**EVACUATION TIME ESTIMATES**
**WITHIN THE**
**PLUME EXPOSURE PATHWAY**
**EMERGENCY PLANNING ZONE**
**FOR THE**
**CALVERT CLIFFS**
**NUCLEAR POWER PLANT**
**REVISION 6**

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**August 2002**

**Calvert Cliffs Nuclear Power Plant Inc.**

EVACUATION TIME ESTIMATES
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FOR THE
CALVERT CLIFFS NUCLEAR POWER PLANT

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CALVERT CLIFFS NUCLEAR POWER PLANT

EVACUATION TIME ESTIMATES

RECORD OF REVISION

| Revision | Change | Summary |
|---|---|---|
| 6 | 0 | ► Added the following:<br>Approval signature for "Director, Nuclear Security and Emergency Planning Section"<br>Record of Revision page<br>List of effective pages<br>Summary Tables for "Summer" table 1-1 and "Winter" table 1-2 to section 1 removed existing summary table 1-1<br>Dept. Natural Resources to Distribution<br>Communities of Drum Point, White Sands, Broomes Island St. Leonard and Lusby to "Study Area Description"<br>Removed "Rock Christian Academy" from Table 2-1 "Major Communities and Facilities in the Protective Action Zones, and added Dowell Elementary, Mill Creek Middle School and St. Mary's Development Center<br>Assumptions of "Over night accommodations are full" and "Marina population based on 30% of the boats are in use and there are three people per boat<br>Description of method for determining vehicle capacity factor<br>Road way capacity determination<br>Population estimation method<br>Events to Special Event Evacuation Time Estimate Methods section 3.4, Tiki Bar opening, summer concerts, 4th of July fireworks and Patuxent River Appreciation Day.<br>Loveville Rd (Route 247) towards Leonardtown to the Primary evacuation route list, section 5.2.<br>► Changed Evacuation Area "0-5 miles South" from zones 1,2 & 3 to zones 1 & 3.<br>► Updated school mobilization times<br>► Updated Table 3-1 Public response times<br>► Corrected figure references in section 4.1, Population in the Emergency Planning Zone, and section reference in section 4.5, Special Events. |

RECORD OF REVISION (continued)

► Corrected locations, added new facilities and updated names of business on the following Tables:

4-2 for schools

- Location of Southern Middle
- Location of Patuxent Elementary
- Location of Mutual Elementary
- Location of Patuxent High
- New, Dowell Elementary
- New, Mill Creek Middle
- Removed, Rock Christian Academy (no longer open)

4-3, Special Facilities

- Updated name of Asbury at Solomons Island

4-5, Overnight Accommodations

- Location of Tideland Park Campground
- Added "Sleep Inn"

4-7, Marinas

- Removed, Calvert Marine Museum (no slip rentals)
- Removed, O'Berry (no slip rentals)
- Location of Boatel California
- Removed, W. Fletcher Johnson (no longer in business)
- Removed, Mill Cove Harbor (no longer in business)
- Removed, Town Creek (no longer in business)
- Removed, Schoefield (no longer in business)
- Added, Hospitality Harbor
- Changed name of Home Port Marina to Reliable Marine
- Changed name of Pine Cove to Mill Creek

► Section 6.4, Special Event Evacuation Time Estimates, removed references to two special alternate evacuation routes, Thomas Johnson Bridge out is the only special alternate evacuation route in estimates.

► Section 6, removed note on tables stating "Times do not include the 30 minute notification /mobilization time" NETVAC2 software accounts for this 30 minutes.

► Updated reference of BGE to CCNPP

► Update of evacuation times and supporting references.

► Updated section 7.2, Recommendations, to include new lighted intersections beyond the edge of the EPZ that could immediately impact traffic flow out of the EPZ for Calvert County. Updated recommend additional traffic control points for St. Mary's county to reflect "Recommended Traffic Control" map (Figure 7-1)

RECORD OF REVISION (continued)

► Corrected descriptions of the following nodes: 600, 602, 638, 658, 660, 662, 664, 514, 540, 544, 419, 433, 436, 439, 448, 265, 285, 303, 315, 323, 325, 330, 335, 336,
Added clarification to node descriptions and/or annotated node as having a traffic light for the following nodes, 680, 505, 507, 509, 530, 560, 412, 433, 353, 360, 365, 367, 235, 250, 328, 329, 331, 341, 343, 350, 138, 139, 800.
► Updated Appendix "D", Key to NETVAC2 Computer Printout, to reflect new NETVAC2 software.
► Changes made to NETVAC 2 Software:
Updated Rt. 235 lane code to three lanes in the Rt. 4 intersection area.
Corrected lane code for Governor Thomas Johnson Bridge
Added node #440 at Flag Ponds Parkway and Rt. 2/4
Added node #537 Rt. 765 and Town Square Dr.
Added node #416 Rt. 2/4 and Patuxent Point Parkway.
► Made various minor editorial corrections

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# SECTION A

# ADMINISTRATIVE CONTROL OF THE EVACUATION TIME ESTIMATES

## I. PURPOSE

The purpose of this section is to delineate the administrative controls for revising the Evacuation Time Estimates (ETE's).

## II. DOCUMENT FORMAT

The ETE document format (outline, topics, page numbering, etc.) is established with revision 0. Revisions to the document will be consistent with this format unless authorized by the Supervisor-Emergency Planning. Authorized format changes will be recognized by the Supervisor's approval of the revision that implements the format alteration.

## III. COMMITMENT

The ETE document reflects Calvert Cliffs Nuclear Power Plant Inc. (CCNPPI) commitment to the guidance presented in NUREG-0654.

## IV. REVISIONS

### A. Preparation

1. Anyone may submit a revision proposal for the ETE's document. Proposals may be submitted in any form to any member of the Emergency Planning Unit, attention: Supervisor-Emergency Planning.

2. Rejected revision proposals will be returned to the originator with an explanation for the rejection.

3. Accepted revision proposals will be prepared as a revision for processing.

    a. The revision will be assigned the next sequential revision number.
    b. Margin indication will be used to identify sections that are affected by the revision.

B. Administrative Revision

1. Revisions processed to implement administrative changes (reference and/or typographical corrections, wording corrections, etc.) shall be reviewed by Supervisor of Emergency Planning. The revision will be annotated as an administrative revision. Administrative revisions shall not change the intent of the ETE's.

C. Distribution

1. Approved revisions to the ETE's are forwarded to all organizations and appropriate individuals with responsibility for recommending and deciding on protective actions during an emergency at Calvert Cliffs Nuclear Power Plant. The
list includes:
   - Maryland Emergency Management Agency
   - Maryland Department of the Environment
   - Maryland Department of Natural Resources
   - Calvert County Emergency Management Agency
   - Dorchester County Emergency Management Agency
   - St. Mary's County Emergency Management Agency
2. Copies of the ETE's are also located in the TSC and in EPU file 3.3

# SECTION 1
# INTRODUCTION

This report presents updated evacuation time estimates for the Plume Exposure Pathway Emergency Planning Zone (EPZ), surrounding the Calvert Cliffs Nuclear Power Plant (CCNPP). The plant is located in Calvert County, Maryland. The U. S. Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) have jointly prepared and issued "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (NUREG-0654, FEMA-REP-1, Rev. 1, November 1980)[1], as guidance to nuclear facility operators, and state and local governments in the preparation of radiological emergency response plans. Appendix 4 of NUREG-0654, "Evacuation Time Estimates Within the Plume Exposure Pathway Emergency Planning Zone", provides guidance for preparing an evacuation time estimate. This report reflects the guidance presented in NUREG-0654.

## 1.1 PURPOSE

This evacuation time estimate report supports the Radiological Emergency Plan (REP) for Calvert Cliffs Nuclear Power Plant, (Annex Q of the Maryland Emergency Operations Plan)[2]. The purpose of this report is to provide the approximate times associated with a range of evacuation scenarios. Emergency response personnel may use this information in planning for radiological emergencies at the plant.

The results of this study reflect the changes in population and the road network which have occurred in the CCNPP EPZ since the last evacuation time estimate analysis performed in 1998. The cut off date for data collection for revision 6 was December 21, 2001.

## 1.2 SUMMARY

A full range of scenarios representative of the various seasonal, time of day, and weather conditions were examined during the assessment of this ETE.

The ETE's presented in this report were developed using a computer traffic simulation model known as NETVAC2. NETVAC2 uses site-specific evacuation road network and vehicle demand data as inputs. Evacuation road network data was derived through detailed field surveys of roadway characteristics. Vehicle demand data (the number of vehicles to be evacuated) was derived from population information provided from the Census 2000 (Table DP-1. Profile of General Demographic Characteristics: 2000) data and each individual county vehicle statistics provided by Maryland Motor Vehicle Administration (MVA). Times and rates for vehicle loading

1.2 **SUMMARY** (continued)

evacuation time estimates were developed for 64 scenarios by combining various summer and winter season; daytime and nighttime; normal and adverse weather conditions for eight evacuation zones. The results of the evacuation time estimate analyses are summarized in Table 1-1. In addition, evacuation time estimates were prepared for those special facilities located within the EPZ. For each of these scenarios the model results provided information on vehicle delay and queuing (backup or congestion) which was used to analyze the network performance and test alternate traffic control options.

The results of the analysis indicate that seasonal variations in population do not have a significant impact on the evacuation time estimates for the winter and summer periods.

Similarities in the time estimates for the different evacuation zones and weather condition cases are due to:

- Relatively moderate EPZ population (and associated vehicle demand) and
- Adequate roadway capacity
- Common mobilization times
- Small difference in time needed to drive beyond the area to be evacuated from each of the PAZ's.
- ETE times are rounded to the nearest 10 minutes

Differences for many of the scenarios evaluated may not be apparent due to rounding to the nearest ten minute interval. Additionally, given the relatively short driving distances, the comparative travel times for limiting factor vehicle (the last vehicle to leave the evacuation road network) associated with normal and adverse weather condition scenarios are slight.

Revision 6 of the Evacuation Time Estimates will be reviewed with Maryland Emergency Management Agency, Maryland Department of the Environment, Maryland Department of Natural Resources, and emergency management officials from Calvert, St. Mary's and Dorchester Counties. Review documentation will be maintained in Calvert Cliffs Emergency Planning Unit file.

1.3 **SCOPE**

This report describes the site specific data and assumptions used to determine evacuation time estimates for off-site evacuation areas within the CCNPP EPZ for a range of evacuation scenarios.

1.3 **SCOPE** (continued)

The study area, protective action zones, and potential evacuation areas addressed in this analysis are described in Section 2, Study Area Description. Section 2.4, Evacuation Scenarios, describes the scenarios for which evacuation time estimates were prepared.

Section 3, Evacuation Time Estimates Methodology and Assumptions, describes the computer model, study methodology and assumptions, and methodologies for assessing special facility and special event evacuation times. Section 4, Population and Vehicle Demand, presents the demographic and vehicle demand considerations used to support the model analysis.

A description of the evacuation road network evaluated in the modeling effort is presented in Section 5, Transportation Network Description. Results of the analyses are summarized in Section 6, Evacuation Time Estimates. Conclusions and recommendations are presented in Section 7, Conclusions and Recommendations.

The Appendices contain detailed information related to the study including a description of the NETVAC2 computer model, population and vehicle data, evacuation road network node identification, and NETVAC2 network file listing.

# Summary of General Population Evacuation Time Estimates – Summer

Table 1-1

| Evacuation areas | Nighttime Population | Nighttime Vehicles | Daytime Population | Daytime vehicles | Notification Time (min) (6) | Preparation Time Nighttime Normal and adverse w weather (min) (6) | Preparation Time Daytime Normal weather (min) (6) | Preparation Time Daytime Adverse weather (min) (6) | Total Public Response Time – Nighttime Normal Weather (min) (6) | Total Public Response Time – Daytime Normal Weather (min) (6) | Total Public Response Time – Nighttime Adverse Weather (min) (6) | Total Public Response Time – Daytime Adverse Weather (min) (6) | General Public Evacuation Time Nighttime – Normal Weather (min) | General Public Evacuation Time Daytime – Normal Weather (min) | General Public Evacuation Time Nighttime – Adverse Weather (min) | General Public Evacuation Time Daytime – Adverse Weather (:min) | Confirmation Time (min) (6) | Special Facilities Evacuation Time Normal Weather (min)(5) | Special Facilities Evacuation Time Adverse Weather (min)(5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-2 Miles, 360° (1) | 5667 | 1941 | 6360 | 2169 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 140 | 190 | 150 | 230 | 45 | 80 | 120 |
| 0-5 Miles, 360° (1, 2, 3) | 29500 | 10580 | 33695 | 12391 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 310 | 350 | 380 | 420 | 90 | 140 | 170 |
| 0-5 Miles, North West(1,2) | 9649 | 3319 | 10986 | 3829 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 140 | 200 | 160 | 250 | 60 | 90 | 130 |
| 0-5 Miles, South (1,3) | 25518 | 9202 | 29069 | 10731 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 310 | 340 | 380 | 420 | 90 | 140 | 170 |
| 0-10 Miles, 360° (1, 2, 3, 4, 5, 6, 7, 8) | 53530 | 19368 | 59621 | 22616 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 310 | 350 | 380 | 440 | 120 | 140 | 170 |
| 0-10 Miles, North West (1, 2, 4, 5) | 17343 | 5971 | 19058 | 6607 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 160 | 190 | 200 | 230 | 90 | 90 | 130 |
| 0-10 Miles, South West (1, 2, 3, 6, 7) | 45121 | 16419 | 50834 | 19541 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 310 | 350 | 380 | 420 | 120 | 140 | 170 |
| 0-10 Miles, East (8) | 715 | 297 | 715 | 297 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 80 | 130 | 80 | 150 | 30 | N/A | N/A |

# Summary of General Population Evacuation Time Estimates – Winter

Table 1-2

| Evacuation areas | Nighttime Population | Nighttime Vehicles | Daytime Population | Daytime vehicles | Notification Time (min) (6) | Preparation Time Nighttime Normal and adverse w weather (min) (6) | Preparation Time Daytime Normal weather (min) (6) | Preparation Time Daytime Adverse weather (min) (6) | Total Public Response Time – Nighttime Normal Weather (min) (6) | Total Public Response Time – Daytime Normal Weather (min) (6) | Total Public Response Time – Nighttime Adverse Weather (min) (6) | Total Public Response Time – Daytime Adverse Weather (min) (6) | General Public Evacuation Time Nighttime – Normal Weather (min) | General Public Evacuation Time Daytime – Normal Weather (min) | General Public Evacuation Time Nighttime – Adverse Weather (min) | General Public Evacuation Time Daytime – Adverse Weather (min) | Confirmation Time (min)(6) | Special Facilities Evacuation Time Normal Weather (min)(5) | Special Facilities Evacuation Time Adverse Weather (min)(5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-2 Miles, 360° (1) | 5492 | 1906 | 7046 | 2065 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 140 | 150 | 150 | 220 | 45 | 80 | 120 |
| 0-5 Miles, 360° (1, 2, 3) | 28141 | 10133 | 35550 | 11372 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 290 | 290 | 360 | 360 | 90 | 140 | 170 |
| 0-5 Miles, North West(1,2) | 9474 | 3284 | 11742 | 3615 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 140 | 190 | 160 | 230 | 60 | 90 | 130 |
| 0-5 Miles, South (1,3) | 24159 | 8755 | 30854 | 9822 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 290 | 290 | 360 | 360 | 90 | 140 | 170 |
| 0-10 Miles, 360° (1, 2, 3, 4, 5, 6, 7, 8) | 51173 | 18751 | 63893 | 21857 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 300 | 290 | 370 | 380 | 120 | 140 | 170 |
| 0-10 Miles, North West (1, 2, 4, 5) | 17168 | 5936 | 19806 | 6637 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 160 | 210 | 190 | 240 | 90 | 90 | 130 |
| 0-10 Miles, South West (1, 2, 3, 6, 7) | 43762 | 15972 | 55522 | 18708 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 290 | 290 | 360 | 380 | 120 | 140 | 170 |
| 0-10 Miles, East (8) | 307 | 127 | 307 | 127 | 15 | 30 | 60 | 75 | 45 | 90 | 45 | 105 | 80 | 130 | 80 | 150 | 30 | N/A | N/A |

# SECTION 2
# STUDY AREA DESCRIPTION

Calvert Cliffs Nuclear Power Plant (CCNPP) is located in Lusby, Maryland, in Calvert County along the western shore of the Chesapeake Bay. The site is approximately 10 1/2 miles southeast of Prince Frederick (see Figure 2-1). The immediate area around the site is densely wooded with a low, flat to gently rolling terrain of low to moderate relief.

Calvert County communities near the plant include Calvert Beach and Long Beach, (approximately 3 miles to the northwest), St. Leonard (approximately 4 miles to the northwest), Lusby (approximately 3 miles to the South) Bertha, (approximately 4 miles to the South) Cove Point, (approximately 4 1/2 miles to the southeast), Broomes Island (approximately 6 miles to the West), Chesapeake Ranch Estates (approximately 6 miles to the south-southeast), Drum Point (approximately 7 miles to the South) and Solomons (approximately 8 miles to the South). Portions of St. Mary's County (approximately 6 to 10 miles west and south) and Dorchester County, (approximately 6 to 10 miles east of the CCNPP site) are also included within the study area.

Changes in the study area include an approximately 10 percent increase in the permanent EPZ population from 44,926 to 50,058 between 1997 and 2000. Population changes in the EPZ:

- Calvert County from 27,681 to 34,345
- St. Mary's County from 16,929 to 15,406
- Dorchester County from 316 to 307

Major land uses around the CCNPP site other than residential is agricultural or minor town center. Primary crops include tobacco, corn, soybeans, and hay. The waters in the vicinity of the CCNPP EPZ are used for commercial fishing, especially for shellfish such as clams, oysters, and crabs, and offer a popular summer boating retreat.

Beyond the study area, the metropolitan centers closest to the site are:

- Washington, D.C., (approximately 45 miles to the northwest)
- Baltimore, Maryland, (approximately 60 miles to the north)
- Richmond, Virginia, (approximately 80 miles to the southwest).

STUDY AREA DESCRIPTION (continued)

In general, the area has moderate weather conditions characteristic of the Mid-Atlantic region. The average annual temperature is 57.6°F. The area receives approximately 40 inches of rainfall annually with precipitation occurring about 10 percent of the time. Mean annual surface wind speeds range from 8-10 miles per hour.

The probability of the occurrence of severe weather conditions is low. The area has an average of 0.5 tornadoes and 40 thunderstorms each year. Although there is approximately one hurricane threat each year, on the average only one hurricane every 10 years has a significant impact in the area. Northeasters or extra-tropical storms can influence the degree of flooding in low lying areas[7].

## 2.1 EMERGENCY PLANNING ZONE

NUREG-0654 defines the Emergency Planning Zone (EPZ) as approximately a 10 miles radius area of study for potential evacuation (see Figure 2-1). The EPZ is the area for which planning is required to assure that prompt and effective actions can be taken to protect the public in the event of a radiological incident at the CCNPP.

The EPZ encompasses portions of Calvert, St. Mary's, and Dorchester Counties in Maryland. The shape of the EPZ reflects geographic and demographic considerations as referenced in NUREG-0654. The majority of the EPZ includes

- South of Prince Frederick in Calvert County
- The northeastern portion of St. Mary's County bordering the Patuxent River.
- Taylors Island area located about 6 miles across the Chesapeake Bay in Dorchester County.

## 2.2 PROTECTIVE ACTION ZONE

Since it may not be necessary nor desirable to evacuate the entire EPZ at once, eight protective action zones have been defined within the EPZ (see Figure 2-1). The protective action zones approximate the 0-2 mile, 2-5 mile and 5-10 miles for 90° sectors (referenced in NUREG-0654). Zone boundaries are defined using easily recognizable man-made and natural features (e.g., roads and rivers). The zone boundaries are agreed upon by county officials and are easily identifiable by the general public.

Table 2-1, Major Communities and Facilities in the Protection Action Zones, lists major communities and facilities contained within each protective action zone.

**Protective Action Zones**

**Zone 1**

Zone 1 is in Calvert County and is bordered to the east by the Chesapeake Bay and to the west by Route 2 & 4 along the St. Leonard Creek. The northern boundary extends to the 5-mile radius along Calvert Beach Road. The southern boundaries include Breenden Road, Sollers Wharf Road, Old Mill Road, Hellan Creek, St. Paul Branch and Calvert Cliffs State Park.

**Zone 2**

Zone 2 is in Calvert County and is the northern quadrant of the 2 to 5 mile portion of the EPZ. This area is bordered on the north by Governor Run road, on the south by the Patuxent River and the east by the Chesapeake Bay, St. Leonard Creek and Protective Action Zone 1. The western boundary is Broomes Island Road down to Nan Cove.

**Zone 3**

Zone 3 in Calvert County and is the southern quadrant of the 2 to 5 mile portion of the EPZ. The northern boundaries for this area include Breeden Road, Sollers Wharf Road, Old Mill Road, Hellen Creek St. Paul Branch (Route 497) and Calvert Cliffs State Park. Zone 3 is bordered on the east by the Chesapeake Bay and to the south and west by the Patuxent River.

**Zone 4**

Zone 4 is in Calvert County and is the northwestern quadrant of the 5 to 10 mile portion of the EPZ. This area is bordered by Route 2 & 4 to the north, Broomes Island Road and Nan Cove to the east, and south by the Patuxent River. The western boundary follows Route 231 to Adelina and Sheridan Roads.

**Zone 5**

Zone 5 is in Calvert County and is the 5 - 10 mile northern most quadrant of the EPZ. It is bordered to the east by the Chesapeake Bay. The northern boundary follows Dares Beach and Cassell Roads. The boundary follows west to and along Tobacco Road (excluding the Media Center) to Main Street (Calvert Towne), and then heads south on Route 2 & 4 to Governor Run Road.

**Zone 6**

Zone 6 located in St. Mary's County makes up the western quadrant of the 5 to 10 mile portion of the EPZ. This area is bordered on the north by the Patuxent River, on the east by Hollywood and Sotterly Gates Road and the south by Brooks Run. The western boundaries include Cat Creek Road, Route 235, Clover Hill Road, McIntosh Road, Riva Ridge Road and McIntosh Run.

**Zone 7**

Zone 7 is in Calvert County and is bordered by the Patuxent River to the north and the Patuxent Naval Air Station to the east. Zone 7 makes up the remainder of the St. Mary's County portion of the 5 to 10 mile southwestern quadrant of the EPZ. The southern boundaries include Brooks Run, Broad Run, Hayden Road, St. Mary's County Airport Drive, Cottonwood Parkway, Wildewood Parkway, Saint Andrews Church Road and Route 235. Zone 7 is bordered to the west by Protective Action Zone 6 and Hollywood and Sotterly Gate Roads.

**Zone 8**

Zone 8 is in Dorchester County and is the 5 to 10 miles eastern quadrant of the EPZ. It encompasses a portion of Taylors Island in Dorchester County approximately 6 miles across the Chesapeake Bay. The north and west boundary of Protective Action Zone 8 is the Chesapeake Bay. The eastern boundary follows Parsons Creek to Goose Dam and continues south on to Smithville Road near James Island. From the south, Boggs Gut approaches Meekins Neck Road and the boundary follows Meekins Neck Road to Hooper Island Road and joins Smithville Road.

## 2.3 EVACUATION AREAS

For evacuation scenarios the Protective Action Zones were aggregated into the following areas:

- 0-2 miles, 360° - Protective Action Zone 1
- 0-5 miles, 360° - Protective Action Zones 1, 2 & 3
- 0-5 miles, North West - Protective Action Zones 1 & 2
- 0-5 miles, South - Protective Action Zones 1 & 3
- 0-10 miles, 360° - Protective Action Zones 1, 2, 3, 4, 5, 6, 7 & 8
- 0-10 miles, North West - Protective Action Zones 1, 2, 4 & 5
- 0-10 miles, South West - Protection Action Zones 1, 2, 3, 6 & 7
- 0-10 miles, East - Protective Action Zone 8

Evacuation time estimates were developed for each of these areas. Figure 2-1 illustrates the relationship between the evacuation areas and the general sector format recommended in NUREG-0654. An issue report was written prior to revision 5 of the ETE's to address the fact that to break up the 10 mile EPZ in accordance with NUREG guidance, zone 2 should be included in the "0-5 miles, South" zone. Evacuation Area "0-5 miles, South" was changed from zones 1, 2 & 3 to 1 & 3 because it duplicated information provided in the "0-5 mile $360^0$".

## 2.3 EVACUATION AREAS (continued)

The Chesapeake Bay and other waterways encompass a large part of the EPZ; the evacuation time estimates are not specifically modeled for boaters. The boating population is given notification (pre-evacuation) by the Maryland Marine Police and the Coast Guard to advise a return to their port of origin. For boaters on the open waters of the Chesapeake Bay, this early notification will provide sufficient time to return to their marina of origin. Assuming boaters are in close proximity to the marina the evacuation times for marina populations and associated vehicle demands would be within the estimated population evacuation times. This is discussed in more detail in Section 4.3, Summer Population. Early notification will ensure that the marina population would be among the first groups to leave the EPZ.

## 2.4 EVACUATION SCENARIOS

Evacuation scenarios are the conditions established by combining the evacuation areas with a specified season and time of day. Evacuation time estimates are also determined for each evacuation scenario under normal and adverse weather conditions (when road capacity could be reduced). Adverse weather conditions for this area can include snow, rain, fog, ice, or high winds.

These time parameters were selected to provide a range of population estimates from which to generate representative evacuation time estimates.

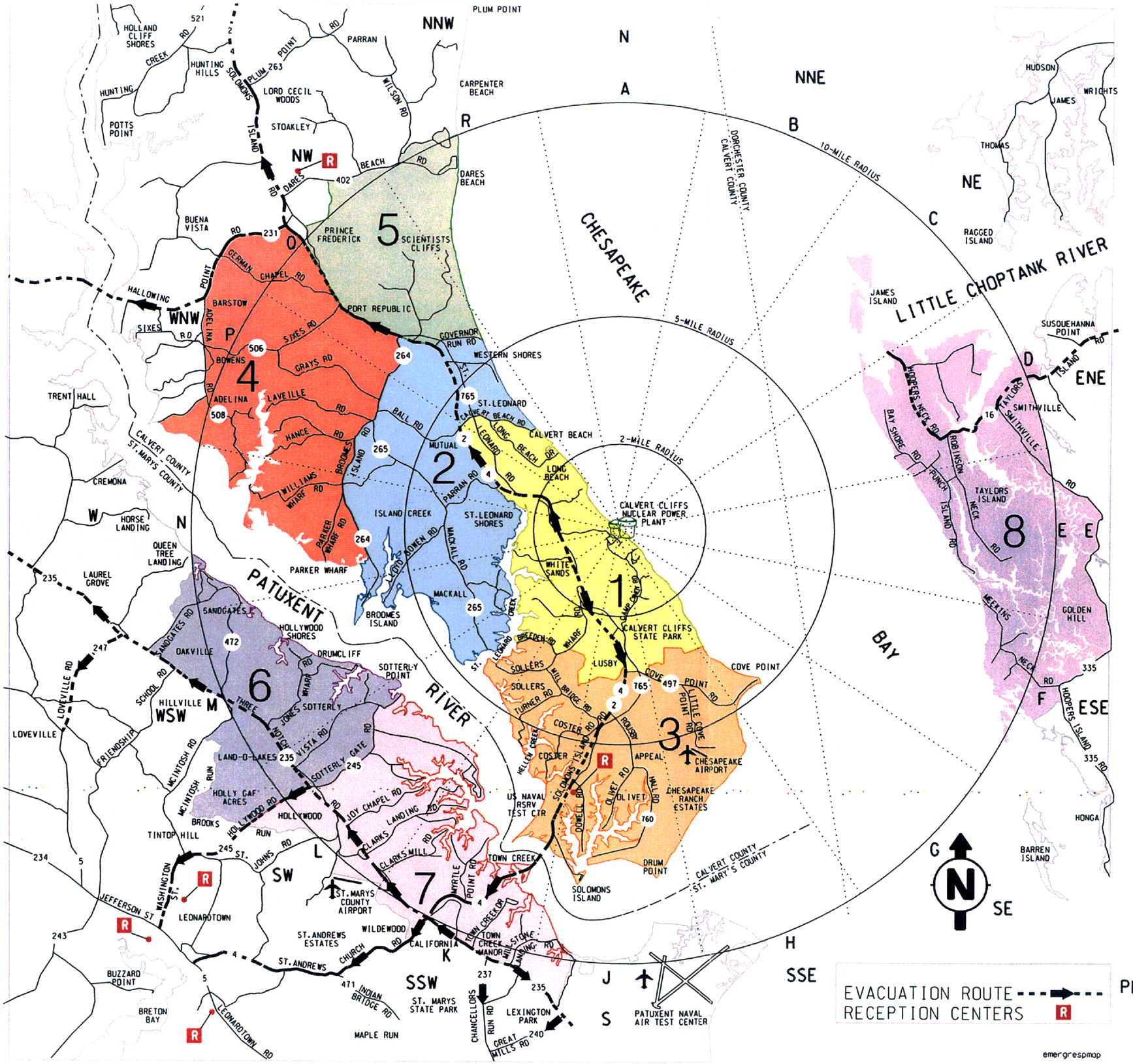
The winter daytime scenario includes the permanent resident, special facilities (schools and nursing homes), school, daytime employee, and appropriate transient populations. The winter nighttime scenario includes the permanent resident, nursing facilities, nighttime employee, and appropriate transient populations.

