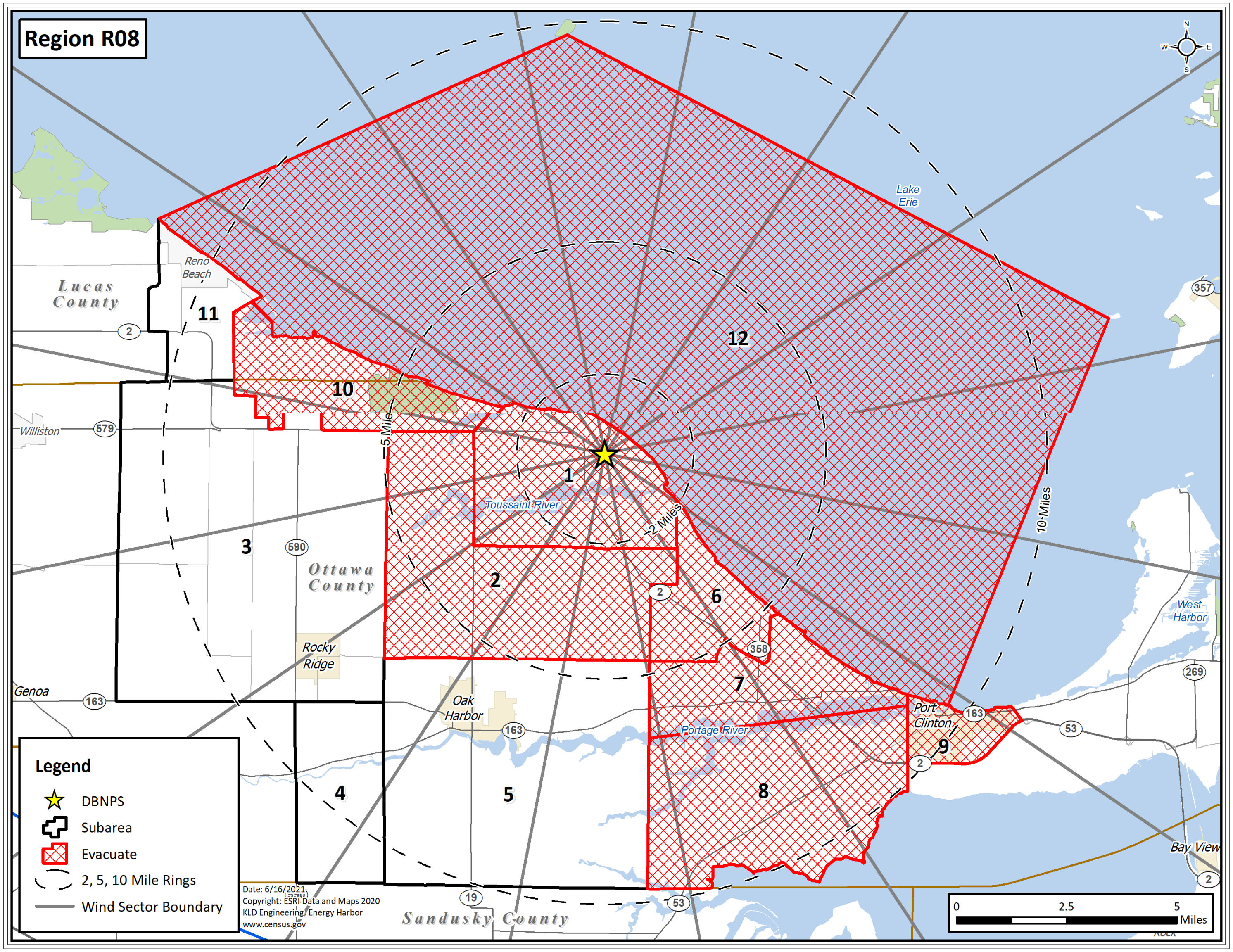


Figure H-8. Region R08

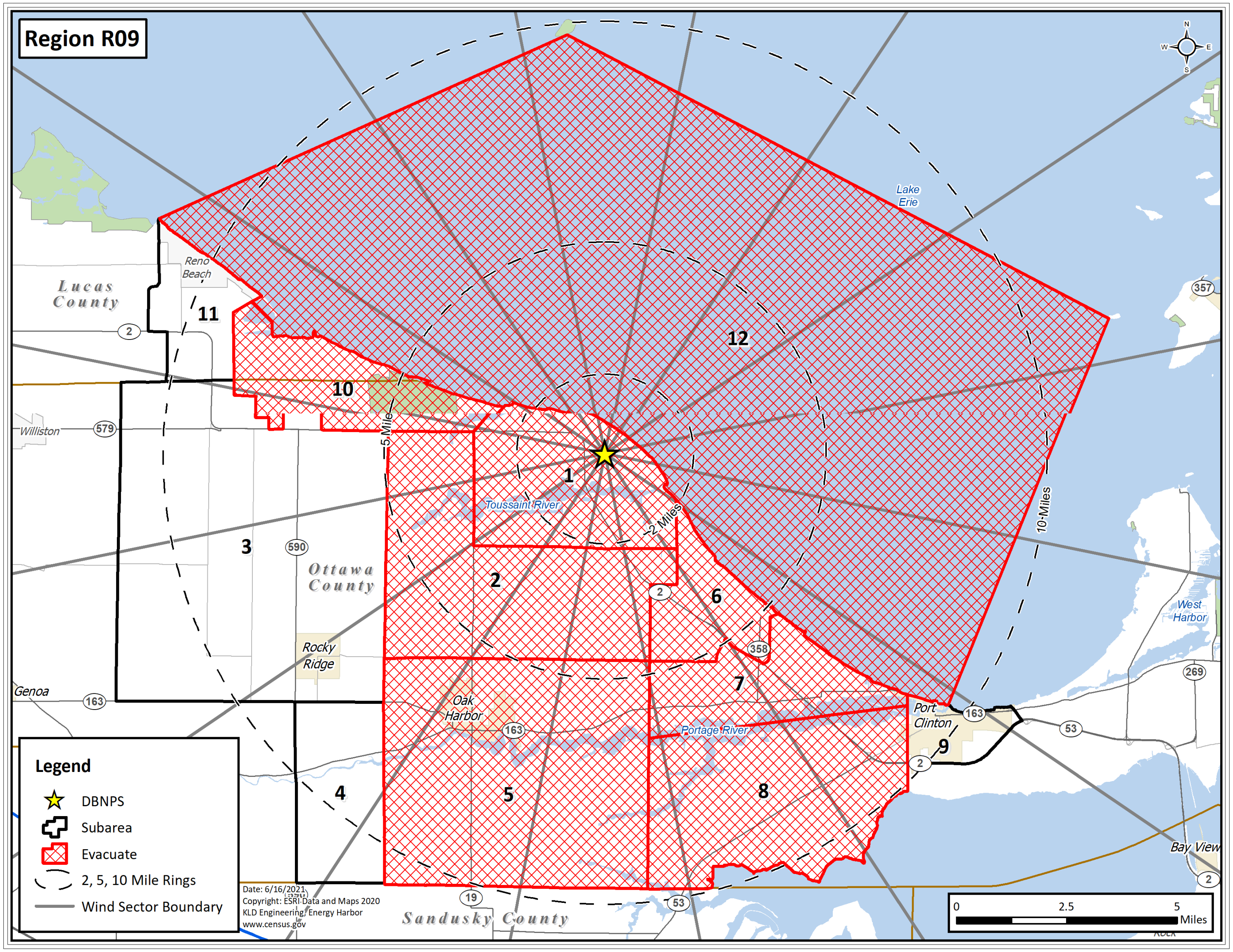


Figure H-9. Region R09

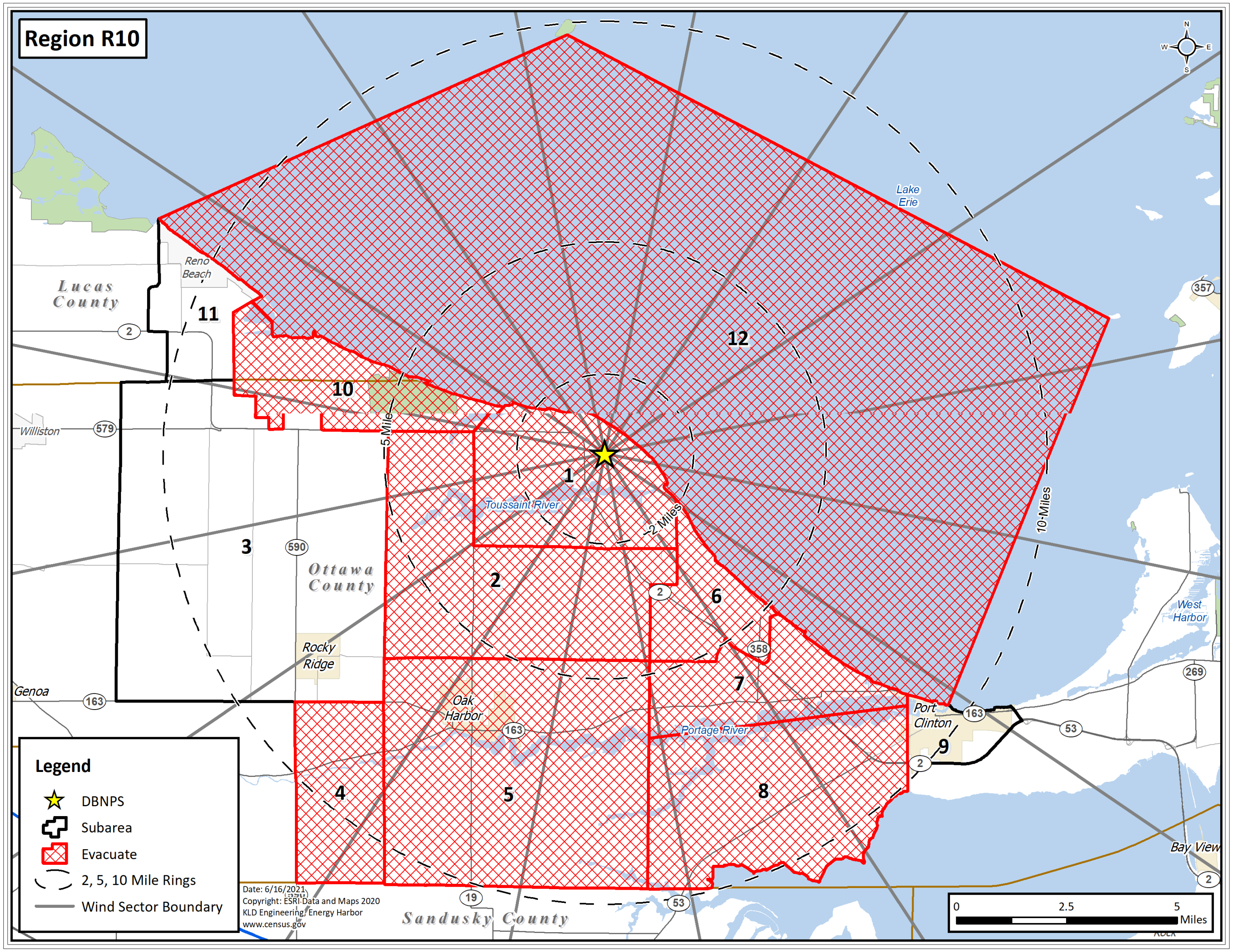


Figure H-10. Region R10

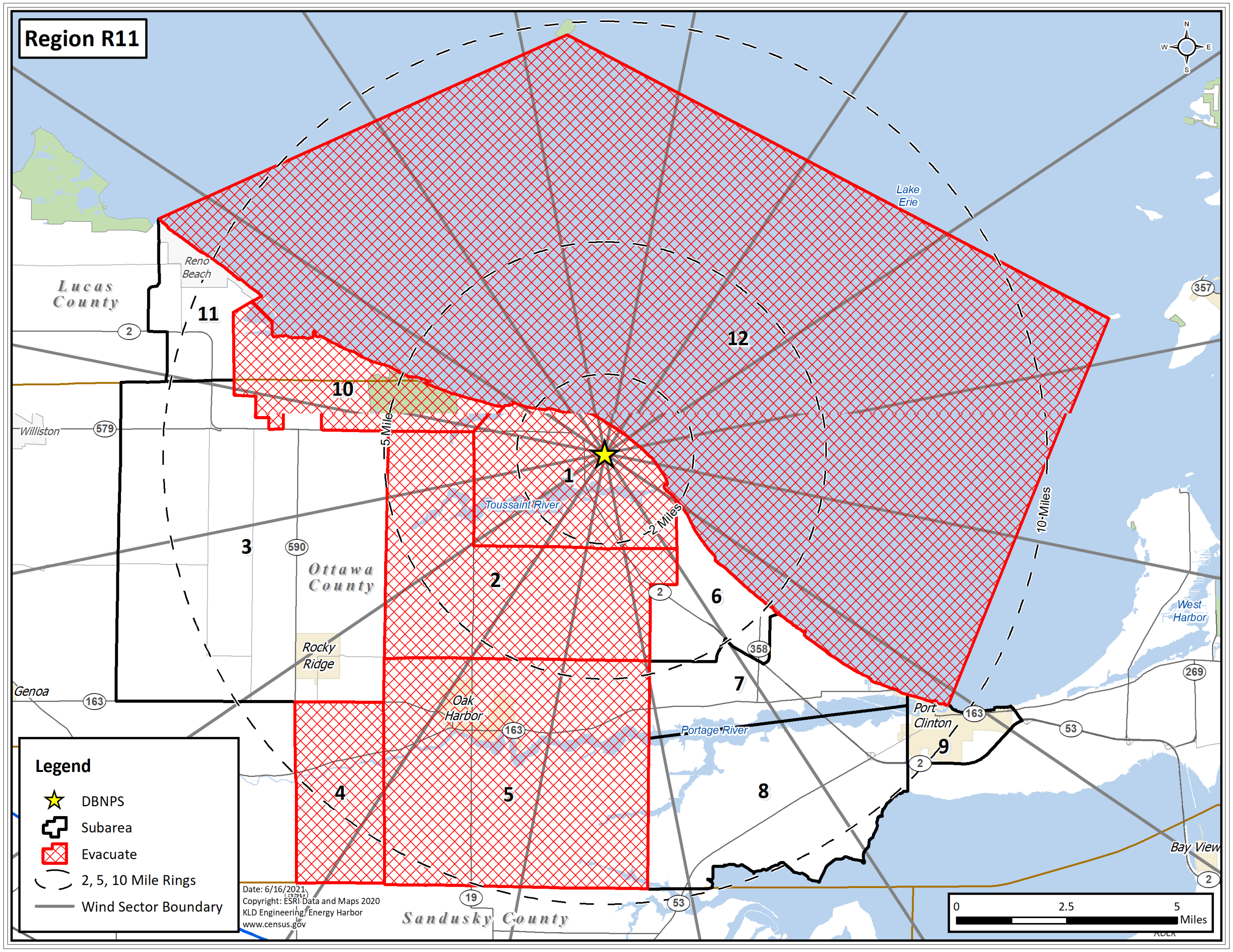


Figure H-11. Region R11

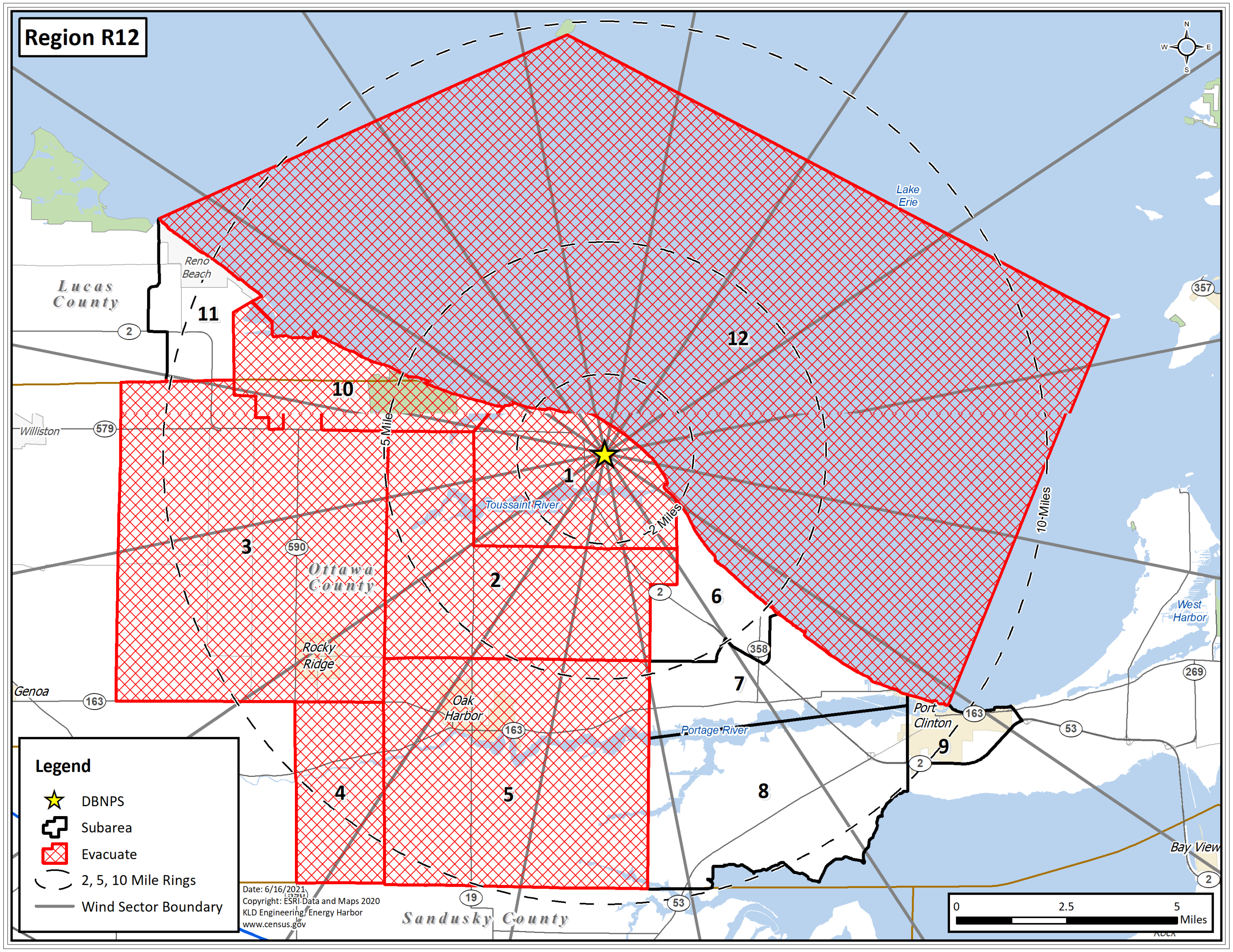


Figure H-12. Region R12

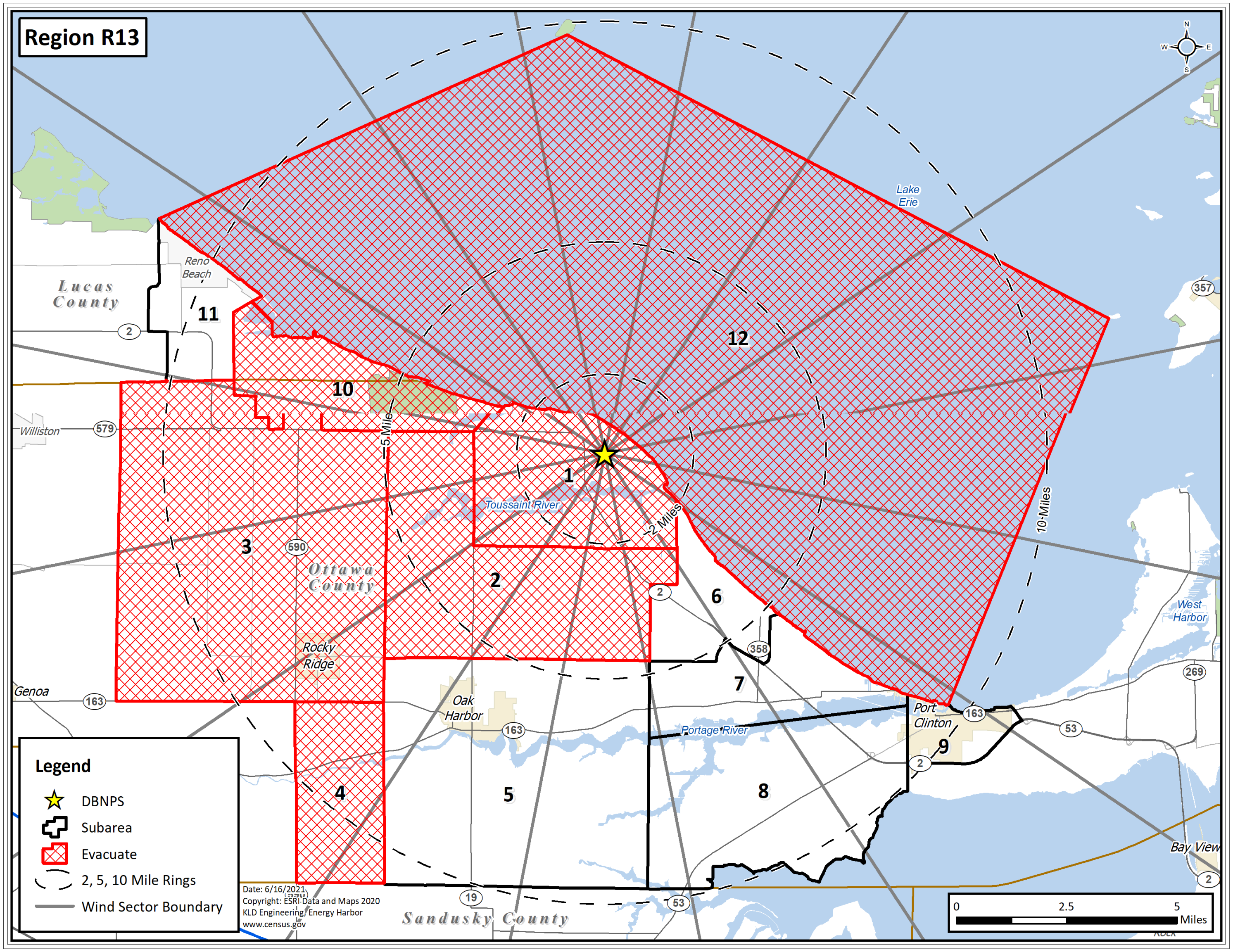


Figure H-13. Region R13

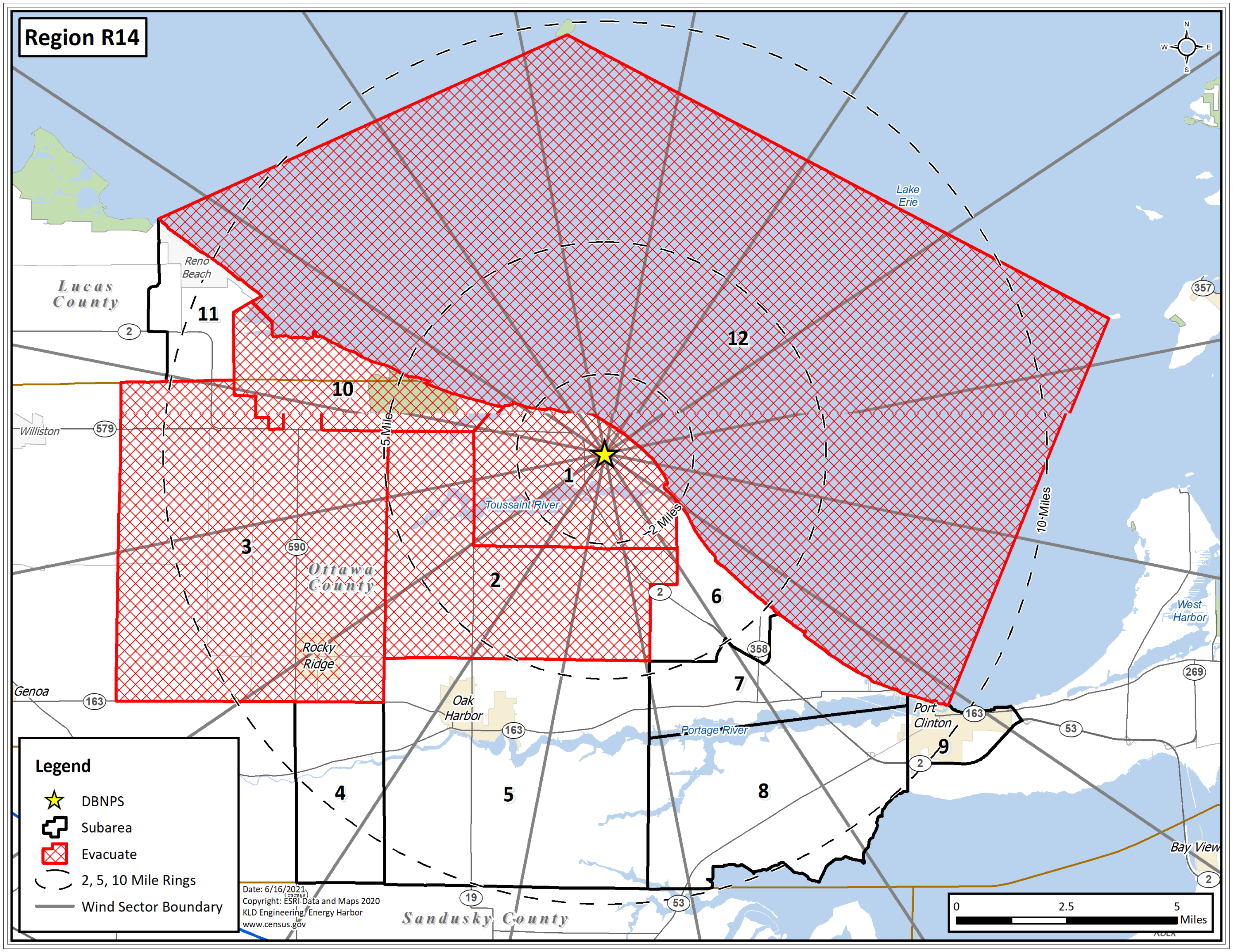


Figure H-14. Region R14

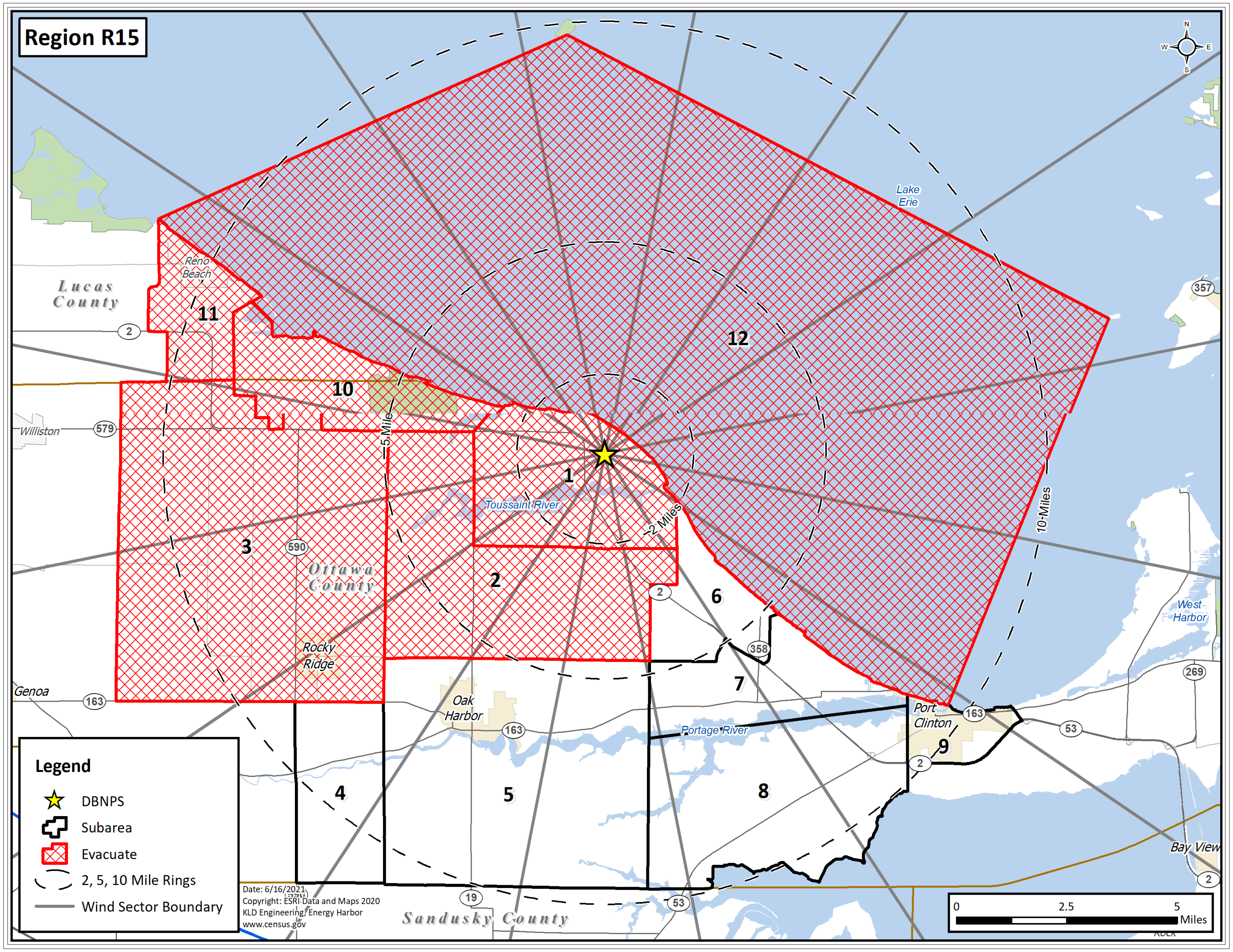


Figure H-15. Region R15

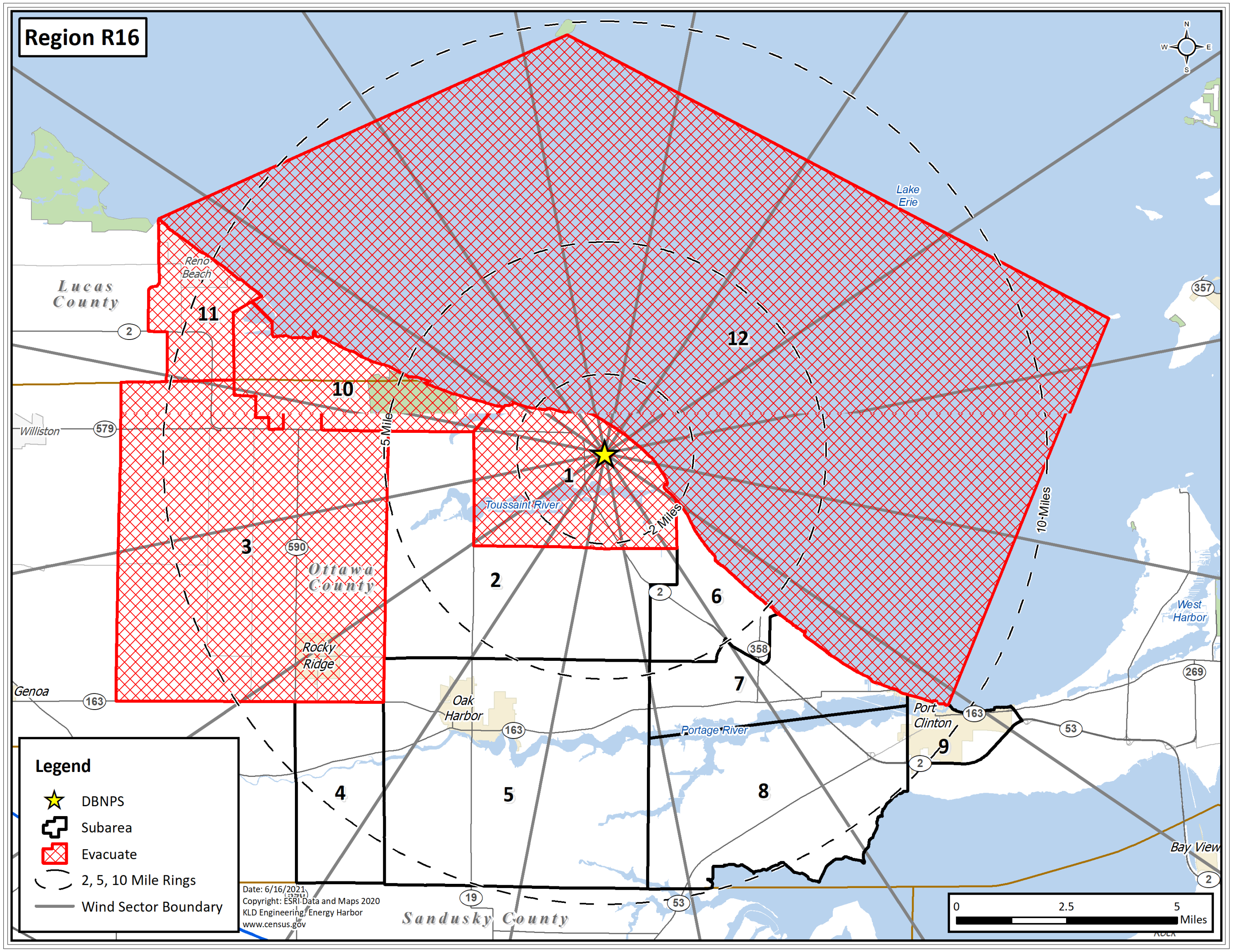


Figure H-16. Region R16

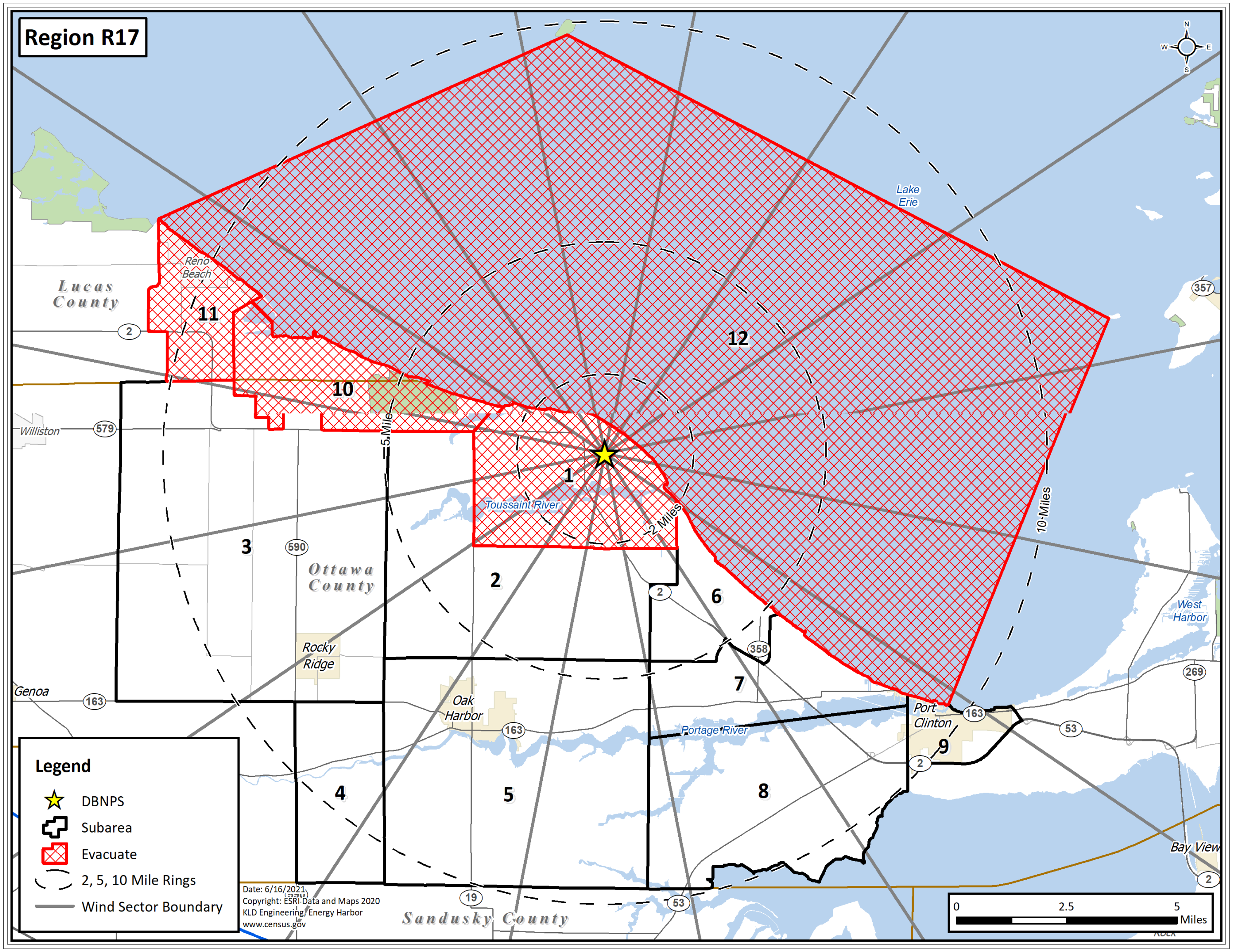


Figure H-17. Region R17

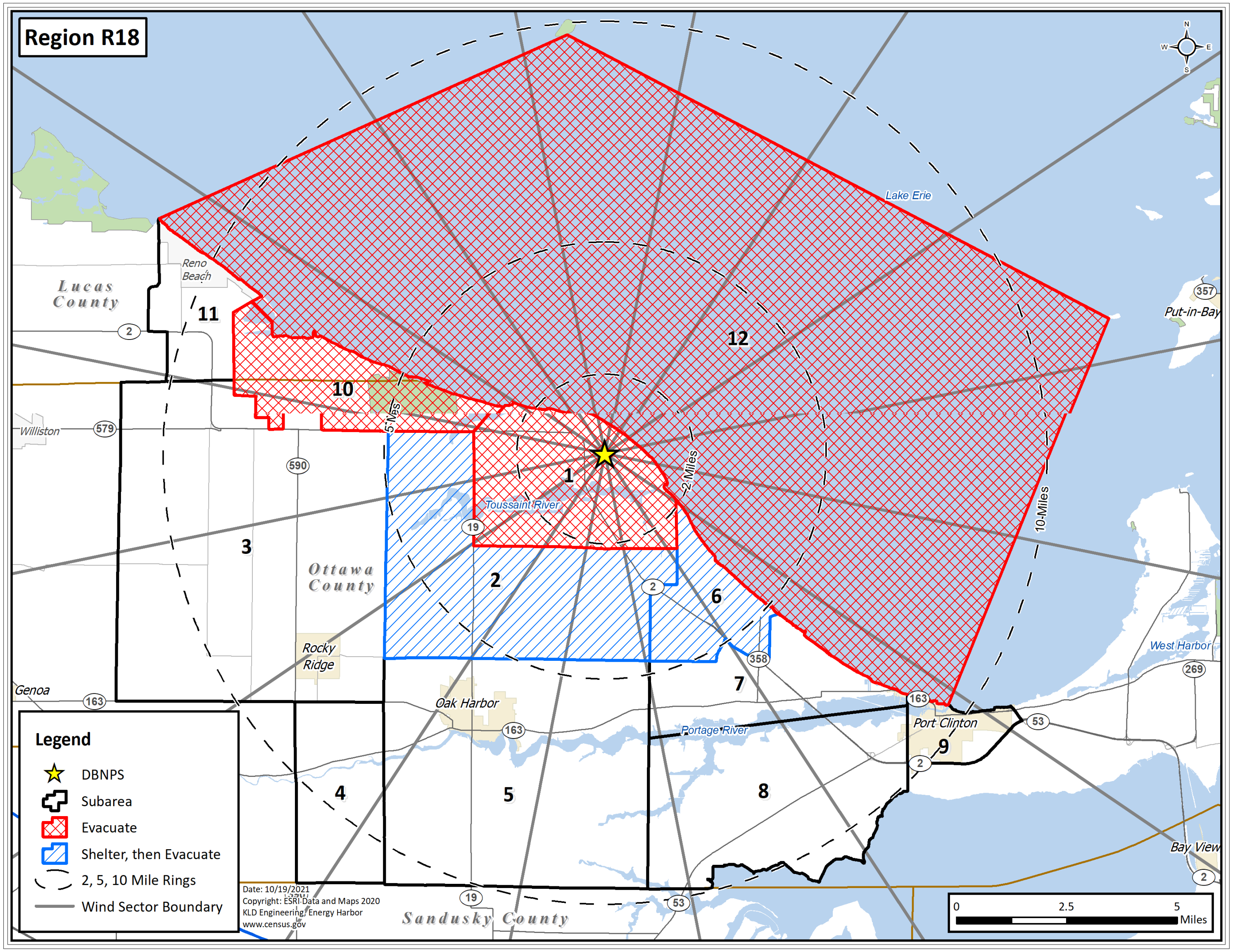


Figure H-18. Region R18

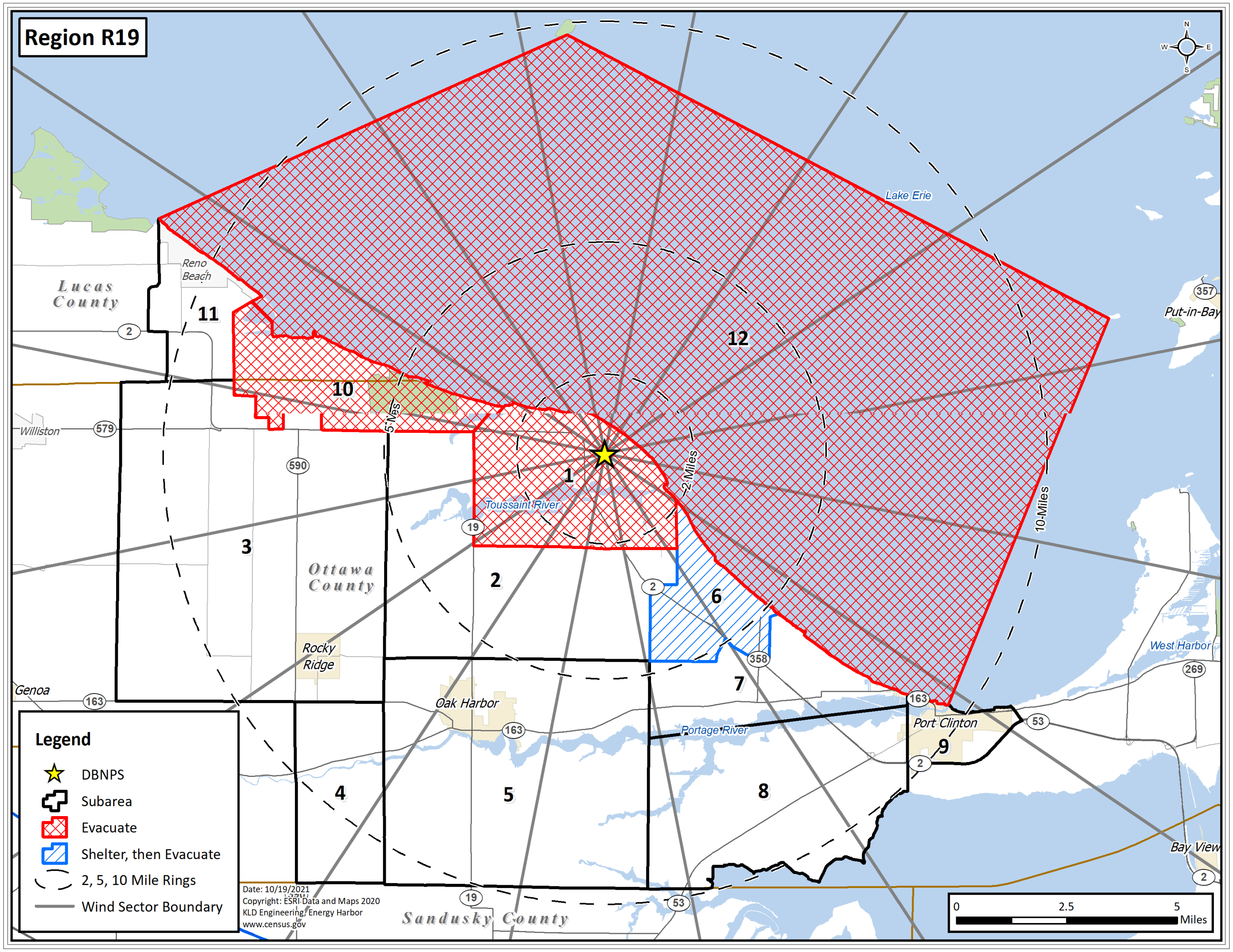


Figure H-19. Region R19

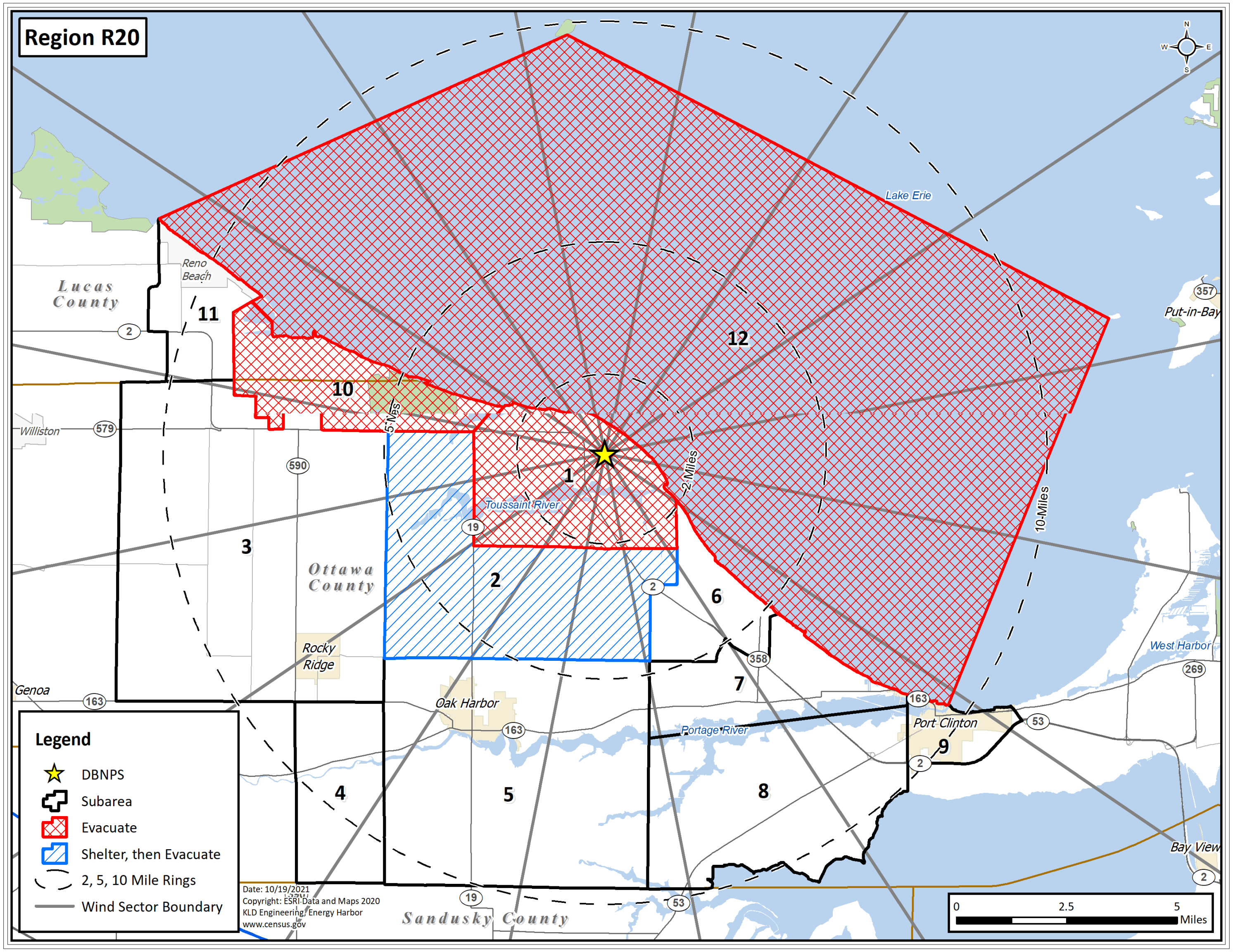


Figure H-20. Region R20

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 254 source links (origins) in the model. The source links are shown as centroid points in Figure J-1. On average, evacuees travel a straight-line distance of 7.23 miles to exit the network.

Table J-2 provides network–wide statistics (average travel time, average delay time[1], average speed and number of vehicles) for an evacuation of the entire EPZ (Region R03) for each scenario. As expected, rain, rain/light snow and heavy 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 3, the additional vehicles the special event introduces slightly lowers and increases the travel times. When comparing scenario 14 (roadway closure) and Scenario 1, the single lane closure on SR-2 eastbound lowers the average speeds, causes higher delays and increases the travel times.

Table J-3 provides statistics (average speed and travel time) for several major evacuation routes – SR 2, SR 163 and SR 105 – for an evacuation of the entire EPZ (Region R03) under Scenario 1 conditions (summer, midweek, midday, with good weather). As discussed in Section 7.3, there is congestion inside Port Clinton especially along SR 2 and SR 163 eastbound. As shown in Table J-3, these two routes have comparably slower speeds.

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 for summer scenarios (higher transient activity) compared to winter scenarios. The increased transient activity causes congestion within the EPZ and separate these two curves (see Section 7.3).

[1] Computed as the difference of the average travel time and the average ideal travel time under free flow conditions.

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
Niagra	121	111	216	SE	8080	4,500
SR-2	148	149	158	W	8156	2,850
Benton Carroll Road	238	520	28	SW	8220	1,700
					8432	1,700
					8069	6,750
SR-19	266	267	96	S	8053	1,700
					8286	2,550
