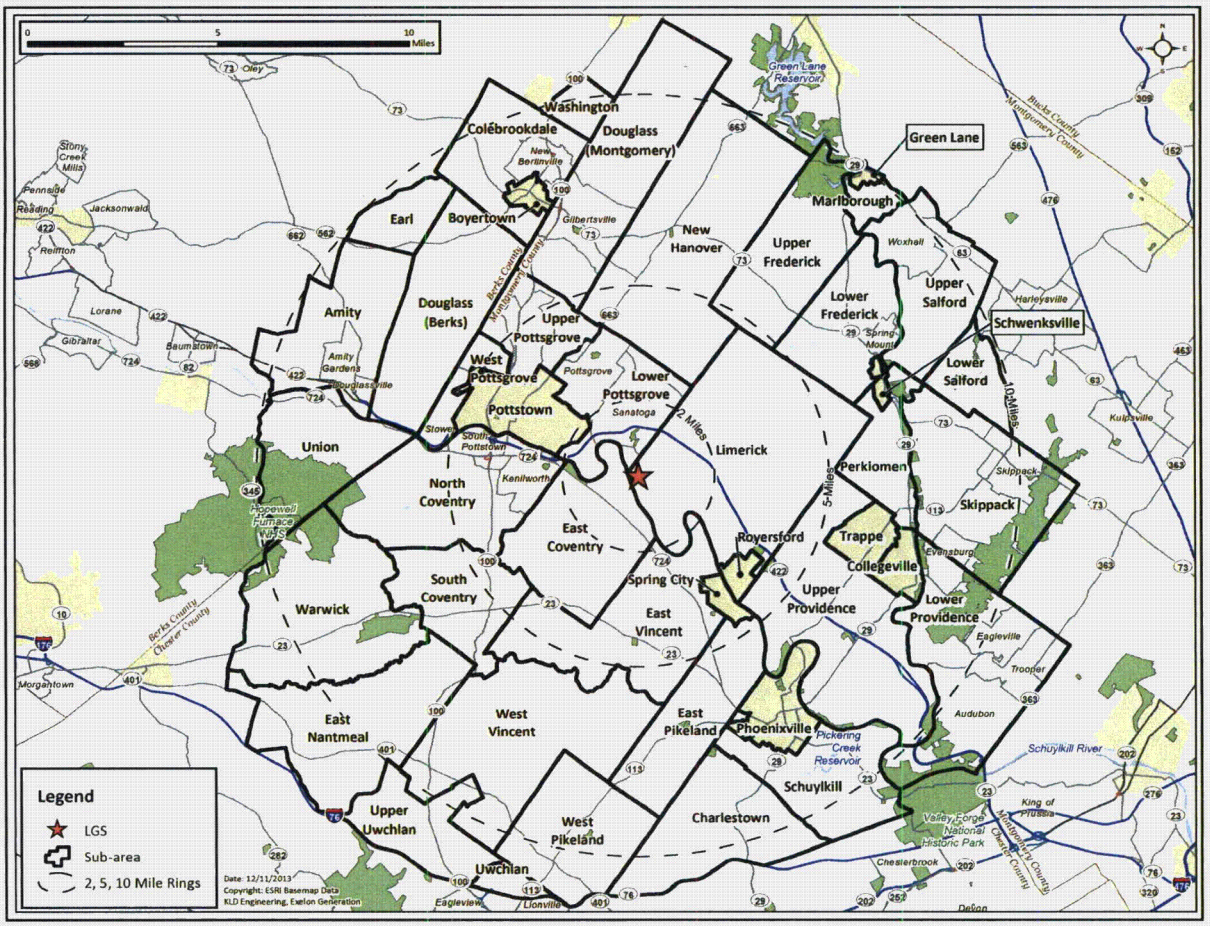
KLD ENGINEERING, P.C.

LIMERICK GENERATING STATION

Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Limerick Generating Station (LGS) located in Montgomery County, Pennsylvania. ETE are part of the required planning basis and provide Exelon and state and local governments with site-specific information needed for Protective Action decision-making.

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

- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, November 2011.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654/FEMA-REP-1, Rev. 1, November 1980.
- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR 1745, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.
- 10CFR50, Appendix E – "Emergency Planning and Preparedness for Production and Utilization Facilities"

Overview of Project Activities

This project began in November, 2013 and extended over a period of 3 months. The major activities performed are briefly described in chronological sequence:

- Accessed U.S. Census Bureau data files for the year 2010. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of the LGS, then conducted a detailed field survey of the highway network.
- Synthesized this information to create an analysis network representing the highway system topology and capacities within the Emergency Planning Zone (EPZ), plus a Shadow Region covering the region between the EPZ boundary and approximately 15 miles radially from the plant.
- Analyzed the results of a telephone survey of residents within the EPZ to gather focused data needed for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by the licensee and offsite response organization (ORO) personnel prior to the survey.
- Data pertaining to employment, transients, and special facilities in each county were provided by Exelon.

- 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 telephone survey of EPZ residents.
- Following federal guidelines, the EPZ is subdivided into 43 Sub-areas. These Sub-areas are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define a total of 46 Evacuation Regions.
- The time-varying external circumstances are represented as Evacuation Scenarios, each described in terms of the following factors: (1) Season (Summer, Winter); (2) Day of Week (Midweek, Weekend); (3) Time of Day (Midday, Evening); and (4) Weather (Good, Rain, Snow). One special event scenario – the Firebird Festival in Phoenixville - was considered. One roadway impact scenario was considered wherein a single lane was closed on US 422 eastbound for the duration of the evacuation.
- Staged evacuation was considered for those regions wherein the 2 mile radius and sectors downwind to 5 miles were evacuated.
- As per NUREG/CR-7002, the Planning Basis for the calculation of ETE is:
    - A rapidly escalating accident at the LGS that quickly assumes the status of General Emergency such that the Advisory to Evacuate is virtually coincident with the siren alert, and no early protective actions have been implemented.
    - While an unlikely accident scenario, this planning basis will yield ETE, measured as the elapsed time from the Advisory to Evacuate until the stated percentage of the population exits the impacted Region, that represent "upper bound" estimates. This conservative Planning Basis is applicable for all initiating events.
- If the emergency occurs while schools are in session, the ETE study assumes that the children will be evacuated by bus directly to reception centers or host schools located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at school prior to the arrival of the buses dispatched for that purpose. The ETE for schoolchildren are calculated separately.
- Evacuees who do not have access to a private vehicle will either ride-share with relatives, friends or neighbors, or be evacuated by buses provided as specified in the county evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: bus, van, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees, for homebound special needs population, and for those evacuated from special facilities.

Computation of ETE

A total of 644 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 46 Evacuation Regions to evacuate from that Region, under the circumstances defined for one of the 14 Evacuation Scenarios (46 x 14 = 644). Separate ETE are calculated for transit-dependent

evacuees, including schoolchildren for applicable scenarios.

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

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

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

The computational procedure is outlined as follows:

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

The ETE statistics provide the elapsed times for 90 percent and 100 percent, 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 90^{th} percentile ETE have been identified as the values that should be considered when making protective action decisions because the 100^{th} 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.

Traffic Management

This study references the comprehensive traffic management plan provided by the Pennsylvania Emergency Management Agency (PEMA) and the EPZ Counties. Despite the pronounced traffic congestion within the EPZ, no additional traffic or access control measures have been identified as a result of this study. The existing traffic management plan is comprehensive.

Selected Results

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

- Figure 6-1 displays a map of the LGS EPZ showing the layout of the 43 Sub-areas that comprise, in aggregate, the EPZ.
- Table 3-1 presents the estimates of permanent resident population in each Sub-area based on the 2010 Census data.
- Tables 6-1 through 6-3 define each of the 46 Evacuation Regions in terms of their respective groups of Sub-areas.
- Table 6-2 lists the Evacuation Scenarios.
- Tables 7-1 and 7-2 are compilations of ETE. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the EPZ and from the Shadow Region.
- Tables 7-3 and 7-4 present ETE for the 2-mile region for un-staged and staged evacuations for the 90^{th} and 100^{th} percentiles, respectively.
- Table 8-7 presents ETE for the schoolchildren in good weather.
- Table 8-11 presents ETE for the transit-dependent population in good weather.
- Figure H-8 presents an example of an Evacuation Region (Region R08) to be evacuated under the circumstances defined in Table 6-1. Maps of all regions are provided in Appendix H.

Conclusions

- General population ETE were computed for 644 unique cases – a combination of 46 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document these ETE for the 90^{th} and 100^{th} percentiles. These ETE range from 1:30 (hr:min) to 5:35 at the 90^{th} percentile.
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100^{th} percentile are significantly longer than those for the 90^{th} percentile, ranging from 3:10 to 8:10. This is the result of the 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

evacuation routes service the remaining demand. See Figures 7-10 through 7-23.

- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation protective action strategy could benefit those people evacuating from within the 2-mile region (specifically Lower Pottsgrove) when wind is blowing over Pottstown, or when evacuating the full 5-mile region (R02), in that ETE are up to 40 minutes less. Although staged evacuation is disadvantageous to those beyond 2 miles (increases ETE up to 55 minutes), it does expedite the evacuation of those evacuees from within the 2-mile region under certain circumstances. See Section 7.6 for additional discussion.
- Comparison of Scenarios 12 (winter, midweek/weekend, evening) and 13 (winter, weekend, evening) in Table 7-2 indicates that the special event does not materially affect the ETE. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that events such as adverse weather or traffic accidents which close a lane on US 422, could significantly impact ETE (increases in ETE of up to 45 minutes). State and local police could consider traffic management tactics such as using the shoulder of the roadway as a travel lane or re-routing of traffic along other evacuation routes to avoid overwhelming US 422. All efforts should be made to remove the blockage on US 422, particularly within the first 3 hours of the evacuation. See Section 7.5 for additional discussion.
- The majority of the EPZ is congested throughout a full EPZ evacuation. All congestion within the EPZ clears by 7 hours and 25 minutes after the Advisory to Evacuate. See Section 7.3 and Figures 7-3 through 7-9.
- Separate ETE were computed for schools, medical facilities, transit-dependent persons, homebound special needs persons and correctional facilities. The average single-wave ETE for these facilities are comparable to the general population ETE at the 90th percentile. See Section 8.
- Table 8-5 indicates that there are enough buses and ambulances available to evacuate the transit-dependent population within the EPZ in a single wave; however, there are not enough wheelchair buses/vans to evacuate the wheelchair bound population in a single wave. The second-wave ETE for wheelchair vans do exceed the general population ETE at the 90th percentile. See Section 8.5.
- The general population ETE at the 90th percentile is insensitive to reductions in the base trip generation time of 3 hours and 15 minutes due to the traffic congestion within the EPZ. See Table M-1.
- The general population ETE is effected by the voluntary evacuation of vehicles in the Shadow Region (tripling the shadow evacuation percentage increases 90th percentile ETE by 30 minutes). An evacuation of 100 percent of the Shadow Region increases 90th percentile ETE by 1 hour. See Table M-2.
- A population increase of 13% or more results in 90th percentile ETE changes which meet the federal criteria for updating ETE between decennial Censuses. See Section M.3.
- Allowing evacuees to access the Pennsylvania Turnpike near Exits 312 and 320 does not significantly impact ETE. See Section M.4.

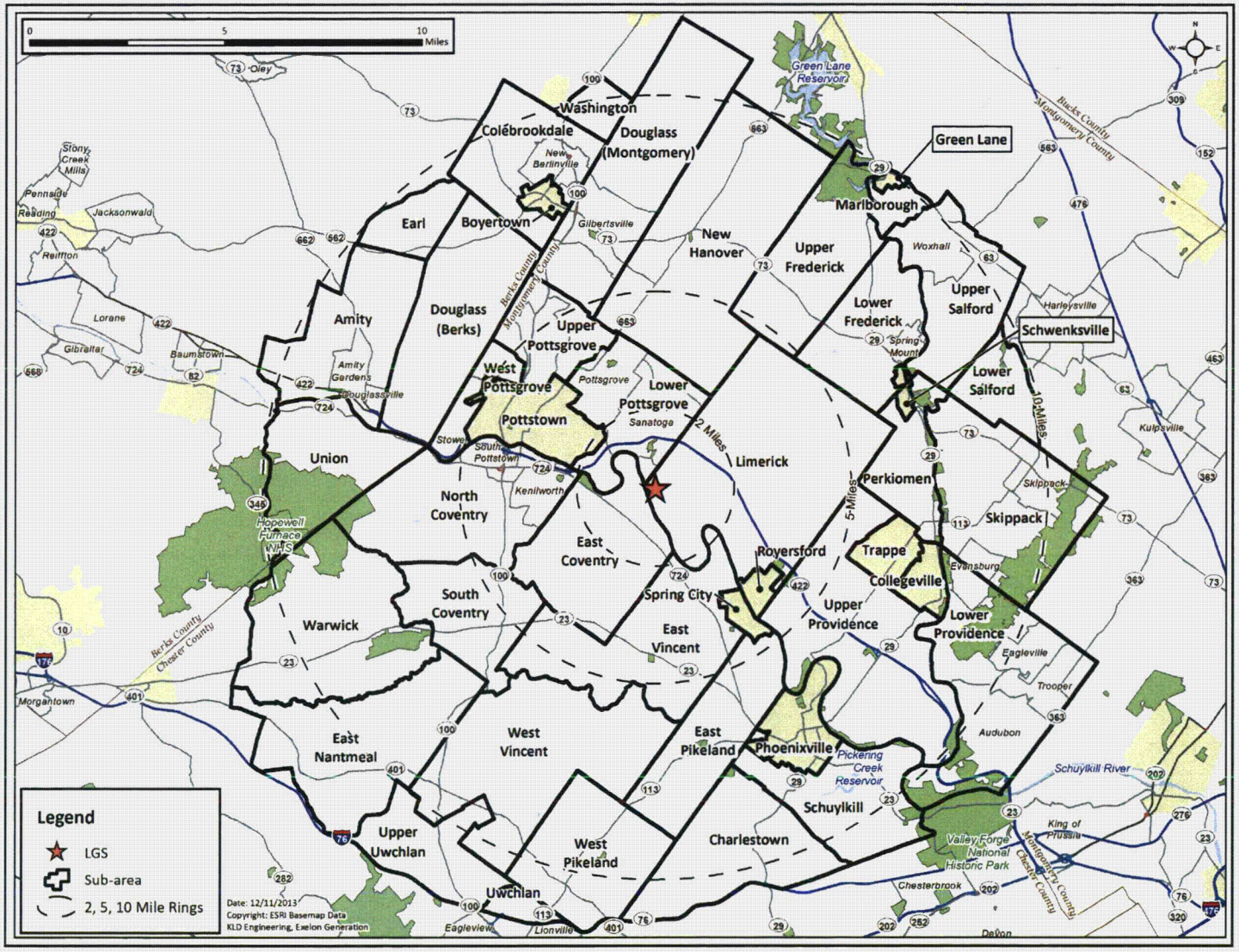

Figure 6-1. LGS EPZ Sub-areas

Table 3-1. EPZ Permanent Resident Population

Sub-area	2000 Population	2010 Population
BERKS COUNTY		
Amity	7,126	10,815
Boyertown	3,941	4,055
Colebrookdale	5,322	5,078
Douglass (Berks)	3,344	3,306
Earl	730	717
Union	1,123	1,215
Washington	610	715
Berks County Total:	**22,196**	**25,901**
CHESTER COUNTY		
Charlestown	3,539	4,141
East Coventry	4,608	6,636
East Nantmeal	1,472	1,500
East Pikeland	6,565	7,079
East Vincent	5,458	6,821
North Coventry	7,381	7,866
Phoenixville	14,757	16,440
Schuylkill	6,991	8,516
South Coventry	1,879	2,604
Spring City	3,298	3,323
Upper Uwchlan	3,674	8,089
Uwchlan	1,399	1,343
Warwick	2,219	2,192
West Pikeland	3,360	3,876
West Vincent	3,190	4,567
Chester County Total:	**69,790**	**84,993**

Table 3-1. EPZ Permanent Resident Population (Continued)

Sub-area	2000 Population	2010 Population
	MONTGOMERY COUNTY	
Collegeville	8,032	5,089
Douglass (Montgomery)	9,098	10,195
Green Lane	584	508
Limerick	13,572	18,074
Lower Frederick	4,793	4,840
Lower Pottsgrove	11,193	12,059
Lower Providence	22,388	25,436
Lower Salford	902	1,503
Marlborough	426	492
New Hanover	7,369	10,939
Perkiomen	7,126	9,139
Pottstown	21,879	22,377
Royersford	4,197	4,752
Schwenksville	1,693	1,385
Skippack	6,516	13,715
Trappe	3,210	3,509
Upper Frederick	3,143	3,523
Upper Pottsgrove	4,085	5,315
Upper Providence	15,376	21,219
Upper Salford	3,024	3,299
West Pottsgrove	3,815	3,874
Montgomery County Total:	**152,421**	**181,242**
TOTAL EPZ POPULATION:	**244,407**	**292,136**
EPZ Population Growth:		**19.53%**

Table 6-1. Description of Evacuation Regions

Region Description:	2-Mile Ring	5-Mile Ring	Full EPZ	Evacuate 2-Mile Radius and Downwind to 5 Miles													
Region Number:	R01	R02	R03	R04	R05	N/A	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16
Wind Direction From:	N/A	N/A	N/A	N	NNE, NE	ENE	E	ESE	SE, SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
SUB-AREA																	
Amity			X			See Region 01											
Boyertown			X														
Charlestown			X														
Colebrookdale			X														
Collegeville			X														
Douglass (Berks)			X														
Douglass (Montgomery)			X														
Earl			X														
East Coventry	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
East Nantmeal			X														
East Pikeland			X														
East Vincent		X	X						X	X	X	X					
Green Lane			X														
Limerick	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Lower Frederick			X														
Lower Pottsgrove	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Lower Providence			X														
Lower Salford			X														
Marlborough			X														
New Hanover		X	X	X	X												X
North Coventry		X	X									X	X	X	X		
Perkiomen			X														
Phoenixville			X														
Pottstown		X	X											X	X	X	X
Royersford		X	X					X	X								
Schuylkill			X														
Schwenksville			X														
Skippack			X														
South Coventry		X	X								X	X	X	X			

Region Description:	2-Mile Ring	5-Mile Ring	Full EPZ	Evacuate 2-Mile Radius and Downwind to 5 Miles													
Region Number:	R01	R02	R03	R04	R05	N/A	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16
Wind Direction From:	N/A	N/A	N/A	N	NNE, NE	ENE	E	ESE	SE, SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
SUB-AREA																	
Spring City		X	X					X	X	X							
Trappe			X														
Union			X														
Upper Frederick			X														
Upper Pottsgrove		X	X	X											X	X	X
Upper Providence		X	X				X	X	X								
Upper Salford			X														
Upper Uwchlan			X														
Uwchlan			X														
Warwick			X														
Washington			X														
West Pikeland			X														
West Pottsgrove			X														
West Vincent			X														
Sub-area Evacuates																	

Table 0-2. Description of Evacuation Regions (Regions R17-R32)

Region Description:	Evacuate 5-Mile Radius and Downwind to the EPZ Boundary															
Region Number:	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32
Wind Direction From:	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
SUB-AREA																
Amity													X	X	X	X
Boyertown	X														X	X
Charlestown							X	X	X	X						
Colebrookdale	X														X	X
Collegeville					X	X	X									
Douglass (Berks)	X												X	X	X	X
Douglass (Montgomery)	X	X													X	X
Earl														X	X	X
East Coventry	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
East Nantmeal										X	X	X				
East Pikeland							X	X	X	X						
East Vincent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Green Lane		X	X	X												
Limerick	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lower Frederick		X	X	X	X											
Lower Pottsgrove	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lower Providence					X	X	X	X								
Lower Salford			X	X	X	X										
Marlborough		X	X	X												
New Hanover	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
North Coventry	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Perkiomen			X	X	X	X										
Phoenixville						X	X	X	X							
Pottstown	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Royersford	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Schuylkill						X	X	X	X							
Schwenksville			X	X	X											
Skippack			X	X	X	X	X									
South Coventry	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring City	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Region Description:	Evacuate 5-Mile Radius and Downwind to the EPZ Boundary															
Region Number:	**R17**	**R18**	**R19**	**R20**	**R21**	**R22**	**R23**	**R24**	**R25**	**R26**	**R27**	**R28**	**R29**	**R30**	**R31**	**R32**
Wind Direction From:	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
SUB-AREA																
Trappe				X	X	X	X									
Union												X	X	X	X	
Upper Frederick	X	X	X	X												
Upper Pottsgrove	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Upper Providence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Upper Salford		X	X	X	X											
Upper Uwchlan									X	X	X	X				
Uwchlan									X	X	X					
Warwick											X	X	X			
Washington	X	X													X	X
West Pikeland								X	X	X	X					
West Pottsgrove	X												X	X	X	X
West Vincent								X	X	X	X	X				
Sub-area not within Plume, but Evacuates because it is surrounded by other Sub-areas which are Evacuating											**Sub-area Evacuates**					

Table 0-3. Description of Evacuation Regions (Regions R33-R46)

Region Description:	Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles														
Region Number:	R33	R34	R35	N/A	R36	R37	R38	R39	R40	R41	R42	R43	R44	R45	R46
Wind Direction From:	5-Mile Ring	N	NNE, NE	ENE	E	ESE	SE, SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
SUB-AREA															
Amity				See Region 01											
Boyertown															
Charlestown															
Colebrookdale															
Collegeville															
Douglass (Berks)															
Douglass (Montgomery)															
Earl															
East Coventry	X	X	X		X	X	X	X	X	X	X	X	X	X	X
East Nantmeal															
East Pikeland															
East Vincent	X						X	X	X	X					
Green Lane															
Limerick	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Lower Frederick															
Lower Pottsgrove	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Lower Providence															
Lower Salford															
Marlborough															
New Hanover	X	X	X												X
North Coventry	X									X	X	X	X		
Perkiomen															
Phoenixville															
Pottstown	X											X	X	X	X
Royersford	X					X	X								
Schuylkill															
Schwenksville															
Skippack															
South Coventry	X								X	X	X	X			

Region Description:	Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles														
Region Number:	R33	R34	R35	N/A	R36	R37	R38	R39	R40	R41	R42	R43	R44	R45	R46
Wind Direction From:	5-Mile Ring	N	NNE, NE	ENE	E	ESE	SE, SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
SUB-AREA															
Spring City	X					X	X	X							
Trappe															
Union															
Upper Frederick															
Upper Pottsgrove	X	X											X	X	X
Upper Providence	X				X	X	X								
Upper Salford															
Upper Uwchlan															
Uwchlan															
Warwick															
Washington															
West Pikeland															
West Pottsgrove															
West Vincent															
Sub-area Evacuates								Sub-area Shelters-in-Place, then Evacuates							

Table 6-4. Evacuation Scenario Definitions

Scenario	Season[1]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Winter	Midweek, Weekend	Evening	Good	Phoenixville Firebird Festival
14	Summer	Midweek	Midday	Good	Single Lane Closure US 422 Eastbound

[1] Winter means that school is in session (also applies to spring and autumn). Summer means that school is not in session.