In contrast to the winter season, the summer attracts seasonal residents, fishing, and other water sports enthusiasts to the marinas, beaches and retreats in the area. The summer daytime scenario includes the permanent resident, nursing facilities, employees, and appropriate special/transient populations. The summer nighttime scenario includes the permanent resident, nursing, nighttime employee, and appropriate transient populations. These populations are discussed further in Section 4, Population and Vehicle Demand.

There are 64 evacuation scenarios considered in this evacuation time estimate study. These are derived from various combinations of eight potential evacuation areas (described in Section 2.3, Evacuation Areas); two seasonal population groups (winter and summer); two time considerations (daytime and nighttime); and two weather conditions (normal and adverse).

TABLE 2-1
**MAJOR COMMUNITIES AND FACILITIES IN THE PROTECTIVE ACTION ZONES**

| Evacuation Area Quadrant | County | Zone(s) | Major Communities/Facilities |
|---|---|---|---|
| 0-2 Miles 360° | Calvert | 1 | CCNPP, Lusby, Calvert Beach Estates, Flag Harbor, Long Beach, Walnut Cove, White Sands, Fort Hill, Southern Middle School, St. Leonard Elementary School, Calvert Cliffs State Park, Flag Ponds Nature Park |
| 2-5 Miles North West | Calvert | 1,2 | Zone 1 above; Zone 2 includes Western Shores, Western Shores Estates, St. Leonard Shores, Long Beach, Wallville Acres, Wallville, Mackall, Broomes Island, Cape Leonard, Kenwood Beach, Mutual Elementary School. |
| 2-5 Miles South | Calvert | 1,2,3 | Zones 1 & 2 above; Zone 3 includes Chesapeake Ranch Estates, Drum Point, Mill Creek, Avondale, Solomon Islands, Solomons Landing, U.S. Naval Recreation Center, Cove Point Park, Our Lady Star of the Sea School, Appeal Elementary School, Patuxent Elementary School, Patuxent High School, Mill Creek Middle School, Asbury at Solomon's Island Care Facility, Solomon's Nursing Center, Southern Pines Nursing Facility. |
| 5-10 Miles North | Calvert | 2,4,5 | Zone 2 above; Zone 4 includes Mutual Estates, Williams Wharf, Parkers Wharf, Adelina, Westlake, Barstow, Battle Creek Cypress Swamp, Community College at Calvert County; Zone 5 includes Dares Beach, Scientists Cliffs, Port Republic, Governors Run, Hidden Valley, Pendleton, Parker Creek Knolls, Chesapeake Heights on the Bay. |
| 5-10 Miles South | Calvert | 3 | See Zones 3 above |
| 5-10 Miles South | St. Mary's | 6, 7 | Zone 6 includes Sandgates, Hollywood Shores, Sotterly Manor, Hillville, Drumcliff, Land-O-Lakes, St. Mary's Beach, St. Mary's Development Center. Zone 7 includes Town Creek, Town Point, Mill Cove, Esperanza Farms, Woodland Acres, Wildewood, Red Hill, Peacock Manor, Clarks Landing, Town Creek Elementary School, Esperanza Middle School, St. John's Elementary School, Hollywood Elementary School, Green Holly Elementary School. |
| 5-10 Miles West | Calvert | 2,4 | See Zones 2 and 4 above |
| 5-10 Miles South West | St. Mary's | 6 | See Zone 6 above |
| 5-10 Miles East | Dorchester | 8 | Taylor Island, Smithville, Meekings Neck Road, Smithville Road |




SITE VICINITY
PROTECTIVE ACTION ZONES
AND RECEPTION CENTERS
PLUME EXPOSURE PATHWAY EPZ
FIGURE 2-1

# SECTION 3
# EVACUATION TIME ESTIMATES
# METHODOLOGY AND ASSUMPTIONS

The following methodology and assumptions were employed in the development of evacuation time estimates for the CCNPP EPZ. In addition to a detailed road network database for the NETVAC2 traffic simulation model, detailed population characteristics with associated vehicle demands and assumptions governing public response, transportation resources, and traffic flow control was considered. A general description of the NETVAC2 model input requirements and the specific methodologies and assumptions applied to this study are provided below.

## 3.1 THE NETVAC2 COMPUTER MODEL

The evacuation time estimates were calculated using the NETVAC2 computer model. NETVAC2 is a special purpose evacuation model designed to simulate the flow of traffic over a transportation network during an area wide emergency evacuation.[11]

NETVAC2 was developed for calculating emergency evacuation time estimates under differing conditions. The model simulates the flow of vehicle traffic from entry nodes, where the vehicles are loaded on to the roadway network, through the network to exit nodes beyond the EPZ where the vehicles leave the network. The model uses the 1985 Highway Capacity Manual[8] as its prime reference to calculate the capacity of the road network and vehicle flow. The model produces several measures of evacuation effectiveness, including travel times, vehicle counts, queues and delays, and person throughput over the links (street segments) and nodes (intersections) of the network. Where the simulated flow of traffic along the network exceeds the calculated roadway capacity causing congestion, or "queuing", alternative traffic routing and/or traffic controls can be identified and assessed.

The NETVAC2 model requires that the evacuation road network be defined in detail. The network data required for input include link (road segment) length, number of lanes, node (intersection) approach characterization, traffic controls, signal timing, turn lanes, and direction of turns. These data are used to determine network capacity and direction of traffic flow. Additional input data used by the model include vehicle loading rates which are associated with each evacuation area.

The vehicle loading rates are entered at specific points on the network and can be varied with time. The vehicle loading rates are tailored to match the actual population and time distributions representative of the public's activity in mobilizing for evacuation. The public mobilization time is derived from a statistical distribution used to account for multiple events including people

3.1 **THE NETVAC2 COMPUTER MODEL** (continued)

receiving notice, leaving work, traveling home, and evacuating their homes. This is discussed in greater detail in Section 3.2.2, Public Response Times and Network Loading Rates. The NETVAC2 Model employs the Highway Capacity Manual equations. These equations are validated on data averaged for the nation for calculating highway capacities. It is assumed that traffic flow on the network is primarily one way with little cross traffic, that there is no major traffic on the network at the start of the simulation, and that all roads are open (e.g., there are no temporary blockages from auto accidents or stalled cars). Route choice is dynamic, however, meaning that vehicle movements are determined by preference and speed instead of fixed, preassigned turning movements. The NETVAC2 Model is discussed in greater detail in Appendix A, Description of NETVAC2 Computer Model.

## 3.2 EVACUATION TIME ESTIMATE ANALYSIS METHODOLOGY

The methodology and assumptions used to develop general population and special facility evacuation time estimates in accordance with NUREG-0654, Appendix 4 are discussed below. In developing population estimates for an evacuation time estimate study, permanent, transient, and special facility populations are identified for each evacuation scenario. The population groups associated with each scenario are discussed in detail in Section 4, Population and Vehicle Demand. The population estimates are used in calculating associated vehicle demand in accordance with the assumptions presented in Section 3.2.1, Assumptions for Vehicle Demand Estimation. The general population evacuation time estimates are then developed for vehicle demand loading schemes calculated in conjunction with assumptions regarding public notification and mobilization (see Section 3.2.2, Public Response Times and Network Loading Rates). Those assumptions that reflect a number of critical aspects pertaining to the implementation of an emergency evacuation are presented in Section 3.2.3, Assumptions Used in Developing the Evacuation Time Estimates. Based on these assumptions, the model is run to simulate the flow of traffic over a transportation network for representative day and night; normal or adverse weather; and identified peak of off-peak population scenario evacuations.

### 3.2.1 ASSUMPTIONS FOR VEHICLE DEMAND ESTIMATION

The following assumptions were used to generate estimates of vehicle demand. These assumptions were based on population and average occupancy data obtained from the Census 2000 data and subsequent updated information:

- One car per household was used for evacuation, based on the assumption the family will desire to evacuate all together.

### 3.2.1 **ASSUMPTIONS FOR VEHICLE DEMAND ESTIMATION** (continued)

- Average household sizes for the three counties are estimated to be 2.91 for Calvert County, 2.72 for St. Mary's County, and 2.36 for Dorchester County (Census 2000 information).
- One car per employee/staff member for business, schools and nursing facilities.
- One bus per 60 students.
- One car per boat for marinas and yacht clubs.
- One car per room for motels.
- Other recreation or special attraction facility vehicle equivalency factors ranging from 2.5 to 5.0 people per vehicle were determined on a facility specific basis.
- Nursing facilities are full.
- Over night accommodations are full
- Marina population based on 30% of the boats are in use and there are three people per boat

### 3.2.2 **PUBLIC RESPONSE TIMES AND NETWORK LOADING RATES**

As mentioned in Section 3.1, The NETVAC2 Computer Model, the rates at which vehicles are loaded on to the model evacuation network were determined from a statistical analysis of assumed event times. These provide an overall time distribution intended to be representative of the public response to a recommendation to evacuate. The public response to such a recommendation was assumed to consist of four components:

1. Receive warning, or the notice to evacuate
2. Leave work, which includes the time required for an employee to leave work and travel to their car
3. Travel from work to home
4. Evacuate the home, which includes time required to pack belongings and prepare home for absence

The average public response times for each event are shown in Table 3-1, Public Response Time Estimates.

It is assumed that the time distribution of the individual response to each of these events could be represented by a normal distribution. The standard deviation was calculated using the mean values of event times. The cumulative distribution of the events generally has an "S" shape representing the magnitude of the public response in mobilizing for an evacuation. These distributions form the basis for determining the vehicle loading rates.

The distribution curves used for this analysis are presented on Figure 3-1, Public Response Curves. The nighttime curves are derived by combining two events: receiving warning and evacuating home. The daytime curves are derived by adding the receive warning, leave work, travel home, and evacuate home time distributions.

### 3.2.2 **PUBLIC RESPONSE TIMES AND NETWORK LOADING RATES** (continued)

These public response curves are used to determine the rates and times for vehicle loading. They provide information on the percent of people leaving work, other transient facilities, or their homes within specific periods of time. The vehicles are loaded on to the network using the percentage and times outlined in the public response curves.

### 3.2.3 **ASSUMPTIONS USED IN DEVELOPING THE EVACUATION TIME ESTIMATES**

Assumptions used in developing the evacuation time estimates include:

- The Alert and Notification system will be used and the Maryland Radiological Emergency Plan will be implemented to notify the public.
- The time for public notification of the EPZ population is 15 minutes. No vehicles will begin to evacuate during the 15-minute initial notification period. A minimum preparation/mobilization time of 15 minutes is assumed for all population zones. Accordingly, no vehicles will begin to evacuate until 30 minutes following the initial notification[6].
- Everyone within the EPZ instructed to evacuate will leave. No one outside the EPZ will evacuate. When inner evacuation areas (e.g., Zone 1) are the only areas evacuated, it is assumed people in the outer evacuation areas (e.g., 2 and/or 3) will not evacuate.
- Private automobiles will be the primary mode of evacuation.
- Vehicle capacity factor determined by using the assumption made earlier, one vehicle used for evacuation per household, and Census 2000 data (Table DP-1. Profile of General Demographic Characteristics: 2000) on average household size for each of the EPZ counties.
- Roadway capacity determined to be 1800 vehicles per lane per hour. Based on Highway Capacity Manual.[4]
- Population estimation for the EPZ based on Census 2000 population numbers as interpreted by Maryland Department of Planning[12]
- Households without vehicles will receive rides from neighbors. Data indicate there are a sufficient number of vehicles distributed throughout the EPZ to support this assumption. Nonetheless, local emergency plans provide buses for people without any means of transportation.
- Traffic rules and controls will be obeyed.
- Only proper travel lanes will be used (not shoulders or opposite flow lanes).
- Only major roads will be used for primary evacuation routes.
- Primary evacuation routes will be open.

### 3.2.3 **ASSUMPTIONS USED IN DEVELOPING THE EVACUATION TIME ESTIMATES** (continued)

- All traffic control points designated in the Calvert, Dorchester and St Mary's County Radiological Emergency Plan and Standard Operating Procedures will be manned by police.
- All traffic lights will be manually overridden by the police.
- Traffic control personnel will prevent vehicles from traveling in the wrong direction or back into evacuated areas of the EPZ.
- During adverse weather, highway capacities are reduced to 70 percent of normal weather capacity. This is a conservative assumption. Studies have shown that rain reduces freeway capacity to 81 to 86 percent[9].
- According to the Naval Air Station Commander, Patuxent Naval Air Test Center will not be evacuated, but the Navy Recreation Center in Calvert County may be evacuated.
- The United States Coast Guard and the Department of Natural Resources Marine Police will notify all watercraft in and around the affected waterways of an emergency and of the necessary evacuation procedures.

## 3.3. **SPECIAL FACILITY EVACUATION TIME ESTIMATE METHODOLOGY AND ASSUMPTIONS**

NUREG-0654 specifies that separate evacuation time estimates be developed for special facilities. This includes schools, hospitals, nursing homes, prisons, or other facilities requiring special transportation considerations during an evacuation.

The special facility population segment includes persons in schools, hospitals, nursing homes and prisons who will require transportation assistance during an evacuation. There are currently no hospitals or prisons within the CCNPP EPZ. School and nursing facility populations and their associated transportation resources are presented in Section 4, Population and Vehicle Demand.

For schools, the evacuation time estimates considered mobilization time for assembling the buses, time for loading the students on the buses, and a calculated travel time out of the EPZ. The mobilization times were obtained through interviews with local officials. Mobilization time estimate of 40 minutes under normal weather conditions[(5)]. The travel times out of the EPZ were determined using approximate vehicle speeds and distances along designated evacuation routes. The total evacuation times are presented in Table 6.3, Special Facilities-Schools Evacuation Time Estimates.

## 3.3. SPECIAL FACILITY EVACUATION TIME ESTIMATE METHODOLOGY AND ASSUMPTIONS (continued)

Assumptions used to determine the school evacuation times are[5]:

- The mobilization time for school buses is 40 minutes for normal weather and 70 minutes for adverse weather conditions.
- The maximum speed of a school bus is 45 mph for normal weather and 30 mph for adverse weather conditions.

Components of mobilization times for nursing facilities include (1) the time required to mobilize the vehicles, (2) the time required for the vehicles to travel to the respective facilities and (3) the time required to load the vehicles. The mobilization times were obtained through interviews with local emergency management officials and the respective nursing facility director. It is assumed that mobilization times for these facilities would range between 1 and 2 hours under normal weather conditions. The posted vehicle speeds and distances along designated evacuation routes were also used to estimate travel times out of the EPZ.

Assumptions used to determine the nursing facility evacuation times are:

- The mobilization time for nursing facilities is 2 hours for normal weather and 2 hours and 30 minutes for adverse weather conditions.
- The maximum speed for nursing facility transportation vehicles (i.e., ambulances, vans, etc.) is 45 mph for normal weather and 30 mph for adverse weather conditions.

## 3.4 SPECIAL EVENT EVACUATION TIME ESTIMATE METHODOLOGY AND ASSUMPTIONS

Special events are generally associated with short-term activities where a significant increase in the transient population may be found. Significant influxes of transient population for the CCNPP EPZ include:

- Opening of the Tiki Bar on Solomons Island
- July 4th fireworks on Solomons Island
- Summer concerts at the Calvert Marine Museum
- Patuxent River Appreciation Day on Solomons Island
- Scottish Highland Games at Jefferson Patterson Park
- Sotterly Mansion Historical Site Concerts

These influxes are for short periods of time to one or two days in duration. The respective County Plans have provisions to cancel these types of events at an Alert classification. This would be sufficient time to disperse these populations prior to an evacuation being declared. For this reason they are not included in the populations for scenarios that they would affect.

## 3.4 SPECIAL EVENT EVACUATION TIME ESTIMATE METHODOLOGY AND ASSUMPTIONS (continued)

Significant influxes associated with the seasonal visitors for to the Navy Recreation Center in Solomons in Calvert County. Because of the regular and expected nature of this population increase, this population group was included, as appropriate, in the general summer daytime and nighttime evacuation scenarios.

The scenario selected for special event sensitivity analysis was daytime simulation involving an evacuation assuming the complete closure of the Governor Thomas Johnson Bridge. The results of this special event analyses is presented in Section 6.4, Special Event Evacuation Time Estimates.

TABLE 3-1

PUBLIC RESPONSE TIME ESTIMATES

**Average Time for Event (Minutes)[a]**

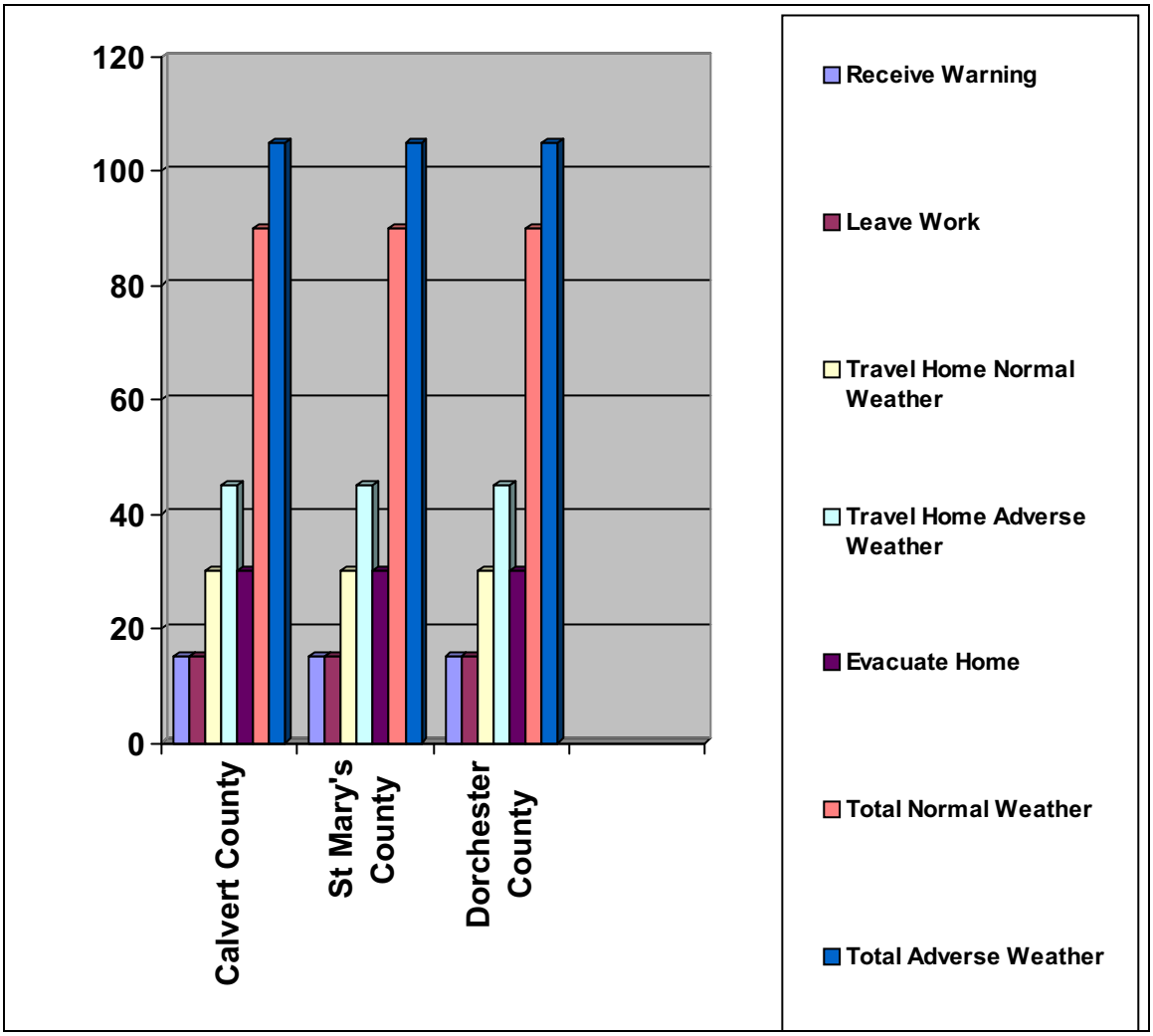
| EVENT | Calvert County[6] | St. Mary's County[6] | Dorchester County[6] |
|---|---|---|---|
| Receive Warning [b] | 15 | 15 | 15 |
| Leave Work | 15 | 15 | 15 |
| Travel Home | | | |
| Normal Weather | 30 | 30 | 30 |
| Adverse Weather | 45 | 45 | 45 |
| Evacuate Home | 30 | 30 | 30 |
| Total Normal/Adverse | 90/105 | 90/105 | 90/105 |

**NOTES:**

(a) Public response time estimate assumption description is in section 3.2.3 "Assumptions used in Developing the Evacuation Time Estimates".

(b) The time required to receive warning reflects the provisions for prompt notification within the CCNPP EPZ consistent with the guidance of NUREG-0654.

FIGURE 3-1
See Table 3-1
PUBLIC RESPONSE TIME ESTIMATES



# SECTION 4
# POPULATION AND VEHICLE DEMAND

## 4.1 POPULATION IN THE EMERGENCY PLANNING ZONE

There are approximately 50,058 permanent residents in the CCNPP EPZ:

- Dorchester County accounts for about 307 residents
- Calvert account for about 33,434
- St. Mary's Counties account for about 16,317

Demographic information was obtained from 2000 census data[12], and local employers.

The following sections and the accompanying tables present descriptions of the specific population scenarios along with an identification of special and transient facility populations. Population and vehicle demand summaries are presented by Protective Action Zone in Table 4-1. Tables 4-2 through 4-3 and Figure 4-1 provide population and location information on schools and nursing homes in the CCNPP EPZ. Tables 4-4 through 4-7 and Figures 4-2 through 4-5 present transient facility populations and locations. Appendix B of this report presents detailed EPZ demographic and vehicle demand data by compass sector and distance.

## 4.2 WINTER POPULATION

The winter season (September to May) is the off-season, or non-tourist months, when schools are in session.

### 4.2.1 Winter Daytime

The winter daytime population includes permanent residents, schools, major employers, and appropriate transient facility populations. Population and vehicle data representing the permanent EPZ resident population are shown on Figures B-1 and B-2. The additional daytime special/transient facility populations and associated vehicle demands are shown on Figures B-3 and B-4. The sum of the permanent resident and daytime facility populations and vehicles represents the total winter daytime population and vehicle demand.

### 4.2.2 Winter Nighttime

Winter nighttime population includes: permanent residents, nighttime employees, and appropriate transient facility populations. The estimates of nighttime employee and special/transient facility populations and corresponding vehicle demands, which were added to the permanent resident population, are shown on Figures B-5 and B-6.

## 4.3 SUMMER POPULATION

The summer season is from Memorial Day weekend through Labor Day weekend. During this time schools are out of session and there is an influx of summer visitors to the area.

### 4.3.1 Summer Daytime

Summer daytime population is comprised of the permanent residents, seasonal residents, appropriate special facility and transient populations including summer visitors and participants in regularly scheduled summer programs. Figures B-7 and B-8 show the incremental special and transient facility population and vehicle data. The addition of the summer day increment to the permanent resident population adjusted for seasonal residents results in the total summer daytime population and vehicle demand.

### 4.3.2 Summer Nighttime

The summer nighttime population is comprised of permanent residents, seasonal residents, nighttime employees and appropriate transient facility populations. Estimates of summer nighttime employee and special/transient facility populations and corresponding vehicle demands are as shown on Figures B-9 and B-10.

## 4.4 SPECIAL FACILITIES

There are no hospitals or prisons within the CCNPP EPZ. The special facilities considered were schools and nursing homes. Schools are identified in Table 4-2, Special Facilities-Schools Within the Emergency Planning Zone. Nursing facilities are identified in Table 4-3, Special Facilities-Nursing Facilities Within the Emergency Planning Zone. Schools and nursing facilities are located on Figure 4-1, Schools and Nursing Facilities. Results of the special facilities analysis are discussed in section 6.2 Special Facility Evacuation Time Estimates – Schools and 6.3 Special Facility Evacuation Time Estimates – Nursing Facilities.

## 4.5 SPECIAL EVENTS

The evacuation time estimates for the special events defined in Section 3.4, Special Event Evacuation Time Estimate Methodology and Assumptions, only involve changes affecting the use of the evacuation road network. Results of the special event analyses are discussed in Section 6.4, Special Event Evacuation Time Estimates.

TABLE 4-1

POPULATION AND VEHICLE DEMAND BY PROTECTIVE ACTION ZONE

| Protective Action Zone | Winter Nighttime Population | Winter Nighttime Vehicles | Winter Daytime Population | Winter Daytime Vehicles | Summer Nighttime Population | Summer Nighttime Vehicles | Summer Daytime Population | Summer Daytime Vehicles |
|---|---|---|---|---|---|---|---|---|
| 1 | 5492 | 1906 | 7046 | 2065 | 5667 | 1941 | 6360 | 2169 |
| 2 | 3982 | 1378 | 4696 | 1550 | 3982 | 1378 | 4626 | 1660 |
| 3 | 18667 | 6849 | 23808 | 7757 | 19851 | 7261 | 22709 | 8562 |
| 4 | 3506 | 1208 | 3876 | 1578 | 3506 | 1208 | 3884 | 1334 |
| 5 | 4188 | 1444 | 4188 | 1444 | 4188 | 1444 | 4188 | 1444 |
| 6 | 4296 | 1591 | 4296 | 1591 | 4296 | 1591 | 4508 | 1662 |
| 7 | 11325 | 4248 | 15676 | 5745 | 11325 | 4248 | 12631 | 5488 |
| 8 | 307 | 127 | 307 | 127 | 715 | 297 | 715 | 297 |
| EPZ Total | 51763 | 18751 | 63893 | 21857 | 53530 | 19368 | 59621 | 22616 |

TABLE 4-2
SPECIAL FACILITIES - SCHOOLS
WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | Student Enrollment(3) | Staff(3) | Total Population | Transportation Resources (Cars/Buses)(2) |
|---|---|---|---|---|---|---|---|---|
| S1 | Southern Middle School | Calvert | 1 | S/2-3 | 694 | 77 | 771 | 77/12 |
| S2 | Patuxent Elementary School | Calvert | 3 | S/3-4 | 434 | 59 | 493 | 59/10 |
| S3 | Appeal Elementary School | Calvert | 3 | S/4-5 | 488 | 55 | 543 | 55/10 |
| S4 | Mutual Elementary School | Calvert | 2 | WNW/5-6 | 542 | 72 | 614 | 72/11 |
| S5 | Our Lady Star of the Sea School | Calvert | 3 | S/7-8 | 199 | 15 | 214 | 15/4 |
| S6 | Community College | Calvert | 4 | NW/6-7 | 350 | 20 | 370 | 370/- |
| S7 | St. Leonard Elementary | Calvert | 1 | WNW/3-4 | 701 | 67 | 768 | 67/13(+1 wheel chair bus) |
| S8 | Mill Creek Middle School | Calvert | 3 | S/5-6 | 636 | 67 | 703 | 67/12(+1 wheel chair bus) |
| S9 | Patuxent High School | Calvert | 3 | S/5-6 | 1747 | 121 | 1868 | 121/32 |
| S10 | Dowell Elementary School | Calvert | 3 | S/5-6 | 727 | 71 | 798 | 71/13 |
| S11 | Town Creek Elementary School | St. Mary's | 7 | SSW/9-10 | 332 | 32 | 364 | 32/6 |
| S12 | Esperanza Middle School | St. Mary's | 7 | SSW/10-11 | 923 | 83 | 1006 | 83/20 |
| S13 | St. Johns Elementary School | St. Mary's | 7 | SW/9-10 | 235 | 21 | 256 | 21/5 |
| S14 | Hollywood Elementary School | St. Mary's | 7 | SW/9-10 | 632 | 57 | 689 | 57/13 |
| S15 | Green Holly Elementary School | St. Mary's | 7 | SSW/10-11 | 732 | 97 | 829 | 97/24 |

**NOTE:**
(1) See Figure 4-1 for facility location.
(2) Local emergency plans provide buses for schools without sufficient means of transportation to evacuate their facility in a single trip.
(3) School student and staff populations were obtained from the Board of Education for their respective counties.