					8433	1,700
North Rymers Road	575	408	56	S	8080	4,500
SR-163	331	334	177	SE	8080	4,500
North Wildacre Road	160	161	47	W	8212	2,850
CR-51	214	213	22	W	8212	2,850
					8220	1,700
					8432	1,700
SR-163	364	359	3	E	8080	4,500
					8079	6,750
					8435	4,500
CR-51	429	167	6	W	8212	2,850

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)	1.3	1.4	1.4	1.6	1.4	1.0	1.1
Network-Wide Average Delay Time (Min/Veh-Mi)	0.0	0.1	0.1	0.3	0.2	0.0	0.0
Network-Wide Average Speed (mph)	48.0	43.4	44.2	38.8	41.7	59.6	53.3
Total Vehicles Exiting Network	76,070	76,155	78,060	78,031	43,909	70,704	70,642
Scenario	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Network-Wide Average Travel Time (Min/Veh-Mi)	1.2	1.1	1.2	1.2	1.1	1.5	1.7
Network-Wide Average Delay Time (Min/Veh-Mi)	0.0	0.0	0.0	0.0	0.0	0.2	0.4
Network-Wide Average Speed (mph)	49.2	56.2	49.3	49.2	56.6	40.3	35.1
Total Vehicles Exiting Network	69,347	70,473	70,259	69,426	38,216	79,633	76,089

Table J-3. Average Evacuation Route Travel Time (min) for Region R03, Scenario 1

		Elapsed Time (hours)									
		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
SR-2 Eastbound	39.8	44.2	54.0	38.0	62.7	57.9	41.2	61.3	38.9	56.5	42.3
SR-2 Westbound	40.3	56.4	42.9	60.2	40.2	59.7	40.5	57.5	42.0	55.2	43.9
SR-163 Westbound	8.8	42.2	12.6	41.3	12.8	42.8	12.4	43.4	12.2	45.4	11.7
SR-163 Eastbound	12.9	16.3	47.4	36.9	20.9	44.7	17.3	45.4	17.0	47.8	16.2
SR-105 Westbound	7.9	50.8	9.3	50.9	9.3	50.8	9.3	51.2	9.2	49.1	9.6

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-6	2	447	0	4	8	9	9
			0.00%	0.01%	0.02%	0.02%	0.01%
SR 53	7	499	14	35	45	49	49
			0.11%	0.12%	0.10%	0.09%	0.08%
SR 19	40	286	183	675	1,032	1,195	1,356
			1.43%	2.24%	2.29%	2.14%	2.11%
US-6	46	53	1,088	2,254	3,413	4,576	5,661
			8.50%	7.48%	7.56%	8.20%	8.81%
I-80/I-90	68	69	2,502	5,145	7,728	10,245	12,717
			19.54%	17.07%	17.12%	18.36%	19.78%
I-80/I-90	78	79	2,586	5,314	7,910	10,423	12,893
			20.20%	17.63%	17.52%	18.68%	20.05%
SR 2	81	80	2,690	6,728	10,770	12,137	12,331
			21.01%	22.32%	23.86%	21.75%	19.18%
SR 163	219	220	53	263	388	441	450
			0.41%	0.87%	0.86%	0.79%	0.70%
Main St	431	432	161	772	1,135	1,309	1,346
			1.26%	2.56%	2.51%	2.35%	2.09%
US-20	435	498	1,076	2,583	3,951	5,088	6,044
			8.41%	8.57%	8.75%	9.12%	9.40%
SR 2	472	506	889	2,147	2,631	2,834	2,871
			6.94%	7.12%	5.83%	5.08%	4.47%
SR 51	504	212	470	1,642	2,235	2,488	2,554
			3.67%	5.45%	4.95%	4.46%	3.97%
US-20	510	59	938	2,177	3,362	4,406	5,318
			7.33%	7.22%	7.45%	7.90%	8.27%
N 5th St	511	433	152	401	536	605	693
			1.19%	1.33%	1.19%	1.08%	1.08%

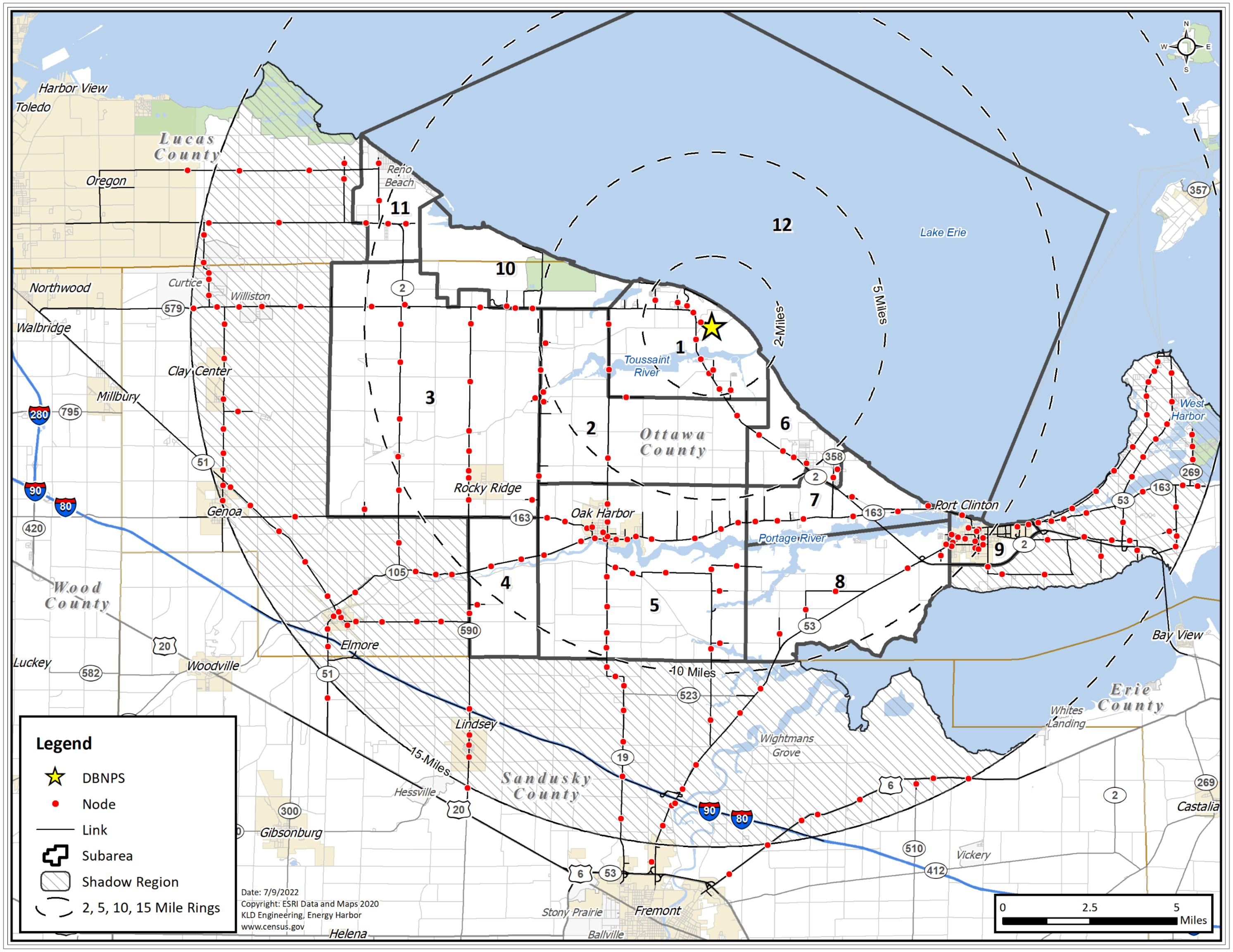


Figure J-1. Network Sources/Origins

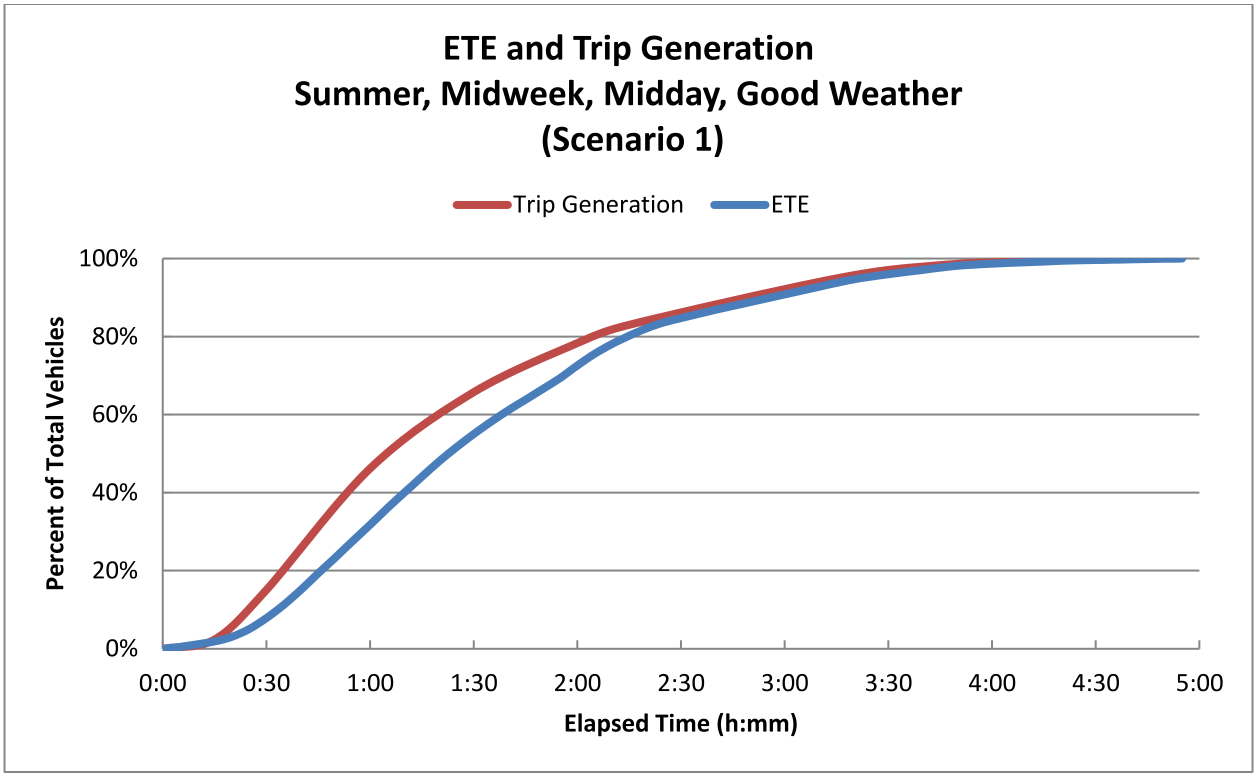


Figure J-2. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather (Scenario 1)

