9 TRAFFIC MANAGEMENT STRATEGY

This section discusses the suggested traffic control and management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy include:

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

The functions to be performed in the field are:

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

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

- A driver may be traveling home from work or from another location, to join other family members prior to evacuating.
- An evacuating driver may be travelling to pick up a relative, or other evacuees.
- The driver may be an emergency worker en route to perform an important activity.

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

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

1. The existing TCPs and ACPs identified by the offsite agencies in their emergency plans serve as the basis of the traffic management plan, as per NUREG/CR-7002.
2. Computer analysis of the evacuation traffic flow environment (see Figures 7-3 through 7-9).

   This analysis identifies the best routing and those critical intersections that experience pronounced congestion. Any critical intersections that would benefit from traffic or access control which are not already identified in the existing offsite plans are suggested as additional TCPs and ACPs.

3. The existing TCPs and ACPs, and how they were applied in this study, are discussed in Appendix G.
4. Prioritization of TCPs and ACPs.

    Application of traffic and access control at some TCPs and ACPs will have a more pronounced influence on expediting traffic movements than at other TCPs and ACPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located far from the power plant. These priorities should be assigned by state/local emergency management representatives and by law enforcement personnel.

The ETE simulations discussed in Section 7.3 indicate minimal congestion within the EPZ. The 100^{th} percentile ETE are dictated by the time to mobilize evacuees rather than the time for traffic congestion to clear. As such, no additional TCPs or ACPs are identified as a result of this study. The existing traffic management plans are adequate.

The use of Intelligent Transportation Systems (ITS) technologies can reduce manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) can be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. DMS can also be placed outside of the EPZ to warn motorists to avoid using routes that may conflict with the flow of evacuees away from the power plant. Highway Advisory Radio (HAR) can be used to broadcast information to evacuees en route through their vehicle stereo systems. Automated Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins their trip, while on board navigation systems (GPS units), cell phones, and pagers can be used to provide information en route. These are only several examples of how ITS technologies can benefit the evacuation process. Consideration should be given that ITS technologies be used to facilitate the evacuation process, and any additional signage placed should consider evacuation needs.

The ETE analysis treated all controlled intersections that are existing ACP or TCP locations in the offsite agency plans as being controlled by actuated signals. Appendix K, Table K-2 identifies those intersections that were modeled as TCPs.

Chapters 2N and 5G, and Part 6 of the 2009 MUTCD are particularly relevant and should be reviewed during emergency response training.

The ETE calculations reflect the assumption that all "external-external" trips are interdicted and diverted after 2 hours have elapsed from the ATE.

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

Study Assumptions 5 and 6 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

10 EVACUATION ROUTES

Evacuation routes are comprised of two distinct components:

- Routing from a Zone being evacuated to the boundary of the Evacuation Region and thence out of the EPZ.
- Routing of transit-dependent evacuees from the EPZ boundary to reception centers.

Evacuees will select routes within the EPZ in such a way as to minimize their exposure to risk. This expectation is met by the DYNEV II model routing traffic away from the location of the plant, to the extent practicable. The DTRAD model satisfies this behavior by routing traffic so as to balance traffic demand relative to the available highway capacity to the extent possible. See Appendices B through D for further discussion.

The routing of transit-dependent evacuees from the EPZ boundary to reception centers is designed to minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary.

Figure 10-1 presents an overview of the reception centers and host schools servicing the EPZ. The major evacuation routes for the EPZ are presented in Figure 10-2.

It is assumed that all school evacuees will be taken to the appropriate host school and subsequently picked up by parents or guardians. Transit-dependent evacuees are transported to the nearest reception center for each county. This study does not consider the transport of evacuees from reception centers to mass care centers (also known as congregate care centers), if the counties do make the decision to relocate evacuees.

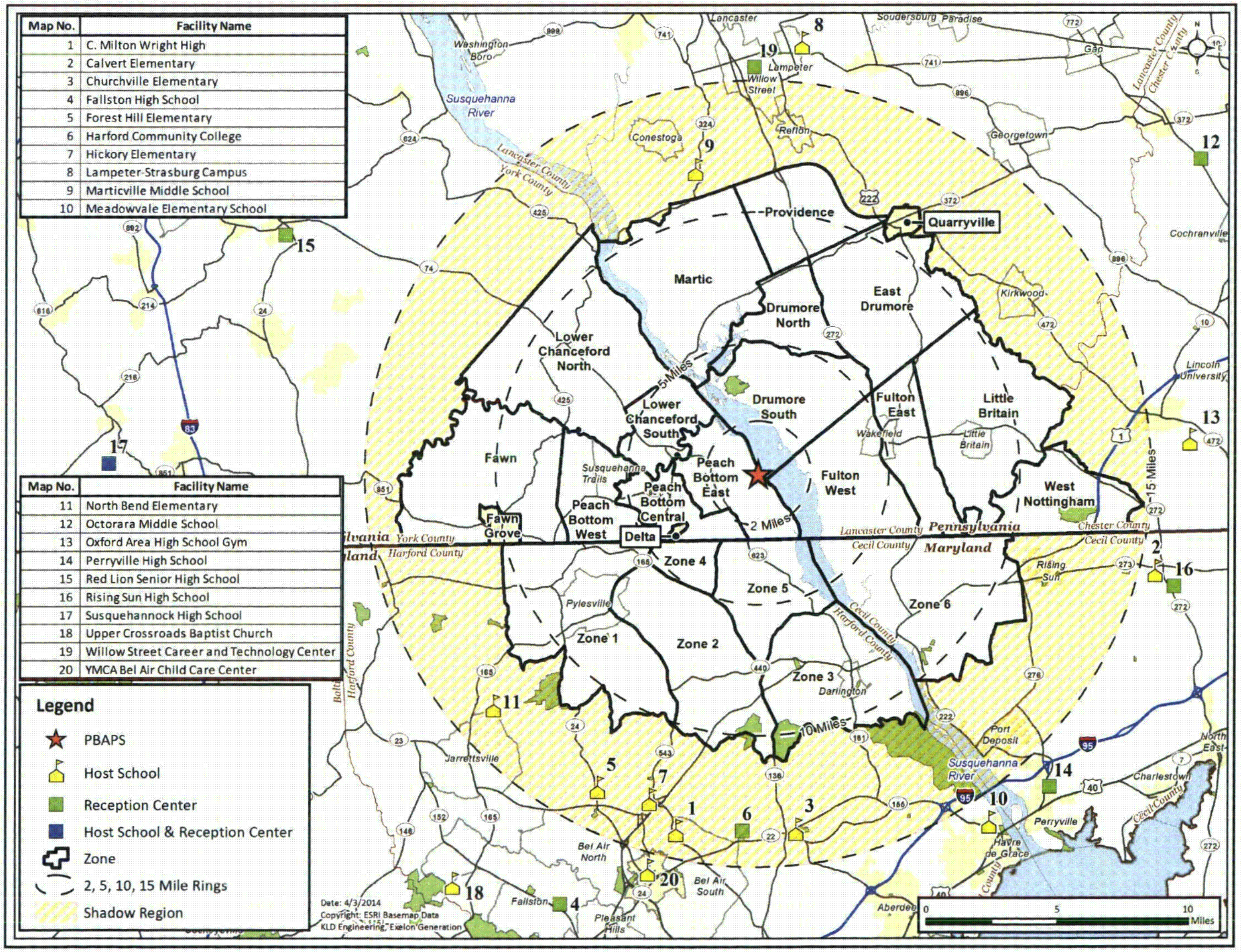

Figure 10-1. Reception Centers and Host Schools

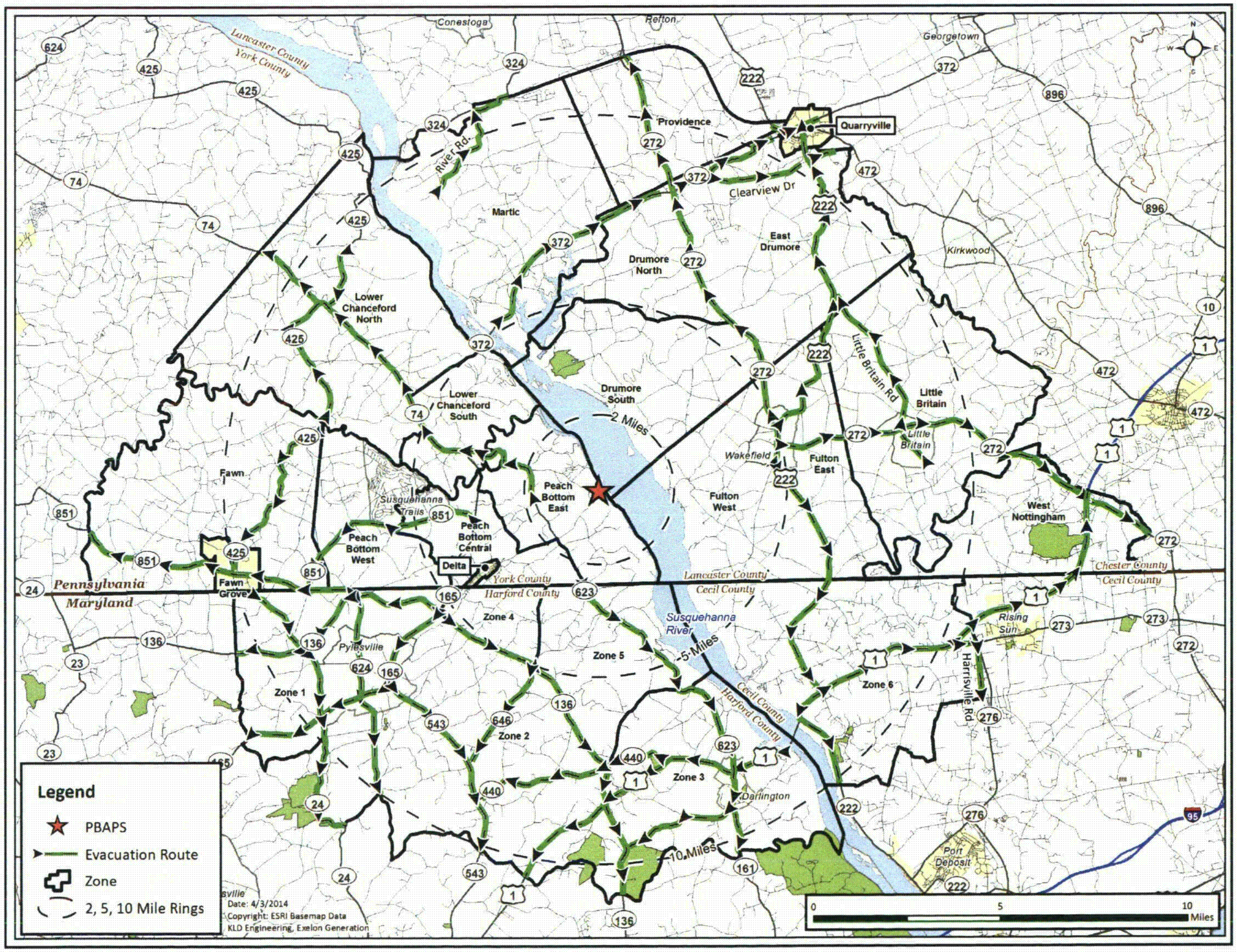

Figure 10-2. Major Evacuation Routes

11 SURVEILLANCE OF EVACUATION OPERATIONS

There is a need for surveillance of traffic operations during the evacuation. There is also a need to clear any blockage of roadways arising from accidents or vehicle disablement. Surveillance can take several forms.

1. Traffic control personnel, located at Traffic Control and Access Control points, provide fixed-point surveillance.
2. Ground patrols may be undertaken along well-defined paths to ensure coverage of those highways that serve as major evacuation routes.
3. Aerial surveillance of evacuation operations may also be conducted using helicopter or fixed-wing aircraft, if available.
4. Cellular phone calls (if cellular coverage exists) from motorists may also provide direct field reports of road blockages.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. It is the responsibility of the offsite response organizations to support an emergency response system that can receive messages from the field and be in a position to respond to any reported problems in a timely manner. This coverage should quickly identify and expedite the response to any blockage caused by a disabled vehicle.

<u>Tow Vehicles</u>

In a low-speed traffic environment, any vehicle disablement is likely to arise due to a low-speed collision, mechanical failure or the exhaustion of its fuel supply. In any case, the disabled vehicle can be pushed onto the shoulder, thereby restoring traffic flow. Past experience in other emergencies indicates that evacuees who are leaving an area often perform activities such as pushing a disabled vehicle to the side of the road without prompting.

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Consideration should be given that tow trucks with a supply of gasoline be deployed at strategic locations within, or just outside, the EPZ. These locations should be selected so that:

- They permit access to key, heavily loaded, evacuation routes.
- Responding tow trucks would most likely travel counter-flow relative to evacuating traffic.

The ORO emergency plans discuss the provision of fuel and removal of traffic obstructions on main evacuation routes.

12 CONFIRMATION TIME

It is necessary to confirm that the evacuation process is effective in the sense that the public is complying with the Advisory to Evacuate. The offsite agency radiological emergency plans do not discuss a procedure for confirming evacuation. Should procedures not already exist, the following alternative or complementary approach is suggested.

The suggested procedure employs a stratified random sample and a telephone survey. The size of the sample is dependent on the expected number of households that do not comply with the Advisory to Evacuate. It is reasonable to assume for the purpose of estimating sample size that at least 80 percent of the population within the EPZ will comply with the Advisory to Evacuate. On this basis, an analysis could be undertaken (see Table 12-1) to yield an estimated sample size of approximately 300.

The confirmation process should start at about 2½ hours after the Advisory to Evacuate, which is when approximately 95 percent of evacuees have completed their mobilization activities (see Figure 5-4). At this time, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Table 12-1, approximately 7½ person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of Zones), then the confirmation process will extend over a timeframe of about 75 minutes. Thus, the confirmation should be completed before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the Evacuation Region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment or other technologies (e.g., reverse 911 or equivalent if available) can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

If this method is indeed used by the offsite agencies, consideration should be given to maintain a list of telephone numbers within the EPZ in the EOC at all times. Such a list could be purchased from vendors and could be periodically updated. As indicated above, the confirmation process should not begin until 2½ hours after the Advisory to Evacuate, to ensure that households have had enough time to mobilize. This 2½ hour timeframe will enable telephone operators to arrive at their workplace, obtain a call list and prepare to make the necessary phone calls.

Should the number of telephone responses (i.e., people still at home) exceed 20 percent, then the telephone survey should be repeated after an hour's interval until the confirmation process is completed.

Other techniques could also be considered. After traffic volumes decline, the personnel manning TCPs can be redeployed to travel through residential areas to observe and to confirm evacuation activities.

Table 12-1. Estimated Number of Telephone Calls Required for Confirmation of Evacuation

Problem Definition

Estimate number of phone calls, n, needed to ascertain the proportion, F of households that have not evacuated.

Reference: Burstein, H., Attribute Sampling, McGraw Hill, 1971

Given:

- No. of households plus other facilities, N, within the EPZ (est.) = 23,200
- Est. proportion, F, of households that will not evacuate = 0.20
- Allowable error margin, e: 0.05
- Confidence level, α: 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

$$p = F + e = 0.25; \; q = 1 - p = 0.75$$

$$n = \frac{A^2 pq + e}{e^2} = 308$$

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 304$$

Thus, some 300 telephone calls will confirm that approximately 20 percent of the population has not evacuated. If only 10 percent of the population does not comply with the Advisory to Evacuate, then the required sample size, $n_F = 214$.

Est. Person Hours to complete 300 telephone calls

Assume:

- Time to dial using touch tone (random selection of listed numbers): 30 seconds
- Time for 6 rings (no answer): 36 seconds
- Time for 4 rings plus short conversation: 60 sec.
- Interval between calls: 20 sec.

Person Hours:

$$\frac{300[30 + 0.8(36) + 0.2(60) + 20]}{3600} = 7.6$$

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APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

Table A-1. Glossary of Traffic Engineering Terms

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

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

APPENDIX B

DTRAD: Dynamic Traffic Assignment and Distribution Model

B. DYNAMIC TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

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

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

Overview of Integrated Distribution and Assignment Model

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

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

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

Interfacing the DYNEV Simulation Model with DTRAD

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

DTRAD Description

DTRAD is the DTA module for the DYNEV II System.