TABLE 4-3

SPECIAL FACILITIES - NURSING HOMES
WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | Number of Residents (3)(4) **Indep/Assisted** | Staff **Day/Night** | Total Population **Day/Night** | Transportation Resources (Cars/Buses) (2) |
|---|---|---|---|---|---|---|---|---|
| N1 | Southern Pines | Calvert | 2 | S/3-4 | 100/-- | 2/0 | 100/100 | 100 |
| N2 | Asbury at Solomon's Island | Calvert | 3 | S/6-7 | 300/66 | 80/25 | 446/391 | 446/1 |
| N3 | Solomon's Nursing Center | Calvert | 3 | S/6-7 | --/127 | 60/12 | 187/139 | 60/1 |

**NOTE:**

(1) See Figure 4-1 for facility location.
(2) Facilities have agreements with other nursing facilities to move transportation dependent residents and local emergency plans provide transportation for evacuation of transportation dependent residents.
(3) 193 transportation dependent residents.
(4) Facility populations obtained from each facility administration.

TABLE 4-4

TRANSIENT POPULATION FACILITIES - MAJOR EMPLOYERS WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | Daytime Population | Nighttime Population | Transportation Resources (Cars-Day/Night) |
|---|---|---|---|---|---|---|---|
| E1 | Williams Cove Point LNG | Calvert | 1 | SSE/3-4 | 35 | 20 | 35/20 |
| E2 | Solomons Strip Malls | Calvert | 3 | S/6-7 | 367 | - | 367 |
| E3 | Chesapeake Biological Laboratory | Calvert | 3 | S/8-9 | 150 | - | 150/- |
| E4 | St. Mary's Industrial Park | St. Mary's | 7 | SW/9-10 | | | |
| | - PRB Associates | | | | 230 | - | 230/- |
| | - Mechanical Products Inc. (Minitec) | | | | 60 | 0 | 60/- |
| | - Merkle Mailing Services. | | | | 150 | 50 | 150/50 |
| E5 | Wildewood Technology Park | St. Mary's | 7 | SSW/10-11 | | | |
| | - Tracor | | | | 500 | 0 | 500/0 |
| | - Congressional Information Service | | | | 70 | 3 | 70/3 |
| E6 | Wildewood Mall | St. Mary's | 7 | SSW/10-11 | 250 | - | 250/- |

**NOTE:**

(1) See Figure 4-2 for facility location.

TABLE 4-5

TRANSIENT POPULATION FACILITIES - OVERNIGHT ACCOMMODATIONS:
MOTELS AND CAMPGROUNDS WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | Population | Transportation Resources (Cars-Day/Night) |
|---|---|---|---|---|---|---|
| OA-1 | Calvert Cliffs State Park Youth Group Campground | Calvert | 1 | SE/2-3 | 175 | 35 |
| OA-2 | The Cliffs Motel | Calvert | 2 | NW/4-5 | 32 | 16 |
| OA-3 | Navy Recreation Center | Calvert | 3 | SSW/6-7 | 1184 | 412 |
| OA-4 | Island Manor Motel | Calvert | 3 | S/7-8 | 20 | 10 |
| OA-5 | Locust Inn | Calvert | 3 | S/7-8 | 18 | 9 |
| OA-6 | Holiday Inn | Calvert | 3 | S/7-8 | 652 | 326 |
| OA-7 | Comfort Inn | Calvert | 3 | S/7-8 | 120 | 60 |
| OA-8 | Sleep Inn | St. Mary's | 7 | SSW/9-10 | 162 | 81 |
| OA-9 | Taylors Island Family Campground | Dorchester | 8 | ENE/6-7 | 336 | 140 |
| OA-10 | Tideland Park Campground | Dorchester | 8 | ENE/8-9 | 72 | 30 |

**NOTE:**

(1) See Figure 4-3 for facility location.

TABLE 4-6

TRANSIENT POPULATION FACILITIES - MAJOR RECREATION AREAS AND ATTRACTIONS WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | Population(2) | Transportation Resources (Cars-Day/Night) |
|---|---|---|---|---|---|---|
| R1 | Flag Ponds Nature Park | Calvert | 1 | NW/1-2 | 263 | 75 |
| R2 | Calvert Cliffs State Park<br>Day Use Area & Park Beach | Calvert | 1 | S/2-3<br>SE/2-3 | 217<br>108 | 108<br>- |
| R3 | Cove Point Recreation Park | Calvert | 3 | SSE/3-4 | 500 | 167 |
| R4 | Calvert County Marine Museum | Calvert | 3 | S/7-8 | 378 | 126 |
| R5 | Battle Creek Cypress Swamp Nature Area & Visitor Center | Calvert | 4 | WNW/9-10 | 378 | 126 |
| R6 | Jefferson Patterson Park & Museum | Calvert | 2 | WSW/4-5 | 360 | 120 |

**NOTE:**

(1) See Figure 4-4 for Facility location.
(2) Populations of each area provided by the administration of each location.

TABLE 4-7
Page 1 of 2
TRANSIENT POPULATION FACILITIES -MARINAS WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | No. of Slips | Population | Transportation Resources (Cars) |
|---|---|---|---|---|---|---|---|
| M1 | Mill Creek | Calvert | 3 | S/6-7 | 100 | 90 | 30 |
| M2 | Hospitality Harbor | Calvert | 3 | S/6-7 | 75 | 68 | 23 |
| M3 | Town Center Marina | Calvert | 3 | S/7-8 | 104 | 93 | 32 |
| M4 | Harbor Island | Calvert | 3 | S/7-8 | 115 | 104 | 35 |
| M5 | Spring Cove Marina | Calvert | 3 | S/7-8 | 246 | 221 | 74 |
| M6 | Comfort Inn / Beacon Marina | Calvert | 3 | S/7-8 | 186 | 168 | 56 |
| M7 | Zahnizer's | Calvert | 3 | S/7-8 | 300 | 270 | 90 |
| M8 | Bunky's | Calvert | 3 | S/7-8 | 10 | 9 | 3 |
| M9 | Solomons Yacht Club | Calvert | 3 | S/7-8 | 32 | 30 | 10 |
| M10 | Calvert Marina | Calvert | 3 | S/7-8 | 450 | 405 | 135 |
| M11 | White Sands | Calvert | 1 | WSW/2-3 | 100 | 90 | 30 |

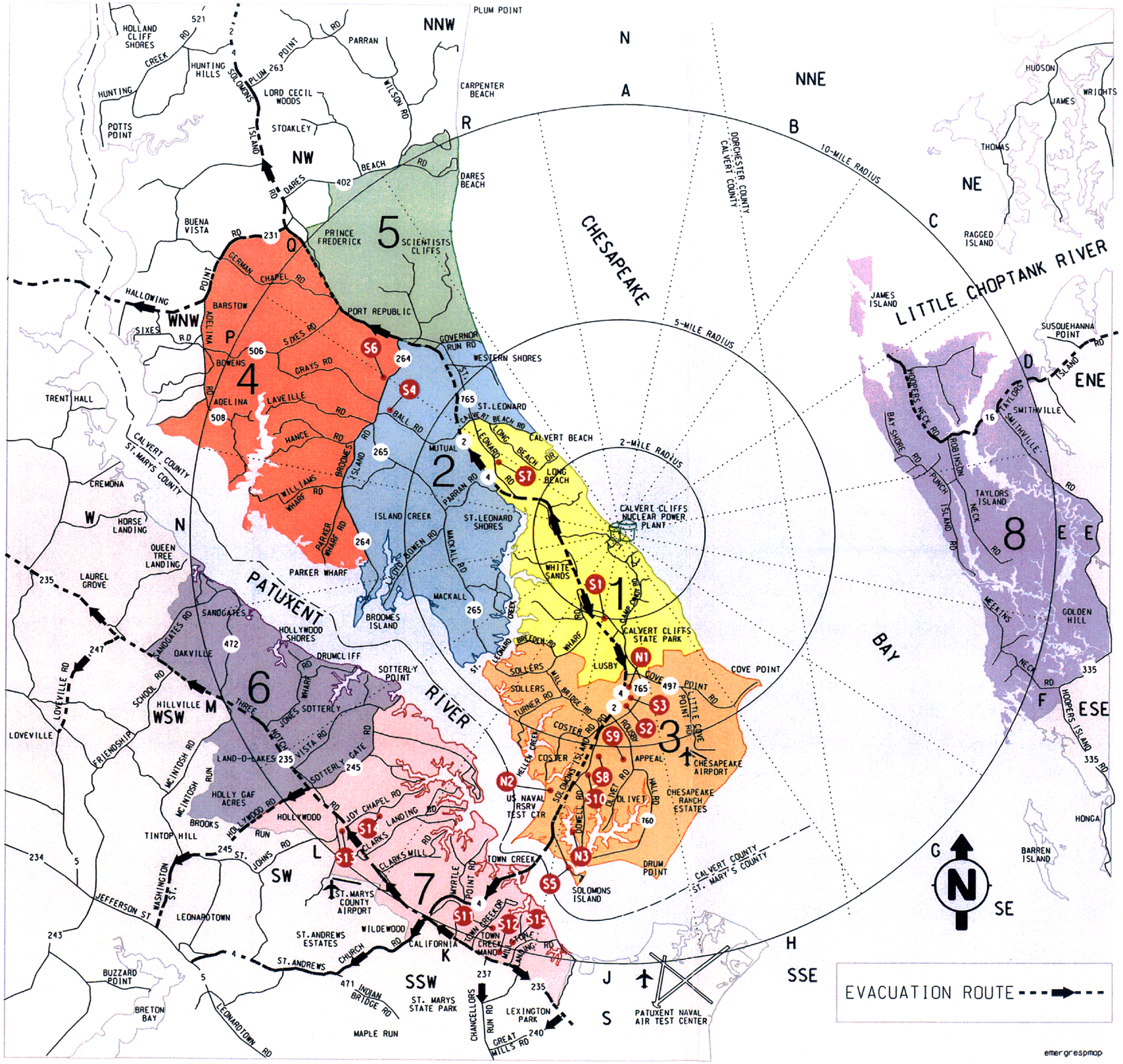
TABLE 4-7
Page 2 of 2
TRANSIENT POPULATION FACILITIES -MARINAS WITHIN THE EMERGENCY PLANNING ZONE

| Facility Number (1) | Name of Facility | County | Zone | Compass Direction/ Distance (Miles) | No. of Slips | Population | Transportation Resources (Cars) |
|---|---|---|---|---|---|---|---|
| M12 | Broome's Island Marina | Calvert | 2 | WSW/5-6 | 20 | 18 | 6 |
| M13 | Bill's | Calvert | 2 | WSW/6-7 | 15 | 15 | 5 |
| M14 | Flag Harbor | Calvert | 2 | NW/2-3 | 168 | 151 | 51 |
| M15 | Blackstone | St. Mary's | 7 | SSW/7-8 | 60 | 54 | 18 |
| M16 | Reliable Marina | St. Mary's | 6 | SSW/8-9 | 26 | 24 | 8 |
| M17 | Weeks Marine Railway | St. Mary's | 7 | SW/7-8 | 50 | 45 | 15 |
| M18 | Cape St. Mary's | St. Mary's | 7 | W/9-10 | 150 | 135 | 45 |
| M19 | Boatel California | St. Mary's | 6 | SSW/8-9 | 58 | 53 | 18 |

**NOTE:**

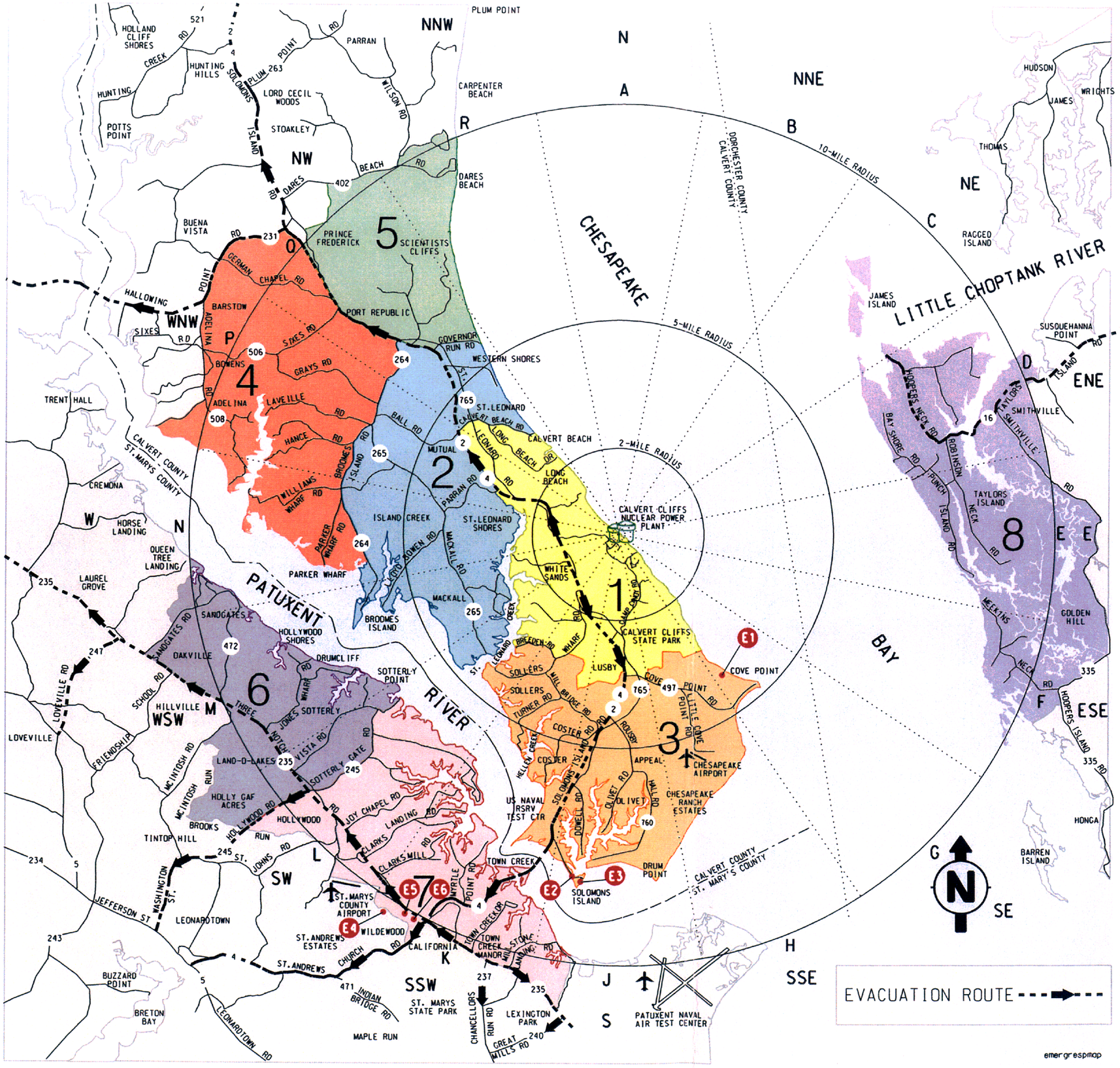
(1) See Figure 4-5 for facility location

CCNPP EPZ ETE
REV. 6



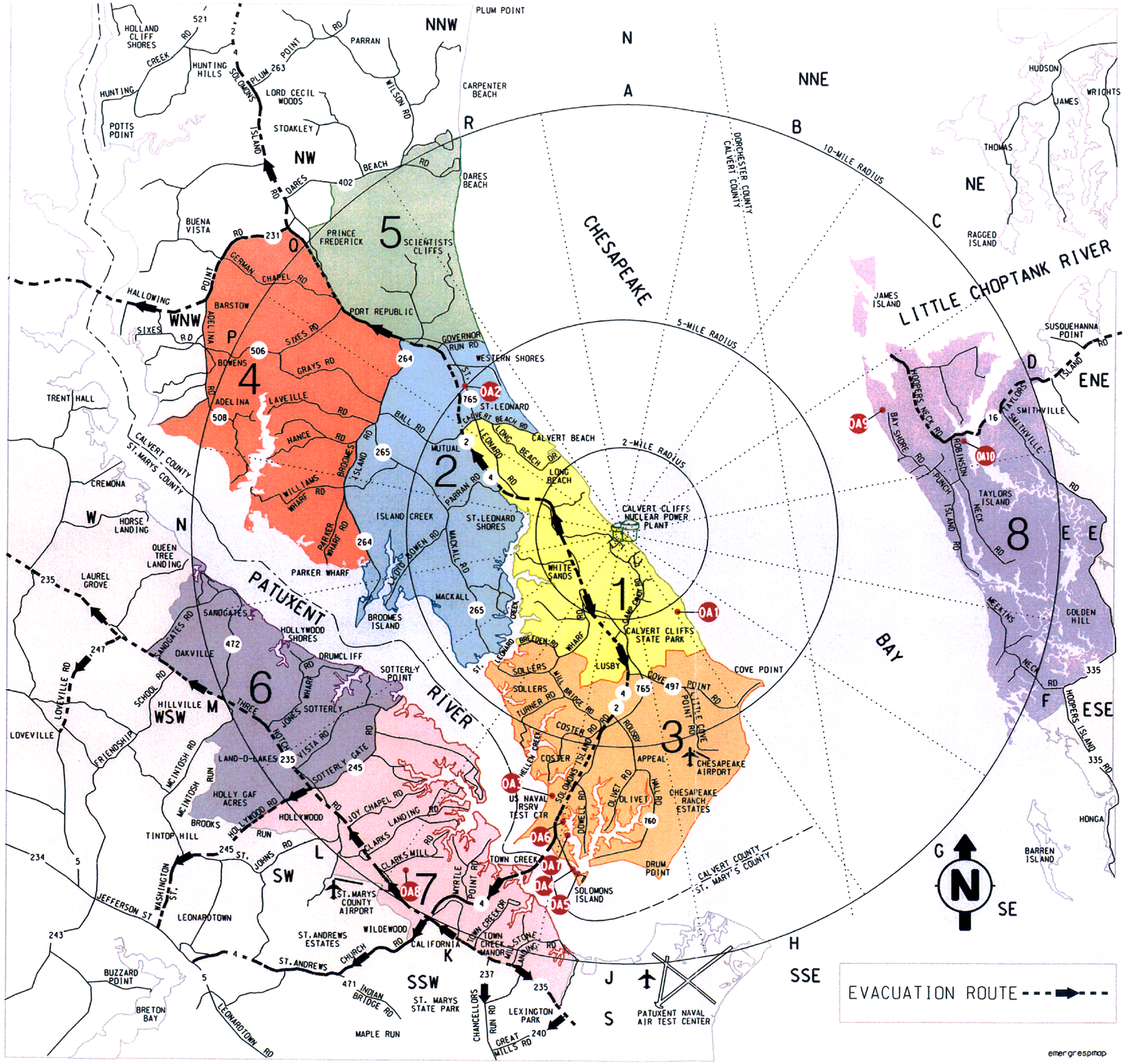

SCHOOLS AND NURSING FACILITIES
FIGURE 4-1
(TABLE 4-2 & 4-3)
PAGE 4-11

CCNPP EPZ ETE
REV. 6



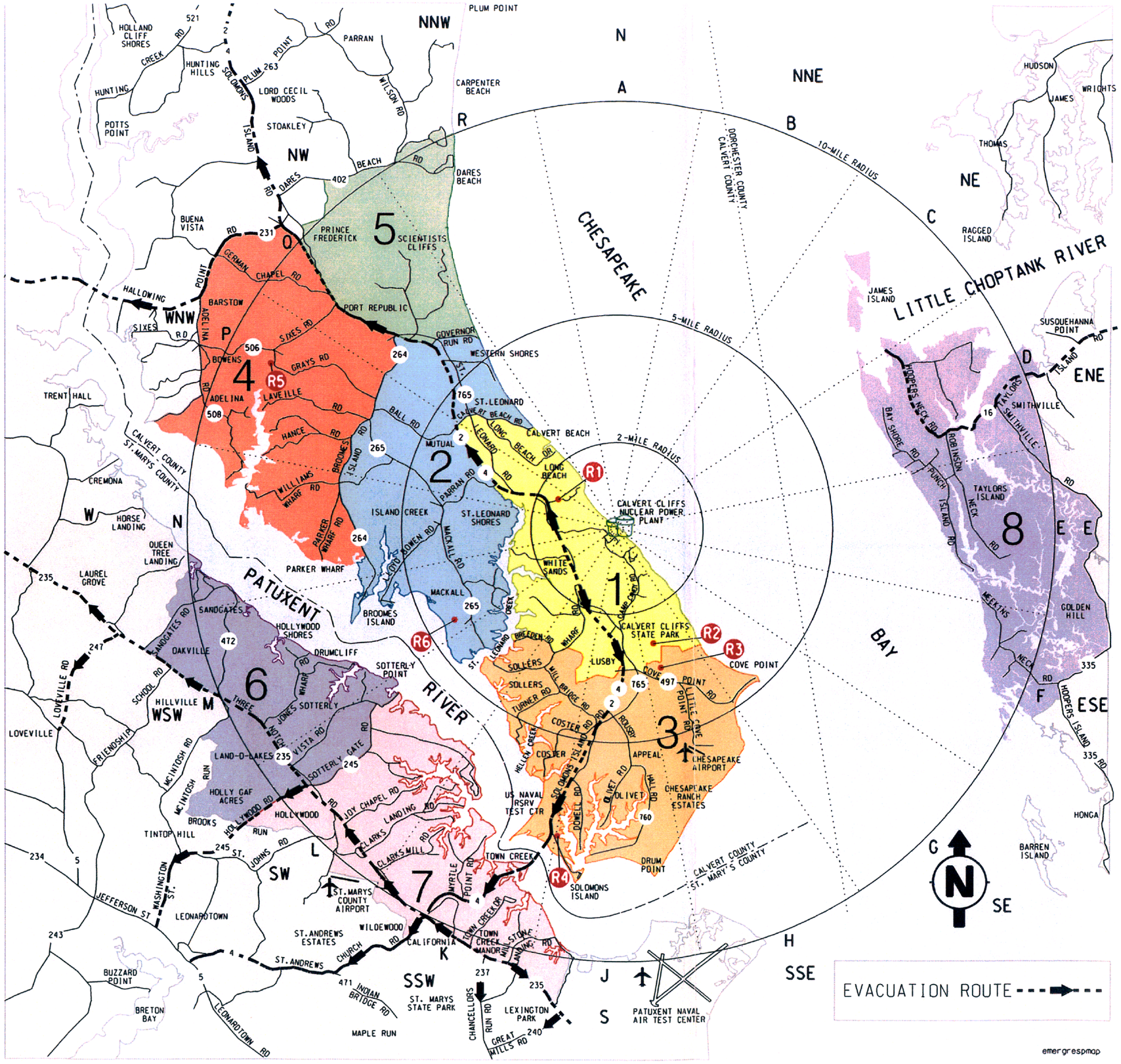

MAJOR EMPLOYERS
FIGURE 4-2
(TABLE 4-4)
PAGE 4-12

CCNPP EPZ ETE
REV. 6



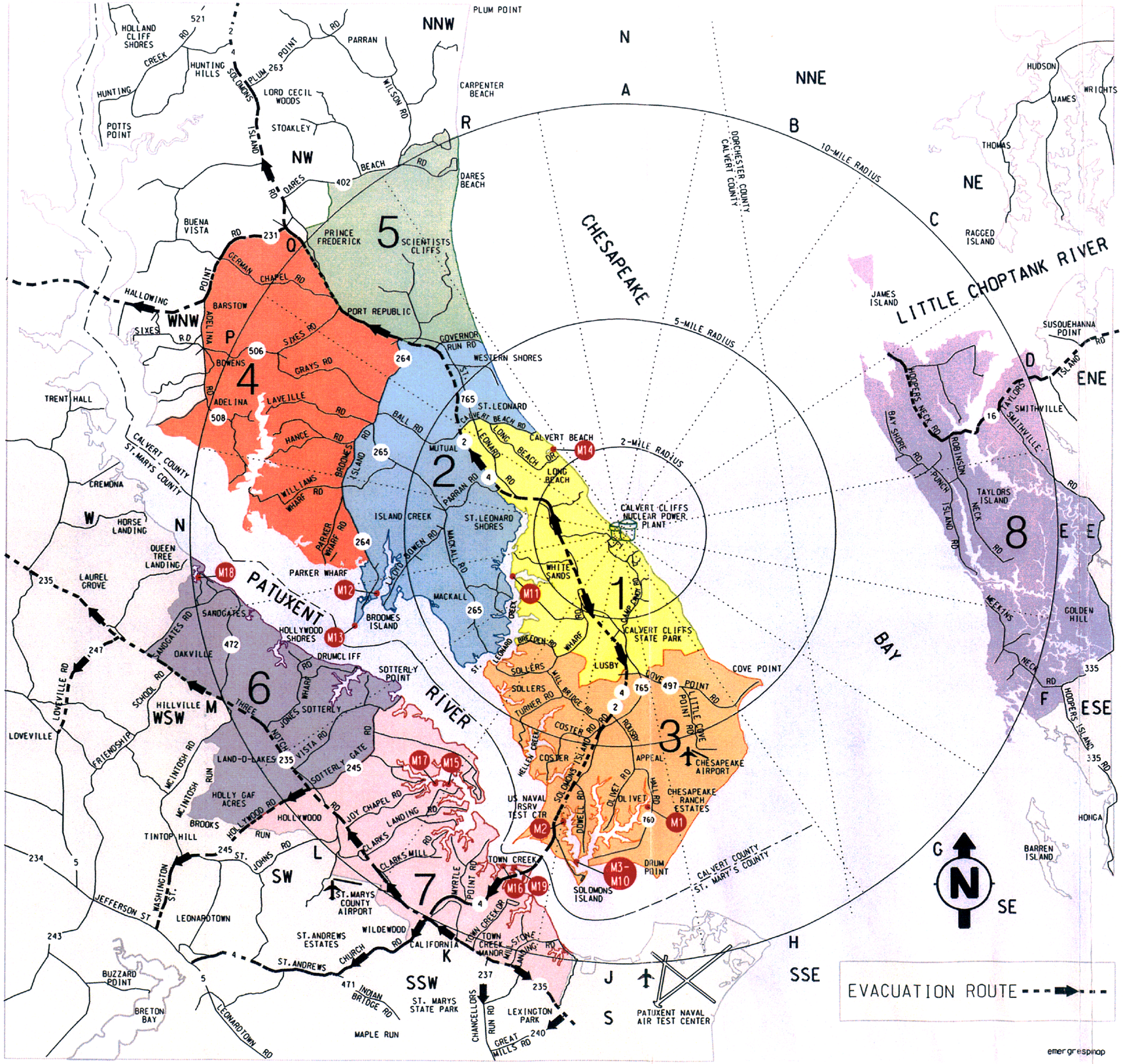

OVERNIGHT ACCOMMODATIONS, RECREATION AREAS AND ATTRACTIONS
FIGURE 4-3
(TABLE 4-5)
PAGE 4-13

CCNPP EPZ ETE
REV. 6




RECREATION FACILITIES
FIGURE 4-4
(TABLE 4-6)
PAGE 4-14

CCNPP EPZ ETE
REV. 6




MARINAS
FIGURE 4-5
(TABLE 4-7)
PAGE 4-15

# SECTION 5

# TRANSPORTATION NETWORK DESCRIPTION

## 5.1 ROAD NETWORK DEFINITION

The road network was defined by identifying the major roads and collector streets and the important intersections on those roads. This road network was then represented as a set of nodes (intersections) connected by a series of links (road segments). These links and nodes are assigned identifying numbers for use in the NETVAC2 Model.