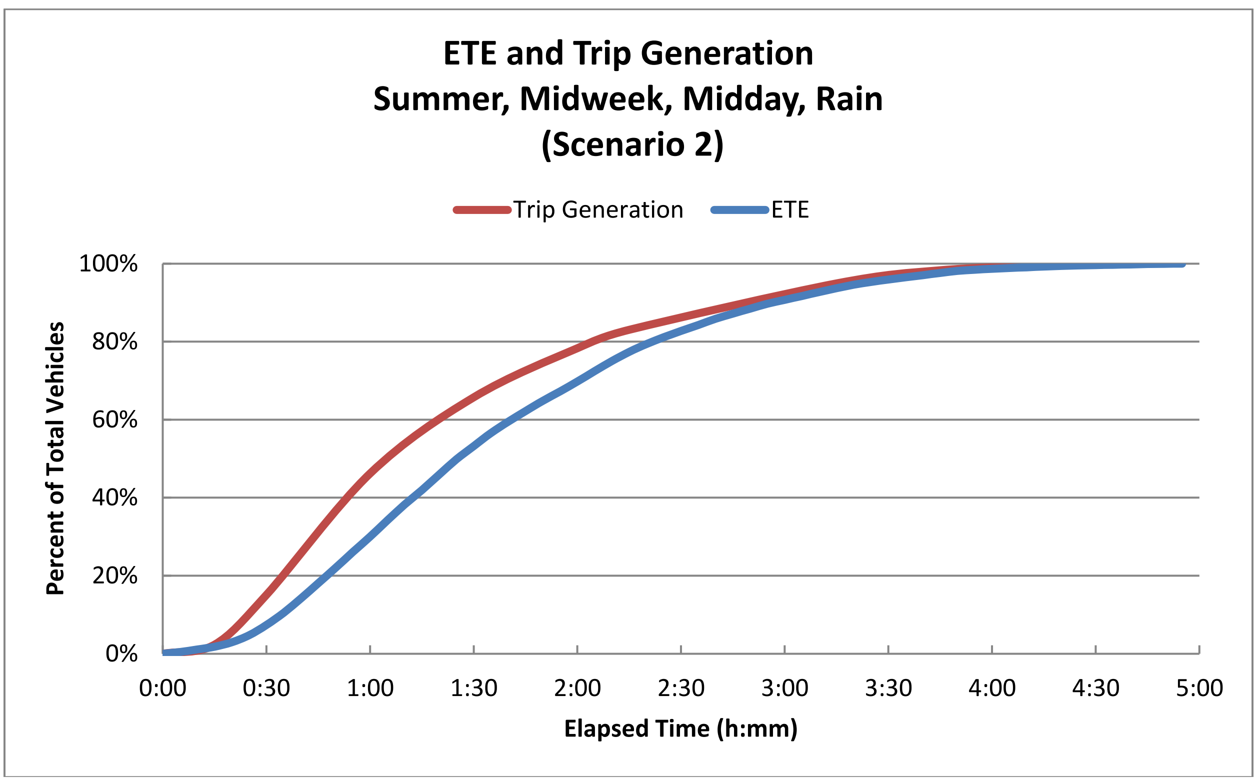


Figure J-3. ETE and Trip Generation: Summer, Midweek, Midday, Rain (Scenario 2)

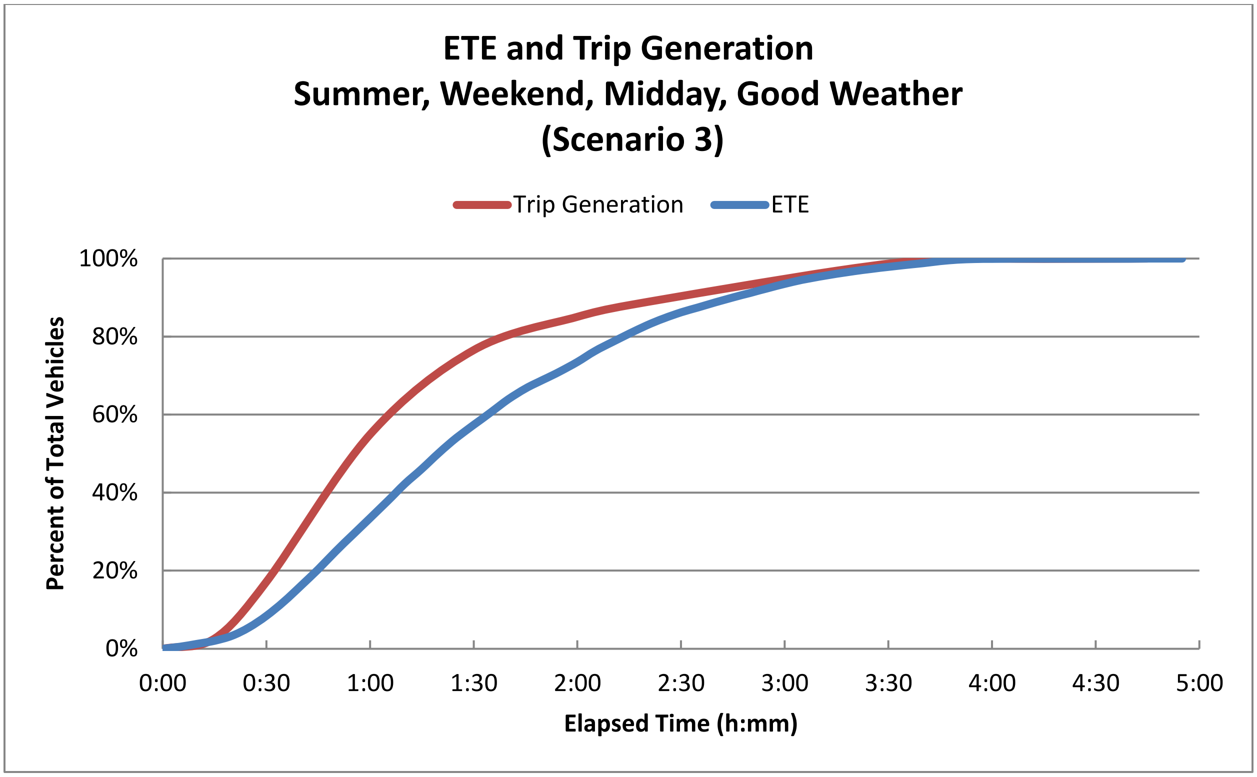


Figure J-4. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather (Scenario 3)

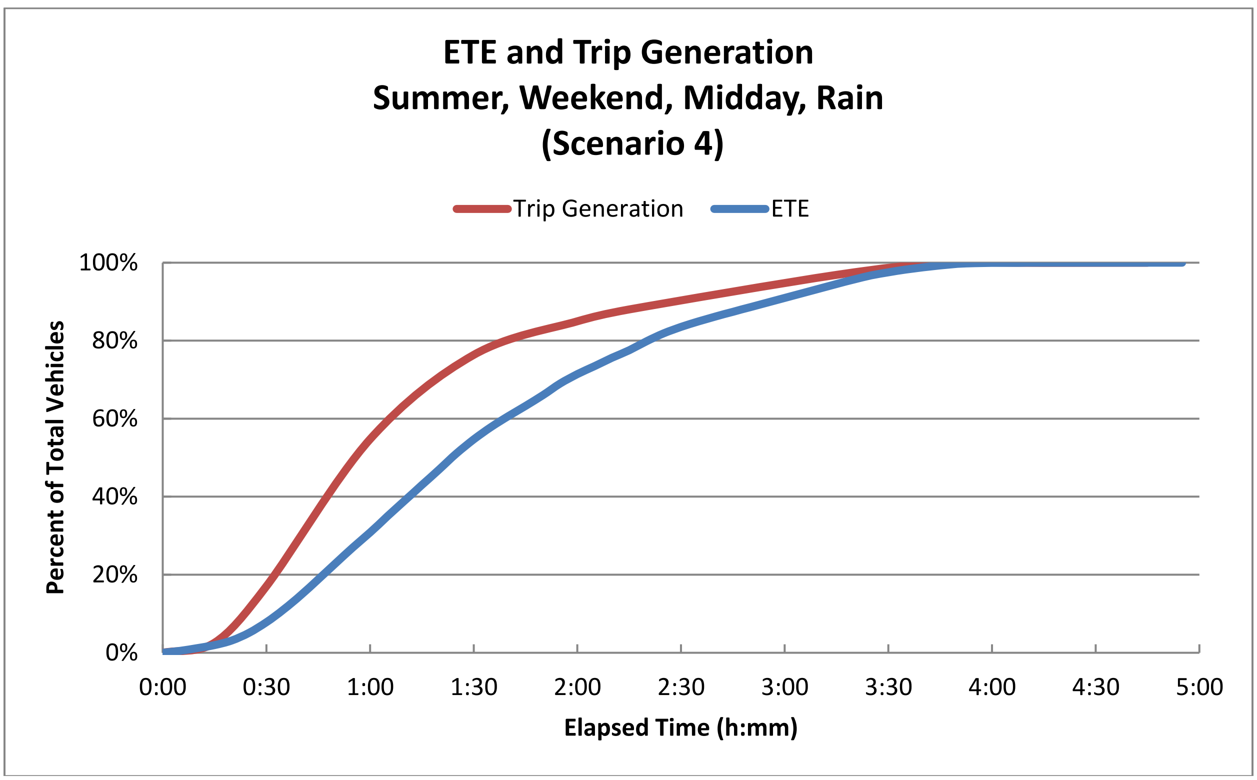


Figure J-5. ETE and Trip Generation: Summer, Weekend, Midday, Rain (Scenario 4)

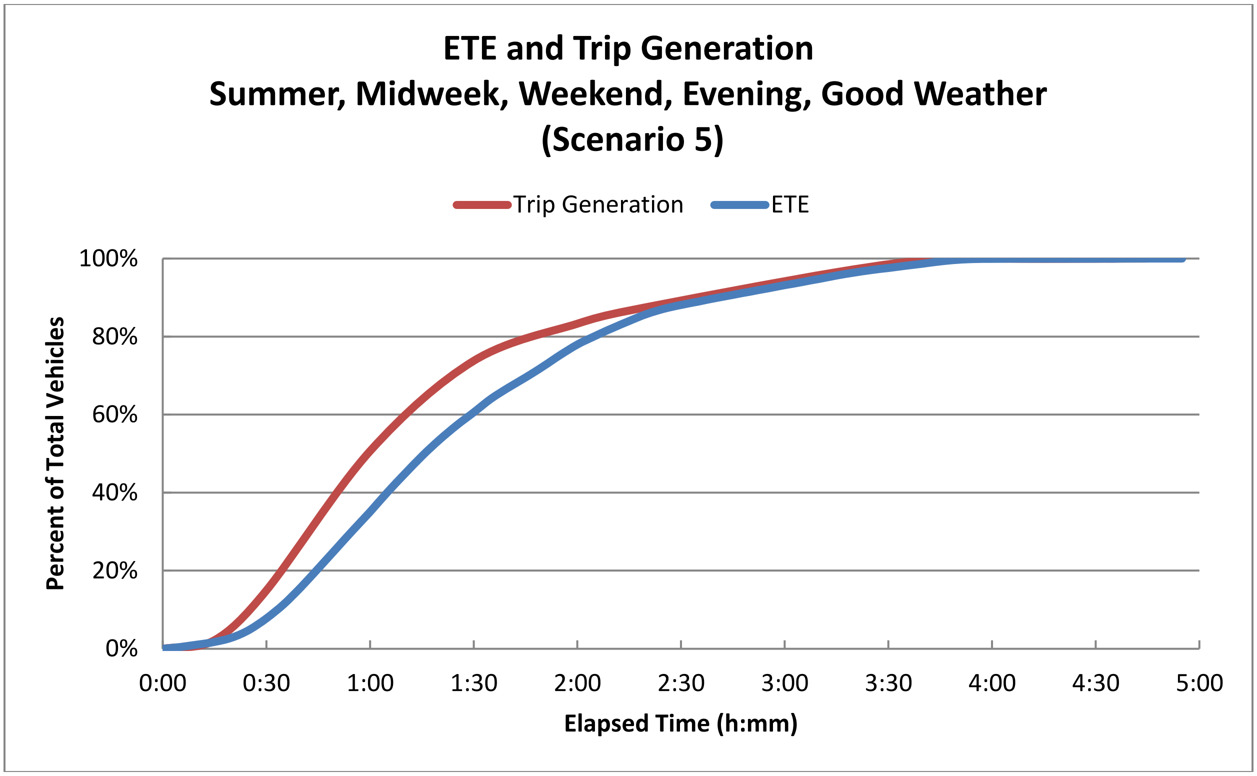


Figure J-6. ETE and Trip Generation: Summer, Midweek, Weekend, Evening, Good Weather (Scenario 5)

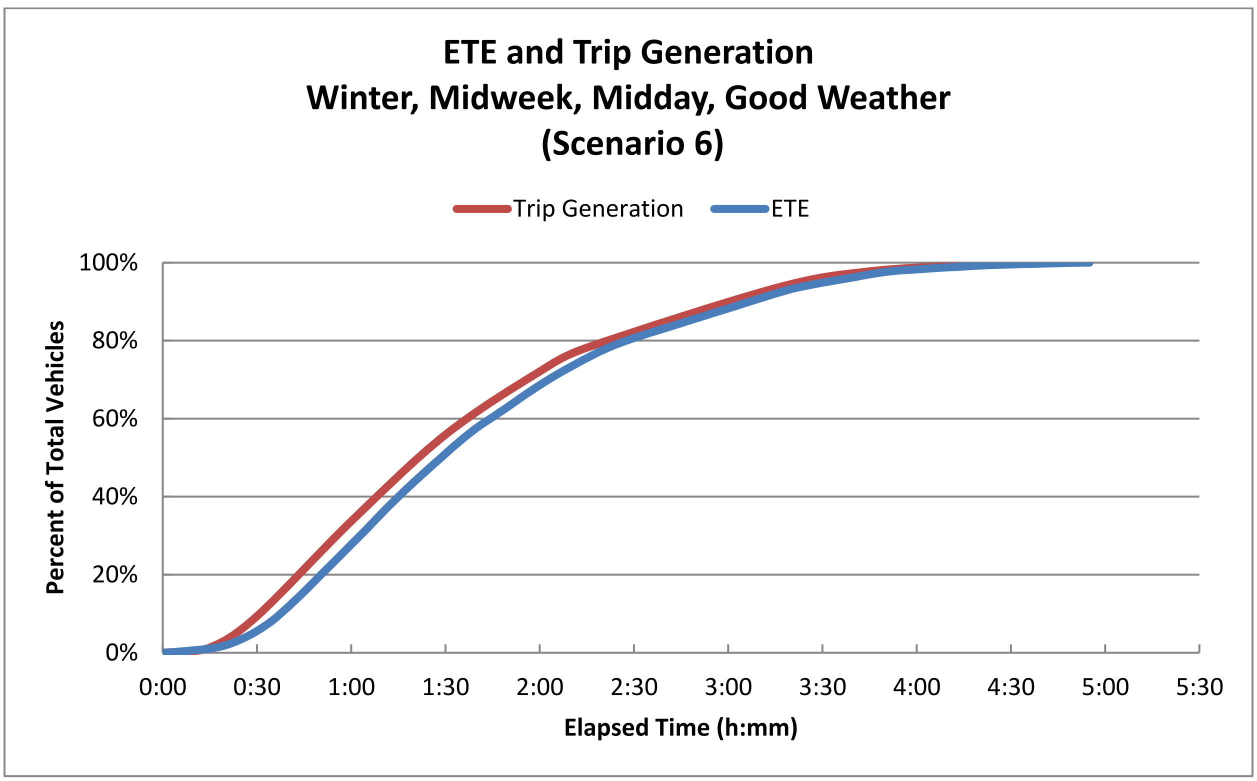


Figure J-7. ETE and Trip Generation: Winter, Midweek, Midday, Good Weather (Scenario 6)

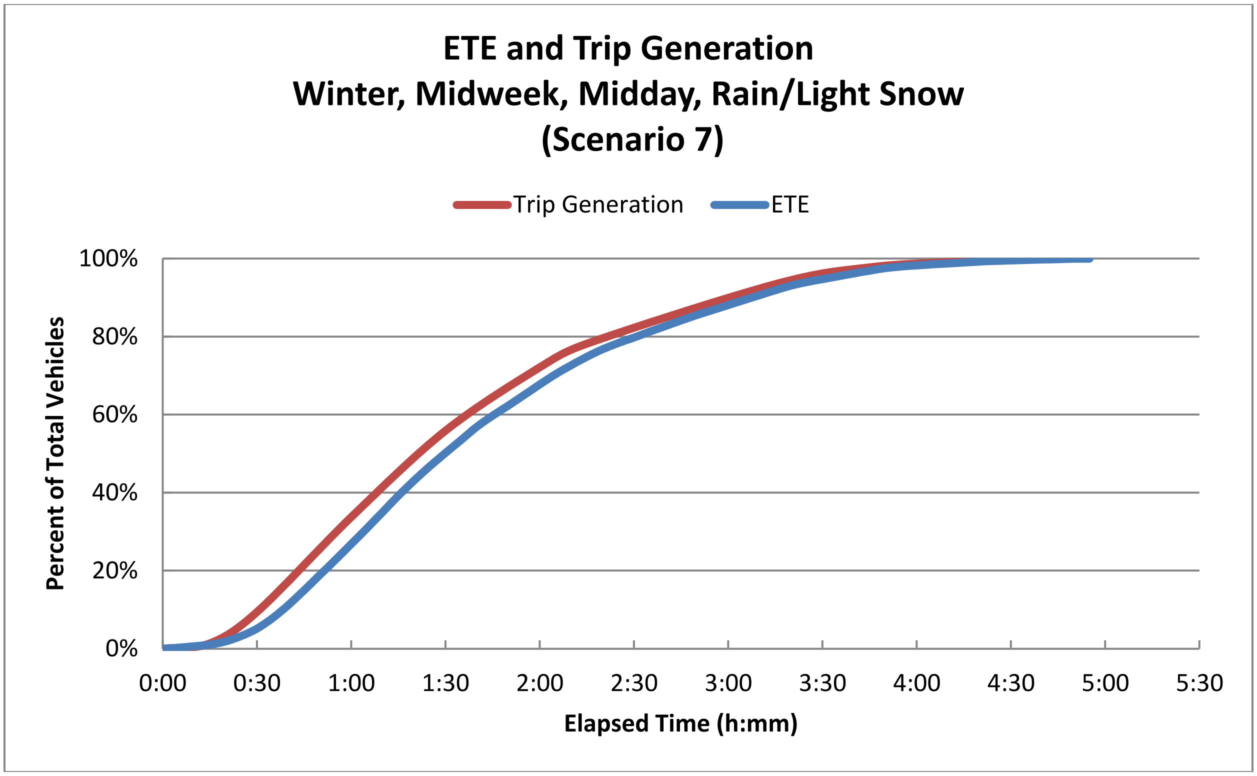


Figure J-8. ETE and Trip Generation: Winter, Midweek, Midday, Rain/Light Snow (Scenario 7)

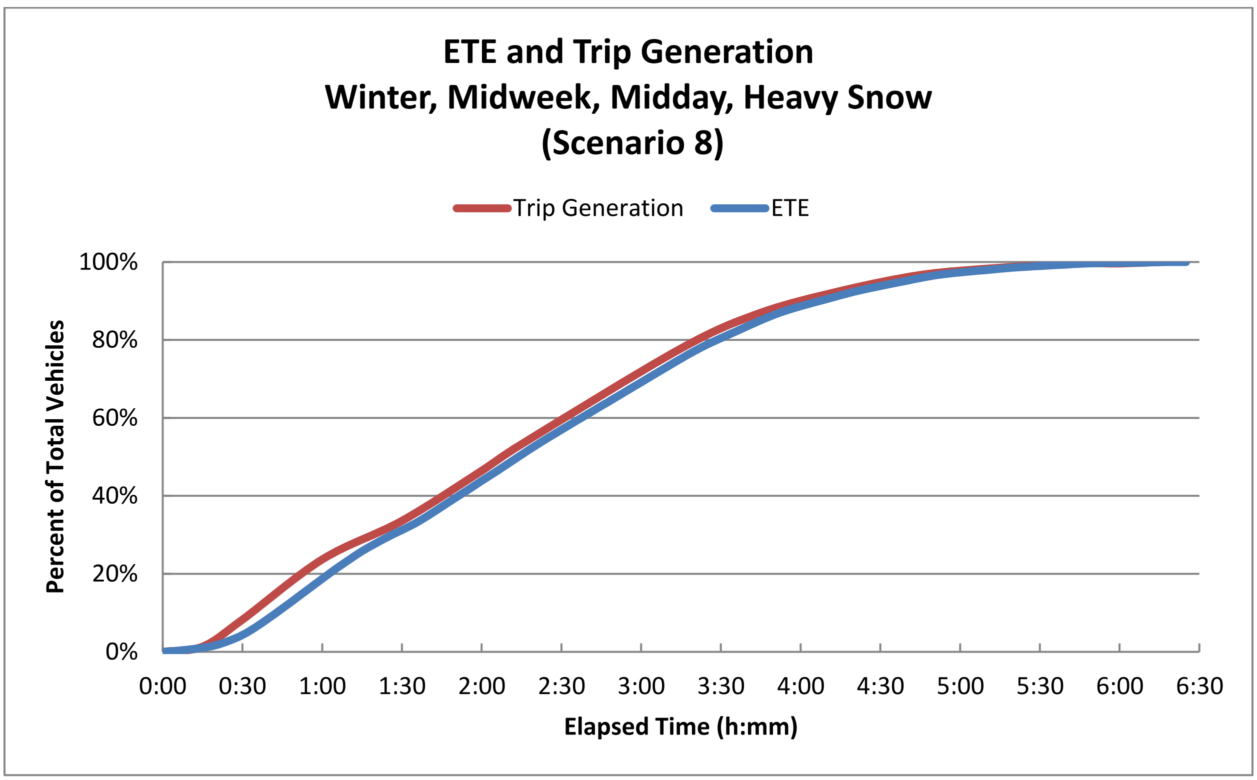


Figure J-9. ETE and Trip Generation: Winter, Midweek, Midday, Heavy Snow (Scenario 8)

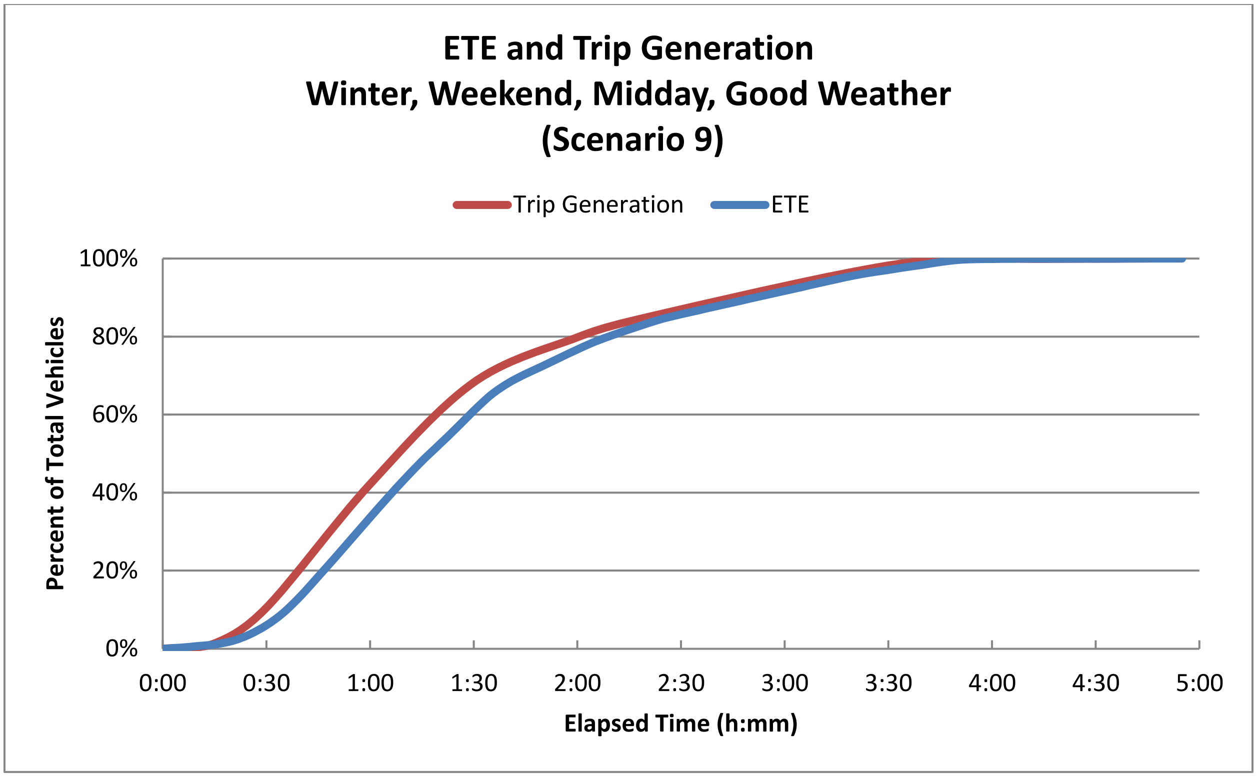


Figure J-10. ETE and Trip Generation: Winter, Weekend, Midday, Good Weather (Scenario 9)

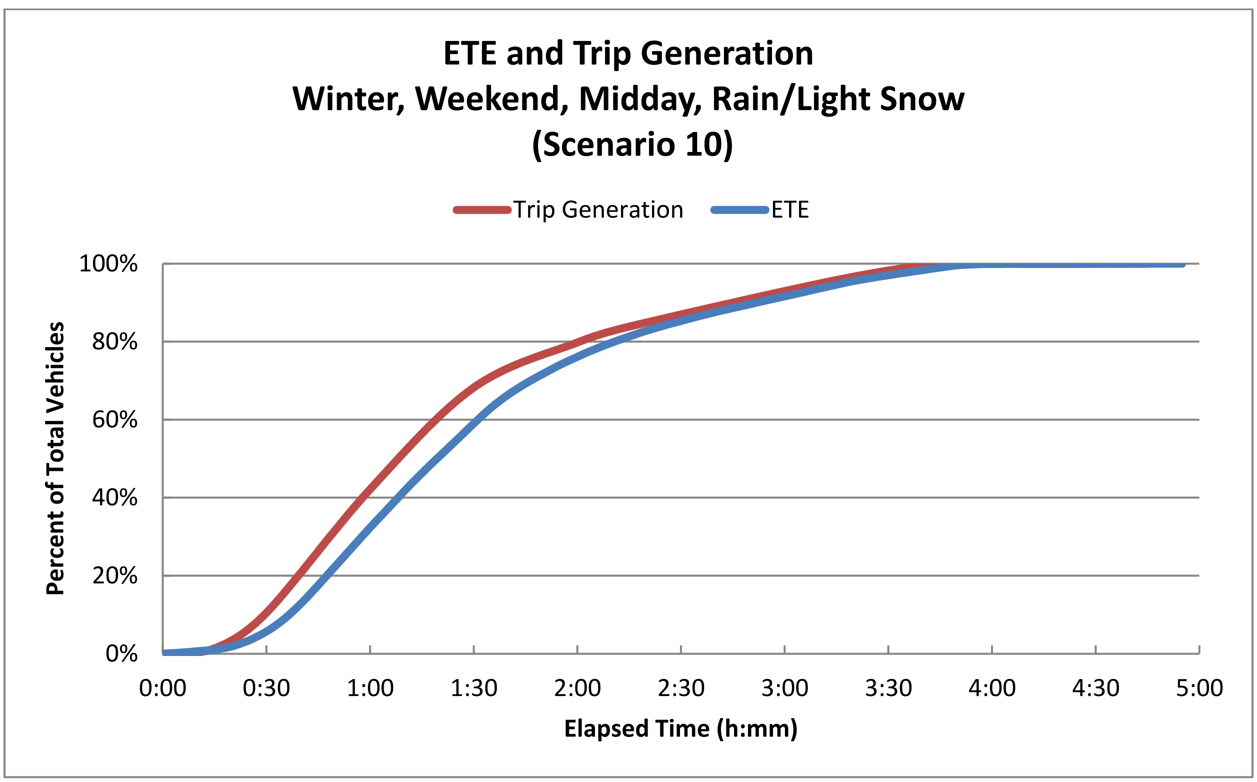


Figure J-11. ETE and Trip Generation: Winter, Weekend, Midday, Rain/Light Snow (Scenario 10)

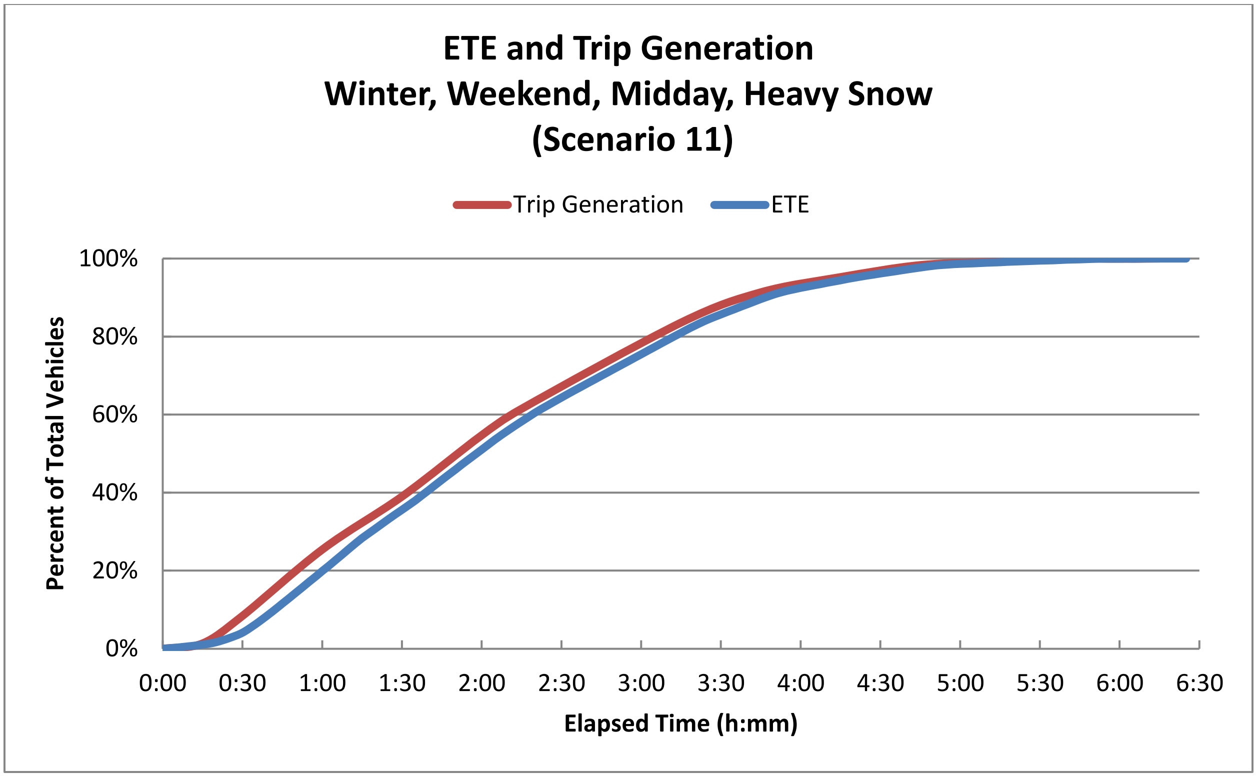


Figure J-12. ETE and Trip Generation: Winter, Weekend, Midday, Heavy Snow (Scenario 11)