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	1:45	1:50	1:35	1:40	1:35	1:40	1:45	2:25	1:30	1:40	2:10	1:35	1:35	1:50
R02	3:10	3:30	2:55	3:15	2:50	3:10	3:25	3:30	2:50	3:00	3:05	2:45	2:50	3:25
R03	5:10	5:30	4:45	5:05	4:35	5:05	5:30	5:35	4:35	4:50	4:50	4:35	4:40	5:30
2-Mile Region and Keyhole to 5 Miles														
R04	2:15	2:25	2:10	2:35	2:25	2:25	2:35	3:00	2:30	2:35	2:35	2:25	2:25	2:30
R05	2:25	2:25	2:05	2:15	2:25	2:20	2:45	3:00	2:20	2:25	2:35	2:25	2:25	2:25
R06	2:30	2:40	2:10	2:10	2:05	2:45	2:45	3:00	2:10	2:15	2:30	2:00	2:05	3:00
R07	2:40	2:40	2:10	2:25	2:10	2:35	2:40	3:00	2:10	2:15	2:30	2:00	2:05	3:00
R08	2:55	3:00	2:20	2:35	2:20	2:50	3:15	3:20	2:20	2:30	2:30	2:15	2:20	3:20
R09	1:45	1:50	1:35	1:40	1:35	1:40	1:50	2:25	1:35	1:40	2:15	1:35	1:40	1:50
R10	1:45	1:50	1:35	1:40	1:35	1:45	1:45	2:25	1:30	1:40	2:10	1:35	1:35	1:50
R11	1:50	2:00	1:45	1:55	1:40	1:45	2:00	2:30	1:40	1:50	2:20	1:40	1:40	1:55
R12	1:50	2:00	1:45	1:55	1:40	1:50	2:00	2:30	1:45	2:00	2:20	1:45	1:45	1:55
R13	2:20	2:40	2:15	2:40	2:10	2:20	2:35	2:40	2:10	2:30	2:40	2:15	2:15	2:25
R14	2:50	3:10	2:40	2:55	2:35	2:45	3:10	3:15	2:40	2:45	2:50	2:35	2:35	2:55
R15	2:25	2:45	2:15	2:35	2:20	2:30	2:40	2:55	2:25	2:25	2:40	2:15	2:15	2:25
R16	2:55	3:10	2:55	3:10	2:45	3:00	3:10	3:15	3:05	3:05	3:05	2:50	2:55	2:55
5-Mile Region and Keyhole to EPZ Boundary														
R17	4:20	4:35	4:10	4:25	4:05	4:20	4:40	4:40	4:10	4:15	4:20	4:05	4:05	4:25
R18	3:40	3:50	3:30	3:35	3:30	3:35	3:50	3:50	3:25	3:35	3:35	3:25	3:25	3:50
R19	3:30	3:40	3:05	3:30	3:05	3:25	3:40	3:45	3:10	3:15	3:15	3:05	3:05	3:45
R20	3:30	3:45	3:15	3:25	3:05	3:30	3:45	3:50	3:10	3:20	3:20	3:05	3:10	3:50
R21	4:30	4:50	3:55	4:10	3:45	4:35	4:50	5:05	3:50	4:10	4:20	3:45	3:45	5:15
R22	4:25	4:45	4:00	4:15	4:00	4:35	4:50	5:00	4:00	4:15	4:20	3:50	4:00	5:10
R23	4:25	4:45	4:00	4:20	3:55	4:25	4:45	4:55	4:00	4:10	4:10	3:50	4:00	5:10
R24	4:15	4:35	3:55	4:10	3:50	4:20	4:30	4:45	3:50	4:00	4:00	3:50	3:55	4:50
R25	3:30	3:50	3:15	3:40	3:10	3:30	3:50	3:50	3:10	3:15	3:15	3:10	3:15	3:45

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	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	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
R26	3:10	3:30	2:55	3:15	2:55	3:10	3:25	3:30	2:55	3:05	3:05	2:50	2:50	3:25
R27	3:10	3:30	2:55	3:15	2:50	3:10	3:30	3:30	2:50	3:05	3:05	2:45	2:50	3:25
R28	3:15	3:30	3:00	3:15	2:55	3:10	3:25	3:30	2:55	3:05	3:05	2:50	2:55	3:25
R29	3:40	4:05	3:35	3:55	3:35	3:40	3:55	4:00	3:25	3:45	3:45	3:25	3:25	4:05
R30	3:40	4:00	3:35	3:55	3:30	3:45	4:00	4:05	3:25	3:40	3:40	3:25	3:25	4:00
R31	4:45	5:00	4:30	4:55	4:30	4:45	5:00	5:20	4:30	4:35	4:35	4:35	4:35	4:50
R32	4:35	5:00	4:30	4:50	4:30	4:45	4:55	4:55	4:30	4:30	4:30	4:25	4:30	4:50
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles														
R33	3:05	3:20	2:55	3:05	2:50	3:05	3:15	3:55	2:50	3:00	3:45	2:55	2:55	3:25
R34	2:40	2:40	2:25	2:35	2:25	2:40	2:45	3:30	2:30	2:40	3:15	2:30	2:35	2:40
R35	2:40	2:50	2:30	2:50	2:25	2:45	2:45	3:35	2:35	2:40	3:30	2:30	2:35	2:40
R36	2:30	2:40	2:15	2:25	2:15	2:30	2:40	3:15	2:20	2:25	3:10	2:15	2:20	3:00
R37	2:30	2:45	2:25	2:30	2:20	2:40	2:50	3:15	2:20	2:30	3:15	2:20	2:20	3:05
R38	2:45	2:55	2:30	2:35	2:25	2:45	3:00	3:30	2:30	2:35	3:25	2:30	2:30	3:15
R39	2:05	2:05	2:00	2:00	2:00	2:05	2:05	2:50	2:00	2:00	2:50	2:00	2:00	2:05
R40	2:00	2:05	2:00	2:00	1:55	2:00	2:05	2:50	2:00	2:00	2:50	2:00	2:00	2:00
R41	2:10	2:15	2:05	2:10	2:05	2:10	2:15	3:00	2:05	2:10	3:00	2:05	2:05	2:10
R42	2:05	2:10	2:00	2:05	2:00	2:05	2:10	2:55	2:00	2:05	2:50	2:05	2:05	2:10
R43	2:25	2:30	2:20	2:30	2:25	2:25	2:30	3:15	2:25	2:30	3:15	2:25	2:25	2:25
R44	2:45	2:45	2:35	2:45	2:45	2:40	2:45	3:30	2:35	2:50	3:40	2:40	2:40	2:45
R45	2:35	2:45	2:40	2:40	2:35	2:35	2:45	3:20	2:35	2:40	3:30	2:35	2:35	2:40
R46	2:55	3:05	2:55	3:10	2:55	3:05	3:10	3:45	3:00	3:10	3:45	3:00	3:00	2:55

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01	3:25	3:35	3:15	3:20	3:15	3:30	3:40	4:45	3:15	3:20	4:45	3:15	3:15	4:10
R02	4:25	4:50	4:15	4:40	4:10	4:25	4:50	5:05	4:10	4:15	5:00	4:05	4:10	5:15
R03	7:25	7:40	6:40	7:05	6:35	6:50	7:35	7:40	6:30	6:35	6:45	6:30	6:35	8:10
2-Mile Region and Keyhole to 5 Miles														
R04	3:45	3:50	3:35	4:00	3:40	3:45	3:50	4:55	3:40	3:40	4:50	3:30	3:30	4:20
R05	3:50	3:50	3:30	3:30	3:30	3:40	4:00	4:55	3:25	3:40	4:45	3:25	3:25	4:20
R06	4:15	4:35	3:50	3:50	3:50	4:15	4:20	4:50	3:50	3:50	4:55	3:50	3:50	4:55
R07	4:20	4:20	3:55	4:00	3:50	4:10	4:25	4:55	3:50	3:55	4:50	3:50	3:50	4:35
R08	4:25	4:35	3:55	4:00	3:50	4:10	4:50	5:00	3:50	4:00	4:50	3:50	3:55	4:40
R09	3:45	3:45	3:35	3:35	3:35	3:45	3:55	4:50	3:25	3:30	4:45	3:30	3:35	4:30
R10	3:45	3:45	3:15	3:25	3:30	3:45	3:50	4:50	3:20	3:35	4:45	3:25	3:30	4:15
R11	3:45	3:45	3:25	3:35	3:35	3:50	3:50	4:50	3:25	3:35	4:45	3:30	3:40	4:15
R12	3:45	3:45	3:25	3:35	3:15	3:40	3:50	4:50	3:25	3:30	4:45	3:25	3:40	4:10
R13	3:50	4:00	3:35	4:00	3:40	3:45	3:55	4:50	3:35	3:50	4:45	3:25	3:40	4:25
R14	3:50	4:10	3:35	4:00	3:35	3:55	4:20	4:50	3:40	3:50	4:45	3:35	3:40	4:15
R15	3:50	4:10	3:35	4:00	3:35	3:55	3:55	4:50	3:40	3:50	4:45	3:35	3:40	4:15
R16	4:15	4:30	4:05	4:30	4:00	4:10	4:30	4:55	4:10	4:10	4:50	3:50	4:10	4:20
5-Mile Region and Keyhole to EPZ Boundary														
R17	6:45	7:05	6:10	6:25	6:30	6:35	7:10	7:10	6:05	6:05	6:10	6:15	6:30	6:45
R18	5:50	6:15	5:50	5:50	5:55	6:00	6:15	6:15	5:55	6:00	6:00	5:45	5:55	5:55
R19	5:35	5:35	5:00	5:00	4:50	4:45	5:00	5:20	4:55	4:55	5:00	4:50	4:55	5:40
R20	5:35	5:35	5:00	5:00	4:50	5:15	5:20	5:20	5:00	5:00	5:00	4:55	5:00	6:20
R21	6:40	7:05	5:55	6:20	5:40	6:50	7:20	7:35	5:50	6:15	6:30	5:35	5:40	8:00
R22	6:40	7:00	6:05	6:25	5:45	6:50	7:25	7:30	5:55	6:15	6:30	5:55	5:55	8:05
R23	6:30	7:00	5:55	6:20	5:40	6:25	7:05	7:35	5:45	6:20	6:20	5:40	5:40	7:55
R24	6:00	6:30	5:25	5:55	5:20	6:10	6:25	7:00	5:20	6:00	6:05	5:20	5:35	7:35
R25	5:10	6:00	5:10	5:45	5:10	5:05	5:05	5:05	5:15	5:20	5:25	5:10	5:35	5:55

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	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	Evening	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
R26	4:25	4:55	4:15	4:40	4:25	4:25	4:50	5:05	4:15	4:25	5:00	4:05	4:25	5:15
R27	4:25	4:50	4:15	4:40	4:10	4:25	5:05	5:05	4:10	4:20	5:00	4:05	4:15	5:15
R28	4:35	4:50	4:15	4:50	4:20	4:30	4:50	5:05	4:20	4:35	5:00	4:15	4:20	5:15
R29	5:35	5:55	5:25	5:50	5:20	5:30	5:55	6:25	5:10	5:50	6:00	5:10	5:20	6:00
R30	5:20	5:40	5:10	5:45	5:20	5:55	5:55	6:15	5:10	5:35	5:40	5:00	5:20	5:55
R31	6:55	7:05	6:40	6:55	6:35	6:50	7:20	7:30	6:30	6:30	6:35	6:30	6:35	6:55
R32	6:50	6:50	6:25	6:55	6:35	6:45	6:55	6:55	6:30	6:30	6:35	6:25	6:35	6:50
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles														
R33	4:10	4:55	4:00	4:40	4:15	4:30	4:35	5:20	4:00	4:05	5:05	4:10	4:10	4:55
R34	3:50	4:00	3:35	3:55	3:40	3:55	3:55	4:55	3:30	3:55	4:45	3:30	3:45	3:50
R35	3:40	3:50	3:25	3:50	3:20	3:45	3:45	4:55	3:35	3:45	4:45	3:25	3:50	4:00
R36	3:55	4:00	3:50	3:50	3:50	3:50	3:50	4:55	3:50	3:50	4:55	3:45	3:50	4:25
R37	3:55	4:15	3:50	3:50	3:45	3:55	4:20	4:55	3:50	3:55	4:50	3:45	3:50	4:50
R38	4:10	4:30	3:50	3:55	3:50	4:05	4:25	5:10	3:50	3:55	4:55	3:50	3:50	5:10
R39	3:40	3:45	3:40	3:40	3:30	3:45	3:50	4:50	3:40	3:40	4:49	3:40	3:40	4:00
R40	3:40	3:50	3:35	3:40	3:30	3:40	3:50	4:50	3:25	3:40	4:45	3:15	3:25	3:55
R41	3:50	3:50	3:35	3:50	3:30	3:45	3:50	4:50	3:25	3:40	4:50	3:30	3:35	4:00
R42	3:40	3:50	3:35	3:40	3:10	3:45	3:50	4:50	3:20	3:40	4:50	3:30	3:30	3:55
R43	3:45	3:50	3:40	3:40	3:40	3:45	3:50	4:50	3:45	3:50	4:50	3:35	3:35	4:00
R44	3:50	3:55	3:35	3:55	3:45	3:55	4:00	4:50	3:40	3:50	4:45	3:35	3:35	3:50
R45	3:50	4:05	3:35	4:05	3:45	3:55	4:05	4:50	3:40	3:50	4:45	3:35	3:35	3:55
R46	4:05	4:25	4:10	4:30	4:05	4:15	4:35	5:10	4:10	4:25	5:00	4:05	4:05	4:05

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	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	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Un-staged Evacuation - 2-Mile Region														
R01	1:45	1:50	1:35	1:40	1:35	1:40	1:45	2:25	1:30	1:40	2:10	1:35	1:30	1:50
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R02	2:10	2:20	2:05	2:20	2:00	2:10	2:15	2:35	2:00	2:15	2:25	2:00	2:00	2:40
R04	1:45	1:50	1:40	1:50	1:40	1:40	1:55	2:20	1:35	1:50	2:10	1:40	1:40	1:50
R05	1:45	1:50	1:30	1:40	1:30	1:40	1:50	2:20	1:30	1:45	2:10	1:30	1:35	1:50
R06	1:45	1:50	1:35	1:40	1:30	1:50	1:50	2:20	1:30	1:35	2:20	1:35	1:30	2:00
R07	1:45	1:50	1:30	1:40	1:30	1:50	1:50	2:25	1:35	1:35	2:15	1:35	1:35	2:10
R08	1:50	1:50	1:30	1:40	1:30	1:45	2:15	2:25	1:30	1:40	2:20	1:40	1:35	2:05
R09	1:45	1:50	1:35	1:40	1:35	1:40	1:50	2:25	1:35	1:40	2:15	1:35	1:35	1:50
R10	1:45	1:50	1:35	1:40	1:35	1:45	1:45	2:25	1:30	1:40	2:10	1:35	1:35	1:50
R11	1:40	1:50	1:30	1:45	1:30	1:40	1:50	2:25	1:30	1:40	2:10	1:30	1:35	1:50
R12	1:40	1:50	1:30	1:40	1:30	1:45	1:50	2:20	1:30	1:45	2:15	1:35	1:35	1:45
R13	1:55	2:10	1:45	2:05	1:50	2:00	2:05	2:30	1:55	2:05	2:25	2:00	2:00	2:00
R14	2:00	2:10	1:50	2:05	1:50	2:05	2:20	2:35	1:55	2:00	2:25	1:55	1:50	2:10
R15	2:05	2:05	1:50	1:55	1:50	2:10	2:10	2:35	1:55	1:55	2:20	1:50	1:55	2:05
R16	2:10	2:20	2:05	2:10	2:00	2:15	2:15	2:35	2:00	2:05	2:25	2:00	2:00	2:15
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles														
R33	2:05	2:10	2:05	2:05	2:00	2:05	2:10	2:55	2:00	2:05	2:50	2:00	2:00	2:15
R34	1:50	1:55	1:35	1:45	1:35	1:45	1:55	2:30	1:35	1:45	2:20	1:35	1:35	1:55
R35	1:50	1:50	1:30	1:35	1:30	1:50	1:55	2:30	1:30	1:40	2:15	1:35	1:35	1:50
R36	1:55	1:55	1:40	1:45	1:40	1:55	2:00	2:35	1:40	1:50	2:30	1:50	1:40	2:05
R37	1:55	2:00	1:55	1:55	1:50	1:55	2:00	2:45	1:50	1:55	2:35	1:50	1:50	2:05
R38	1:55	2:00	1:50	1:55	1:50	2:00	2:05	2:45	1:50	1:55	2:40	1:55	1:50	2:15
R39	1:45	1:55	1:40	1:40	1:35	1:50	1:55	2:30	1:35	1:40	2:25	1:35	1:35	1:50
R40	1:45	1:55	1:40	1:45	1:35	1:50	1:55	2:30	1:30	1:40	2:25	1:35	1:35	1:50
R41	1:45	1:50	1:40	1:40	1:35	1:50	1:55	2:30	1:40	1:40	2:30	1:40	1:35	1:55
R42	1:50	1:50	1:30	1:35	1:30	1:45	1:50	2:30	1:30	1:40	2:20	1:35	1:40	1:55
R43	2:00	2:00	1:55	2:00	2:00	2:00	2:00	2:50	2:00	2:00	2:45	1:55	2:00	2:00
R44	2:05	2:05	1:55	2:00	2:05	2:00	2:05	2:45	1:55	2:00	2:45	1:55	1:55	2:05
R45	2:05	2:05	2:00	2:00	2:00	2:05	2:05	2:45	2:00	2:00	2:45	2:00	2:00	2:05
R46	2:00	2:00	1:55	1:55	1:55	2:00	2:05	2:45	1:55	2:00	2:45	1:55	1:55	2:00