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

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

- It is assumed that drivers not only select the best route (i.e., lowest cost path) but some also select less attractive routes. The algorithm implemented by DTRAD archives several "efficient" routes for each O-D pair from which the drivers choose.
- The choice of one route out of a set of possible routes is an outcome of "discrete choice modeling". Given a set of routes and their generalized costs, the percentages of drivers that choose each route is computed. The most prevalent model for discrete choice modeling is the logit model. DTRAD uses a variant of Path-Size-Logit model (PSL). PSL overcomes the drawback of the traditional multinomial logit model by incorporating an additional deterministic path size correction term to address path overlapping in the random utility expression.
- DTRAD executes the traffic assignment algorithm on an abstract network representation called "the path network" which is built from the actual physical link-node analysis network. This execution continues until a stable situation is reached: the volumes and travel times on the edges of the path network do not change significantly from one iteration to the next. The criteria for this convergence are defined by the user.
- Travel "cost" plays a crucial role in route choice. In DTRAD, path cost is a linear summation of the generalized cost of each link that comprises the path. The generalized cost for a link, a, is expressed as

  $$c_a = \alpha t_a + \beta l_a + \gamma s_a ,$$

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

- The supplemental cost is based on the "survival distribution" (a variation of the exponential distribution). The Inverse Survival Function is a "cost" term in DTRAD to represent the potential risk of travel toward the plant:

  $s_a = -\beta \ln(p),\ 0 \le p \le 1;\ \beta > 0$

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

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

The value of d_o = 15 miles, the outer distance of the Shadow Region. Note that the supplemental cost, s_a, of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

Network Equilibrium

In 1952, John Wardrop wrote:

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

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

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

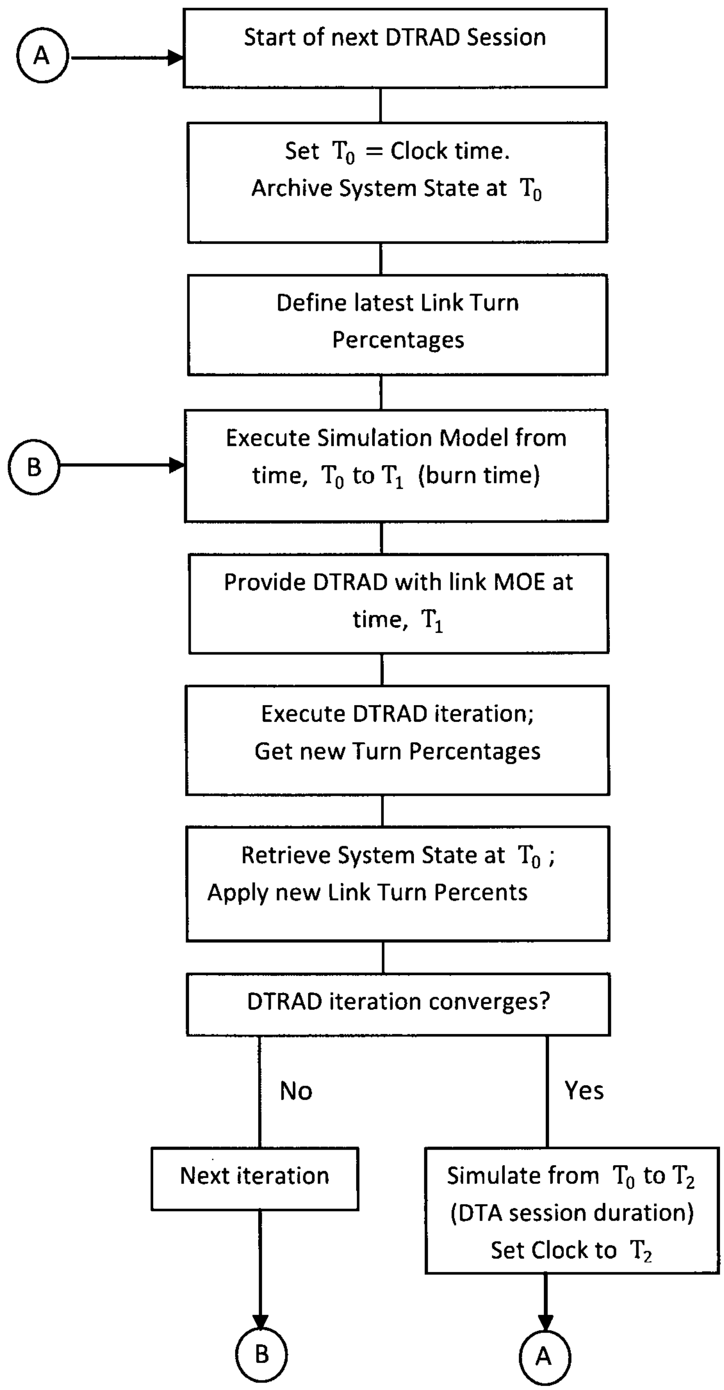


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

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

Model Features Include:

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

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

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

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

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

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

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

HIGHWAY NETWORK

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

GENERATED TRAFFIC VOLUMES

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

TRAFFIC CONTROL SPECIFICATIONS

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

DRIVER'S AND OPERATIONAL CHARACTERISTICS

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

DYNAMIC TRAFFIC ASSIGNMENT

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

INCIDENTS

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

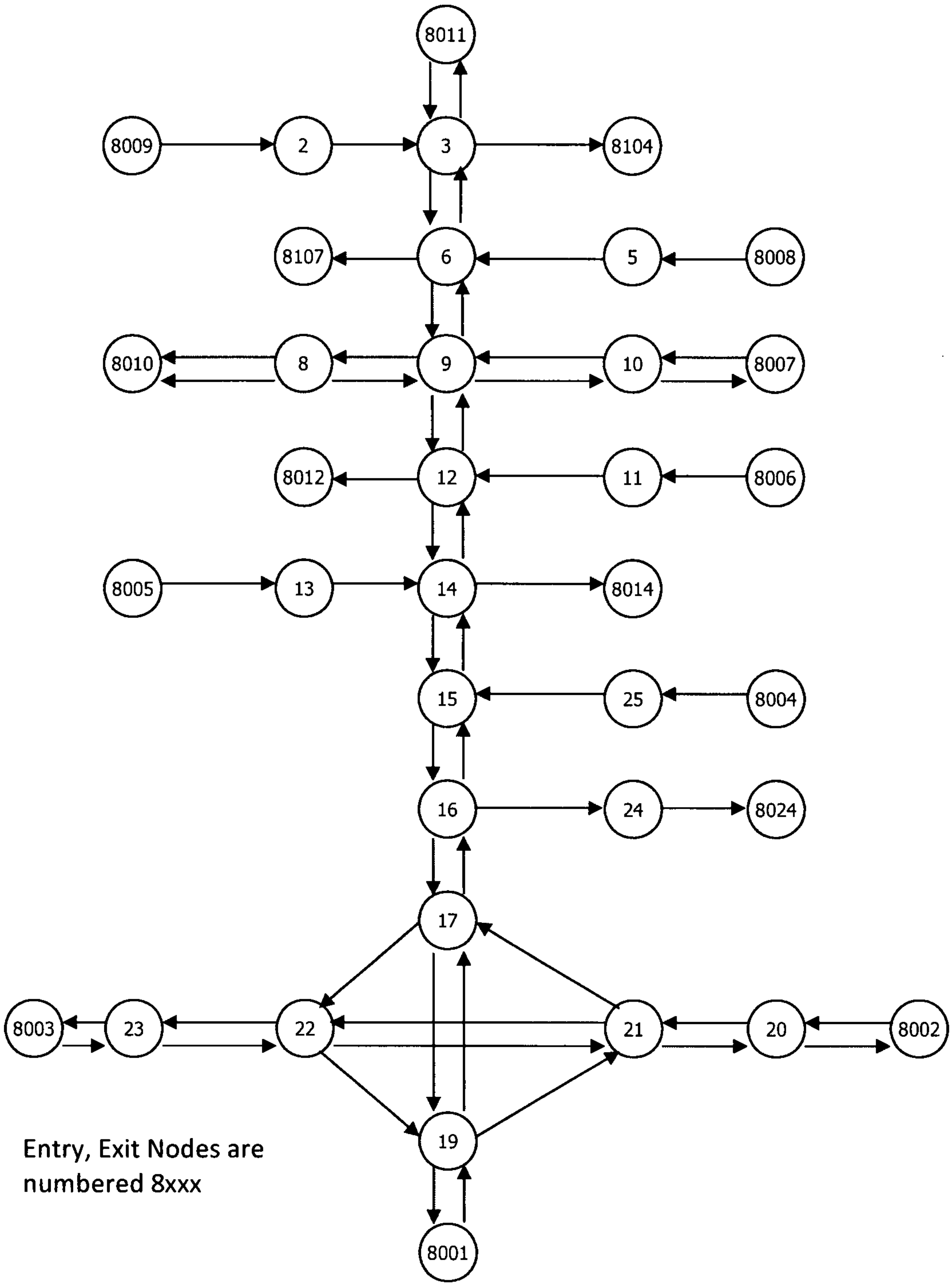


Figure C-1. Representative Analysis Network

C.1 Methodology

C.1.1 The Fundamental Diagram

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

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

C.1.2 The Simulation Model

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

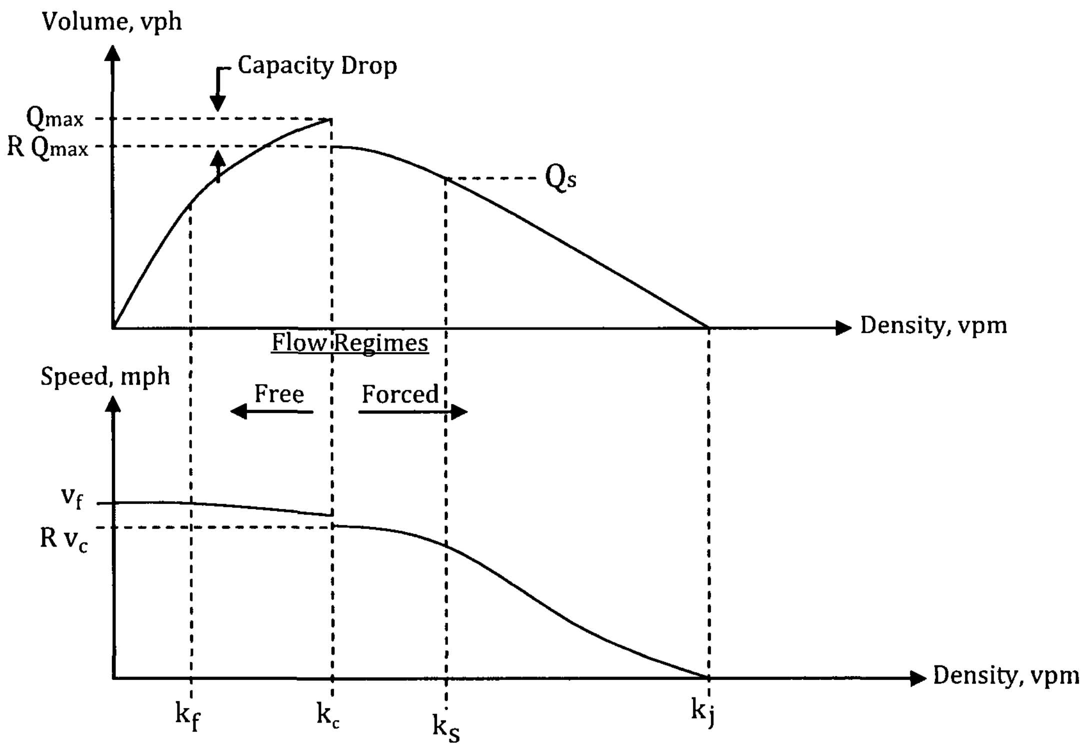


Figure C-2. Fundamental Diagrams

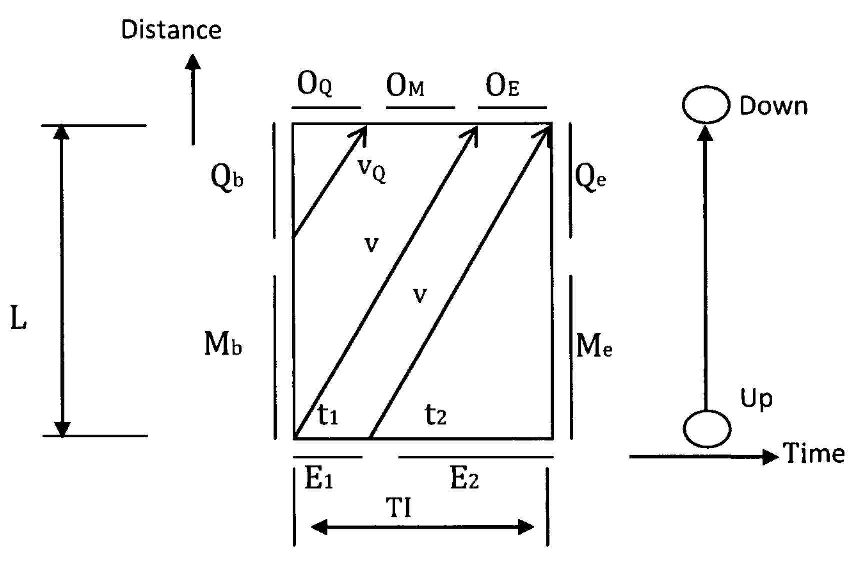


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

Table C-3. Glossary

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

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

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

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

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

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

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

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

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

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

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

8. If $t_1 > 0$, $O_M = M_b$, $O_E = \min\left(RCap - M_b, \frac{t_1\ Cap}{TI}\right) \geq 0$

$Q'_e = E_1 - O_E$

If $Q'_e > 0$, then

Calculate Q_e, M_e with Algorithm A

Else

$Q_e = 0$, $M_e = E_2$

End if

Else $(t_1 = 0)$

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

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

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$, then

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

Calculate Q_e and M_e using Algorithm A

10. Else $(t_1 = 0)$

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

If $M_d > RCap$, *then*

$O_M = RCap$

$Q'_e = M_d - O_M$

Apply Algorithm A to calculate Q_e and M_e

Else

$O_M = M_d$

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

End if

End if

End if

End if

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

where k_b = density at the beginning of the TI

k_e = density at the end of the TI

k_m = density at the mid-point of the TI

All values of density apply only to the moving vehicles.