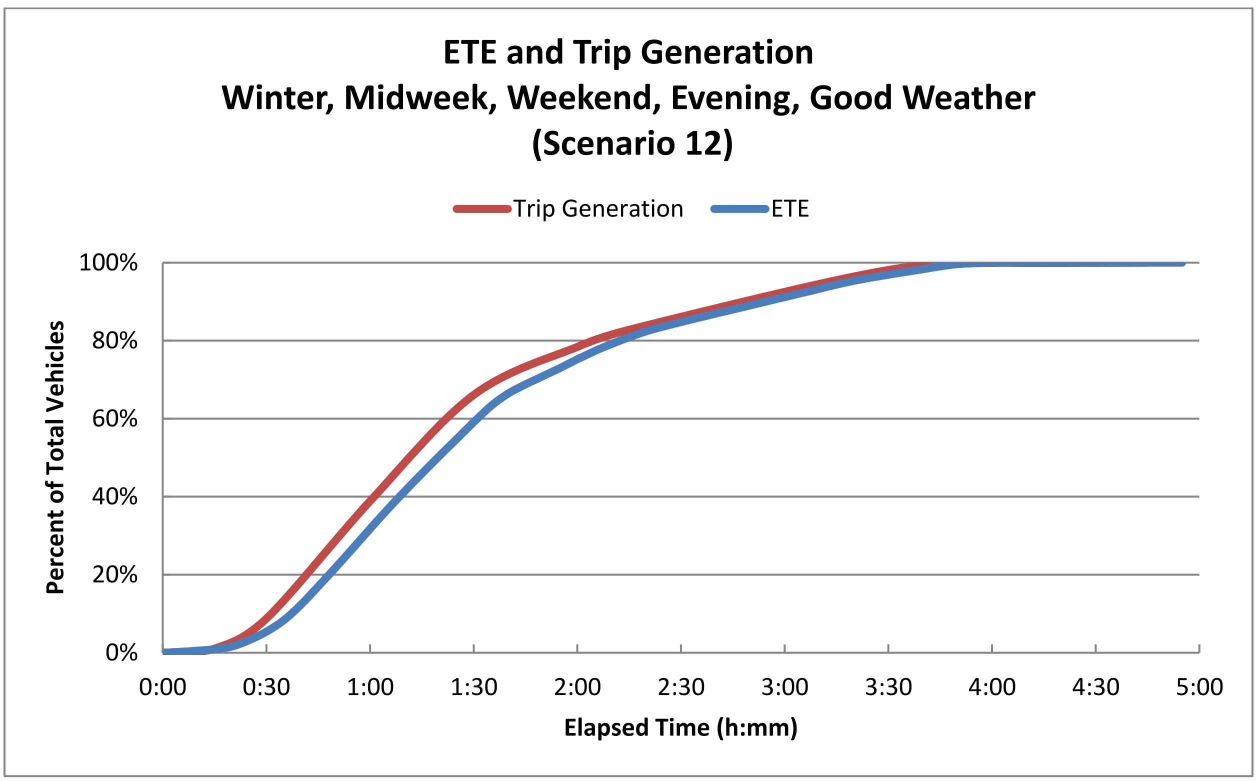


Figure J-13. ETE and Trip Generation: Winter, Midweek, Weekend, Evening, Good Weather (Scenario 12)

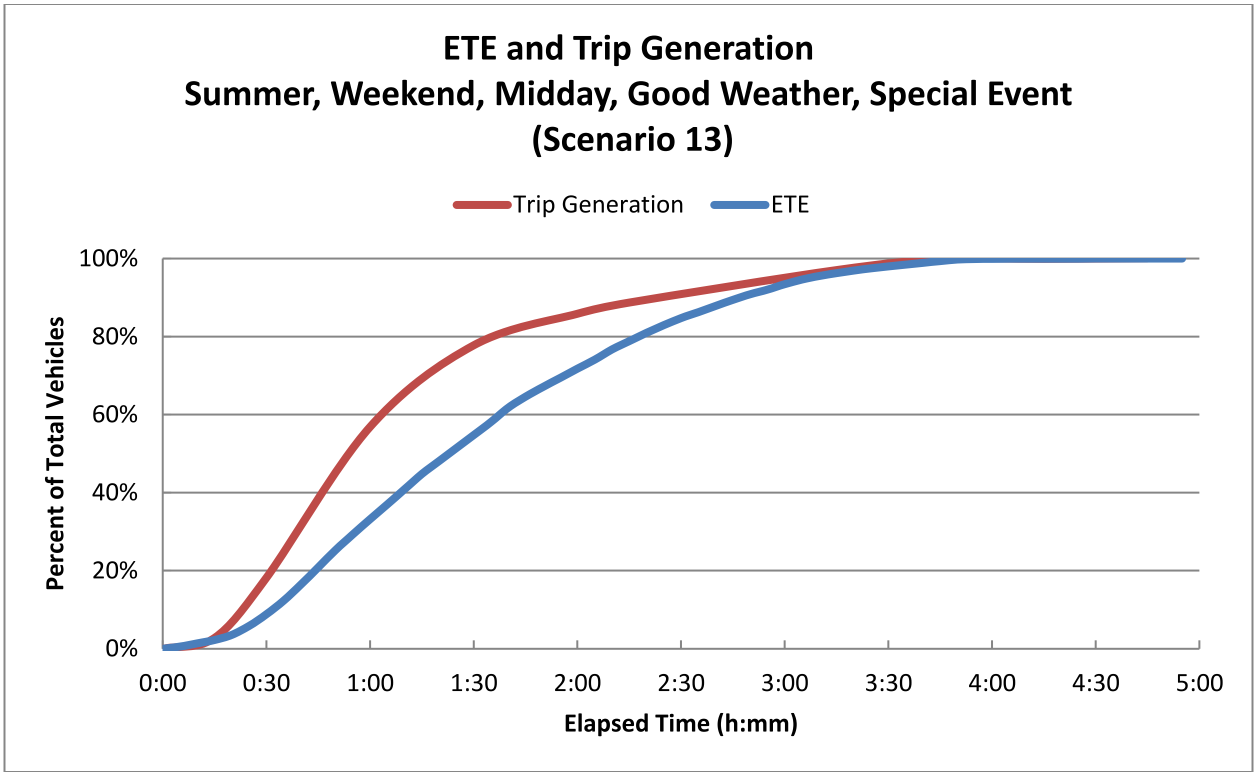


Figure J-14. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather, Special Event (Scenario 13)

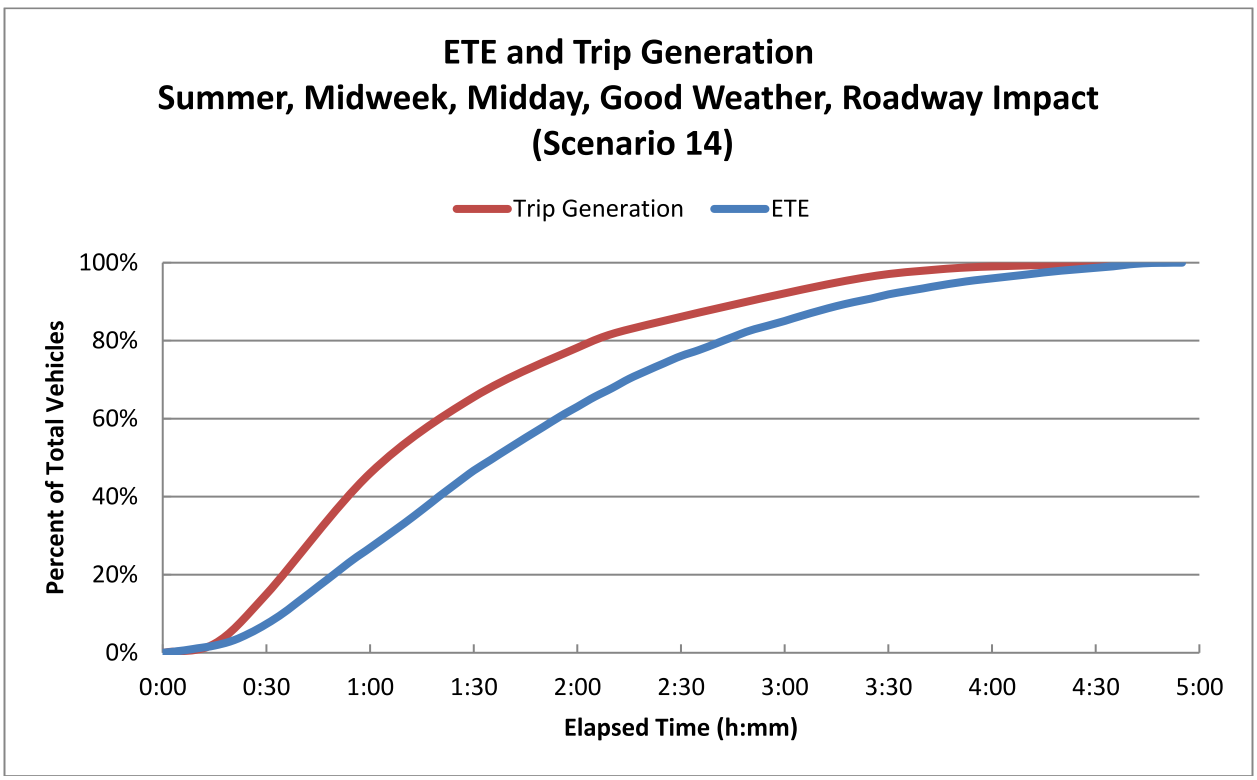


Figure J-15. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather, Roadway Impact (Scenario 14)

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. This figure has been divided up into 33 more detailed figures (Figure K-2 through Figure K-34) 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 and access control points [TCP/ACP], uncontrolled).

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

Control Type	Number of Nodes
Uncontrolled	434
Pretimed	14
Actuated	21
Stop	74
TCP/ACP	56
Yield	11
Total:	**610**