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

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	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	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Un-staged Evacuation - 2-Mile Region														
R01	3:25	3:35	3:15	3:20	3:15	3:30	3:40	4:45	3:15	3:20	4:45	3:15	3:15	4:15
Un-staged Evacuation - 2-Mile Region and Keyhole to 5-Miles														
R02	3:55	4:00	3:50	4:05	3:50	3:50	3:55	5:05	3:45	4:00	5:00	3:50	3:50	4:10
R04	3:45	3:50	3:35	3:35	3:40	3:45	3:45	4:50	3:30	3:30	4:49	3:25	3:25	4:20
R05	3:50	3:50	3:30	3:30	3:10	3:50	3:50	4:50	3:30	3:40	4:45	3:25	3:25	4:20
R06	4:00	4:00	3:50	3:50	3:50	4:00	4:00	4:50	3:50	3:50	4:55	3:50	3:50	4:05
R07	3:55	3:55	3:55	4:00	3:55	4:00	4:00	4:55	3:50	3:55	5:00	3:50	3:50	4:00
R08	3:55	3:55	3:55	3:55	3:40	3:55	5:00	5:00	3:50	4:00	4:50	3:50	3:55	4:05
R09	3:45	3:45	3:35	3:35	3:35	3:45	3:55	4:50	3:25	3:30	4:45	3:30	3:35	4:30
R10	3:45	3:50	3:15	3:25	3:30	3:40	3:50	4:50	3:20	3:45	4:45	3:30	3:30	4:15
R11	3:50	3:50	3:25	3:25	3:35	3:50	3:50	4:50	3:10	3:30	4:35	3:30	3:30	4:15
R12	3:50	3:50	3:20	3:25	3:10	3:45	3:50	4:50	3:40	3:40	4:45	3:30	3:40	4:20
R13	3:50	3:50	3:20	3:30	3:50	3:45	3:50	4:50	3:30	3:30	4:45	3:15	3:40	4:20
R14	3:50	3:50	3:15	3:30	3:25	3:45	4:00	4:50	3:35	3:35	4:50	3:20	3:25	4:05
R15	3:45	3:55	3:25	3:45	3:25	3:45	3:50	4:50	3:25	3:35	4:45	3:25	3:30	4:20
R16	3:45	4:10	3:35	3:40	3:30	3:40	4:00	4:50	3:35	4:00	4:45	3:35	3:35	4:00
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles														
R33	3:55	3:55	3:45	3:55	3:50	3:50	4:05	5:05	3:50	3:55	4:55	3:50	3:50	4:05
R34	3:50	3:50	3:30	3:30	3:40	3:40	3:45	4:50	3:20	3:30	4:40	3:30	3:30	3:50
R35	3:45	3:50	3:15	3:20	3:20	3:40	3:40	4:50	3:25	3:35	4:40	3:20	3:50	4:00
R36	3:50	3:50	3:50	3:50	3:50	3:50	3:50	4:55	3:50	3:50	4:55	3:45	3:50	4:20
R37	3:55	4:00	3:50	3:50	3:45	3:55	4:00	4:55	3:55	3:55	4:50	3:45	3:50	4:10
R38	3:50	4:00	3:50	3:55	3:50	3:55	4:05	5:10	3:50	3:50	4:55	3:50	3:50	3:50
R39	3:35	3:45	3:45	3:45	3:30	3:40	3:50	4:50	3:40	3:40	4:49	3:30	3:30	4:00
R40	3:40	3:50	3:35	3:40	3:30	3:40	3:45	4:50	3:25	3:45	4:45	3:15	3:25	3:55
R41	3:45	3:45	3:35	3:35	3:30	3:45	3:50	4:50	3:25	3:35	4:49	3:20	3:25	4:00
R42	3:45	3:50	3:20	3:25	3:10	3:45	3:50	4:50	3:40	3:45	4:40	3:20	3:30	3:55
R43	3:45	3:50	3:25	3:25	3:25	3:45	3:50	4:50	3:30	3:30	4:35	3:10	3:10	3:55
R44	3:40	3:50	3:25	3:35	3:35	3:45	3:50	4:50	3:20	3:35	4:50	3:20	3:30	4:00
R45	3:50	3:50	3:20	3:45	3:25	3:50	3:55	4:50	3:20	3:40	4:45	3:25	3:25	3:55
R46	3:45	3:55	3:30	3:35	3:20	3:45	3:45	4:50	3:30	3:45	4:40	3:30	3:30	3:55

Table 8-7. School Evacuation Time Estimates – Good Weather

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Schools									
BERKS COUNTY SCHOOLS									
Amity Elementary Center	90	15	4.5	1.8	149	**4:15**	17.3	19	**4:35**
Boyertown Area High School	90	15	3.4	2.6	79	**3:05**	14.9	16	**3:25**
Boyertown Area Junior High School West	90	15	3.8	3.0	77	**3:05**	14.9	16	**3:25**
Boyertown Elementary School	90	15	3.8	3.0	77	**3:05**	14.9	16	**3:25**
Brookeside Montessori	90	15	2.2	4.5	29	**2:15**	20.9	23	**2:40**
Colebrookdale Elementary School	90	15	4.0	2.7	88	**3:15**	14.9	16	**3:35**
Daniel Boone Middle School	90	15	7.0	30.2	14	**2:00**	7.0	8	**2:10**
Jessie R. Wagner Adventist Elementary School	90	15	6.1	2.0	179	**4:45**	33.1	36	**5:25**
Monocacy Elementary Center	90	15	0.8	40.0	1	**1:50**	2.2	2	**1:55**
Pine Forge Elementary School	90	15	3.3	1.5	128	**3:55**	17.3	19	**4:15**
CHESTER COUNTY SCHOOLS									
Barkley Elementary School	90	15	4.7	5.6	50	**2:35**	4.2	5	**2:40**
Center for Arts and Technology-Pickering Campus	90	15	4.9	12.0	25	**2:10**	7.1	8	**2:20**
Charlestown Elementary School	90	15	0.4	3.6	7	**1:55**	2.1	2	**2:00**
Collegeville Montessori Academy	90	15	15.4	4.7	195	**5:00**	6.3	7	**5:10**
East Coventry Elementary School	90	15	13.4	16.1	50	**2:35**	3.4	4	**2:40**
East Pikeland Elementary School	90	15	6.3	8.4	45	**2:30**	4.2	5	**2:35**
East Vincent Elementary School	90	15	10.4	13.3	47	**2:35**	3.4	4	**2:40**
French Creek Elementary School	90	15	6.0	9.9	37	**2:25**	3.4	4	**2:30**
Holy Family School	90	15	4.5	7.3	37	**2:25**	5.6	6	**2:35**
Kimberton-Waldorf School	90	15	7.4	13.4	33	**2:20**	16.9	18	**2:40**
Kindergarten Center	90	15	4.6	7.1	39	**2:25**	6.5	7	**2:35**
Montgomery School	90	15	2.2	40.5	3	**1:50**	7.2	8	**2:00**
North Coventry Elementary School	90	15	10.3	10.9	57	**2:45**	3.4	4	**2:50**
Owen J. Roberts High School	90	15	7.5	10.6	42	**2:30**	4.4	5	**2:35**
Owen J. Roberts Middle School	90	15	7.3	10.6	41	**2:30**	4.4	5	**2:35**
Phoenixville Area High School	90	15	3.5	7.6	28	**2:15**	4.2	5	**2:20**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Phoenixville Area Middle School	90	15	3.6	7.6	28	**2:15**	4.2	5	**2:20**
Pickering Valley Elementary School	90	15	1.0	2.1	28	**2:15**	7.2	8	**2:25**
Renaissance Academy	90	15	5.3	11.8	27	**2:15**	12.2	13	**2:30**
Schuylkill Elementary School	90	15	2.5	8.4	18	**2:05**	4.2	5	**2:10**
Spring City Elementary School	90	15	12.1	6.4	113	**3:40**	12.7	14	**3:55**
St. Basil the Great School	90	15	7.3	9.9	44	**2:30**	7.8	9	**2:40**
Upattinas Open Community School	90	15	1.3	3.3	23	**2:10**	16.9	18	**2:30**
Valley Forge Christian College	90	15	5.0	12.0	25	**2:10**	12.2	13	**2:25**
West Vincent Elementary School	90	15	7.7	42.4	11	**2:00**	3.4	4	**2:05**
West-Mont Christian Academy	90	15	11.3	3.2	213	**5:20**	10.1	11	**5:35**
MONTGOMERY COUNTY SCHOOLS									
Arcola Intermediate School	90	15	2.8	2.0	85	**3:10**	20.3	22	**3:35**
Arrowhead Elementary School	90	15	4.7	2.0	144	**4:10**	2.4	3	**4:15**
Audubon Elementary	90	15	1.2	8.1	9	**1:55**	3.0	3	**2:00**
Blessed Theresa of Calcutta	90	15	11.6	8.9	78	**3:05**	6.2	7	**3:15**
Boyertown Area Junior High School East	90	15	6.7	3.3	122	**3:50**	14.9	16	**4:10**
Bright Spot Kindergarten	90	15	3.7	1.4	154	**4:20**	7.8	9	**4:30**
Brooke Elementary School	90	15	11.4	3.3	209	**5:15**	6.2	7	**5:25**
Chapel Christian Academy	90	15	10.2	2.9	209	**5:15**	8.8	10	**5:25**
Coventry Christian Schools	90	15	11.2	10.4	64	**2:50**	2.2	2	**2:55**
Eagleville Elementary School	90	15	0.6	2.7	13	**2:00**	3.1	3	**2:05**
Edgewood Elementary School	90	15	9.7	3.0	192	**5:00**	13.2	14	**5:15**
Elizabeth B. Barth Elementary School	90	15	10.7	3.1	207	**5:15**	13.2	14	**5:30**
Evans Elementary School	90	15	9.4	2.9	196	**5:05**	6.2	7	**5:15**
Evergreen Elementary School	90	15	6.1	10.6	34	**2:20**	4.8	5	**2:25**
Franklin Elementary School	90	15	10.1	3.0	202	**5:10**	13.2	14	**5:25**
Gilbertsville Elementary School	90	15	4.8	2.5	117	**3:45**	14.9	16	**4:05**
Limerick Elementary School	90	15	8.8	2.8	188	**4:55**	9.5	10	**5:05**
Lincoln Elementary School	90	15	8.8	2.7	193	**5:00**	14.0	15	**5:15**
Lower Pottsgrove Elementary School	90	15	9.3	4.5	125	**3:50**	16.6	18	**4:10**
New Hanover-Upper Frederick Elementary School	90	15	5.9	2.4	146	**4:15**	18.5	20	**4:35**
New Life Youth & Family Services	90	15	1.2	29.0	2	**1:50**	20.8	23	**2:15**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Oaks Elementary School	90	15	4.6	5.0	55	**2:40**	12.7	14	**2:55**
Perkiomen Valley Academy	90	15	4.5	39.2	7	**1:55**	36.1	39	**2:35**
Perkiomen Valley High School	90	15	6.0	10.0	36	**2:25**	4.8	5	**2:30**
Perkiomen Valley Middle School - East	90	15	6.2	10.6	35	**2:20**	4.8	5	**2:25**
Perkiomen Valley Middle School -West	90	15	8.8	11.3	47	**2:35**	4.8	5	**2:40**
Perkiomen Valley South Elementary School	90	15	3.7	8.2	27	**2:15**	8.3	9	**2:25**
Pope John Paul II High School	90	15	9.4	13.8	41	**2:30**	17.0	19	**2:50**
Pottsgrove High School	90	15	8.7	4.1	126	**3:55**	16.6	18	**4:15**
Pottsgrove Middle School	90	15	9.7	4.5	130	**3:55**	16.6	18	**4:15**
Pottstown High School	90	15	9.9	2.9	203	**5:10**	13.2	14	**5:25**
Pottstown Middle School	90	15	10.4	3.1	205	**5:10**	13.2	14	**5:25**
Ringing Rocks Elementary	90	15	8.7	4.1	126	**3:55**	16.6	18	**4:15**
Royersford Elementary School	90	15	11.8	6.2	115	**3:40**	6.2	7	**3:50**
Rupert Elementary School	90	15	12.4	3.6	205	**5:10**	13.2	14	**5:25**
Sacred Heart School	90	15	10.1	6.2	98	**3:25**	12.4	14	**3:40**
Salford Hills Elementary	90	15	1.9	17.1	7	**1:55**	2.3	3	**2:00**
Schwenksville Elementary School	90	15	6.1	8.2	45	**2:30**	4.8	5	**2:35**
Skippack Elementary School	90	15	3.1	10.0	19	**2:05**	4.8	5	**2:10**
Skyview Upper Elementary School	90	15	0.0	0.0	0	**1:45**	2.1	2	**1:50**
Spring-Ford 5th-6th Grade Center	90	15	9.9	6.2	96	**3:25**	6.2	7	**3:35**
Spring-Ford 7th Grade Center	90	15	10.5	6.2	101	**3:30**	6.2	7	**3:40**
Spring-Ford 8th Grade Center	90	15	10.6	6.2	102	**3:30**	6.2	7	**3:40**
Spring-Ford Senior High School 10-12 Grade Center	90	15	10.1	6.2	98	**3:25**	6.2	7	**3:35**
Spring-Ford Senior High School 9th Grade Center	90	15	10.9	6.2	105	**3:30**	6.2	7	**3:40**
St. Aloysius	90	15	9.7	3.5	167	**4:35**	16.1	18	**4:55**
St. Eleanor School	90	15	8.9	3.8	142	**4:10**	2.9	3	**4:15**
St. Gabriel's Hall	90	15	2.5	2.2	69	**2:55**	20.3	22	**3:20**
St. Mary's School	90	15	2.7	28.1	6	**1:55**	7.4	8	**2:05**
St. Peter's Lutheran Church - School	90	15	10.9	3.1	212	**5:20**	13.5	15	**5:35**
The Hill School	90	15	11.2	4.6	147	**4:15**	32.8	36	**4:55**
Upper Providence Elementary School	90	15	9.7	6.1	95	**3:20**	6.2	7	**3:30**
Ursinus College	90	15	3.1	1.4	133	**4:00**	22.3	24	**4:25**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Valley Forge Baptist Temple Academy	90	15	6.1	1.9	198	**5:05**	5.3	6	**5:15**
Wayside Christian School	90	15	5.5	2.7	123	**3:50**	7.0	8	**4:00**
West Pottsgrove Elementary School	90	15	14.0	5.3	158	**4:25**	16.6	18	**4:45**
Western Center for Technical Studies	90	15	10.5	31.6	20	**2:05**	6.2	7	**2:15**
Woodland Elementary	90	15	1.1	4.3	15	**2:00**	2.4	3	**2:05**
Wyndcroft School	90	15	10.3	3.1	198	**5:05**	17.8	19	**5:25**
					Maximum for EPZ:	**5:20**		**Maximum:**	**5:35**
					Average for EPZ:	**3:20**		**Average:**	**3:30**
Preschools									
BERKS COUNTY PRESCHOOLS									
Almost Home Children's Center	90	15	3.8	2.4	94	**3:20**	7.0	8	**3:30**
Boyertown Area YMCA	90	15	3.4	2.8	72	**3:00**	3.4	4	**3:05**
Douglassville Children's Center	90	15	2.1	7.3	17	**2:05**	2.1	2	**2:10**
Douglassville KinderCare	90	15	2.8	6.0	28	**2:15**	7.0	8	**2:25**
Gail Swartz Family Daycare	90	15	0.2	29.1	0	**1:45**	6.7	7	**1:55**
Saint Columbkill Preschool	90	15	2.8	2.5	67	**2:55**	7.0	8	**3:05**
St. Gabriel's Good Shepherd Learning Center	90	15	2.8	3.8	44	**2:30**	2.8	3	**2:35**
St. John's Lutheran Church	90	15	3.0	2.8	65	**2:50**	7.0	8	**3:00**
St. Paul's Day Care	90	15	4.1	7.1	34	**2:20**	4.1	4	**2:25**
Teresa Walter Family Daycare	90	15	1.0	5.3	11	**2:00**	6.6	7	**2:10**
CHESTER COUNTY PRESCHOOLS									
Bright Light Early Learning Center	90	15	0.5	8.0	4	**1:50**	7.2	8	**2:00**
Children's House of Northern Chester County	90	15	5.1	9.6	32	**2:20**	10.9	12	**2:35**
East Coventry Elementary School	90	15	13.4	16.1	50	**2:35**	5.4	6	**2:45**
Grace Assembly Day Care Center	90	15	12.6	4.4	173	**4:40**	3.3	4	**4:45**
International Montessori	90	15	4.8	6.5	45	**2:30**	12.2	13	**2:45**
Kiddie Academy	90	15	5.4	9.8	33	**2:20**	12.2	13	**2:35**
Kids Kare Korner	90	15	12.2	4.8	153	**4:20**	3.3	4	**4:25**
Kindercare Learning Center No. 1405	90	15	9.6	6.3	92	**3:20**	3.3	4	**3:25**
Little Angels Day Care	90	15	5.0	6.5	46	**2:35**	12.2	13	**2:50**
Magic Memories	90	15	4.9	8.8	33	**2:20**	12.2	13	**2:35**
Our House Early Learning Center	90	15	12.8	10.1	76	**3:05**	5.4	6	**3:15**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Phoenixville Area Children Learning Center	90	15	4.6	6.4	43	**2:30**	12.2	13	**2:45**
Phoenixville Area Children's Learning Center 2	90	15	5.0	4.3	70	**2:55**	12.2	13	**3:10**
Phoenixville Area YMCA Child Care Center	90	15	4.6	8.0	35	**2:20**	12.2	13	**2:35**
Pottstown YMCA French Creek Elementary	90	15	6.0	9.9	37	**2:25**	4.2	5	**2:30**
Stepping Stone Education Center	90	15	5.0	4.3	70	**2:55**	12.2	13	**3:10**
Teach & Learn Day School	90	15	8.3	5.8	85	**3:10**	3.3	4	**3:15**
The Goddard School - Chester Springs	90	15	0.8	7.6	6	**1:55**	7.2	8	**2:05**
Valley Forge Kinder House Montessori School	90	15	3.9	12.4	19	**2:05**	12.2	13	**2:20**
Warwick Child Care - North Coventry Center	90	15	6.9	8.8	47	**2:35**	5.4	6	**2:45**
Warwick Child Care - South Coventry Center	90	15	6.5	9.8	40	**2:25**	4.2	5	**2:30**
MONTGOMERY COUNTY PRESCHOOLS									
Boyertown Children's Center	90	15	17.9	13.8	78	**3:05**	6.2	7	**3:15**
Bright Beginnings Child Care Center	90	15	10.2	8.3	74	**3:00**	6.2	7	**3:10**
Bright Spot Child Care	90	15	3.7	1.5	149	**4:15**	7.8	9	**4:25**
Chesterbrook Academy - Collegeville	90	15	1.4	1.9	45	**2:30**	8.1	9	**2:40**
Chesterbrook Academy - Limerick	90	15	13.5	5.5	148	**4:15**	6.6	7	**4:25**
Chesterbrook Academy - Norristown	90	15	2.9	5.9	29	**2:15**	7.4	8	**2:25**
Chesterbrook Academy - Phoenixville	90	15	6.9	4.6	90	**3:15**	6.6	7	**3:25**
Chesterbrook Academy - Royersford	90	15	11.4	5.2	131	**4:00**	6.6	7	**4:10**
Children of America Trappe	90	15	7.7	4.4	106	**3:35**	6.2	7	**3:45**
Country Tyme Day Care	90	15	11.5	5.4	129	**3:55**	5.4	6	**4:05**
Coventry Christian Pre-School	90	15	11.2	7.2	93	**3:20**	2.2	2	**3:25**
Creative Beginnings Preschool	90	15	1.2	1.9	39	**2:25**	8.1	9	**2:35**
Creative Child Care Too	90	15	3.4	1.7	117	**3:45**	8.1	9	**3:55**
Creative Minds Montessori	90	15	19.3	11.4	102	**3:30**	6.2	7	**3:40**
Dotlen Academy	90	15	20.7	8.0	155	**4:20**	6.2	7	**4:30**
Flanagan's Pre-School	90	15	5.9	9.0	39	**2:25**	6.2	7	**2:35**
FV YMCA - Audubon Elementary	90	15	1.2	5.6	13	**2:00**	3.0	3	**2:05**
FV YMCA - Brooke Elementary School	90	15	11.4	5.2	131	**4:00**	6.2	7	**4:10**
FV YMCA - Evans Elementary School	90	15	9.4	8.3	68	**2:55**	6.2	7	**3:05**
FV YMCA - Limerick Elementary School	90	15	8.8	7.6	69	**2:55**	9.5	10	**3:05**
FV YMCA - Perkiomen Valley Middle School	90	15	6.2	6.8	55	**2:40**	4.8	5	**2:45**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
FV YMCA - Pottstown Day Care	90	15	20.0	8.0	149	**4:15**	6.2	7	**4:25**
FV YMCA - Royersford Elementary School	90	15	11.8	9.2	77	**3:05**	6.2	7	**3:15**
FV YMCA - Spring Valley	90	15	9.3	8.3	68	**2:55**	6.2	7	**3:05**
FV YMCA - Woodland Elementary	90	15	1.1	5.6	12	**2:00**	2.4	3	**2:05**
Hendricks Family Growing Dreams	90	15	14.6	8.8	100	**3:25**	6.2	7	**3:35**
Jerusalem Lutheran Day Care Center	90	15	6.2	8.6	43	**2:30**	6.2	7	**2:40**
Kiddie Academy Collegeville	90	15	7.7	7.5	62	**2:50**	6.2	7	**3:00**
Kiddie Academy Royersford	90	15	13.1	5.5	144	**4:10**	6.6	7	**4:20**
Kids Kare Korner III	90	15	11.6	9.2	76	**3:05**	6.2	7	**3:15**
Kinder Works	90	15	10.2	8.3	74	**3:00**	6.2	7	**3:10**
Kindercare 3056	90	15	22.0	9.6	137	**4:05**	6.2	7	**4:15**
Kindercare 3060	90	15	9.0	4.7	115	**3:40**	6.6	7	**3:50**
Little Faces Learning Center	90	15	16.2	13.1	74	**3:00**	6.2	7	**3:10**
Little Footprints	90	15	23.9	7.2	198	**5:05**	6.2	7	**5:15**
Little Mary Daycare	90	15	20.7	8.0	155	**4:20**	6.2	7	**4:30**
Montgomery Early Learning Center	90	15	20.6	8.0	154	**4:20**	6.2	7	**4:30**
New Hanover Child Care	90	15	15.7	8.9	106	**3:35**	6.2	7	**3:45**
North Penn YMCA - Salford Hills Elementary	90	15	1.9	18.7	6	**1:55**	2.3	3	**2:00**
North Penn YMCA - Schwenksville Elementary	90	15	6.1	8.2	45	**2:30**	4.8	5	**2:35**
Oaks Early Learning	90	15	5.3	4.5	70	**2:55**	6.6	7	**3:05**
Phoenixville Area YMCA - Eagleville Elementary	90	15	0.6	1.5	24	**2:10**	3.1	3	**2:15**
Phoenixville Area YMCA-Arrowhead Elementary	90	15	4.7	1.9	147	**4:15**	2.4	3	**4:20**
Phoenixville Area YMCA-Oaks Elementary School	90	15	4.6	4.4	63	**2:50**	12.7	14	**3:05**
Play and Learn - Collegeville	90	15	1.6	1.9	51	**2:40**	15.8	17	**3:00**
Play and Learn - Green Lane	90	15	3.2	25.4	8	**1:55**	23.9	26	**2:25**
Play and Learn - Royersford	90	15	10.0	4.7	127	**3:55**	6.6	7	**4:05**
Providence Christian Preschool	90	15	9.6	4.7	123	**3:50**	6.6	7	**4:00**
SEI Family Center	90	15	5.0	4.5	67	**2:55**	6.6	7	**3:05**
Short Stuff & Co	90	15	0.9	5.5	10	**1:55**	7.0	8	**2:05**
Spring Valley YMCA Child Care Facility	90	15	11.3	8.5	80	**3:05**	6.2	7	**3:15**
Sunny Dayz Child Care	90	15	20.7	8.0	155	**4:20**	6.2	7	**4:30**
The Goddard School - Gilbertsville	90	15	16.8	13.1	77	**3:05**	6.2	7	**3:15**