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

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

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

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

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

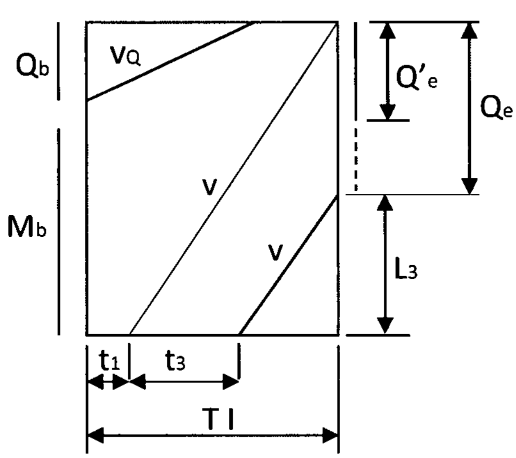
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W)\cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

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

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

Algorithm A

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



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

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

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

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

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

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

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

C.1.3 Lane Assignment

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

C.2 Implementation

C.2.1 Computational Procedure

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

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

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

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

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

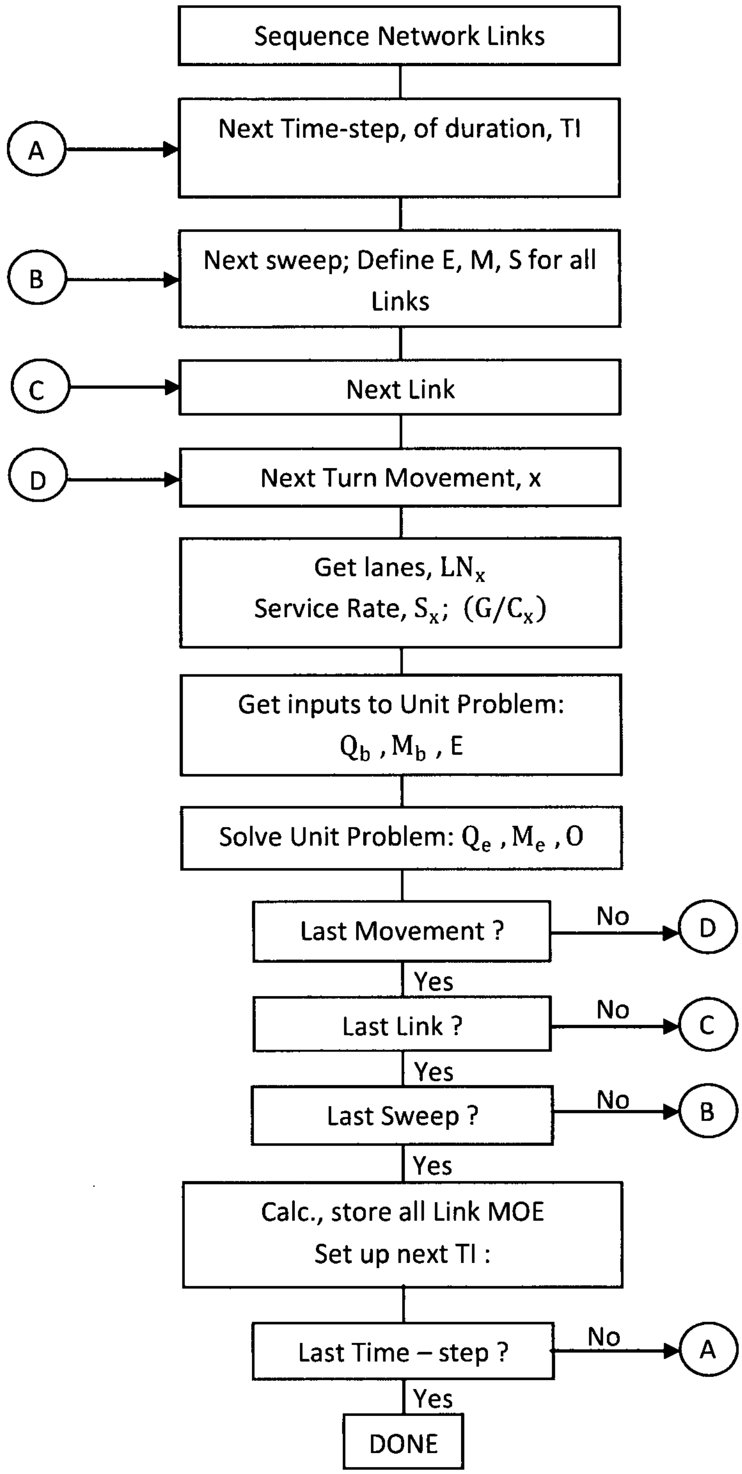


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

C.2.2 Interfacing with Dynamic Traffic Assignment (DTRAD)

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

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

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

Additional details are presented in Appendix B.

APPENDIX D

Detailed Description of Study Procedure

D. DETAILED DESCRIPTION OF STUDY PROCEDURE

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

Step 1

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

Step 2

2010 Census block information was obtained in GIS format. This information was used to estimate the resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. Transient, employment, and special facility data were obtained from Exelon, the offsite agencies and phone calls to individual facilities.

Step 3

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

Step 4

The results of a telephone survey of households within the EPZ were obtained from Exelon to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the EPZ population. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 5

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the UNITES software (see Section 1.3) developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 3). Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. 2010 Census data were overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 6

The EPZ is subdivided into 24 Zones. Based on wind direction and speed, Regions (groupings of Zones) that may be advised to evacuate, were developed.

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

Step 7

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

Step 8

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

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

Step 9

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

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

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

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

Step 10

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 11

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 10. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 12

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

Step 13

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the highway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 14

All evacuation cases are executed using the DYNEV II System to compute ETE. Once results are available, quality control procedures are used to assure the results are consistent, dynamic routing is reasonable, and traffic congestion/bottlenecks are addressed properly.

Step 15

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes are used to compute evacuation time estimates for transit-dependent permanent residents, schools, hospitals, and other special facilities.

Step 16

The simulation results are analyzed, tabulated and graphed. The results were then documented, as required by NUREG/CR-7002.

Step 17

Following the completion of documentation activities, the ETE criteria checklist (see Appendix N) was completed. An appropriate report reference is provided for each criterion provided in the checklist.

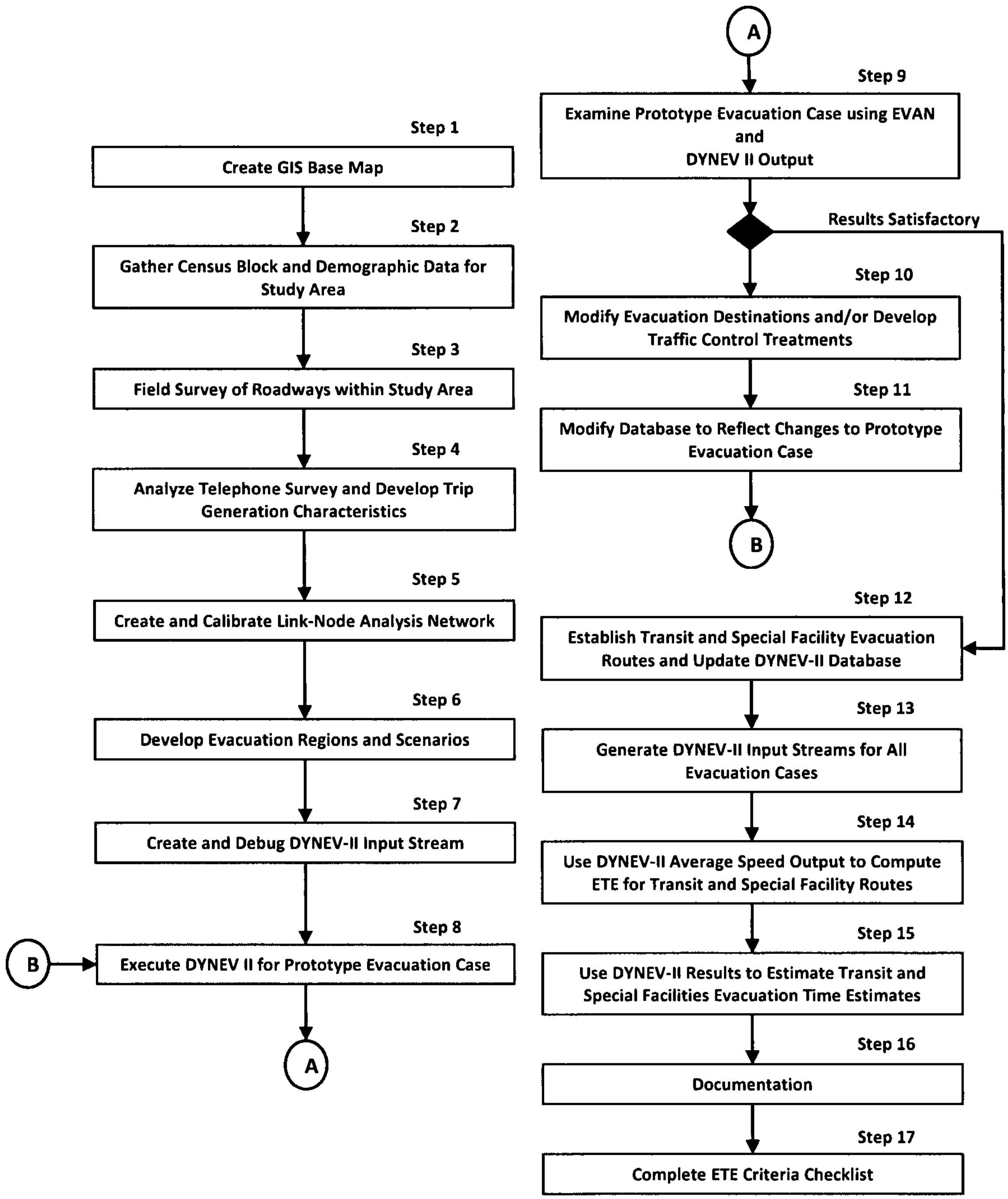


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

E. SPECIAL FACILITY DATA

The following tables list population information, as of March 2014, for special facilities, transient attractions and major employers that are located within the PBAPS EPZ. Special facilities are defined as schools, preschools/daycares, day camps, and medical facilities. Transient population data is included in the tables for recreational areas and lodging facilities. Note vehicles (cars with boat trailers and RVs) that were discussed in Section 3 as being represented in the simulation as 2 vehicles are shown as 1 vehicle in this appendix. Employment data is included in the table for major employers. Each table is grouped by state, then by county. The location of the facility is defined by its straight-line distance (miles) and direction (magnetic bearing) from the center point of the plant. Maps of schools, preschools/daycares, day camps, medical facilities, major employers, recreational areas, and lodging facilities are also provided.

Table E-1. Schools within the EPZ

Zone	Distance (miles)	Direction	School Name	Street Address	Municipality	Enrollment	Staff
CECIL COUNTY, MD							
Zone 6	8.2	SE	Conowingo Elementary School	471 Rowlandsville Road	Conowingo	567	52
					Cecil County Subtotal:	*567*	*52*
HARFORD COUNTY, MD							
Zone 1	8.5	SW	Harford Friends School	708 Highland Road	Street	40	18
Zone 1	9.1	SW	North Harford Elementary School	120 Pylesville Road	Pylesville	490	54
Zone 1	9.1	SW	North Harford High School	211 Pylesville Road	Pylesville	1,393	120
Zone 1	9.3	SW	North Harford Middle School	112 Pylesville Road	Pylesville	1,113	108
Zone 2	6.8	S	Harford Christian School	1736 Whiteford Road	Darlington	413	75
Zone 3	9.1	SSE	Darlington Elementary School	2119 Shuresville Road	Dublin	123	25
Zone 3	7.5	S	Dublin Elementary School	Whiteford Road	Dublin	247	35
					Harford County Subtotal:	*3,819*	*435*
LANCASTER COUNTY, PA							
East Drumore	9.7	NE	Solanco Senior High School	585 Solanco Road	Quarryville	1,219	120
Fulton East	6.9	ENE	Clermont Elementary School	1868 Robert Fulton Highway	Quarryville	532	52
Fulton East	6.9	ENE	Swift Middle School	1866 Robert Fulton Highway	Quarryville	465	54
Martic	8.9	N	Martic Elementary School	266 Martic Heights Drive	Holtwood	374	46
Quarryville	11.0	NNE	Quarryville Elementary School	121 South Hess Street	Quarryville	459	40
Shadow Region[1]	11.4	NNE	Smith Middle School	645 Kirkwood Pike	Quarryville	421	52
					Lancaster County Subtotal:	*3,470*	*364*
YORK COUNTY, PA							
Fawn	10.8	W	Fawn Area Elementary School	504 Main Street	Fawn Grove	315	38
Fawn	10.6	W	South Eastern Middle School East	375 Main Street	Fawn Grove	423	60
Fawn	10.7	W	South Eastern Middle School West	417 Main Street	Fawn Grove	456	60
Fawn Grove	10.6	W	Kennard-Dale High School	393 Main Street	Fawn Grove	936	90
Peach Bottom Central	3.2	SW	Delta-Peach Bottom Elementary School	1081 Atom Road	Delta	330	44
					York County Subtotal:	*2,460*	*292*
					EPZ TOTAL:	**10,316**	**1,143**

[1] Facility is located just beyond the EPZ boundary; however, the facility will evacuate.

Table E-2. Preschools / Daycares within the EPZ

Zone	Distance (miles)	Dire-ction	Pre-School Name	Street Address	Municipality	Enroll-ment	Staff
HARFORD COUNTY, MD							
Zone 1	8.5	SW	Childrens Center of North Harford	707 Highland Road	Street	48	10
Zone 1	6.6	SW	Christian Childcare Center	719 Wheeler School Road	Whiteford	33	7
Zone 3	9.0	SSE	Wilson Community Center	1024 Main Street	Darlington	28	6
					Harford County Subtotal:	*109*	*23*
LANCASTER COUNTY, PA							
East Drumore	8.3	NE	Mechanic Grove CLASP	1392 Robert Fulton Highway	Quarryville	13	4
East Drumore	9.9	NE	The Crayon Box Day Care Center	550 Solanco Road	Quarryville	10	3
Providence	11.4	N	Busy Hands Daycare	290 Sawmill Road	New Providence	12	3
Quarryville	11.2	NNE	Shining Stars Daycare	7 South Hess Street	Quarryville	30	6
					Lancaster County Subtotal:	*65*	*16*
YORK COUNTY, PA							
Fawn	10.8	WSW	Kidsville Junction Childcare	89 Hunt Club Road	Fawn Grove	66	15
Peach Bottom Central	4.3	WSW	Delta Christian Academy	6610 Delta Road	Delta	110	22
					York County Subtotal:	*176*	*37*
					EPZ TOTAL:	**350**	**76**

Table E-3. Day Camps within the EPZ

Zone	Distance (miles)	Dire-ction	Day Camp Name	Street Address	Municipality	Enroll-ment
CECIL COUNTY, MD						
Zone 6	8.6	ESE	BSA Camp Horseshoe	1286 Ridge Road	Rising Sun	800
Zone 6	5.9	SE	Camp Conowingo GSA	378 Bell Manor Road	Conowingo	275
					Cecil County Subtotal:	*1,075*
HARFORD COUNTY, MD						
Zone 1	9.7	SSW	Camp Habonim	615 Cherry Hill Road	Street	190
Zone 3	9.2	SE	Camp Ramblewood	Silver Road	Darlington	300
Zone 3	6.4	SSE	Indian Lake Christian Camp	3915 River Road	Darlington	110
Zone 5	4.3	S	Broadcreek Memorial Camp	1929 Susquehanna Hall Road	Whiteford	1,000
					Harford County Subtotal:	*1,600*
LANCASTER COUNTY, PA						
Drumore North	5.7	N	Camp Andrews	1226 Silver Spring Road	Holtwood	140
Little Britain	7.9	ESE	Camp John H. Ware	Campsite Access Road	Peach Bottom	300
					Lancaster County Subtotal:	*440*
YORK COUNTY, PA						
Lower Chanceford North	5.7	NW	Camp Donegal	303 East Telegraph Road	Airville	70
					York County Subtotal:	*70*
					EPZ TOTAL:	**3,185**

Table E-4. Medical Facilities within the EPZ

Zone	Distance (miles)	Direction	Facility Name	Street Address	Municipality	Capacity	Current Census	Ambulatory Patients	Wheelchair Patients	Bedridden Patients
CECIL COUNTY, MD										
Zone 6	9.6	SE	Allcare Assisted Living	405 McCauley Road	Conowingo	9	8	6	2	0
Zone 6	7.9	SE	Conowingo Veterans Center	775 Ragan Road	Conowingo	22	18	16	2	0
Zone 6	10.2	SE	Liberty Garden Elderly Care	1670 Liberty Grove Road	Conowingo	12	9	4	3	2
					Cecil County Subtotal:	*43*	*35*	*26*	*7*	*2*
HARFORD COUNTY, MD										
Zone 1	9.4	SW	Hart Heritage Estate	3708 Grier Nursery Road	Street	39	34	25	7	2
					Harford County Subtotal:	*39*	*34*	*25*	*7*	*2*
LANCASTER COUNTY, PA										
East Drumore	8.2	NNE	Country View Manor	12 Friendly Drive	Quarryville	24	20	20	0	0
East Drumore	10.6	NNE	Quarryville Presbyterian Retirement Community	625 Robert Fulton Highway	Quarryville	375	372	242	128	2
					Lancaster County Subtotal:	*399*	*392*	*262*	*128*	*2*
					EPZ TOTAL:	**481**	**461**	**313**	**142**	**6**