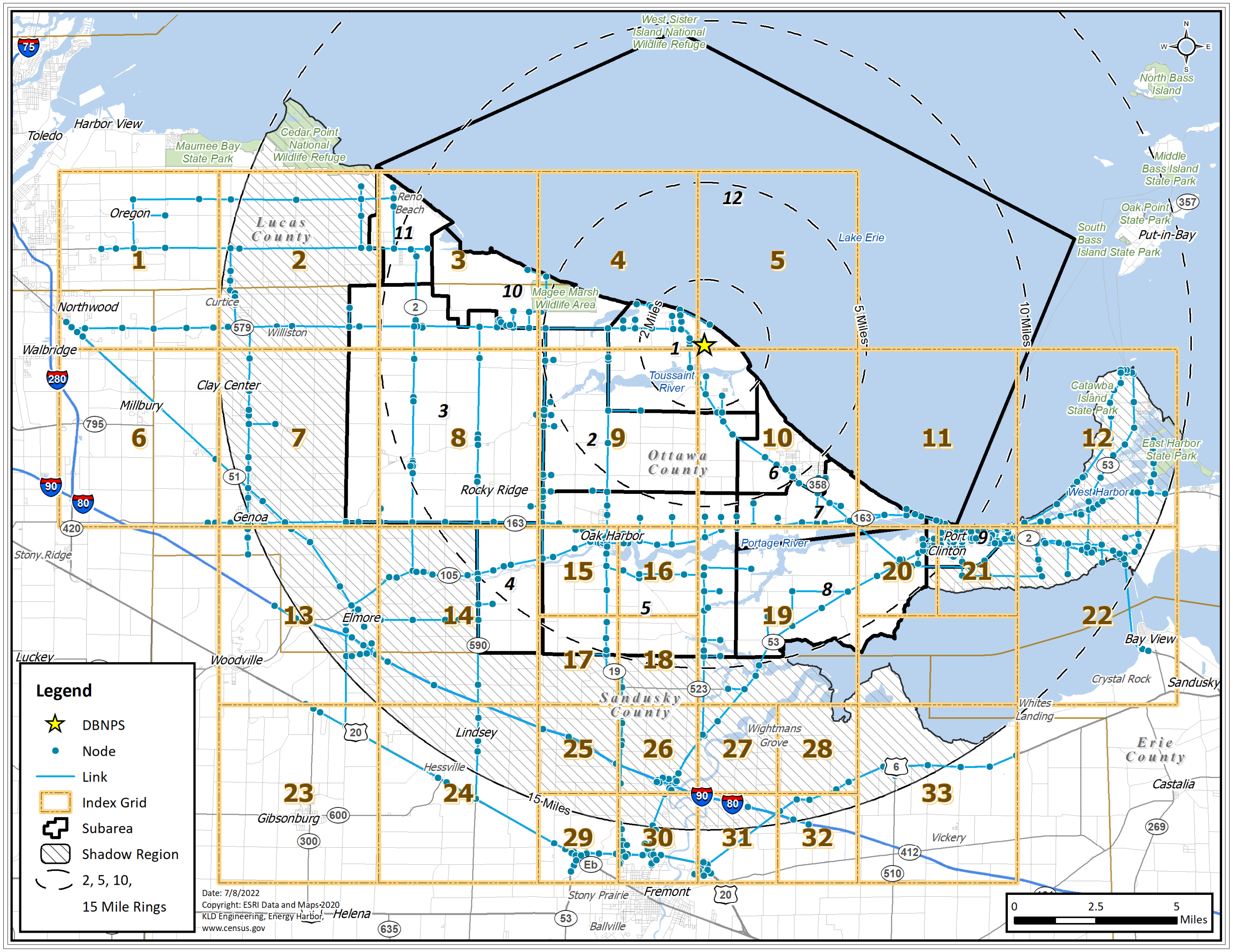


Figure K-1. Link-Node Analysis Network Overview

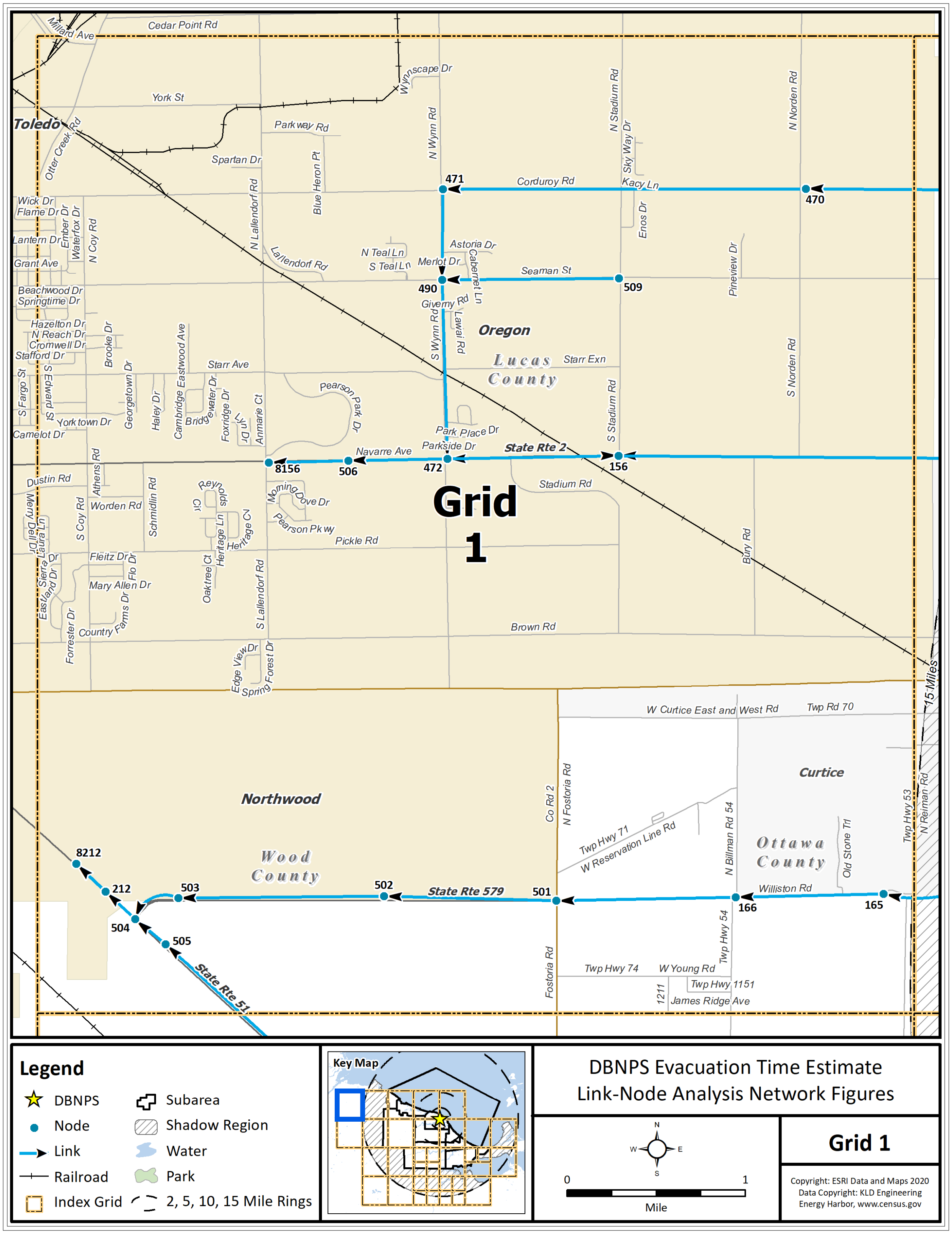


Figure K-2. Link-Node Analysis Network - Grid 1

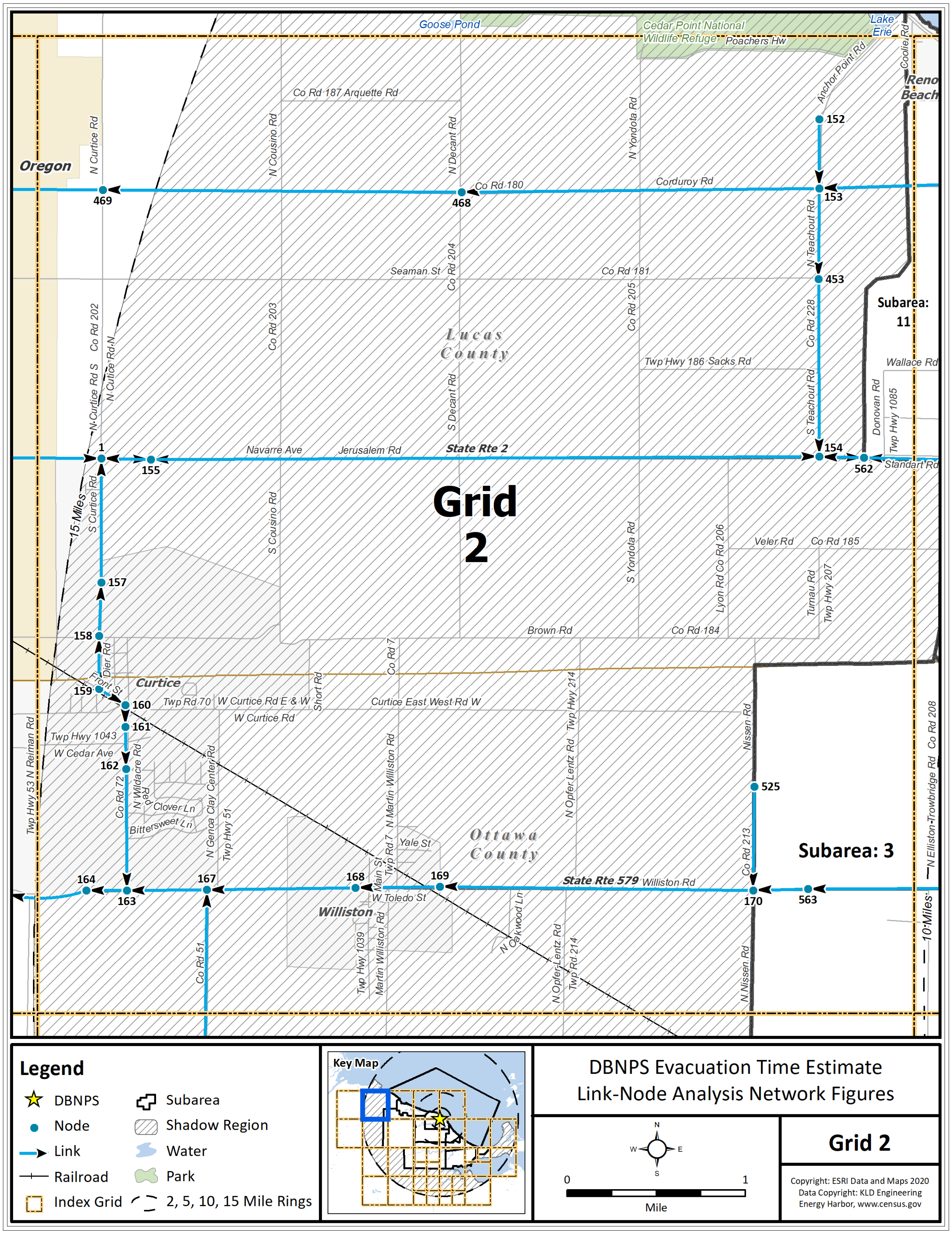


Figure K-3. Link-Node Analysis Network - Grid 2

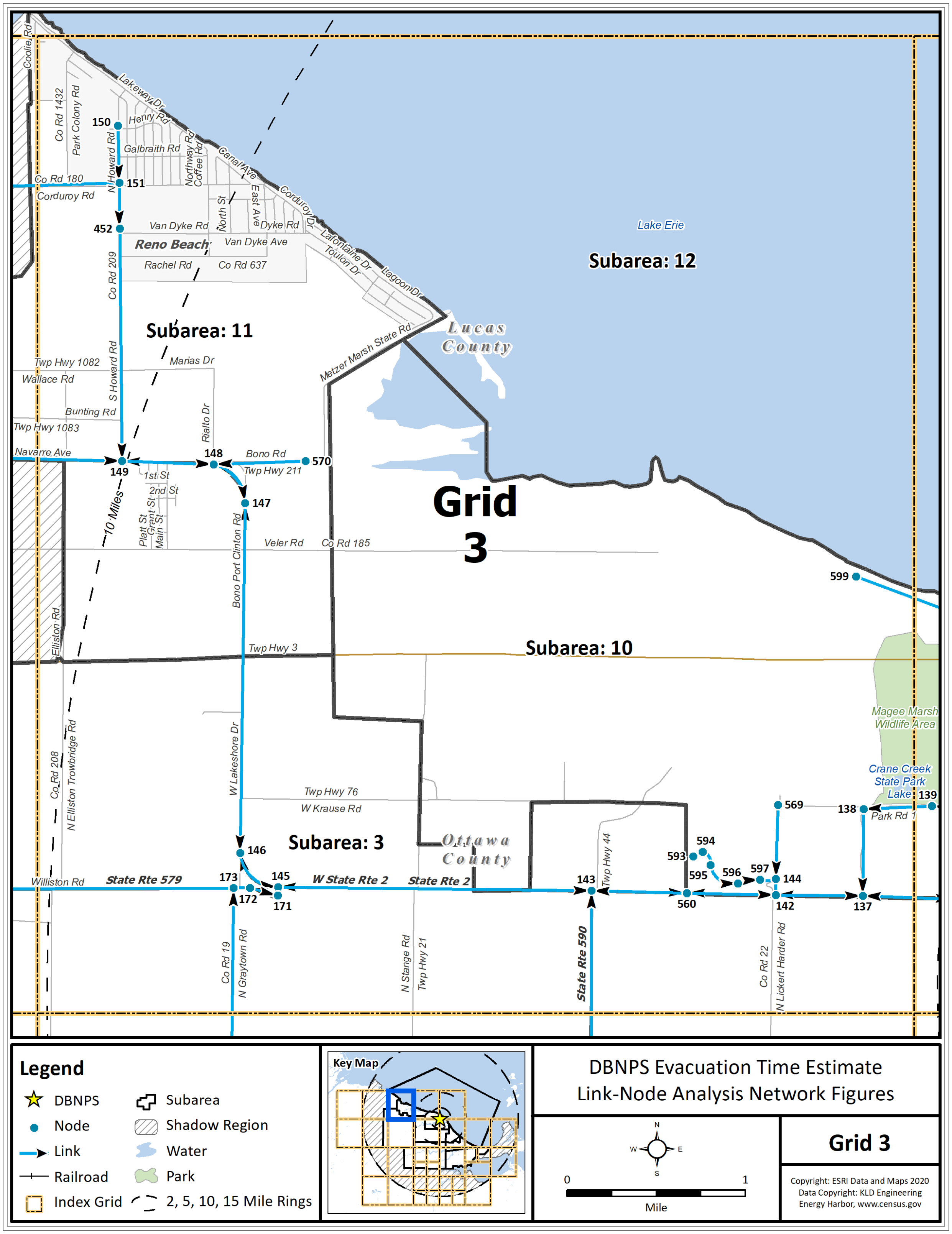


Figure K-4. Link-Node Analysis Network - Grid 3

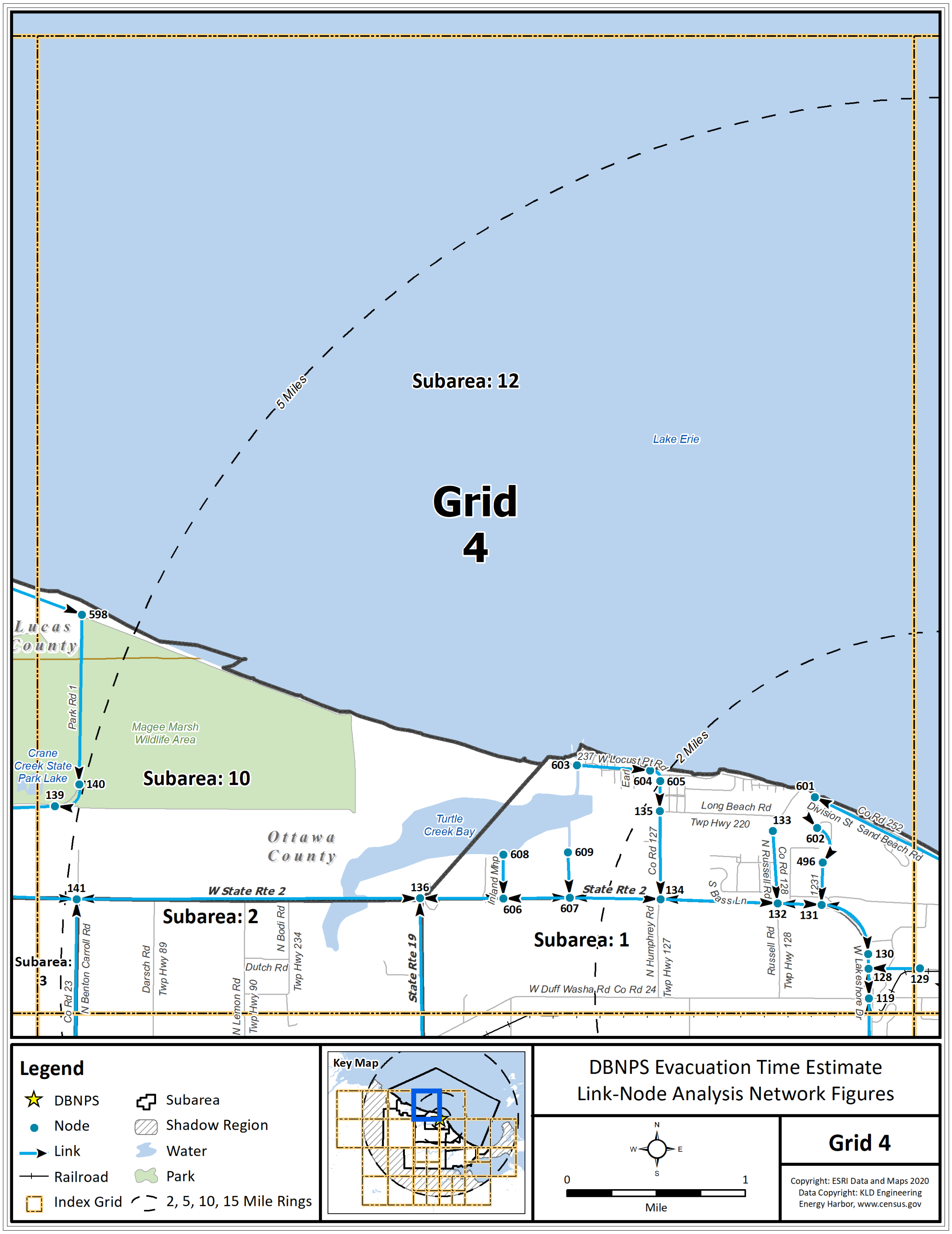


Figure K-5. Link-Node Analysis Network - Grid 4

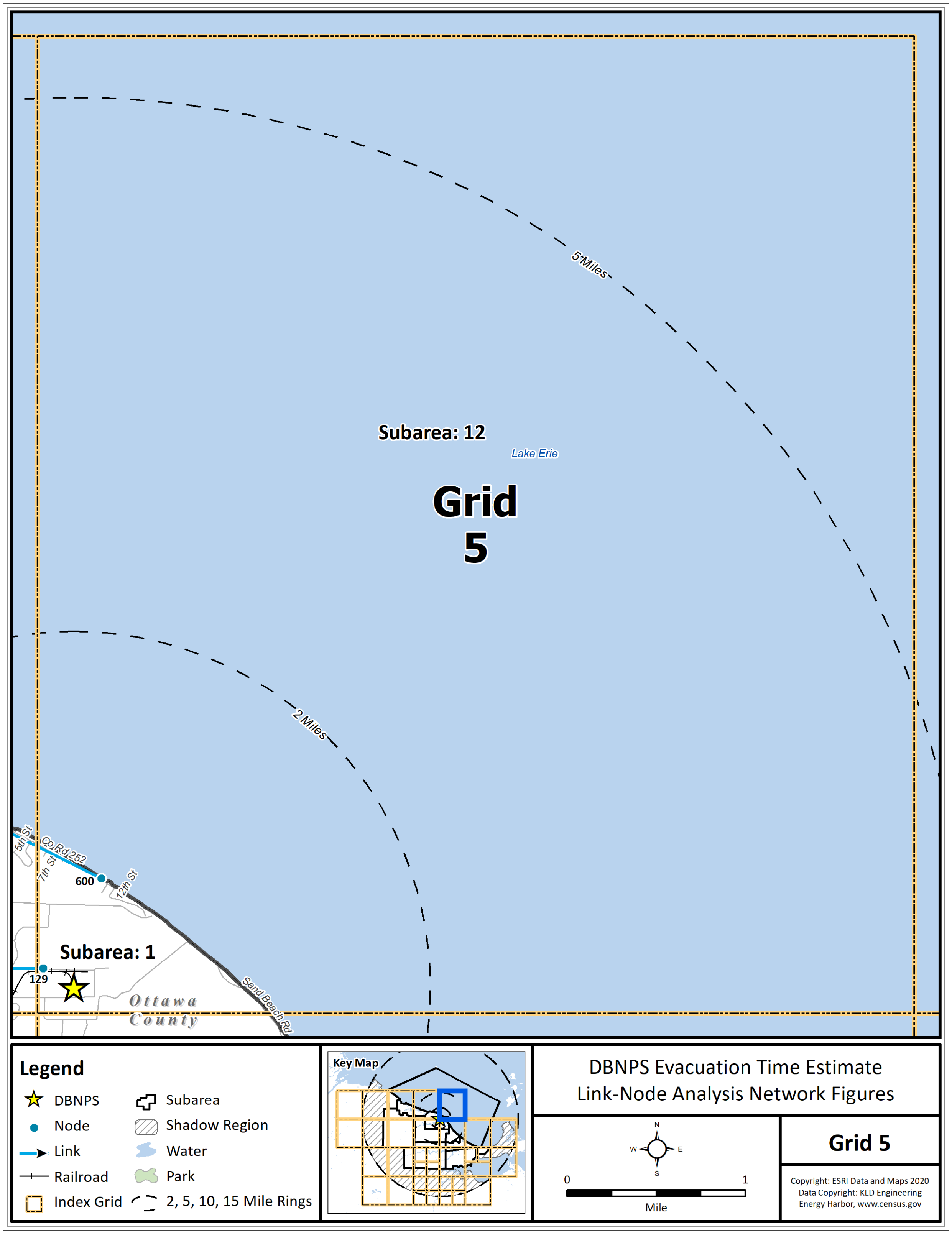


Figure K-6. Link-Node Analysis Network - Grid 5

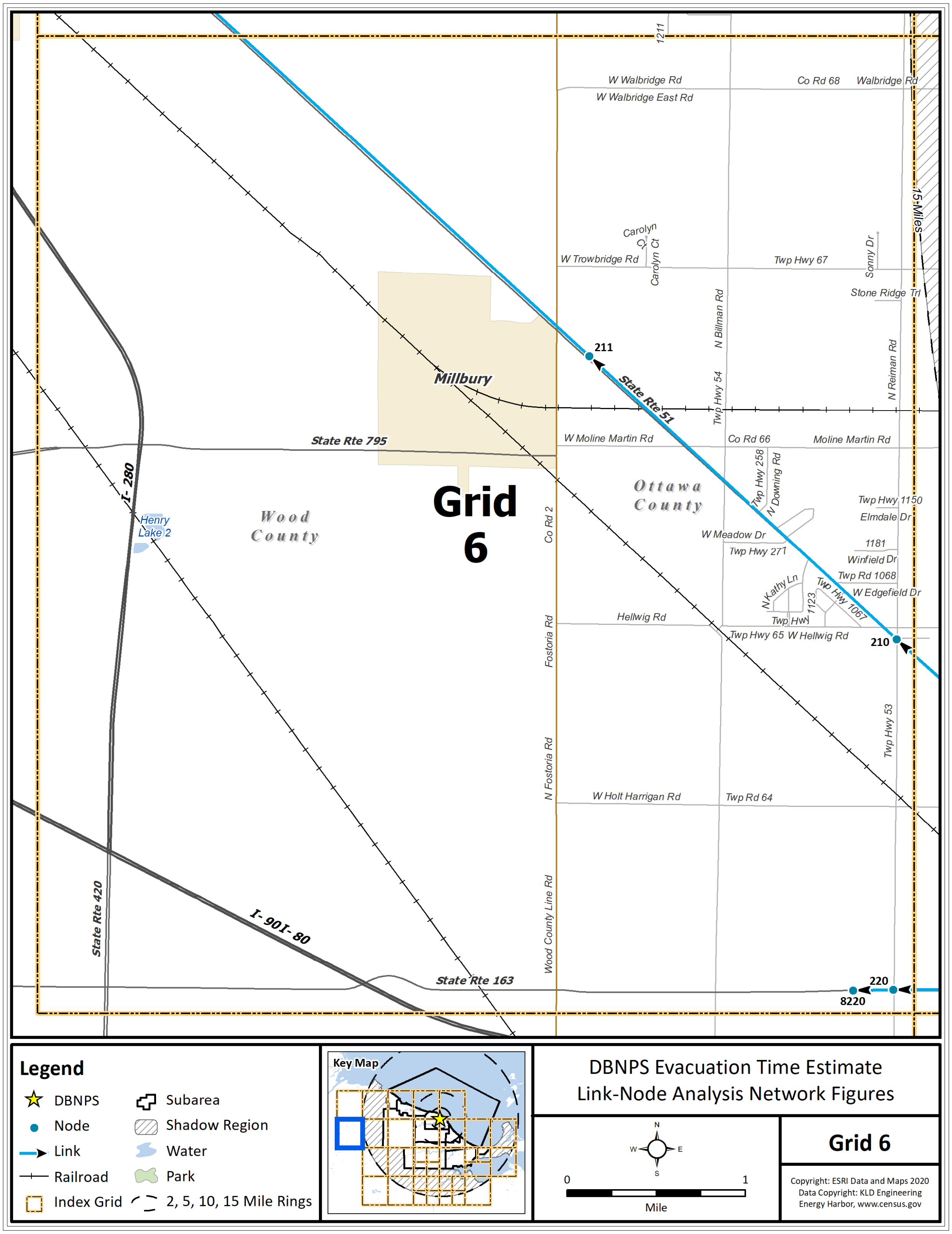


Figure K-7. Link-Node Analysis Network - Grid 6

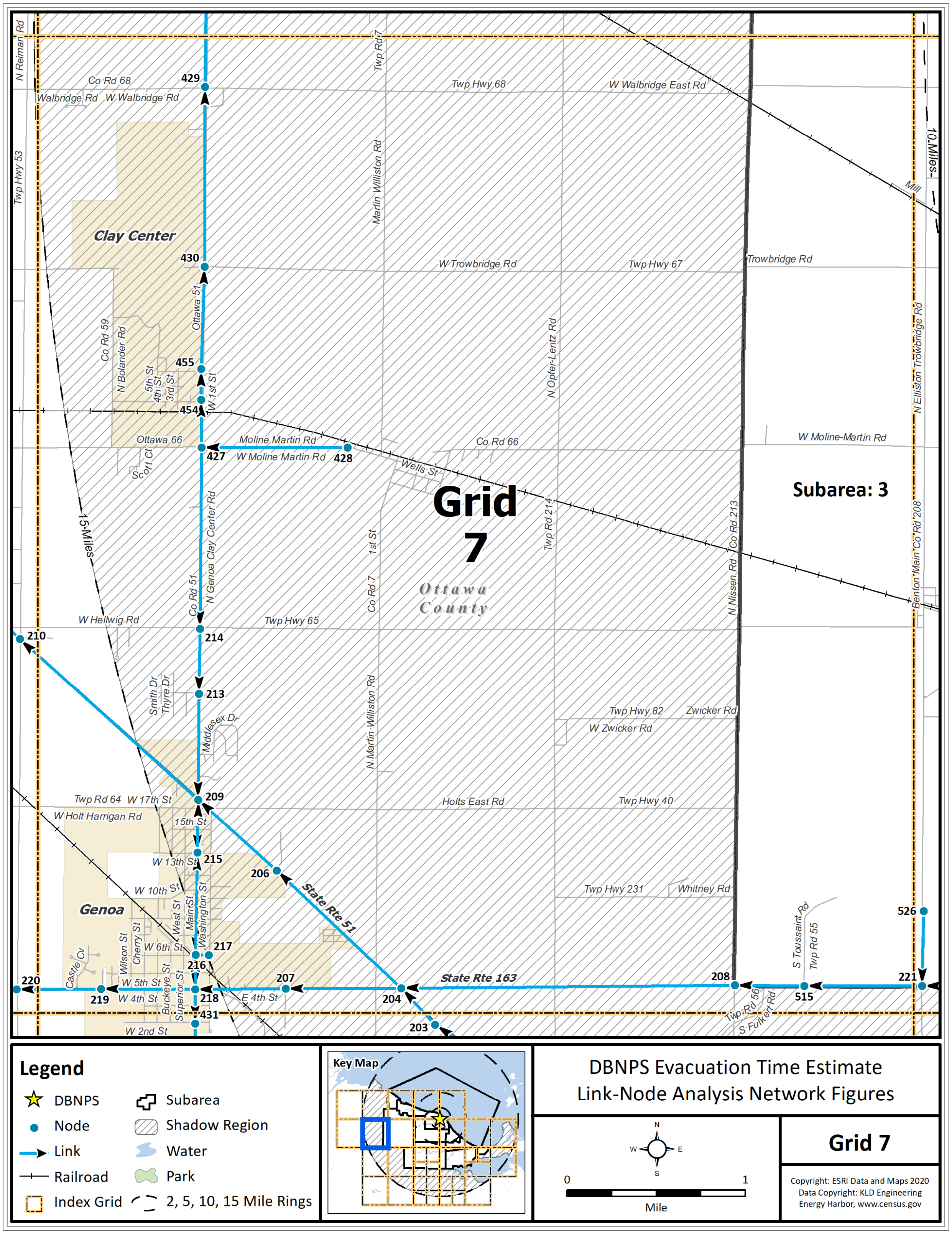


Figure K-8. Link-Node Analysis Network - Grid 7

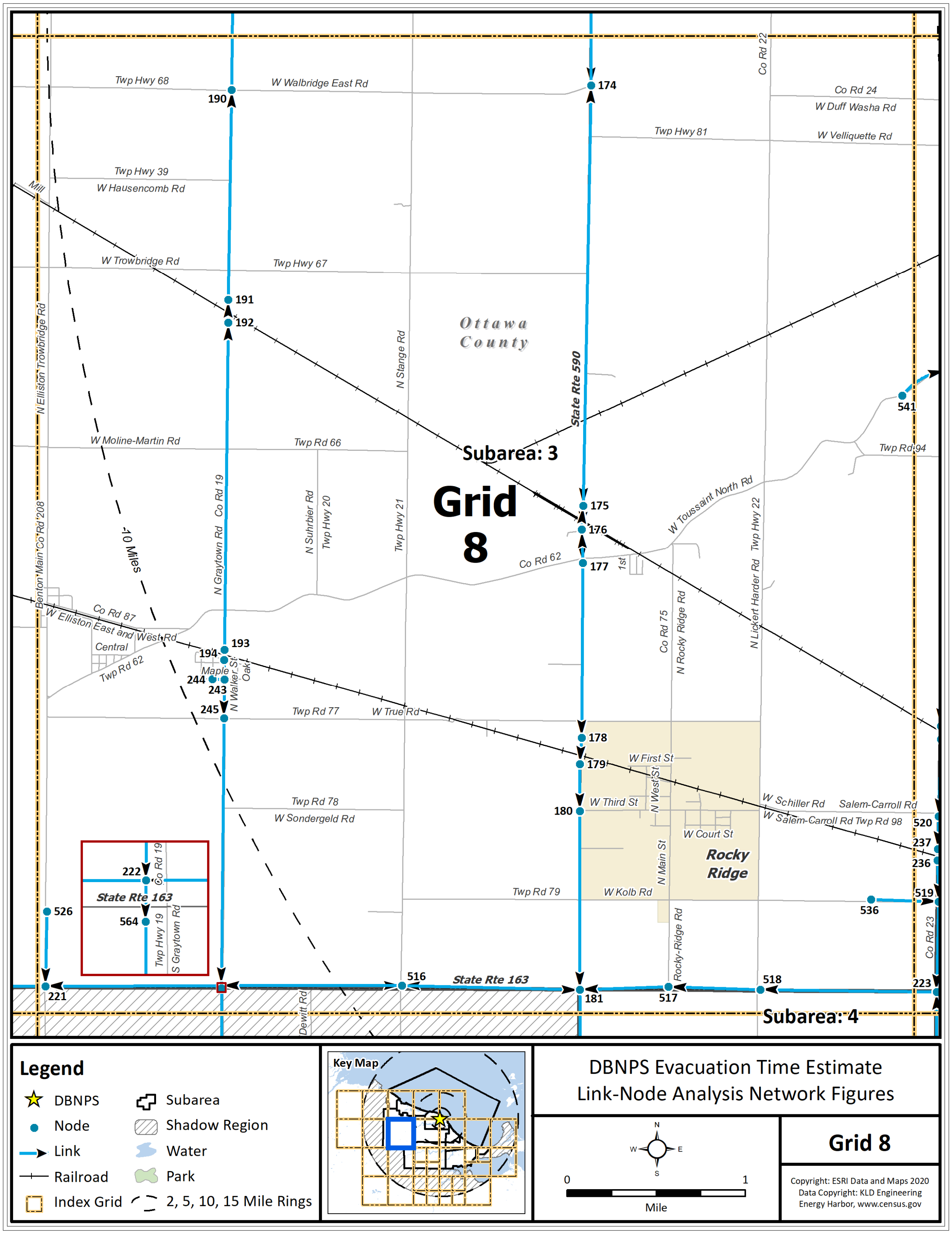


Figure K-9. Link-Node Analysis Network - Grid 8

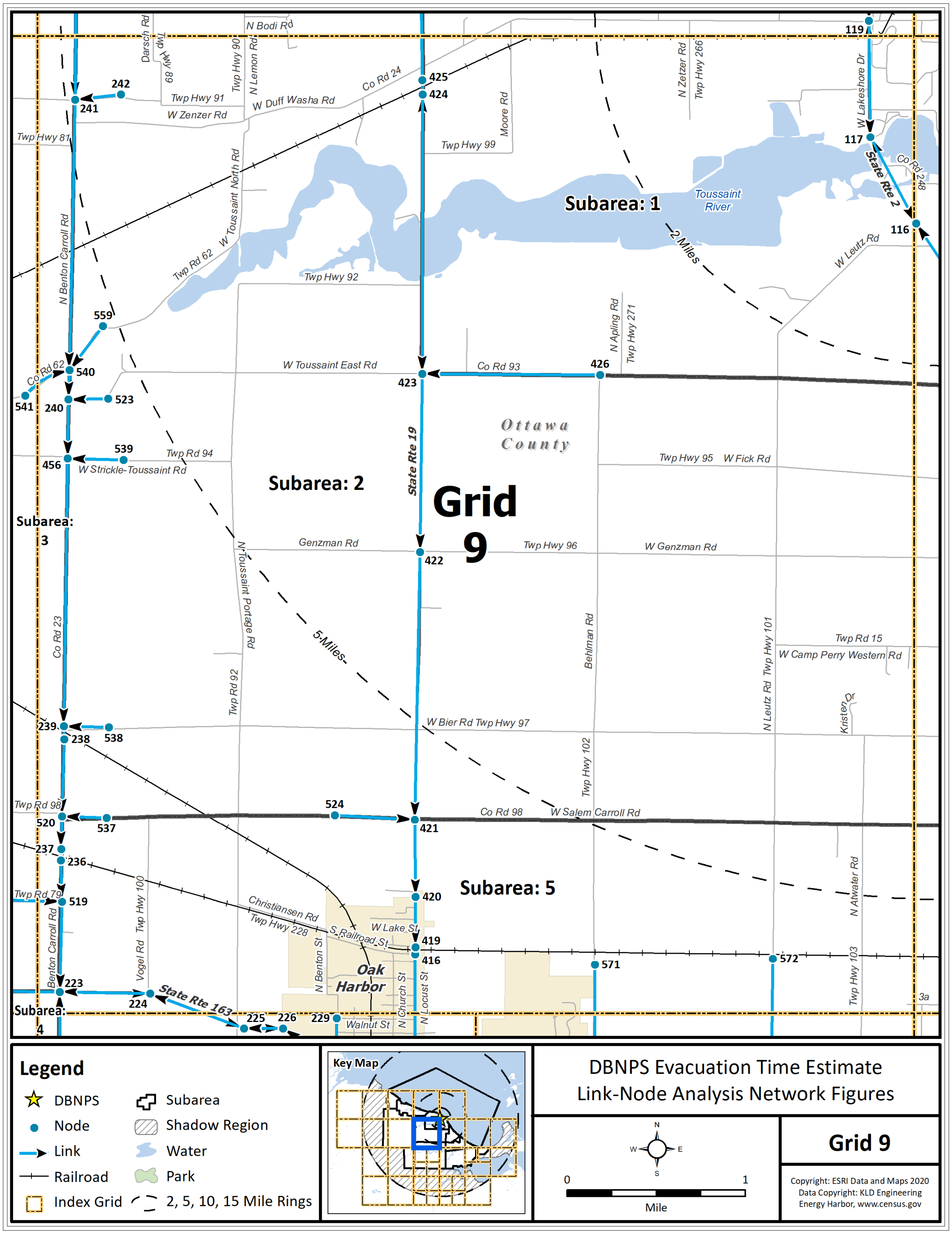


Figure K-10. Link-Node Analysis Network - Grid 9

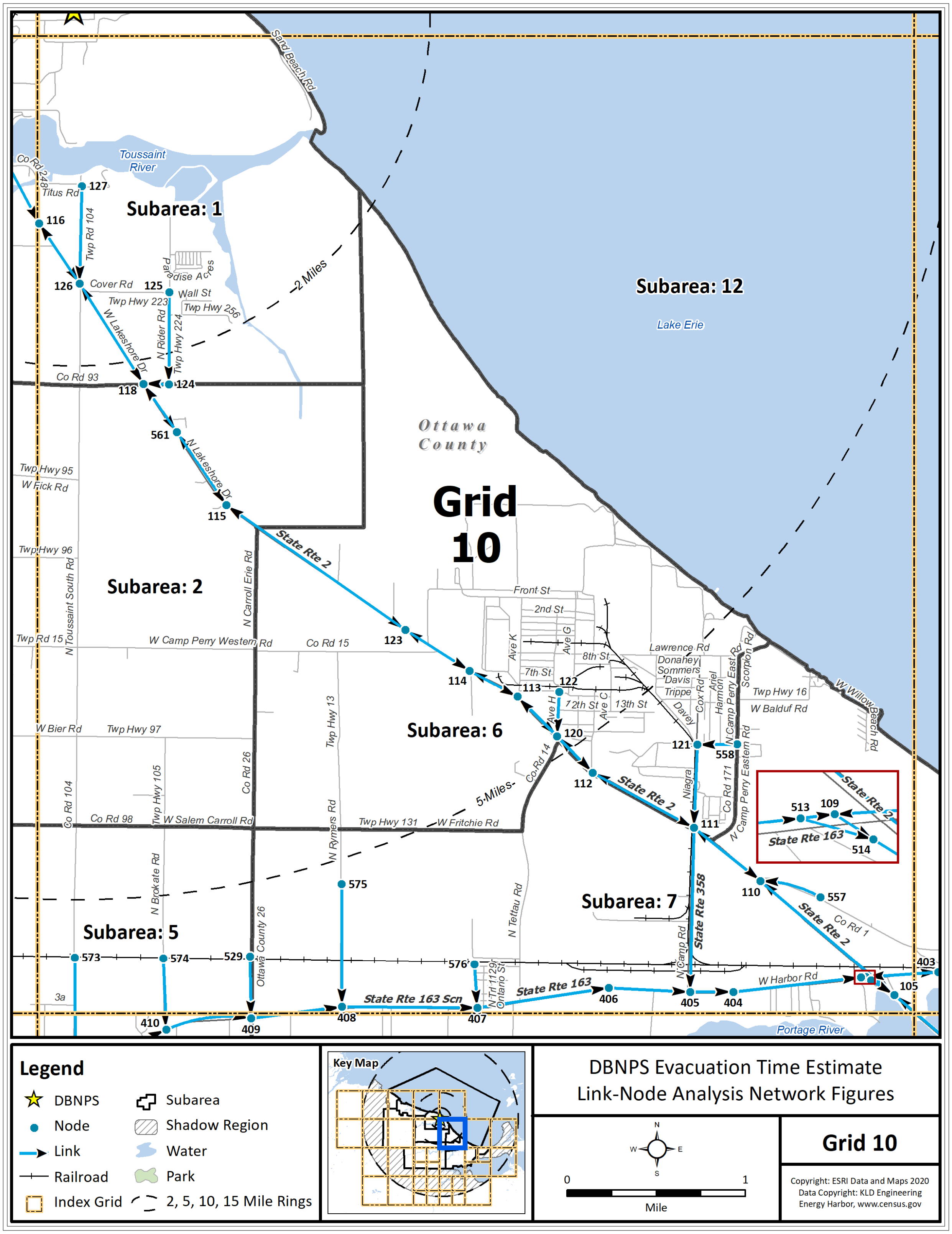


Figure K-11. Link-Node Analysis Network - Grid 10

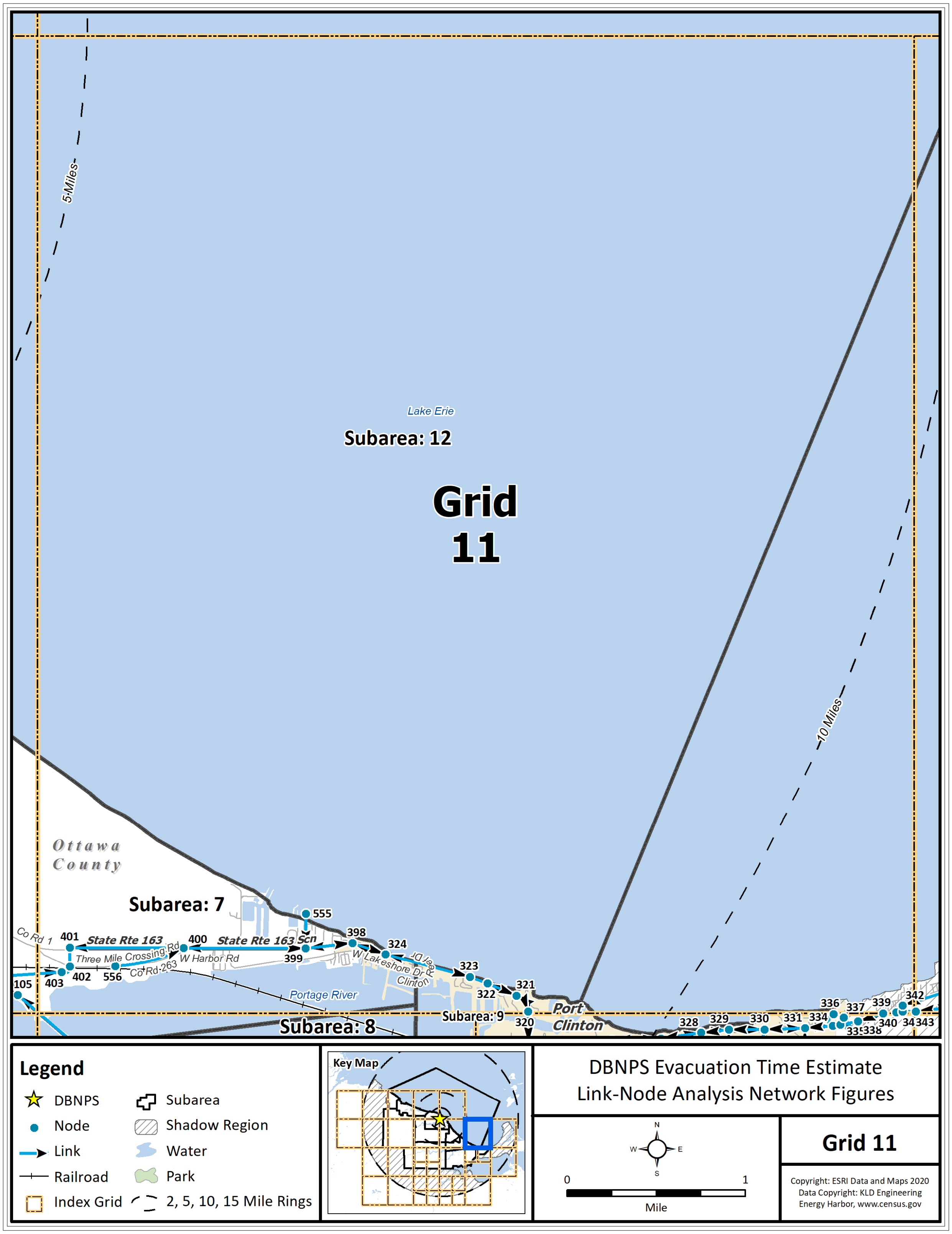


Figure K-12. Link-Node Analysis Network - Grid 11

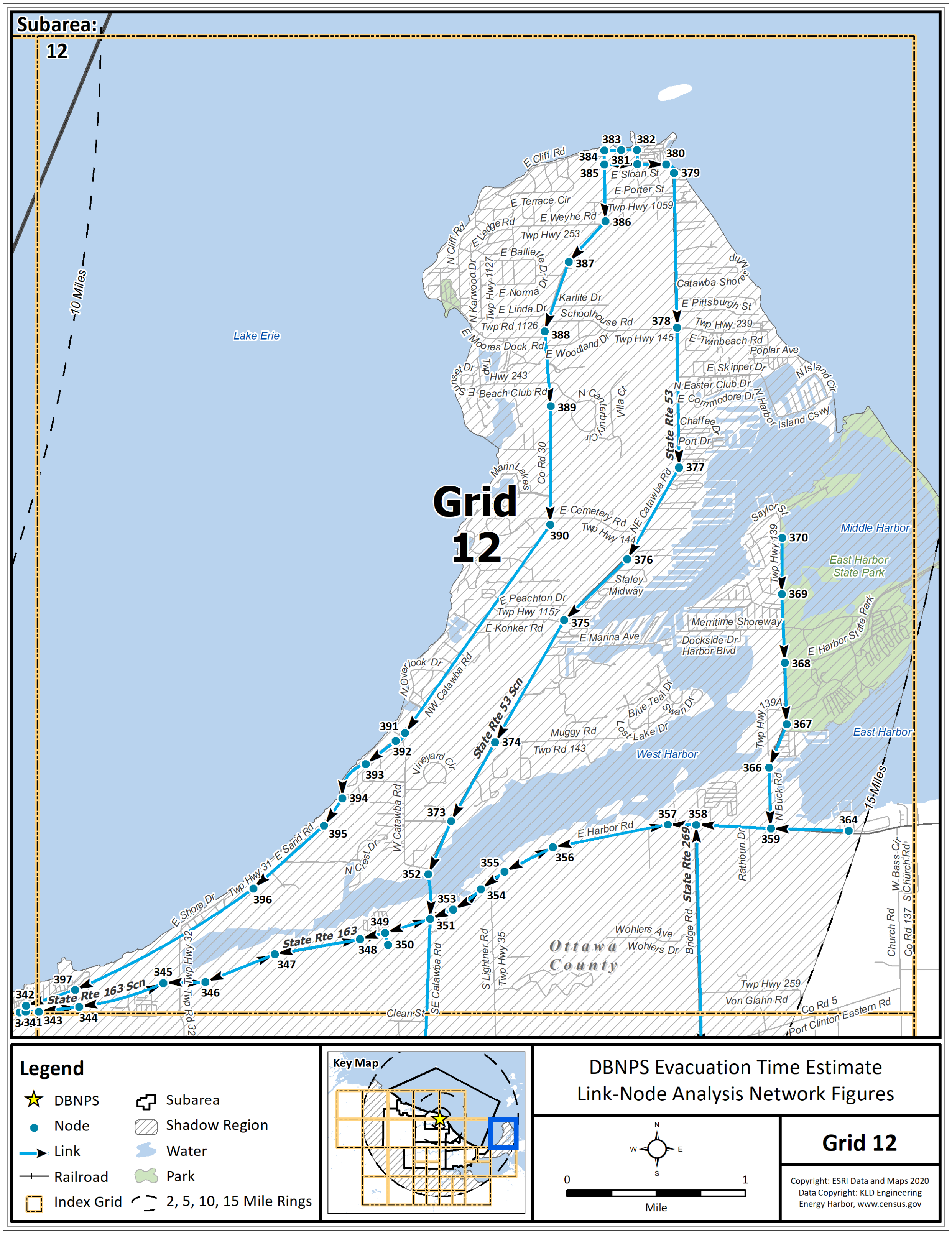


Figure K-13. Link-Node Analysis Network - Grid 12

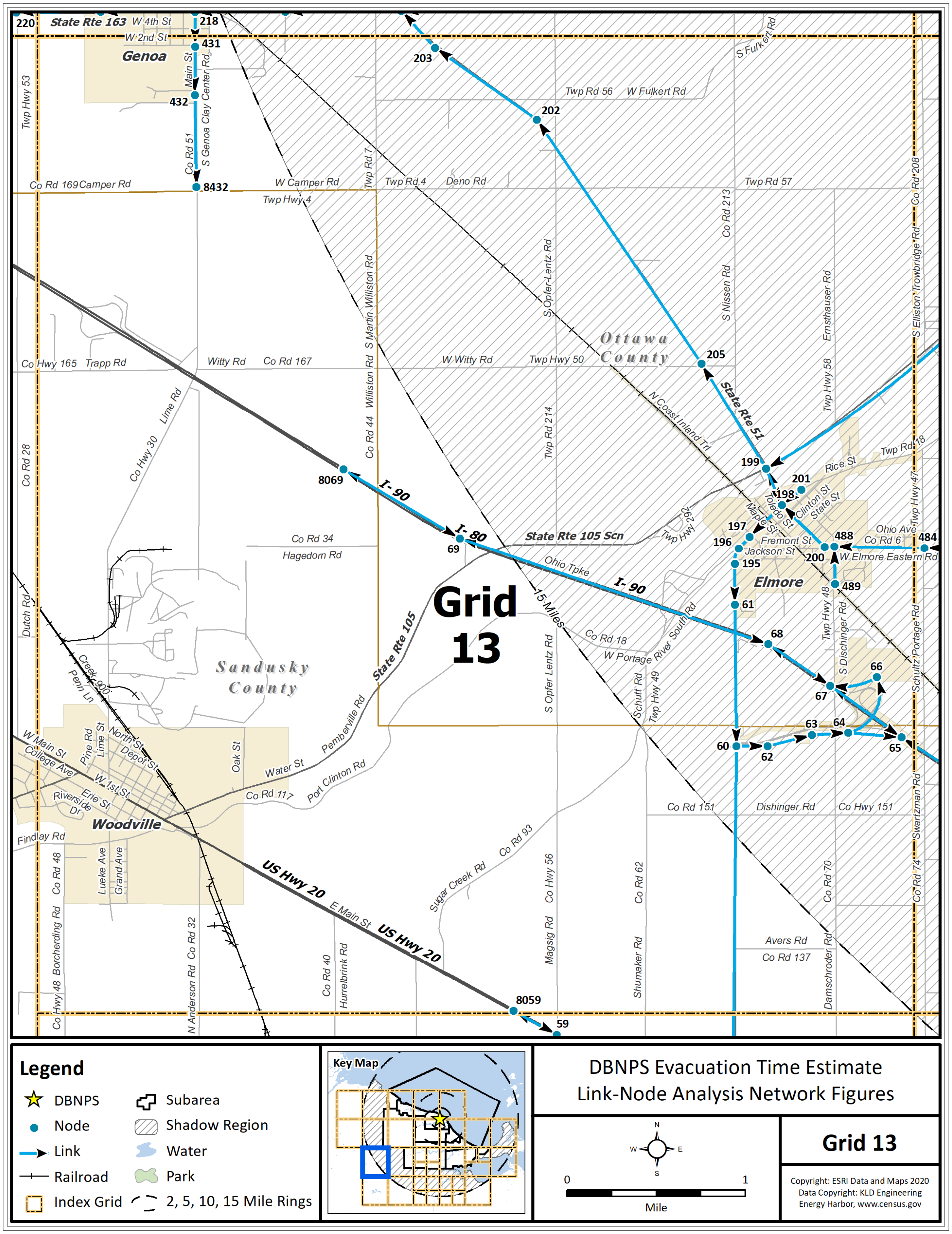


Figure K-14. Link-Node Analysis Network - Grid 13

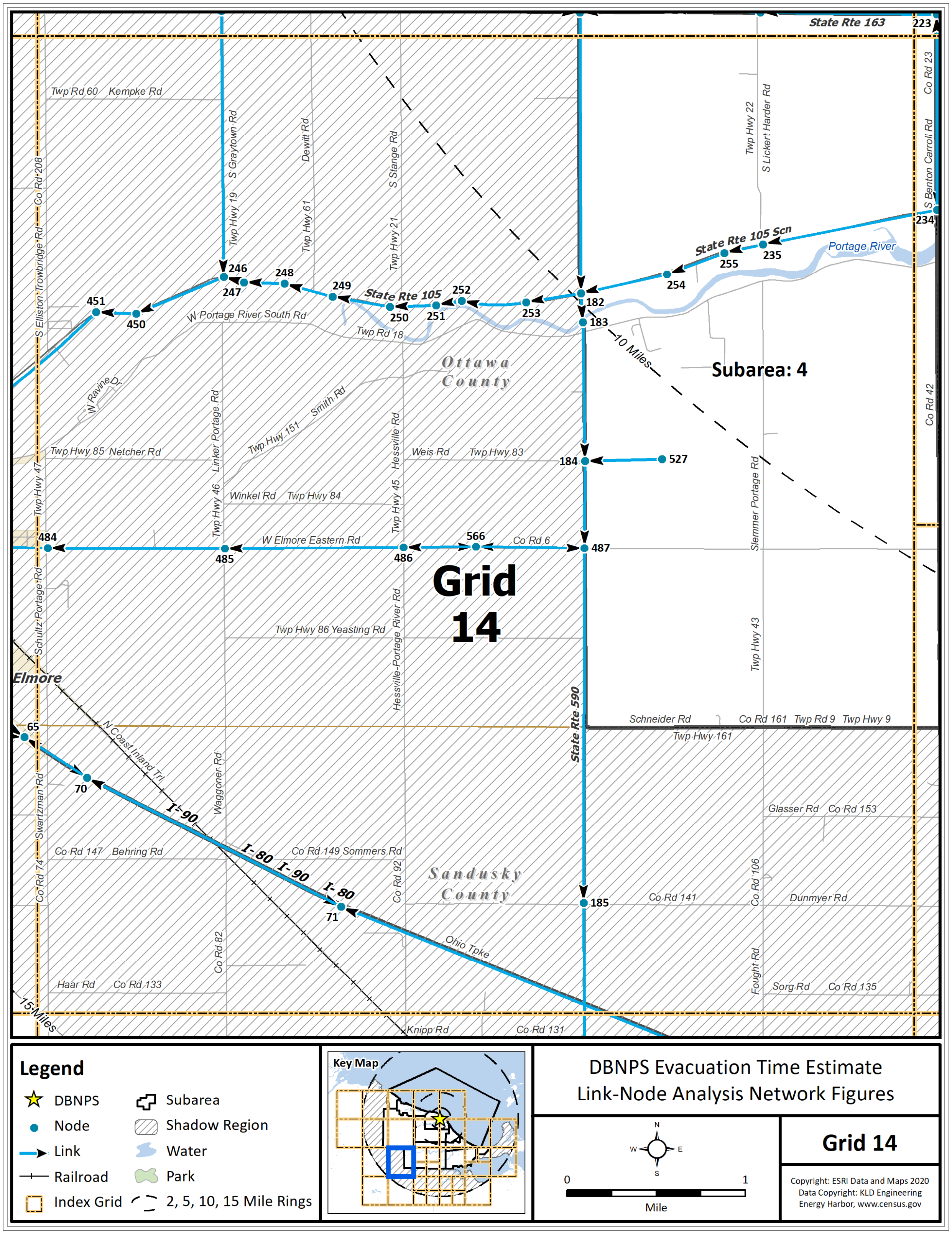


Figure K-15. Link-Node Analysis Network - Grid 14

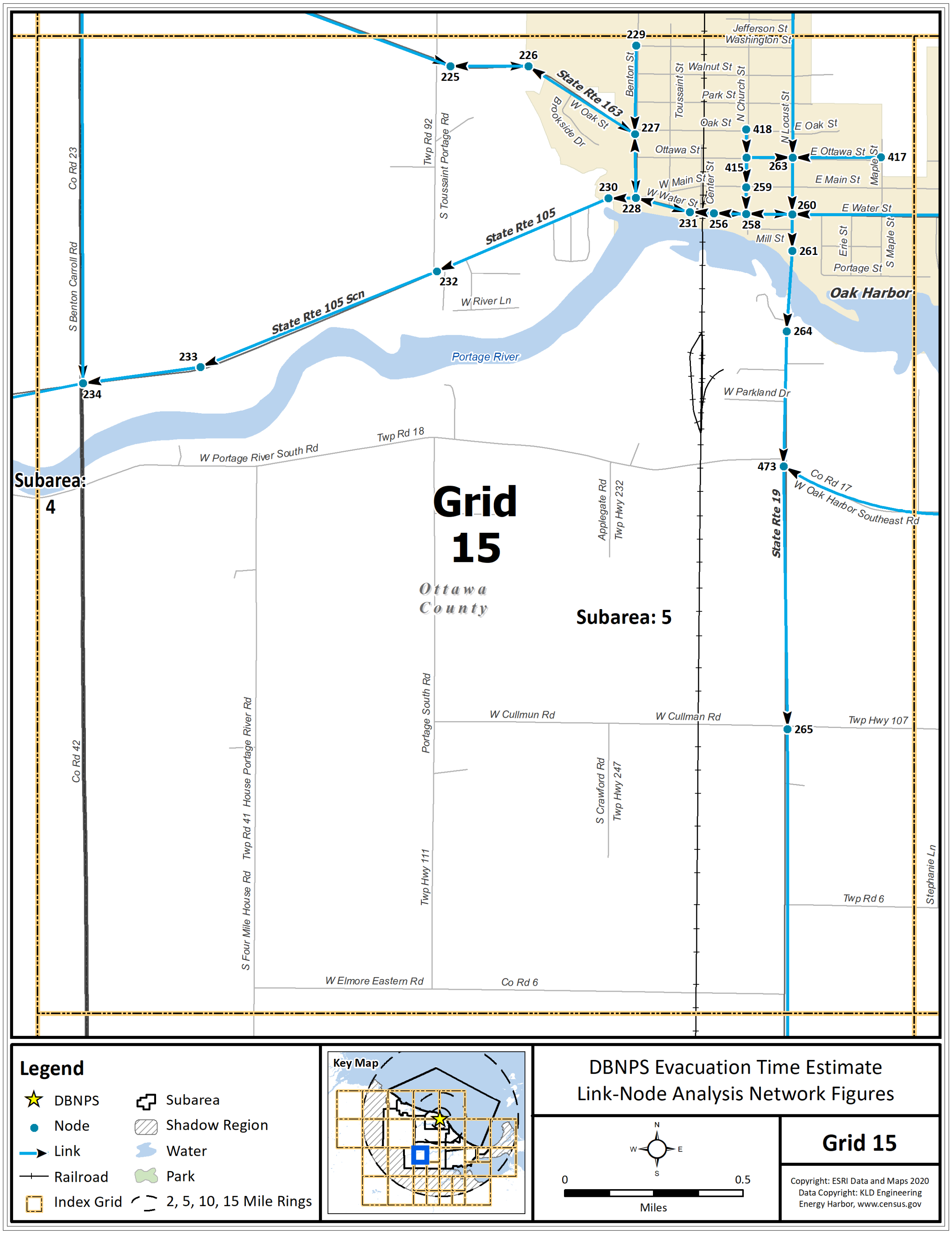


Figure K-16. Link-Node Analysis Network - Grid 15

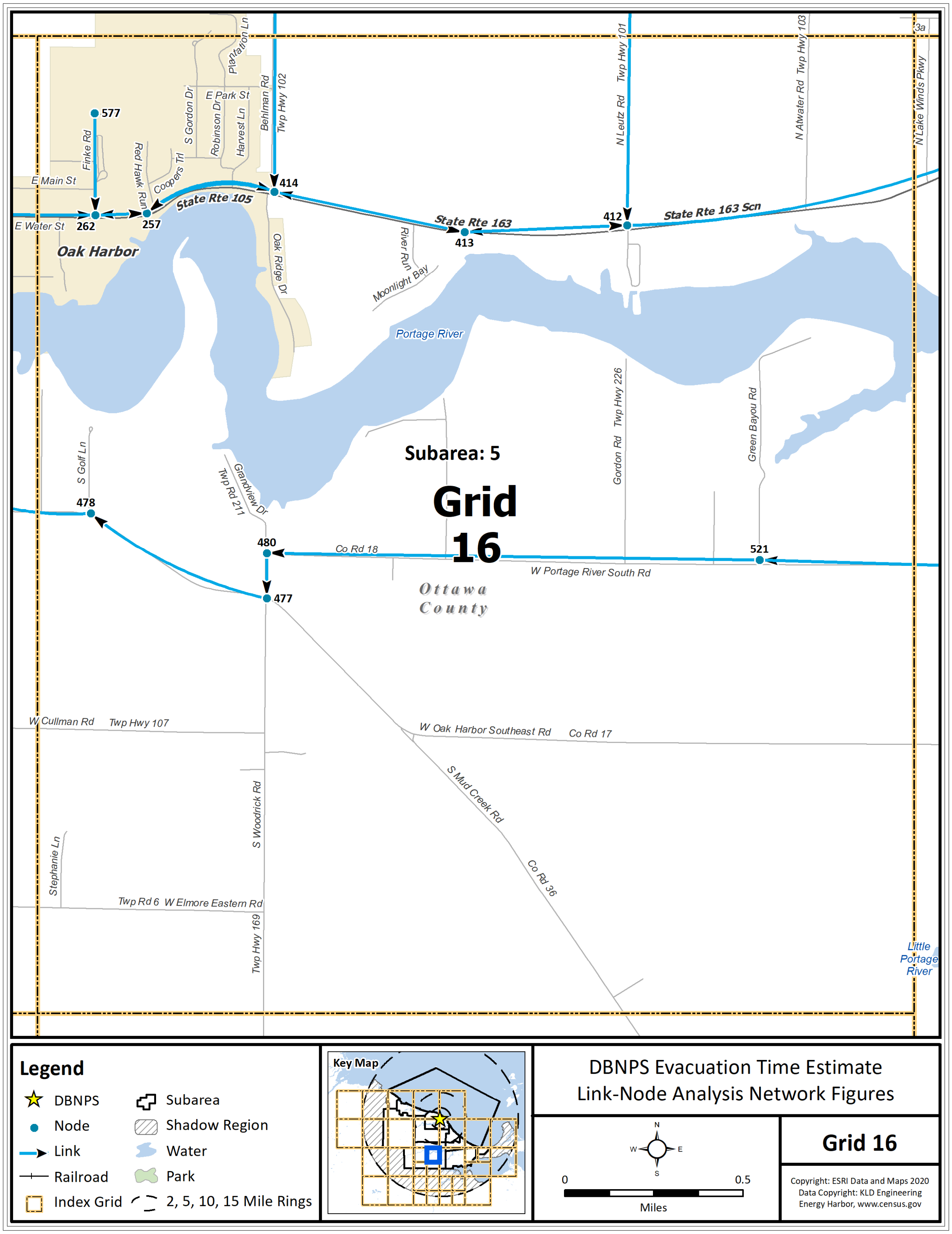


Figure K-17. Link-Node Analysis Network - Grid 16

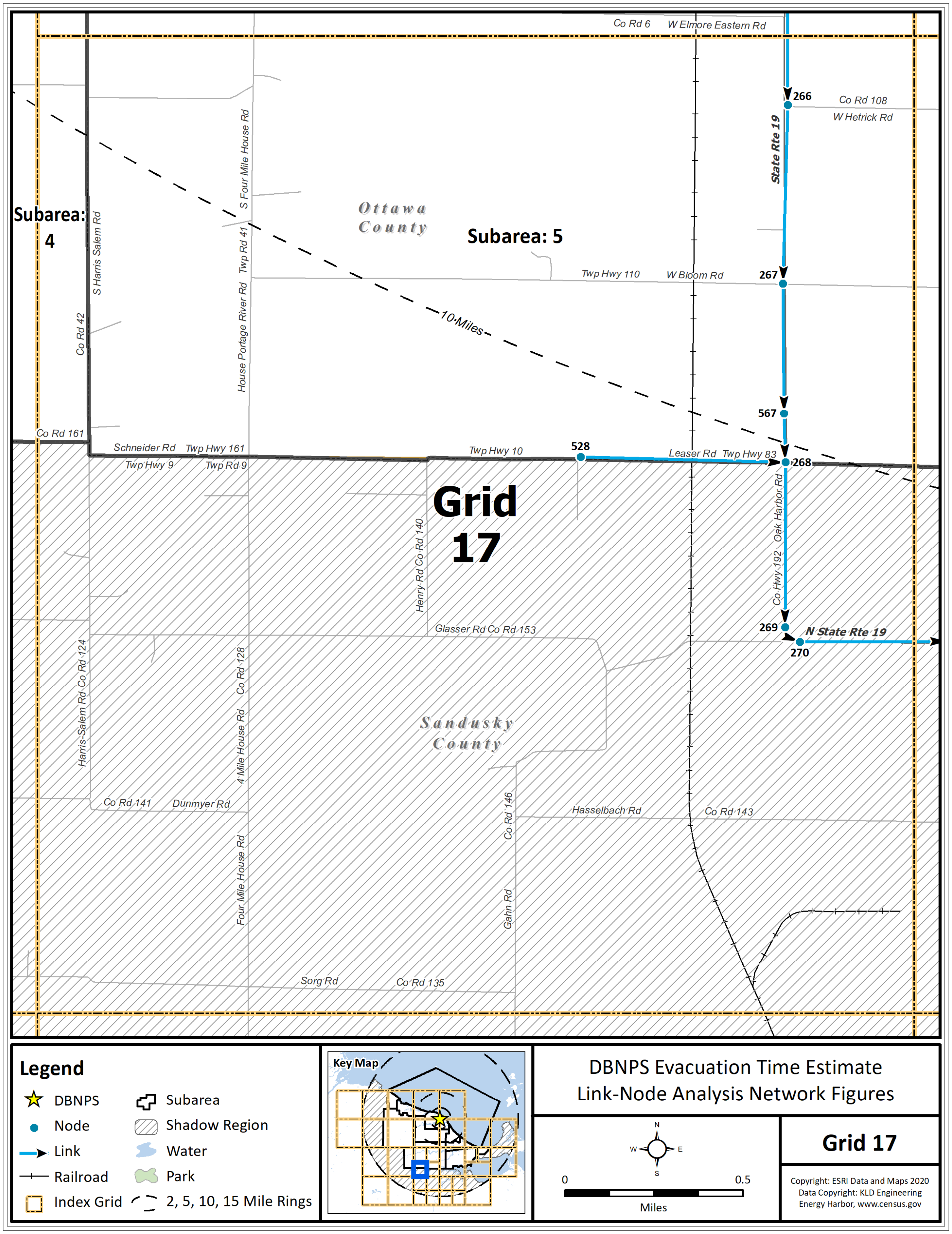


Figure K-18. Link-Node Analysis Network - Grid 17

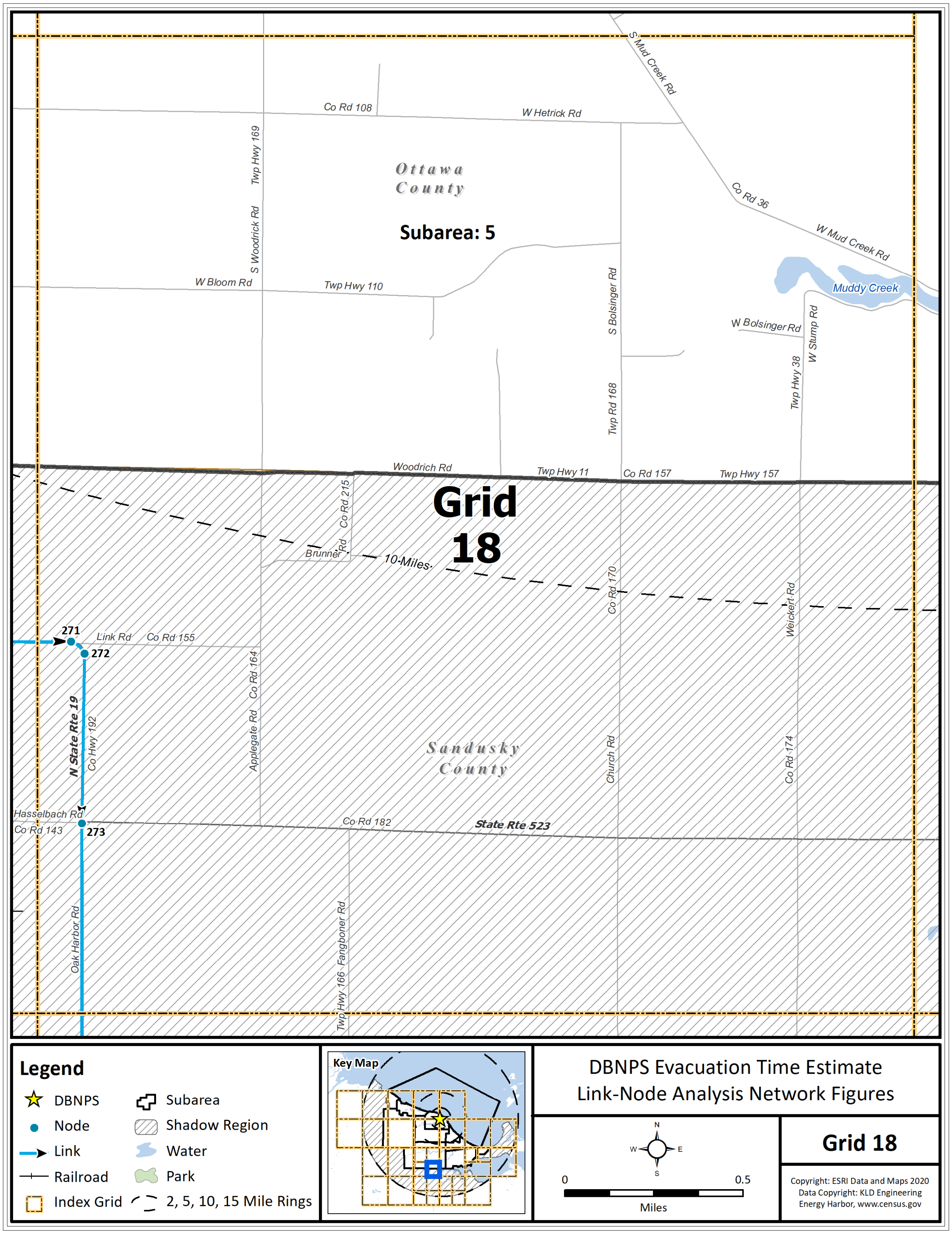


Figure K-19. Link-Node Analysis Network - Grid 18

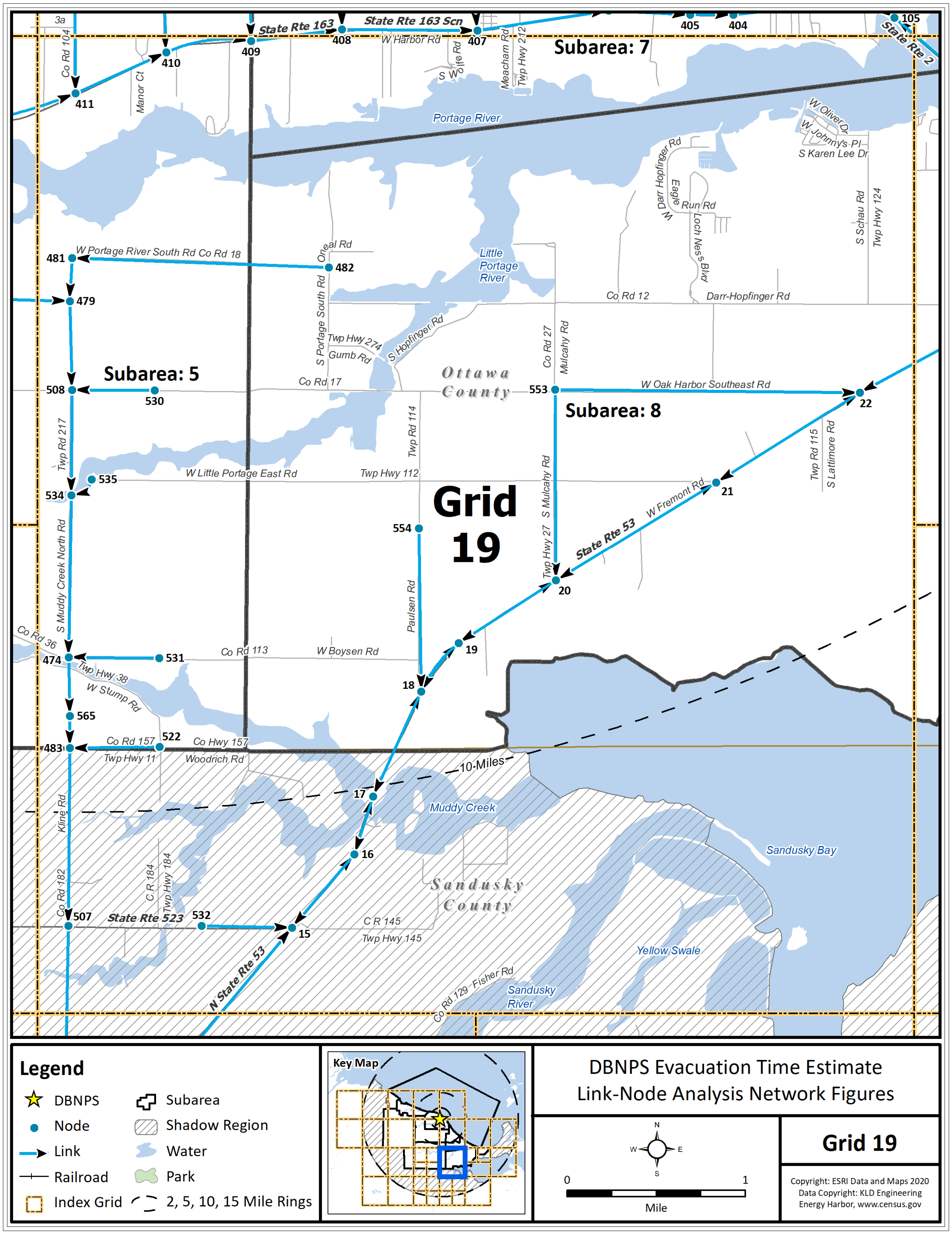


Figure K-20. Link-Node Analysis Network - Grid 19

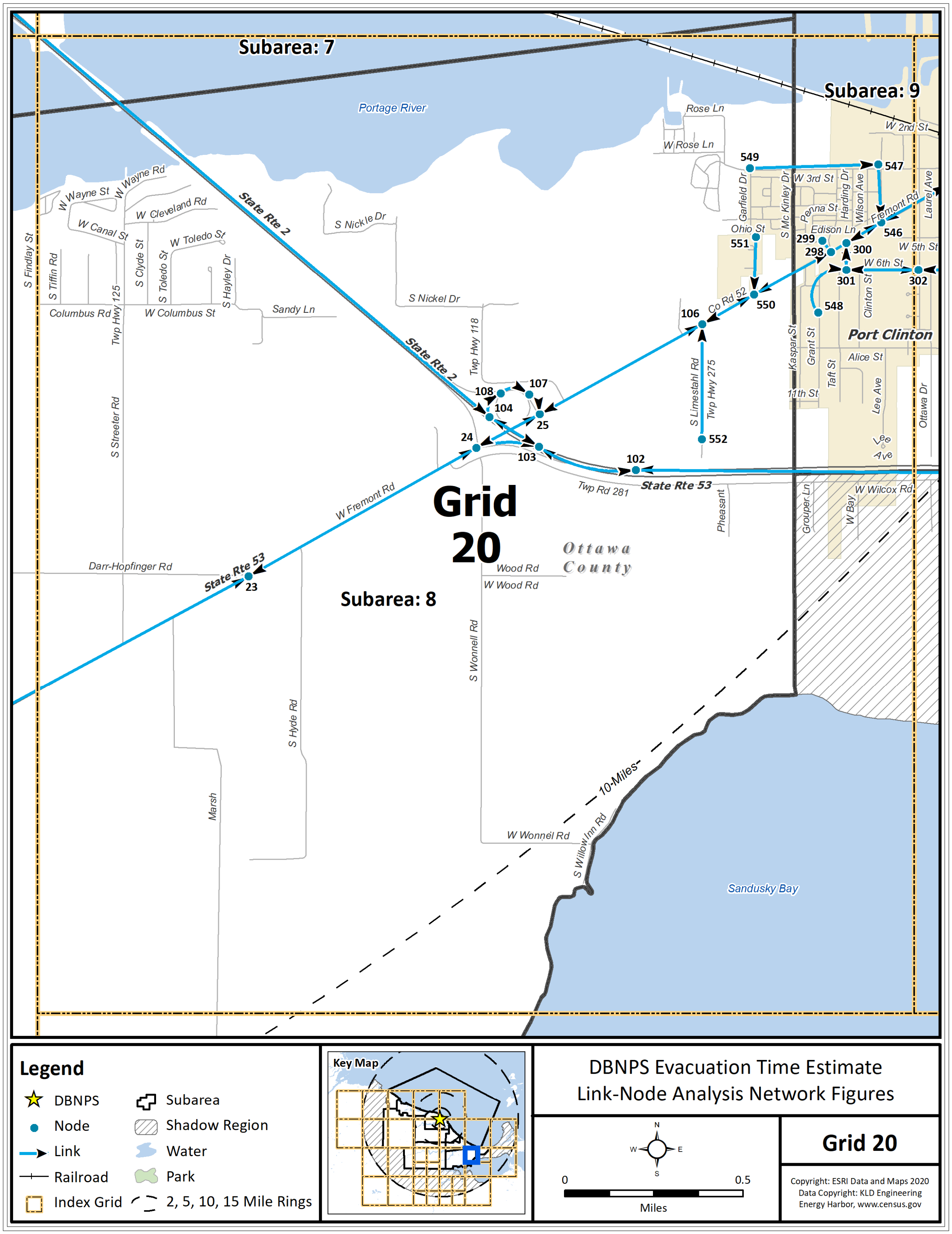


Figure K-21. Link-Node Analysis Network - Grid 20

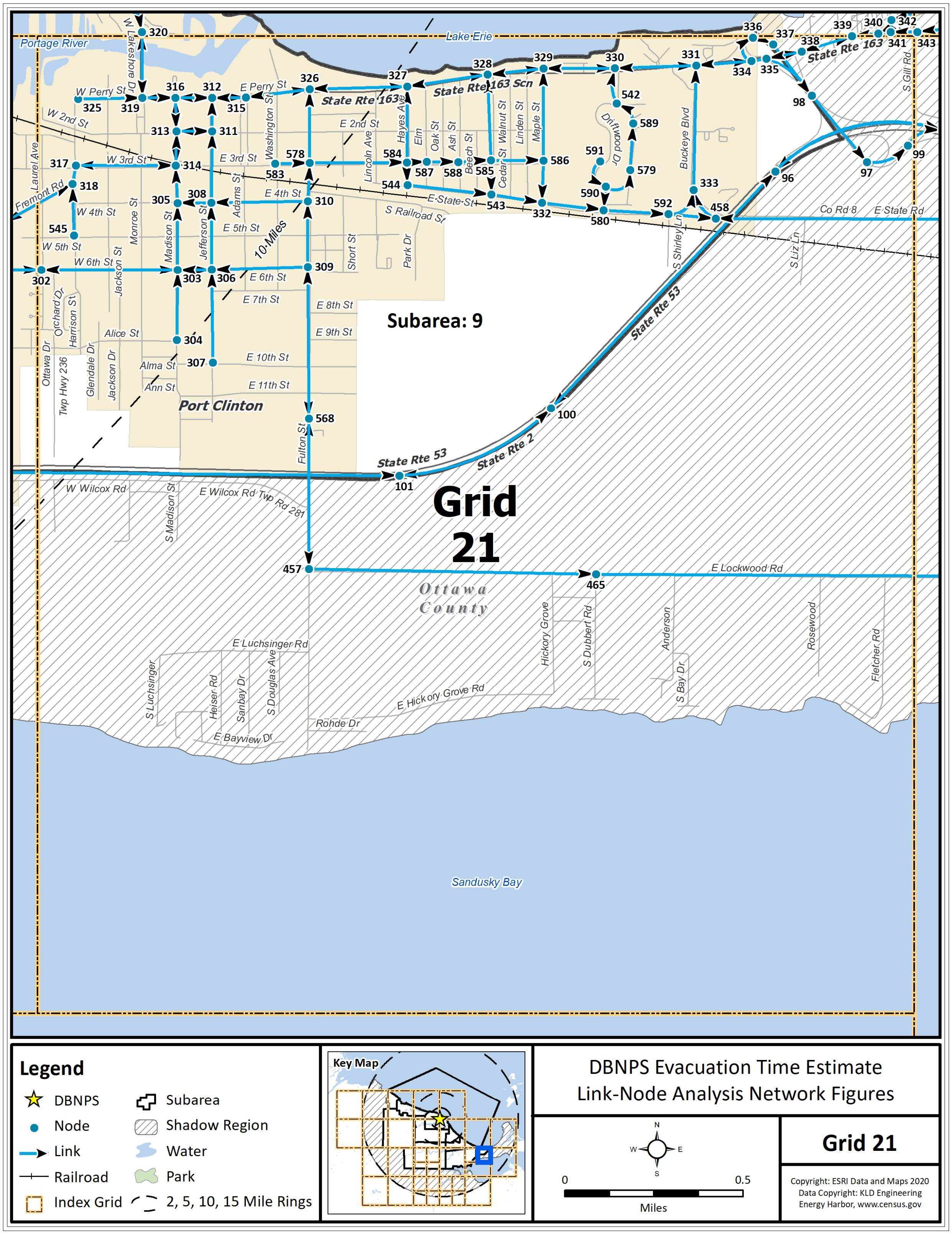


Figure K-22. Link-Node Analysis Network - Grid 21

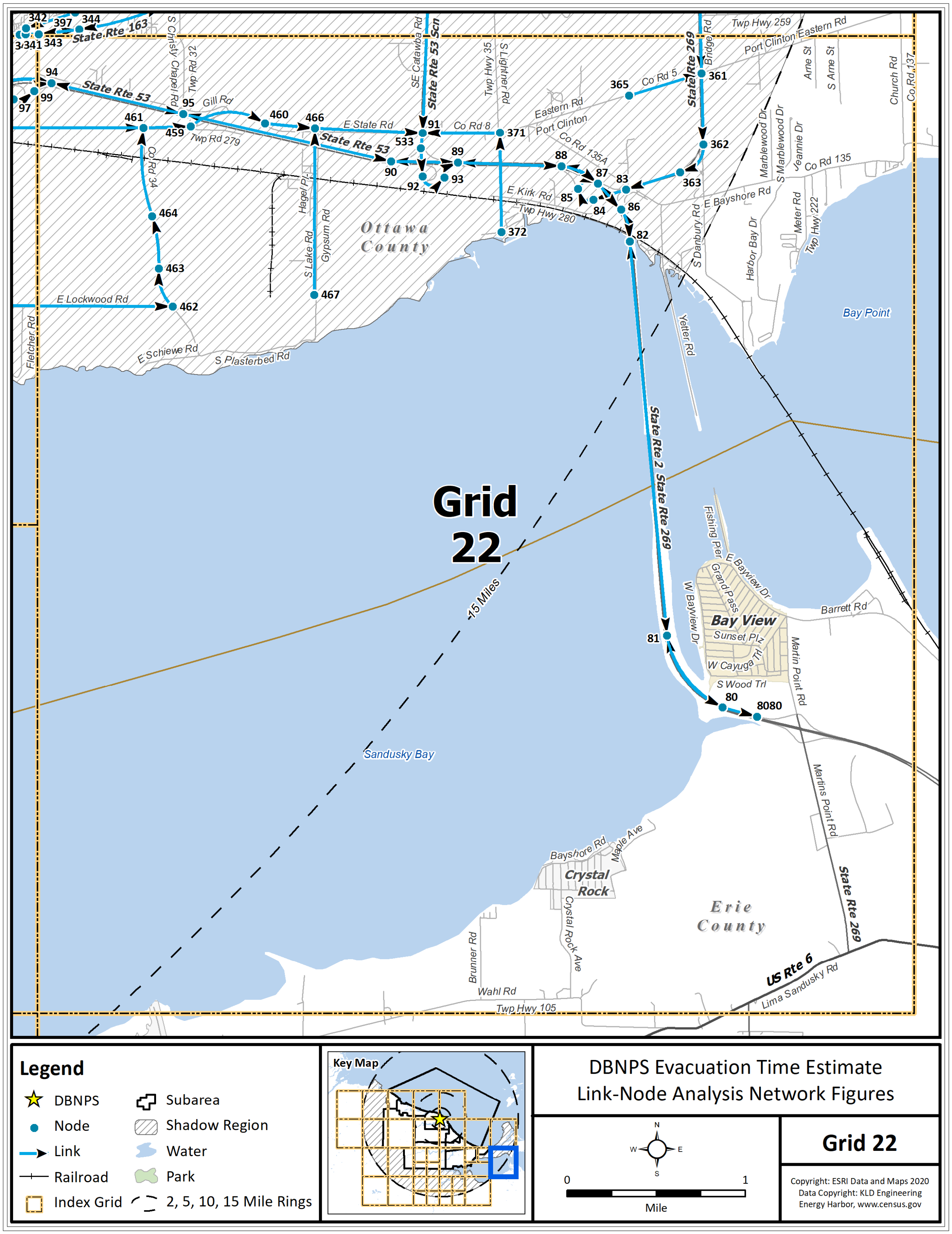


Figure K-23. Link-Node Analysis Network - Grid 22

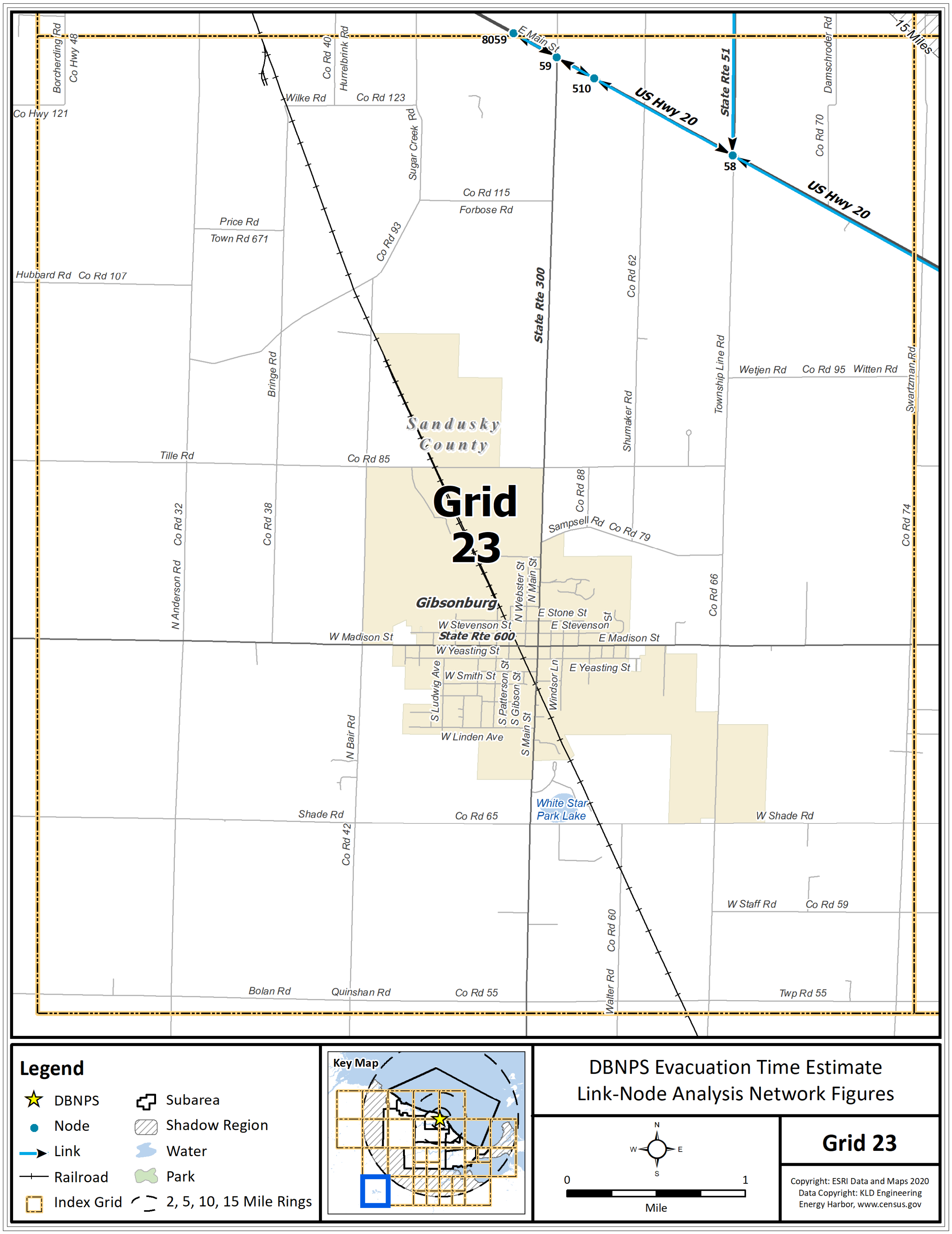


Figure K-24. Link-Node Analysis Network - Grid 23

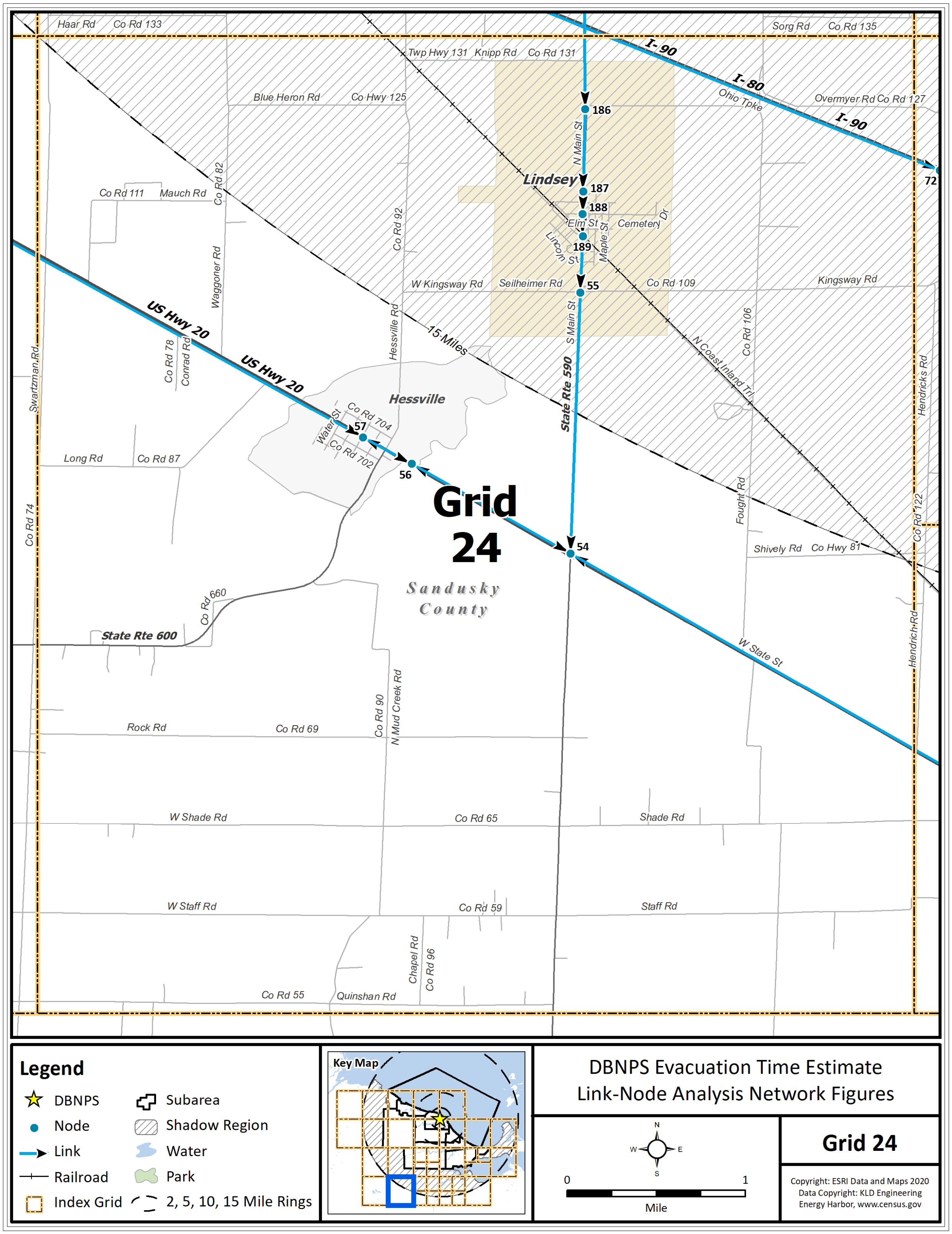


Figure K-25. Link-Node Analysis Network - Grid 24

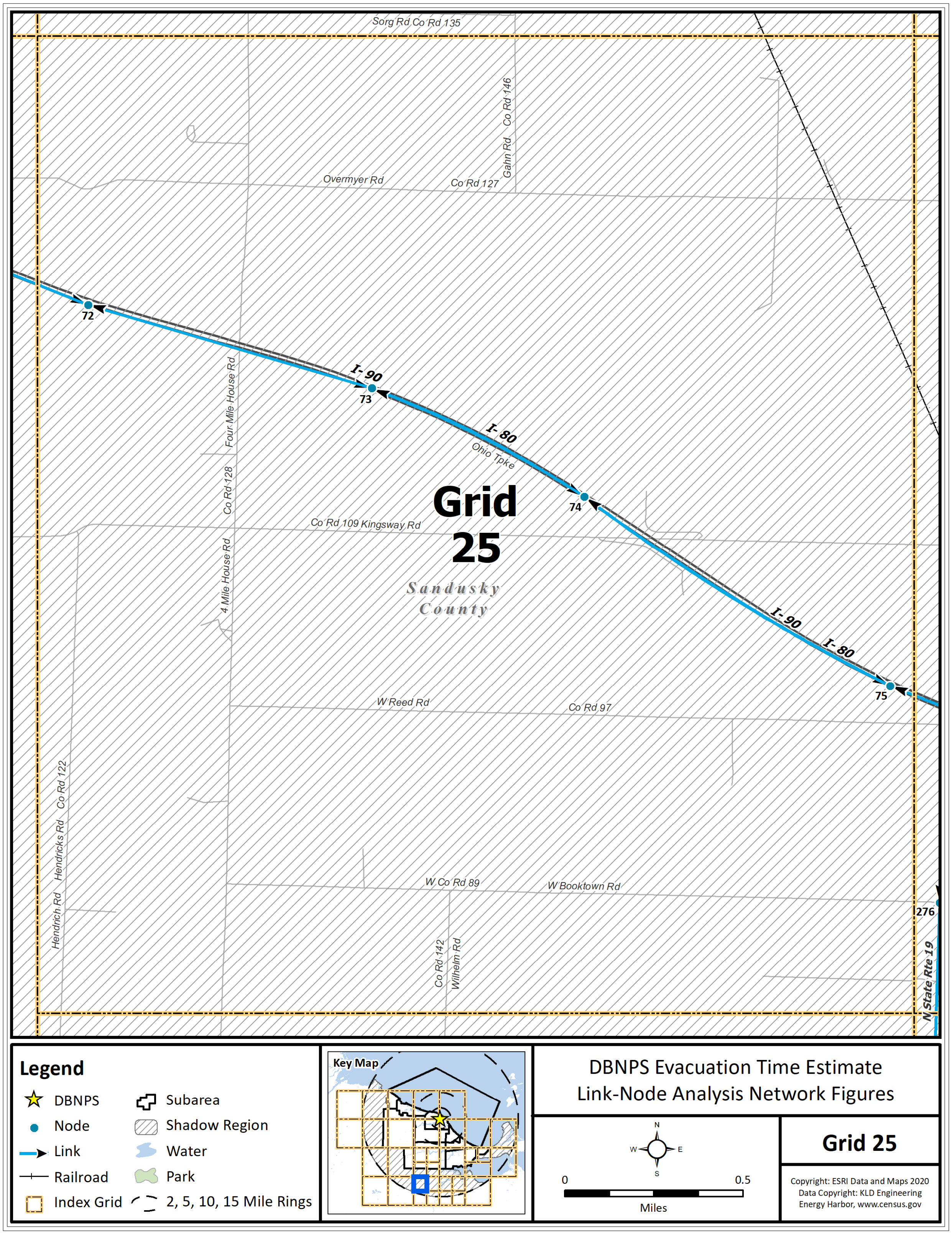


Figure K-26. Link-Node Analysis Network - Grid 25

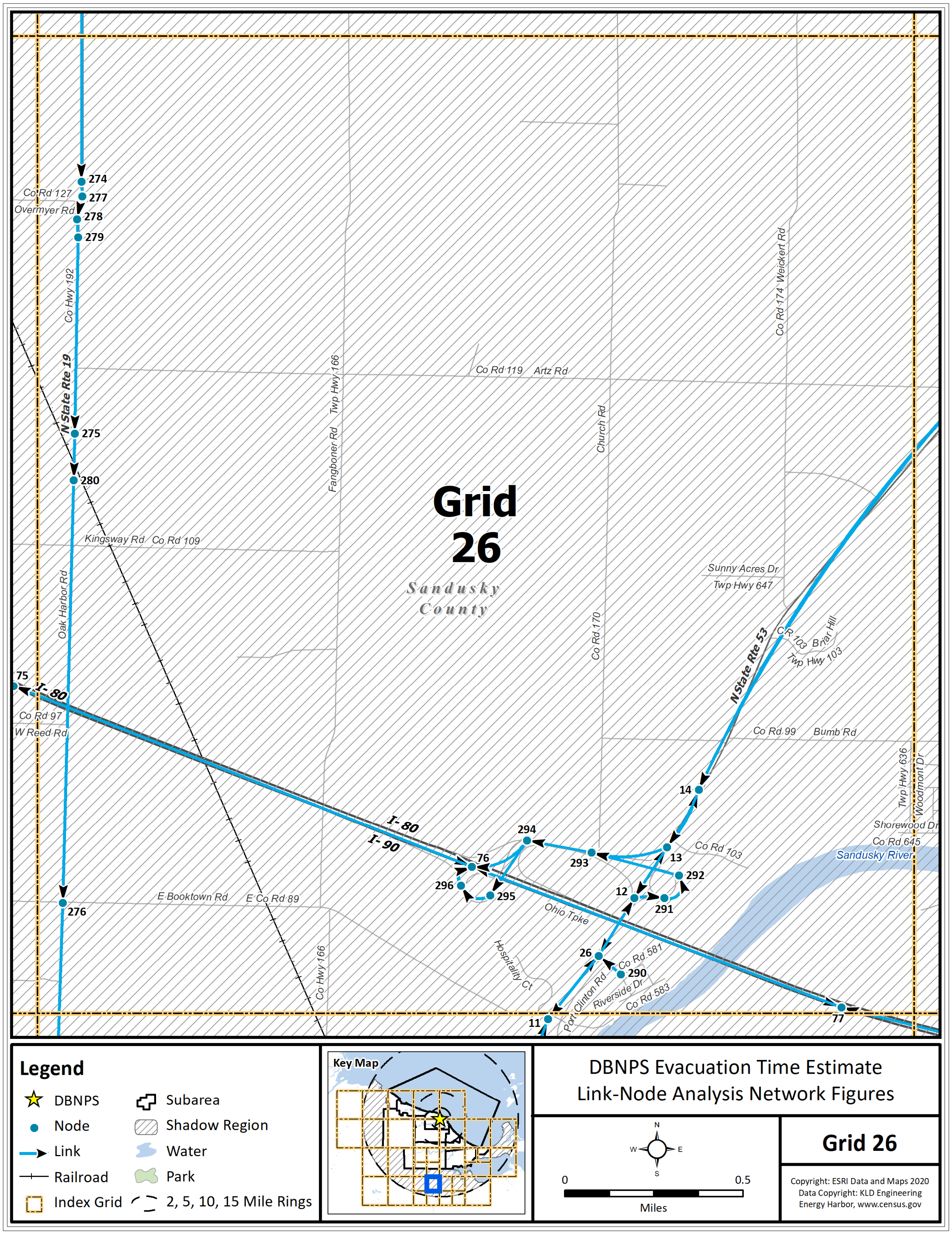


Figure K-27. Link-Node Analysis Network - Grid 26

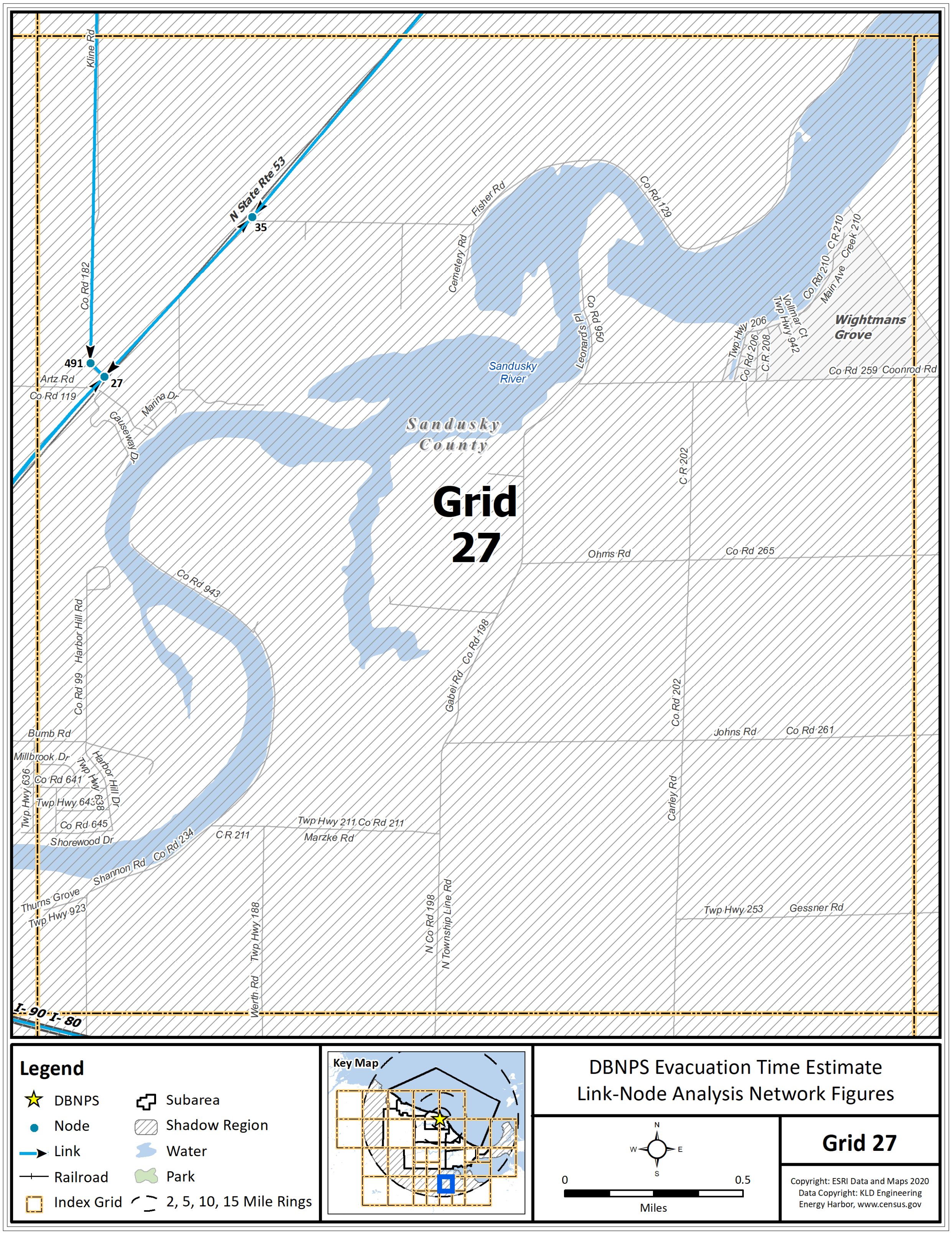


Figure K-28. Link-Node Analysis Network - Grid 27

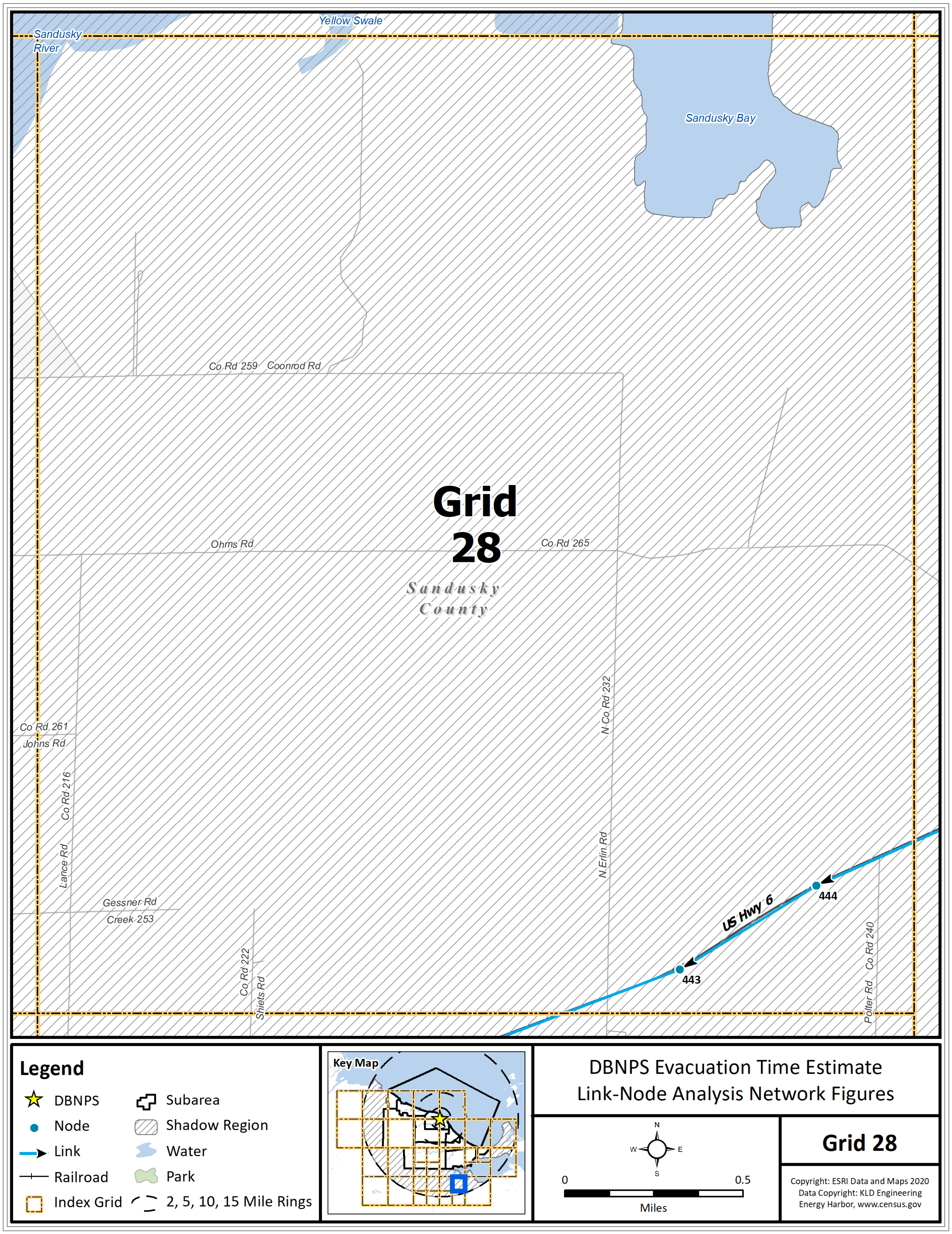


Figure K-29. Link-Node Analysis Network–Grid 28

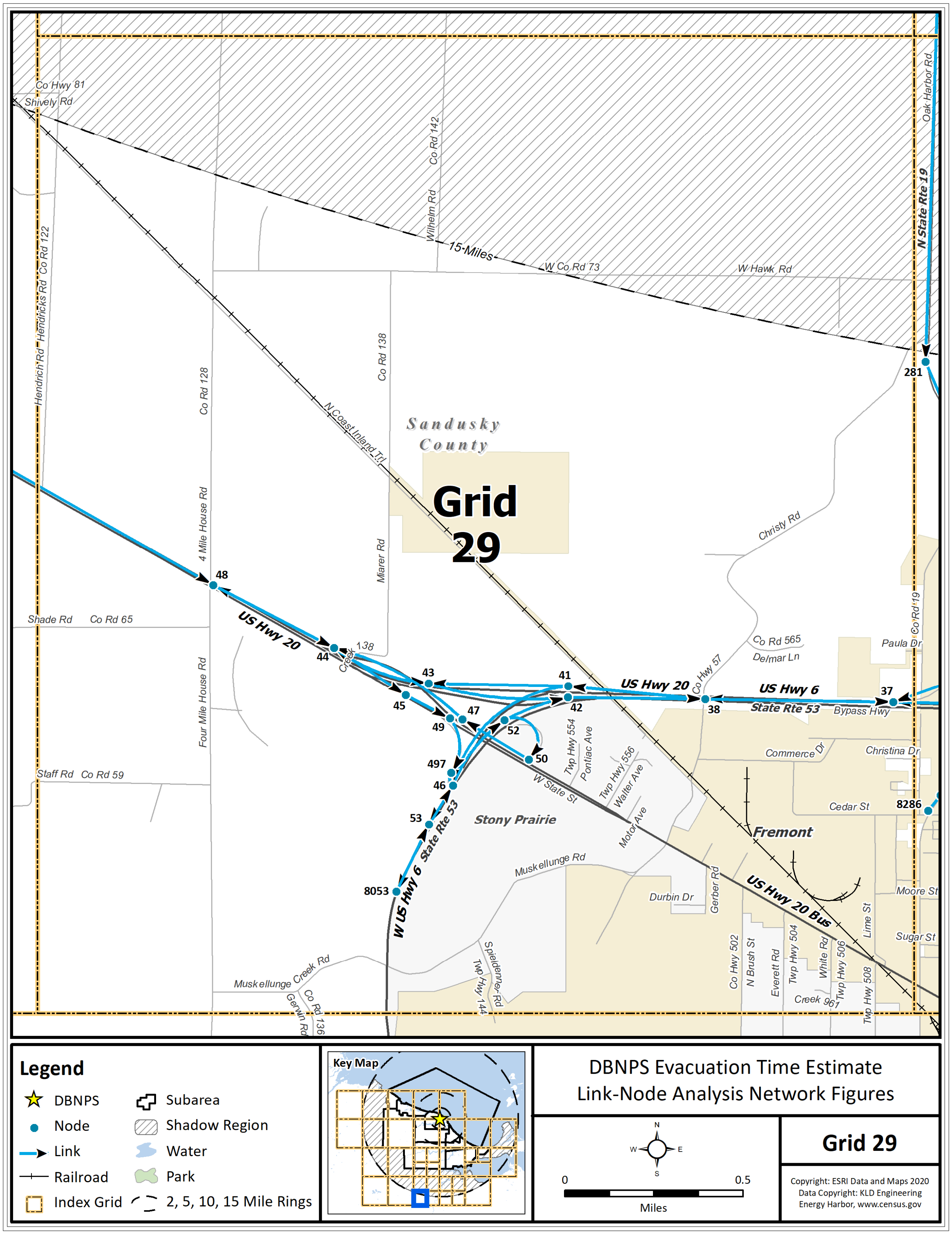


Figure K-30. Link-Node Analysis Network - Grid 29

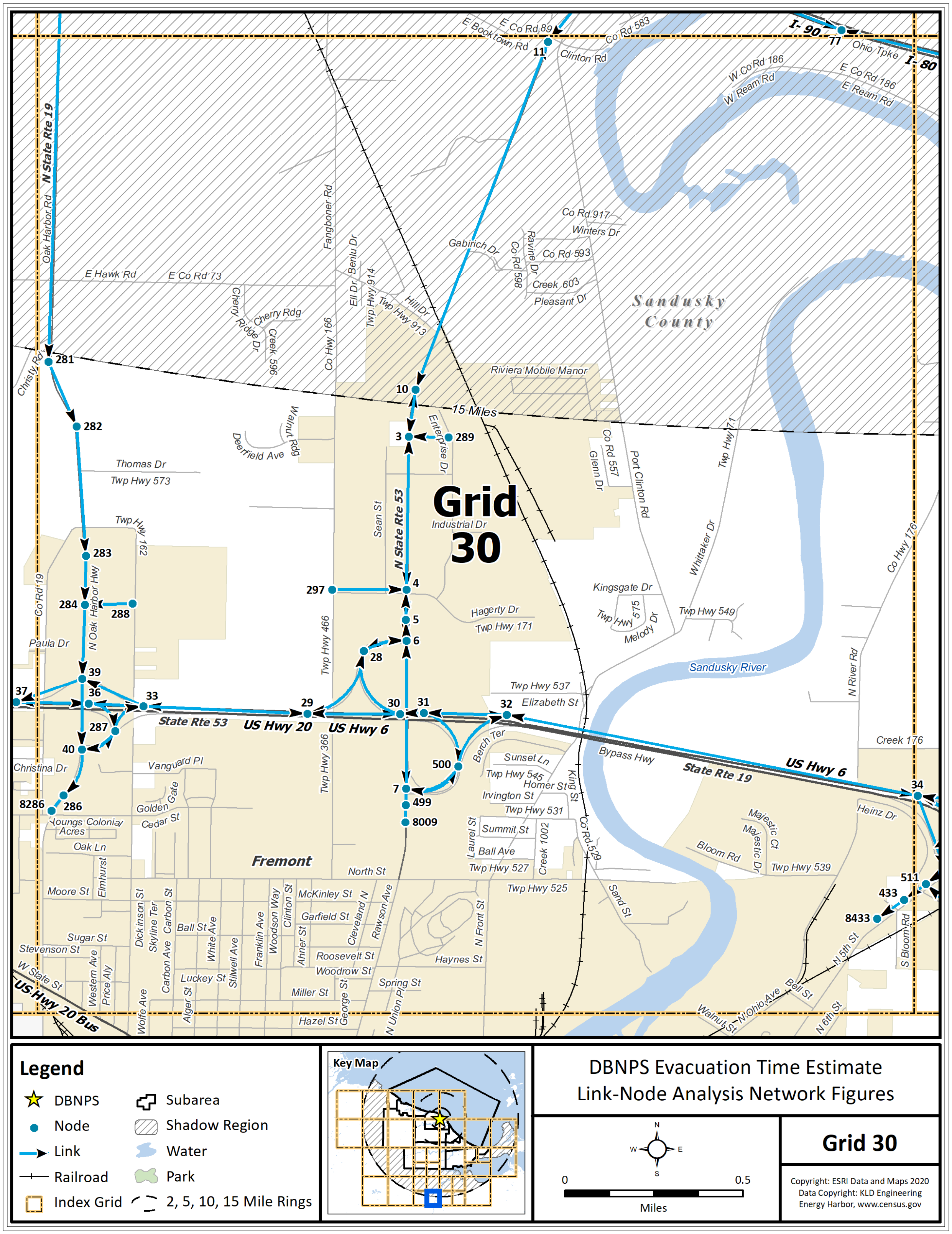


Figure K-31. Link-Node Analysis Network - Grid 30

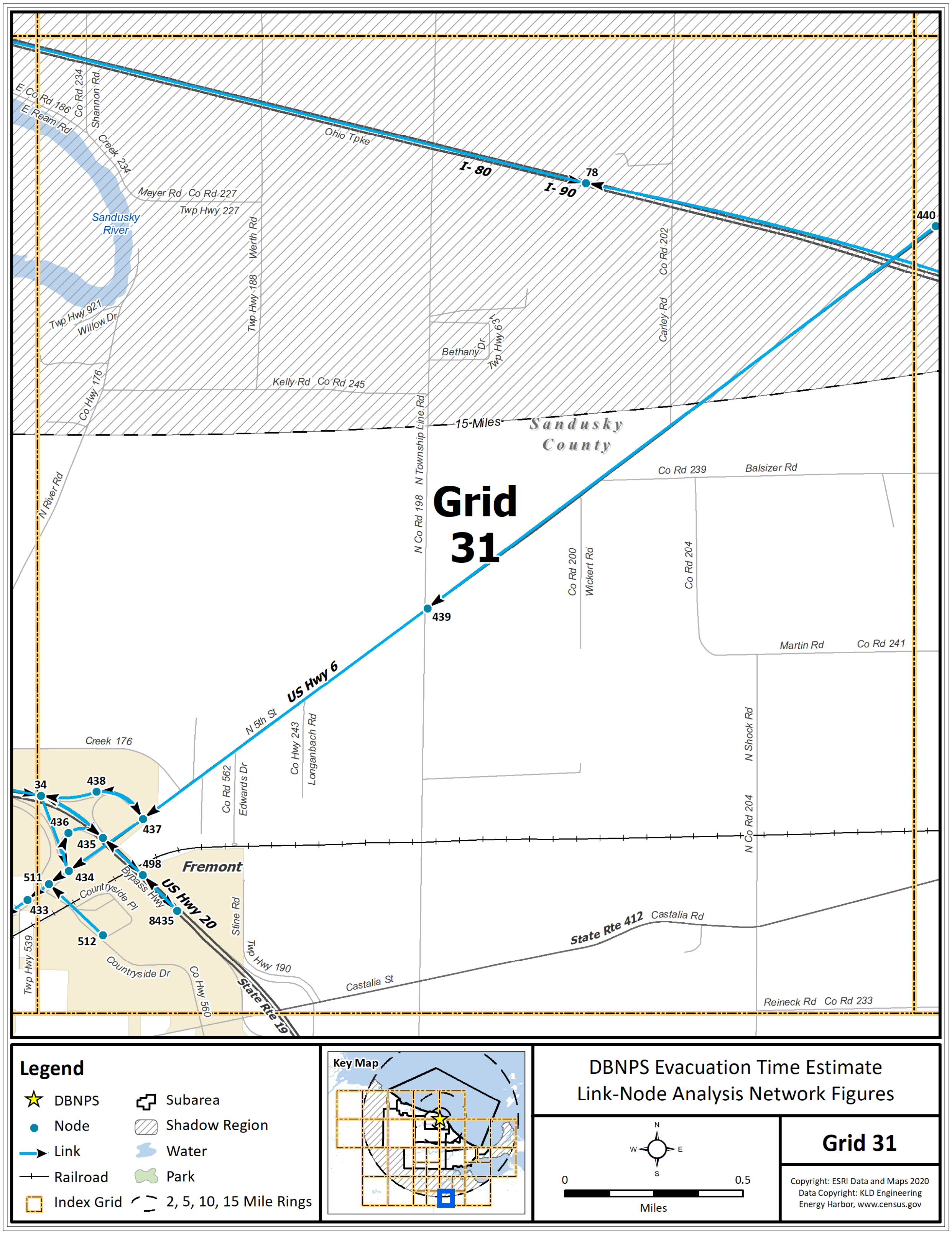


Figure K-32. Link-Node Analysis Network - Grid 31

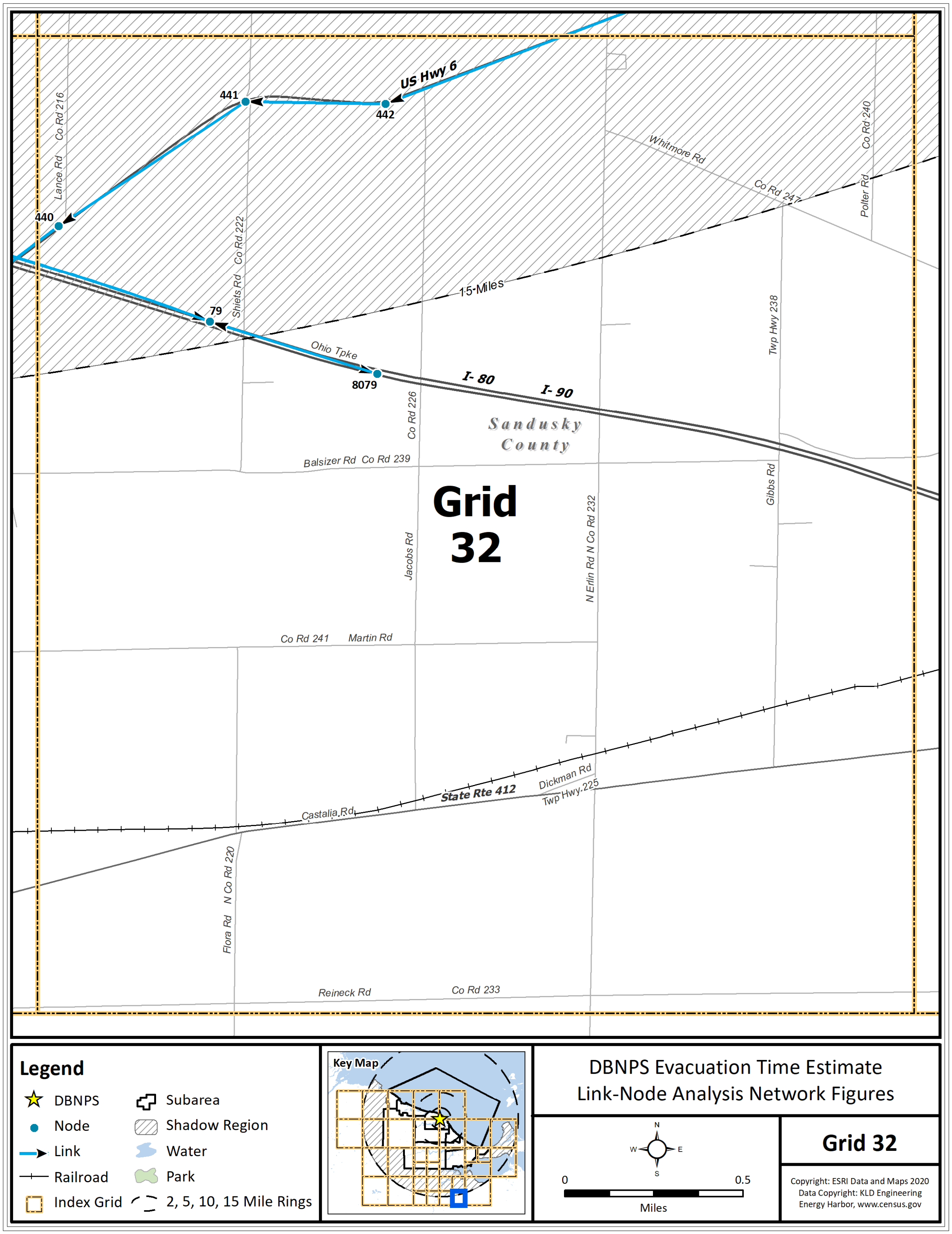


Figure K-33. Link-Node Analysis Network - Grid 32

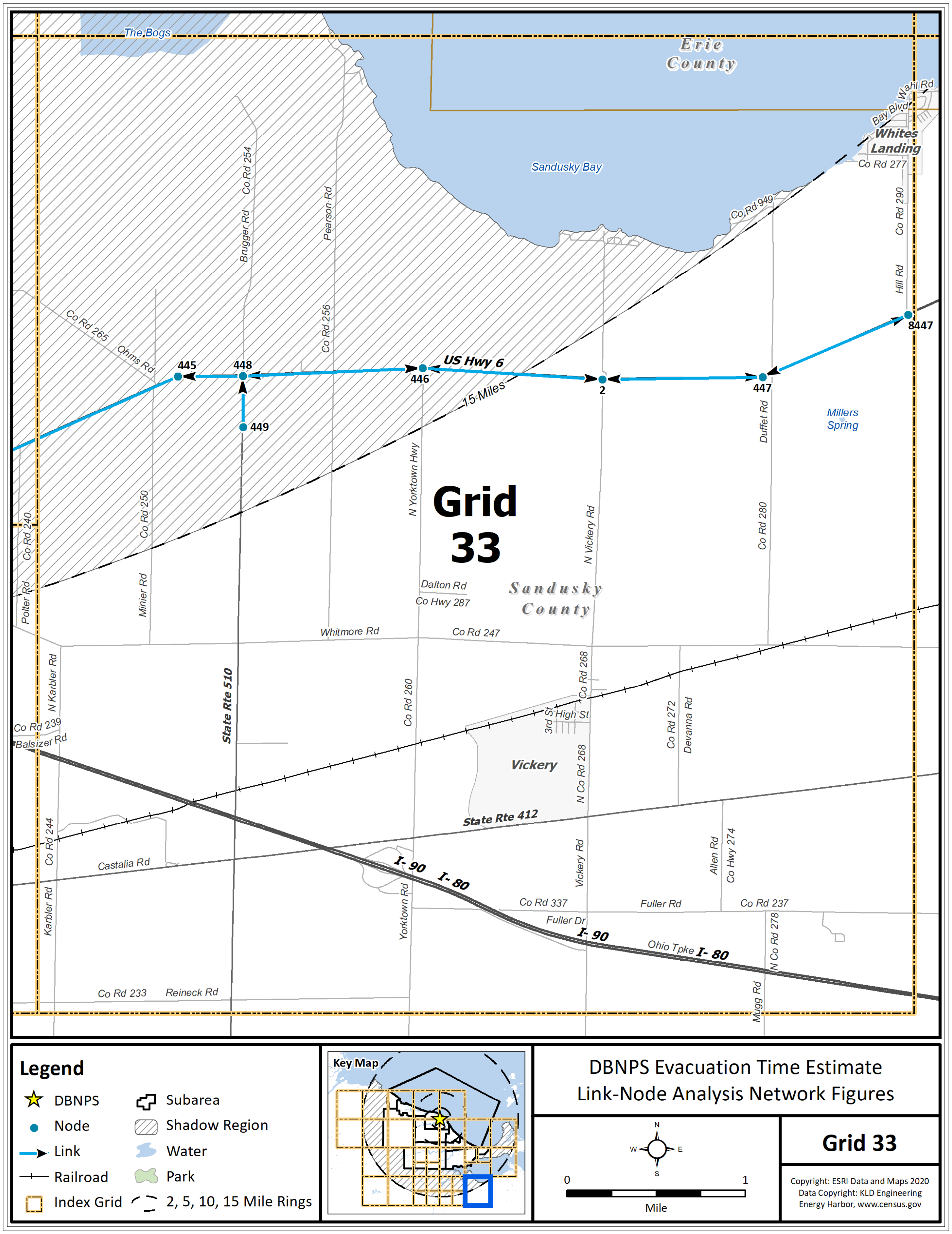


Figure K-34. Link-Node Analysis Network - Grid 33

APPENDIX L

Subarea Boundaries

L. SUBAREA BOUNDARIES

Subarea 1 County: Ottawa

Defined as the area within the following boundary: Carroll Township east of State Route 19 and north of Toussaint East Road.

Subarea 2 County: Ottawa

Defined as the area within the following boundary: Carroll Township west of State Route 19 and south of Toussaint East Road.

Subarea 3 County: Ottawa

Defined as the area within the following boundary: Benton Township

Subarea 4 County: Ottawa

Defined as the area within the following boundary: Harris Township east of State Route 590.

Subarea 5 County: Ottawa

Defined as the area within the following boundary: Salem Township

Subarea 6 County: Ottawa

Defined as the area within the following boundary: Erie Township north of Fritchie Road and west of Tettau Road including the Erie Industrial Park and Camp Perry.

Subarea 7 County: Ottawa

Defined as the area within the following boundary: Erie Township south of Fritchie Road and east of Tettau Road.

Subarea 8 County: Ottawa

Defined as the area within the following boundary: Bay Township

Subarea 9 County: Ottawa

Defined as the area within the following boundary: City of Port Clinton and areas of Portage Township that are north of the State Route 2 bypass and west of the State Route 163 and State Route 2 exchange.

Subarea 10 Counties: Lucas & Ottawa

Defined as the area within the following boundary: Magee Marsh Wildlife Area, and the Ottawa National Wildlife Refuge.

Subarea 11 County: Lucas

Defined as the area within the following boundary: Jerusalem Township east of a line formed by Elliston Trowbridge Road to State Route 2, then west along State Route 2 to the Reno Side Cut Ditch, also known as Cooley Canal, then north following the Reno Side Cut Ditch to Lake Erie.

Subarea 12 Counties: Lucas & Ottawa

Defined as the area within the following boundary: Areas of Lake Erie bounded by Reno Side Cut Ditch, also known as Cooley Canal, to the southern tip of West Sister Island to the southern tip of Green Island to the Portage River.

APPENDIX M

Evacuation Sensitivity Studies

M. EVACUATION SENSITIVITY STUDIES

This appendix presents the results of a series of sensitivity analyses. These analyses are designed to identify the sensitivity of the Evacuation Time Estimates (ETE) to changes in some base evacuation conditions.

M.1 Effect of Changes in Trip Generation Times