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time from EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
The Goddard School - Royersford	90	15	11.0	8.5	77	**3:05**	6.2	7	**3:15**
The Goddard School - Sanatoga	90	15	20.7	9.4	133	**4:00**	6.2	7	**4:10**
The Goddard School - Schwenksville	90	15	6.2	6.8	55	**2:40**	6.2	7	**2:50**
The Goddard School - Skippack	90	15	2.3	6.6	21	**2:10**	6.2	7	**2:20**
The Learning Experience	90	15	20.7	9.4	133	**4:00**	6.2	7	**4:10**
The Malvern School - Collegeville	90	15	3.4	1.7	117	**3:45**	8.1	9	**3:55**
The Malvern School - Royersford	90	15	13.0	5.5	143	**4:10**	6.6	7	**4:20**
The Malvern School of Oaks	90	15	6.0	4.5	79	**3:05**	6.6	7	**3:15**
Tot Spot Learning Center	90	15	4.3	1.8	144	**4:10**	8.1	9	**4:20**
Twin Acres Country Day School	90	15	7.8	5.1	92	**3:20**	4.4	5	**3:25**
Tykes and Tots Day Care	90	15	3.1	7.2	26	**2:15**	6.2	7	**2:25**
Valley Forge Children's Academy	90	15	1.8	5.6	19	**2:05**	8.2	9	**2:15**
Victory Early Learning Academy	90	15	1.5	5.6	16	**2:05**	8.7	9	**2:15**
Wee Care Child Dev Center	90	15	20.7	9.4	133	**4:00**	6.2	7	**4:10**
YMCA Growing Dreams Child Care Center	90	15	17.4	13.1	80	**3:05**	6.2	7	**3:15**
YWCA Hill School Preschool	90	15	21.2	8.0	158	**4:25**	6.2	7	**4:35**
YWCA Ready Set Grow	90	15	20.6	8.0	154	**4:20**	6.2	7	**4:30**
YWCA Tricounty Daycare	90	15	20.9	8.0	156	**4:25**	6.2	7	**4:35**
					Maximum for EPZ:	**5:05**		**Maximum:**	**5:15**
					Average for EPZ:	**3:05**		**Average:**	**3:15**

Table 8-11. Transit-Dependent Evacuation Time Estimates – Good Weather

Route	Bus Number	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
BERKS COUNTY														
Schedule 1	1-2	90	3.6	2.5	85	30	**3:25**	7.0	8	5	10	77	30	**5:35**
Schedule 2	1-2	90	4.0	2.2	107	30	**3:50**	7.0	8	5	10	74	30	**6:00**
Schedule 3	1-2	90	3.5	2.7	77	30	**3:20**	7.0	8	5	10	65	30	**5:20**
Schedule 4	1-2	90	2.9	2.9	59	30	**3:00**	7.0	8	5	10	40	30	**4:35**
Schedule 5	1-2	90	3.4	2.6	78	30	**3:20**	7.0	8	5	10	61	30	**5:15**
CHESTER COUNTY														
Downtown Area	1-7	90	5.6	5.3	63	30	**3:05**	13.2	14	5	10	45	30	**4:50**
Downtown Area	8-14	110	5.6	5.7	59	30	**3:20**	13.2	14	5	10	40	31	**5:05**
East Side	1-7	90	13.4	7.2	112	30	**3:55**	13.2	14	5	10	55	30	**5:50**
East Side	8-14	110	13.4	7.6	106	30	**4:10**	13.2	14	5	10	53	31	**6:05**
North Side	1-7	90	10.1	5.1	119	30	**4:00**	13.2	14	5	10	43	30	**5:45**
North Side	8-14	110	10.1	5.5	110	30	**4:10**	13.2	14	5	10	43	31	**5:55**
West Side	1-4	90	17.9	5.5	197	30	**5:20**	13.2	14	5	10	60	30	**7:20**
West Side	5-9	110	17.9	5.8	184	30	**5:25**	13.2	14	5	10	60	31	**7:30**
MONTGOMERY COUNTY														
Central Zone	1-7	90	12.1	3.3	220	30	**5:40**	12.5	14	5	10	44	30	**7:25**
Central Zone	8-14	110	12.1	3.4	214	30	**5:55**	12.5	14	5	10	41	31	**7:40**
East Zone	1-7	90	13.4	3.7	217	30	**5:40**	12.5	14	5	10	48	30	**7:30**
East Zone	8-15	110	13.4	3.7	215	30	**5:55**	12.5	14	5	10	45	31	**7:40**
North Zone	1-7	90	10.5	3.5	182	30	**5:05**	12.5	14	5	10	49	30	**6:55**
North Zone	8-14	110	10.5	3.5	180	30	**5:20**	12.5	14	5	10	45	31	**7:05**

Route	Bus Number	One-Wave						Two-Wave						
		Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
South Zone	1-7	90	10.8	3.1	209	30	**5:30**	12.5	14	5	10	44	30	**7:15**
South Zone	8-14	110	10.8	3.3	197	30	**5:40**	12.5	14	5	10	41	30	**7:20**
						Maximum ETE:	**5:55**						**Maximum ETE:**	**7:40**
						Average ETE:	**4:35**						**Average ETE:**	**6:25**

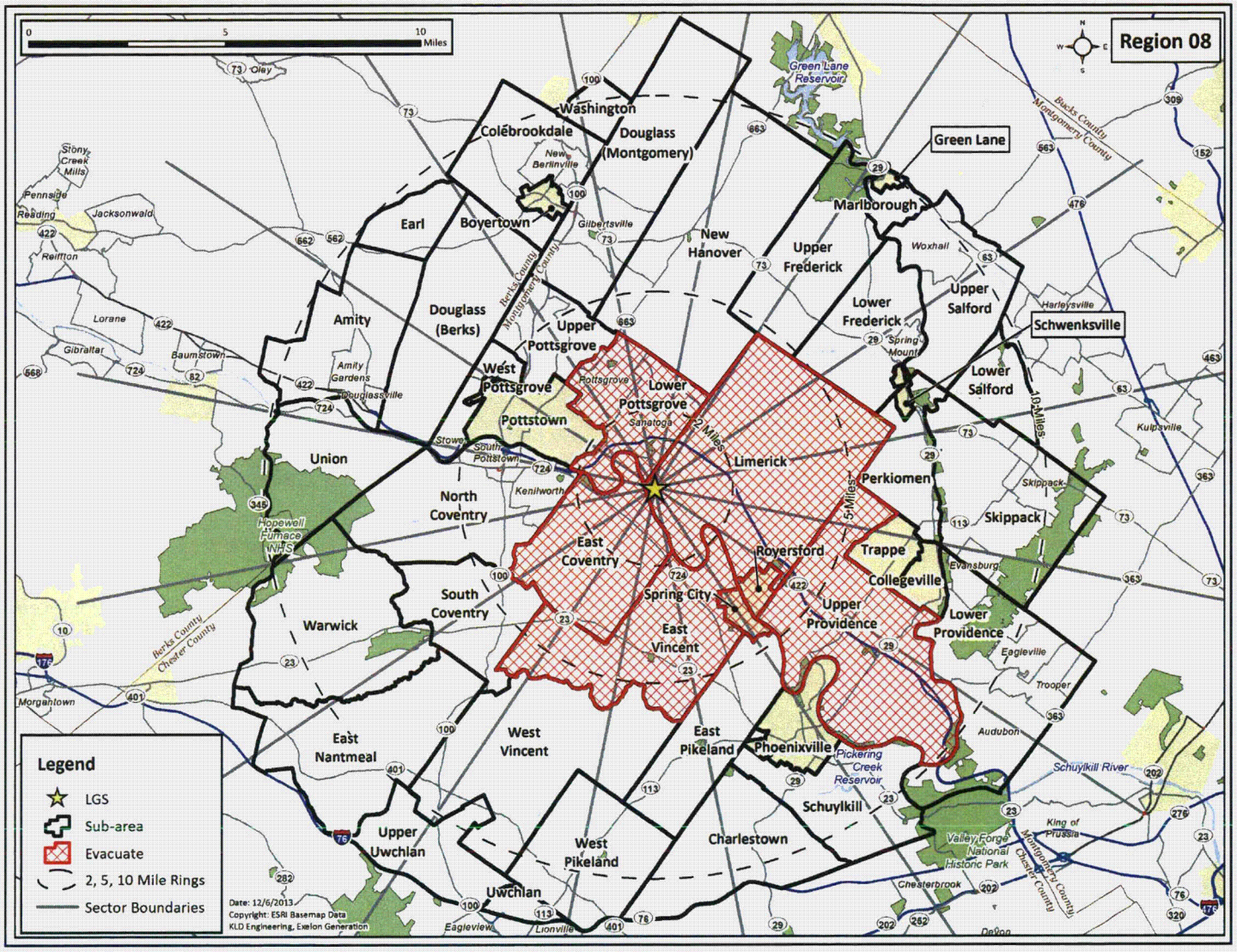

Figure H-8. Region R08

1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Limerick Generating Station (LGS), located in Montgomery County, Pennsylvania. ETE provide state and local governments with site-specific information needed for Protective Action decision-making.

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

- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, November 2011.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/FEMA REP 1, Rev. 1, November 1980.
- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR 1745, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.
- 10CFR50, Appendix E – "Emergency Planning and Preparedness for Production and Utilization Facilities"

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

Table 1-1. Stakeholder Interaction

Stakeholder	Nature of Stakeholder Interaction
Exelon	Provided data (telephone survey, employees, transients, special facilities, transit resources) needed for the study. Coordinated information exchange with offsite response organizations. Reviewed draft report and provided comments.
Berks County	Provided existing emergency plan, including traffic and access control points and other information critical to the ETE study. Engaged in the ETE development and informed of the study results.
Chester County	
Montgomery County	
Pennsylvania Emergency Management Agency	

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 Exelon.
    b. Conducted bi-weekly conference calls with Exelon to identify issues to be addressed and resources available.
    c. Conducted a detailed field survey of the highway system and of area traffic conditions within the Emergency Planning Zone (EPZ) and Shadow Region.
    d. Obtained demographic data from the 2010 census and from Exelon.
    e. Obtained results of a random sample telephone survey of EPZ residents from Exelon.
    f. Obtained data from Exelon to identify and describe schools, special facilities, major employers, transportation providers, and other important information.
2. Estimated distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the random sample telephone survey.
3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, in trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.
4. Reviewed the existing traffic management plan to be implemented by local and state police in the event of an incident at the plant. Traffic and access control are applied at specified Traffic Control Points (TCP) and Access Control Points (ACP) located within the study area.
5. Divided the EPZ into 43 Sub-areas along township and borough boundaries. Used these Sub-areas to define Evacuation Regions. "Regions" are groups of contiguous sub-areas for which ETE are calculated. The configurations of these Regions reflect wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a "key-hole section" within the EPZ as recommended by NUREG/CR-7002.
6. Estimated demand for transit services for persons at special facilities and for transit-dependent persons at home.
7. Prepared the input streams for the DYNEV II system.
    a. Estimated the evacuation traffic demand, based on the available information derived from Census data, and from data provided by local and state agencies, Exelon and from the telephone survey.

b. Applied the procedures specified in the 2010 Highway Capacity Manual (HCM[1]) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.

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

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

e. Specified selected candidate destinations for each "origin" (location of each "source" where evacuation trips are generated over the mobilization time) to support evacuation travel consistent with outbound movement relative to the location of the LGS.

8. Executed the DYNEV II model to determine optimal evacuation routing and compute ETE for all residents, transients and employees ("general population") with access to private vehicles. Generated a complete set of ETE for all specified Regions and Scenarios.
9. Documented ETE in formats in accordance with NUREG/CR-7002.
10. Calculated the ETE for all transit activities including those for special facilities (schools, medical facilities, etc.), for the transit-dependent population and for homebound special needs population.

1.2 The Limerick Generating Station Location

The LGS is located along the Schuylkill River in Limerick Township, Montgomery County, Pennsylvania. The site is approximately 30 miles northwest of Philadelphia, PA. The EPZ consists of parts of Berks, Chester and Montgomery Counties in Pennsylvania. Figure 1-1 displays the area surrounding the LGS. This map identifies the communities in the area and the major roads.

[1] Highway Capacity Manual (HCM 2010), Transportation Research Board, National Research Council, 2010.

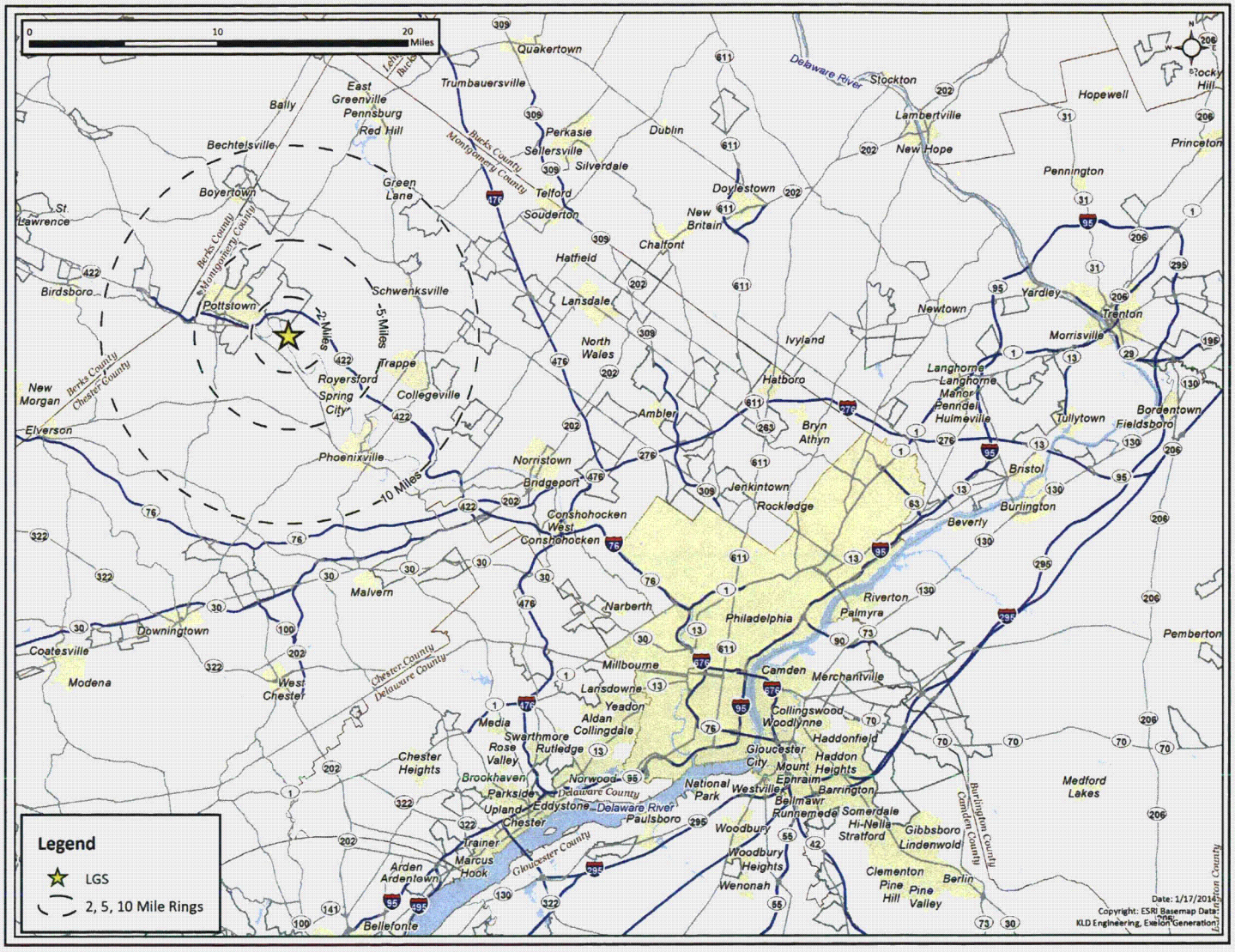

Figure 1-1. LGS Location

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 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:

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.

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 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 15-30 in the HCM shows little sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographical information systems (GIS) shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the DYNEV II System.

As documented on page 15-5 of the HCM 2010, the capacity of a two-lane highway is 1700 passenger cars per hour in one direction. For freeway sections, a value of 2250 vehicles per hour per lane is assigned, as per Exhibit 11-17 of the HCM 2010. The road survey has identified several segments which are characterized by adverse geometrics on two-lane highways which are reflected in reduced values for both capacity and speed. These estimates are consistent with the service volumes for LOS E presented in HCM Exhibit 15-30. These links may be

identified by reviewing Appendix K. Link capacity is an input to DYNEV II which computes the ETE. Further discussion of roadway capacity is provided in Section 4 of this report.

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

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

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

Telephone Survey

The results of a telephone survey conducted in 2012 were obtained 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 returns.

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

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).