Table E-5. Major Employers within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Employees (max shift)	% Non-EPZ	Employees (Non EPZ)
CECIL COUNTY, MD								
Zone 6	8.2	SE	Conowingo Elementary School	471 Rowlandsville Road	Conowingo	52	68.9%	36
					Cecil County Subtotal:	*52*	-	*36*
HARFORD COUNTY, MD								
Zone 1	6.6	WSW	McCorquodale Color Card Co.	2737 Whiteford Road	Whiteford	50	68.9%	35
Zone 1	9.1	SW	North Harford Elementary School	120 Pylesville Road	Pylesville	54	68.9%	38
Zone 1	9.1	SW	North Harford High School	211 Pylesville Road	Pylesville	120	68.9%	83
Zone 1	9.3	SW	North Harford Middle School	112 Pylesville Road	Pylesville	108	68.9%	75
Zone 2	6.8	S	Harford Christian School	1736 Whiteford Road	Darlington	75	68.9%	52
Zone 2	7.6	S	Maryland Lava Co.	3102 Dublin Road	Street	50	68.9%	35
					Harford County Subtotal:	*457*	-	*318*
CHESTER COUNTY, PA								
West Nottingham	13.2	E	Herr Foods Inc.	20 Herr Drive	Nottingham	125	68.9%	87
					Chester County Subtotal:	*125*	-	*87*
LANCASTER COUNTY, PA								
East Drumore	10.6	NNE	Quarryville Presbyterian Retirement Community	625 Robert Fulton Highway	Quarryville	369	68.9%	255
East Drumore	9.7	NE	Solanco Senior High School	585 Solanco Road	Quarryville	120	68.9%	83
Fulton East	6.9	ENE	Clermont Elementary School	1868 Robert Fulton Highway	Quarryville	52	68.9%	36
Fulton East	6.9	ENE	Swift Middle School	1866 Robert Fulton Highway	Quarryville	54	68.9%	38
Providence	8.7	NNE	Buck Company	897 Lancaster Pike	Quarryville	250	68.9%	173
Quarryville	10.7	NNE	Lancaster General	317 West Chestnut Street	Quarryville	50	68.9%	35
					Lancaster County Subtotal:	*895*	-	*620*
YORK COUNTY, PA								
Fawn	10.6	W	South Eastern Middle School East	375 Main Street	Fawn Grove	60	68.9%	42
Fawn	10.7	W	South Eastern Middle School West	417 Main Street	Fawn Grove	60	68.9%	42
Fawn Grove	10.6	W	Kennard-Dale High School	393 Main Street	Fawn Grove	90	68.9%	63
Peach Bottom East	0.0	-	Peach Bottom Atomic Power Station	1848 Lay Road	Delta	801	68.9%	552
					York County Subtotal:	*1,011*	-	*699*
					EPZ TOTAL:	**2,540**	-	**1,760**

Table E-6. Recreational Areas within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
CECIL COUNTY, MD							
Zone 6	6.5	SE	Conowingo Creek Boat Launch	Old Conowingo Road	Conowingo	40	16[2]
Zone 6	9.3	ESE	Hilltop Farm Inc.	1089 Nesbitt Road	Colora	320	130
					Cecil County Subtotal:	*360*	*146*
HARFORD COUNTY, MD							
Zone 1	9.6	SW	Geneva Farm Golf Course	217 Davis Road	Street	400	161
Zone 1	11.2	SW	Rocks 4-H Camp	6 Cherry Hill Road	Street	162	66
Zone 3	9.0	SE	Conowingo's Fisherman's Park	Shures Landing Road	Darlington	100	41
					Harford County Subtotal:	*662*	*268*
CHESTER COUNTY, PA							
West Nottingham	12.2	E	Nottingham Park	150 Park Road	Nottingham	900	363
					Chester County Subtotal:	*900*	*363*
LANCASTER COUNTY, PA							
Drumore South	4.8	NE	Pilgrim's Oak Golf Course	1107 Pilgrims Pathway	Peach Bottom	209	84
Drumore South	3.4	NNW	Susquehannock State Park	State Park Road	Drumore	613	247
East Drumore	7.6	NNE	Tanglewood Manor Golf Course	653 Scotland Road	Quarryville	377	152
East Drumore	10.1	NE	Yogi Bear's Jellystone Park	340 Blackburn Road	Quarryville	521	210[3]
Martic	6.3	N	Muddy Run Recreation Park	172 Bethesda Church Road	West Holtwood	469	189[4]
Martic	10.6	NNW	Pequea Creek Campground	86 Fox Hollow Road	Pequea	248	100[2]
Martic	7.6	NNW	Tucquan Park Family Campground	917 River Road	Holtwood	492	198[2]
					Lancaster County Subtotal:	*2,929*	*1,180*
YORK COUNTY, PA							
Lower Chanceford North	9.1	NW	Gamler's Campground	211 Indian Steps Road	Airville	348	140[2]
Lower Chanceford North	5.0	NW	Lock 12 Recreation Park	Mccalls Ferry Road	Lower Chanceford	30	13
Lower Chanceford North	10.2	NW	Otter Creek Campground	1101 Furnace Road	Airville	221	89[2]
Lower Chanceford North	9.9	NW	York Furnace Boat Launch	Indian Steps Road	Airville	102	41[1]
Lower Chanceford South	3.6	NW	Lock 15 Recreation Park	River Road	Lower Chanceford	30	13
Lower Chanceford South	3.5	NW	Muddy Creek Access Area	River Road	Lower Chanceford	110	44[1]

[2] Vehicles with boat trailers, treated as two passenger cars in simulation

[3] RVs, treated as two passenger cars in simulation

[4] Vehicle breakdown: 41 passenger vehicles, 148 RVs, treated as 337 passenger cars in simulation

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
Peach Bottom East	1.8	NW	Cold Cabin Public Park	Cold Cabin Road	Delta	20	9
					York County Subtotal:	*861*	*349*
					EPZ TOTAL:	**5,712**	**2,306**

Table E-7. Lodging Facilities within the EPZ

Zone	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Transients	Vehicles
YORK COUNTY, PA							
Peach Bottom Central	3.5	WSW	Peach Bottom Inn	6085 Delta Road	Delta	48	24
					YORK COUNTY AND EPZ TOTAL:	**48**	**24**