A sensitivity study was performed to determine whether changes in the estimated trip generation time have an effect on the ETE for the entire Emergency Planning Zone (EPZ). Specifically, if the tail of the mobilization distribution were truncated (i.e., if those who responded most slowly to the Advisory to Evacuate (ATE), could be persuaded to respond much more rapidly) or if the tail were elongated (i.e., spreading out the departure of evacuees to limit the demand during peak times), how would the ETE be affected? The case considered was Scenario 1, Region 3; a summer, midweek, midday, with good weather evacuation of the entire EPZ. Table M-1 presents the results of this study.

If evacuees mobilize one hour quicker, the ETE is reduced by 30 minutes and 60 minutes for the 90^{th} and 100^{th} percentile ETE, respectively. If evacuees take an additional hour to mobilize, there is no impact to the 90^{th} percentile ETE but the 100^{th} percentile ETE increases by 1 hour (a significant change).

As discussed in Section 7.3, traffic congestion persists within the EPZ for approximately 2 hours and 30 minutes after the ATE. After this time, trip generation (plus a 10-minute travel time to the EPZ boundary) dictates the 100^{th} percentile ETE.

M.2 Effect of Changes in the Number of People in the Shadow Region Who Relocate

A sensitivity study was conducted to determine the effect on ETE due to changes in the percentage of people who decide to relocate from the Shadow Region. The case considered was Scenario 1, Region 3; a summer, midweek, midday, with good weather evacuation for the entire EPZ. The movement of people in the Shadow Region has the potential to impede vehicles evacuating from an Evacuation Region within the EPZ. Refer to Sections 3.2 and 7.1 for additional information on population within the Shadow Region.

Table M-2 presents the ETE for each of the cases considered. The results show that eliminating (0%) or increasing the shadow evacuation has no impact to the 90^{th} percentile, except for quadrupling (80%) the shadow evacuation or having a full shadow (100%) evacuation which increases the 90^{th} percentile ETE by at most 10 minutes. There is no impact to the 100^{th} percentile ETE is since it is dictated by the trip generation time (plus 10-minute travel time to the EPZ boundary).

The Shadow Region includes the population centers of Gypsum to the east, and Elmore and Curtice to the west which are not considered highly populated and the remaining portions of the Shadow Region is sparsely populated areas. The evacuation of these population centers within the Shadow Region does not cause any significant congestion to propagate into the EPZ to delay the

departure of EPZ evacuees.

M.3 Effect of Changes in the Permanent 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 96%. 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 (as presented in Appendix K) remained fixed; 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 longest 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 the longest 90th percentile ETE change greater than or equal to 30 minutes are highlighted in red in Table M-3 – a 95% or greater increase in the 2-Mile Region population. Energy Harbor will have to estimate the EPZ population on an annual basis. If the 2-Mile Region population increases by 95% 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 (3.10 people per household) and the results from the 2020 census (2.28 people per household). The difference between the Census data and survey data is 30%, which exceeds the sampling error of 5.83%. Upon discussions with Energy Harbor, it was decided that an average of the estimated household size from the 2020 Census data and the results of the 2020 demographic survey 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 1, Region 3; a summer, midweek, midday, with good weather evacuation of the 2-Mile Region, 5-Mile Region, and entire EPZ. Table M-4 presents the results of this study.

Increasing the average household size (decreasing the total number evacuating vehicles) to 3.10 people per household has little impact on ETE (decreasing the 90th percentile ETE by 5 minutes at most). The difference in vehicles is only 8% of the total evacuating traffic (1,922 vehicles of 24,441[1] vehicles for this scenario – see Table 6-4). As such, this incremental decrease in vehicles has little to no impact on the ETE. The 100th percentile ETE remains dictated by trip generation time and as a result is not impacted by the change in people per household.

Decreasing the average household size (increasing the total number evacuating vehicles) to 2.28 people per household also has little impact on ETE (increasing the 90th percentile ETE by 5 minutes at most). The difference in vehicles is 10% of the total evacuating traffic (2,616 vehicles of 24,441[1] vehicles for this scenario – see Table 6-4). As such, this incremental increase in vehicles has little to no impact on the ETE. The 100th percentile ETE remains dictated by trip generation time and as a result is not impacted by the change in people per household.

M.5 Bird Watching Event at Magee Marsh

After discussions with Energy Harbor, it was indicated that one week in May there is a bird watching event that takes place in Magee Marsh. On a day-to-day basis this facility attracts 85 transients in 50 vehicles. During the bird watching event, this facility attracts 2,500 people in 1,500 vehicles. A sensitivity study was considered to quantify the effects of the additional traffic that this event brings to the EPZ in the event there is an emergency at DBNPS at the same time.