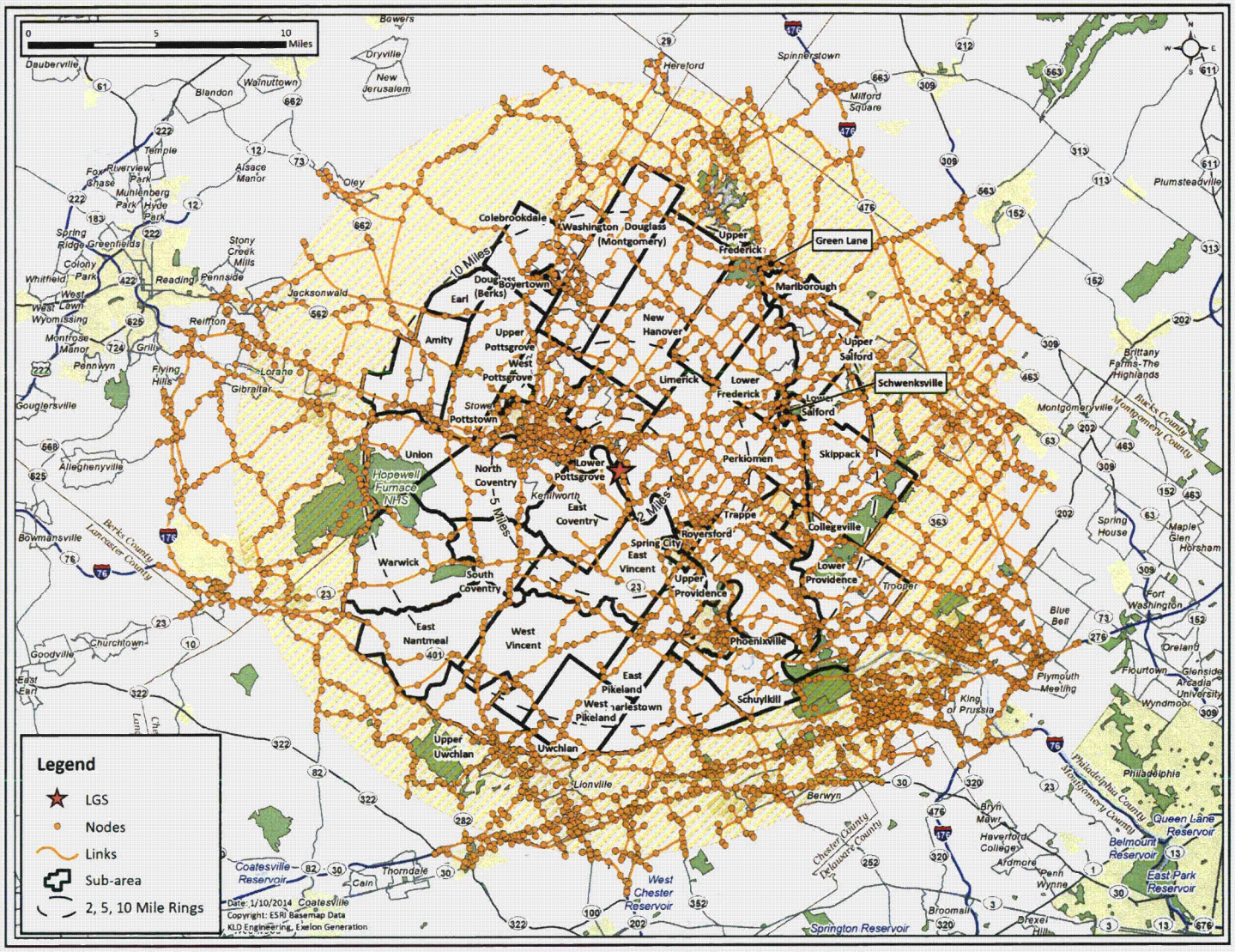

Figure 1-2. LGS Link-Node Analysis Network

DYNEV II consists of four sub-models:

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

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

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

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

For the reader interested in an evaluation of the original model, I-DYNEV, the following references are suggested:

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

The evacuation analysis procedures are based upon the need to:

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

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

countermeasures may then be tested with the model.

1.4 Comparison with Prior ETE Study

Table 1-3 presents a comparison of the present ETE study with the 2008 study. Despite the significant population increase in the EPZ since the last ETE study, the ETE for winter scenarios are comparable and for summer scenarios ETE are less in this study. The follow factors contribute to these changes in ETE:

- 2010 HCM used – baseline capacity estimates have continuously increased from one version to the next of the HCM. The previous study used the 1985 HCM. Higher capacity estimates result in lower ETE.
- The highway representation is far more detailed providing more routing choices for evacuees, which could reduce ETE.
- Dynamic evacuation modeling used which adjusts routing to avoid traffic congestion to the extent feasible (similar to a modern GPS) and could reduce in ETE.
- Roadway improvements to accommodate the significant increase in population.

Table 1-3. ETE Study Comparisons

Topic	Previous ETE Study	Current ETE Study
Resident Population Basis	2000 US Census Data; Population = 244,306	ArcGIS Software using 2010 US Census blocks; area ratio method used. Population = 292,136
Resident Population Vehicle Occupancy	Vehicle occupancy based on Census 2000 average household occupancy rates and Census 2000 data on vehicles available per household. Vehicle occupancy ranges from 2 to 3 persons per vehicle.	2.54 persons/household, 1.21 evacuating vehicles/household yielding: 2.10 persons/vehicle.
Employee Population	Employee estimates based on lists obtained from the Harris InfoSource Directory, local Chambers of Commerce, and the facility list from the 1992 study. 1.0 employee per vehicle was used for all major employers. Employees = 18,200	Employee estimates based on information provided about major employers in EPZ, US Census Longitudinal Employer-Household Dynamics Employees = 13,930

Topic	Previous ETE Study	Current ETE Study
Transit-Dependent Population	Recognized there will be some transport dependent population and pick up points have been established for this population. No number provided and no explicit assignment of vehicles was made to reflect this population.	Estimates based upon U.S. Census data and the results of the telephone survey. A total of 3,533 people who do not have access to a vehicle, requiring 118 buses to evacuate. An additional 264 homebound special needs persons needed special transportation to evacuate (61 wheelchair vans and 11 ambulances are required to evacuate this population).
Transient Population	Transient estimates based on information from the 2002 AAA Tour Book listings and local tourism websites and the 2002 AAA Tour Book listings, phone calls to local facilities, and data obtained from state and county agencies. Transients = 10,048	Transient estimates based upon information provided about transient attractions in EPZ. Transients = 14,486
Special Facilities Population	Special facility population based on information provided by each county within the EPZ. Considered the evacuation of Graterford Prison. Special Facility Population = 3,552 Vehicles originating at special facilities = 1,384	Special facility population based on information provided by Exelon Current census = 2,765 Buses Required = 78 Wheelchair Vans Required = 149 Ambulances Required = 77
School Population	School population based on information provided by regional school districts, private schools, colleges, and the Department of Public Welfare. School enrollment = 41,231 Daycare enrollment = 7,770	School population based on information provided by Exelon School enrollment = 49,321 Preschool enrollment = 12,110
Voluntary evacuation from within EPZ in areas outside region to be evacuated	The impact of "voluntary evacuation" has been addressed in this study by identifying locations where voluntary evacuation could interfere with traffic evacuating from the EPZ. No traffic demand associated with "voluntary evacuees" was considered.	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	The impact of "voluntary evacuation" has been addressed in this study by identifying locations where voluntary evacuation could interfere with traffic evacuating from the EPZ. No traffic demand associated with "voluntary evacuees" was considered.	20% of people outside of the EPZ within the Shadow Region (see Figure 7-2)
Network Size	315 links; 262 nodes	5,156 links; 3,020 nodes
Roadway Geometric Data	Field surveys conducted in 2002 and 2008. Road capacities based on 1985 HCM	Field surveys conducted in November 2013. Roads and intersections were video archived. Road capacities based on 2010 HCM.
School Evacuation	Direct evacuation to designated Host School.	Direct evacuation to designated Host School.
Ridesharing	Not considered	50 percent of transit-dependent persons will evacuate with a neighbor or friend.
Trip Generation for Evacuation	Preparation and mobilization times were developed in consultation with state emergency preparedness officials. Permanent Residents leave between 15 and 135 minutes. Employees and transients leave between 15 and 45 minutes.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 15 and 195 minutes. Residents without commuters returning leave between 15 and 120 minutes. Employees and transients leave between 15 and 75 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 20% in the event of rain and 30% for snow.	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.
Modeling	NetVac2	DYNEV II System – Version 4.0.17.0
Special Events	None considered	Phoenixville Firebird Festival Special Event Population = 6,000 additional transients
Evacuation Cases	12 Scenarios for full EPZ producing 12 unique cases.	46 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 644 unique cases.

Topic	Previous ETE Study	Current ETE Study
Evacuation Time Estimates Reporting	ETE reported for 90th and 100th percentile for a full EPZ evacuation. Results presented by 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 Day, Fair Weather : 4:58 Summer Weekend, Fair Weather: 6:38	Winter Weekday Midday, Good Weather: 5:05 Summer Weekend, Midday, Good Weather: 4:45

2 STUDY ESTIMATES AND ASSUMPTIONS

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

2.1 Data Estimates

1. Population estimates are based upon Census 2010 data.
2. Estimates of employees who reside outside the EPZ and commute to work within the EPZ are based upon US Census Longitudinal Employer-Household Dynamics tools (see Section 3.4).
3. Population estimates at special facilities are based on data provided by Exelon.
4. Roadway capacity estimates are based on field surveys and the application of the Highway Capacity Manual 2010.
5. Population mobilization times are based on a statistical analysis of data acquired from a random sample telephone survey of EPZ residents (see Section 5 and Appendix F).
6. The relationship between resident population and evacuating vehicles is developed from the telephone survey. Average values of 2.54 persons per household (See Appendix F, Figure F-1) and 1.21 evacuating vehicles per household (Figure F-4) are used. The relationship between persons and vehicles for transients and employees is as follows:
    a. Employees: vehicle occupancy data (provided by Exelon) varies by facility for schools and medical facilities and is approximately one employee per vehicle on average; one employee per vehicle assumed for all other major employers.
    b. Transients: varies from 1.79 to 2.85 persons per vehicle depending on the type of facility.
    c. Special Events: Transients attending the Phoenixville Firebird Festival have an estimated occupancy of 2 persons per vehicle.

2.2 Study Methodological Assumptions

1. ETE are presented for the evacuation of the 90th and 100th percentiles of population for each Region and for each Scenario. The percentile ETE is defined as the elapsed time from the Advisory to Evacuate issued to a specific Region of the EPZ, to the time that Region is clear of the indicated percentile of evacuees. A Region is defined as a group of Sub-areas that is issued an Advisory to Evacuate. A scenario is a combination of circumstances, including time of day, day of week, season, and weather conditions.
2. The ETE are computed and presented in tabular format and graphically, in a format compliant with NUREG/CR-7002.
3. Evacuation movements (paths of travel) are generally outbound relative to the plant to the extent permitted by the highway network. All major evacuation routes are used in the analysis.
4. Regions are defined by the underlying "keyhole" or circular configurations as specified in Section 1.4 of NUREG/CR-7002. These Regions, as defined, display irregular boundaries reflecting the geography of the Sub-areas included within these underlying configurations.
5. As indicated in Figure 2-2 of NUREG/CR-7002, 100% of people within the impacted "keyhole" evacuate. 20% of those people within the EPZ, not within the impacted keyhole, will voluntarily evacuate. 20% of those people within the Shadow Region will voluntarily evacuate. See Figure 2-1 for a graphical representation of these evacuation percentages. Sensitivity studies explore the effect on ETE of increasing the percentage of voluntary evacuees in the Shadow Region (see Appendix M).
6. A total of 14 "Scenarios" representing different temporal variations (season, time of day, day of week) and weather conditions are considered. These Scenarios are outlined in Table 2-1.
7. Scenario 14 considers the closure of a single lane eastbound on US 422 from the interchange with Evergreen Rd to the interchange with US 202.
8. 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[1]). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The new DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment. The DYNEV II System is used to compute ETE in this study.

[1] Urbanik, T., et. al. Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code, NUREG/CR-4873, Nuclear Regulatory Commission, June, 1988.

Table 2-1. Evacuation Scenario Definitions

Scenario	Season[2]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Winter	Midweek, Weekend	Evening	Good	Phoenixville Firebird Festival
14	Summer	Midweek	Midday	Good	Single Lane Closure US 422 Eastbound

[2] Winter assumes that school is in session (also applies to spring and autumn). Summer assumes that school is not in session.

Figure 2-1. Voluntary Evacuation Methodology

2.3 Study Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following:
    a. Advisory to Evacuate is announced coincident with the siren notification.
    b. Mobilization of the general population will commence within 15 minutes after siren notification.
    c. ETE are measured relative to the Advisory to Evacuate.
2. It is assumed that everyone within the group of Sub-areas forming a Region that is issued an Advisory to Evacuate will, in fact, respond and evacuate in general accord with the planned routes.
3. 60 percent of the households in the EPZ have at least 1 commuter (see Figure F-3); 43 percent of those households with commuters will await the return of a commuter before beginning their evacuation trip (see Figure F-5), based on the telephone survey results. Therefore 26 percent (60% x 43% = 26%) of EPZ households will await the return of a commuter, prior to beginning their evacuation trip.
4. The ETE will also include consideration of "through" (External-External) trips during the time that such traffic is permitted to enter the evacuated Region. "Normal" traffic flow is assumed to be present within the EPZ at the start of the emergency.
5. Access Control Points (ACP) will be staffed within approximately 120 minutes following the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no through traffic will enter the EPZ after this 120 minute time period.
6. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. Their number and location will depend on the Region to be evacuated and resources available. The objectives of these TCP are:
    a. Facilitate the movements of all (mostly evacuating) vehicles at the location.
    b. Discourage inadvertent vehicle movements towards the plant.
    c. Provide assurance and guidance to any traveler who is unsure of the appropriate actions or routing.
    d. Act as local surveillance and communications center.
    e. Provide information to the emergency operations center (EOC) as needed, based on direct observation or on information provided by travelers.

    In calculating ETE, it is assumed that evacuees will drive safely, travel in directions identified in the plan, and obey all control devices and traffic guides.

    Special consideration was given to the Pennsylvania Turnpike ACPs and TCPs in accordance with the Pennsylvania State Plan Annex E, Attachment B, Appendix 20, pages E-20-10 and E-20-11.

7. Buses will be used to transport those without access to private vehicles:
    a. If schools are in session, transport (buses) will evacuate students directly to the designated host schools.
    b. Buses, wheelchair vans and ambulances will evacuate patients at medical facilities and at any senior facilities within the EPZ, as needed.
    c. Transit-dependent general population will be evacuated to Reception Centers.
    d. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
    e. Bus mobilization time is considered in ETE calculations.
    f. Analysis of the number of required round-trips ("waves") of evacuating transit vehicles is presented.
8. Provisions are made for evacuating the transit-dependent portion of the general population to reception centers by bus, based on the assumption that some of these people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. We assume that the percentage of people who rideshare is 50 percent. This assumption is based upon reported experience for other emergencies[3], and on guidance in Section 2.2 of NUREG/CR-7002.
9. 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 plowing the roads as they would normally when snowing.

    Adverse weather scenarios affect roadway capacity and the free flow highway speeds. The factors applied for the ETE study are based on recent research on the effects of weather on roadway operations[4]; the factors are shown in Table 2-2.

10. School buses used to transport students are assumed to transport 70 students per bus for elementary schools and 50 students per bus for middle and high schools. Transit buses used to transport the transit-dependent general population are assumed to transport 30 people per bus. Buses evacuating patients from medical facilities can transport 30 ambulatory people per bus; 4 wheelchair bound persons per wheelchair van; and bedridden patients per ambulance.

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[3] 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 76% (Page 5-10).

[4] Agarwal, M. et. al. Impacts of Weather on Urban Freeway Traffic Flow Characteristics and Facility Capacity, Proceedings of the 2005 Mid-Continent Transportation Research Symposium, August, 2005. The results of this paper are included as Exhibit 10-15 in the HCM 2010.

Table 2-2. Model Adjustment for Adverse Weather

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time for General Population
Rain	90%	90%	No Effect
Snow	80%	80%	Clear driveway before leaving home (See Figure F-9)
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

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 2010 Census, however, is not adequate for directly estimating some transient groups.

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

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

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

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

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

- Permanent residents - people who are year round residents of the EPZ.
- Transients - people who reside outside of the EPZ who enter the area for a specific purpose (shopping, recreation) and then leave the area.
- Employees - people who reside outside of the EPZ and commute to businesses 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 Sub-area and by polar coordinate representation (population rose). The LGS EPZ is subdivided into 43 Sub-areas. The EPZ is shown in Figure 3-1.

3.1 Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. The average household size (2.54 persons/household – See Figure F-1) and the number of evacuating vehicles per household (1.21 vehicles/household – See Figure F-4) were adapted from the telephone survey results.

Population estimates are based upon Census 2010 data. The estimates are created by cutting the census block polygons by the Sub-area and EPZ boundaries. 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 what the population is within the EPZ. This methodology assumes that the population is evenly distributed across a census block. Table 3-1 provides the permanent resident population within the EPZ by Sub-area based on this methodology.

The year 2010 permanent resident population is divided by the average household size and then multiplied by the average number of evacuating vehicles per household in order to estimate number of vehicles. 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 LGS. This "rose" was constructed using GIS software.

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

- Assume 50 percent of all households vacation for a two-week 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.

3.1.1 Special Facilities

Montgomery County Correctional Facility, the State Correctional Institute at Graterford, and several large medical facilities are located within the EPZ (see Table E-3 and Table E-7). These facilities have permanent residents that are included in the Census; however, the correctional facilities will shelter-in-place (based on discussions with Exelon), and the medical facilities are transit dependent (will not evacuate in personal vehicles) and are addressed in Section 8. As such, these residents are included in the EPZ resident population, but no evacuating vehicles are considered for these residents. The vehicles in Table 3-2 and Figure 3-3 have been adjusted accordingly.

3.1.2 Colleges and Universities

There are two higher education facilities with the EPZ. For students evacuating in private vehicles, the same trip generation distribution (see Section 5) as permanent residents was used. Based on discussions with college officials students will evacuate using personal vehicles. Thus, no buses were considered for these facilities.

Ursinus College (located in Collegeville, 7.3 miles east-southeast of LGS) has 1,750 enrolled students according to enrollment data provided by Exelon. Emergency plans posted on the Ursinus College website[1] indicate students will evacuate in private vehicles. The college emergency plans assume ridesharing amongst students will occur such that all students will have a ride out of the EPZ. Using aerial imagery, student parking lots were located and parking spaces were counted on campus to estimate the upper bound of student vehicles on campus. A total of 908 evacuating student vehicles have been incorporated for this facility and have been counted as resident vehicles in both Table 3-2 and Figure 3-3.

Valley Forge Christian College (located in Schuylkill, 7.6 miles south-southeast of LGS) has a total of 800 enrolled students according to enrollment data provided by Exelon. College officials confirmed that students will evacuate using private vehicles. This college also assumes that ridesharing will occur amongst students such that all students will have a ride out of the EPZ. Again, aerial imagery was used to locate student parking lots and count parking spaces. A total of 337 evacuating student vehicles have been incorporated for this campus and have been counted as resident vehicles in both Table 3-2 and Figure 3-3.