The roads and intersections used for evacuation time estimates study are presented on Figure 5-1, Evacuation Road Network, and in Appendix C, Evacuation Network Node Identification.

## 5.2 PRIMARY EVACUATION ROUTES

The primary evacuation routes for the Calvert Cliffs EPZ are:

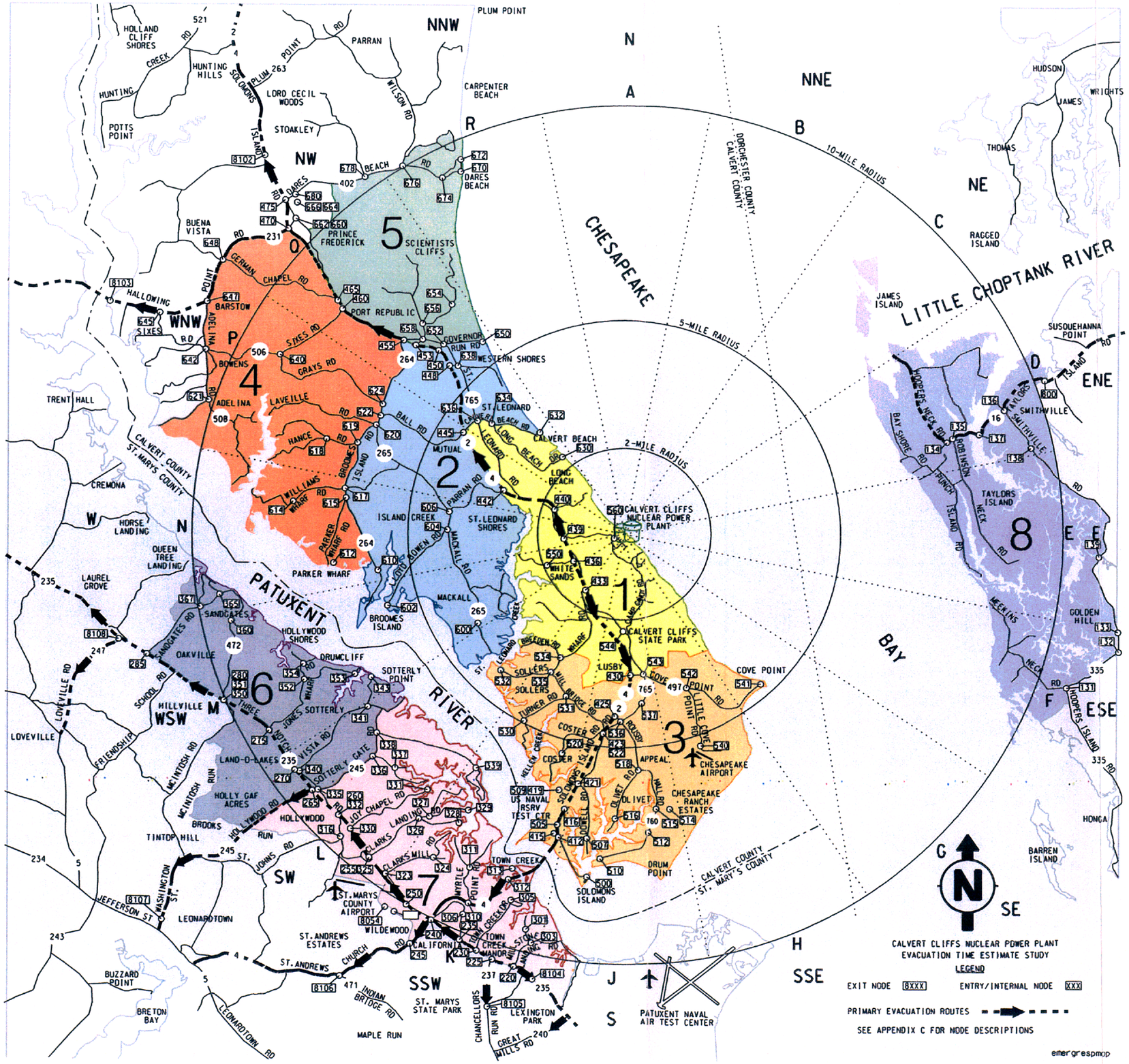
- Route 2/4 North from the CCNPP entrance towards Prince Frederick
- Hollowing Point Road, Route 231 West from Prince Frederick towards Benedict
- Route 2/4 South from the CCNPP entrance towards Solomons Island
- Route 4 South from Solomons Island to Route 235
- Route 235 North from Route 4 (California) towards Oakville
- Route 235 South from Route 4 (California) towards Lexington Park
- St. Andrews Church Road South from Route 235 towards Leonardtown
- Chancellors Run Road (Route 237) South from Route 235 towards Great Mills Road (Route 246)
- Hollywood Road (Route 245) South from Route 235 towards Leonardtown
- Loveville Rd (Route 247) South from Route 235 towards Leonardtown
- Taylors Island Road (Route 16) East from Taylors Island towards Madison
- Hooper Island Road (Route 335) East from Swan Harbor towards Golden Hill

## 5.3 ROADWAY CAPACITIES, CLASSIFICATION, AND VEHICLE ROUTING

The capacity of each of the links and nodes included in the evacuation road network was calculated by the NETVAC2 Model using field data, such as length and number of travel lanes. Roadways were also classified by type of road and the surrounding land use development. The majority of the roads in the EPZ are rural undivided highways, with two rural divided highways (Routes 2/4 and 235). The land use in the EPZ is considered to be residential based on the Highway Capacity Manual classification system (the manual classification does not include agricultural use).

5.3 **ROADWAY CAPACITIES, CLASSIFICATION, AND VEHICLE ROUTING** (continued)

The routing of vehicles over the network was defined using preference factors for each link. Preference factors are similar to fixed turning movements since they control turning percentages at intersections. It should be noted, however, that they are not fixed and can change depending on the speed of the downstream link. The variable turning percentages are felt to model real situations because less traffic would turn onto a congested and slow moving link than a free flowing link. The preference factors were assigned to the links to create traffic flows away from the CCNPP following the primary evacuation routes.




EVACUATION ROAD NETWORK
FIGURE 5-1
APPENDIX C
PAGE 5-3

# SECTION 6
# EVACUATION TIME ESTIMATES

## 6.1 GENERAL POPULATION EVACUATION TIME ESTIMATES

Evacuation time estimates for the general, auto-owning public were performed using the NETVAC2 model. The 64 evacuation scenarios discussed in Section 2.4, Evacuation Scenarios, were evaluated. The results of the NETVAC2 runs are presented in Tables 6-1 and 6-2. A summary of vehicle departures as a function of time for each full EPZ case is presented in Appendix B.

## 6.2 SPECIAL FACILITY EVACUATION TIME ESTIMATES- SCHOOLS

The evacuation time estimates for schools are shown in Table 6-3, Special Facility-Schools Evacuation Time Estimates. The evacuation times range from 30 to 90 minutes for normal weather conditions and from 70 to 130 minutes for adverse weather conditions. The times listed are based on the following[5]:

- 40 minutes to alert the school bus driver and drive the bus to the risk school
- 20 minutes to evacuate the students from the school to the school buses
- 20 – 30 minutes to drive from the risk school to the edge of the 10 mile EPZ

## 6.3 SPECIAL FACILITY EVACUATION TIME ESTIMATES-NURSING FACILITIES

Evacuation time estimates for nursing facilities are shown in Table 6-4, Special Facility-Nursing Facilities Evacuation Time Estimates. Local emergency management officials in consultation with the respective nursing facility director estimated evacuation time estimates. The evacuation times for normal weather conditions range from 130 to 140 minutes and from 160 to 170 minutes for adverse weather conditions. The primary component of these times is the mobilization time (120 minutes for normal weather and 150 minutes for adverse weather). The major constraints in evacuating nursing facilities are

(1) the time required to mobilize the vehicles,
(2) the time required for the vehicles to travel to the respective facility, and
(3) the time required to load the vehicles.

## 6.4 SPECIAL EVENT EVACUATION TIME ESTIMATES

Evacuation time estimate for the special event scenario discussed in Section 3.4, Special Event Evacuation Time Estimates Methodology and Assumptions, was prepared. The Thomas Johnson Bridge closure special event scenario is based on both summer and winter daytime adverse weather conditions.

The special event analysis assumes that the Governor Thomas Johnson Bridge is not available for use. For a full EPZ for both summer and winter daytime adverse weather scenario, the expected evacuation time would be summer 600 minutes and winter 520 minutes. This is 160 minutes greater than the full EPZ normal weather daytime summer evacuation and 140 minutes greater than the full EPZ normal weather daytime winter evacuation and (see Table 6-1). The increase is expected due to the additional travel distance and corresponding time introduced for vehicles leaving the Solomons area en route to the EPZ boundary north of Prince Frederick. The evacuation time for this scenario could be reduced if northbound travel were permitted on Rt. 2/4 southbound lanes in addition to Rt. 2/4 northbound through Prince Frederick.

## 6.5 EVACUATION CONFIRMATION TIME ESTIMATES

Evacuation confirmation time estimate is the time required to patrol the evacuated area to observe that residents have left. State Police and the County Sheriff's Department will ensure that there are no evacuees with disabled vehicles or residents left without transportation.

The county emergency management agency officials in consultation with county law enforcement personnel estimate confirmation times. The estimates are based upon the number of vehicles available and the number of miles to be driven in each evacuation area. Evacuation confirmation time estimates for each Emergency Action Zone are presented in Table 6-5.

TABLE 6-1

EVACUATION TIME ESTIMATES

**NORMAL WEATHER**

| EVACUATION AREA | Protective Action Zone(s) (1) | Winter | | Summer | |
|---|---|---|---|---|---|
| | | Day | Night | Day | Night |
| | | (min) (2) | | (min) (2) | |
| 0-2 Miles, 360° | 1 | 190 | 140 | 190 | 140 |
| 0-5 Miles, 360° | 1,2,3 | 290 | 290 | 350 | 310 |
| 0-5 Miles, North West | 1,2 | 190 | 140 | 200 | 140 |
| 0-5 Miles, South | 1,3 | 290 | 290 | 340 | 310 |
| 0-10 Miles, 360°(3) | 1,2,3,4,5,6,7,8 | 290 | 300 | 350 | 310 |
| 0-10 Miles, North West | 1,2,4,5 | 210 | 160 | 190 | 160 |
| 0-10 Miles, South West | 1,2,3,6,7 | 290 | 290 | 350 | 310 |
| 0-10 Miles, East | 8 | 130 | 80 | 130 | 80 |

**NOTES:**

(1) See Figure 2-1 for identification of Protective Action Zone location.

(2) NETVAC2 software rounds the evacuation times up to the next 10 minutes;

TABLE 6-2

EVACUATION TIME ESTIMATES

**ADVERSE WEATHER**

| EVACUATION AREA | Protective Action Zone(s) (1) | Winter | | Summer | |
|---|---|---|---|---|---|
| | | Day | Night | Day | Night |
| | | (min) (2) | | (min) (2) | |
| 0-2 Miles, 360° | 1 | 220 | 150 | 230 | 150 |
| 0-5 Miles, 360° | 1,2,3 | 360 | 360 | 440 | 380 |
| 0-5 Miles, North West | 1,2 | 230 | 160 | 250 | 160 |
| 0-5 Miles, South | 1,3 | 360 | 360 | 420 | 380 |
| 0-10 Miles, 360° | 1,2,3,4,5,6,7,8 | 380 | 370 | 440 | 380 |
| 0-10 Miles, North West | 1,2,4,5 | 240 | 190 | 230 | 200 |
| 0-10 Miles, South West | 1,2,3,6,7 | 380 | 360 | 420 | 380 |
| 0-10 Miles, East | 8 | 150 | 80 | 150 | 80 |

**NOTES:**

(1) See Figure 2-1 for identification of Protective Action Zone location.

(2) NETVAC2 software rounds the evacuation times up to the next 10 minutes.

(3) Expected evacuation time with Governor Thomas Johnson Bridge closure is

- Summer daytime 600 minutes
- Winter daytime 520 minutes

TABLE 6-3
SPECIAL FACILITY - SCHOOLS
EVACUATION TIME ESTIMATES

| School (1) | County | Compass Direction/ Distance (miles) | Students (3) | Normal Weather (min) (2) | Adverse Weather (min) (2) |
|---|---|---|---|---|---|
| Southern Middle School | Calvert | S/2-3 | 694 | 80 | 120 |
| Patuxent Elementary School | Calvert | S/3-4 | 434 | 90 | 130 |
| Appeal Elementary School | Calvert | S/4-5 | 488 | 80 | 120 |
| Mutual Elementary | Calvert | WNW/5-6 | 542 | 80 | 120 |
| Mill Creek Middle School | Calvert | S/5-6 | 636 | 90 | 130 |
| Our Lady Star of the Sea School | Calvert | S/7-8 | 199 | 80 | 120 |
| Community College | Calvert | NW/6-7 | 370 | 30 | 70 |
| St. Leonard Elementary | Calvert | WNW/3-4 | 701 | 80 | 120 |
| Patuxent High School | Calvert | S/5-6 | 1747 | 90 | 130 |
| Dowell Elementary | Calvert | S/5-6 | 727 | 90 | 130 |
| Town Creek Elementary School | St. Mary's | SSW/9-10 | 332 | 70 | 100 |
| Esperanza Middle School | St. Mary's | SSW/10-11 | 923 | 70 | 100 |
| St. Johns Elementary School | St. Mary's | SW/9-10 | 235 | 70 | 100 |
| Hollywood Elementary School | St. Mary's | SW/9-10 | 632 | 70 | 100 |
| Green Holly Elementary School | St. Mary's | SSW/10-11 | 732 | 70 | 100 |

NOTES:

(1) See Table 4-2 and Figure 4-1 for facility location.

(2) The County EMA Directors in cooperation with county public school transportation directors provided evacuation time estimates.

(3) Student populations provided by respective county Board of Education.

TABLE 6-4
SPECIAL FACILITY - NURSING FACILITIES
EVACUATION TIME ESTIMATES

| Facility (1) | County | Compass Direction/ Distance (miles) | Residents | Normal Weather (min) (2) | Adverse Weather (min) (2) |
|---|---|---|---|---|---|
| Southern Pines | Calvert | S/3-4 | 100 | 140 | 170 |
| Asbury at Solomon's Island | Calvert | S/5-6 | 366 | 130 | 160 |
| Solomon's Nursing Center | Calvert | S/6-7 | 127 | 130 | 160 |

NOTES:

(1) See Table 4-3 and Figure 4-1 for facility location.

(2) Times are determined by County Emergency Management Director and the administration of the respective facility.

TABLE 6-5

EVACUATION CONFIRMATION TIME ESTIMATES BY EMERGENCY ACTION ZONE

| Protective Action Zone (1) | Evacuation Confirmation Time Estimate (2) (minutes) |
|---|---|
| 1 | 45 |
| 2 | 60 |
| 3 | 90 |
| 4 | 90 |
| 5 | 60 |
| 6 | 90 |
| 7 | 90 |
| 8 | 30 |

**NOTES:**

(1) See Figure 2-1 for Protective Action Zone location.

(2) County emergency management agency officials provided evacuation confirmation times.

# SECTION 7

# CONCLUSIONS AND RECOMMENDATIONS

## 7.1 CONCLUSIONS

Based on the NETVAC2 model EPZ evacuations calculations it is concluded:

- Longest full EPZ normal weather evacuation time estimate for either winter or summer daytime scenario is 350 minutes.
- Full EPZ adverse weather evacuation time estimate for winter daytime scenario is 380 minutes.
- Full EPZ adverse weather evacuation time estimate for winter nighttime scenario is 380 minutes.
- Full EPZ adverse weather evacuation time estimate for summer nighttime scenario is 380 minutes.
- Full EPZ adverse weather evacuation time estimate for summer daytime scenario is 440 minutes.
- Full EPZ evacuation time estimate without the use of the Govenor Thomas Johnson Bridge scenario for day time summer is 600 minutes, for the winter day time is 520 minutes.

Traffic congestion locations can be anticipated. Delays at these locations are temporary. The final evacuation times are primarily a factor of the modeled vehicle loading.
The major constraint for the winter and summer daytime scenarios is the traffic congestion encountered at Route 765 and Route 497 (Cove Point road) and at Route 765 and Route 760 (Rousby Hall road) (see Figure 7-1). While other routes in the evacuation network experience only light to moderate traffic flows that clear relatively quickly, the availability of more indirect evacuation routes as would be available along Ball or Sixes Road in Calvert County were found to result in slightly longer evacuation times.

Traffic management strategies can be implemented that could reduce the evacuation times. Two intersections were identified that are beyond the EPZ boundary that impact the evacuation time estimates. Provision for traffic control at the intersections of Rt. 231 (Hallowing Point Road) and Sixes Road in Calvert County and Rt. 245 (Old Hollywood Road) and McIntosh Road in St. Mary's County would reduce potential backups in traffic flow exiting the EPZ.

In an attempt to maintain a sense of realism in assigning traffic flow movements, provisions were not made in Calvert or St. Mary's Counties for vehicles to travel over less direct routes out of the EPZ.

For Calvert County it was assumed that some vehicles would travel from Rt. 2/4 across Ball and/or Sixes Roads to Hollowing Point Road before leaving the evacuation road network. Travel along these more circuitous routes resulted in a slightly longer time estimate than using Rt. 2/4 exclusively.[10]

7.1 **CONCLUSIONS** (continued)

IDYNEV computer model, the evacuation time estimate software used prior to NETVAC2, runs were performed to incorporate traffic flow measures. With all other factors remaining unchanged, the results showed that the daytime full EPZ normal weather scenario evacuation time would be reduced by approximately 10 minutes. Reductions of a similar magnitude could also be expected for full EPZ adverse weather and nighttime evacuation scenarios.[10]

7.2 **RECOMMENDATIONS**

A traffic management strategy that could reduce the evacuation time estimates is adding additional traffic control points.

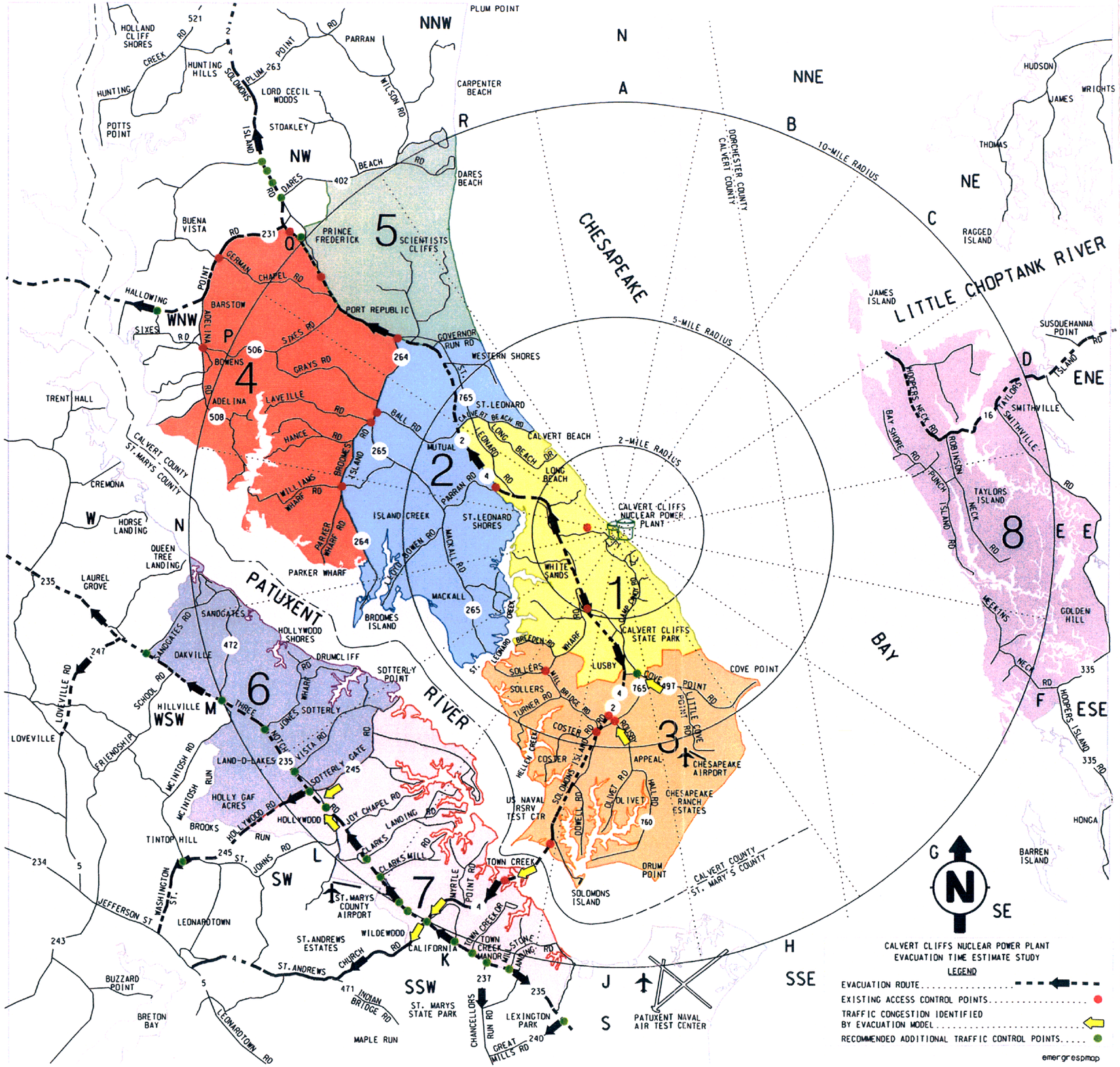
As a result of the road network validation surveys for both Calvert County and St. Mary's County the following recommended sites were found:

1. For Calvert County:
   a. The intersection of Route 765 and Route 497 (Cove Point Rd.).
   b. The intersection of Route 231 (Hollowing Point Rd.) and Sixes Rd.
   c. Six signalized intersections not in the EPZ were identified as recommended additional traffic control points, these locations are:
      - Route 2/4 and Old Field Rd.
      - Route 2/4 and Rt. 231 (Hallowing Point Road)
      - Route 2/4 and Dares Beach Rd.
      - Route 2/4 and Fox Run Blvd
      - Route 2/4 and Trasker Blvd
      - Route 2/4 and Stoakley Rd.

   Provisions for manually overriding these signalized intersections would reduce potential backups in traffic flow exiting the EPZ.

2. For St. Mary's County 16 additional intersections were identified as recommended additional traffic control points, these locations are:
   a. Route 235 and Great Mills Rd. (Rt. 240)
   b. Route 235 and Mill Stone Landing Rd.
   c. Route 235 and Chancellors Run Rd (Rt. 237).
   d. Route 235 and Town Creek Dr.
   e. Route 235 and St. Andrews Church Rd. (Rt. 4)
   f. Route 235 and Wildewood Blvd
   g. Route 235 and Airport Rd.
   h. Route 235 and Clarks Mill Rd.
   i. Route 235 and Clarks Landing Rd.
   j. Route 235 and Joy Chapel Rd.
   k. Route 235 and Hollywood Rd. (Rt. 245)
   l. Hollywood Rd. (Rt. 245) and McIntosh
   m. Route 235 and Vista Rd.
   n. Route 235 and Jones Wharf Rd
   o. Route 235 and Sandgates Rd. (Rt. 472) south.
   1. Route 235 and Sandgates Rd. (Rt. 472) north.

   Provisions for additional traffic control at these points or manually overriding this signalized intersection would reduce potential backups in traffic flow exiting the EPZ.




RECOMMENDED TRAFFIC CONTROL
FIGURE 7-1
PAGE 7-3

# REFERENCES

1. Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654/FEMA-REP-1, Rev. 1, Appendix 4, U.S. Nuclear Regulatory Commission and Federal Emergency Management Agency, November 1980.

2. Maryland Emergency Operations Plan, Annex Q, Radiological Emergency Plan, Calvert Cliffs Nuclear Power Plant, September 1996.

3. Demographic Profile of the Plume Exposure Pathway Emergency Planning Zone for the Calvert Cliffs Nuclear Power Plant, April 1981.

4. Personal communication with Mr. Greg Phillips, State Highway Administration, Annapolis office, November 2001.

5. School and Special Facility evacuation times were obtained as a result of meetings held between County Emergency Management Directors and the administration of the respective facility, fall of 2001.

6. Personal communications with Mr. Donald Hall, Calvert County Director of Emergency Management, Mr. Paul Wible St. Mary's County Director of Emergency Management, Mr. Wayne Robinson, Dorchester County Director of Emergency Management, fall of 2001.

7. Calvert Cliffs Nuclear Power Plant, Units 1 and 2, Finial Safety Analysis Report, volume 1, chapter 2, revision 26.

8. 1985 Highway Capacity Manual, Highway Research Board, Highway Research Board of the Division of Engineering and Industrial Research, National Academy of Sciences - National Research Council, Washington, DC, 1985.

9. Jones, E. Roy, et al. The Environmental Influence of Rain on Freeway Capacity. Highway Research Record Number 321, 1970, pps. 74-82 and September 1995.

10. Evacuation Time Estimates Within the Plume Exposure Pathway Emergency Planning Zone for Calvert Cliffs Nuclear Power Plant, December 1989, September 1995 and December 1998.

11. NETVAC2, A State of the Art Computer Evacuation Simulation Model, User's Manual, EARTH TECH formerly HMM Associates, Concord, MA, December, 1999.

12. Census 2000 population data for Calvert, St. Mary's and Dorchester Counties as interpreted by Jesse Ash, Planner at Maryland Department of Planning, fall of 2001.

# APPENDIX A
# DESCRIPTION OF NETVAC2 COMPUTER MODEL

NETVAC2 Model is organized in four basic units (procedures): the main program, the data procedure, the preprocessor, and the simulator. The main program controls the entire execution. It starts by calling on the data procedure, which reads in the data and the execution instructions, then calls in the preprocessor that performs some preliminary capacity calculations. The main program controls the simulation itself and the reporting network conditions at specified intervals. This program also controls the rest of the reports and the length of the simulation by terminating the program once the network is empty (or after a specified time).

The data procedure reads in the network, the parameters and the options to be used in the run. On request, the data procedure performs a set of checks on the network to ensure connectivity and validity. The preprocessor procedure converts the physical description of each link into measures of capacity, speed and density. For each specified type of link, the preprocessor computes two types of capacity: section capacity - which is the capacity along the link regardless of downstream intersection restrictions; and approach capacity - which is the capacity of the link to handle vehicles approaching the downstream intersection. Section capacities are associated with highway sections, whereas the traffic flow through intersections is controlled by the approach capacity. The section capacity serves as an upper bound on the flow that can move along a link, restricting the number of vehicles that will reach the intersection during a simulation interval and the number of vehicles that can be loaded onto a link from the intersection. The approach capacity, on the other hand, limits the number of cars that can actually move through the intersection. Vehicles that reach the intersection but cannot move through it are assigned to a queue.

The NETVAC2 simulator includes two separate procedures, the link pass and the node pass. The link pass handles the flow on the links, while the node pass handles the transfer of flow from link to link.
Dynamic route selection allows the turning movements to be determined at each simulation interval as a function of the changing traffic conditions and directionality of the links. Drivers approaching an intersection are assumed to make a choice of outbound (away from intersection) links based on how fast this outbound link can get them to safety. This, in turn, is a function of the direction of the outbound links (away from the nuclear plant or potential hazard area) and the traffic conditions on the links.
Even under evacuation conditions, it can be expected that traffic approaching an unsignalized intersection from certain links would have the right of way over incoming traffic from lower priority approaches. Since it is not clear that such priority would correspond to the existing intersection controls, the input to NETVAC2 includes a user-specified link priority parameter. This is a binary parameter indicating primary or secondary priority of a link.

APPENDIX A
DESCRIPTION OF NETVAC2 COMPUTER MODEL
(continued)

The volume of vehicles being processed (at every intersection and at each simulation interval) and transferred from inbound to outbound links is subject to several constraints. These constraints determine the effective capacity of the intersection. During the simulation, traffic entering from all primary priority links is assigned to the intersection first, subject only to the intersection capacity constraints. Lower priority traffic, on the other hand, is restricted by both the capacity of the intersection and the effect of the higher priority traffic.

The capacity of a transportation facility is the maximum flow that can go through the facility. NETVAC2 determines the capacity in two stages: first, the preprocessor assigns a section capacity and an approach capacity to each link in the network. Second, approach capacities are updated continuously, throughout the simulation as changing turning movements affect the maximum throughput of each link into its downstream intersection.