The case considered was Scenario 1, Region 3; a summer, midweek, midday, with good weather evacuation of the 2-Mile Region, 5-Mile Region, and entire EPZ. Ottawa County emergency personnel mentioned that the intersection of Park Road 1 and SR-2 can be manned to control the traffic. If there are not enough resources to allocate an officer for this intersection, two cases were considered – a case with no TCP at this intersection and when the intersection is operated by a trained officer.

[1] This number is the sum of all vehicles groups in Table 6-4 excluding external traffic vehicles (73,365 – 48,924 = 24,441).

Table M-5 represents the 90th and the 100th percentile ETE results for this sensitivity study. When there is an event at Magee Marsh and no TCP has been established, the 2-Mile Region ETE and 5-Mile Region ETE increases by at most 40 minutes at the 90th percentile, a significant change. Alternatively, when there is an event at Magee Marsh but there is an officer dictating the traffic, the 2-Mile Region ETE increases by 10 minutes and the 5-Mile and Full EPZ ETE is unaffected at the 90th percentile. The 100th percentile ETE for both cases remain dictated by trip generation time and as a result is not impacted by this event.

M.6 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 30 minutes and the 100th percentile ETE by 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 has little to no impact on ETE (Section M.2). Nonetheless, 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) and decreasing the average household size (increasing the total number of evacuating vehicles), has little impact on ETE (impacting the 90th percentile ETE by at most 5 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. Alternatively, families using multiple vehicles could increase the 90th percentile ETE.

Table M-1. ETE for Trip Generation Sensitivity Study

Trip Generation Period	Evacuation Time Estimate for Entire EPZ	
	90th Percentile	100th Percentile
3 hours and 45 minutes	2:25	3:55
4 hours and 45 minutes (Base)	2:55	4:55
5 hours and 45 minutes	2:55	5:55

Table M-2. ETE for Shadow Sensitivity Study

Percent Shadow Evacuation	Evacuating Shadow Vehicles[2]	Evacuation Time Estimate for Entire EPZ	
		90th Percentile	100th Percentile
0	0	2:55	4:55
20 (Base)	2,414	2:55	4:55
40	4,828	2:55	4:55
60	7,242	2:55	4:55
80	9,656	3:00	4:55
100	12,070	3:05	4:55

Table M-3. ETE Variation with Population Change

EPZ and 20% Shadow Permanent Resident Population	Base	Population Change		
		94%	95%	96%
	23,251	45,107	45,339	45,572
ETE (hrs:mins) for the 90th Percentile				
		Population Change		
Region	**Base**	**94%**	**95%**	**96%**
2-MILE	3:05	3:30	**3:35**	**3:35**
5-MILE	3:40	3:55	3:55	3:55
Full EPZ	4:05	4:20	4:20	4:25
ETE for the 100th Percentile				
		Population Change		
Region	**Base**	**94%**	**95%**	**96%**
2-MILE	6:15	6:15	6:15	6:15
5-MILE	6:20	6:20	6:20	6:20
Full EPZ	6:25	6:25	6:25	6:25

[2] The Evacuating Shadow Vehicles, in Table M-2, represent the residents and employees who will spontaneously decide to relocate during the evacuation. The basis, for the base values shown, is a 20% relocation of shadow residents along with a proportional percentage of shadow employees. See Section 6 for further discussion.

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

EPZ and 20% Shadow Resident Vehicles	Average HH Size of 2.28 people per household	Base (Average HH Size of 2.69 people per household)	Average HH Size of 3.10 people per household
	17,264	14,648	12,726
ETE for 90th Percentile			
2-MILE	2:05	2:00	2:00
5-MILE	2:20	2:15	2:10
FULL EPZ	3:00	2:55	2:55
ETE for 100th Percentile			
2-MILE	4:45	4:45	4:45
5-MILE	4:50	4:50	4:50
FULL EPZ	4:55	4:55	4:55

Table M-5. ETE Results for an Event at Magee Marsh

Region	Base (No Event at Magee Marsh)	Magee Marsh Bird Watch with No TCP	Magee Marsh Bird Watch with TCP
ETE for 90th Percentile			
2-MILE	2:00	2:40	2:10
5-MILE	2:15	2:45	2:15
FULL EPZ	2:55	3:00	2:55
ETE for 100th Percentile			
2-MILE	4:45	4:45	4:45
5-MILE	4:50	4:50	4:50
FULL EPZ	4:55	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 1.2
b. A map is included that identifies primary features of the site including major roadways, significant topographical features, boundaries of counties, and population centers within the EPZ.	Yes	Figures 1-1, 3-1, 6-1
c. A comparison of the current and previous ETE is provided including information similar to that identified in Table 1-1, "ETE Comparison."	Yes	Section 1.4, 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,
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	Table 2-1, 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, Section 5.4.2
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
c. Population values are adjusted as necessary for growth to reflect population estimates to the year of the ETE.	N/A	N/A - 2020 Census used as the base year of the analysis
d. A sector diagram, similar to Figure 2-1, "Population by Sector," is included showing the population distribution for permanent residents.	Yes	Figure 3-2
2.1.1 Permanent Residents with Vehicles		
a. The persons per vehicle value is between 1 and 3 or justification is provided for other values.	Yes	Section 3.1, Appendix F
2.1.2 Transient Population		
a. A list of facilities that attract transient populations is included, and peak and average attendance for these facilities is listed. The source of information used to develop attendance values is provided.	Yes	Section 3.3, Table E-5 through Table E-8
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 and employees 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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