[1] http://www.ursinus.edu/netcommunity/document.doc?id=1747

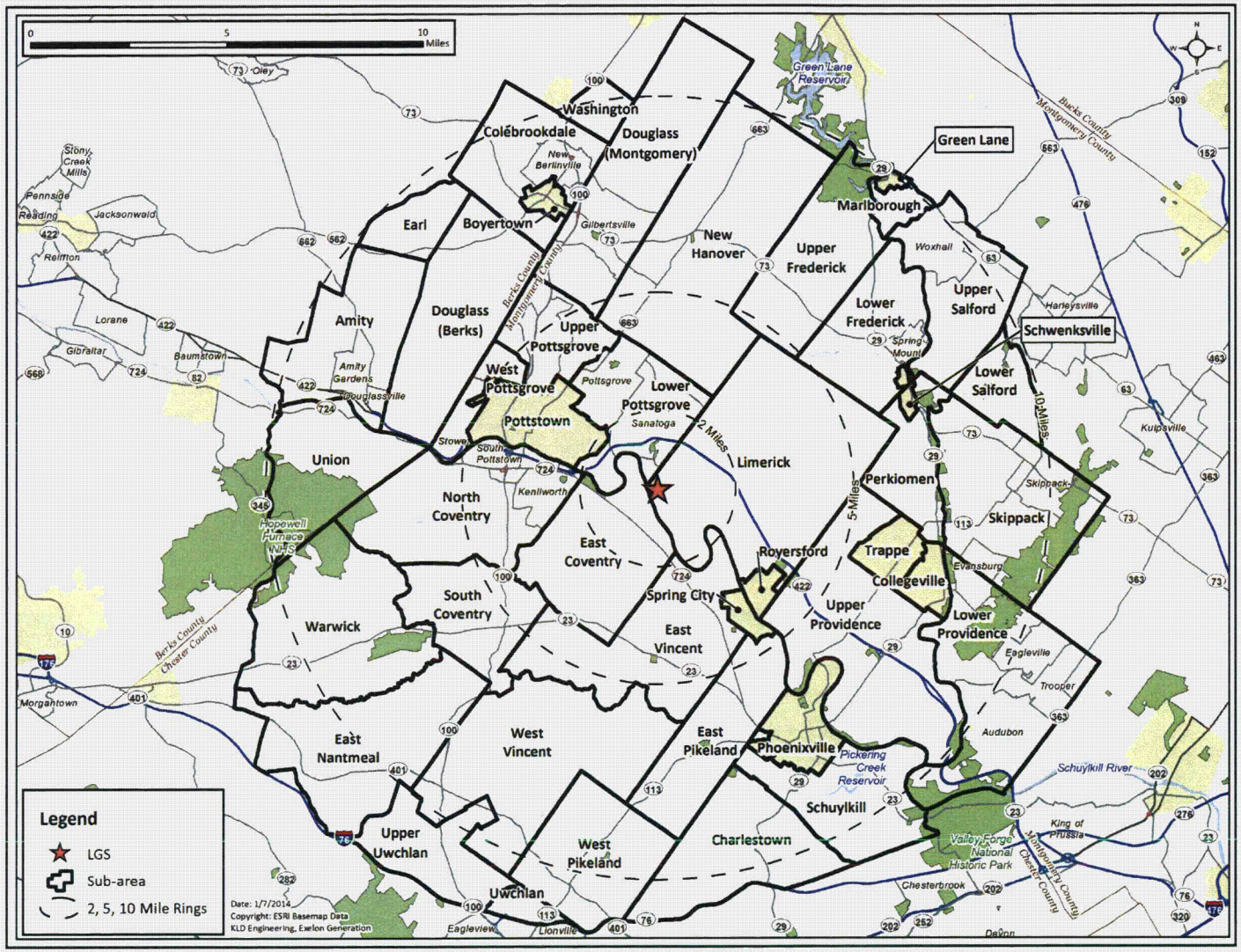


Figure 3-1. LGS EPZ

Table 3-1. EPZ Permanent Resident Population

Sub-area	2000 Population	2010 Population
BERKS COUNTY		
Amity	7,126	10,815
Boyertown	3,941	4,055
Colebrookdale	5,322	5,078
Douglass (Berks)	3,344	3,306
Earl	730	717
Union	1,123	1,215
Washington	610	715
Berks County Total:	**22,196**	**25,901**
CHESTER COUNTY		
Charlestown	3,539	4,141
East Coventry	4,608	6,636
East Nantmeal	1,472	1,500
East Pikeland	6,565	7,079
East Vincent	5,458	6,821
North Coventry	7,381	7,866
Phoenixville	14,757	16,440
Schuylkill	6,991	8,516
South Coventry	1,879	2,604
Spring City	3,298	3,323
Upper Uwchlan	3,674	8,089
Uwchlan	1,399	1,343
Warwick	2,219	2,192
West Pikeland	3,360	3,876
West Vincent	3,190	4,567
Chester County Total:	**69,790**	**84,993**

Table 3-1. EPZ Permanent Resident Population (Continued)

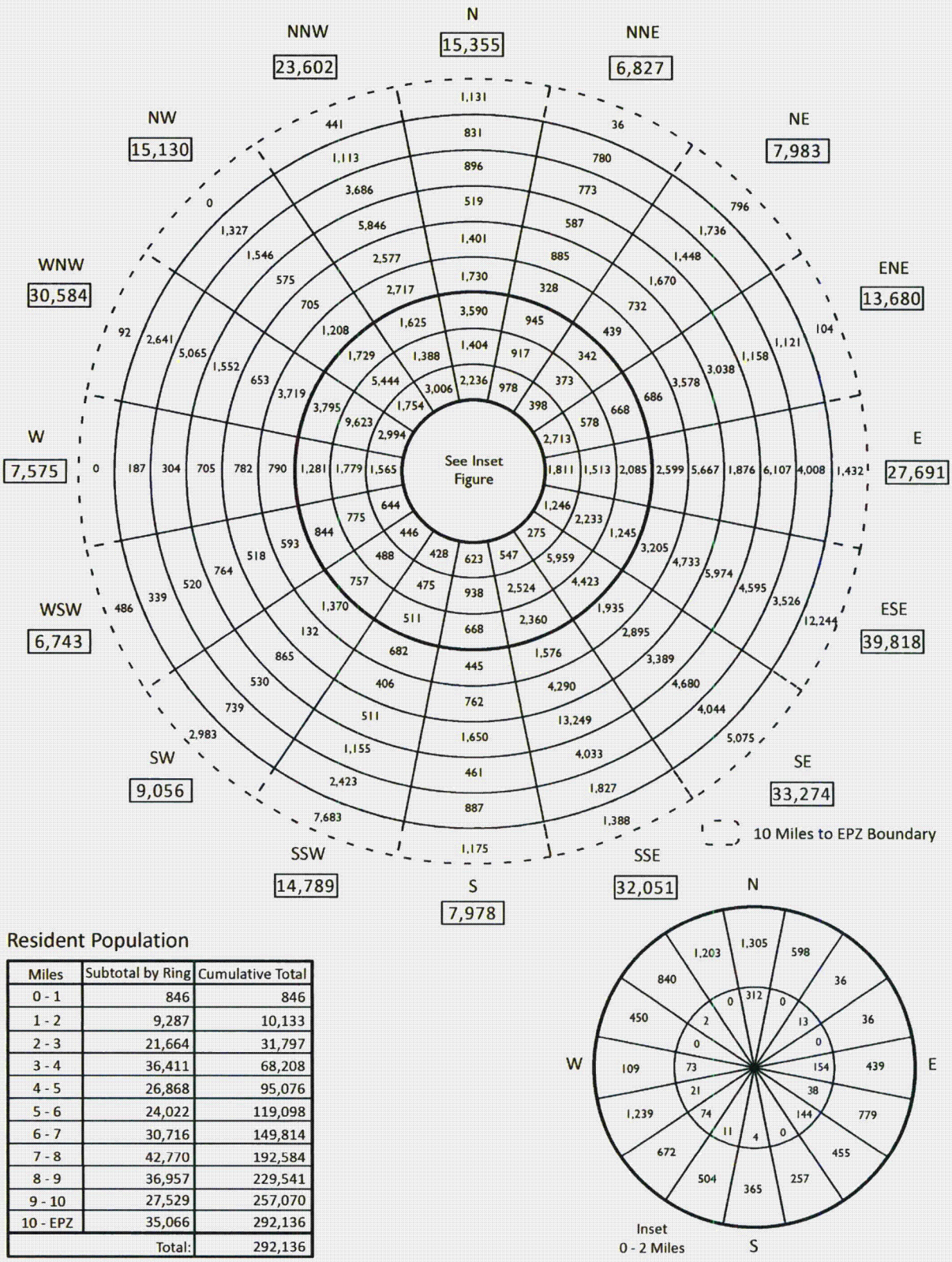
Sub-area	2000 Population	2010 Population
	MONTGOMERY COUNTY	
Collegeville	8,032	5,089
Douglass (Montgomery)	9,098	10,195
Green Lane	584	508
Limerick	13,572	18,074
Lower Frederick	4,793	4,840
Lower Pottsgrove	11,193	12,059
Lower Providence	22,388	25,436
Lower Salford	902	1,503
Marlborough	426	492
New Hanover	7,369	10,939
Perkiomen	7,126	9,139
Pottstown	21,879	22,377
Royersford	4,197	4,752
Schwenksville	1,693	1,385
Skippack	6,516	13,715
Trappe	3,210	3,509
Upper Frederick	3,143	3,523
Upper Pottsgrove	4,085	5,315
Upper Providence	15,376	21,219
Upper Salford	3,024	3,299
West Pottsgrove	3,815	3,874
Montgomery County Total:	**152,421**	**181,242**
TOTAL EPZ POPULATION:	**244,407**	**292,136**
EPZ Population Growth:		**19.5%**

Table 3-2. Permanent Resident Population and Vehicles by Sub-area

Sub-area	2010 Population	2010 Resident Vehicles
BERKS COUNTY		
Amity	10,815	5,146
Boyertown	4,055	1,931
Colebrookdale	5,078	2,412
Douglass (Berks)	3,306	1,569
Earl	717	342
Union	1,215	579
Washington	715	341
Berks County Total:	**25,901**	**12,320**
CHESTER COUNTY		
Charlestown	4,141	2,037
East Coventry	6,636	3,156
East Nantmeal	1,500	713
East Pikeland	7,079	3,366
East Vincent	6,821	3,249
North Coventry	7,866	3,746
Phoenixville	16,440	7,826
Schuylkill	8,516	4,259
South Coventry	2,604	1,238
Spring City	3,323	1,584
Upper Uwchlan	8,089	3,851
Uwchlan	1,343	640
Warwick	2,192	1,042
West Pikeland	3,876	1,843
West Vincent	4,567	2,171
Chester County Total:	**84,993**	**40,721**

Table 3-2. Permanent Resident Population and Vehicles by Sub-area (Continued)

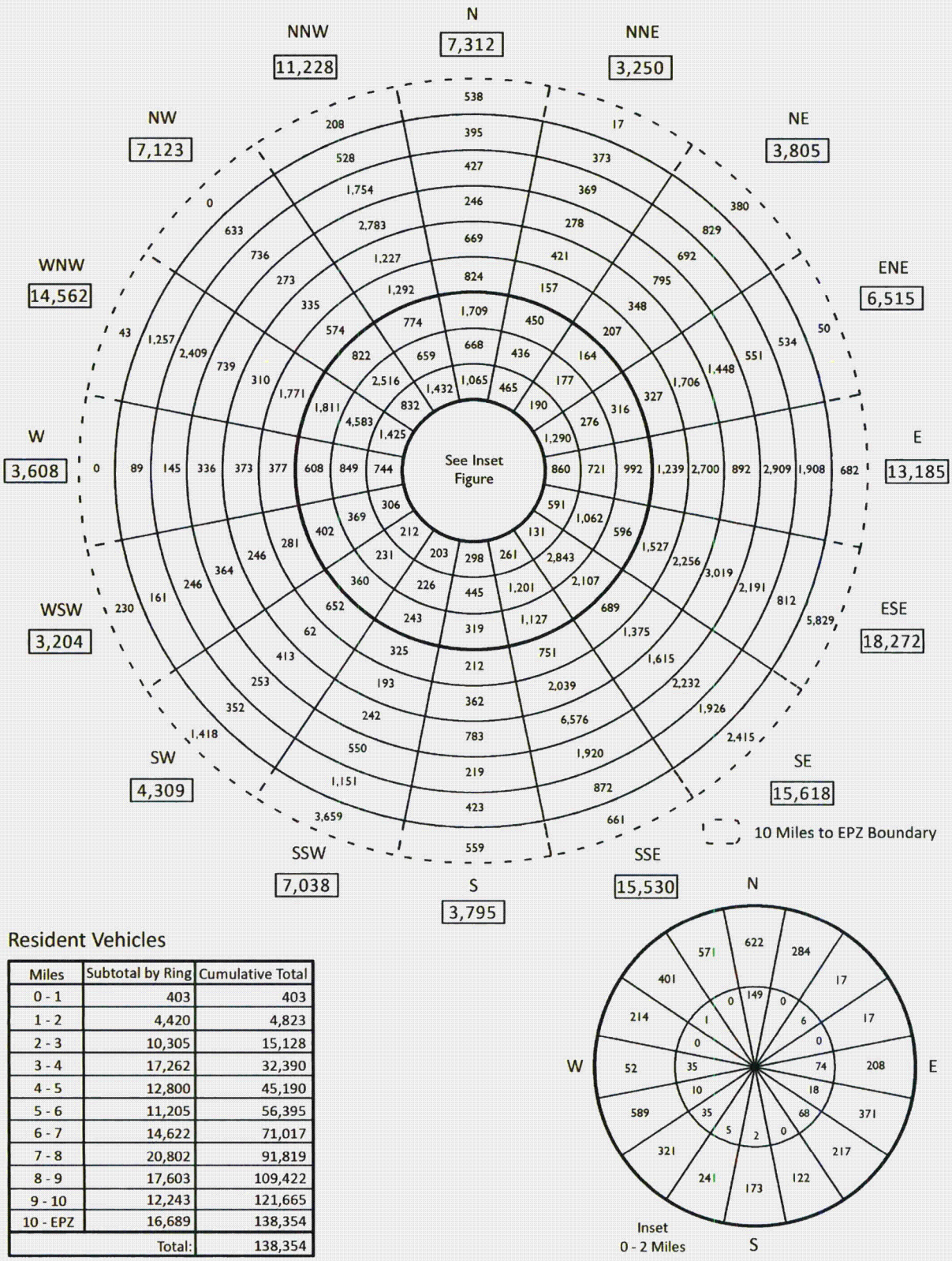
Sub-area	2010 Population	2010 Resident Vehicles
MONTGOMERY COUNTY		
Collegeville	5,089	2,597
Douglass (Montgomery)	10,195	4,852
Green Lane	508	243
Limerick	18,074	8,598
Lower Frederick	4,840	2,305
Lower Pottsgrove	12,059	5,739
Lower Providence	25,436	11,246
Lower Salford	1,503	716
Marlborough	492	236
New Hanover	10,939	5,208
Perkiomen	9,139	4,352
Pottstown	22,377	10,582
Royersford	4,752	2,267
Schwenksville	1,385	660
Skippack	13,715	6,530
Trappe	3,509	1,673
Upper Frederick	3,523	1,679
Upper Pottsgrove	5,315	2,530
Upper Providence	21,219	9,883
Upper Salford	3,299	1,572
West Pottsgrove	3,874	1,845
Montgomery County Total:	**181,242**	**85,313**
TOTAL EPZ POPULATION:	**292,136**	**138,354**



Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	846	846
1 - 2	9,287	10,133
2 - 3	21,664	31,797
3 - 4	36,411	68,208
4 - 5	26,868	95,076
5 - 6	24,022	119,098
6 - 7	30,716	149,814
7 - 8	42,770	192,584
8 - 9	36,957	229,541
9 - 10	27,529	257,070
10 - EPZ	35,066	292,136
	Total:	292,136

Figure 3-2. Permanent Resident Population by Sector



Resident Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	403	403
1 - 2	4,420	4,823
2 - 3	10,305	15,128
3 - 4	17,262	32,390
4 - 5	12,800	45,190
5 - 6	11,205	56,395
6 - 7	14,622	71,017
7 - 8	20,802	91,819
8 - 9	17,603	109,422
9 - 10	12,243	121,665
10 - EPZ	16,689	138,354
	Total:	138,354

Figure 3-3. Permanent Resident Vehicles by Sector

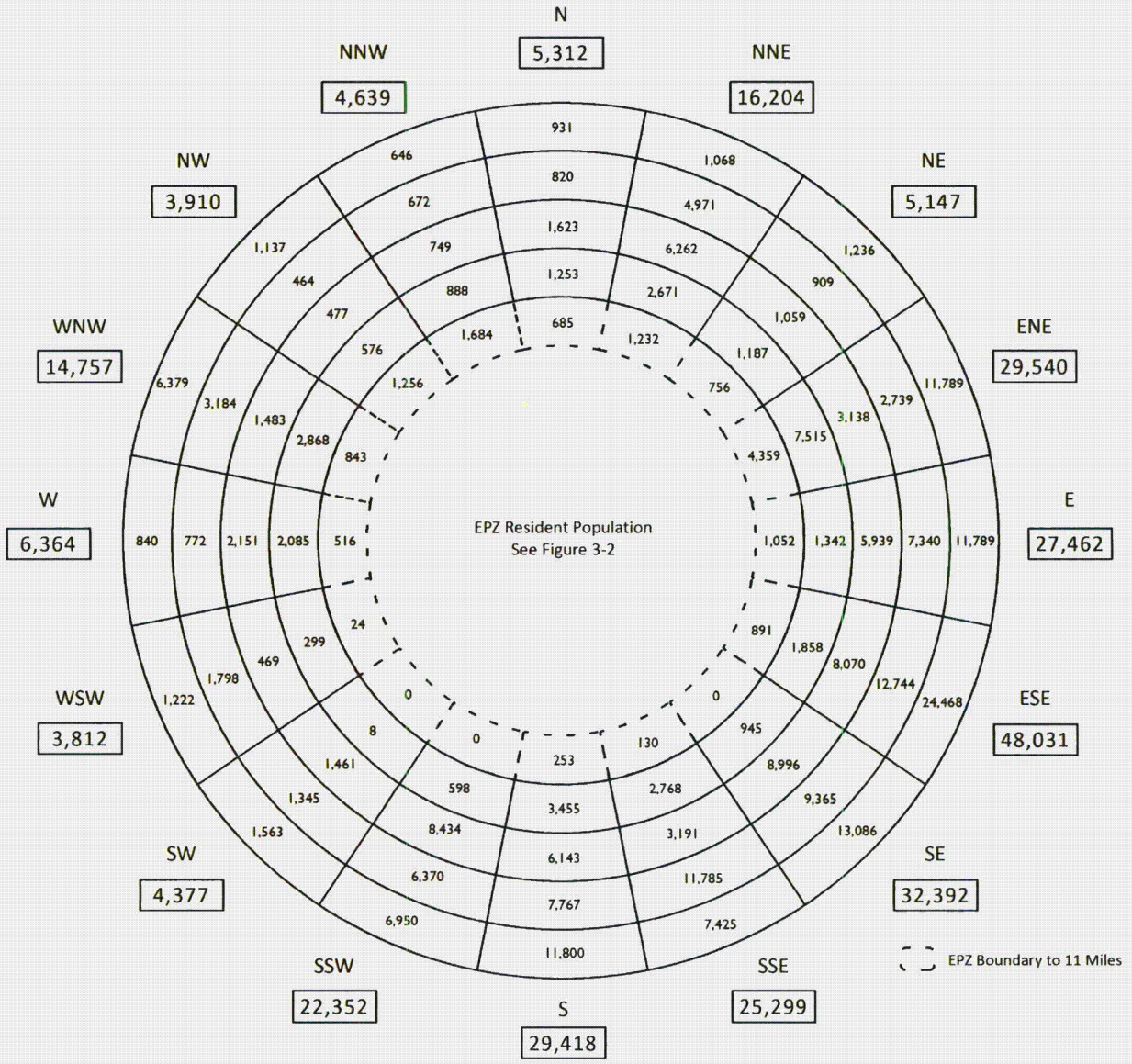
3.2 Shadow Population

A portion of the population living outside the evacuation area extending to 15 miles radially from the LGS (in the Shadow Region) may elect to evacuate without having been instructed to do so. Based upon NUREG/CR-7002 guidance, it is assumed that 20 percent 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, by sector.