The capacity calculations are based on the Highway Research Board's Highway Capacity Manual (HCM)[(4)(8)]. Section capacity is calculated in the preprocessor for links with and without physical separation between opposing direction. The approach capacity is calculated as a function of the physical conditions (area type, peak hour and load factors), traffic characteristics (traffic mix and percentage of turning movements), and approach type.

**Road Network Construction**

The road network used by this model is crafted from Alexandria Drafting Company (ADC) maps for Calvert, St. Mary's and Dorchester Counties.

**NETVAC2 Input**

Input data to NETVAC2 includes information regarding the network links and the rate at which the evacuating vehicles load the network. In order to run the program the user has to specify certain parameters and options. This section addresses the input data and all the instructions needed for executing a computer run.

The network data are input to NETVAC2 as a list of directional links characterized by their end nodes (two-way streets can be modeled as two links). The model can accept up to 1000 nodes (numbered from 1 to 1000) and 500 links. Traffic can be loaded onto the network at any node, thus avoiding the need to designate special entry nodes. Exit nodes are those nodes where traffic leaves the network.

# APPENDIX A
## DESCRIPTION OF NETVAC2 COMPUTER MODEL
(continued)

The network data input to NETVAC2 includes two components: link information and loading rates. Most of the network information is contained in the link record, which include the following data for each network link:

Identification - upstream and downstream nodes

Physical information - link length, number of lanes, etc.

Traffic engineering information - link type, including parking information and area type

Traffic flow model parameters - free flow speed and jam density

Routing information and turning movements

The set of vehicle loading records specifies the rate at which traffic is loaded onto the network; one such record is provided for every node that is used as an entry node. The vehicle loading file can be created manually or by using the POPDIS preprocessor.

For further information or documentation concerning the operation of the NETVAC2 computer model contact Eric Schrader, Emergency Planning Analyst, Emergency Planning Unit at Calvert Cliffs Nuclear Power Plant, 410 495 6927.

# APPENDIX B
# POPULATION AND VEHICLE DATA

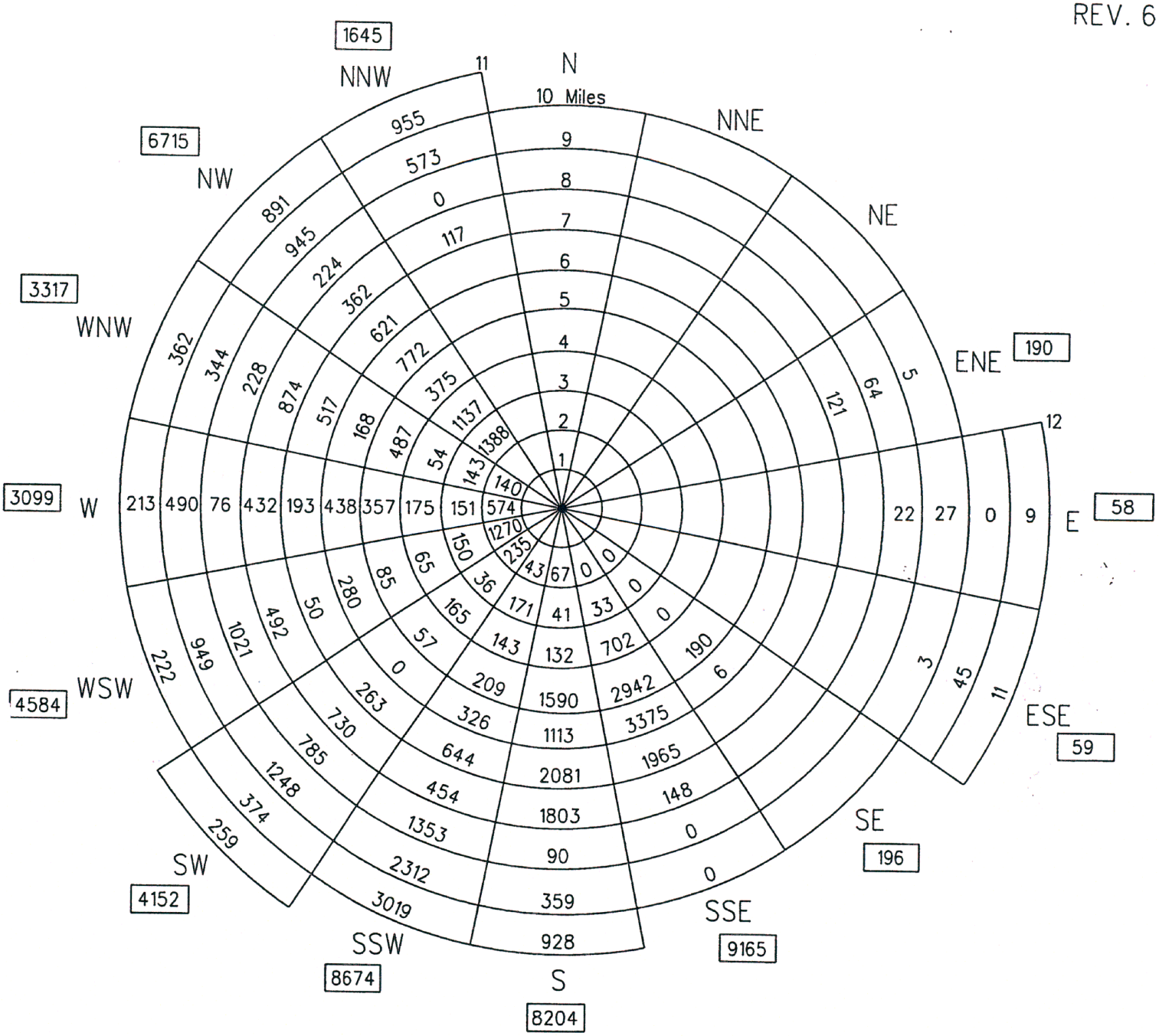



FIGURE B-1

PERMANENT POPULATION DISTRIBUTION
BY COMPASS SECTOR

POPULATION TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 2329 | 13307 | 42770 | 10978 | 29463 | 50058 |

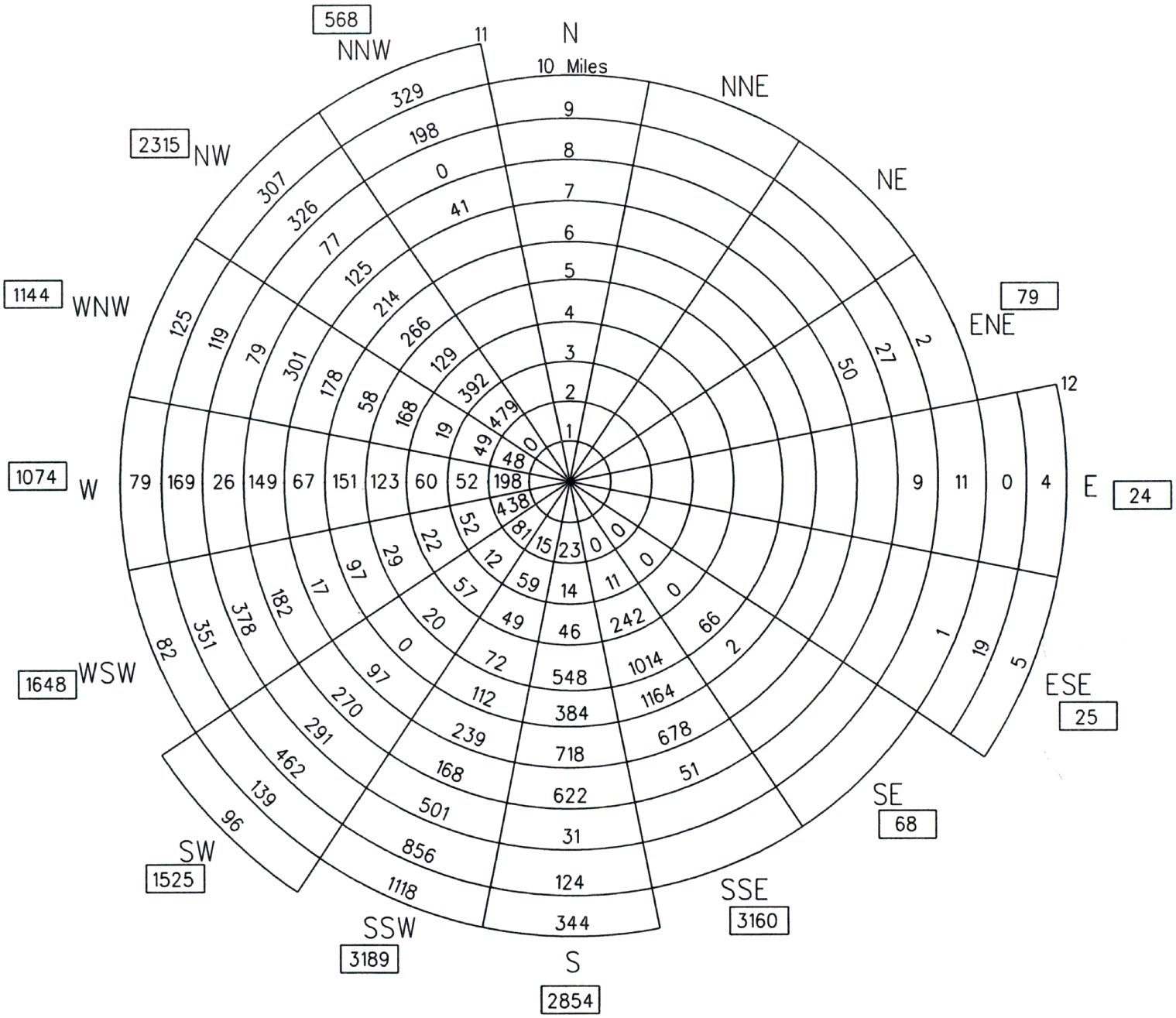



FIGURE B-2

PERMANENT VEHICLE DISTRIBUTION
BY COMPASS SECTOR

VEHICLE TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 803 | 4587 | 15026 | 3784 | 10439 | 17673 |

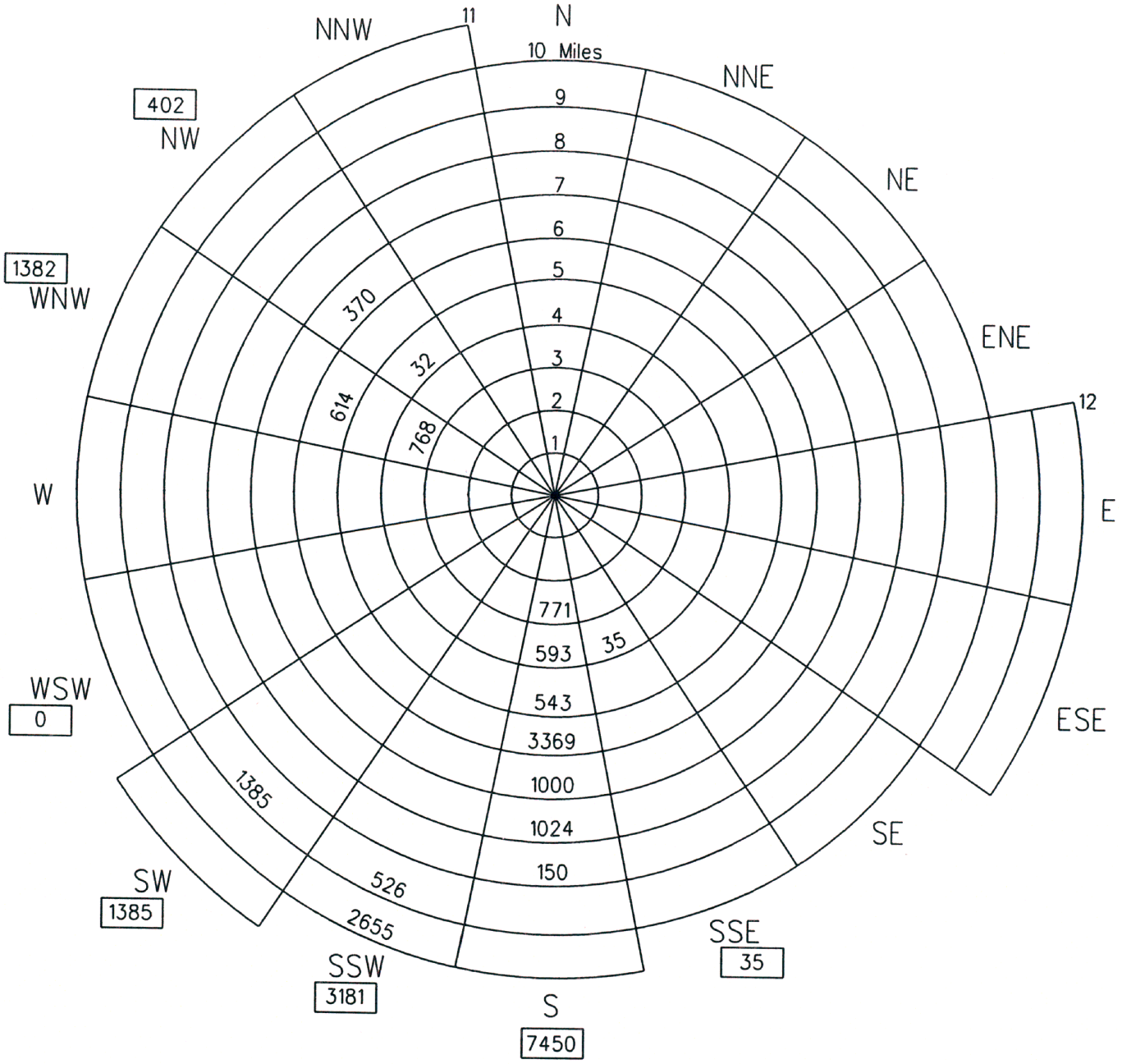



FIGURE B-3

WINTER DAY TIME SPECIAL/TRANSIENT
FACILITY POPULATION DISTRIBUTION
BY COMPASS SECTOR

POPULATION TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 2742 | 11180 | 2742 | 8438 | 13835 |

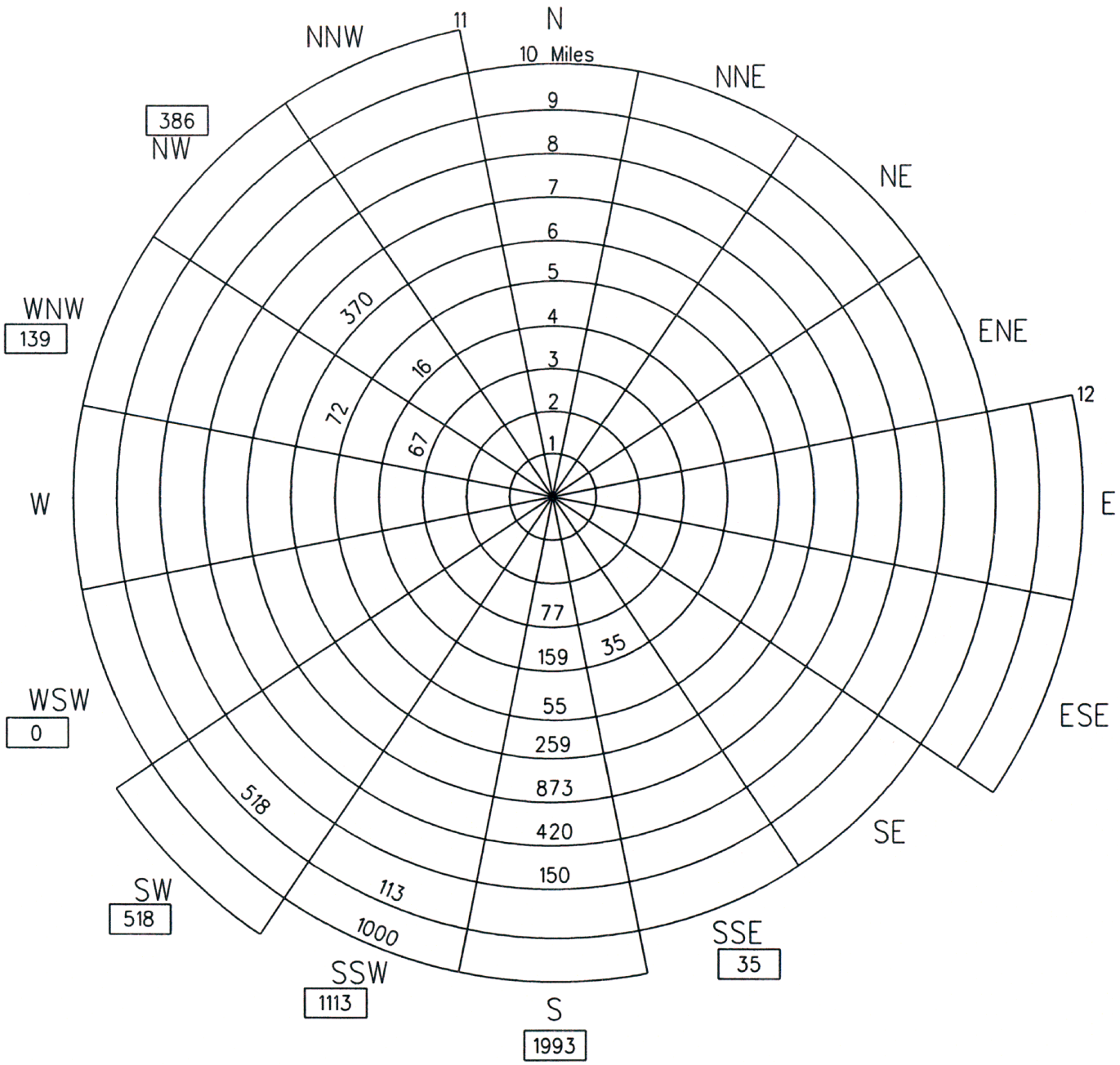



FIGURE B-4

WINTER DAY TIME SPECIAL/TRANSIENT
FACILITY VEHICLE DISTRIBUTION
BY COMPASS SECTOR

VEHICLE TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 409 | 3184 | 409 | 2775 | 4184 |

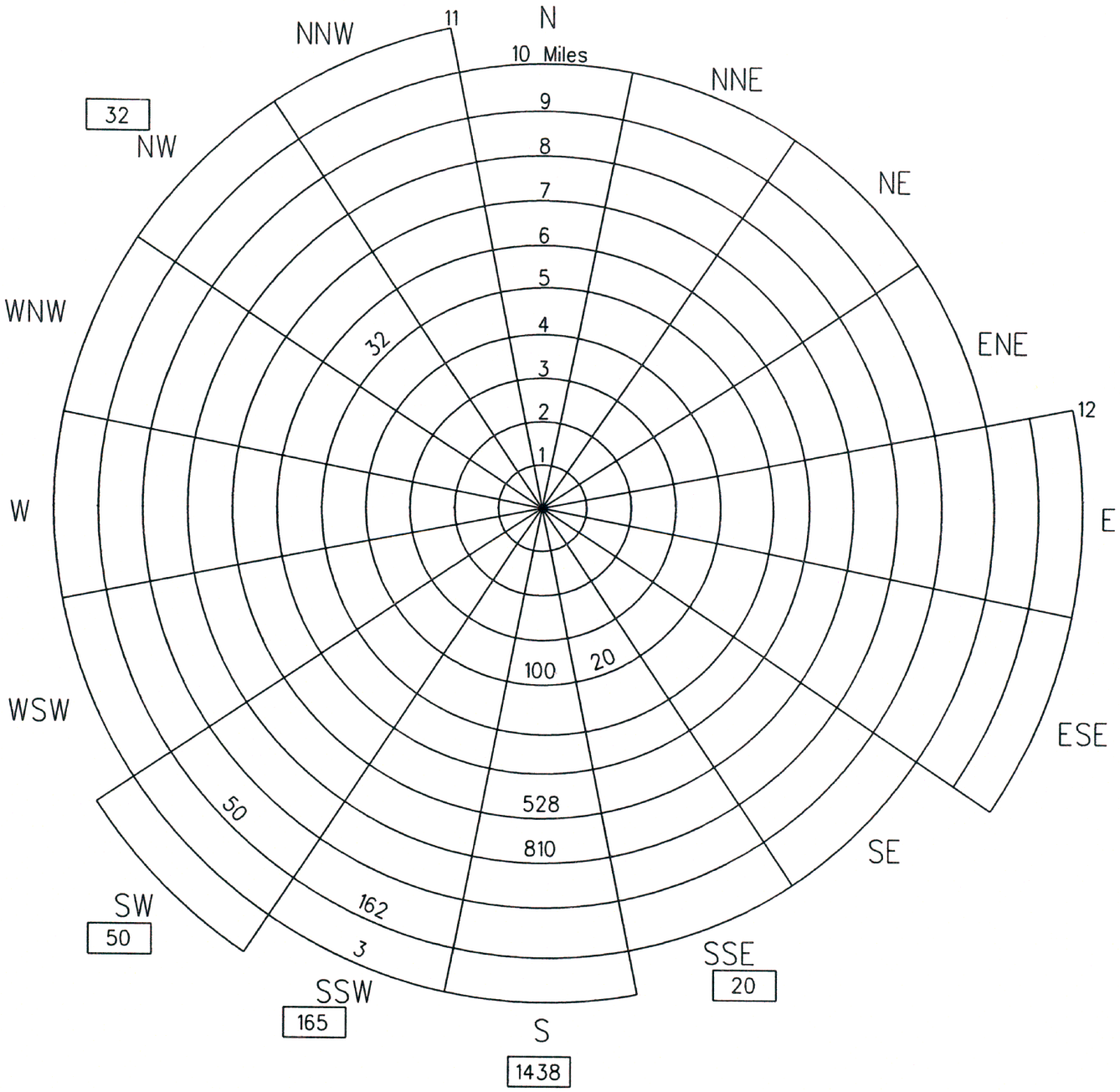



FIGURE B-5

WINTER NIGHT TIME SPECIAL/TRANSIENT
FACILITY POPULATION DISTRIBUTION
BY COMPASS SECTOR

POPULATION TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 120 | 1702 | 120 | 1582 | 1705 |

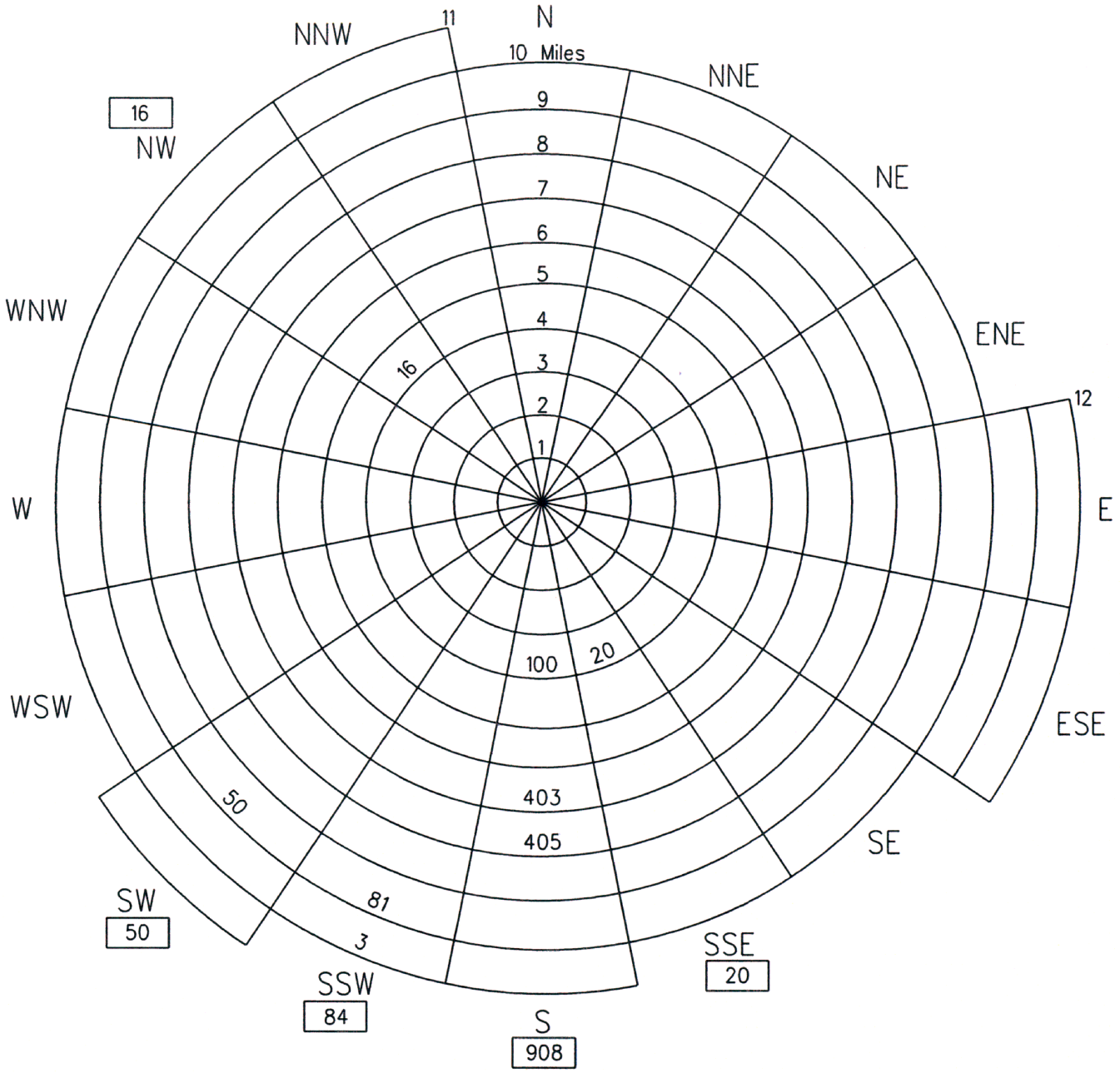



FIGURE B-6

WINTER NIGHT TIME SPECIAL/TRANSIENT
FACILITY VEHICLE DISTRIBUTION
BY COMPASS SECTOR

VEHICLE TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 136 | 1075 | 136 | 939 | 1078 |

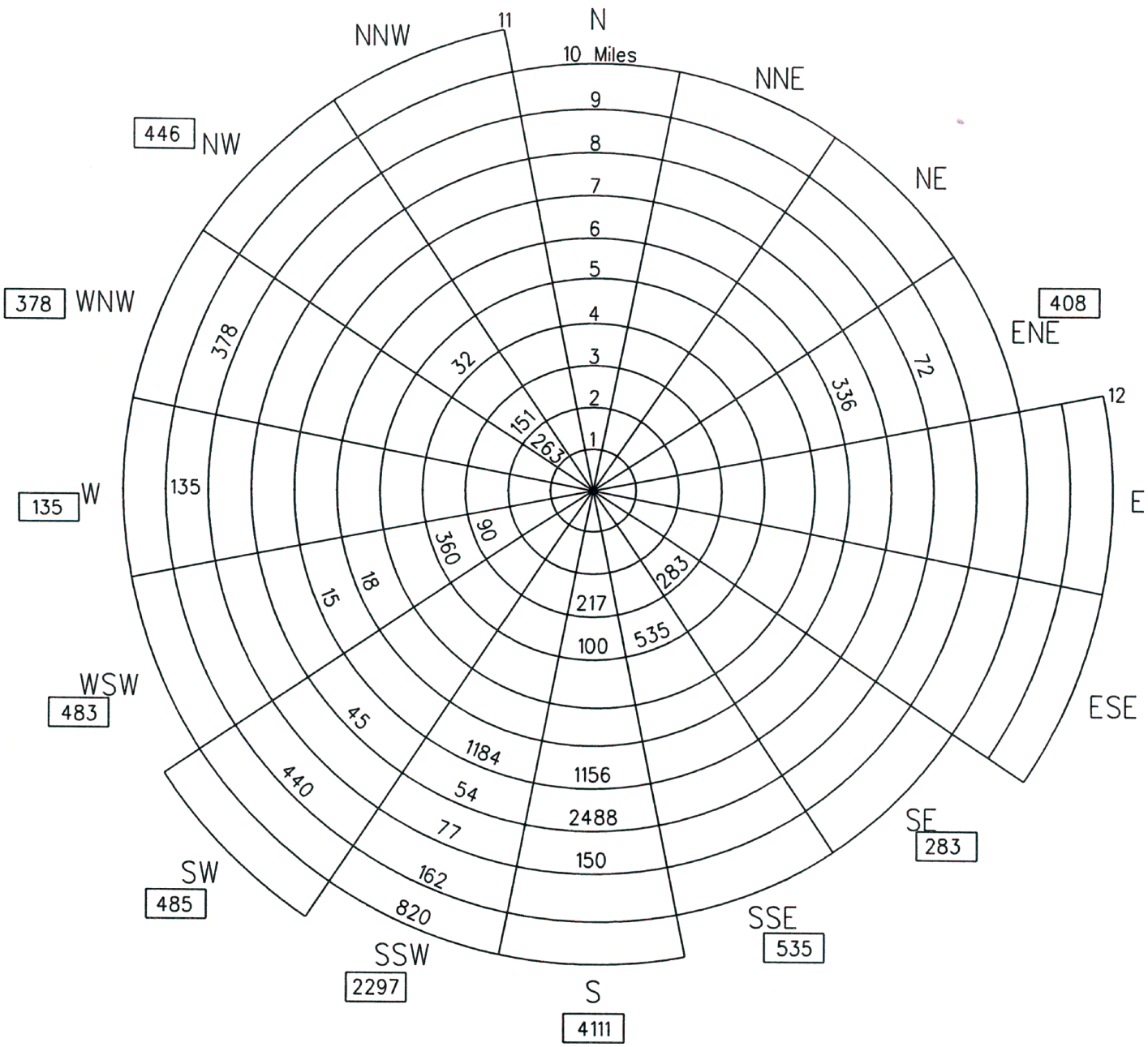



FIGURE B-7

SUMMER DAY TIME SPECIAL/TRANSIENT
FACILITY POPULATION DISTRIBUTION
BY COMPASS SECTOR

POPULATION TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 263 | 2031 | 8743 | 1768 | 6712 | 9563 |