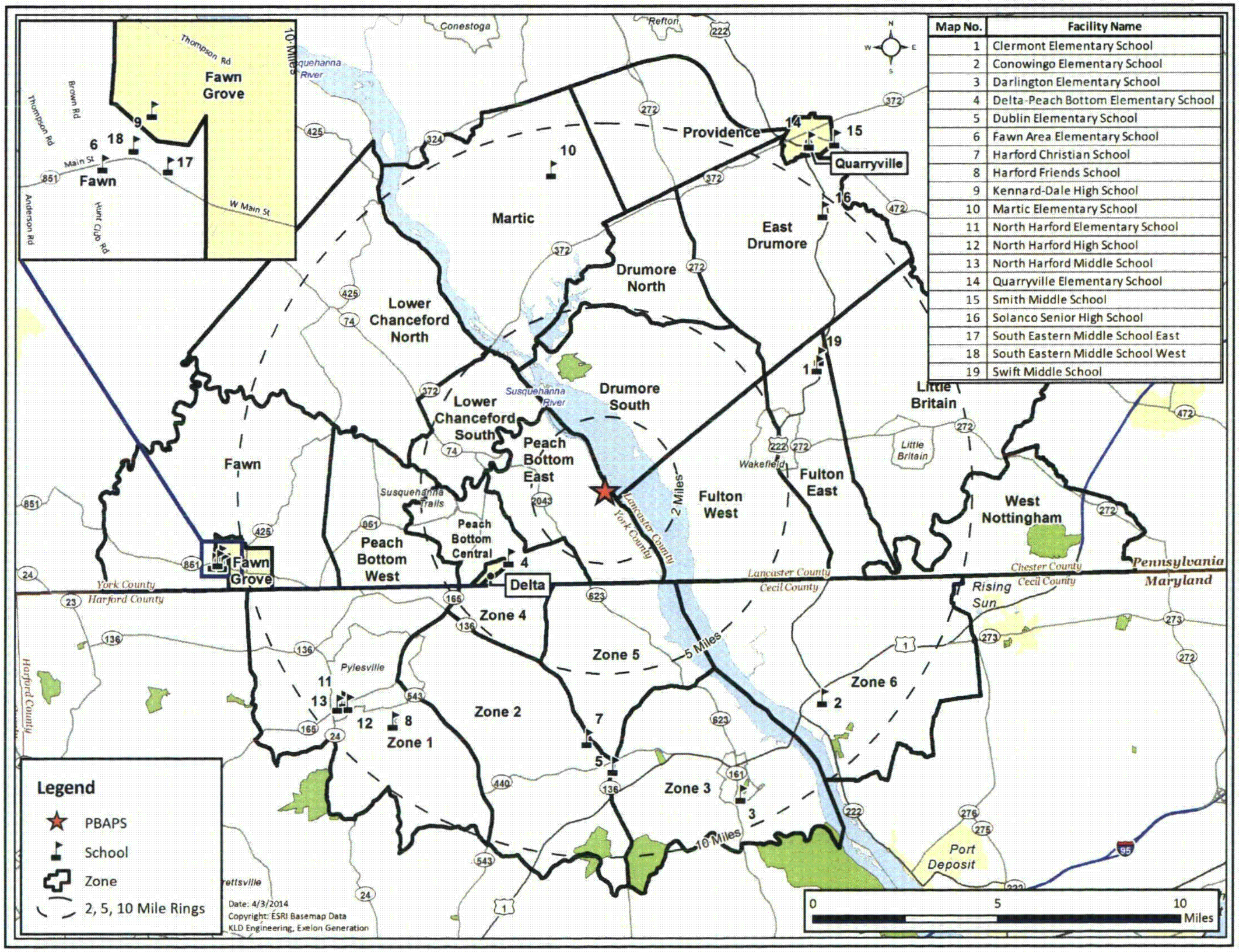


Figure E-1. Schools within the PBAPS EPZ

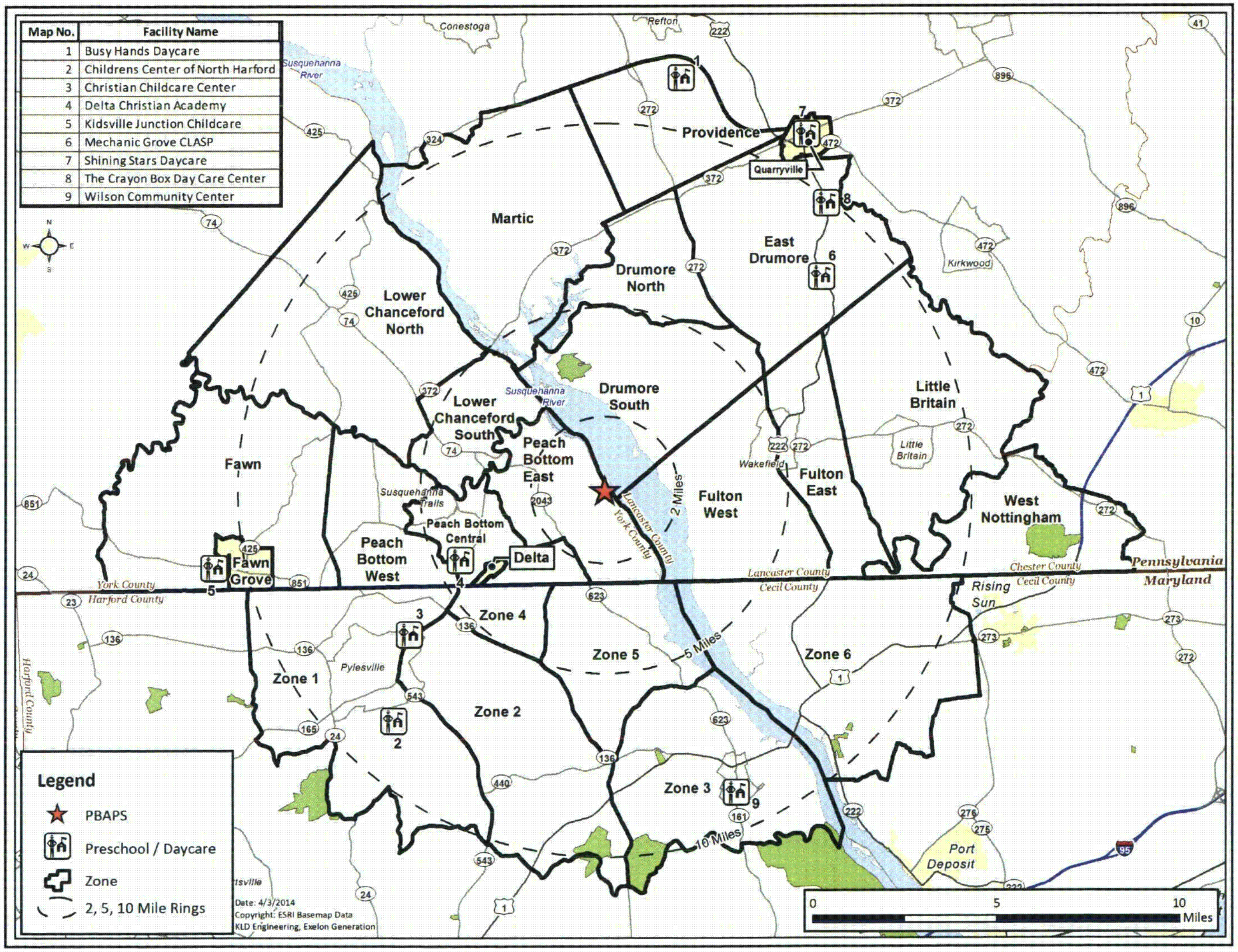


Figure E-2. Preschools / Daycares within the PBAPS EPZ

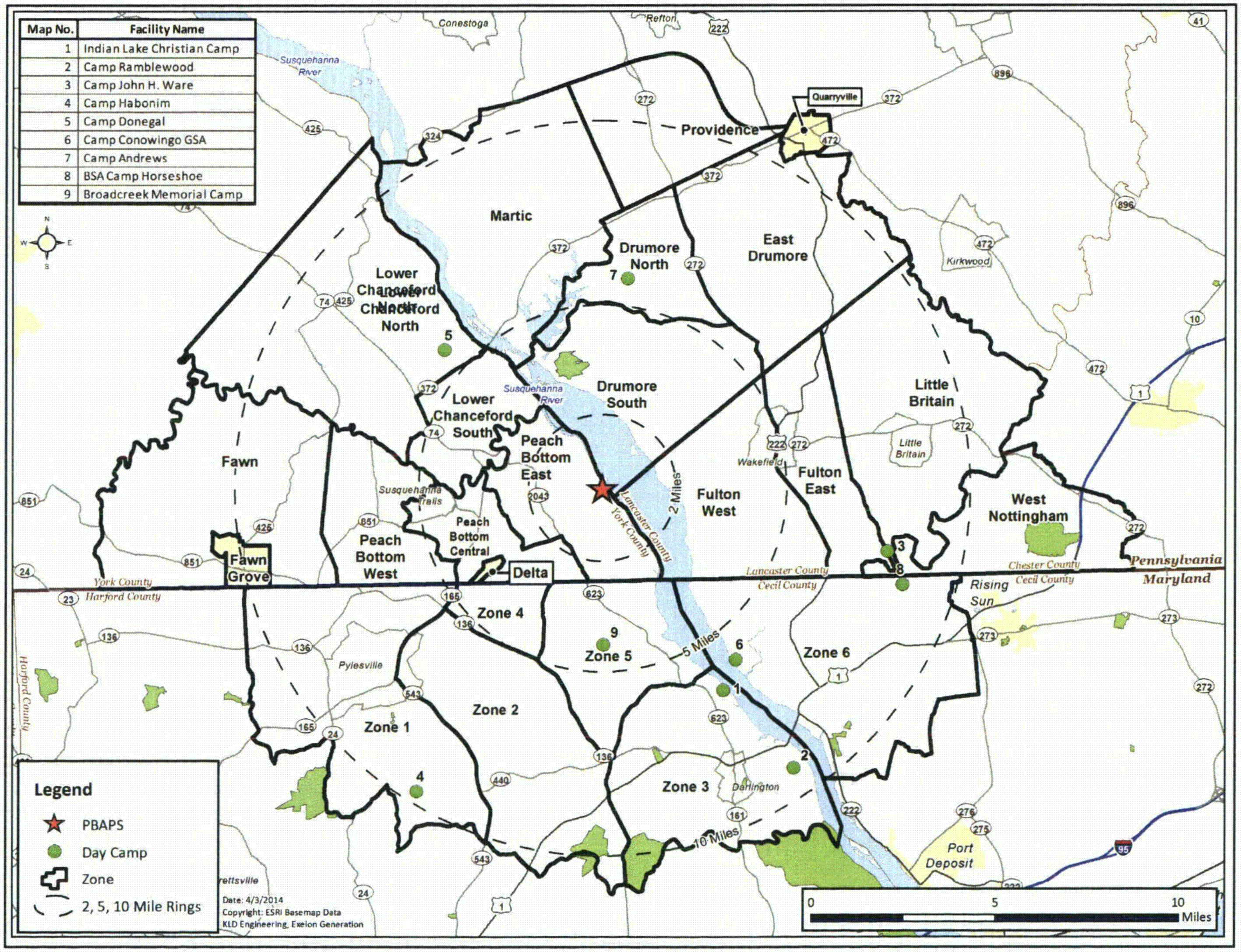


Figure E-3. Day Camps within the PBAPS EPZ

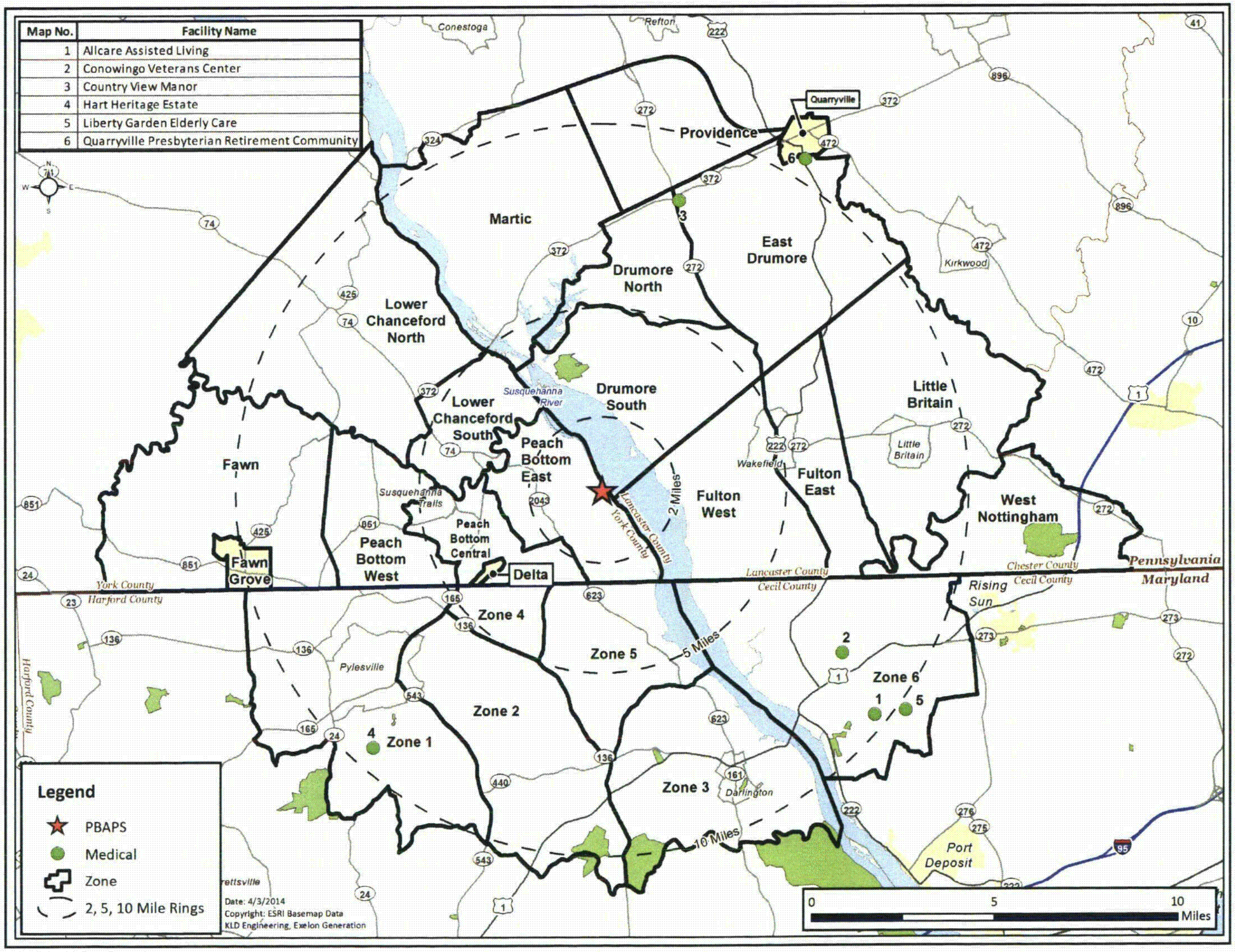


Figure E-4. Medical Facilities within the PBAPS EPZ

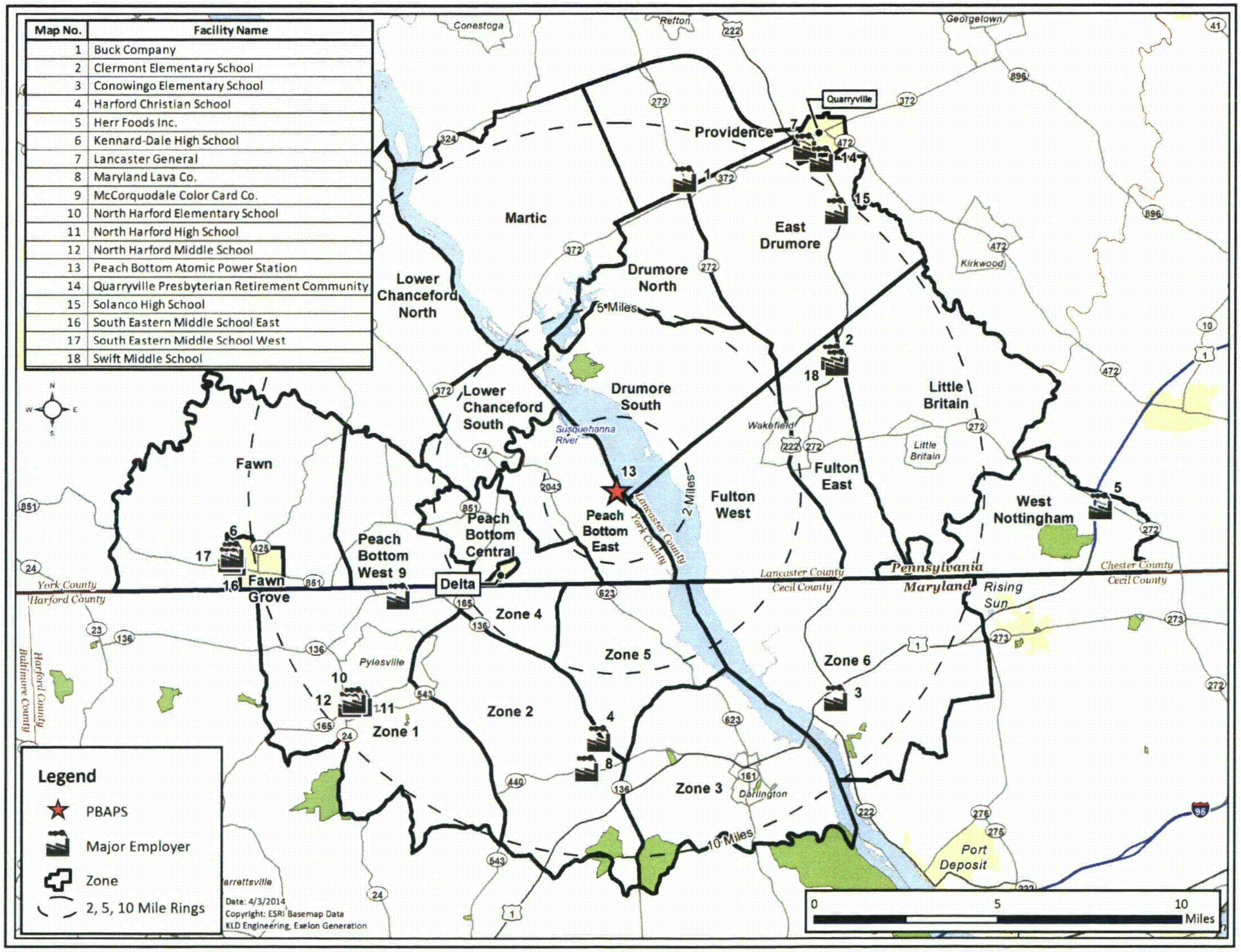
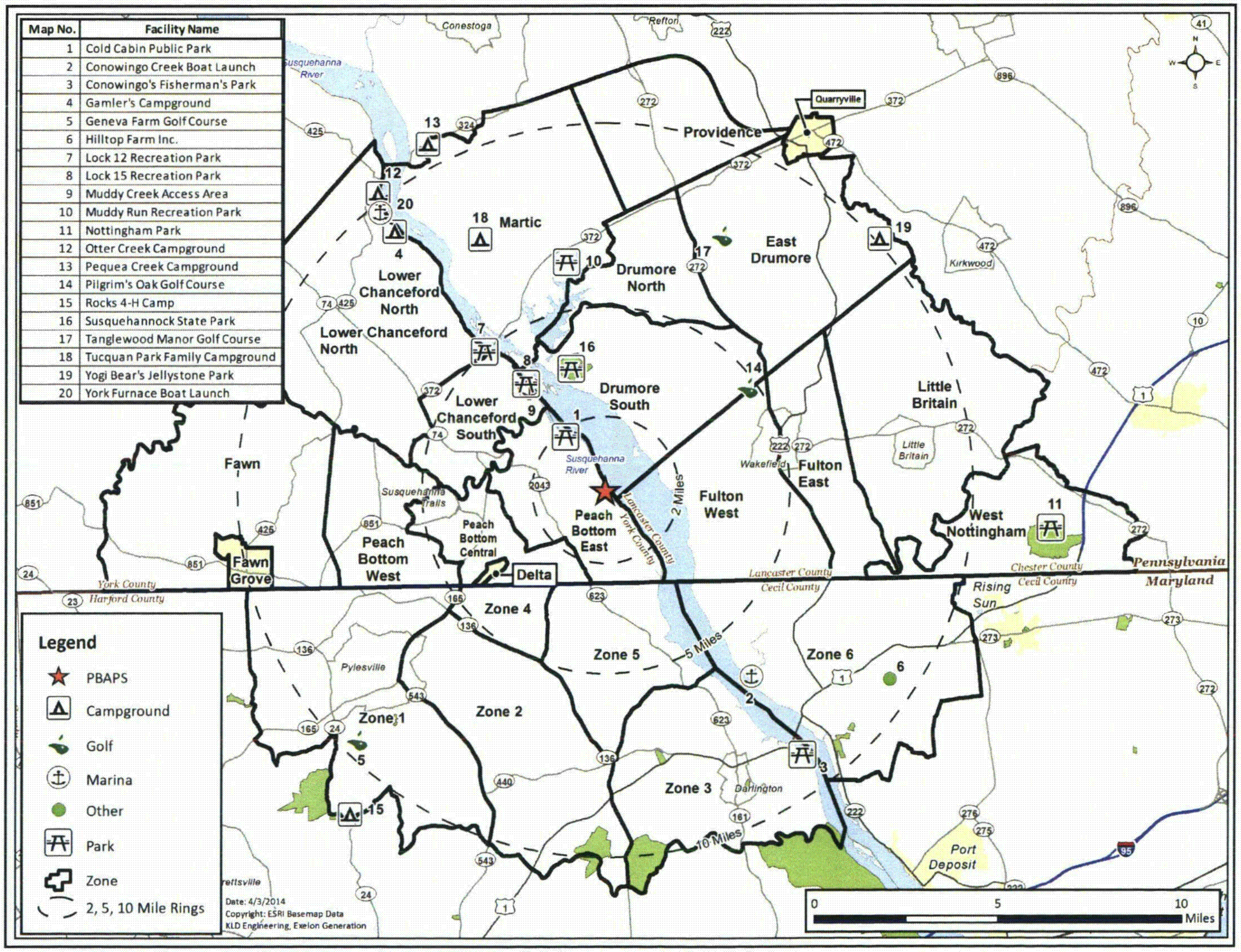


Figure E-5. Major Employers within the PBAPS EPZ



Map No.	Facility Name
1	Cold Cabin Public Park
2	Conowingo Creek Boat Launch
3	Conowingo's Fisherman's Park
4	Gamler's Campground
5	Geneva Farm Golf Course
6	Hilltop Farm Inc.
7	Lock 12 Recreation Park
8	Lock 15 Recreation Park
9	Muddy Creek Access Area
10	Muddy Run Recreation Park
11	Nottingham Park
12	Otter Creek Campground
13	Pequea Creek Campground
14	Pilgrim's Oak Golf Course
15	Rocks 4-H Camp
16	Susquehannock State Park
17	Tanglewood Manor Golf Course
18	Tucquan Park Family Campground
19	Yogi Bear's Jellystone Park
20	York Furnace Boat Launch

Figure E-6. Recreational Areas within the PBAPS EPZ

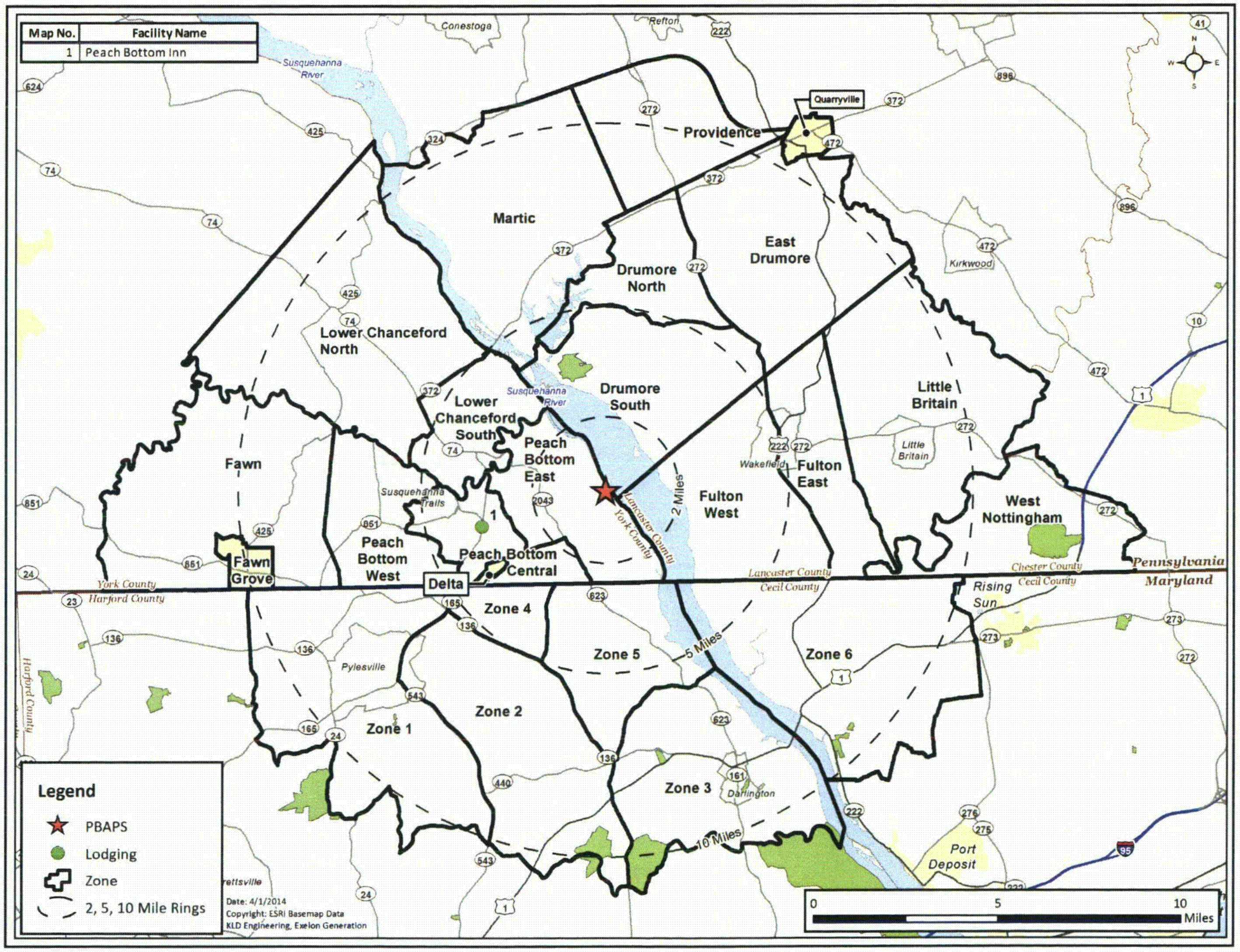


Figure E-7. Lodging Facilities within the PBAPS EPZ

APPENDIX F

Telephone Survey

F. TELEPHONE SURVEY

F.1 Introduction

The development of evacuation time estimates for the PBAPS EPZ requires the identification of travel patterns, car ownership and household size of the population within the EPZ. Demographic information can be obtained from Census data. The use of this data has several limitations when applied to emergency planning. First, the Census data do not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data do not contain attitudinal responses needed from the population of the EPZ and consequently may not accurately represent the anticipated behavioral characteristics of the evacuating populace.