Table 3-3. Shadow Population and Vehicles by Sector

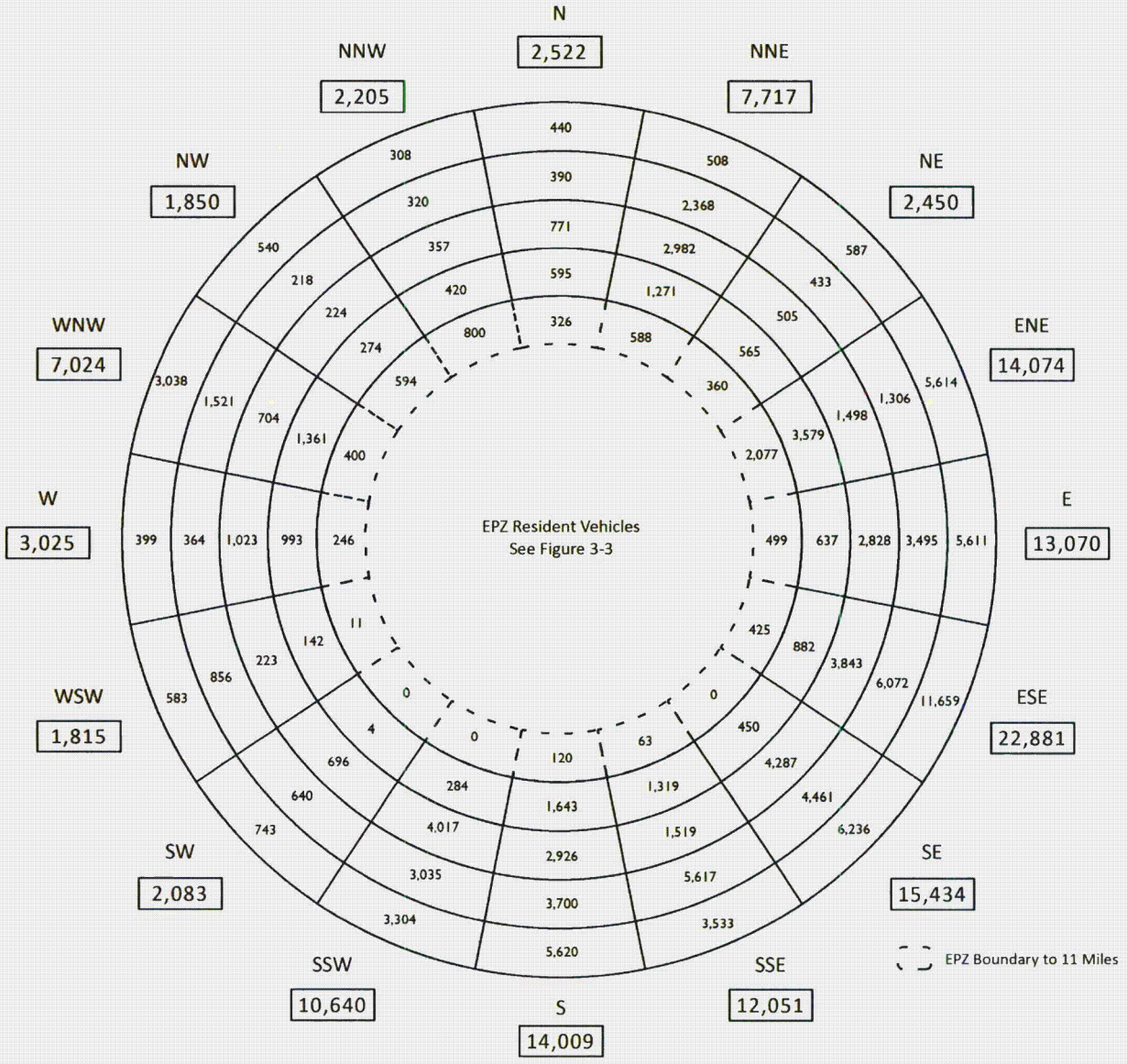
Sector	Population	Evacuating Vehicles
N	5,312	2,522
NNE	16,204	7,717
NE	5,147	2,450
ENE	29,540	14,074
E	27,462	13,070
ESE	48,031	22,881
SE	32,392	15,434
SSE	25,299	12,051
S	29,418	14,009
SSW	22,352	10,640
SW	4,377	2,083
WSW	3,812	1,815
W	6,364	3,025
WNW	14,757	7,024
NW	3,910	1,850
NNW	4,639	2,205
TOTAL	**279,016**	**132,850**



Shadow Population

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	13,681	13,681
11 - 12	30,316	43,997
12 - 13	59,645	103,642
13 - 14	73,045	176,687
14 - 15	102,329	279,016
	Total:	279,016

Figure 3-4. Shadow Population by Sector



Shadow Vehicles

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	6,509	6,509
11 - 12	14,419	20,928
12 - 13	28,403	49,331
13 - 14	34,796	84,127
14 - 15	48,723	132,850
	Total:	132,850

Figure 3-5. Shadow Vehicles by Sector

3.3 Transient Population

Transient population groups are defined as those people (who are not permanent residents, nor commuting employees) who enter the EPZ for a specific purpose (shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. Data for these facilities were provided by Exelon. The LGS EPZ has a number of areas and facilities that attract transients, including:

- Lodging Facilities – 2,079 transients; 1,164 vehicles; 1.79 people per vehicle
- Campgrounds – 1,023 transients; 359 vehicles; 2.85 people per vehicle
- Parks – 3,794 transients; 1,563 vehicles; 2.43 people per vehicle (NOTE: Local parks are not included; visitors to these facilities are local residents and have already been counted as permanent residents in Section 3.1.)
- Expo Center – 1,800 transients; 900 vehicles; 2.00 people per vehicle
- Retailers – 5,250 transients; 2,625 vehicles; 2.00 people per vehicle
- Phoenixville YMCA Program Center – 540 transients; 203 vehicles; 2.66 people per vehicle

Appendix E summarizes the transient data that was gathered for the EPZ. Table E-5 presents the number of transients and vehicles at recreational areas (campgrounds, parks, YMCA, Expo Center and Retailers), while Table E-6 presents the number of transients and vehicles at lodging facilities within the EPZ.

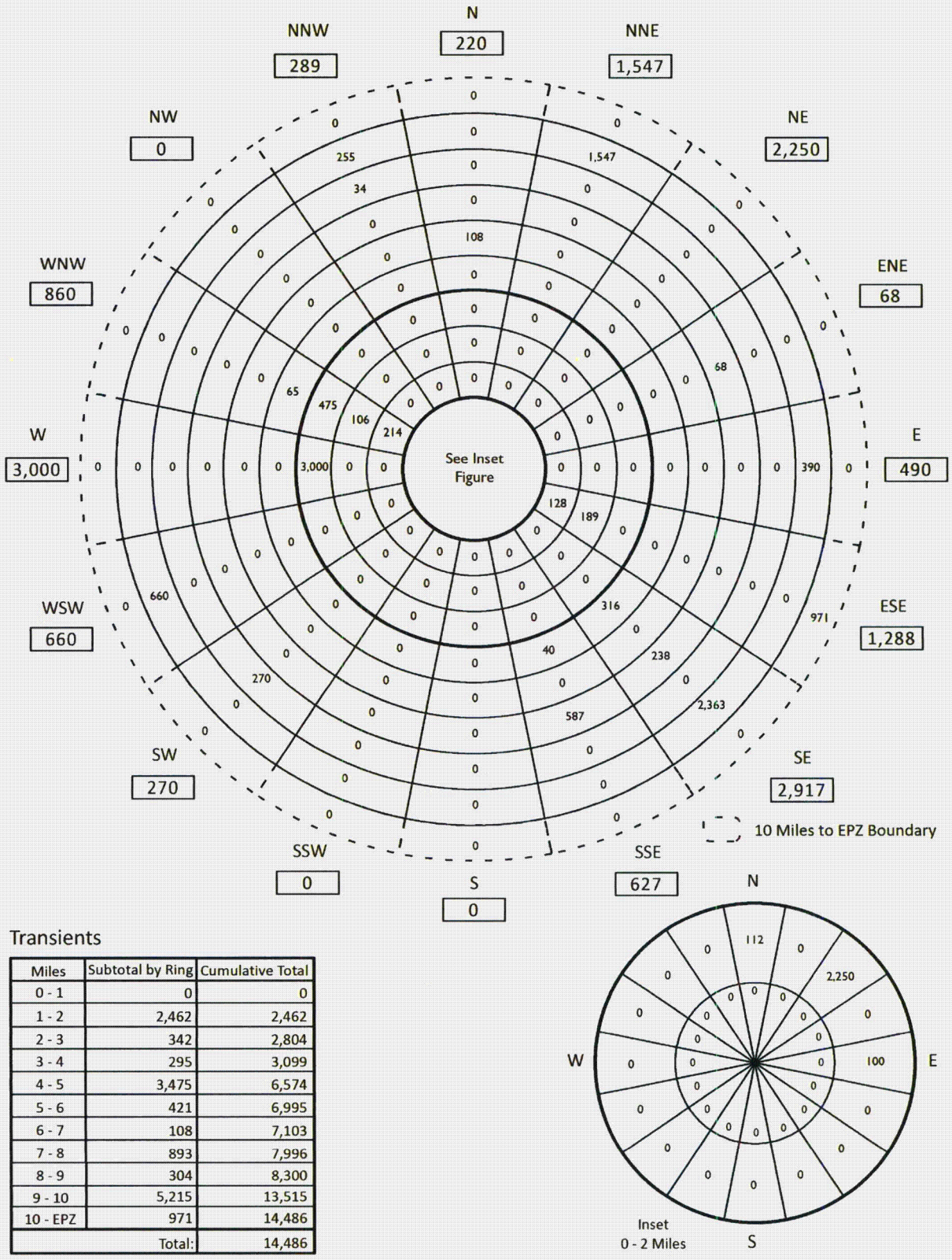
In total there are 14,486 transients evacuating in 6,814 vehicles, an average of 2.13 transients per vehicle. Table 3-4 presents transient population and transient vehicle estimates by Sub-area. Figure 3-6 and Figure 3-7 present these data by sector and distance from the plant.

Table 3-4. Summary of Transients and Transient Vehicles

Sub-area	Transients	Transient Vehicles
BERKS COUNTY		
Amity	0	0
Boyertown	0	0
Colebrookdale	289	104
Douglass (Berks)	65	36
Earl	0	0
Union	0	0
Washington	0	0
Berks County Total:	**354**	**140**
CHESTER COUNTY		
Charlestown	0	0
East Coventry	0	0
East Nantmeal	0	0
East Pikeland	40	22
East Vincent	0	0
North Coventry	3,000	1,500
Phoenixville	47	26
Schuylkill	540	203
South Coventry	0	0
Spring City	0	0
Upper Uwchlan	0	0
Uwchlan	0	0
Warwick	930	321
West Pikeland	0	0
West Vincent	0	0
Chester County Total:	**4,557**	**2,072**

Table 3-4. Summary of Transients and Transient Vehicles (Continued)

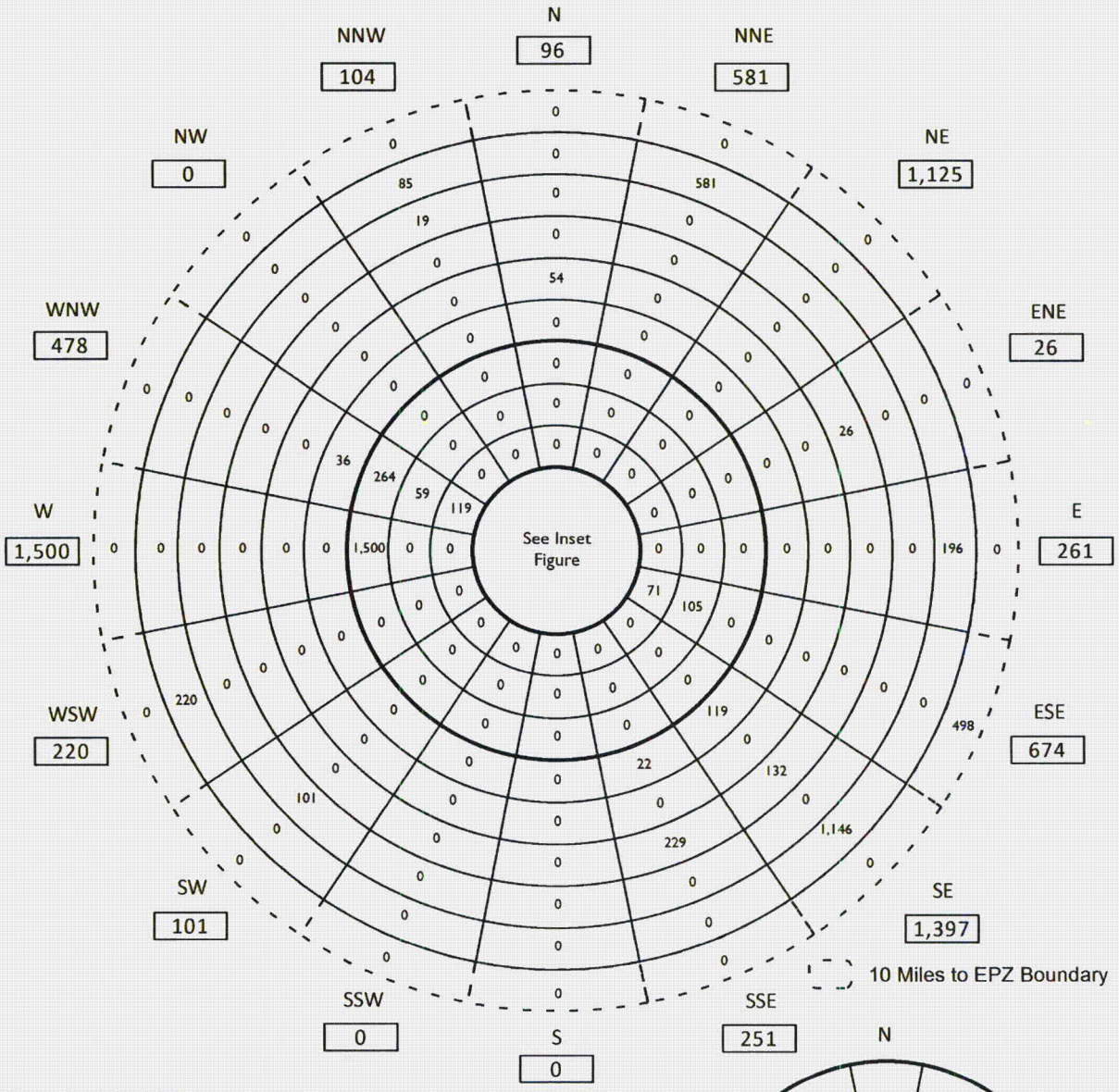
Sub-area	Transients	Transient Vehicles
MONTGOMERY COUNTY		
Collegeville	0	0
Douglass (Montgomery)	0	0
Green Lane	0	0
Limerick	2,667	1,366
Lower Frederick	0	0
Lower Pottsgrove	326	161
Lower Providence	971	498
Lower Salford	0	0
Marlborough	0	0
New Hanover	108	54
Perkiomen	0	0
Pottstown	581	323
Royersford	0	0
Schwenksville	0	0
Skippack	458	222
Trappe	0	0
Upper Frederick	1,547	581
Upper Pottsgrove	0	0
Upper Providence	2,917	1,397
Upper Salford	0	0
West Pottsgrove	0	0
Montgomery County Total:	**9,575**	**4,602**
TOTAL EPZ TRANSIENTS:	**14,486**	**6,814**



Transients

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	2,462	2,462
2 - 3	342	2,804
3 - 4	295	3,099
4 - 5	3,475	6,574
5 - 6	421	6,995
6 - 7	108	7,103
7 - 8	893	7,996
8 - 9	304	8,300
9 - 10	5,215	13,515
10 - EPZ	971	14,486
	Total:	14,486

Figure 3-6. Transient Population by Sector



Transient Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	0	0
1 - 2	1,232	1,232
2 - 3	190	1,422
3 - 4	164	1,586
4 - 5	1,764	3,350
5 - 6	177	3,527
6 - 7	54	3,581
7 - 8	387	3,968
8 - 9	120	4,088
9 - 10	2,228	6,316
10 - EPZ	498	6,814
	Total:	6,814

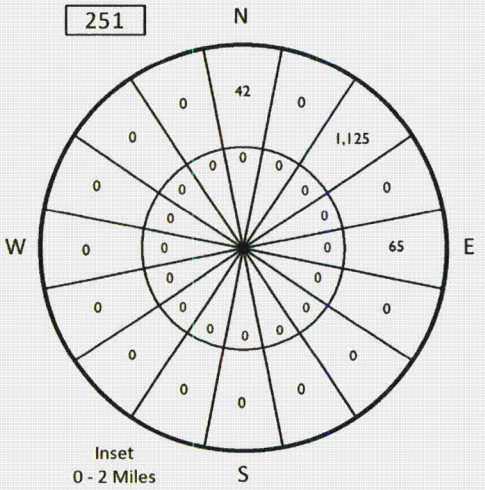


Figure 3-7. Transient Vehicles by Sector

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.

Maximum shift employment data were provided by Exelon for the major employers (generally speaking 50 or more employees in accordance with NUREG/CR-7002) in the EPZ.

Data obtained from the US Census Longitudinal Employer-Household Dynamics OnTheMap Census analysis tool[2] were used to estimate the number of employees commuting into the EPZ to avoid double counting. This tool allows the user to draw a cordon around any area in the US and a report of the number of employees commuting into and out of the cordoned area is produced. The tool was used to draw a cordon around the EPZ. The inflow/outflow report for the EPZ was then used to calculate the percent of employees that work within the EPZ but live outside. This value, 58.3%, was applied to the maximum shift employment to compute the number of people commuting into the EPZ to work at peak times.

In Table E-4, the Employees (Max Shift) column is multiplied by the percent of employees commuting into the EPZ (58.3%) factor to determine the number of employees who are not residents of the EPZ. Vehicle occupancy data were provided by Exelon for staff at schools and medical facilities; these occupancies varied but were approximately 1 employee per vehicle. It is conservatively assumed for all other major employers that there is 1 employee per vehicle as carpooling in the US is minimal.

Based on information provided by the facility, Montgomery County Correctional Facility has 100 employees during the average day shift. During an evacuation, half of these employees would remain at the facility to maintain security at the prison while the other half would evacuate. Applying the 58.3% non-EPZ resident employee factor and a vehicle occupancy factor of 1, the number of non-EPZ resident employee vehicles evacuating from this facility is 30 (100 x 50% = 50 x 58.3% = 30 x 1 = 30), rounding up. The employee and employee vehicle totals for Lower Providence in Table 3-5 reflect this information.

Based on information provided by the facility, the State Correctional Institute at Graterford has 350 employees during the average day shift. During an evacuation, 250 of these employees would remain at the facility to maintain security at the prison. Applying the 58.3% non-EPZ resident employee factor and a vehicle occupancy factor of 1, the number of non-EPZ resident employee vehicles evacuating from this facility is 59 (350 – 250 = 100 x 58.3% = 59 x 1 = 59), rounding up. The employee and employee vehicle totals for Skippack in Table 3-5 reflect this information.

[2] http://onthemap.ces.census.gov/

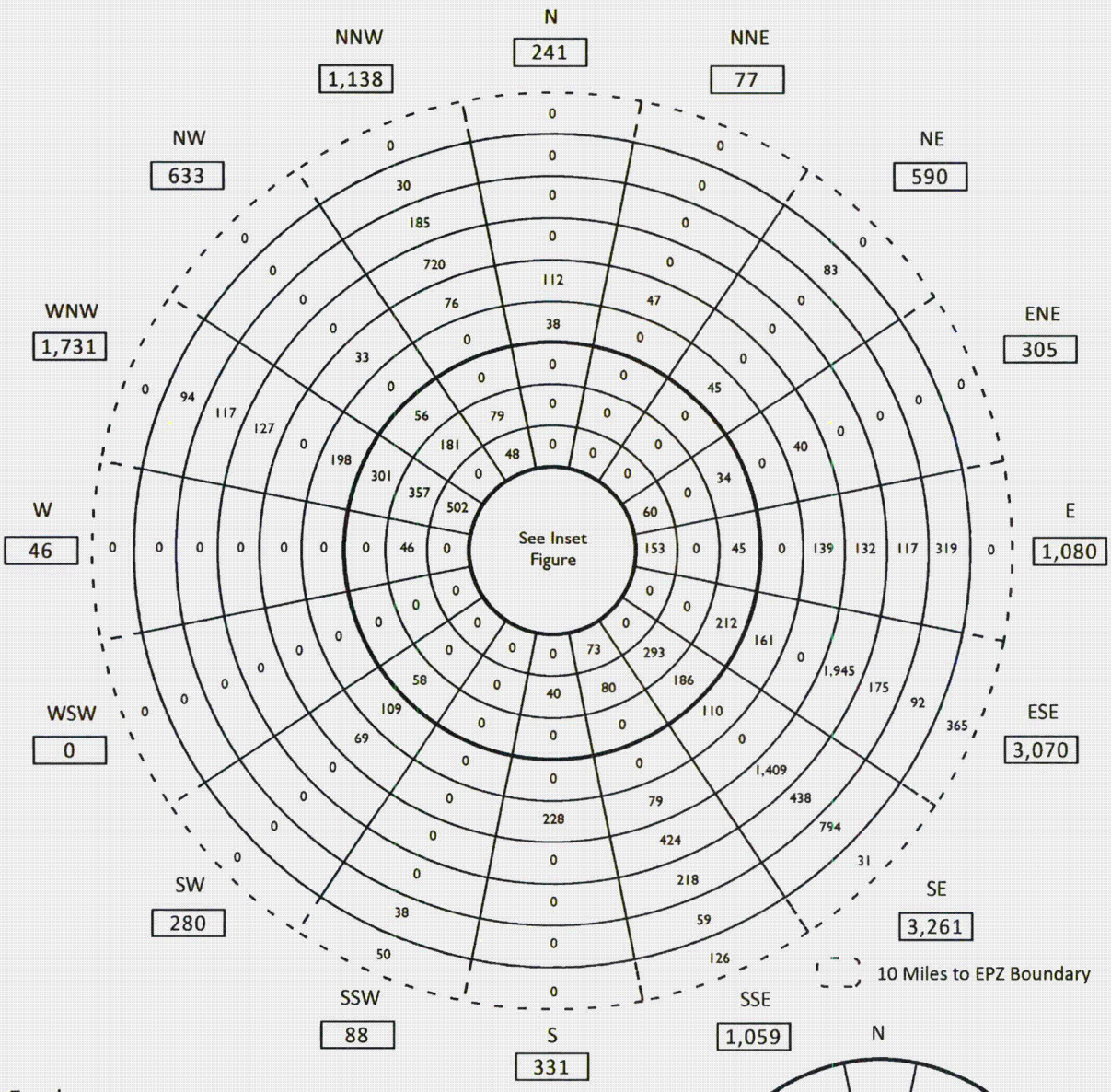
Table 3-5 presents employees commuting into the EPZ and their vehicles by Sub-area. Figure 3-8 and Figure 3-9 present these data by sector.