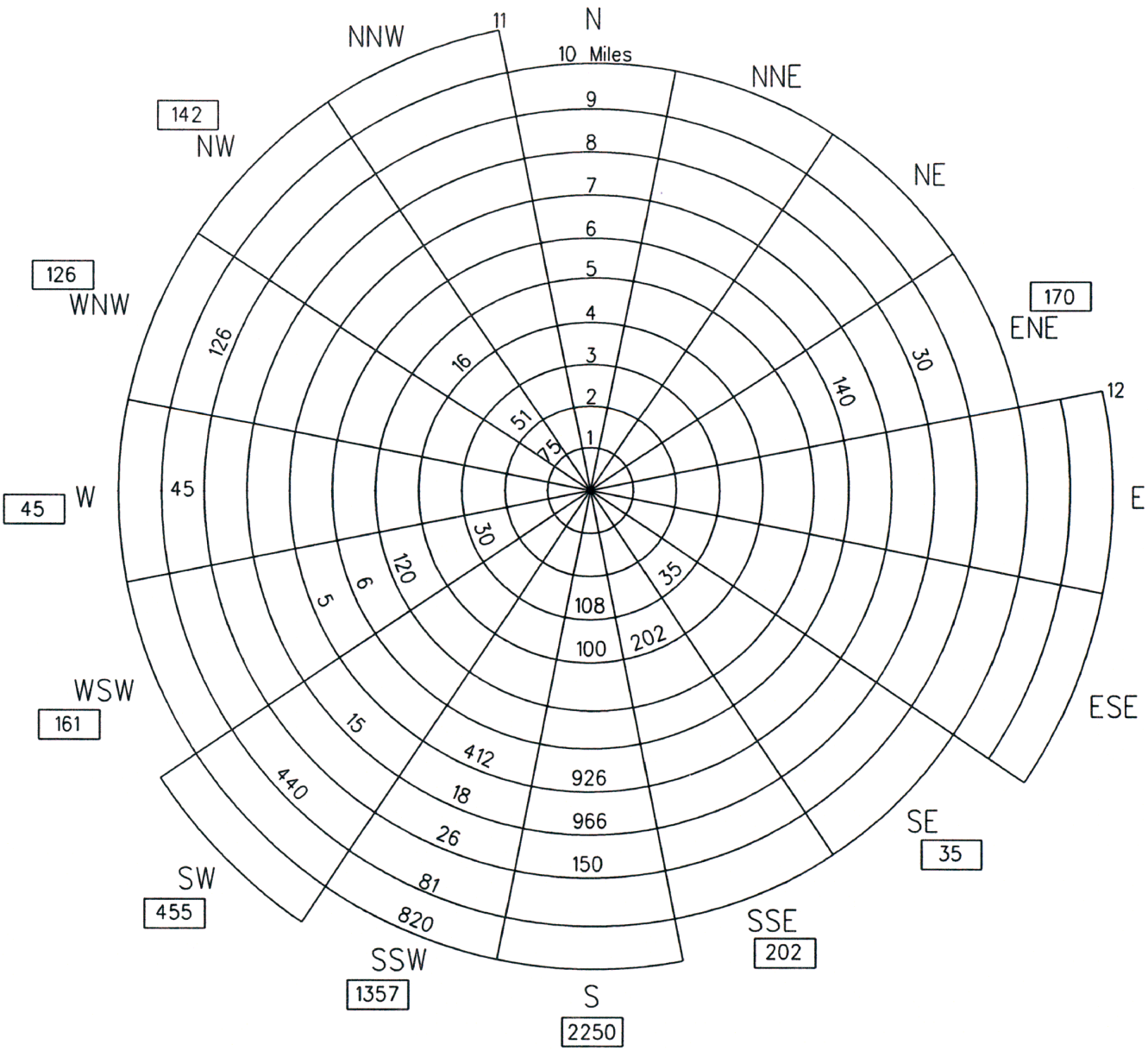



FIGURE B-8

SUMMER DAY TIME SPECIAL/TRANSIENT
FACILITY VEHICLE DISTRIBUTION
BY COMPASS SECTOR

VEHICLES TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 75 | 737 | 4123 | 662 | 3386 | 4943 |

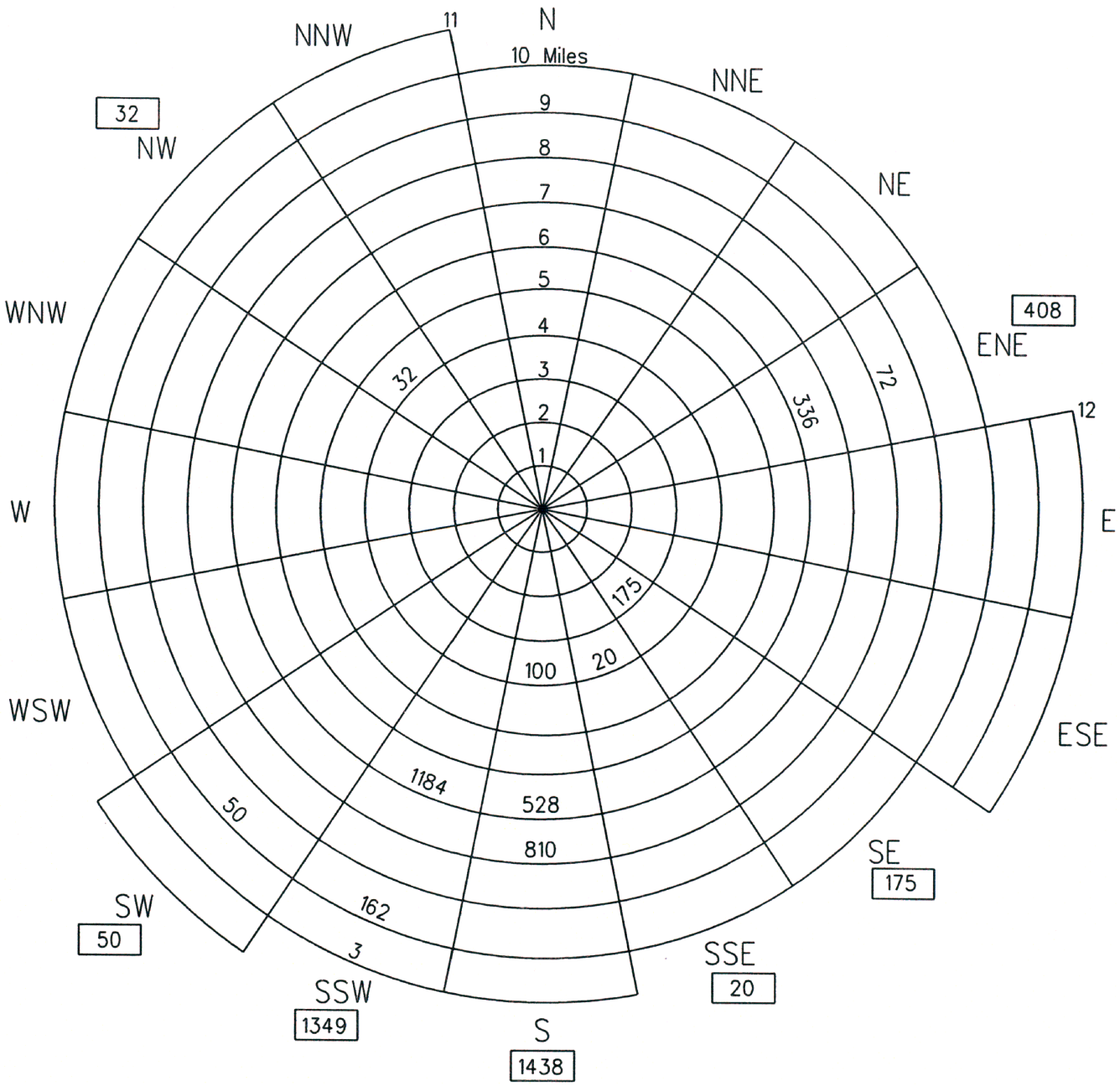



FIGURE B-9

SUMMER NIGHT TIME SPECIAL/TRANSIENT
FACILITY POPULATION DISTRIBUTION
BY COMPASS SECTOR

POPULATION TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 327 | 3469 | 327 | 3142 | 3472 |

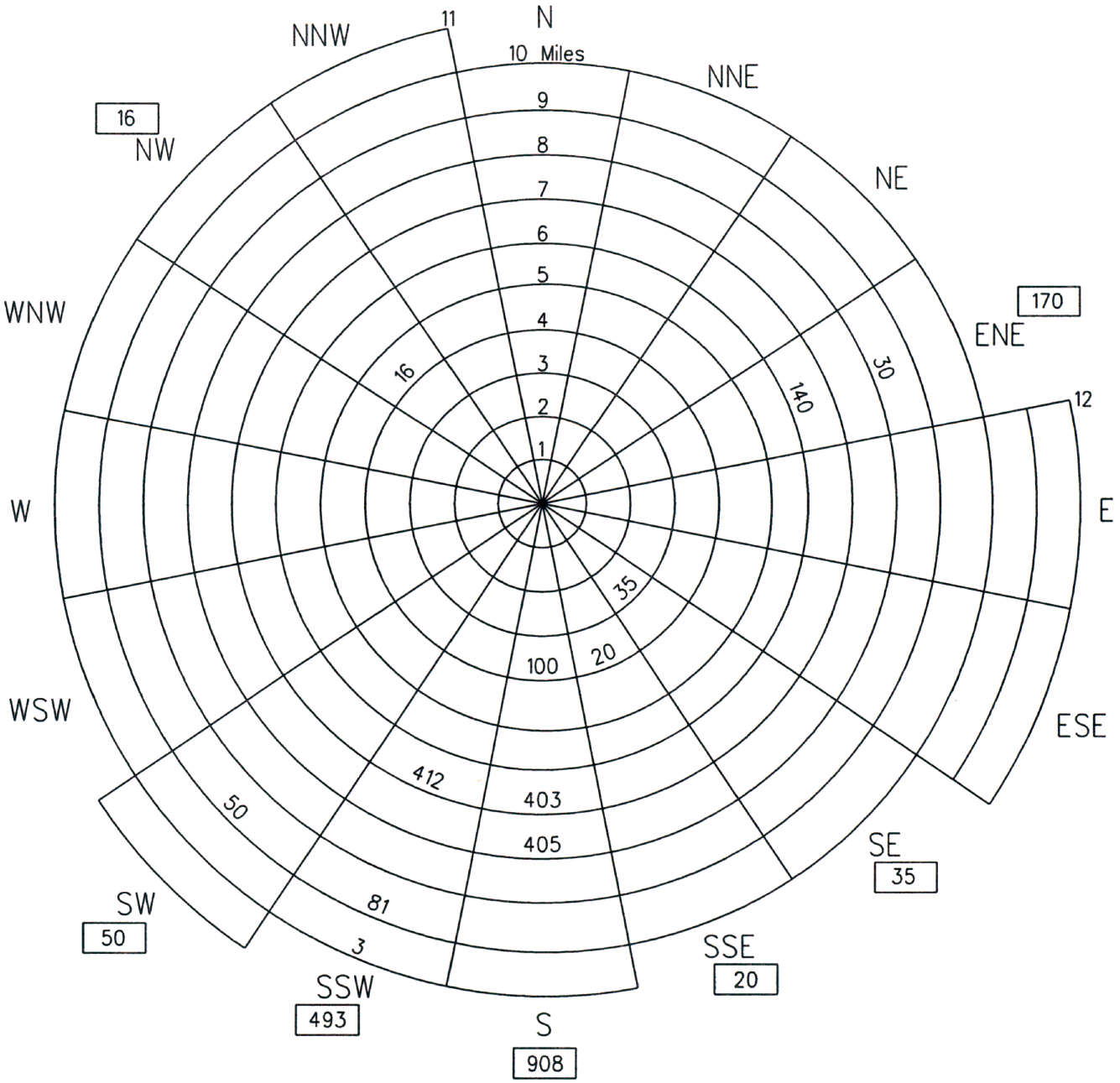


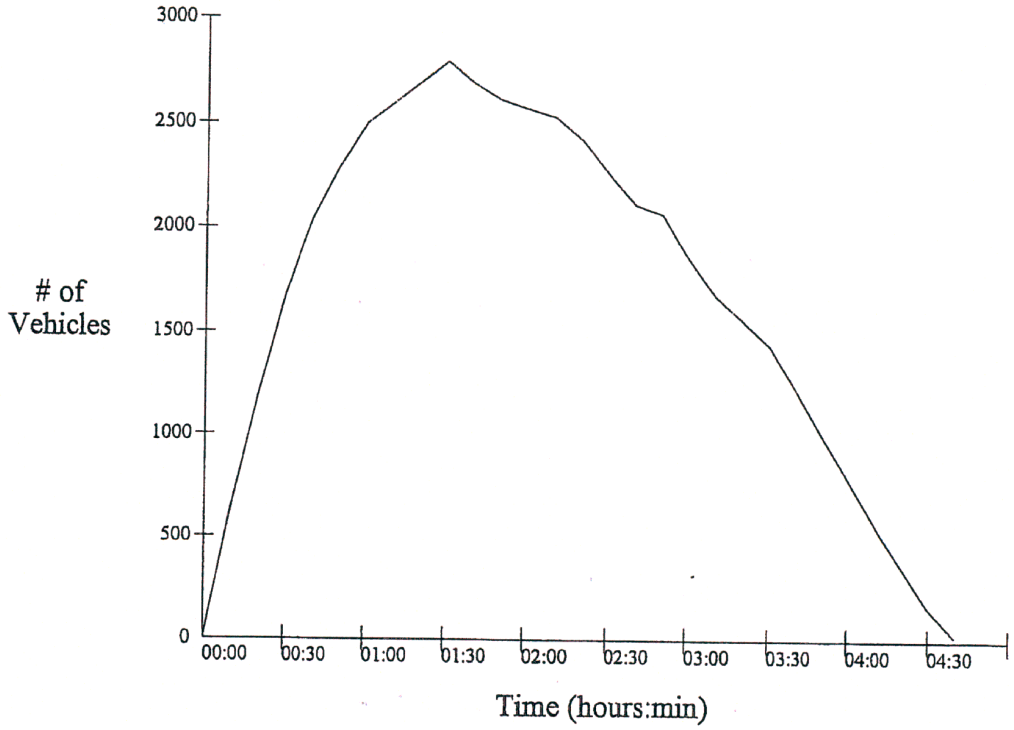

FIGURE B-10

SUMMER NIGHT TIME SPECIAL/TRANSIENT
FACILITY VEHICLE DISTRIBUTION
BY COMPASS SECTOR

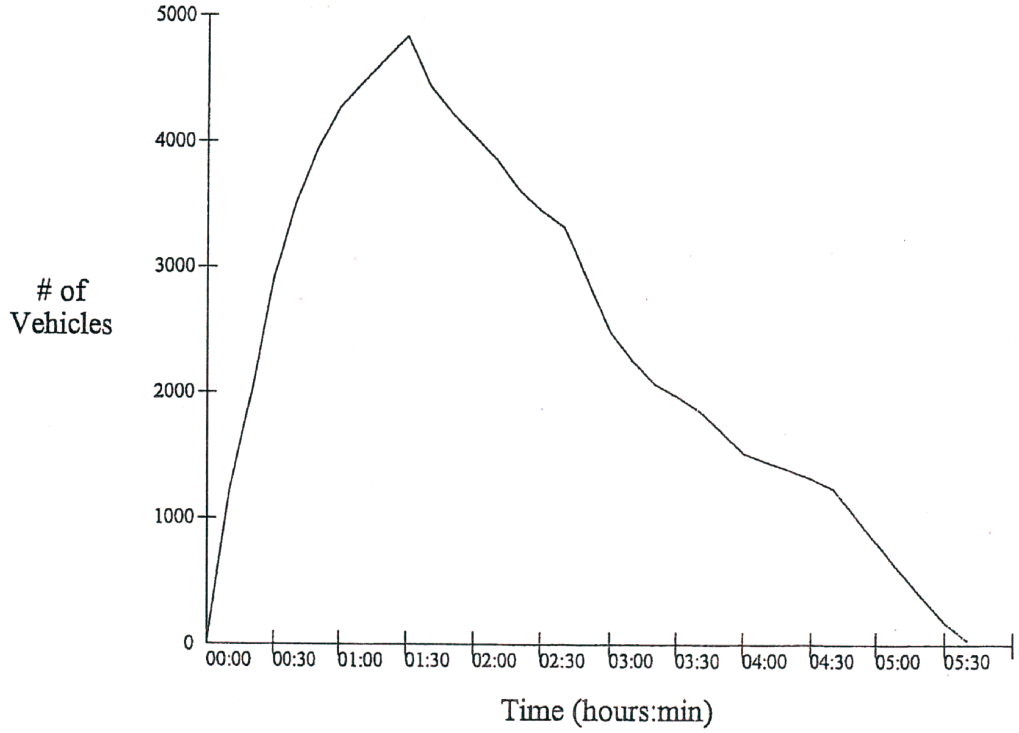
VEHICLES TOTALS

| 0-2 MILES | 0-5 MILES | 0-10 MILES | 2-5 MILES | 5-10 MILES | FULL EPZ |
|---|---|---|---|---|---|
| 0 | 171 | 1692 | 171 | 1521 | 1695 |

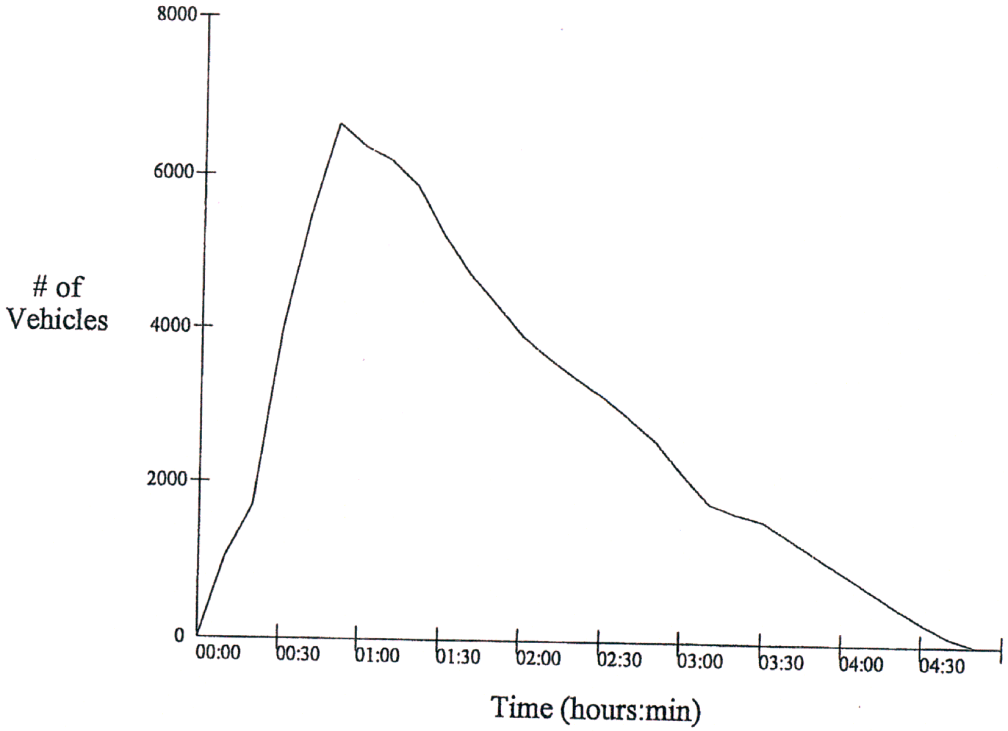
FIGURE B-11
VEHICLE DEPARTURES (PER TIME INTERVAL)– WINTER DAYTIME
NORMAL WEATHER