e. The number of people per vehicle is provided. Numbers may vary by scenario, and if so, reasons for the variation are discussed.	Yes	Section 3.3 and Section 3.4
f. A sector diagram is included, similar to Figure 2-1, "Population by Sector", is included showing the population distribution for the transient population.	Yes	Figure 3-6 (transients) and Figure 3-8 (employees)
2.2 Transit Dependent Permanent Residents		
a. The methodology (e.g., surveys, registration programs) used to determine the number of transit dependent residents is discussed.	Yes	Section 3.7
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 3.8
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 3.7, Table 3-8, Table 3-11

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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
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. Table E-9 lists all correctional facilities by facility name, location, and capacity.
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" Section 8.1 – under "Evacuation of Correctional Facilities "
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 3-7, Table E-1 (Schools) and Table E-2 (Day Care Centers/Nursery Schools), Section 3.6
b. Transportation resources for elementary and middle schools are based on 100 percent of the school capacity.	Yes	Section 3.6

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 3.6
d. The need for return trips is identified.	Yes	Section 8.1, No return trips are needed as there are enough resources to evacuate all facilities in a single wave.
2.5 Other Demand Estimate Considerations		
2.5.1 Special Events		
a. A complete list of special events is provided including information on the population, estimated duration, and season of the event.	Yes	Section 3.9
b. The special event that encompasses the peak transient population is analyzed in the ETE.	Yes	Section 3.9
c. The percentage of permanent residents attending the event is estimated.	Yes	Section 3.9
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)

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
2.5.3 Background and Pass Through Traffic		
a. The volume of background traffic and pass-through traffic is based on the average daytime traffic. Values may be reduced for nighttime scenarios.	Yes	Section 3.10 and Section 3.11
b. The method of reducing background and pass-through traffic is described.	Yes	Section 2.2 – Assumptions 10 and 11 Section 2.5 Section 3.10 and Section 3.11 Table 6-3 – 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, Section 3.10 No Access Control Points exists along the external traffic routes (I-80, US 20 and US 6), which is located in Shadow Region. External traffic will continue to pass through the Shadow Region for the entire evacuation.
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

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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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.
d. The effect of adverse weather on mobilization is considered and assumptions for snow removal on streets and driveways are identified, when applicable.	Yes	Assumption 6 of Section 2.6, 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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
b. The number of origin nodes and method for distributing vehicles among the origin nodes are described.	Yes	Appendix J, Appendix C
c. A glossary of terms is provided for the key performance measures and parameters used in the analysis.	Yes	Appendix A, Table C-1, Table C-3
4.3 Trip Generation Time		
a. The process used to develop trip generation times is identified.	Yes	Section 5
b. When surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance are provided.	Yes	Appendix F
c. Data used to develop trip generation times are summarized.	Yes	Appendix F, Section 5
d. The trip generation time for each population group is developed from site-specific information.	Yes	Section 5
e. The methods used to reduce uncertainty when developing trip generation times are discussed, if applicable.	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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 3.9 Public Transportation is not provided for the special event and was therefore not considered.
4.3.2 Transit Dependent Permanent Residents		
a. If available, existing and approved plans and bus routes are used in the ETE analysis.	N/A	Established bus routes do not exist. Basic bus routes were developed for the ETE analysis. Section 8.1 under "Evacuation of Transit-Dependent Population (Residents without access to a vehicle)"
b. The means of evacuating ambulatory and non-ambulatory residents are discussed.	Yes	Section 8.1 under "Evacuation of Transit-Dependent Population (Residents without access to a vehicle)", 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 (Residents without access to a vehicle)"
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
f. A map of bus routes is included.	Yes	Figure 10-2
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
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

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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
4.4 Stochastic Model Runns		
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 mesoscopic 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
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

NRC Review Criteria	Addressed in ETE Analysis (Yes/No/NA)	Comments
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 7-6
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 10-3