Table 3-5. Summary of Non-EPZ Resident Employees and Employee Vehicles

Sub-area	Employees	Employee Vehicles
BERKS COUNTY		
Amity	338	322
Boyertown	461	461
Colebrookdale	301	301
Douglass (Berks)	33	33
Earl	0	0
Union	0	0
Washington	0	0
Berks County Total:	**1,133**	**1,117**
CHESTER COUNTY		
Charlestown	126	126
East Coventry	107	107
East Nantmeal	0	0
East Pikeland	263	263
East Vincent	193	170
North Coventry	46	46
Phoenixville	167	137
Schuylkill	578	578
South Coventry	236	236
Spring City	148	148
Upper Uwchlan	50	50
Uwchlan	0	0
Warwick	0	0
West Pikeland	0	0
West Vincent	38	38
Chester County Total:	**1,952**	**1,899**

Table 3-5. Summary of Non-EPZ Resident Employees and Employee Vehicles (Continued)

Sub-area	Employees	Employee Vehicles
MONTGOMERY COUNTY		
Collegeville	282	282
Douglass (Montgomery)	296	296
Green Lane	83	83
Limerick	1,364	1,364
Lower Frederick	0	0
Lower Pottsgrove	366	355
Lower Providence	663	649
Lower Salford	0	0
Marlborough	0	0
New Hanover	150	150
Perkiomen	271	271
Pottstown	1,656	1,570
Royersford	143	143
Schwenksville	40	40
Skippack	436	436
Trappe	161	161
Upper Frederick	45	45
Upper Pottsgrove	56	56
Upper Providence	4,670	4,670
Upper Salford	0	0
West Pottsgrove	163	163
Montgomery County Total:	**10,845**	**10,734**
TOTAL EPZ EMPLOYEES:	**13,930**	**13,750**



Employees

Miles	Subtotal by Ring	Cumulative Total
0 - 1	492	492
1 - 2	1,062	1,554
2 - 3	836	2,390
3 - 4	1,076	3,466
4 - 5	892	4,358
5 - 6	661	5,019
6 - 7	823	5,842
7 - 8	4,757	10,599
8 - 9	1,250	11,849
9 - 10	1,509	13,358
10 - EPZ	572	13,930
	Total:	13,930

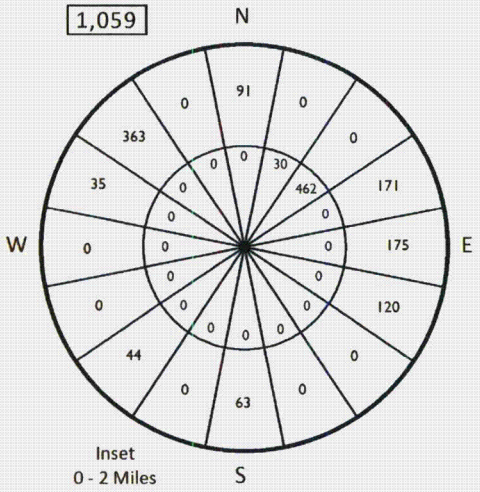
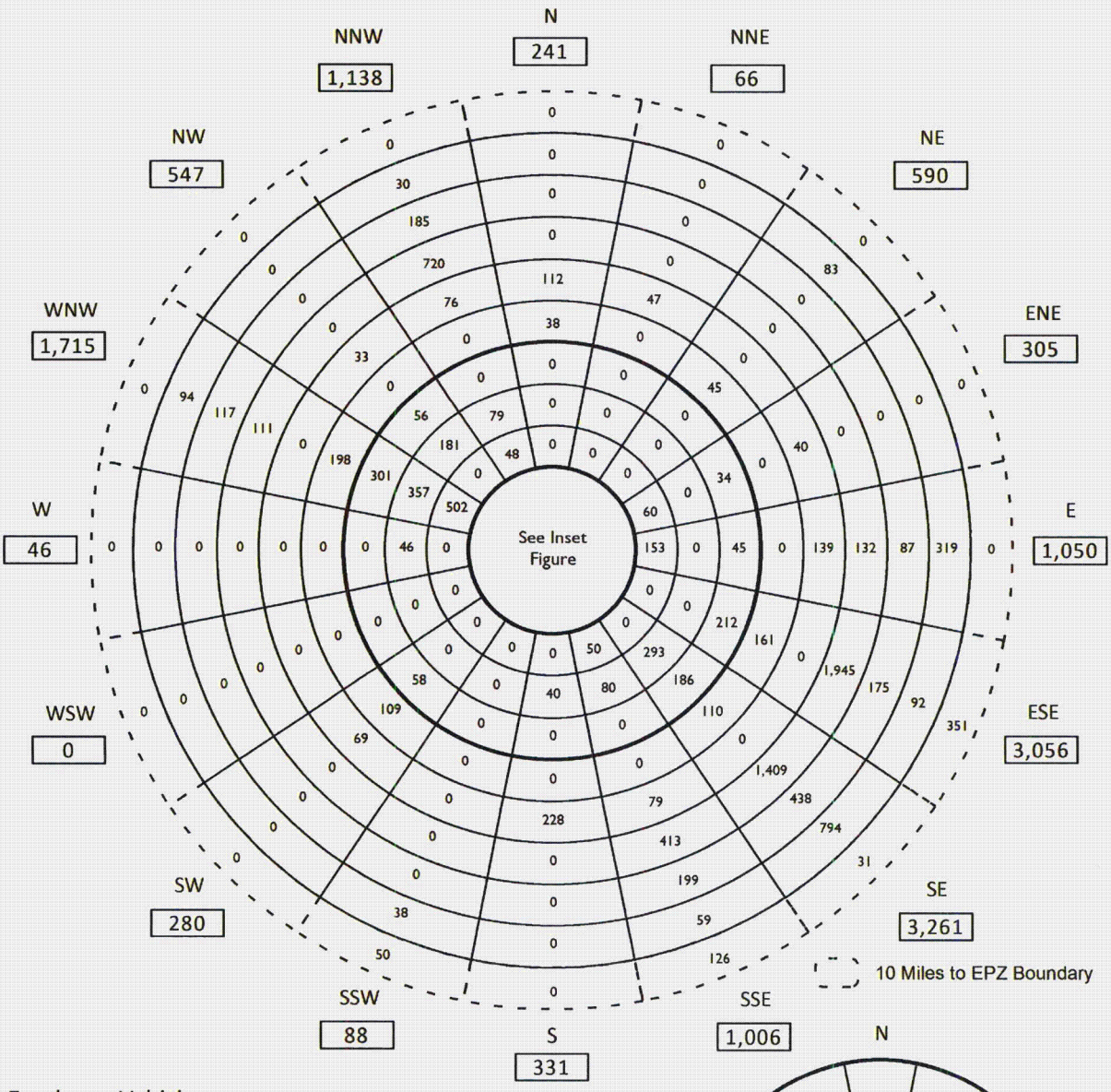


Figure 3-8. Employee Population by Sector



Employee Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	481	481
1 - 2	976	1,457
2 - 3	813	2,270
3 - 4	1,076	3,346
4 - 5	892	4,238
5 - 6	661	4,899
6 - 7	823	5,722
7 - 8	4,730	10,452
8 - 9	1,231	11,683
9 - 10	1,509	13,192
10 - EPZ	558	13,750
	Total:	13,750

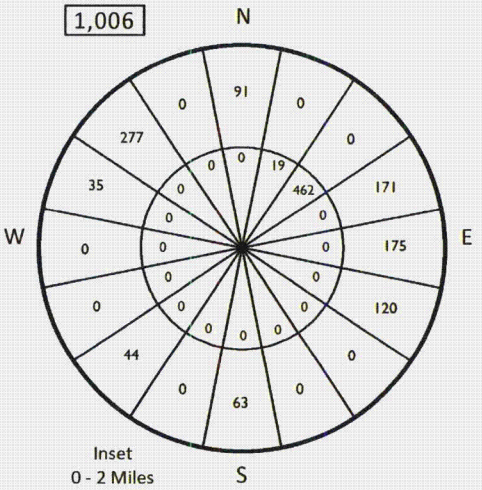


Figure 3-9. Employee Vehicles by Sector

3.5 Medical Facilities

Data were provided by Exelon for each of the medical facilities within the EPZ. Table E-3 in Appendix E summarizes the data provided. Section 8 details the evacuation of medical facilities and their patients. 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 vans, up to 4 people; and ambulances, up to 2 people.

3.6 Total Demand in Addition to Permanent Population

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through-travelers will also evacuate. These through vehicles are assumed to travel on the major routes traversing the EPZ – I-476, Route 309, I-76, I-276, US 202, US 30 and US 422. It is assumed that this traffic will continue to enter the EPZ during the first 120 minutes following the Advisory to Evacuate.

Average Annual Daily Traffic (AADT) data was obtained from Federal Highway Administration to estimate the number of vehicles per hour on the aforementioned routes. The AADT was multiplied by the K-Factor, which is the proportion of the AADT on a roadway segment or link during the design hour, resulting in the design hour volume (DHV). The design hour is usually the 30th highest hourly traffic volume of the year, measured in vehicles per hour (vph). The DHV is then multiplied by the D-Factor, which is the proportion of the DHV occurring in the peak direction of travel (also known as the directional split). The resulting values are the directional design hourly volumes (DDHV), and are presented in Table 3-6, for each of the routes considered. The DDHV is then multiplied by 2 hours (access control points – ACP – are assumed to be activated at 120 minutes after the advisory to evacuate) to estimate the total number of external vehicles loaded on the analysis network. As indicated, there are 41,386 vehicles entering the EPZ as external-external trips prior to the activation of the ACP and the diversion of this traffic. This number is reduced by 60% for evening scenarios (Scenarios 5, 12 and 13) as discussed in Section 6.

3.7 Special Event

One special event (Scenario 13) is considered for the ETE study – the Phoenixville Firebird Festival, which occurs annually in December (winter) on a weekend in the evening. The festival is located in downtown Phoenixville and the exact location of the event varies from year to year.

The Phoenixville Director of Emergency Management estimated that there are 15,000 attendees for this event; 40% of attendees are transients, and the estimated vehicle occupancy is 2 people per vehicle. This results in 3,000 additional transient vehicles which are added to the simulation throughout the town of Phoenixville. The special event vehicle trips were generated utilizing the same mobilization distributions as transients.

Shuttle buses are used to transport attendees from parking lots to the festival site; however, these shuttle buses would not be used to evacuate attendees. It is assumed that the time to shuttle attendees to parking lots or for attendees to walk to their vehicles is within the 75 minute mobilization time for transients discussed in Section 5.

Temporary road closures are used for the parade portion of the festival, but all roadways could be quickly re-opened in the event of an emergency.

Table 3-6. LGS EPZ External Traffic

Upstream Node	Downstream Node	Road Name	Direction	HPMS[1] AADT	K-Factor[2]	D-Factor[2]	Hourly Volume	External Traffic
8265	265	I-476	SB	50,960	0.091	0.5	2,319	4,638
8237	237	I-476	NB	50,960	0.091	0.5	2,319	4,638
8868	1868	Route 309	SB	31,735	0.107	0.5	1,698	3,396
8884	1884	Route 309	NB	31,735	0.107	0.5	1,698	3,396
8,185	185	I-76	WB	79,603	0.091	0.5	3,622	7,244
8112	112	I-76	EB	35,174	0.107	0.5	1,882	3,764
8167	228	I-276	WB	63,476	0.091	0.5	2,888	5,776
8375	4119	US 202	WB	9,381	0.118	0.5	553	1,106
8227	3989	US 202	EB	9,381	0.118	0.5	553	1,106
8279	279	US 30	EB	41,847	0.107	0.5	2,239	4,478
8090	90	US 422	SB	15,899	0.116	0.5	922	1,844
							TOTAL:	**41,386**

[1]Highway Performance Monitoring System (HPMS), Federal Highway Administration (FHWA), Washington, D.C., 2011
[2]HCM 2010

3.8 Summary of Demand

A summary of population and vehicle demand is provided in Table 3-7 and Table 3-8, respectively. This summary includes all population groups described in this section. Additional population groups – transit-dependent, special facility and school population – are described in greater detail in Section 8. A total of 450,121 people and 229,754 vehicles are considered in this study.

Table 3-7. Summary of Population Demand

Sub-area	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Shadow Population	External Traffic	Total
BERKS COUNTY									
Amity	10,815	0	0	338	214	2,892	0	0	14,259
Boyertown	4,055	300	0	461	100	1,755	0	0	6,671
Colebrookdale	5,078	0	289	301	0	2,295	0	0	7,963
Douglass (Berks)	3,306	0	65	33	0	299	0	0	3,703
Earl	717	0	0	0	0	0	0	0	717
Union	1,215	0	0	0	24	12	0	0	1,251
Washington	715	0	0	0	0	50	0	0	765
Berks County Total:	**25,901**	**300**	**354**	**1,133**	**338**	**7,303**	**0**	**0**	**35,329**
CHESTER COUNTY									
Charlestown	4,141	0	0	126	0	313	0	0	4,580
East Coventry	6,636	0	0	107	120	693	0	0	7,556
East Nantmeal	1,500	0	0	0	0	0	0	0	1,500
East Pikeland	7,079	0	40	263	142	726	0	0	8,250
East Vincent	6,821	0	0	193	185	1,054	0	0	8,253
North Coventry	7,866	0	3,000	46	0	1,174	0	0	12,086
Phoenixville	16,440	1,260	47	167	325	1,391	0	0	19,630
Schuylkill	8,516	0	540	578	0	4,237	0	0	13,871
South Coventry	2,604	0	0	236	41	2,904	0	0	5,785
Spring City	3,323	263	0	148	0	29	0	0	3,763
Upper Uwchlan	8,089	0	0	50	0	968	0	0	9,107
Uwchlan	1,343	0	0	0	0	0	0	0	1,343
Warwick	2,192	0	930	0	0	35	0	0	3,157
West Pikeland	3,876	0	0	0	0	271	0	0	4,147
West Vincent	4,567	0	0	38	0	506	0	0	5,111
Chester County Total:	**84,993**	**1,523**	**4,557**	**1,952**	**813**	**14,301**	**0**	**0**	**108,139**

Sub-area	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Shadow Population	External Traffic	Total
MONTGOMERY COUNTY									
Collegeville	5,089	0	0	282	0	1,403	0	0	6,774
Douglass (Montgomery)	10,195	0	0	296	0	1,267	0	0	11,758
Green Lane	508	0	0	83	0	0	0	0	591
Limerick	18,074	0	2,667	1,364	0	6,108	0	0	28,213
Lower Frederick	4,840	0	0	0	0	345	0	0	5,185
Lower Pottsgrove	12,059	0	326	366	204	3,152	0	0	16,107
Lower Providence	25,436	0	971	663	2,412	4,439	0	0	33,921
Lower Salford	1,503	0	0	0	0	0	0	0	1,503
Marlborough	492	0	0	0	0	189	0	0	681
New Hanover	10,939	0	108	150	0	1,991	0	0	13,188
Perkiomen	9,139	0	0	271	0	3,870	0	0	13,280
Pottstown	22,377	1,710	581	1,656	501	5,140	0	0	31,965
Royersford	4,752	0	0	143	0	1,663	0	0	6,558
Schwenksville	1,385	0	0	40	0	818	0	0	2,243
Skippack	13,715	0	458	436	3,957	985	0	0	19,551
Trappe	3,509	0	0	161	0	198	0	0	3,868
Upper Frederick	3,523	0	1,547	45	126	605	0	0	5,846
Upper Pottsgrove	5,315	0	0	56	0	866	0	0	6,237
Upper Providence	21,219	0	2,917	4,670	451	5,746	0	0	35,003
Upper Salford	3,299	0	0	0	0	490	0	0	3,789
West Pottsgrove	3,874	0	0	163	0	552	0	0	4,589
Montgomery County Total:	**181,242**	**1,710**	**9,575**	**10,845**	**7,651**	**39,827**	**0**	**0**	**250,850**
Shadow Region	0	0	0	0	0	0	55,803	0	55,803
Total:	**292,136**	**3,533**	**14,486**	**13,930**	**8,802**	**61,431**	**55,803**	**0**	**450,121**

NOTE: Shadow Population has been reduced to 20%. Refer to Figure 2-1 for additional information.
NOTE: Special Facilities include both medical facilities and correctional facilities.

Table 3-8. Summary of Vehicle Demand

Sub-area	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Shadow Vehicles	External Traffic	Total
BERKS COUNTY									
Amity	5,146	0	0	322	22	104	0	0	5,594
Boyertown	1,931	20	0	461	9	72	0	0	2,493
Colebrookdale	2,412	0	104	301	0	80	0	0	2,897
Douglass (Berks)	1,569	0	36	33	0	10	0	0	1,648
Earl	342	0	0	0	0	0	0	0	342
Union	579	0	0	0	4	2	0	0	585
Washington	341	0	0	0	0	2	0	0	343
Berks County Total:	**12,320**	**20**	**140**	**1,117**	**35**	**270**	**0**	**0**	**13,902**
CHESTER COUNTY									
Charlestown	2,037	0	0	126	0	10	0	0	2,173
East Coventry	3,156	0	0	107	28	24	0	0	3,315
East Nantmeal	713	0	0	0	0	0	0	0	713
East Pikeland	3,366	0	22	263	14	24	0	0	3,689
East Vincent	3,249	0	0	170	18	38	0	0	3,475
North Coventry	3,746	0	1,500	46	0	40	0	0	5,332
Phoenixville	7,826	84	26	137	53	54	0	0	8,180
Schuylkill	4,259	0	203	578	0	160	0	0	5,200
South Coventry	1,238	0	0	236	7	114	0	0	1,595
Spring City	1,584	18	0	148	0	2	0	0	1,752
Upper Uwchlan	3,851	0	0	50	0	30	0	0	3,931
Uwchlan	640	0	0	0	0	0	0	0	640
Warwick	1,042	0	321	0	0	2	0	0	1,365
West Pikeland	1,843	0	0	0	0	8	0	0	1,851
West Vincent	2,171	0	0	38	0	16	0	0	2,225
Chester County Total:	**40,721**	**102**	**2,072**	**1,899**	**120**	**522**	**0**	**0**	**45,436**

Sub-area	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Shadow Vehicles	External Traffic	Total
MONTGOMERY COUNTY									
Collegeville	2,597	0	0	282	0	48	0	0	2,927
Douglass (Montgomery)	4,852	0	0	296	0	42	0	0	5,190
Green Lane	243	0	0	83	0	0	0	0	326
Limerick	8,598	0	1,366	1,364	0	220	0	0	11,548
Lower Frederick	2,305	0	0	0	0	14	0	0	2,319
Lower Pottsgrove	5,739	0	161	355	25	118	0	0	6,398
Lower Providence	11,246	0	498	649	38	156	0	0	12,587
Lower Salford	716	0	0	0	0	0	0	0	716
Marlborough	236	0	0	0	0	6	0	0	242
New Hanover	5,208	0	54	150	0	72	0	0	5,484
Perkiomen	4,352	0	0	271	0	148	0	0	4,771
Pottstown	10,582	114	323	1,570	102	200	0	0	12,891
Royersford	2,267	0	0	143	0	66	0	0	2,476
Schwenksville	660	0	0	40	0	26	0	0	726
Skippack	6,530	0	222	436	0	32	0	0	7,220
Trappe	1,673	0	0	161	0	6	0	0	1,840
Upper Frederick	1,679	0	581	45	17	26	0	0	2,348
Upper Pottsgrove	2,530	0	0	56	0	36	0	0	2,622
Upper Providence	9,883	0	1,397	4,670	45	218	0	0	16,213
Upper Salford	1,572	0	0	0	0	18	0	0	1,590
West Pottsgrove	1,845	0	0	163	0	18	0	0	2,026
Montgomery County Total:	**85,313**	**114**	**4,602**	**10,734**	**227**	**1,470**	**0**	**0**	**102,460**
Shadow Region	0	0	0	0	0	0	26,570	41,386	67,956
Total:	**138,354**	**236**	**6,814**	**13,750**	**382**	**2,262**	**26,570**	**41,386**	**229,754**

NOTE: Buses represented as two passenger vehicles. Refer to Section 8 for additional information.