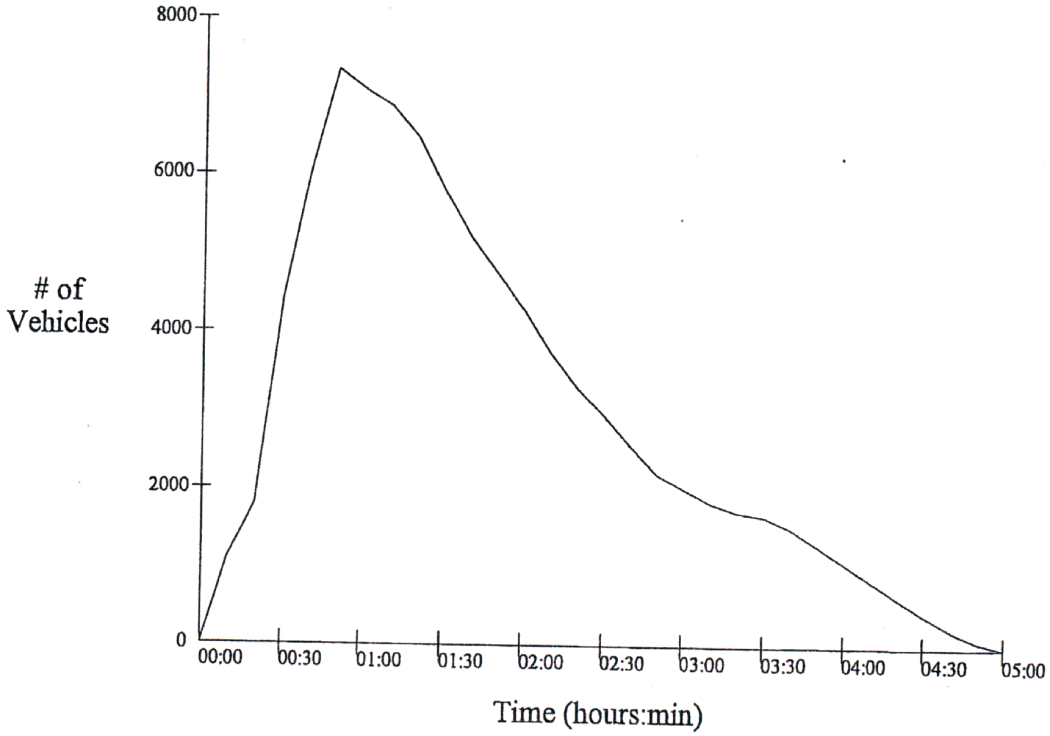

VEHICLE DEPARTURES (PER TIME INTERVAL)– SUMMER DAYTIME
NORMAL WEATHER



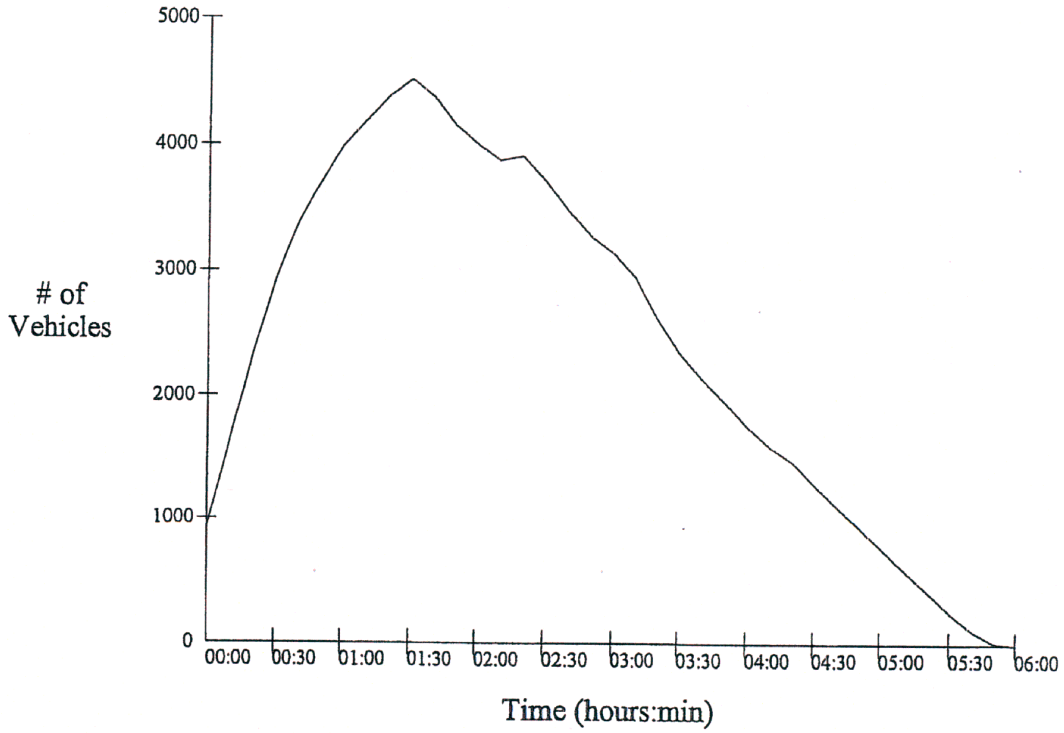
B-12
VEHICLE DEPARTURES (PER TIME INTERVAL)–WINTER NIGHTTIME
NORMAL WEATHER



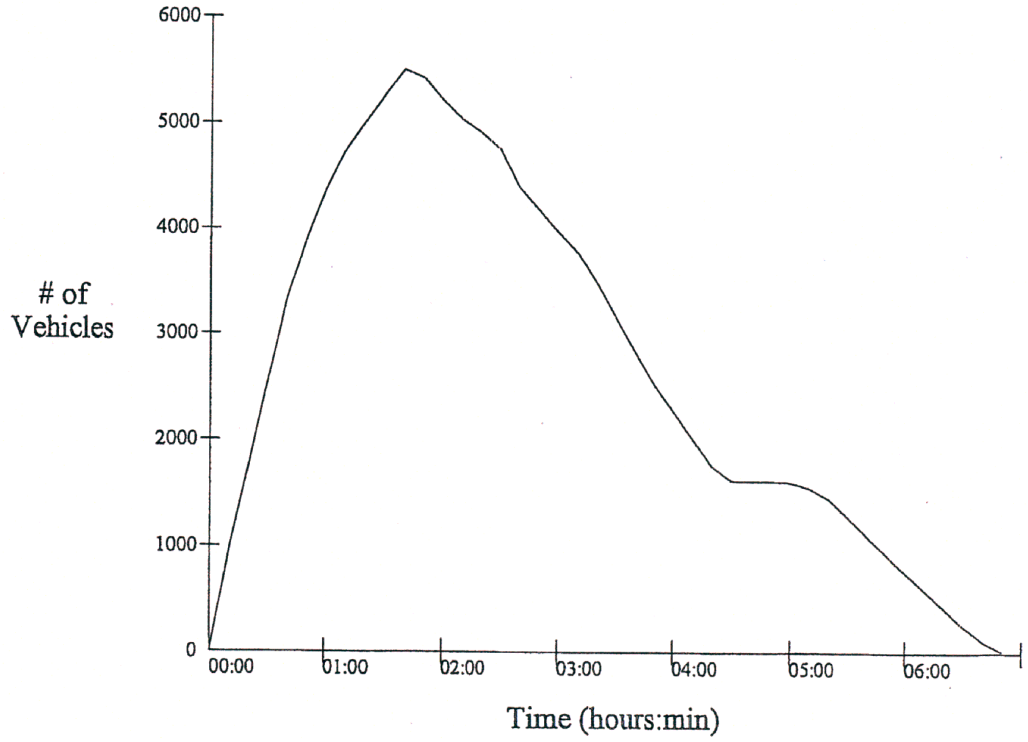

VEHICLE DEPARTURES (PER TIME INTERVAL)– SUMMER NIGHTTIME
NORMAL WEATHER



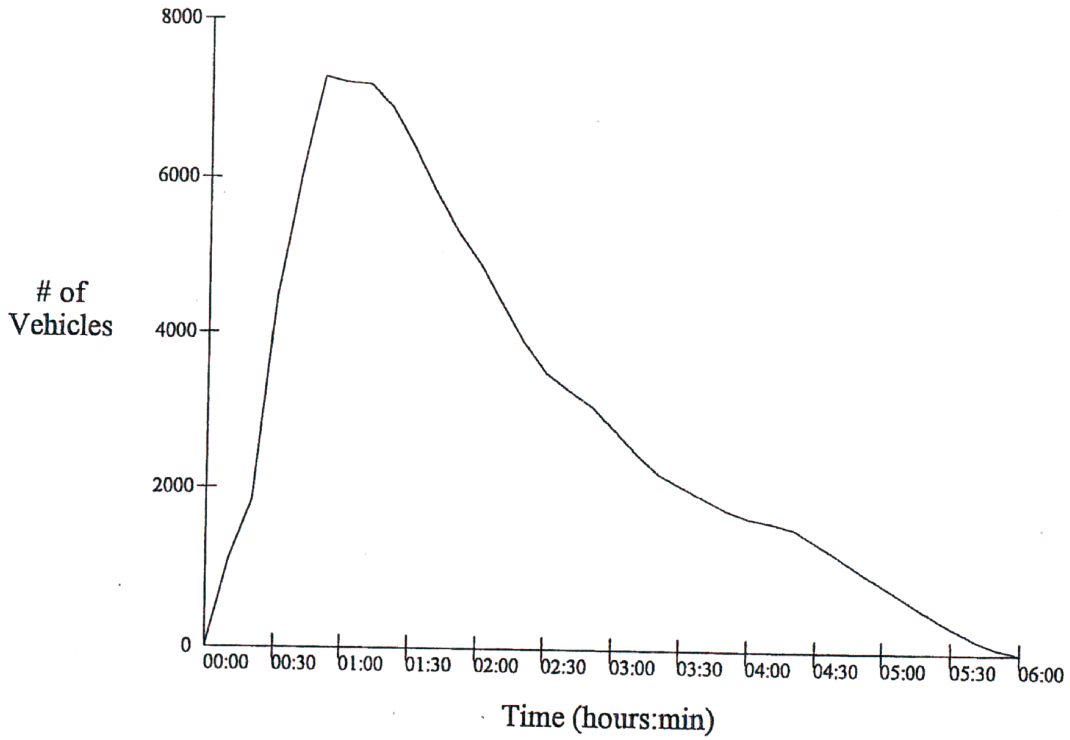
B-13
VEHICLE DEPARTURES (PER TIME INTERVAL)– WINTER DAYTIME
ADVERSE WEATHER




VEHICLE DEPARTURES (PER TIME INTERVAL)– SUMMER DAYTIME
ADVERSE WEATHER



B-14
VEHICLE DEPARTURES (PER TIME INTERVAL)–WINTER NIGHTTIME
ADVERSE WEATHER




VEHICLE DEPARTURES (PER TIME INTERVAL)– SUMMER NIGHTTIME
ADVERSE WEATHER

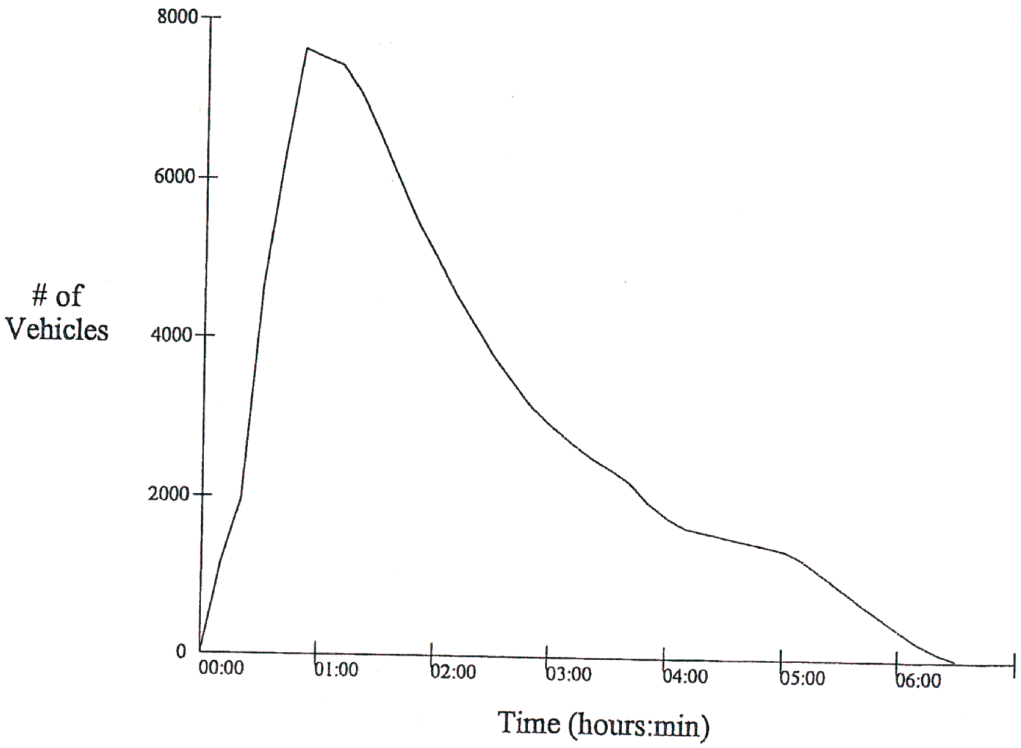
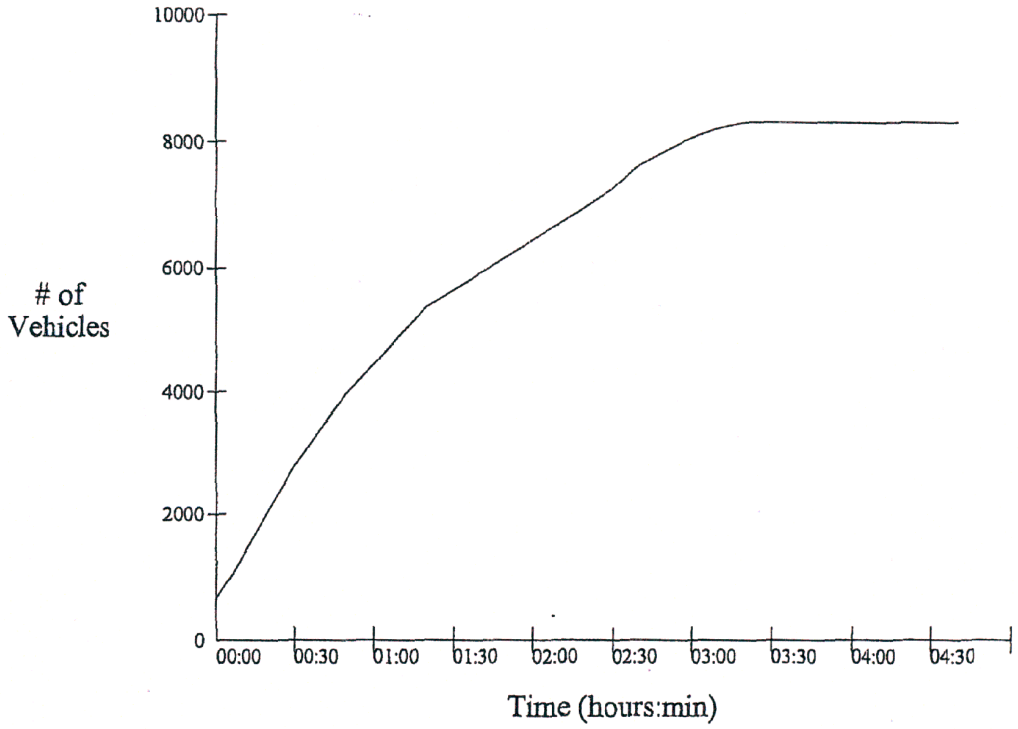
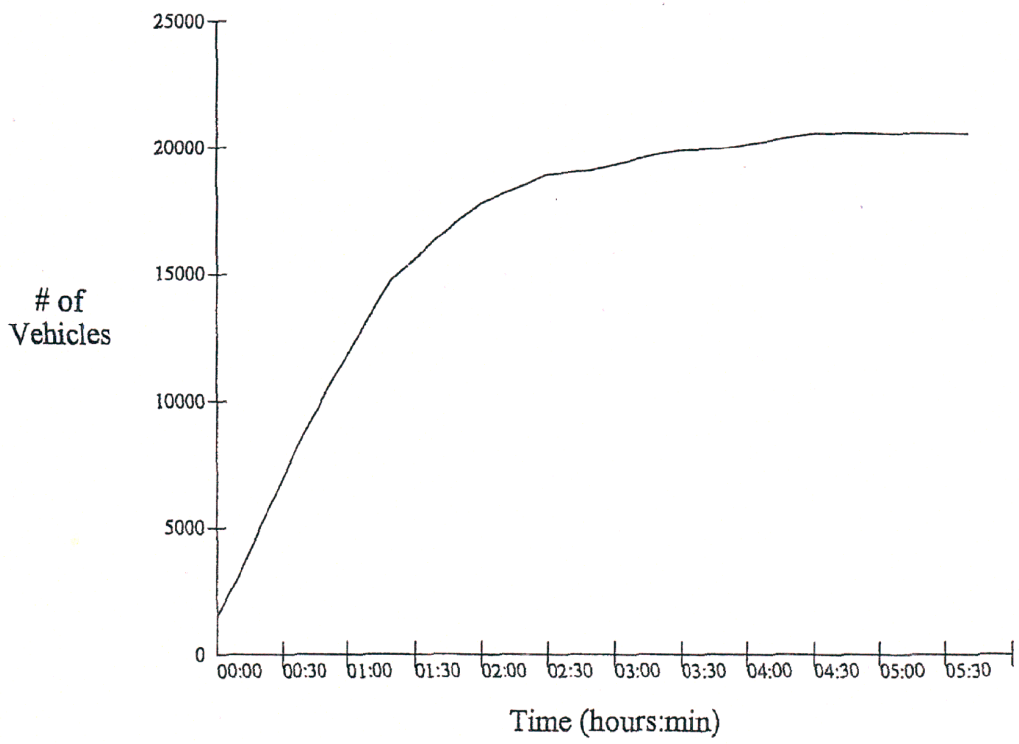


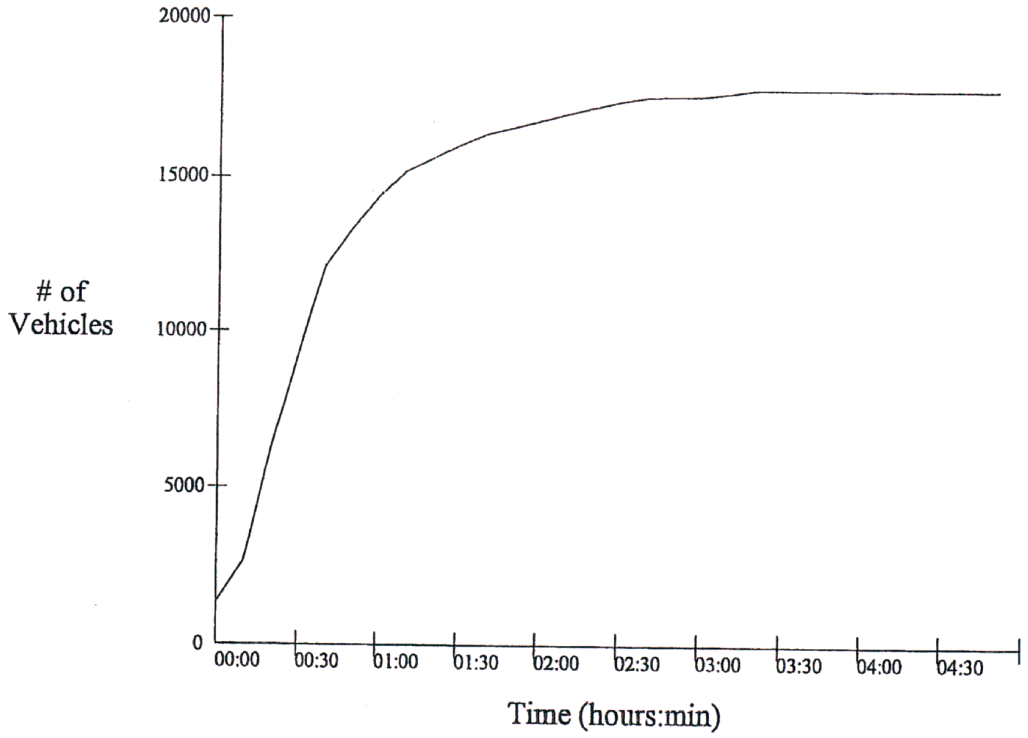
FIGURE B-15
VEHICLE DEPARTURES (ACCUMULATIVE)– WINTER DAYTIME
NORMAL WEATHER



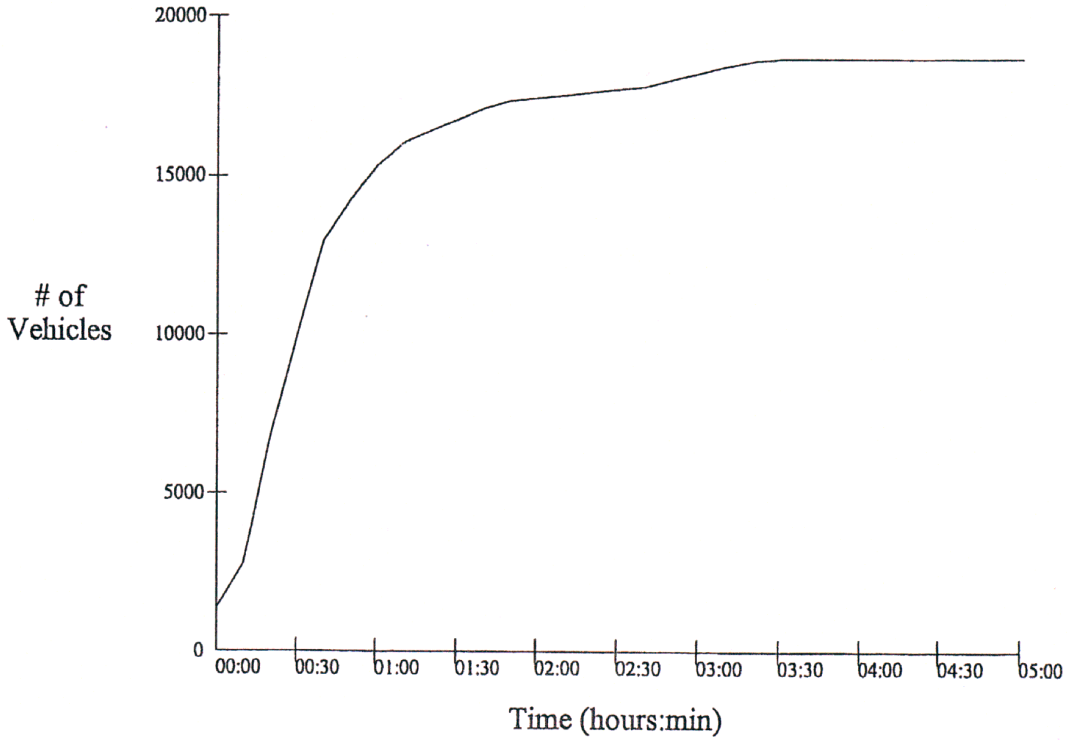

VEHICLE DEPARTURES (ACCUMULATIVE)– SUMMER DAYTIME
NORMAL WEATHER



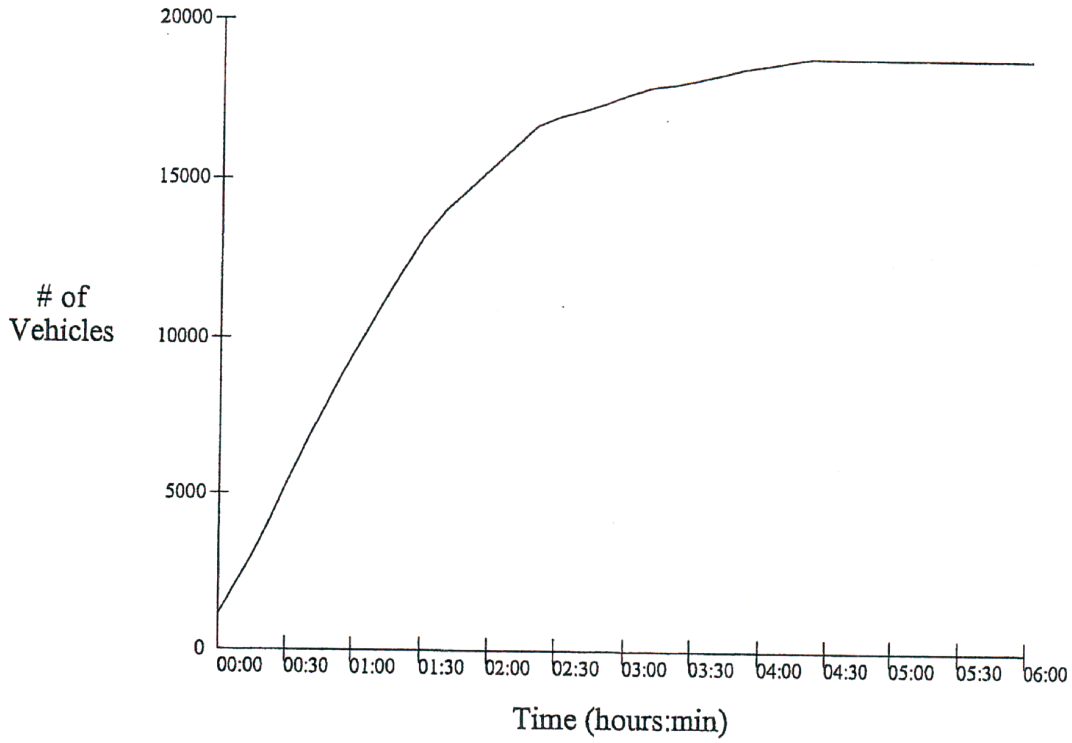
B-16
VEHICLE DEPARTURES (ACCUMULATIVE)–WINTER NIGHTTIME
NORMAL WEATHER



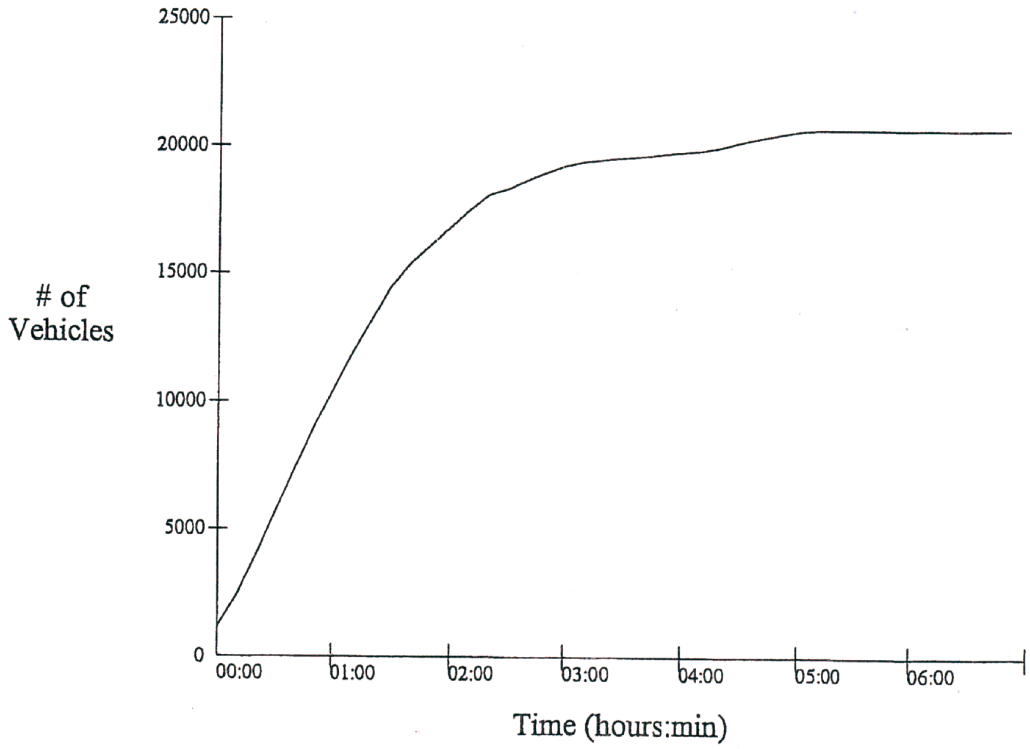

VEHICLE DEPARTURES (ACCUMULATIVE)– SUMMER NIGHTTIME
NORMAL WEATHER



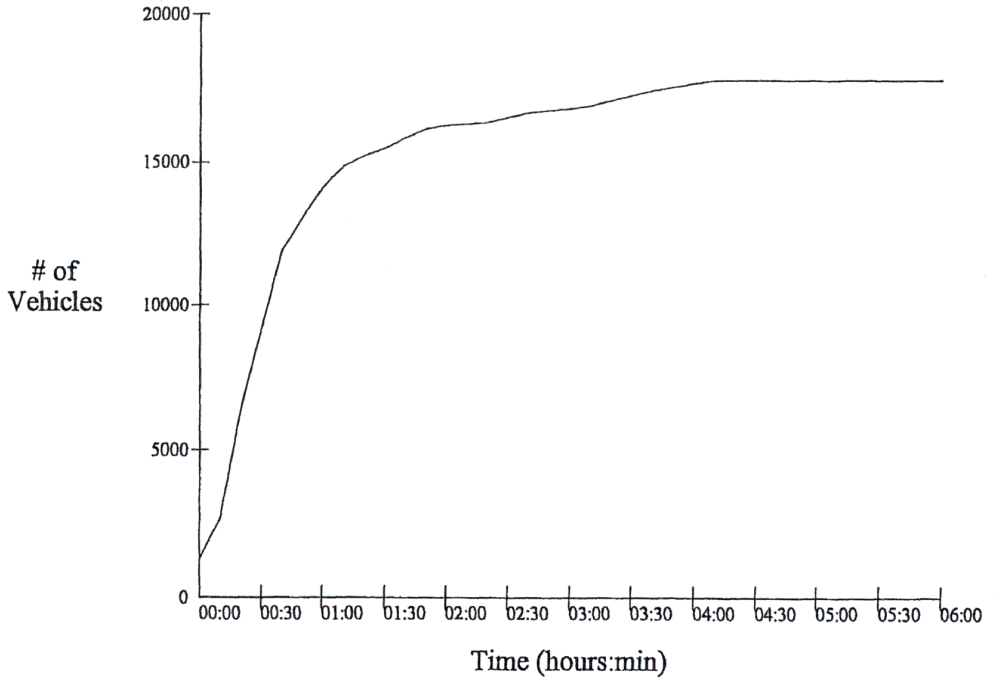
B-17
VEHICLE DEPARTURES (ACCUMULATIVE)– WINTER DAYTIME
ADVERSE WEATHER



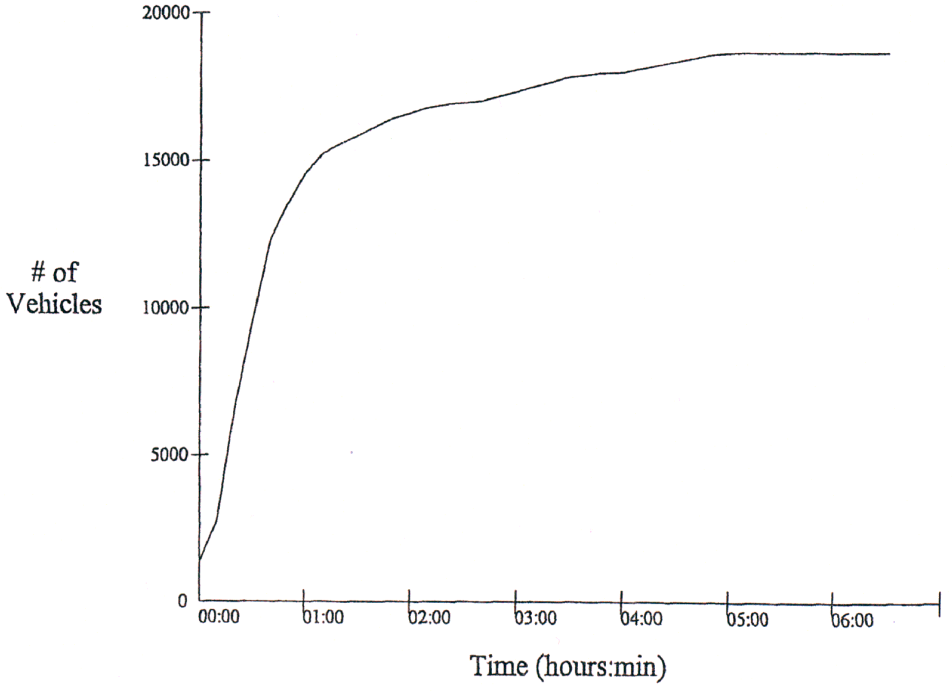

VEHICLE DEPARTURES (ACCUMULATIVE)– SUMMER DAYTIME
ADVERSE WEATHER



B-18
VEHICLE DEPARTURES (ACCUMULATIVE)–WINTER NIGHTTIME
ADVERSE WEATHER




VEHICLE DEPARTURES (ACCUMULATIVE)– SUMMER NIGHTTIME
ADVERSE WEATHER



APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**NORTH CALVERT**

| NODE | LOCATION |
|---|---|
| 600 | Mackall Rd. & Cape Leonard Dr. |
| 602 | Lloyd Bowen Rd. (beginning at Island Creek) |
| 604 | Mackall Rd. & Bowen Rd. |
| 606 | Mackall Rd. & Parran Rd. |
| 610 | Broomes Island Rd. & Church/Cemetery Rd. |
| 612 | Briscoe Rd. & Patuxent Dr. at end of Parkers Wharf Rd. |
| 614 | Williams Wharf Rd. & Quarles Rd. |
| 615 | Broomes Island Rd. & Parkers Wharf Rd. |
| 617 | Broomes Island Rd. & Williams Wharf Rd./Ross Rd. |
| 618 | Hance Rd. & Crane Rd. |
| 619 | Broomes Island Rd. & Hance Rd. |
| 620 | Broomes Island Rd. & Mackall Rd. |
| 621 | Adelina Rd. & Sheridan Point Rd. |
| 622 | Broomes Island Rd. & Ball Rd. |
| 624 | Broomes Island Rd. & Grays Rd. |
| 630 | Long Beach Rd. & Bayside Rd. |
| 632 | Calvert Beach Rd. & Bayview Rd. |
| 634 | Long Beach Rd. & Calvert Beach Rd. |
| 636 | *Rt. 765 & Calvert Beach Rd. |
| 638 | Rt. 765 & Western Shore Blvd. |
| 640 | Sixes Rd. (Rt. 506) & Grays Rd. |
| 642 | Adelina Rd. & Sixes Rd. |
| 645 | Hallowing Point Rd. & Sixes Rd. |
| 647 | Adelina Rd. & Hallowing Point Rd. |