These concerns are addressed by conducting a telephone survey of a representative sample of the EPZ population. The survey is designed to elicit information from the public concerning family demographics and estimates of response times to well defined events. The design of the survey includes a limited number of questions of the form "What would you do if ...?" and other questions regarding activities with which the respondent is familiar ("How long does it take you to ...?")

Attachment A presents the final survey instrument used in this study. A sample size of 381 **completed** survey forms yields results with a sampling error of ±5% at the 95% confidence level. The sample must be drawn from the EPZ population.

The preliminary determination of whether a household was located inside the EPZ was based on "land-line" telephone listings with street addresses. Telephone surveys were then conducted using those numbers, selected in random order, until the target level of surveys was completed, or the entire calling list was exhausted. Rejections or households outside the EPZ were discarded. Numbers with "no answer" were re-cycled for up to ten attempts in different time windows.

F.2 Survey Results

The results of the survey fall into two categories. First, the household demographics of the area can be identified. Demographic information includes such factors as household size, automobile ownership, and automobile availability. The distributions of the time to perform certain pre-evacuation activities are the second category of survey results. These data are processed to develop the trip generation distributions used in the evacuation modeling effort, as discussed in Section 5.

A review of the survey instrument reveals that several questions have a "don't know" (DK) or "refused" entry for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a DK response for a few questions or who refuses to answer a few questions. To address the issue of occasional DK/refused responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the DK/refused responses are ignored and the distributions are based upon the positive data that is acquired.

F.2.1 Household Demographic Results

Household Size

Figure F-1 presents the distribution of household size within the EPZ. The average household contains 2.48 people.

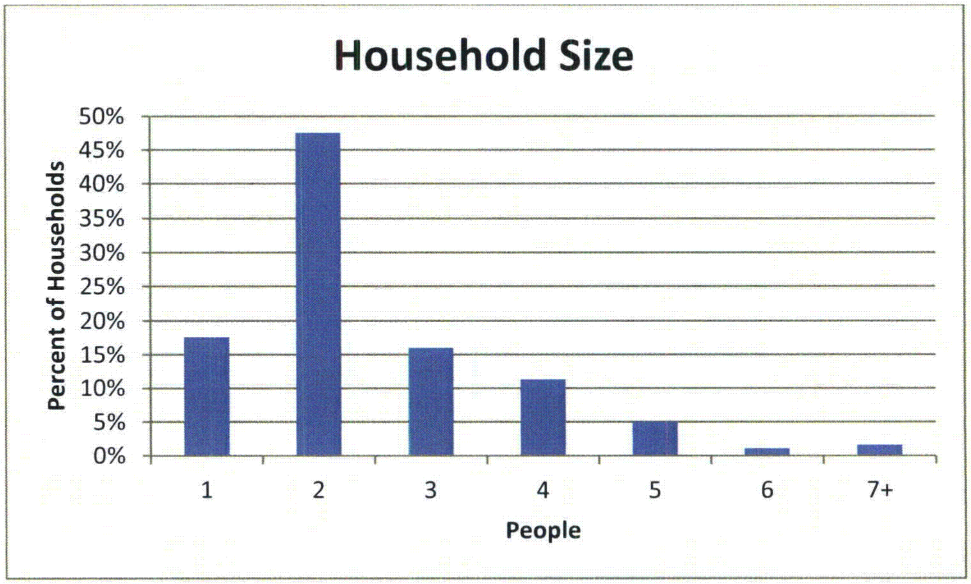


Figure F-1. Household Size in the EPZ

Automobile Ownership

The average number of automobiles available per household in the EPZ is 2.30. Approximately 4.5% of households do not have a vehicle available, as shown in Figure F-2.

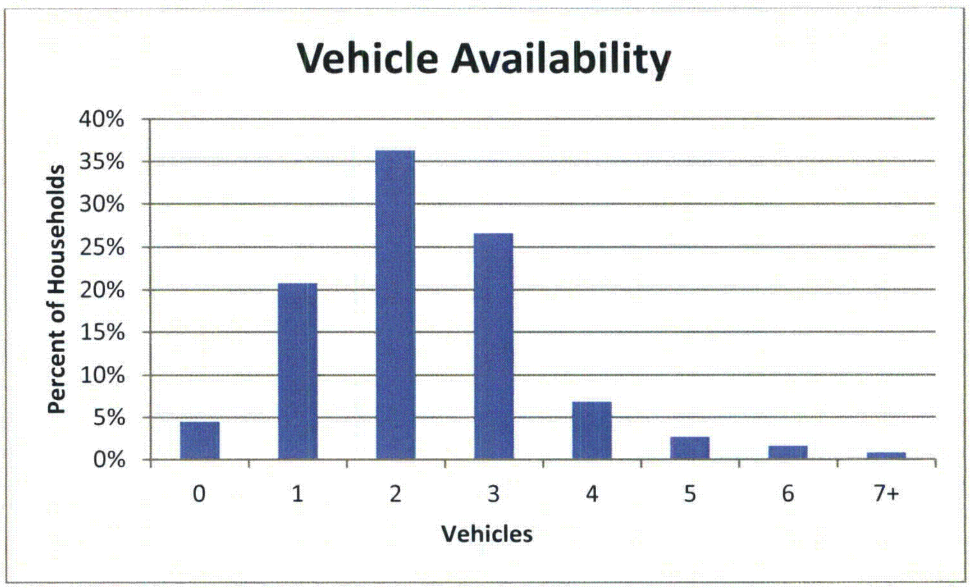


Figure F-2. Household Vehicle Availability

Commuters

Figure F-3 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data shows an average of 1.04 commuters in each household in the EPZ, and 55% of households have at least one commuter.

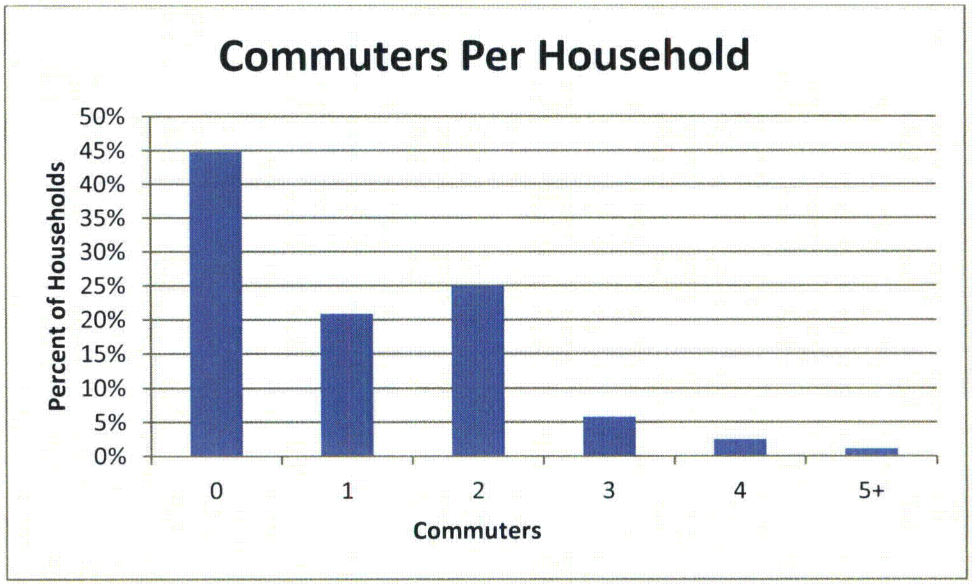


Figure F-3. Commuters in Households in the EPZ

F.2.2 Evacuation Response

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

"How many vehicles would your household take if an evacuation were ordered when all household members were at home??" The response is shown in Figure F-4. On average, evacuating households would use 1.36 vehicles.

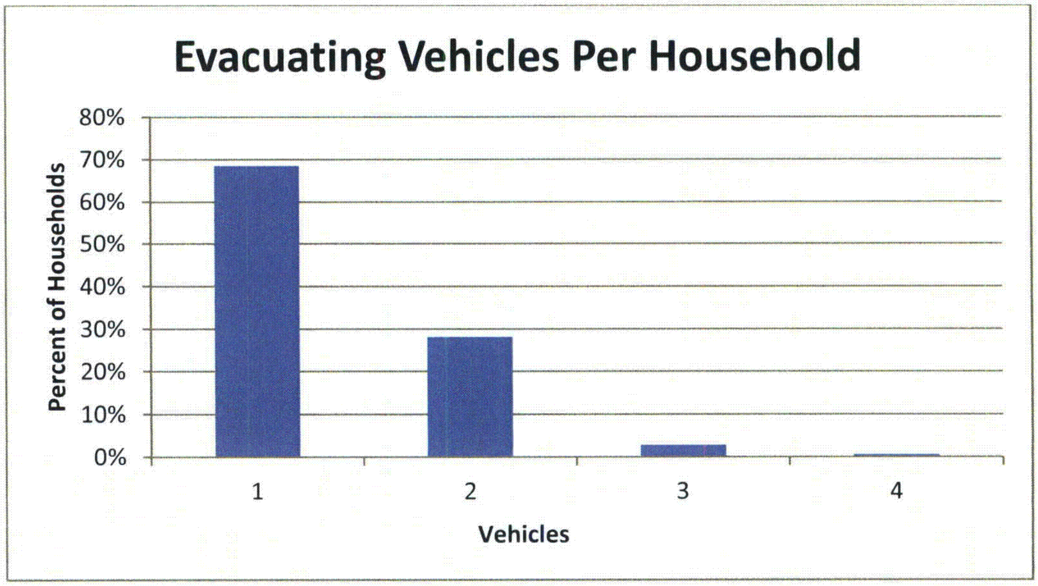


Figure F-4. Number of Vehicles Used for Evacuation

"If an evacuation notice were given while [the primary commuter] was at work, do you think they would most likely…" The response is shown in Figure F-5. Of the survey participants who responded, 32 percent indicated they would evacuate from work, 50 percent said they would return home first and then evacuate, and 18 percent indicated that they would stay outside the evacuation zone where they work.

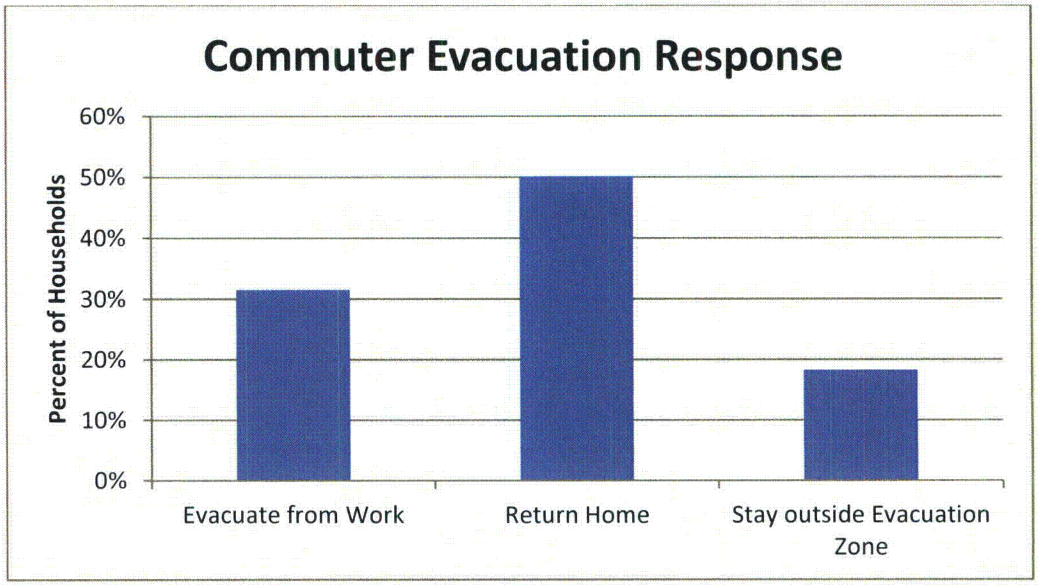


Figure F-5. Commuter Evacuation Response

F.2.3 Time Distribution Results

The survey asked several questions about the amount of time it takes to perform certain pre-evacuation activities. These activities involve actions taken by residents during the course of their day-to-day lives. Thus, the answers fall within the realm of the responder's experience.

The mobilization distributions provided below are the result of having applied the analysis described in Section 5.4.1 on the component activities of the mobilization.

"How long do you think it would take [the primary commuter] to get prepared and actually leave work?" Figure F-6 presents the cumulative distribution; in all cases, the activity is completed within 75 minutes. Eighty-eight percent can leave within 30 minutes.

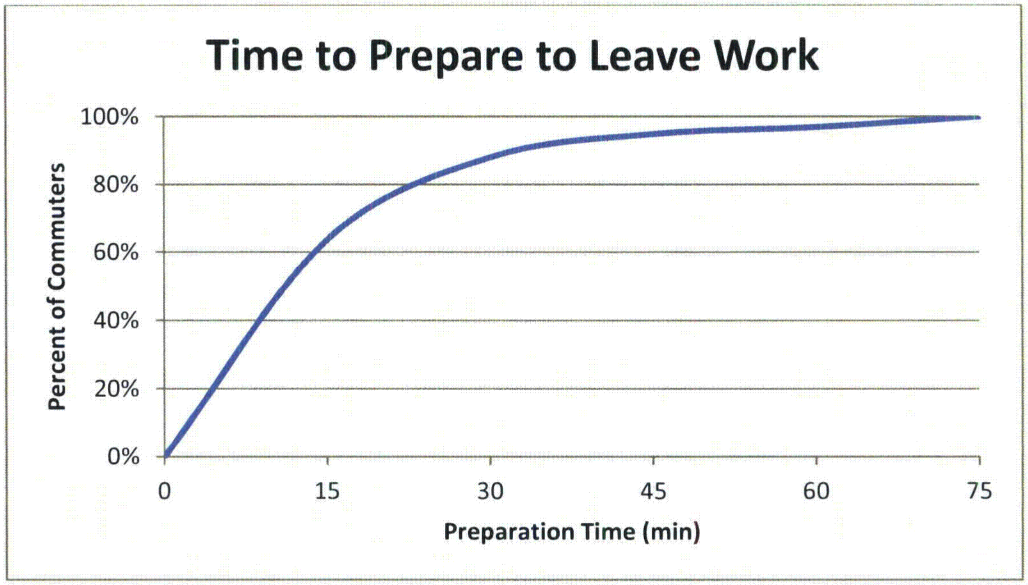


Figure F-6. Time Required to Prepare to Leave Work

"About how long does it take [the primary commuter] to get from work to home?" Figure F-7 presents the work to home travel time for the EPZ. Approximately 70 percent of commuters can arrive home within about 30 minutes of leaving work; all within 75 minutes.

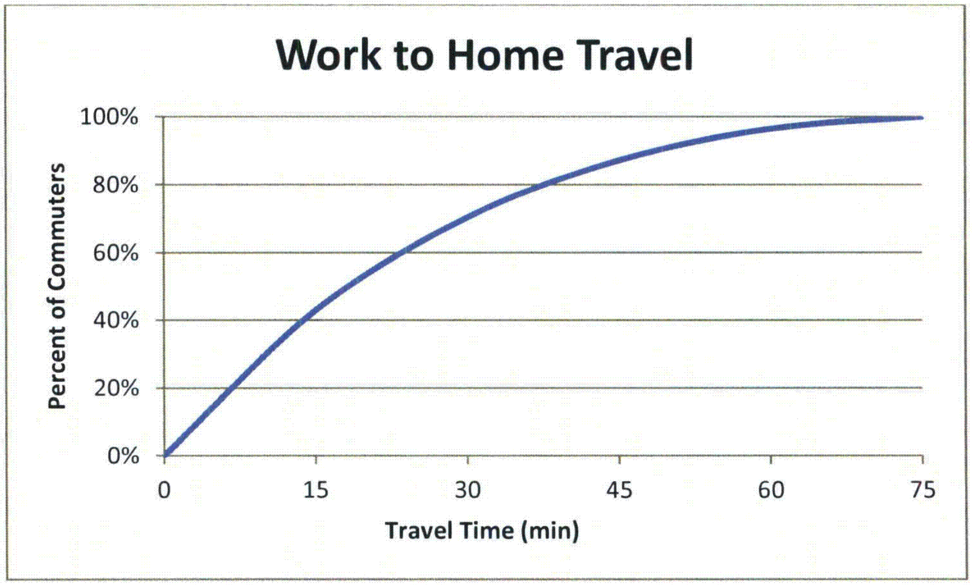


Figure F-7. Work to Home Travel Time

"If an evacuation were ordered when all household members were at home (for example, at night or on a weekend), approximately how long would it take your household to prepare to depart? Please assume that you are advised to plan to be away from your home for 3 days." Figure F-8 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities. About 65 percent of households can be ready to leave home within 40 minutes; the remaining households require up to an additional 80 minutes.