* Traffic Signal

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**NORTH CALVERT**

**(CONTINUED)**

| NODE | LOCATION |
|---|---|
| 648 | Hallowing Point Rd. & German Chapel Rd. |
| 650 | Governors Run Rd. & Woodbridge Ave. |
| 652 | Rt. 765 & Governors Run Rd. |
| 654 | Scientists Cliffs Rd. & Aspen Rd. |
| 656 | Parkers Creek Rd. & Scientists Cliffs Rd. |
| 658 | Rt. 765 & Parkers Creek Rd. |
| 660 | Rt. 765 & Duke St. |
| 662 | Church St. & Rt. 765 |
| 664 | Fairground Rd. & Armory Rd. |
| 666 | Rt. 765 & Armory Rd. |
| 670 | Dares Beach Rd. & Chesapeake Avenue |
| 672 | Virginia St. & Chesapeake Ave. |
| 674 | Dares Beach Rd. & Virginia Ave./Goldstein Rd. |
| 676 | Dares Beach Rd. & Wilson Rd. |
| 678 | Dares Beach Rd. & Clay Hammond Rd. |
| 680 | *Armory Rd. & Dares Beach Rd. |

* Traffic Signal

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**SOUTH CALVERT**

| NODE | LOCATION |
|---|---|
| 500 | Solomons Island Rd. (Rt. 2) & Charles St. |
| 505 | U. S. Navy Recreation Center north entrance (Rt. 2/4) |
| 507 | Beginning of Dowell Rd.(Calvert Marina) |
| 509 | Rt. 4 Monticello Dr. |
| 510 | Drumpoint end of Rousby Hall Rd. |
| 512 | Rousby Hall Rd. & Barreda Blvd./Harbor Drive |
| 516 | Cherry Hill Area & Olivet Rd. |
| 518 | Rousby Hall Rd. & Olivet Rd. |
| 515 | Rousby Hall Rd. & Club House Dr. |
| 520 | Coster Rd. & Tongue Cove |
| 522 | Coster Rd. & Mill Bridge Rd. |
| 530 | Turner Rd. at Parran Point |
| 531 | Mill Bridge Rd. & Turner Rd. |
| 532 | Beginning of Sollers Wharf Rd. |
| 534 | Sollers Wharf Rd. & McQueen Rd. |
| 535 | Sollers Wharf Rd. & Mill Bridge Rd. |
| 536 | *Rt. 765 & Rousby Hall Rd. |
| 537 | *Rt. 765 & Town Square Dr. |
| 540 | Tomahawk Tr. & Little Cove Point Rd. |
| 541 | Cove Point Rd. & Lighthouse Blvd. |
| 542 | Cove Point Rd. & Little Cove Point Rd. |
| 543 | *Rt. 765 & Cove Point Rd. |
| 544 | Rt. 765 & Camp Canoy Rd. |
| 550 | White Sands Dr. at St. Leonard Creek |
| 560 | CCNPP Entrance at Main Gate |

* Traffic Signal

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**ROUTE 2/4**

| NODE | LOCATION |
|---|---|
| 412 | Solomons Island Rd. (Rt. 2) & Rt. 4 (north end of Thomas Johnson Bridge) |
| 415 | Rt. 2/4 & U.S. Navy Rec. Center south entrance |
| 416 | *Rt. 2/4 & Patuxent Point Parkway |
| 419 | Rt. 2/4 Monticello Dr. |
| 421 | Rt. 2/4 & Dowell Rd. |
| 423 | Rt. 2/4 & Coster Rd. & Mill Bridge Rd. |
| 425 | *Rt. 2/4 & Rousby Hall Rd. |
| 430 | Rt. 2/4 & Cove Point Rd. |
| 433 | Rt. 2/4 & Sollers Wharf Rd. |
| 436 | Rt. 2/4 & White Sands Dr. |
| 439 | *Rt. 2/4 & Calvert Cliffs Parkway (CCNPP Entrance) |
| 440 | Rt. 2/4 & Flag Ponds Parkway |
| 442 | Rt. 2/4 & Parran Rd. |
| 445 | *Rt. 2/4 & Calvert Beach Rd. |
| 448 | Rt. 2/4 & Western Shore Blvd. |
| 450 | Rt. 2/4 & Governors Run Rd. |
| 453 | Rt. 2/4 & Parkers Creek Rd. |
| 455 | *Rt. 2/4 & Broomes Island Rd. |
| 460 | Rt. 2/4 & Sixes Rd. |
| 465 | Rt. 2/4 & German Chapel Rd |
| 470 | *Rt. 2/4 & Hallowing Point Rd. (Rt. 231) |
| 475 | *Rt. 2/4 & Dares Beach Road & Rt. 765 |

* Traffic Signal

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**ST. MARY'S**

| NODE | LOCATION |
|---|---|
| 301 | Lake Dr. & Esperanza Dr. |
| 303 | Millstone Landing Rd. & Lake Dr. |
| 305 | Town Creek Drive & Sunrise Rd. |
| 306 | Shady Mile Drive. & Baringer Dr. |
| 310 | Rt. 4 & Kingston Creek Rd. |
| 311 | Mill Cove Rd. & Myrtle Point Rd. |
| 312 | Rt. 4 & Patuxent Beach Rd. |
| 313 | Patuxent Lane & Patuxent Beach Rd |
| 315 | Wildewood Blvd. & Wildewood Parkway |
| 316 | St. Johns Rd. & Lawrence Hayden Rd. |
| 323 | Clarks Mill Rd. & Mervell Dean Rd. |
| 324 | Clarks Mill Rd. & Nalley Rd. |
| 325 | Clarks Landing Rd. & Mervell Dean Rd. |
| 326 | Clarks Landing Rd. & Scotch Neck Rd. |
| 327 | Clarks Landing Rd. & Blackstone Rd. |
| 328 | Scotch Neck Rd. |
| 329 | Clarks Landing Rd. |
| 330 | Joy Chapel Rd. & Mervell Dean Rd. |
| 331 | Joy Chapel Rd. |
| 332 | St. Johns Rd. & Rt. 235 north access |
| 335 | Sotterly Rd. (Rt. 245) & Old Three Notch Rd. |
| 336 | Sotterly Rd. (Rt. 245) & Forest Landing Rd. |
| 337 | Forest Landing Rd. & Three Coves Rd. |
| 338 | Steerhorn Neck Rd. & Sotterly Rd. |
| 339 | Steerhorn Neck Rd. & Half Pone Pt. Rd. |
| 340 | Old Three Notch Rd. & Vista Rd. |
| 341 | Vista Rd. & Sotterly Rd. (245) |
| 343 | Sotterly Rd.(245) (at St Thomas Creek) |
| 350 | Clover Hill Rd. & McIntosh Rd. |

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**ST. MARY'S**

| NODE | LOCATION |
|---|---|
| 351 | Clover Hill Rd. & Sandgates Rd. (Rt. 472). |
| 352 | Jones Wharf Rd. & Drum Cliff Rd. |
| 353 | Drum Cliff Rd. at Captains Point |
| 354 | Hollywood Shores Area onto Jones Wharf Rd. |
| 360 | Sandgates Rd. & Della Brook Lane |
| 365 | Sandgates Rd. (472) & Ridge Rd. |
| 367 | Sandgates Rd. (472) & Holly Lane Rd. |

**ROUTE 235**

| NODE | LOCATION |
|---|---|
| 220 | Rt. 235 & Millstone Landing Rd. |
| 225 | *Rt. 235 & Chancellors Run Rd. |
| 230 | *Rt. 235 & Town Creek Drive |
| 235 | *Rt. 235 & Shady Mile Dr. |
| 240 | *Rt. 235 & Rt. 4/St. Andrews Church Rd. |
| 245 | St. Andrews Church & Wildewood - South |
| 250 | *Rt. 235 & Wildewood - North |
| 255 | Rt. 235 & Clarks Landing Rd. |
| 260 | Rt. 235 & St. Johns Rd. south access |
| 265 | Rt. 235 & Sotterly Rd. (245) /Hollywood Rd. |
| 270 | Rt. 235 & Old Three Notch Rd. |
| 275 | Rt. 235 & Jones Wharf Rd. |
| 280 | Rt. 235 & Sandgates Rd. (Rt. 472) south |
| 285 | Rt. 235 & Sandgates Rd. (Rt. 472) north |

Note: Traffic lights that control access to and from local shopping only have not been added.

* Traffic
Signal

APPENDIX C

**EVACUATION NETWORK NODE IDENTIFICATION**

**DORCHESTER**

| NODE | LOCATION |
|---|---|
| 131 | Meekins Neck Rd. & Hooper Island Rd. |
| 132 | Smithville Rd. & Hooper Island Rd. |
| 133 | Smithville Rd. Hip Roof Rd. |
| 134 | Hooper Neck Rd. & Bay Shore Rd. |
| 135 | Taylors Island Rd./Hooper Neck Rd. & Robinson Neck Rd. |
| 136 | Taylors Island Rd. & Smithville Rd. |
| 137 | Taylors Island Rd. - east end of Bridge |
| 138 | Smithville Rd. & Miller Court |
| 139 | Smithville Rd at the South end of Smithville Bridge. |
| 800 | Taylors Island Rd. at Parsons Creek |

# APPENDIX D

## KEY TO NETVAC2 COMPUTER PRINTOUT

| | | |
|---|---|---|
| Description | = | Link identification number |
| A-Node | = | Upstream node number (A-node) for associated link |
| B-Node | = | Downstream node number of (B-node) for associated link |
| Link Length | = | Link length in feet (A-node to B-node) |
| Approach Width | = | Lane width for associated link at the downstream node number (B-node) |
| Lane Width | = | Link lane width |
| Later Clearance | = | Lateral clearance = Distance from edge of travel-way to obstructions along link midblock |
| Number of Lanes | = | Number of lanes in direction of travel |
| Priority (Pri) | = | Priority of movement along link, in reference to movement along intersecting links. Dominant or major link approaches are classified as Priority 1. Secondary (i.e., those link approaches controlled by stop signs, yield signs, etc.) approaches are generally classified as Priority 2. |
| Roadway Type | = | Lane type, classified as follows: |

| | | |
|---|---|---|
| 1 | - | One-way, no parking |
| 2 | - | One-way, no parking on 1 side |
| 3 | - | One-way, parking on 2 sides |
| 4 | - | Two-way, no parking |
| 5 | - | Two-way, with parking |
| 6 | - | Rural divided highway, no parking |
| 7 | - | Rural undivided highway, no parking |
| 8 | - | Freeways and expressways |

**KEY TO NETVAC2 COMPUTER PRINTOUT (continued)**

| | | |
|---|---|---|
| Area Type | = | Area type, classified as follows:<br>1 - Central business district<br>2 - Fringe<br>3 - Outer business district<br>4 - Residential |
| Free Flow Speed | = | Free-flow speed over link |
| Straight, Right, Left, Diagonal Movement | = | Identifies destination node when travel is straight, right, left or diagonal upon reaching the B-Node<br>Note: Diagonal not used. |

## Roadway Link and Node Characteristics

| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link 1 | 480 | 812 | 2500.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 45.0 | 0 | 0 | 0 |
| Link 2 | 645 | 813 | 2500.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 45.0 | 0 | 0 | 0 |
| Link 3 | 439 | 440 | 4750.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 442 | 0 | 0 |
| Link 3a | 440 | 442 | 4750.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 445 | 0 | 0 |
| Link 4 | 439 | 436 | 3200.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 433 | 0 | 0 |
| Link 5 | 436 | 439 | 3200.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 440 | 0 | 0 |
| Link 6 | 436 | 433 | 7900.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 430 | 0 | 0 |
| Link 7 | 433 | 436 | 7900.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 439 | 0 | 0 |
| Link 8 | 433 | 430 | 9000.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 425 | 0 | 0 |
| Link 9 | 430 | 433 | 9000.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 436 | 0 | 0 |
| Link 10 | 430 | 425 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 423 | 0 | 0 |
| Link 11 | 425 | 430 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 433 | 0 | 0 |
| Link 12 | 425 | 423 | 2100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 421 | 0 | 0 |
| Link 13 | 423 | 425 | 2100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 430 | 0 | 0 |
| Link 14 | 423 | 421 | 7400.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 419 | 0 | 0 |
| Link 15 | 421 | 423 | 7400.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 425 | 0 | 0 |
| Link 16 | 421 | 419 | 1600.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 416 | 0 | 0 |
| Link 17 | 419 | 421 | 1600.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 423 | 0 | 0 |
| Link 18 | 419 | 416 | 580.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 415 | 0 | 0 |
| Link 18a | 416 | 419 | 580.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 421 | 0 | 0 |
| Link 19 | 415 | 416 | 1520.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 419 | 0 | 0 |
| Link 19a | 416 | 415 | 1520.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 412 | 0 | 0 |
| Link 20 | 415 | 412 | 1050.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 312 | 0 | 0 |
| Link 21 | 412 | 415 | 1050.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 416 | 0 | 0 |
| Link 22 | 412 | 312 | 11100.0 | 12.0 | 12.0 | 6.0 | 1 | 1 | 7 | 4 | 55.0 | 310 | 0 | 0 |
| Link 23 | 442 | 445 | 9000.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 448 | 0 | 0 |
| Link 24 | 445 | 448 | 7900.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 450 | 0 | 0 |
| Link 25 | 448 | 450 | 3200.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 453 | 0 | 0 |
| Link 26 | 450 | 453 | 2400.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 455 | 0 | 0 |
| Link 27 | 453 | 455 | 2100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 460 | 0 | 0 |
| Link 28 | 455 | 460 | 8700.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 465 | 0 | 0 |
| Link 29 | 460 | 465 | 1300.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 470 | 0 | 0 |

| Roadway Link and Node Characteristics | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
| Link 30 | 465 | 470 | 11100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 475 | 0 | 648 |
| Link 31 | 470 | 475 | 3700.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 480 | 0 | 0 |
| Link 32 | 475 | 480 | 1600.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 7 | 4 | 55.0 | 812 | 0 | 0 |
| Link 33 | 610 | 615 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 617 | 0 | 0 |
| Link 34 | 612 | 615 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 617 |
| Link 35 | 615 | 617 | 1050.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 619 | 0 | 0 |
| Link 36 | 614 | 617 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 619 |
| Link 37 | 617 | 619 | 5800.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 620 | 0 | 0 |
| Link 38 | 618 | 619 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 620 |
| Link 39 | 619 | 620 | 3200.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 5 | 4 | 50.0 | 622 | 0 | 0 |
| Link 40 | 602 | 604 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 606 |
| Link 41 | 600 | 604 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 606 | 0 | 0 |
| Link 42 | 604 | 606 | 2100.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 620 | 0 | 0 |
| Link 43 | 606 | 620 | 16500.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 622 | 0 |
| Link 44 | 620 | 622 | 1300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 624 | 0 | 0 |
| Link 45 | 622 | 624 | 1600.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 455 | 0 | 640 |
| Link 46 | 445 | 622 | 12150.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 624 | 0 |
| Link 47 | 624 | 455 | 9000.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 460 |
| Link 48 | 624 | 640 | 16900.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 642 |
| Link 49 | 460 | 640 | 10000.0 | 11.0 | 11.0 | 3.0 | 2 | 1 | 4 | 4 | 40.0 | 642 | 0 | 0 |
| Link 50 | 640 | 642 | 10000.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 25.0 | 645 | 647 | 0 |
| Link 51 | 621 | 642 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 647 | 0 | 645 |
| Link 52 | 642 | 645 | 9500.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 813 |
| Link 53 | 642 | 647 | 6300.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 648 | 645 |
| Link 54 | 647 | 645 | 6300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 813 | 0 | 0 |
| Link 55 | 647 | 648 | 5280.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 470 | 0 | 0 |
| Link 56 | 648 | 647 | 5280.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 645 | 0 | 0 |
| Link 57 | 465 | 648 | 16350.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 470 | 647 |
| Link 58 | 648 | 470 | 9500.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 0 | 0 | 475 |
| Link 59 | 470 | 648 | 9500.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 647 | 0 | 0 |

| Roadway Link and Node Characteristics | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
| Link 60 | 660 | 662 | 300.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 1 | 25.0 | 470 | 666 | 0 |
| Link 61 | 662 | 470 | 300.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 5 | 1 | 25.0 | 648 | 475 | 0 |
| Link 62 | 662 | 666 | 1500.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 5 | 1 | 25.0 | 0 | 0 | 475 |
| Link 63 | 664 | 666 | 300.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 25.0 | 475 | 0 | 0 |
| Link 64 | 666 | 475 | 1500.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 25.0 | 480 | 0 | 0 |
| Link 65 | 670 | 674 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 25.0 | 676 | 0 | 0 |
| Link 66 | 672 | 674 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 25.0 | 676 | 0 | 0 |
| Link 67 | 674 | 676 | 6000.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 678 | 0 | 0 |
| Link 68 | 676 | 678 | 4750.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 680 | 0 | 0 |
| Link 69 | 678 | 680 | 6200.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 475 | 0 | 0 |
| Link 70 | 680 | 475 | 1320.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 1 | 40.0 | 0 | 480 | 0 |
| Link 71 | 630 | 634 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 636 |
| Link 72 | 632 | 634 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 636 | 0 | 0 |
| Link 73 | 634 | 636 | 2500.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 445 | 638 | 0 |
| Link 74 | 636 | 445 | 1000.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 30.0 | 622 | 448 | 0 |
| Link 75 | 636 | 638 | 6300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 40.0 | 652 | 0 | 448 |
| Link 76 | 638 | 448 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 450 | 0 |
| Link 77 | 638 | 652 | 3200.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 40.0 | 658 | 0 | 450 |
| Link 78 | 650 | 652 | 2500.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 450 | 658 | 0 |
| Link 79 | 652 | 450 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 453 | 0 |
| Link 80 | 652 | 658 | 3200.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 40.0 | 453 | 455 | 0 |
| Link 81 | 654 | 656 | 3200.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 658 | 0 | 0 |
| Link 82 | 656 | 658 | 1850.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 453 | 455 | 0 |
| Link 83 | 658 | 453 | 1050.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 455 | 0 |
| Link 84 | 658 | 455 | 2100.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 460 | 0 |
| Link 85 | 560 | 439 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 440 | 436 |
| Link 86 | 550 | 436 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 433 | 439 |
| Link 87 | 544 | 433 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 436 | 430 |
| Link 88 | 532 | 535 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 0 | 531 | 534 |
| Link 89 | 535 | 534 | 500.0 | 10.0 | 10.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 433 | 0 | 0 |
| Link 90 | 534 | 433 | 2000.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 430 | 436 |

## Roadway Link and Node Characteristics

| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link 91 | 535 | 531 | 1500.0 | 10.0 | 10.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 522 | 0 | 0 |
| Link 92 | 530 | 531 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 35.0 | 0 | 522 | 0 |
| Link 93 | 531 | 522 | 6500.0 | 10.0 | 10.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 423 | 0 | 0 |
| Link 94 | 520 | 522 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 423 | 0 |
| Link 95 | 522 | 423 | 1500.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 421 | 425 |
| Link 96 | 509 | 419 | 500.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 416 | 421 |
| Link 97 | 505 | 415 | 500.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 416 | 412 |
| Link 98 | 500 | 412 | 1250.0 | 10.0 | 10.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 415 | 312 |
| Link 99 | 541 | 542 | 5000.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 543 | 0 | 0 |
| Link 100 | 540 | 542 | 5000.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 543 |
| Link 101 | 542 | 543 | 5250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 430 | 0 | 536 |
| Link 102 | 543 | 430 | 1500.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 50.0 | 0 | 433 | 425 |
| Link 103 | 543 | 537 | 4620.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 40.0 | 536 | 0 | 0 |
| Link 103a | 537 | 543 | 4620.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 40.0 | 430 | 0 | 0 |
| Link 104 | 536 | 537 | 2380.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 40.0 | 543 | 0 | 0 |
| Link 104a | 537 | 536 | 2380.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 40.0 | 525 | 425 | 0 |
| Link 105 | 536 | 425 | 1500.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 50.0 | 0 | 430 | 423 |
| Link 106 | 536 | 525 | 2500.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 0 | 423 | 0 |
| Link 107 | 525 | 423 | 1250.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 5 | 4 | 50.0 | 0 | 425 | 421 |
| Link 108 | 510 | 512 | 1250.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 515 | 0 | 0 |
| Link 109 | 512 | 515 | 2750.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 518 | 0 | 0 |
| Link 110 | 514 | 515 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 518 | 0 |
| Link 111 | 515 | 518 | 6250.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 536 | 0 | 0 |
| Link 112 | 516 | 518 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 0 | 536 |
| Link 113 | 518 | 536 | 6250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 425 | 0 | 525 |
| Link 114 | 507 | 421 | 6250.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 40.0 | 0 | 423 | 419 |
| Link 115 | 220 | 225 | 2640.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 230 | 0 | 815 |
| Link 116 | 225 | 220 | 2640.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 814 | 0 | 0 |
| Link 117 | 225 | 230 | 2100.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 235 | 0 | 0 |
| Link 118 | 230 | 225 | 2100.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 220 | 815 | 0 |
| Link 119 | 230 | 235 | 2640.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 240 | 0 | 0 |
| Link 120 | 235 | 230 | 2640.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 225 | 0 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link 121 | 235 | 240 | 4225.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 245 | 0 | 308 |

| Roadway Link and Node Characteristics | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
| Link 122 | 240 | 235 | 4225.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 230 | 0 | 0 |
| Link 123 | 240 | 245 | 3700.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 250 | 0 | 0 |
| Link 124 | 245 | 240 | 3700.0 | 12.0 | 12.0 | 6.0 | 3 | 1 | 4 | 4 | 55.0 | 235 | 308 | 0 |
| Link 125 | 245 | 250 | 2100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 255 | 0 | 0 |
| Link 126 | 250 | 245 | 2100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 240 | 0 | 0 |
| Link 127 | 250 | 255 | 5280.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 260 | 0 | 0 |
| Link 128 | 255 | 250 | 5280.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 245 | 0 | 0 |
| Link 129 | 255 | 260 | 5280.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 265 | 0 | 0 |
| Link 130 | 260 | 255 | 5280.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 250 | 0 | 0 |
| Link 131 | 260 | 265 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 270 | 0 | 317 |
| Link 132 | 265 | 260 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 255 | 0 | 0 |
| Link 133 | 265 | 270 | 3200.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 275 | 0 | 0 |
| Link 134 | 270 | 265 | 3200.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 260 | 317 | 0 |
| Link 135 | 270 | 275 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 280 | 0 | 0 |
| Link 136 | 275 | 270 | 5800.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 265 | 0 | 0 |
| Link 137 | 275 | 280 | 6900.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 285 | 351 | 0 |
| Link 138 | 280 | 275 | 6900.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 270 | 0 | 0 |
| Link 139 | 280 | 285 | 11100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 818 | 0 | 0 |
| Link 140 | 285 | 280 | 11100.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 4 | 4 | 55.0 | 275 | 351 | 0 |
| Link 141 | 301 | 303 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 220 | 0 | 0 |
| Link 142 | 303 | 220 | 4750.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 814 |
| Link 143 | 305 | 230 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 225 |
| Link 144 | 306 | 235 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 230 |
| Link 145 | 309 | 308 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 816 | 0 |
| Link 146 | 240 | 308 | 3200.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 40.0 | 816 | 0 | 0 |
| Link 147 | 308 | 816 | 12000.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 40.0 | 0 | 0 | 0 |
| Link 148 | 225 | 815 | 14000.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 0 | 0 | 0 |
| Link 149 | 220 | 814 | 8000.0 | 11.0 | 11.0 | 6.0 | 2 | 1 | 4 | 3 | 40.0 | 0 | 0 | 0 |
| Link 150 | 313 | 312 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 310 | 0 |
| Link 151 | 312 | 310 | 6300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 45.0 | 240 | 0 | 0 |
| Link 152 | 311 | 310 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 240 | 0 |
| Link 153 | 310 | 240 | 5800.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 45.0 | 308 | 245 | 0 |

## Roadway Link and Node Characteristics

| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link 154 | 315 | 250 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 245 | 0 |
| Link 155 | 324 | 323 | 6000.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 250 | 325 | 0 |
| Link 156 | 323 | 250 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 255 | 0 |
| Link 157 | 323 | 325 | 3000.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 40.0 | 330 | 0 | 255 |
| Link 158 | 328 | 327 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 326 |
| Link 159 | 329 | 327 | 3000.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 326 | 0 | 0 |
| Link 160 | 327 | 326 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 325 | 0 | 0 |
| Link 161 | 326 | 325 | 8000.0 | 11.0 | 11.0 | 6.0 | 1 | 2 | 4 | 4 | 30.0 | 255 | 330 | 0 |
| Link 162 | 325 | 255 | 300.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 260 | 0 |
| Link 163 | 325 | 330 | 4000.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 30.0 | 335 | 0 | 0 |
| Link 164 | 330 | 325 | 4000.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 255 | 0 |
| Link 165 | 331 | 330 | 6000.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 335 | 325 |
| Link 166 | 330 | 335 | 5300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 30.0 | 340 | 0 | 265 |
| Link 167 | 335 | 330 | 5300.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 4 | 4 | 30.0 | 325 | 0 | 0 |
| Link 168 | 337 | 336 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 335 |
| Link 169 | 339 | 338 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 336 | 0 | 0 |
| Link 170 | 338 | 336 | 3150.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 335 | 0 | 0 |
| Link 171 | 336 | 335 | 11600.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 265 | 340 | 330 |
| Link 172 | 335 | 265 | 1580.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 317 | 270 | 0 |
| Link 173 | 335 | 340 | 3150.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 270 |
| Link 174 | 340 | 335 | 3150.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 330 | 265 | 0 |
| Link 175 | 343 | 341 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 340 | 0 | 0 |
| Link 176 | 341 | 340 | 12150.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 270 | 0 | 335 |
| Link 177 | 340 | 270 | 500.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 275 | 0 |
| Link 178 | 353 | 352 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 275 |
| Link 179 | 354 | 352 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 275 | 0 | 0 |
| Link 180 | 352 | 275 | 8700.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 280 | 0 |
| Link 181 | 360 | 280 | 5280.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 285 | 0 |
| Link 182 | 367 | 365 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 285 | 0 | 0 |
| Link 183 | 365 | 285 | 13700.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 818 | 0 |
| Link 184 | 285 | 818 | 5280.0 | 12.0 | 12.0 | 6.0 | 2 | 1 | 5 | 4 | 55.0 | 0 | 0 | 0 |
| Link 185 | 332 | 260 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 255 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link 186 | 316 | 317 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 0 | 817 |

| Roadway Link and Node Characteristics | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | A Node | B Node | Link Length | Approach Width | Lane Width | Lateral Clearance | Number of Lanes | Pri | Road way type | Area type | Free Flow Speed | Straight Move | Right Move | Left Move |
| Link 187 | 265 | 317 | 16350.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 45.0 | 817 | 0 | 0 |
| Link 188 | 317 | 817 | 1580.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 45.0 | 0 | 0 | 0 |
| Link 189 | 280 | 351 | 2100.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 830 | 0 | 0 |
| Link 190 | 351 | 830 | 1250.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 30.0 | 0 | 0 | 0 |
| Link 191 | 134 | 135 | 1250.0 | 11.0 | 11.0 | 2.0 | 1 | 1 | 4 | 4 | 30.0 | 137 | 0 | 0 |
| Link 192 | 135 | 137 | 3750.0 | 11.0 | 11.0 | 2.0 | 1 | 1 | 4 | 4 | 30.0 | 136 | 0 | 0 |
| Link 193 | 137 | 136 | 4250.0 | 11.0 | 11.0 | 2.0 | 1 | 1 | 4 | 4 | 30.0 | 800 | 0 | 0 |
| Link 194 | 138 | 136 | 5280.0 | 11.0 | 11.0 | 3.0 | 1 | 2 | 4 | 4 | 30.0 | 0 | 800 | 0 |
| Link 195 | 136 | 800 | 5280.0 | 11.0 | 11.0 | 6.0 | 1 | 1 | 5 | 4 | 50.0 | 0 | 0 | 0 |
| Link 196 | 131 | 132 | 2500.0 | 11.0 | 11.0 | 3.0 | 1 | 1 | 4 | 4 | 40.0 | 801 | 0 | 0 |
| Link 197 | 139 | 133 | 2500.0 | 11.0 | 11.0 | 2.0 | 1 | 1 | 4 | 4 | 30.0 | 132 | 0 | 0 |
| Link 198 | 133 | 132 | 2500 | 11 | 11 | 2 | 1 | 2 | 4 | 4 | 30 | 0 | 0 | 801 |
| Link 199 | 132 | 801 | 5280 | 11 | 11 | 4 | 1 | 1 | 4 | 4 | 40 | 0 | 0 | 0 |