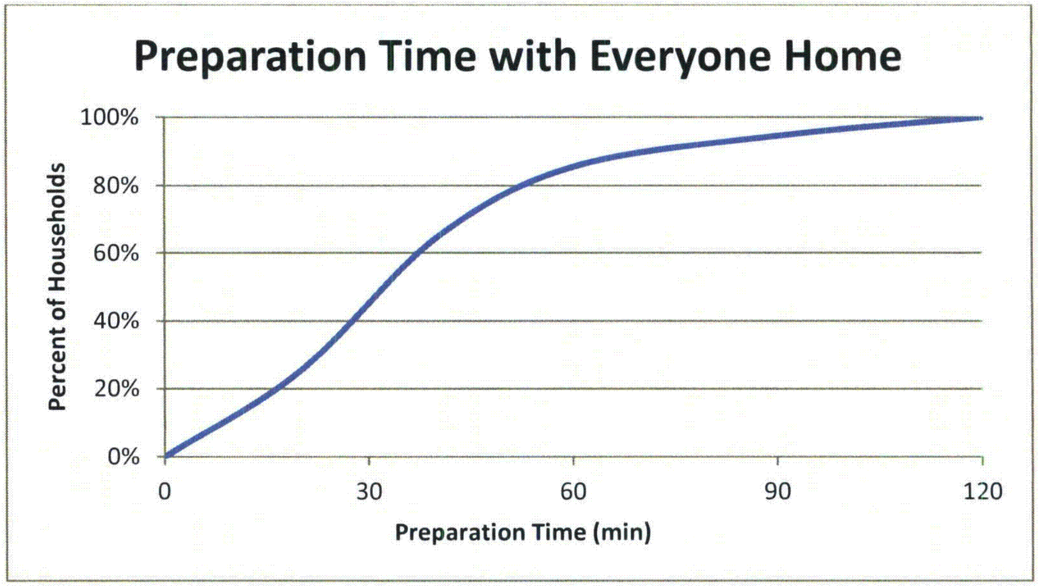


Figure F-8. Time to Prepare Home for Evacuation

The survey conducted in support of this study did not ask residents how long it would take them to remove snow from their driveway if there were snow on the ground when an evacuation was ordered. As discussed in Section 5.3, the response to the snow removal question in a survey conducted in 2008 in support of ETE development for the Susquehanna Steam Electric Station (SSES) is adapted for this study. SSES is also in the Commonwealth of Pennsylvania, only 92 miles north of PBAPS. It is assumed that snowfall and snow removal times are comparable in both EPZs.

"How long would it take you to clear 6 to 8 inches of snow from your driveway?" During adverse, snowy weather conditions, an additional activity must be performed before residents can depart on the evacuation trip. Although snow scenarios assume that the roads and highways have been plowed and are passable (albeit at lower speeds and capacities), it may be necessary to clear a private driveway prior to leaving the home so that the vehicle can access the street. Figure F-9 presents the time distribution for removing 6 to 8 inches of snow from a driveway. The time distribution for clearing the driveway has a long tail; about 90 percent of driveways are passable within 60 minutes. The last driveway is cleared two hours and 15 minutes after the start of this activity. Forty percent of respondents answered that they would need less than 15 minutes to render the driveway passable (the first data point plotted is at 15 minutes). This group includes those who would not clear the snow at all but would drive through the snow on the driveway to access the roadway and begin their evacuation trip.

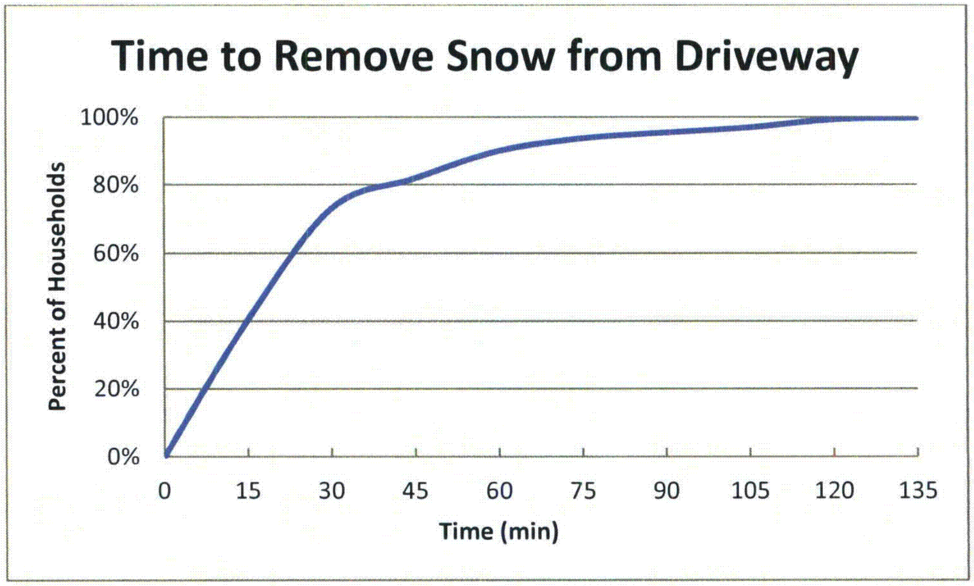


Figure F-9. Time to Clear Driveway of 6"-8" of Snow

F.3 Conclusions

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

ATTACHMENT A

Telephone Survey Instrument

Telephone Survey Instrument

Exelon Survey
Final v6 - August 23, 2011

INTRODUCTION

Hello, my name is _______ and I am calling from MDC Research, a public opinion firm. We are conducting a brief survey to gather information from households in your area about emergency response planning, and we'd like to include your opinions. This survey is being conducted on behalf of the (insert facility name) Nuclear Facility, and will take approximately 5 minutes to complete. We are not trying to sell you anything. The information gathered from this survey will help local agencies more effectively provide community assistance should an emergency situation arise.

Can I please speak with an adult member of the household?

SCREENER

S1. What is the zip code of your primary residence? This is the home where you live the majority of the time. DO NOT READ ZIP CODE LIST
List of appropriate zip codes will be displayed here

99999 Location outside the EPZ – **THANK & TERMINATE**

S2. Which of the following categories best describes your age?

11 Under 18 yrs of age – **ASK FOR REFERRAL or THANK & TERMINATE**
12 18 to 24
13 25 to 34
14 35 to 44
15 45 to 54
16 55 to 64
17 65 to 74
18 75 or older
98 (DO NOT READ) Refused

QUESTIONNAIRE

Q1 How many people currently reside in your household?
Record: ________ # of residents
98 (DO NOT READ) Refused – THANK & TERMINATE

Q2 How many motor vehicles are normally based at your home?
Record: ________ # of vehicles
997 None - SKIP TO Q14
998 (DO NOT READ) Refused

Q3 How many members of your household are over the age of 16?
Record: _______ # of residents
998 (DO NOT READ) Refused

Q4 How many members of your household are licensed drivers?
Record: _______ # of drivers
998 (DO NOT READ) Refused

Q5 How many of the adults in your household work outside the home?
Record □ Skip to Q6A
997 None – Continue to Q5A
998 (DO NOT READ) Refused
If refused, explain; The nature of this project is to estimate traffic volumes and flow in the event of an emergency evacuation, so this data is necessary in order for us to continue with the survey.
If still refused - THANK & TERMINATE

Q5A (ONLY ASK IF Q5=997) Which of the following best describes the non-working adults in your household? MULTIPLE MENTION – IP NOTE: No more mentions than Q3 mentions.
11 Currently unemployed/actively looking for work
12 Retired
13 On Disability or leave of absence
14 Student/continuing education
15 Homemaker
99 Other – please specify
SKIP TO Q11

Repeat the following Q6A-F sequence for each working adult cited in Q5
For each of the working adults you just referenced, I'd like to ask a few questions related to what their likely actions would be in the case of an emergency evacuation. I understand that I will be asking you to speculate on what other members of the household may do in this situation, but your best guesses are just fine for our purposes.

Q6A Who is the first working adult in the household that you are thinking about? What is their relationship to you?
1 Self
2 Spouse or significant other
3 Parent of child
4 Other relative or in-law
5 Roommate
6 Boarder
7 Other

Q6B Which of the following best describes this person's usual work schedule?
1 Monday – Friday, 8:00am to 5:00pm
2 Swing Shift
3 Graveyard
4 Evenings and weekends
5 Rotating shifts
6 Other or irregular schedule
7 **(DO NOT READ)** Don't know

Q6C Does this person generally use a personal vehicle to commute back and forth to work?
1 Yes
2 No
7 **(DO NOT READ)** Don't know

Q6D If an evacuation notice were given while this person was at work, do you think they would most likely…
1 Evacuate directly from work
2 Come home first and then evacuate, or
3 Stay outside the evacuation zone where they work □ **Skip to Q7**
7 **(DO NOT READ)** Don't know

Q6E How long do you think it would take this person to get prepared and actually leave work?
(Read list if necessary)
1 Less than 15 minutes
2 15 to 30 minutes
3 30 to 45 minutes
4 45 to 60 minutes
5 More than 60 minutes
7 **(DO NOT READ)** Don't know
If response at 6D is 1, skip from here to Q7

Q6F About how long does it take this household member to get from work to home?
(Read list if necessary)
1 Less than 15 minutes
2 15 to 30 minutes
3 30 to 45 minutes
4 45 to 60 minutes
5 More than 60 minutes

7 (DO NOT READ) Don't know

Q7A-F Repeat Q6 sequence for worker #2

Q8A-F Repeat Q6 sequence for worker #3

Q9A-F Repeat Q6 sequence for worker #4

Q10 And once everyone who is coming home from work has arrived, how long would it take to prepare and depart from home, taking into consideration whether or not someone else is usually home who may be starting these preparation while they are travelling?
1 Less than 15 minutes
2 15 to 30 minutes
3 30 to 45 minutes
4 45 to 60 minutes
5 More than 60 minutes
7 (DO NOT READ) Don't know

Q11 Are any of the licensed drivers in your household restricted to daytime driving only?
1 Yes
2 No
9 (DO NOT READ) Refused

Q12 If an evacuation were ordered when all household members were at home (for example, at night or on a weekend), approximately how long would it take your household to prepare to depart? Please assume that you are advised to plan to be away from your home for 3 days. Would you say that it would take… READ LIST
1 Less than 20 minutes to depart
2 20 to 40 minutes to depart
3 40 to 60 minutes to depart
4 60 to 90 minutes to depart; or
5 More than 90 minutes to depart

Q13 How many vehicles would your household take if an evacuation were ordered when all household members were at home?
Record: _________ # of vehicles
998 (DO NOT READ) Refused

Q14 Are any members of your household seasonal residents? And by seasonal we mean any people who do not reside in your home the majority of the year.
1 Yes
2 No - SKIP TO Q15
9 (DO NOT READ) Refused

Q14A (ASK IF Q14=1) How many of your <insert Q1 response> household members are seasonal?
Record: _______ # of seasonal household members
998 (DO NOT READ) Refused

Q14B (ASK IF Q14=1) What seasons do they live in another location away from your home? READ LIST – Multiple Mention
1 Spring
2 Summer
3 Fall

4 Winter

Q15 Would any member of your household require a specialized vehicle, such as a wheelchair, van or ambulance, to evacuate from your home in case of an emergency?

1 Yes

2 No

9 **(DO NOT READ)** Refused

This is all the questions we have for you today/tonight. Thank you for participating in this survey. Your responses will help us to make an accurate prediction of traffic conditions during an emergency situation. If you have any questions about this survey, please feel free to contact <insert contact name, job title, and phone number/email>.

APPENDIX G

Traffic Management Plan

G. TRAFFIC MANAGEMENT PLAN

NUREG/CR-7002 indicates that the existing TCPs and ACPs identified by the offsite agencies should be used in the evacuation simulation modeling. The traffic and access control plans for the EPZ were provided by the county and state emergency management agencies.

These plans were reviewed and the TCPs and ACPs were modeled accordingly.

G.1 Traffic Control Points

As discussed in Section 9, traffic control points at intersections (which are controlled) are modeled as actuated signals. If an intersection has a pre-timed signal, stop, or yield control, and the intersection is identified as a traffic control point, the control type was changed to an actuated signal in the DYNEV II system. Table K-2 provides the control type and node number for those nodes which are controlled. If the existing control was changed due to the point being a TCP, the control type is indicated as "TCP – Actuated" or "TCP – Uncontrolled" in Table K-2. The TCPs and ACPs within the study area are mapped in Figure G-1.

G.2 Access Control Points

It is assumed that ACPs will be established within 2 hours of the advisory to evacuate to discourage through travelers from using major through routes which traverse the EPZ. As discussed in Section 3.6, external traffic was considered on the major routes which traverse the study area – I-95, US-1, and US-40 – in this study. The generation of the external trips ceases at 2 hours after the advisory to evacuate in the simulation due to the ACPs.

As shown in Figure G-1, the TCPs and ACPs identified in the county and state emergency plans are concentrated along major evacuation routes and on roadways giving access to the EPZ. These TCPs and ACPs would be manned during evacuation by traffic guides who would direct evacuees in the proper direction away from the plant and facilitate the flow of traffic through the intersections.

Detailed descriptions of each of the TCPs and ACPs and the actions to be taken by traffic guides at these intersections are provided in the county and state plans. These actions were modeled explicitly in the DYNEV II system. For additional information, refer to the county and state plans.

As discussed in Section 9, this study did not identify any additional intersections as TCPs or ACPs. The existing county and state traffic management plans are comprehensive and do not require revision.

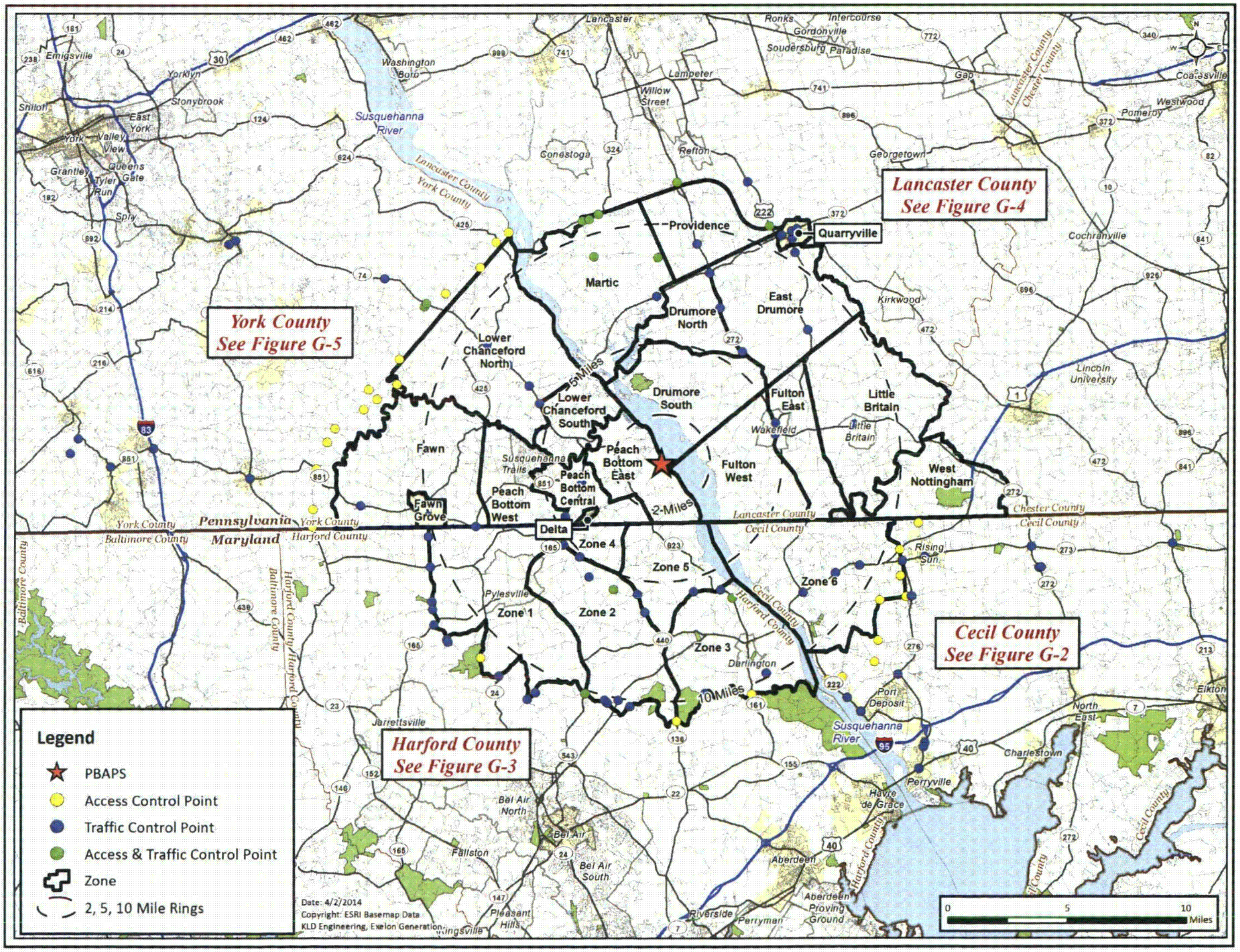


Figure G-1. Overview of Traffic and Access Control Points for the Peach Bottom Atomic Power Station

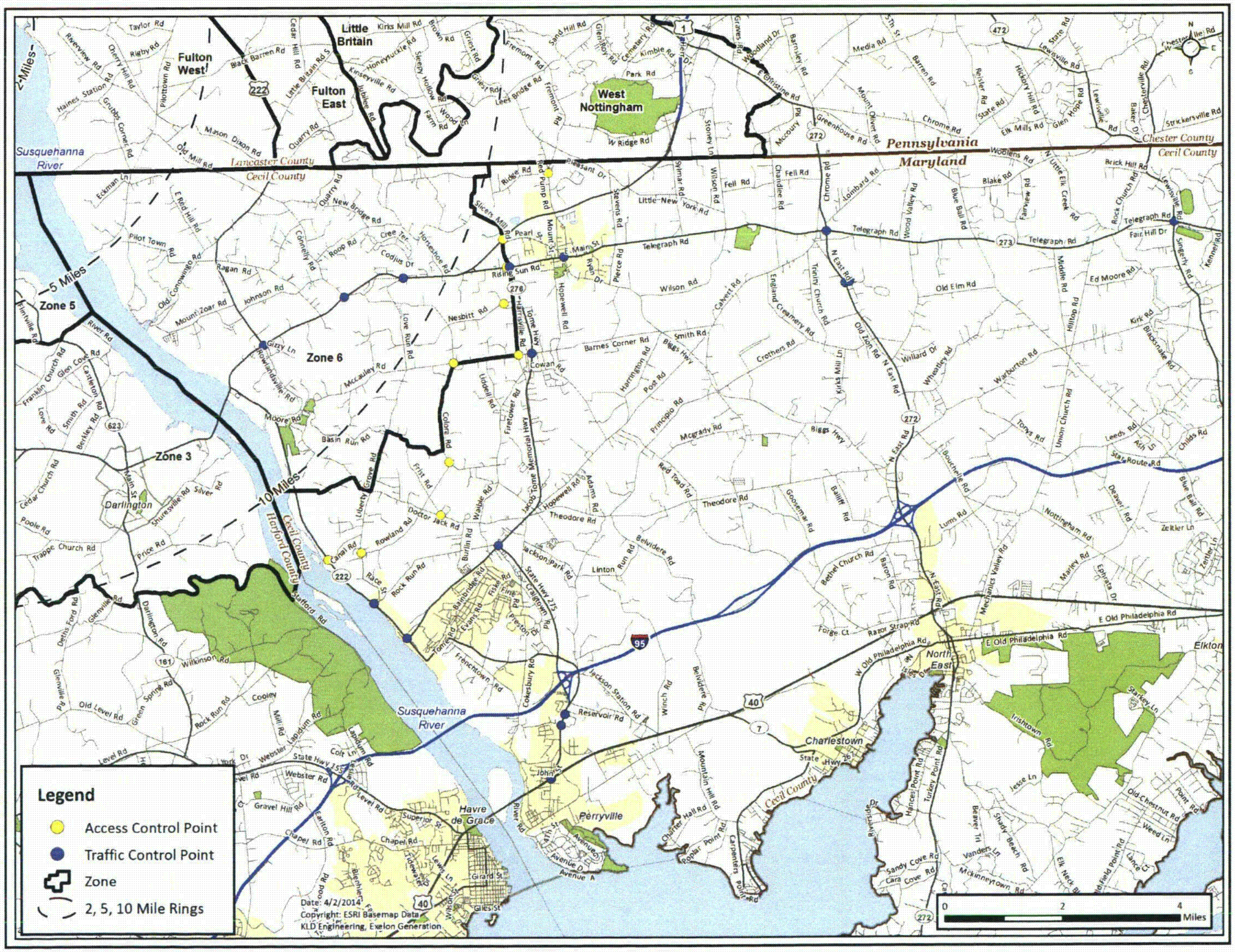


Figure G-2. Traffic and Access Control Points – Cecil County, MD

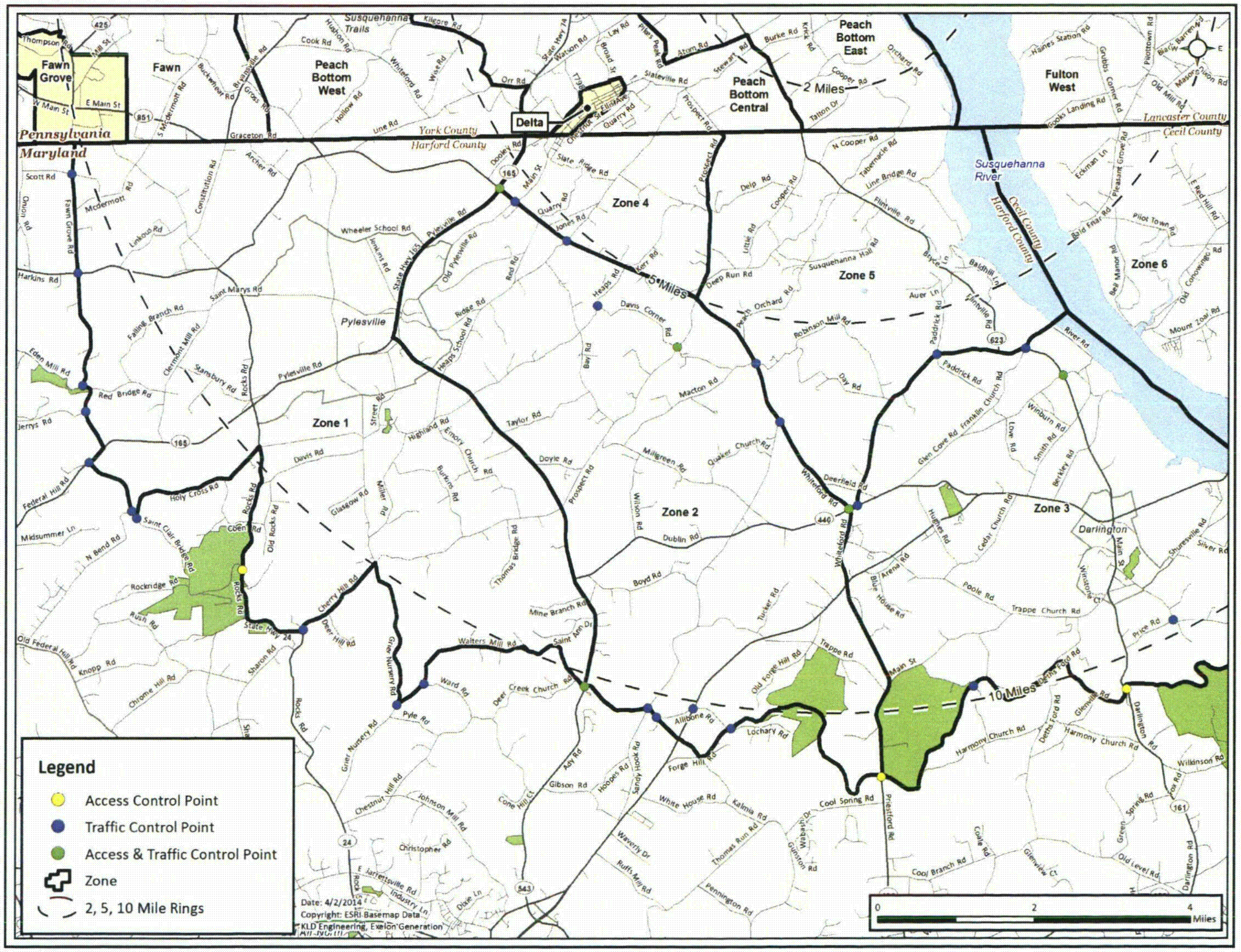


Figure G-3. Traffic and Access Control Points – Harford County, MD

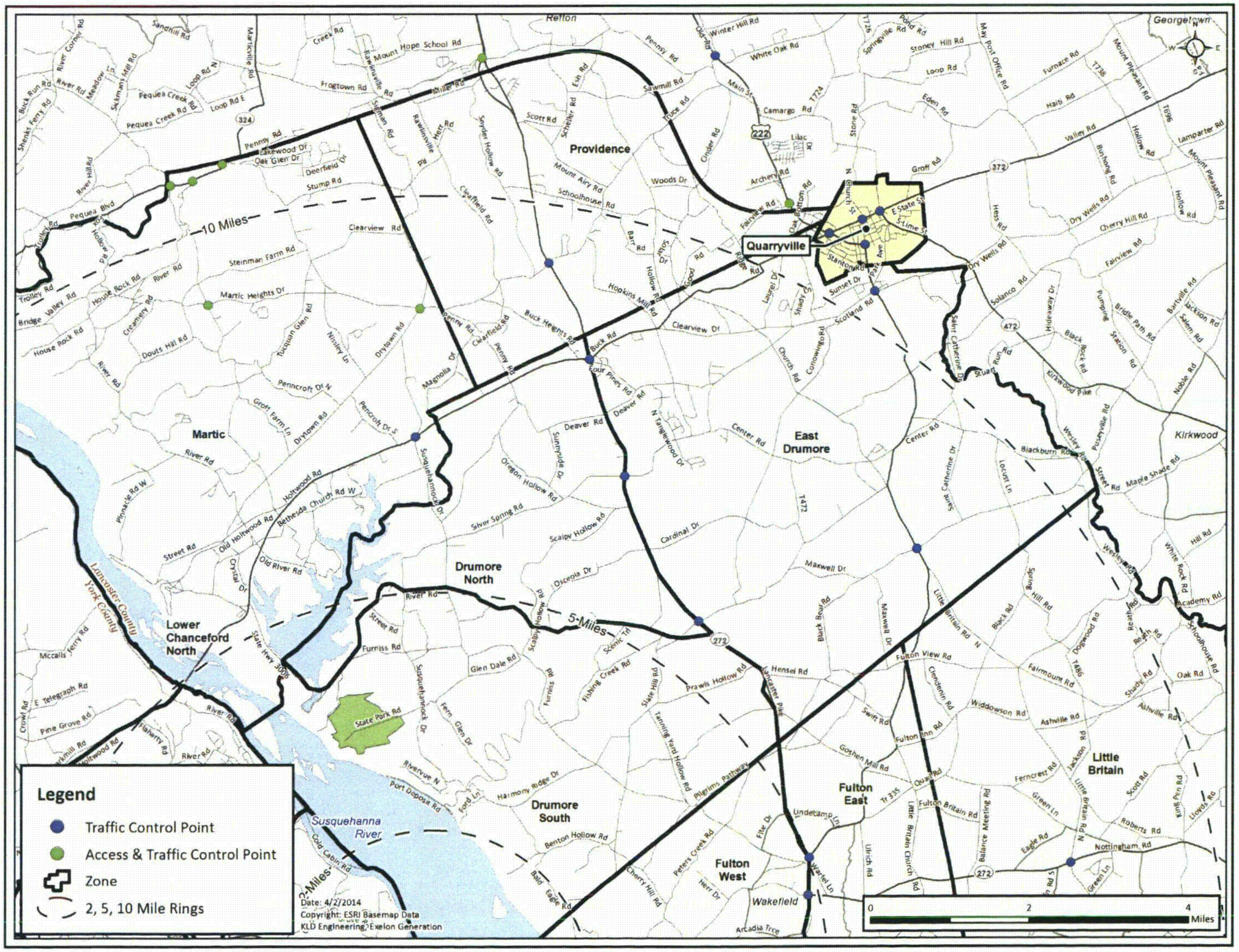


Figure G-4. Traffic and Access Control Points – Lancaster County, PA

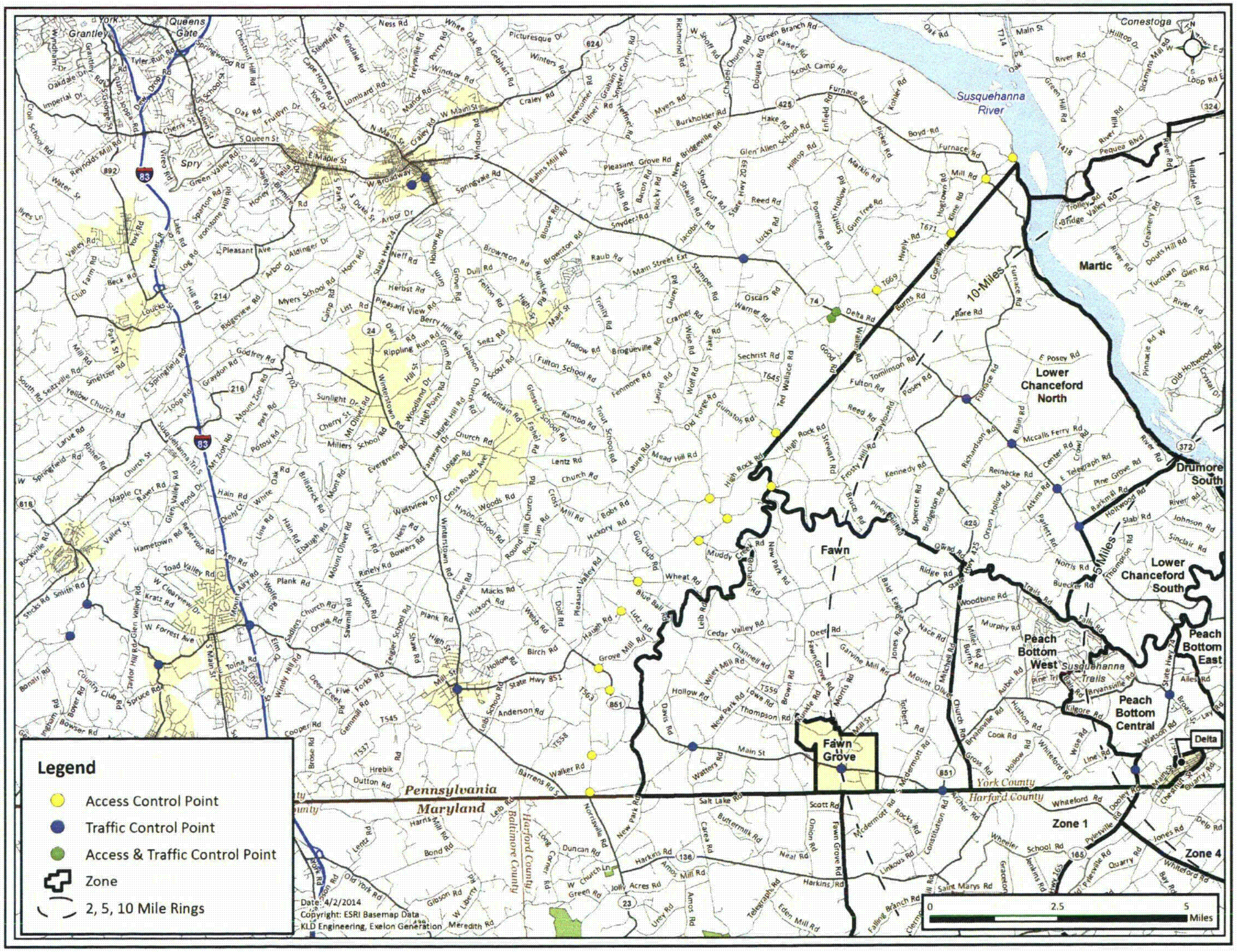


Figure G-5. Traffic and Access Control Points – York County, PA